INTERIM COMPREHENSIVE BASIN OPERATING PLAN

for the

Yakima Project
Washington

U.S. DEPARTMENT of the INTERIOR
U.S. BUREAU OF RECLAMATION

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ABBREVIATIONS AND ACRONYMS

BIA	- Bureau of Indian Affairs
BP	- Before Present
BPA	- Bonneville Power Association
CFR	- Code of Federal Regulations
cfs	- Cubic Feet per Second
Corps	- U.S. Army Corps of Engineers
CWA	- Clean Water Act
DECREE	- 1945 Consent Decree
EIS	- Environmental Impact Statement
EPA	- Environmental Protection Agency
EQIP	- Environmental Quality Incentives Program
ESA	- Endangered Species Act
FCRPS	- Federal Columbia River Power System
FERC	- Federal Energy Regulatory Commission
FWCA	- Fish & Wildlife Coordination Act
FWS	- U.S. Fish & Wildlife Service
IOP	- Interim Comprehensive Basin Operating Plan
KID	- Kennewick Irrigation District
KRD	- Kittitas Reclamation District
LWD	- Large Woody Debris
MAF	- Million-acre Feet
NEPA	- National Environmental Policy Act
NMFS	- National Marine Fisheries Service
NPS	- Non-point Source
PEIS	- Programmatic Environmental Impact Statement
NWPPC	- Northwest Power Planning Council
PP&L	- Pacific Power and Light
RECLAMATION	- U.S. Bureau of Reclamation
RCW	- Revised Code of Washington
RID	- Roza Irrigation District
RM	- River Mile
SECRETARY	- Secretary of the Interior
SHPO	- State Historic Preservation Office
SOAC	- System Operations Advisory Committee
SVID	- Sunnyside Valley Irrigation District
TAG	- Enhancement Technical Activities Group
TITLE XII	- Title XII of the Act of October 31, 1994, Public Law 103-434, Section 1210
TMDL	- Total Maximum Daily Load
TWSA	- Total Water Supply Available
USGS	- U.S. Geological Survey
WAC	- Washington Administrative Code
WDFW	- Washington Department of Fish & Wildlife

WDOE	- Washington State Department of Ecology
WIP	- Wapato Irrigation Project
YBJB	- Yakima Basin Joint Board
YN	- Yakama Nation
YRBWEP	- Yakima River Basin Water Enhancement Project
YTID	- Yakima-Tieton Irrigation District

CONTENTS

EXECUTIVE SUMMARY

This Interim Comprehensive Basin Operating Plan (IOP) provides a framework within which the Field Office Manager for the Bureau of Reclamation (Reclamation) will operate the Yakima Project to meet the multiple use objectives of the project and the directives of Title XII of the October 31, 1994, Public Law 103-434, Section 1210 (Title XII). Title XII legislation is known as the Yakima River Basin Water Enhancement Project (YRBWEP). The stated goals of Title XII are to: 1) protect, mitigate, and enhance fish and wildlife through various means; and 2) to improve the reliability of water supply for irrigation. In addition to the IOP, Title XII includes directives to develop water conservation, water acquisition, habitat enhancement, improved fish passage and screening, and other means to enhance water supplies in the basin.

The IOP was developed by a group of representatives of the Yakama Nation, basin irrigation districts, Bonneville Power Administration, National Marine Fisheries Service, the State of Washington Department of Ecology (WDOE), Reclamation, and American Rivers on behalf of the environmental community. The group met monthly over a period of 2 years to develop a "comprehensive" report with sufficient background to allow for a thorough analysis.

The IOP presents a historical context of the project and its current operation, describes its legal and institutional aspects, articulates the impacts of project operations on the natural resources of the basin, analyzes various operational alternatives, and recommends strategies and operational changes that will address the goals of Title XII. The IOP is prepared for planning purposes only and is not intended by its drafters to be evidence nor admissions as to any party's rights including water rights in Ecology v. Acquavella or elsewhere. The savings clause in Section 1212 of Title XII applies fully to this document. The description of the project and some current operations does not address all applicable requirements of law nor does it describe the Yakama Nation's Treaty water right for fish.

As indicated, the IOP is an "interim" plan. It will be amended periodically to address new legal decisions; various study results and other new information; water supply and water needs; and the ongoing activities of the System Operations Advisory Committee (SOAC).

HISTORY & OVERVIEW

The Yakima River basin drains about 6,150 square miles, or 4 million acres. Elevations range from 8184 feet in the Cascades to 340 feet at the mouth of the River. The Yakima River flows for about 215 miles. Its major tributaries include the Naches, Kachess, Cle Elum, and Teanaway Rivers in the upper basin (above Yakima), and Toppenish and Satus Creeks in the lower basin. Timber, cattle, fish and wildlife habitat, and recreation are the major uses of the northern and western areas of the basin, while irrigated agriculture is the main economy of the lower basin. Climate ranges from alpine to arid, with precipitation varying from 140 inches annually in the Cascades to less than 10 inches in the Kennewick area.

The basin has been inhabited by the Yakama people since time immemorial. They lived sustainabley on fish, game, and native plants. The first non-Indian settlement of the basin began in about 1847. By the 1860s, cattle and sheep ranchers had settled in the area, followed by wheat and oat farming, irrigated by private ditches. By 1902, 121,000 acres were irrigated in the basin, but lacking storage facilities, water demand rapidly exceeded unregulated summer flow. In 1905, the Yakima Project was authorized. Between 1910 and 1933, 6 Federal reservoirs were constructed, with a total storage capacity of 1,070,000 acre-feet.

During years of low runoff, disputes began over water use in the basin. In 1945, the District Court of Eastern Washington issued the 1945 Consent Decree (Decree), which established the rules under which Reclamation should operate the project. The Decree determined the quantities of water to which all project users are entitled, and defines a prioritization for water-short years. Users were divided into two classes, non-proratable (those with the most senior rights) and proratable. Non-proratable users would be served first from the total water supply available (TWSA) and proratable users would share equally in the balance of available supply.

Since 1945, the Courts have issued numerous other decisions relative to the Yakima Basin Adjudication. These decisions are described in section 4 of this plan. They have involved issues such as protection of fish resources ("Quackenbush"), the rights of the Yakama Nation, return flows, groundwater involvement, abandonment of claims, and flood water use.

There are nine hydroelectric power plants and nine hydraulic pump plants in the basin. These are operated by Reclamation, irrigation districts, a private individual, and by PacificCorp (Wapatox). Only the Wapatox facilities have a right senior to the project. All others operate on flows subordinate to irrigation and storage.

The Yakima basin enjoys a diverse economic base, with over 50 percent of jobs being in the trade and service sectors. Agriculture represents 8.4 percent of the region's total sales revenue. Yakima County is among the leading agricultural counties in the nation, having ranked 1st in the production of many crops and 5th in total agricultural production.

Hydrology - The total estimated unregulated runoff at the mouth of the Yakima River for the period 1961 through 1990, is 3.97 million acre-feet per year. The runoff pattern was significantly altered by the project storage, moderating flood events, and sustaining higher flows during the irrigation season in some reaches. The groundwater regime has also been modified by project operations. Basin-wide activities including channel modifications and reduced flood frequency and magnitude have changed the timing and quality of flows to the lower basin.

Water Quality - Generally, water quality in the upper basin is high, but degrades downstream. Many reaches of the rivers and streams in the basin are included on the Federal Clean Water Act 303(d) list. The water quality problems are turbidity, pesticides, low dissolved oxygen, elevated temperatures, metals, fecal coliform, low flows, and pH. WDOE is developing Total Maximum Daily Loads (TMDL) for the reaches and water bodies on the 303(d) list.

Natural Resources - The basin contains a wide variety of wildlife and habitats. Table 2-6. outlines the wildlife by habitat type and species of special interest. Habitat areas include coniferous forest, scrub-shrub, shrub-steppe, riparian, wetlands, and agricultural zones. Table 2-7. shows fish species by species type and occurrence by reach throughout the basin.

CURRENT OPERATIONS

Section 5 of this plan describes the current project operational considerations, constraints, and thought processes. Reclamation operates the project to meet the specific purposes of irrigation water supply, flood control, and instream flows for fish. Anadromous fish management is part of operations during “flip-flop.” Recreation and hydroelectric power production are incidental to other project purposes.

The project consists of storage in six reservoirs (over 1 million-acre-feet) and six irrigation delivery “divisions.” The project serves approximately 465,000 acres. Reclamation physically operates the storage division of the project, but considers the entire basin outflow in the calculation of TWSA for all demands. All demands cannot be met in water-short years. Project operations makes use of a monthly forecasting process to provide advance notice of water availability and makes daily adjustments based upon weather conditions, water demand, travel time, unregulated inflows, and return flows to maximize management of the available supply. Junior districts share available short supplies in drought years.

The “operational year” consists of a 15 month period, beginning in August and ending in October of the following year. Tables 5.2. through 5.5. in section 5 demonstrate the complexity of considerations and constraints during each operational season.

Beginning in January, Reclamation develops monthly runoff forecasts for each of the five major reservoirs. The forecasts are used for flood control operations as well as in the calculations of TWSA, and are developed for anticipated precipitation levels of 50, 100, and 150 percent of normal. The forecast is determined using a multiple regression analysis formula which contains coefficients developed from basin data collected annually since 1940. Each user has an assigned “water bucket,” which is their proportion of the available TWSA.

Target instream flows were established through Title XII at the Sunnyside and Prosser Diversion Dams. These flows range between 300 and 600 cubic feet per second (cfs), depending upon the latest estimates of TWSA. Title XII states that, as conservation and other means reduce diversion demands, the target flows will be increased over time, at a rate of 50 cfs per each 27,000 acre-feet of reduced diversions, provided that such increases shall not further diminish the amount of water that otherwise would have been delivered by an entity to its water users in years of water proration Acquired consumptive use water increases target flows in direct proportion, i.e., 1 cfs acquired = 1 cs target flow.

Project operations seek to lessen impacts on fish resources. Water needs for spawning, incubation, rearing, and passage are all considerations in operations. The Yakama Nation's Treaty water rights for fish has the senior priority date in the basin and must be met before other water rights. The "Quackenbush" decision in 1980 directed Reclamation to safeguard salmon redds in the Yakima River below the mouth of the Cle Elum River to the confluence of the Teanaway and Yakima Rivers. The "flip-flop" operation is one example of operational considerations for fish, whereby flows are reduced during the September-October spawning period to encourage salmon to spawn in the reduced channel. This allows the resulting redds to be protected during the incubation stage with lower flows, and maximizes the storage opportunity.

In consultation with SOAC, operations also consider the needs for spawning, rearing, incubation, and rearing flows. Passage flows, ramping rates, flushing/pulse flows, and power subordination are also strong considerations with the mandate of maintaining fish life in the basin.

Fish passage and protection facilities have been constructed and maintained throughout the project. Through YRBWEP funding and funding provided under the Northwest Power Planning Act, old ladders have been upgraded, new ladders installed, and extensive fish screening devices have been installed or upgraded.

Section 5 of this plan includes detailed descriptions of project storage and delivery facilities, and annual maintenance and inspection criteria.

PROJECT EFFECTS

Basin-wide activities, including project operations, continue to impact the basin's natural resources. To the extent possible, the reader should attempt to distinguish between project effects, and those caused by other basin activities. Section 6 of the plan outlines existing impacts on the resources of water quantity and quality, fish, wildlife riparian zones, and floodplain function. Potentially negative impacts on irrigation, flood control, and hydropower production are also described.

Water Quality - Low water levels in some reaches due, in part, to agricultural diversions, and agricultural return flows contribute to water quality degradation in the basin. Water temperatures, turbidity, dissolved oxygen levels, and nutrient loading are all negative water quality impacts. The project has altered the timing, volumes, and magnitude of both the natural hydrograph and naturally occurring sediment and bedload movement. Drain maintenance has also contributed to increased sediment and pollution.

WDOE is conducting TMDL studies, and the Roza and Sunnyside Divisions have recently implemented highly successful pollution reduction programs.

Water Quantity - Operations' effects on water quantity vary by reach and timing throughout the basin. Section 6.1.2 examines the differences between regulated and unregulated (natural) flows at a number of key locations. Summary hydrographs are provided that graphically demonstrate these differences. The Yakima Project is typical of systems that are regulated for irrigation and flood control. Natural winter flows are captured for storage, reducing the magnitude and frequency of ecologically significant winter discharges.

Operational fluctuations, along with other human activities, have contributed to changes in the pattern of spatial and temporal habitat dynamics. These alterations can create new conditions to which the native species may or may not be able to adapt.

Fisheries - Numerous factors, including both in- and out-of-basin factors, have effected the fishery resources of the basin. Steelhead and bull trout are currently listed as threatened under the Endangered Species Act, and other native species such as chinook, coho, and sockeye salmon are either significantly reduced or have been extirpated from the basin. Lack of fish passage at all Yakima Project storage dams has prevented anadromous fish habitat and caused the extinction of sockeye salmon.

New information is continually being collected. A Biological Opinion on the project is anticipated soon, as are completions of the Ecosystem Diagnostic and Treatment (EDT) model, and the Subbasin Summary by the Northwest Power Planning Council. The synthesis study by Dr. Jack Stanford has been completed.

Section 6.2 assesses the effects of operations on the species of concern in eight separate reaches of the system. Within each reach, the factors of storage dams; diversion dams; flow regulation on habitat, survival and productivity; and water quality are examined. Each of these factors has had some degree of negative impact to fish resources.

Wildlife - Irrigated agriculture, including Yakima Project, as well as other types of human activities, have affected wildlife. The conversion of habitat has reduced native habitats by about a half-million acres, interrupted connectivity of habitats and created barriers to wildlife movement. The hydrologic alterations have resulted in a loss of wetlands, reduced channel-forming flows, and sediment delivery to the floodplain, and have altered the flow regime. Canals and dams have blocked migration corridors and fish passage, and blocked recruitment of large woody debris from the upper basin. The loss of large runs of fish have altered food chain and energy flows in the basin, contributing to the decline of the top level carnivores.

Riparian Vegetation - Naturally occurring riparian ecosystems normally extend one active channel width on each side of the free-flowing water body. In the Yakima basin, much of this area has been destroyed by railroads, highways, flood control levees, agricultural development, grazing, or human habitation. Essentially no true riparian areas exist around the project reservoirs due to the fluctuations of the water levels throughout the year. Along the main stem, flood control operations have allowed residential development in the floodplain. Pesticides and high nutrient levels from return flows in the lower river can be harmful to native riparian plants.

Floodplain Function - Properly functioning alluvial floodplains provide abundant and diverse habitats for cold water fish. They require a natural (normative) hydrograph that interacts with accessible floodplains.

In the Yakima basin, the reduction of flood peaks by capture in reservoirs reduces the frequency, duration, magnitude, and spatial extent of floodplain inundation. This decreases the size of the regulatory floodplain and allows development to encroach on the floodplain. Reductions in floodplain extent and overbank flows, while increasing irrigation induced recharge, has altered the quantity, quality, locations, and timing of groundwater discharge to the river.

Irrigation - The project is operated for many purposes, including irrigation, fish and wildlife, and flood control. Each of these other competing demands has compromised, to some extent, the ability of the project to provide a maximum irrigation benefit.

Hydropower and Flood Damage Reduction - There were no noted negative impacts to these functions caused by the project. The pertinent facts about them are described in sections 6.7 and 6.8, respectively.

RESOURCE OBJECTIVES

Section 7 of this plan identifies goals for the reduction of project impacts identified in section 6. In addition, interim measures of success toward the attainment of those goals are described.

OPERATIONAL ALTERNATIVES

The group summarized the "Project Effects" and the "Resource Objectives" developed in sections 6 and 7, respectively, into worksheets. The "Alternatives" shown in the tables in section 8 were then developed through a series of "brainstorming" sessions, designed to identify all available ideas from the individual group members without regard to legal, institutional or financial constraints, or any other issues affecting the practicality of the alternatives. No attempt was made to prioritize, edit, or censor this list.

RECOMMENDATIONS

The final recommendations for this plan were developed from the list of alternatives in section 8. The worksheets in section 9 show the project effect, the list of alternatives that were developed in the group's brainstorming sessions, and the 94 recommendations that the IOP committee chose to recommend for further action or follow-up.

Many of the resulting recommendations are repetitive in an effort to maintain the integrity and thorough nature of the group's efforts and to demonstrate that many of the recommendations address multiple project effects. For example, recommendations numbered 2 and 50 are essentially the same, but appear under the 2 project effect categories which the group felt would be improved by the recommendation.

Unlike the list of alternatives in section 8, the general view of the group was that each of the listed recommendations may have merit within the known legal and institutional constraints. The group did not, however, attempt to determine the financial implications of any particular recommendation or whether sufficient scientific data is currently available to allow the precise recommendation to be implemented without further study, modeling, or data collection.

The scope of the recommendations is recognized to be quite large. Due to financial constraints combined with legal and contractual issues, it is likely that the Yakima Field Office will be able, practically, to implement only some of the IOP recommendations. It is anticipated that the selected recommendations will be implemented over a period of many years, depending on funding. Some recommendations could require environmental impact statements prior to implementation. In addition, those recommendations that serve to directly improve Reclamation's ability to meet the Endangered Species Act responsibilities or Yakama Nation trust responsibilities would likely be given priority for implementation.

The list of recommendations reflects the general agreement of all members of the group who participated in its development, though not necessarily the complete consensus of every group member. As was previously stated, this plan is indeed "interim." It is anticipated that the Yakima Field Office staff or other basin interests will determine when and if the plan (recommendations) needs to be updated to reflect new knowledge gained from any number of sources. Experience in implementation of the recommendations or new scientific findings relative to the needs of the fish in the basin are two examples of developments which would prompt the need to update the IOP.

The recommendations involving large dollar modifications, such as the construction of large structures or fish ladders at major dams, will require congressional authorization and appropriations. Typically those modifications would require a full feasibility level study prior to congressional action. Constituents will need to initiate the needed congressional actions on a collaborative basis prior to any Reclamation implementation. As a Federal agency, Reclamation by law is not allowed to participate in any lobbying activity for such projects.

1.0 INTRODUCTION

1.1 AUTHORITY FOR INTERIM COMPREHENSIVE BASIN OPERATING PLAN

Title XII of the Act of October 31, 1994, Public Law 103-434, Section 1210 (Title XII), directed the Secretary of the Interior (Secretary), in consultation with the State of Washington, Yakama Nation, Yakima River basin irrigation districts, Bonneville Power Administration (BPA), and other entities as determined by the Secretary, to develop an Interim Comprehensive Basin Operating Plan (IOP).

As explained in the House Report accompanying Title XII, the Act of December 17, 1979 (Public Law 96-162), which authorized the Enhancement Project study, provided for the preparation of a comprehensive plan to assist the Field Office Manager in the operation of the Yakima Project. This comprehensive plan was to include a general operating framework for existing facilities as well as those that may be constructed as a result of Yakima River Basin Water Enhancement Project (YRBWEP) activities. Because a comprehensive plan was never written, Title XII directed the Secretary to develop an "Interim Comprehensive Plan."

The statute further directs the Secretary to prepare a draft IOP within 18 months after the completion of the Yakima River Basin Conservation Plan. Thereafter, the draft is to be published and distributed for a 90-day review period. The Secretary is to complete and publish the IOP within 90 days after the close of the public review period. The Secretary will update the IOP as needed to respond to decisions from water adjudications relating to the Yakima River basin.

1.2 PURPOSE FOR INTERIM COMPREHENSIVE BASIN OPERATING PLAN

The purpose of the IOP is to provide a framework within which the Field Office Manager operates the Yakima Project as well as a detailed explanation of current operations. It also attempts to analyze the impacts of current operations on various natural resources in the Yakima basin and to propose changes for future operations in light of those impacts. It also places current operations in a historical context.

1.3 OBJECTIVES FOR THE INTERIM COMPREHENSIVE BASIN OPERATING PLAN

The IOP is intended as a reference document to assist the Field Office Manager in operating the Yakima Project to meet the multiple use objectives of the project and the directives of Title XII and other Federal legislation, and to assist others in understanding the "how and why" of operations. The plan is a living document which will be updated periodically and include plans and recommendations for future operations. It is also anticipated the plan will be used by the Field Office Manager to obtain future funding to carry out the IOP recommendations.

Congress directed the Secretary to include measures implemented under the YRBWEP in the operating plan, including, but not limited to, the operating capability and constraints of the system; information on water supply calculations and water needs; system operations and stream flow objectives; and the activities of the System Operations Advisory Committee (SOAC).

Thus, it is clear that the plan must meet the needs of fish and wildlife, water quality, wetlands, and other habitat and natural resources of the Yakima basin as well as irrigation and other contractual obligations of the U.S. Bureau of Reclamation to deliver water, including the Treaty Rights of the Yakama Nation. The overarching goals of Title XII are: (1) to protect, mitigate, and enhance fish and wildlife through improved water management, instream flows, and water quality and the protection, creation and enhancement of wetlands, and by other appropriate means of habitat improvement; and (2) to improve the reliability of water supply for irrigation. These are also the overarching objectives of the IOP.

Within those overarching goals, the IOP has as its objectives:

- Making current operations of the Yakima Project as understandable as possible to the various stakeholders in the Yakima basin and beyond;

- consolidate the legal authorities, policies and practices that govern current operations of the Yakima Project;

- articulating the impacts of project operations on various resources in the Yakima basin;

- analyzing various alternative operation scenarios; and

- recommending strategies and operational changes that would serve the overarching goals better than current operations.

1.4 PLAN ADMINISTRATION

The plan will be administered and implemented by the Field Office Manager with the advice from the YRBWEP manager. As anticipated by Congress, the plan will be amended from time-to-time to incorporate water conserved under YRBWEP, decisions from the Yakima Basin Water Adjudication, and for other matters, such as new information and changes in the operating capability and constraints of the system; water supply and water needs; stream flow objectives and the ongoing activities of SOAC as well as the Endangered Species Act activities and other requirements of related Federal law. This document is not intended to represent any party's views, now or in the future, as the interpretation of applicable law or Treaty.

2.0 HISTORICAL & CURRENT OVERVIEW OF THE YAKIMA BASIN

2.1 GEOGRAPHY

The Yakima River basin is located in south central Washington bounded on the west by the Cascade Range, on the north by the Wenatchee Mountains, on the east by the Rattlesnake Hills, and on the south by the Horse Heaven Hills. About half the basin lies in and occupies most of Yakima County. The upper part of the basin lies in and occupies most of Kittitas County, the southeastern portion occupies about half of Benton County, and the southern part of the basin extends slightly into Klickitat County. The entire basin lies within areas either ceded to the United States by the Yakama Nation (YN) or areas reserved for their use. The Yakama Indian Reservation occupies about 40 percent of Yakima County and about 15 percent of the entire basin. In total, the basin drains about 6,150 square miles, or 4 million acres.

The Yakima River flows southeasterly for about 215 miles from its headwaters in the Cascades east of Seattle, Washington to its confluence with the Columbia River near Richland, Washington. Altitudes in the basin range from 8184 feet above mean sea level in the Cascades to 340 feet at the confluence. The Naches River is the largest tributary of the Yakima, entering the river at the city of Yakima. Major tributaries of the upper Yakima River (above the Naches confluence) include the Kachess, Cle Elum, and Teanaway Rivers. Major tributaries of the Naches River are the Bumping River, Rattlesnake Creek, and the Tieton River. Toppenish and Satus Creeks, both originating on the Yakama Indian Reservation, are the major tributaries of the lower Yakima River (below the Naches confluence). Numerous smaller tributaries contribute seasonal flows to the rivers in the basin. A more detailed description of Yakima River basin hydrology will be provided in a subsequent section of this document.

Timber harvest, cattle grazing, fish and wildlife habitat, and recreation are the major uses of about 2,200 square miles mainly in the forested northern and western areas of the basin. About one-forth of this area is designated as wilderness. Cattle grazing, wildlife, and military training are the main uses of about 2,900 square miles of rangeland. Irrigated agriculture, the main economy of the basin, occupies about 1,000 square miles. Agriculture is the single major use in the eastern and southern portions of the basin.

2.2 CLIMATE

The climate of the Yakima River basin ranges from alpine along the crest of the Cascade Range to arid in the lower valleys. The mountainous western and northern parts of the basin receive precipitation principally as snow during the period of November to March and as rain during the remainder of the year. Much of the snowfall in the mountains is retained through the winter; some is retained for longer periods in the perennial snow fields and glaciers at higher altitudes

(Pearson, 1985).[1] Chinook winds (warm air descending the eastern slopes of the Cascade Range) and "rain-on-snow" events occasionally cause rapid melting of the snowpack. At times, these events result in severe erosion of soils and flooding along lowland stream channels.

Precipitation varies considerably across the basin throughout the year. Mean-annual precipitation ranges from about 140 inches in the higher mountains of the northwestern part of the basin to less than 10 inches throughout the lower Yakima Valley. The amount of precipitation that occurs during the October to March period, in both the arid and alpine parts of the basin, ranges from 61 to 81 percent of the annual precipitation. The variation in annual precipitation can be large. The geographic variability in mean-annual precipitation for the Yakima River basin, 1951-1980, is shown in figure 2-1.

Air temperatures in the basin generally are inversely related to altitude. Minimum and maximum mean-monthly temperatures occur in January and in July, respectively. Mean-monthly temperatures ranged from 24 to 63 °F at Lake Kachess (about 2300 feet in altitude) and 31 to 77 at Kennewick (about 350 feet in altitude; McKenzie and Rinella, 1987). At Lake Kachess, the extreme daily minimum temperature was -33 °F on January 31, 1950, and the maximum was 104 °F on July 28, 1939, for the period of record, 1931-1977 (Western Regional Climate Center). At Kennewick, the extreme daily minimum temperature was -19 °F on January 29, 1950, and the maximum was 110 °F on August 17, 1977, for the period of record, 1948-1999 (Western Regional Climate Center).

[1] For full documentation, see Rinella et al., 1991.

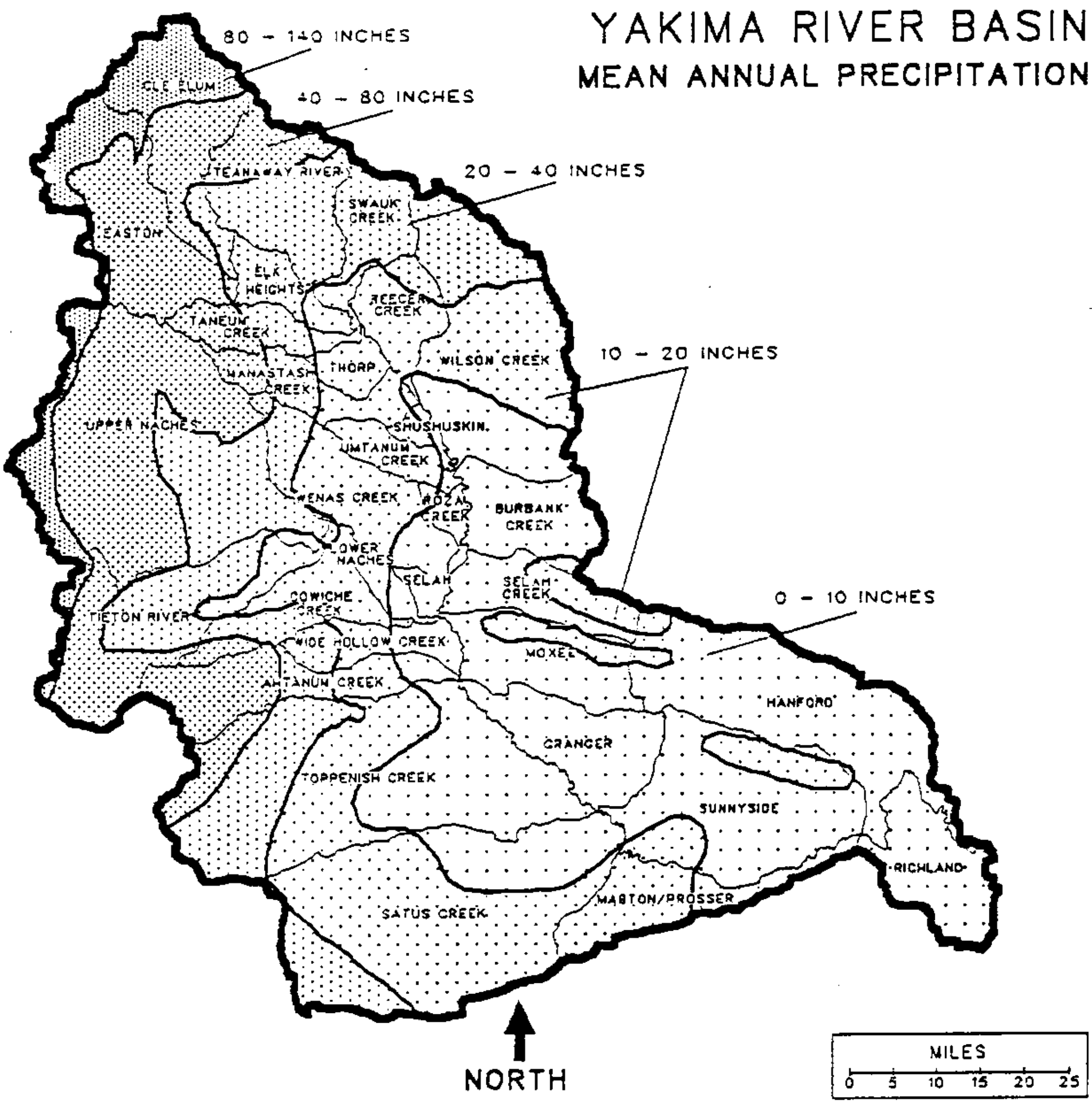

Figure 2-1.–Mean-Annual Precipitation in the Yakima River basin (from Rinella et al., 1991)

2.3 GEOLOGY

The geologic history of the Yakima basin produced features that regulate the hydrologic cycle and aquatic ecosystem. Contemporary river ecology emphasizes the importance of alluvial (river deposited) floodplain reaches. The basin contains many extensive floodplain reaches separated by relatively short canyon reaches which effectively subdivides it into several alluvial subbasins. Within each, surface water downwells and recharges the shallow groundwater zone at the upstream end; most of this water upwells to the surface again near the downstream end of the reach. In other western river basins alluvial floodplain reaches have been shown to be centers of biological productivity and ecological diversity (Stanford, 1996, 1997). Kinnison and Sceva, 1963, show the major gaining and losing stream reaches in the Yakima River basin.

Geologic structures such as folds and faults alter the groundwater flow pattern in the Yakima River basin. Folded ridges and troughs dominate the topography in the lower basin. The uplift of the ridges occurred slowly enough to allow the Yakima River to maintain its course across the structures, as seen at Union Gap where the river flows through Ahtanum Ridge. The bedrock folds determine flow patterns and form hydrologic boundaries.

Glacial outwash, reworked glacial deposits, and recently deposited river alluvium are important aquifers, primarily because of their storage capacities and high permeabilities. The aquifers are recharged during periods of high runoff and precipitation. They discharge to streams during late season dry periods and help maintain stream base flows.

The Yakima River basin consists of three principal aquifer systems: the unconfined alluvial aquifer system; the Ellensburg Formation/postbasalt aquifer system; and the Yakima Basalt aquifer system. Structural bedrock controls (anticlines and synclines) effectively isolate each groundwater basin and prevent most underflow (from one subbasin to another) through the alluvial and Ellensburg Formation/postbasalt aquifers and restrict underflow through the basalts.

2.4 BASIN HISTORY & DEVELOPMENT

Prior to Euro-American development, the economy of the basin was rooted in the abundant fish, wildlife, and vegetation resources. The complex water issues facing the Yakima River basin today are rooted in the history of basin development, which began in earnest in the late 1800s. The economic potential of the Yakima basin's rich and fertile land rapidly drew settlers to this promising valley. The Yakima River and its tributaries were, as they are today, the lifeblood of the region, fueling a rapidly expanding farming economy. Before long, the Yakima basin area had become one of the most agriculturally productive regions of the State. Coupled with this burgeoning agricultural economy, however, came the pressing issues surrounding water; who owned how much, and how was this resource to be effectively and fairly managed?

Within 20 years of full-scale irrigation development, farmers realized that they could not rely on natural runoff alone to meet year-round water demands. Certainly, no additional acreage could be developed unless water storage and supply management issues were resolved.

Throughout the history of the basin, fundamental questions of water rights, water supply management and storage have been addressed through State and Federal legislation and court decisions. Some court cases, such as the basin adjudication, have not yet been resolved.

Water quality issues were addressed to a limited degree in the early part of the 1900s, but did not gain prominence in the water discussion arena until the last 30 years. Since 1970, a number of State and Federal Acts have been passed to ensure water quality, enhance fish runs and preserve riparian vegetation.

A brief overview of the basin history is essential to understanding where we stand today, and the very urgent need to develop solutions which encompass all basin water users.

2.4.1 Human Development

The following outline of prehistoric land use patterns is largely synopsized from reports of YN archaeological surveys near Cle Elum Lake and in the Yakima River Canyon (Lothson and Hemphill, 1994). Historic period use and events are synopsized from Babcock et al., 1986.

Archaeological evidence indicates that human occupation of areas east of the Cascade Mountains extends back 9,000 to 12,000 years before present (BP). This evidence is clearly documented by Clovis materials found near East Wenatchee. An isolated Clovis-like point has also been collected at Cle Elum Lake, and Cascade or Vantage Phase artifacts (ca. 8,000 to 4,500 BP) have been found at Keechelus, Kachess, and Cle Elum Lakes. However, use of montane or upland areas appears to have been infrequent during early periods, and most sites found away from the lowland river corridors appear to date no earlier than 4,000 to 2,800 BP. Information available is insufficient to determine if this apparent settlement pattern reflects reality or is because most archaeological investigations have occurred along the main stem Columbia.

Despite data limits, archaeological and ethnographic information and Tribal history are sufficient to outline prehistoric land use patterns. At the earliest periods of human occupation, the focus was on large game hunting by highly mobile groups, primarily using areas near rivers and their tributary creeks. A shift appears to have taken place during the Cascade Phase to hunting smaller “big” game (deer, mountain sheep, etc.), with an increasing reliance upon roots and fish; this shift most probably occurred in response to general environmental changes affecting resource availability. By about 3,500 BP, regional populations had adopted what has been characterized as the “Plateau Pattern,” (Lothson and Hemphill, 1994).

The first non-Indian settlement in the Yakima River basin occurred from 1847 to 1852, with establishment of Catholic missions at seven locations in the Yakima, Kittitas, and Moxee Valleys.

In 1846, Great Britain had ceded land claims south of the 49th parallel and, soon afterward, the U.S. Army began explorations for transcontinental railroad routes through the Yakima River basin. In 1854, treaty negotiations began with area tribes in order to open lands for American settlement, and the Treaty of Walla Walla was signed in 1855 (Treaty of 1855). In the Treaty of June 9, 1855, the Tribes and bands later to become the YN ceded 10.3 million acres to the United States and reserved a 1.4 million-acre homeland. In the Treaty of 1855, the Tribes of the YN retained the rights to hunt, fish, and gather native foods and medicines off the Reservation. War with the Yakama and Kittitas Indians broke out within months of signature of the Treaty, when miners began illegally crossing the Yakama Indian Reservation on their way to gold fields in north-central Washington. The U.S. Army moved into the area to subdue the Tribes, but fighting continued sporadically until 1858.

Following the 1855 Treaty, settlement of the Yakima River basin occurred rapidly. By 1860, cattle ranchers had settled along the Columbia and in the Yakima area, and sheep grazing soon followed. In the 1860s, wheat and oat farming began along the rivers, irrigated by small private irrigation ditches. The Northern Pacific Railroad completed construction through the Yakima River basin in 1885, linking the area to wider markets. This link resulted in a population boom and also converted farming from largely subsistence to commercial enterprises. The Northern Pacific also fostered expansion of irrigated agriculture; they had received large “checkerboard” land tracts from the Federal Government and launched an aggressive program to sell these lands to settlers. The Northern Pacific was initially a substantial backer of Walter N. Granger’s Sunnyside Irrigation Project and was involved in developing coal mining and timber industries in the Cle Elum vicinity.

2.4.2 Irrigation Development

By the turn of the century, numerous private irrigation systems served the Yakima River basin lands. However, over allocation of water and lack of reservoir storage resulted in insufficient water to meet demands during irrigation season.

By 1902, about 121,000 acres were irrigated in the Yakima River basin. This acreage was served by unregulated flows in the river and tributaries. Irrigation diversions exceeded the unregulated runoff during periods of low flow by the turn of the century. Before additional irrigation developments could take place, reservoirs were needed to store early season natural runoff, which peaks in May and June. This water could subsequently be released and used during the dry summer months when natural runoff drops to its lowest point and irrigation demands are high.

A petition dated January 28, 1903, from citizens of Yakima County to the Secretary of the Interior (Secretary), requested United States involvement in irrigation development. Investigations were initiated which led to the beginning of the construction of features of the Yakima Project by the U.S. Bureau of Reclamation (Reclamation). The Yakima Project was authorized in 1905, and the Sunnyside and Tieton Units were approved for construction in 1905. Early in 1906, investigation of storage sites was initiated, including Bumping Lake, McAllister Meadows (Tieton Reservoir), and Cle Elum, Kachess, and Keechelus Lakes.

Development of the Yakima Project progressed with the construction of Bumping Dam (1910), Kachess Dam (1912), Clear Creek Dam (1914), Keechelus Dam (1917), Tieton Dam (Rimrock Lake, 1925), and Cle Elum Dam (1933). These 6 Federal reservoirs have a total storage capacity of 1,070,000 acre-feet and provide the water supply necessary to help meet the irrigation and instream flow needs by storing and regulating a portion of the flow of the Yakima River and its tributaries. Other principal features of the Yakima Project include several diversion dams, two hydroelectric generating plants, and numerous canals, laterals, and pumping plants.

During years of low runoff, disputes began over the use of water from the Yakima River. In 1945, the District Court of Eastern Washington issued a decree under Civil Action No. 21 called the 1945 Consent Decree (Decree). The Decree is a legal document pertaining to water distribution and water rights in the basin. The Decree established the rules under which Reclamation should operate the Yakima Project system to meet the water needs of the irrigation districts that predated the Yakima Project, as well as the rights of divisions formed in association with the Yakima Project. The Decree determined water delivery entitlements for all major irrigation systems in the Yakima basin except for lower reaches of the Yakima River near the confluence with the Columbia River. The Decree states the quantities of water to which all project water users are entitled (maximum monthly and annual diversion limits) and defines a method of prioritization to be placed into effect during water-deficient years. The water entitlements are divided into two classes: non-proratable and proratable. Non-proratable entitlements are held by those water users with the earliest filed water rights, and these entitlements are to be served first from the total water supply available (TWSA). All other project water rights are proratable. They are of equal priority to each other, but second in line to the non-proratables. Any shortages that may occur are shared equally by the proratable water users. Section 5 contains a detailed description of current operations.

Development of the Wapato Irrigation Project (WIP), which is operated by Bureau of Indian Affairs (BIA), began just prior to the 1898 Spanish American War. The Yakama Indian Reservation encompasses an area of about 1,400,000 acres, about 800,000 acres of which are located within the Yakima River basin. About 142,000 acres of land on the Yakama Indian Reservation are irrigated through facilities of the WIP. The primary water supply is diverted from the Yakima River at the Wapato Diversion Dam. Water savings resulting from WIP irrigation system improvements developed through Section 4 of Title XII of YRBWEP would be available for use by the YN for irrigation and for other purposes on the Reservation, as well as for fish and wildlife in the Yakima River basin, at the discretion of the YN.

Today, the Yakima Project serves approximately 465,000 acres over an area extending from the Cle Elum vicinity to the Tri-Cities.

2.4.3 Hydropower

There are presently nine hydroelectric power plants and nine hydraulic pump plants within the Yakima basin. Of the nine power plants, the Chandler and Roza Plants are operated by Reclamation; the Drop 2 and Drop 3 plants are operated by the WIP; the Yakima-Tieton Irrigation District (YTID) operates two projects; the Pacific Power and Light Company (PP&L) (dba PacifiCorp, parent company is Scottish Power) operates the Naches, and Naches Drop Plants (Wapatox); and one small 32.5 kW plant (Leishman Irrigation System) operated by a private individual, J. Leishman. All of the power plants are served by water supplied through canal systems. These are described further under section 2.4.3.1, below. The nine federally-constructed, direct-connected hydraulic turbine-pump units are operated by Reclamation and/or the appropriate irrigation entity. These are described in section 2.4.3.2 below. Generally, there are no charges for power water usage of United State's claimed waters (RCW 90.16.050).

There are no hydroelectric power plants at any of the storage dams on the Yakima Project. A small hydroelectric station-service unit at Tieton Dam went out of service on December 23, 1969.

None of the above hydro plants have storage water rights, and all (except the PacifiCorp system) operate on flows subordinate to irrigation and storage rights. The PacifiCorp system has senior water rights that can require bypassing of inflow from Tieton or Bumping Lake Reservoirs to supply natural flow rights of the Company. All hydraulic pump plants are integral with downstream irrigation operations.

2.4.3.1 Hydroelectric Plants

Chandler Power Plant -

Constructed and operated by Reclamation, the plant is located on the left bank of the Yakima River, about 11 miles downstream from Prosser. Water diverted into the Chandler Canal (maximum 1,500 cubic feet per second [cfs] capacity for power and irrigation) at Prosser Diversion Dam (river mile 47.1 [RM]) is delivered to the pumping and power plant at canal mile 10.0, pumping a maximum of 334 cfs to Kennewick Irrigation District (KID) with the residual pumping and power water discharging to the Yakima River (RM 35.8) at the Chandler Power Plant. Two 6.0 MW generators (total rated capacity 12.0 MW at 1,325 cfs maximum flow) feed into the Bonneville Power Administration (BPA) transmission system. The first commercial power generation was in February 1956. The plant operates year around except for annual maintenance shutdown and ice conditions. The Chandler plant utilizes the entire canal capacity of 1,500 cfs when available, subject to the canal's variable hydraulic carrying capacity, irrigation and hydro pump requirements, and power subordination agreements for fish resource protection. The summer output of electric energy can be as low as zero, but usually ranges between 3.0 and 6.0 MW. The total power output from Chandler, less station power, is marketed and sold by BPA as part of the Federal Columbia River Power System (FCRPS). See section 6.7.1 for a discussion of the FCRPS.

The Interior Department Appropriation Act for 1931 (Act of May 14, 1930, ch. 273, 46 Stat. 279) provides that all net revenues received from the disposition of power not required for pumping water for irrigation of lands in the KID shall be applied to repayment costs incurred by the United States in connection with the Kennewick Highlands unit, including the power plant and appurtenances, until said construction costs are fully paid. In addition, Public Law 629 authorized the construction, operation, and maintenance of the Kennewick Division of the Yakima Project, Washington (Act of June 12, 1948, ch. 453, 62 Stat. 382, Sec. 1) for the purposes of irrigating lands, and of generating, transmitting, and marketing hydroelectric energy. Under Sec. 3. (Sale of Power - Rates), the Secretary is authorized to enter into contracts for the sale of electric power and energy not required for project uses.

The water right for power generation is based on State of Washington Surface Water Permit No. 1720, Application No. 3204 issued June 15, 1931, amended August 3, 1931. The permit was extended to proof stage,[2] December 31, 1981, by the Department of Ecology (WDOE). This permit is for 1,600 cfs diversion at Prosser Dam, with 600 cfs for irrigation, 1,000 cfs for power water for hydraulic turbine powered pumping units for delivery of KID water, and up to 1,600 cfs for power for pumping and commercial use. Currently, all water rights are subject to the final decree of the Yakima River Basin Adjudication. WDOE will not issue the final certificate of water rights for this permit until after the adjudication is completed.

The power water for electric generation at Chandler is subordinate to furnishing fishery flows, as defined by the Project Superintendent, over Prosser Dam and below in the Yakima River. The original operating agreement pertaining to minimum river flows in the Prosser Reach dates back to January 6, 1958, between the Reclamation and U.S. Bureau of Sport Fisheries and Wildlife. The agreement provides for minimum flows of 200 cfs from March 1st to July 10th; 50 cfs from July 10th to September 1st; 200 cfs from September 1st to November 30th; and 50 cfs from November 30th to March 1st. These flows are subject to maintaining prior existing water rights and water contracts, but have a priority over use of water for generation of electric power at Chandler Power Plant. Since the mid-1990s, other requests for power subordination have come to the forefront for increasing the Prosser Reach flows; including spawning, incubation, rearing, and upstream and downstream migration/passage flows. The most recent agreed upon power subordination was to target minimums of 450-1,400 cfs from November 1st to March 31st for the period of 1995 through 2000, and 450-1,000 cfs from April 1st to June 30th for the period of 1994 through 2000. The current minimum subordination target is for 450 cfs through the non-irrigation season, but for the past two years (1999 & 2000), all subordination target flows are annually inspected, reviewed, negotiated, and established between the System Operations Advisory Committee (SOAC), the Project Superintendent (Yakima Field Office Manager), and others.

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[2] The final stage in the State water right permitting process, prior to issuance of the final certificate of water right, is submitted as proof of appropriation by the permit holder. Upon the completion of a final “proof examination” the Department of Ecology then issues a certificate of water right for the amount of water actually put to beneficial use. RCW 90.03.320, RCW 90.03.330.

Reclamation has the authority to subordinate Chandler Power Plant as identified in Public Law 103-434, Title XII of the YRBWEP.

Roza Power Plant -

Constructed and operated by Reclamation, the plant is located in the Terrace Heights area, 2 miles northeast of Yakima. Water diverted into the Roza main canal (maximum 2,100 cfs capacity for power and irrigation) at Roza Diversion Dam (RM 127.9) is delivered to the power plant at canal mile 10.9 discharging into Roza Wasteway No. 2, and returning to the Yakima River (RM 113.2). One 12.0 MW generator provides power to 18 Roza Irrigation District (RID) electric pumps. Surplus power feeds into the BPA system. The first commercial power was generated here in August 1958. The plant can utilize up to 1,123 cfs of power water, and operates year-round except for annual maintenance shutdown and ice conditions.

The Roza Power Plant was built as an integral part of the Roza Division. Title to the plant rests with the U.S. Government, but Reclamation is under contractual obligation with the Roza District to supply all pumping power needs. Power generated in excess of that needed for project purposes is marketed and sold by BPA as part of the FCRPS. Any pumping power needed, in excess of plant production, is purchased from BPA. Lost generation to allow for the flip-flop[3] operation is covered by BPA through a power shaping agreement[4] with Reclamation.

The Roza Division was authorized on November 6, 1935, under the provisions of the Fact Finder's Act of December 5, 1924 (43 Stat. 672). The State water right for power generation is included in the Certificate of Surface Water Right issued by the State of Washington on May 22, 1961, based on Permit No. 1727. Diversion is limited to 2,200 cfs for irrigation, domestic supply, and power generation, with maximum power diversion of 1,123 cfs with preference to be given for irrigation.

Currently, power water for electric generation at Roza Power Plant is subordinated to improve fishery flows in the Yakima River below the Roza Diversion Dam. The original operations agreement with Reclamation pertaining to minimum river flows in the reach below Roza Dam dates back to a January 14, 1964 letter, between Reclamation and the Washington State Department of Game. Reclamation tentatively agreed to pass a minimum of 250 cfs in the Yakima River below the Roza Dam. An attempt to hold minimum flows in the 200 to 300 cfs range was made in the late 1960s through the early 1980s. In the late 1980s, power subordination became a larger issue. Reclamation does not have clear direction on the authority to subordinate Roza Power Plant, but maintains an informal agreement, in consultation with the SOAC and others to subordinate power generation to maintain a 400 cfs minimum in the river (at least

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[3] See Chapter 5, Consideration 15 & 16

[4] Power Shaping Agreement, BPA Contract No. DE-MS79-88BP92512 and Revision No. 1 of Exhibit H, Power Sales Contract No. DE-MS79-81BP90579.

300 cfs when no power is being generated). Since the late 1990s, other requests for power subordination have come to the forefront for increasing minimum flow below Roza Dam. During water year 2000, power was subordinated to provide a minimum flow of 600 cfs. BPA agreed to cover the cost for year 2000 of lost power generation, for this operational year only, so as not to impact the RID cost of power production in its water supply contract.

Wapato Drop 2 Plant -

This plant was constructed and is operated as part of Wapato Project, BIA. The plant is located north of West Wapato Road, in Section 11, Township 11N, Range 18E W.M., 5 miles west of Wapato. Water is delivered through the Wapato main canal, to the plant located about 6 miles below the headworks. There is one 2,500 kW generator with 33 foot of head. Power water is about 1,000 cfs. Tailwater continues down the lower main irrigation canal. The power generated is used for electric pumping within the project, but is inter-tied to BPA. The normal period of use is from April through September.

The water right for power generation is incidental to the irrigation deliveries through the canal system. There is no State certificate or permit. In the past, the Wapato Project engineer interpreted the Indian Appropriation Act of August 1, 1914, which provides 720 cfs for irrigation, to also permit use of 720 cfs during the non-irrigation season for power production, if water is available from natural river flow.[5] One interpretation holds that the Decree[6] was what justified the water use in the non-irrigation season for power production. (Note - Power generation continued after the end of the 1973 season, due to an electric energy shortage in the Northwest.)

Wapato Drop 3 Plant -

This plant was constructed and is operated as part of the Wapato Project, BIA. The plant is located north of Progressive Road in SW¼ of Section 22, Township 11N, Range 12E W.M., 7 miles southwest of Wapato. Water is delivered through the Wapato main canal, to the plant about 8 miles below the headworks. There are two 600 kW units (total 1,200 kW) with 33 foot of head. The total power water is about 600 cfs, and the tailwater continues down the irrigation canal system. The power is used for electric pumping within the project, but is also interconnected to BPA. The normal period of use is April through September.

The water right for power generation is incidental to irrigation. Comments for Wapato Drop 3 Plant regarding rights and usage are the same as for Drop 2 Plant, above.

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[5] N. A. Nybakken, Wapato Project

[6] Civil Action No. 21 (1945 Consent Decree) Article 4, 1st Para.

PacifiCorp Drop Plant -

This plant was constructed by Northwest Light and Water Company, and is now operated by PP&L (dba PacifiCorp - parent company, Scottish Power), the successor of Northwest Light and Water Company. This plant is located on the Wapatox Power Canal (Diversion point, Naches River @ RM 17.1 with 500+ cfs canal capacity) about 6 miles downstream from the Naches River Diversion, and 1 mile east of the town of Naches. Plant capacity of the single unit is approximately 1,100 kW, with tailwater continuing down the Wapatox Canal. The canal is operated year-round, except for maintenance shutdown, with generation becoming a part of PacifiCorp's commercial power service.

The State water right is based on an October 3, 1904 appropriation in Yakima County Water Rights Book B, page 178 for 1,000 cfs, which was modified by a limiting agreement of February 9, 1906, filed by Yakima County March 12, 1906, Volume 41 deeds, page 426. This agreement limits power flow to 300 cfs minimum and 450 cfs maximum, plus an irrigation schedule of approximately 51.6 cfs for April through September and 26.6 cfs for October.

This PacifiCorp water right was reviewed and confirmed by the State Superior Court of Yakima County in the ongoing Yakima Adjudication proceedings. The adjudication court's Conditional Final Order for Subbasin No. 19 (lower Naches), entered December 14, 1995, confirms a power generation water right to PacifiCorp with an October 4, 1904 priority date, for the year-round diversion of a minimum of 300 cfs and a maximum of 450 cfs (or more, under certain limited conditions) of the natural flow of the Naches River, when available. During the irrigation season PacifiCorp shares the use of the Wapatox Power Canal with the members of the Wapatox Ditch Company and several other named individual water users, whose water rights total 50.835 cfs from April 1st to September 30th each year, and 25.835 cfs for the month of October each year for irrigation of 2,548.67 acres. This PacifiCorp power generation water right's limitation of use states that the total authorized diversion into the Wapatox Power Canal is limited to 300 cfs as a minimum and 450 cfs as a maximum under the PacifiCorp power generation right and the rights confirmed for diversions into the canal by the Wapatox Ditch Company and several other named individual water users. It further states that all water diverted and not used for irrigation by the other users on the canal shall be returned to the Naches River not lower than the tailrace for the Wapatox Power Canal.

This PacifiCorp right precedes the 1905 Reclamation withdrawal, and because of this right's senior priority, it is sometimes necessary to bypass inflow from Tieton or Bumping Lake Reservoirs to satisfy this natural flow power right.

PacifiCorp Naches Plant -

This plant was constructed by Northwest Light and Water Company, and is operated by PP&L. It is located at the lower end of the Wapatox Power Canal, and has about 500 cfs capacity, of which 50.835 cfs are for irrigation diversion. It is located about 3 miles downstream from the

Drop Plant. Plant capacity is approximately 5,200 kW, being 2,200 kW from one unit, and 3,000 kW from the second unit. Tailwater returns to the Naches River at RM 9.7. Canal and power generation continues year-round, except for maintenance shutdown, with generation part of PP&L's commercial power service.

Water right data are the same as for the Drop Plant, above.

Yakima-Tieton Irrigation District Hydroelectric Plants -

The YTID operates the Cowiche and Orchard Avenue Hydroelectric Plants under Federal Energy Regulatory Commission (FERC) License Nos. 7337 and 7338 and State WDOE permit No. 256. The 2 plants have a combined capacity of 3 MW. The Cowiche plant is located on Summitview Road halfway between unincorporated Cowiche and the Town of Tieton. The Orchard Avenue plant is located on the intersection of Orchard Avenue and Mize Road. The hydroelectric plants serve as pressure-reducing stations for the pressurized pipeline distribution system completed in 1986. The in-line plants operate only during the irrigation season April through October. The operation of the plants is contingent upon the water demand within the district during the irrigation season.

2.4.3.2 Hydraulic Pump Plants

These installations are designed for hydraulic turbine powered pumping units (direct-drive from hydraulic turbine to pump without the use of electric motor power). Of the nine hydraulic pump plants described herein, eight are designed to reuse the power tailwater for in-district irrigation purposes (except for a portion of Wippel plant tailwater), and one, the Chandler Pump Plant, releases power tailwater into the Yakima River.

In all cases, except Chandler, the power water needed to activate the irrigation pumps is incidental to other irrigation requirements and no separate water right is involved (except part of Kittitas Reclamation District's [KRD] Wippel Plant); however, the right to use the water for power is expressed or implied along with the diversion right for irrigation.

Chandler Pump Plant -

This plant was constructed and is operated by Reclamation for the KID. It is located on the left bank of the Yakima River, 10 miles below Prosser and is contained in the same building as Chandler Power Plant, with a common forebay served by the Chandler Power Canal (capacity 1,500 cfs). The present installation includes 2 hydraulic turbine powered pumping units, each rated to deliver 167 cfs of water pumped to the KID Canal, and about 210 cfs each additional water required to generate the power required to pump the KID water, for a total demand of 754 cfs. Provision is made for installation of a third similar turbine-pump unit for Kennewick Extension, which would make a total of 500 cfs for irrigation and 625 cfs for power water, or a total diversion requirement of 1,125 cfs.

The water right for Chandler Power Plant water is included in State of Washington Surface Water Permit No. 1720, which was issued under an application filed with the State on June 15, 1931, and amended August 3, 1931. The permit was extended to proof stage,[7] December 31, 1981, by WDOE, which includes a provision for 1,000 cfs for power water for hydraulic pumping. Currently, all water rights are subject to the final decree of the Yakima River Basin Adjudication. WDOE will not issue the final certificate of water right for this permit until after the adjudication is completed.

Wapato Project Drop 1 Pump Plant -

This plant was constructed and is operated by BIA, Wapato Project. It is located on Wapato main canal, at canal mile 3.5 near the East ¼ corner of Section 35, Township 12N, Range 18E W.M., about 4 miles northwest of Wapato. The installation includes 3 hydraulic turbine powered pumping units, each with 90 foot of pump head and pump capacity of 60 cfs, or total of 180 cfs. The power water head is 26 foot and the pump power water ratio is 6:1. About 1,080 cfs total power water is needed to generate the power required to pump the 180 cfs of water. Tailwater is all used for irrigation in the lower main canal.

Wippel Pump Plant Kittitas Division -

This plant was constructed by Reclamation in 1932, and is operated by KRD. It is served by KRD North Branch Canal, and is located in Section 33, Township 17N, Range 20E W.M., about 10 miles southeast of Ellensburg. There are 2 hydraulic turbine pumping units operating under a net power head of 83 foot. Each unit is designed to pump 25 cfs with 130 cfs power water or a total power water requirement of 260 cfs. In 1954, 2 supplemental electric driven pumps of 5 cfs and 10 cfs capacity respectively, were installed.

Surface Water Certificate No. 4498 (Permit No. 1719), issued to the United States by the State of Washington on January 18, 1952, provides for 1,320 cfs diversion into the KRD main canal for purposes of irrigation, domestic supply, and power for use on lands within KRD. This quantity was reduced by 23.33 cfs (6,000 acre-feet annually) by way of a transfer to the City of Ellensburg on August 17, 1972. The power water is incidental to irrigation reuse within KRD, except that portion of excess power water returned to the Yakima River.

For many years the City of Ellensburg operated a hydroelectric generating plant on the Yakima River. Power generating water rights for the operation of the facility were secured by the City in 1902. The use of this generating facility was discontinued in 1957. The City of Ellensburg transferred up to 70 cfs of its power right to the KRD and then converted to M&I use the

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[7] The final stage in the State water right permitting process, prior to issuance of the final certificate of water right, is submitted as proof of appropriation by the permit holder. Upon the completion of a final "proof examination" the Department of Ecology then issues a certificate of water rights for the amount of water actually put to beneficial use. RCW 90.03.320, RCW 90.03.330.

6,000 acre-feet of KRD irrigation water for the City's future municipal water supply needs. The City released to the State the balance of its non-consumptive power right pursuant to a December 21, 1971 contract between the City, KRD, and the United States.

Amon Pump Plant -

This plant was constructed by Reclamation in 1955-1956. It was placed in service in 1957, and is now operated by the KID. It is served by the KID main canal out of the Amon siphon and is located in Section 7, Township 8N, Range 29E W.M., 6 miles southwest of Kennewick. There is one hydraulic turbine powered pumping unit connected to a two-stage pump system. The turbine operates under 63 foot of head, pump discharge is 20 cfs, and power water required is 148 cfs. All water is reused for irrigation purposes in the Highlands Feeder Canal.

The power water right is included in Chandler Power Canal diversion under State Permit No. 1720, previously discussed under "Chandler Power Plant."

Sunnyside Division -

The five pumping plants on the Sunnyside Division that utilize hydraulic turbine powered pumping systems for all or part of their irrigation water requirements serve Outlook, Snipes Mountain, Grandview, and the former Prosser Irrigation[8] Districts, the latter being served by the Prosser and Spring Creek Plants. Irrigation water supply for all these pump-supplied districts is contained in Warren Act contracts between the respective districts and the United States. None of the contracts state a fixed quantity of water available for power for pumping, but each basic contract includes a statement to the effect that power water is not a surplus power water privilege, but shall be available for beneficial reuse for irrigation of lands in the Yakima Project, and that it is appurtenant to the land irrigated thereby.

Outlook Pump Plant -

This plant was constructed by Reclamation and first utilized in 1916. It is now operated by the Outlook Irrigation District, Sunnyside Division, and receives its water supply from Sunnyside main canal at canal mile 30.2. The location is in Section 8, Township 10N, Range 22E W.M., about 4 miles northwest of Sunnyside. The hydraulic turbine powered pumping units consist of 2 units with ratings of 240 horse power (hp) and 560 hp, respectively. Power head is 45 foot, pump lift 107 feet, discharging about 48 cfs maximum, with a ratio of approximately 4:1 of power to pumped water. The power water requirement is thus about 200 cfs. In 1969, an auxiliary 250 hp vertical shaft turbine type electric pump unit was installed at the Sunnyside Canal crossing connecting into the main pump discharge line with a rated capacity of 15 cfs at 120 foot total developed head.

[8] Merge with Sunnyside Valley Irrigation District.

Water right claims for power for pumping are included in the irrigation diversion rights for the Sunnyside Valley Irrigation District (SVID) Canal at its headworks. Tailwater from Outlook Pump Plant is reused for irrigation in Snipes Mountain Lateral, which in turn, also serves the hydro pump units for Snipes Mountain Irrigation District.

Snipes Mountain Pump Plant -

This plant was constructed by Reclamation and first utilized in 1915. It is operated by the Snipes Mountain Irrigation District, Sunnyside Division, and receives its water supply from Snipes Mountain Gravity Lateral, which begins at the tailrace of the Outlook Pump Plant as described above. The plant is located on the east line of Section 8, Township 9N, Range 22E W.M., about 2 miles southwest of Sunnyside. The original installation consisted of 2 hydraulic turbine powered pumping units operating under a 64 foot power head and 190 foot pump head, with the following individual characteristics:

a. 10.7 cfs 2-stage pump discharge with 65 cfs power water, and
b. 4.2 cfs single-stage pump discharge with 25 cfs power water.

Subsequently, the smaller pump was abandoned, and a third unit similar to "a." above was installed, providing the present total pump capacity of about 22 cfs, and 130 cfs power water for the entire plant.

A small hydraulic turbine powered pumping unit, Hillcrest Plant, is also operated out of the Snipes Mountain Lateral, in SW¼SW¼ of Section 25, Township 10N, Range 22E W.M., pump capacity is only about 1 cfs. This system was originally powered by the "Harrison Hill Ram," and is interconnected with the lateral system of the main Snipes Mountain Pump distribution system.

Water rights for power for pumping are included in the diversion rights for SVID Canal at its headworks. Tailwater from the Snipes plant is utilized for irrigating lands in the SVID.

Grandview Pump Plant -

This plant was constructed by Reclamation with first water delivered to it in 1917, and is operated by the Grandview Irrigation District, Sunnyside Division, receiving its water supply from SVID main canal at canal mile 50.35. The location is in the SW¼SE¼ of Section 30, Township 9N, Range 24E W.M., 2 miles southeast of Grandview. The plant presently consists of one 4-stage hydraulic turbine powered pumping unit (16 cfs) and 2 electric driven pumps of 150 hp (13 cfs) and 75 hp (6 cfs) capacity, respectively. Power head is 21 foot and the pump lift is 78 feet. Total output is about 35 cfs with an additional 5 cfs pumped into the lateral system from a drain. The original installation received its electric power supply from the Rocky Ford Power Plant, constructed as a part of the Grandview system to supply 187 kW of power to the Grandview plant via a 3-mile transmission line. The Rocky Ford plant was abandoned in 1953, and electrical energy is now supplied from commercial sources.

Water rights claims for power for pumping are included in the irrigation diversion rights for the SVID Canal at its headworks. Tailwater from the Grandview plant is utilized for irrigation of lands in the SVID in the vicinity of Mabton, south of the Yakima River, served by the Mabton Feeder Canal.

Prosser Pump Plant -

The plant was constructed by Reclamation with first water delivered to it in 1919, and is operated by SVID (former Prosser Irrigation District). This is the upstream-most of 2 hydroplants serving the former Prosser Irrigation District, Sunnyside Division, receiving its water supply from SVID Canal at canal mile 55.05. The location is in the SE¼NE¼ of Section 26, Township 9N, Range 24E W.M., 2 miles north of Prosser. The plant was rehabilitated in 1964, and now consists of a higher speed pump (in service in 1965) driven by original hydro-turbine of 174 hp, utilizing 45 cfs maximum of power water, with a power head of 52 foot, pump lift 106 feet, and discharging about 13 cfs.

Water right claims for power for pumping are included in irrigation diversion rights for SVID Canal at its headworks. Tailwater from the Prosser plant is utilized for irrigation of lands south of the Yakima River in the vicinity of Prosser, as part of SVID.

Spring Creek Plant -

The plant was constructed by Reclamation with the first water delivered to it in 1919, and is operated by the Prosser Irrigation District. This is the lower, or downstream, of the 2 hydroplants serving the Prosser Irrigation District, Sunnyside Division, receiving its water supply from SVID Canal at canal mile 59.32. The location is in the SW¼NE¼ of Section 20, Township 9N, Range 25E W.M., 4 miles northeast of Prosser. The plant was rehabilitated in 1963, and now consists of a higher speed pump (in service in 1964) driven by original hydro-turbine of 174 hp, utilizing 25 cfs maximum of power water, with a power head of 77 foot, and a pump lift of 95 feet, and discharging about 13 cfs.

Water right claims for power for pumping are included in the irrigation diversion rights for the SVID Canal at its headworks. Tailwater from the Spring Creek Plant is utilized for irrigation of adjacent lands within the SVID.

2.4.3.3 Federal Energy Regulatory Commission - Licenses
(Approved Use or Approved Future Use)

FERC issues licenses to successful applicants to construct and operate hydroelectric projects for a term of up to 50 years; projects must be relicensed when the license expires. Applicants are required to consult with local, State, and Federal agencies during preparation of a license application, and include evidence of these consultations in the application. FERC normally requires compliance with State and local requirements prior to issuance of a license. FERC will also issue a short term development permit to allow study of a potential hydroelectric power site.

Note: A FERC license does not provide a water right. Water rights for power water use must be obtained from WDOE. A list of current FERC licenses or permits in Yakima River basin is as follows:

Current FERC Status -- Active Power Projects in the Yakima River Basin

Project Name	FERC No.	Developer Name	Status
Exemptions			
Leishman Irrigation Sys. - Hydroelectric Plant	07684-00	J. & I. Leishman	On-Line
Licensed Projects			
Tieton Dam	03701-28	Yakima-Tieton Irrigation District	License Granted
Cowiche Hydroelectric Plant	07337-02	Yakima-Tieton Irrigation District	On-Line
Orchard Ave. Hydroelectric Plant	07338-02	Yakima-Tieton Irrigation District	On-Line
Non-Federal & Outside FERC's Jurisdiction			
Naches - Wapatox Power Plant	02672AOO	PacifiCorp (Scottish Power)	On-Line
Naches - Wapatox - Drop Power Plant	02672BOO	PacifiCorp (Scottish Power)	On-Line
Federally Owned			
Wapato I.P. Drop No. 3 Power Plant	00000S46	U.S. Bureau of Indian Affairs	On-Line
Wapato I.P. Drop No. 2 Power Plant	00000S45	U.S. Bureau of Indian Affairs	On-Line
Chandler Power Plant (Prosser)	00000S43	U.S. Bureau of Reclamation	On-Line
Roza Power Plant	00000S47	U.S. Bureau of Reclamation	On-Line

Note: There are currently 30 Non-Active FERC projects with proposed power in the Yakima River basin. Current FERC status of the 30 Non-Active FERC projects is as follows: 2 Rejected, 3 Cancelled, 3 Dismissed, 2 Withdrawn, 6 Expired, and 14 Surrendered.

2.4.4 Other Development

Logging, urban buildup, expanding transportation and recreational uses have influenced the history and development of the basin.

2.4.4.1 Forestry

Approximately 2,014,000 acres of the Yakima River basin are forested areas. Most of the forested areas are located in the higher elevations of Yakima, Kittitas, and Klickitat[9] Counties. The forested areas receive and provide the majority of water to the basin. Water from precipitation, primarily snowmelt, is routed through stream networks to the larger rivers and reservoirs or infiltrates into the ground to recharge groundwater aquifers.

Early settlement in the Yakima River basin was concentrated in alluvial bottom lands along lower-elevation tributary rivers and streams, where arable soils and water were plentiful and transportation was most feasible. Logging in the riparian areas accompanied the earliest settlement for the purposes of land clearance and construction materials.

The first sawmills in the basin were built in the 1870s. Initially the mills were small and were located in the Upper Wenas and Ahtanum Valleys, and in various canyons leading into the Kittitas Valley. The first water powered mill was built on the Yakima River near Ellensburg in 1876. Log drives were common in the mid-1880s when logs and lumber were needed to build the railroad. It took about 6 weeks to float logs downstream from Easton to Yakima. Horses were used for logging and, by the 1890s, horses and oxen were being used to pull logs to the mills on wagons and sleds. The last log drive on the Yakima River was in 1915.

Major logging operations were carried out in the early 1900s. The Cascade Lumber Company carried out extensive operations for about 15 years in the Teanaway region beginning in the World War I years. The company then logged in the Swauk watershed during the 1930s, and during World War II. Taneum Canyon was also logged in the 1930s. Railroads were built along these streams and their tributaries. Up to 40 miles of Cascade Lumber Company track was in use in the logging regions, connecting to the Northern Pacific near the Yakima River. By the mid-1900s, clear cutting was more common. The Cabin Creek watershed was logged using clear cuts between 1950 and 1980. Substantial timber harvest in the Naches Pass area did not begin until the mid-1970s, with partial cutting at lower elevations and clear cutting in the 1980s and early 1990s at higher elevations.

2.4.4.2 Urbanization

Yakima began as a trading post and was incorporated as Yakima City on December 1, 1883, at the original site in Union Gap. In 1884, Northern Pacific Railway Company established a station 4 miles west and moved over 100 buildings from Yakima to the new site, free. The new settlement was called “North Yakima.” The reason behind this was because the Northern Pacific could not obtain the concession to operation from the existing “Yakima.” North Yakima was incorporated and officially became the county seat in 1886.

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[9] Approximately 1,000 acres

Sunnyside was recognized as the commercial center of the Yakima Valley in the early 1800s, with its history closely linked to the development of the early irrigation canals. Prosser was a recognized center due to its railroad access and surrounding irrigation developments. The Ellensburg townsite was established in 1875. Cle Elum and Roslyn developed as mining towns in the 1880s, supplying coal to the railroads. The Ellensburg State Normal School (predecessor to Central Washington University) was established in 1890.

There has been the rapid growth of diverse populations and the simultaneous development of urban and suburban areas in the three major counties of the watershed. For example, from 1990 to July 1, 1997, the populations of Kittitas, Benton, and Yakima Counties increased by more than 15 percent, or about 60,000 people. A detailed analysis of floodplain development in the area from Lake Easton to the Cle Elum River confluence found that five major subdivisions with 230 individual housing structures were built in the designated river floodplain between 1961-1970.

In 1998, about one-half of the population lived within incorporated cities. The larger cities (over 5,000 population) include Yakima, West Richland, Richland (part), Kennewick (part), Ellensburg, Sunnyside, Toppenish, Grandview, and Selah. The Yakima River basin includes 24 incorporated municipalities, of which 5 are in Kittitas County, 14 are in Yakima County, and 5 are in Benton County.

2.4.4.3 Transportation

Railroads played a major role in the early development years of the Yakima basin. An important point in agricultural history occurred when the Northern Pacific Railroad's transcontinental line reached Yakima in 1886, and opened populous market areas to the farmers. In 1883, the Northern Pacific Railroad started construction of its mainline up the Yakima Valley, following the south bank of the Yakima River from Kiona through Prosser and on to the west.

Most of the roads were developed from widening trails that followed along the rivers and streams. Snoqualmie Pass has long been a favorite route across the Cascade Range; this route was used for hundreds of years by the Yakama and Snoqualmie Indian Tribes who traded frequently using the trail across this well known gap in the mountains. The original Snoqualmie wagon road used by the 19th century settlers was hacked out along the old Indian trail in about 1868. Freeway construction that created Interstate 90 was carried out in the 1970s and 1980s. Gravel was excavated for the new roadway at various locations along the route creating ponds and lakes visible from the roadway. Similar construction created ponds along State Highway 10 in the 1930s, and along I-82 in more recent times.

Railway and road locations altered the riparian ecosystem throughout the basin. They reduced backwater areas, sloughs, oxbows, and meandering features of the river systems by channelizing the streams.

2.4.4.4 Recreation

The recreation setting of the Yakima River basin varies from designated wilderness areas to urban greenways. Features are mainly situated in roaded natural settings. Recreationists are attracted to the basin by quality of the scenery, water, and recreation opportunities. Primary recreation activities include fishing the reservoirs and rivers for cold water sport species; whitewater boating and kayaking; motorized boating; and other related activities such as camping, hiking, picnicking, and wildlife viewing.

Interagency Committee for Outdoor Recreation surveys indicate the number one preferred recreation setting is water oriented. Public demand for access to rivers, streams, and reservoirs continues to increase yearly. Recreation concerns and actions taken by project operations are addressed in section 5 of this plan.

2.5 SOCIAL

The Yakama and Kittitas people were the primary inhabitants of the Yakima basin in the 1700s to the mid-1800s. Before 1870, poor transportation kept immigration to a minimum. Population increased rapidly from 1880 to 1910, because of the new railroads, settlement of irrigated lands developed by Federal irrigation projects, and increased lumbering activity. Between 1910 and 1940, population grew slowly, but steadily. County population trends over the 1940 to 1990 period have generally been up. Between 1940 and 1950, Benton County experienced a tremendous jump, from just over 12,000 to over 51,000 residents, because of the establishment of the Hanford Atomic Works. The City of Richland experienced an 88-fold population increase as a result of the development.

In 1990, about 29.6 percent of the area population was classified as rural. Many small towns in the region are supported primarily by agriculture and agricultural processing plants. Many of the rural residents are employed in the major cities of Yakima, a trade and food-processing center; Richland, with nuclear research; Kennewick, with a mixed industrial base; and Ellensburg, an educational, food-processing, and farm trade center.

The 1990 census data on population by race for the Yakima River basin indicated that whites are the largest group (over 80 percent). Race and ethnicity are overlapping categories. In 1990, 16 percent of the population identified themselves as Hispanic, regardless of race. The percentage of Hispanics in the region has increased from about 10 percent in 1980. (This is partly due to changes in census taking methods.)

Among the persons living on the Yakama Indian Reservation, Tribal members are in the minority. The 1990 census counted 27,522 total persons within the Reservation boundaries, and of that total, about 6,300 were Tribal members. Some of the non-Indian residents live on or have developed business enterprises on allotted lands that were purchased from Indian owners in the earlier part of the century. The YN and its members own the majority of irrigated and irrigable land on the

Reservation and own the single biggest block of irrigated land in the Yakima basin. The YN manages its land through a Tribal Enterprise which grows and markets apples and other fruit and vegetables.

Prior to the 1990 census, the Bureau of the Census did not display information to facilitate comparisons of demographic information specific to the Reservation. Therefore, historical information and population trends are only briefly discussed below. The estimated enrollment of the Yakama Tribe in March 1975 was 6,650 members. About 70 percent (5,150) of the Tribal members resided on the Reservation. The enrollment register for July 1996 listed 8,586 Tribal members, and 5,685 Tribal members resided on the Reservation (Yakama Nation, Economic Development Division, Business and Management Office, personal communication, 1995).

2.6 ECONOMIC

The Yakima basin has developed a diverse economy, providing many opportunities for employment and income, with a strong agricultural base. The employment and personal income in the basin depends more on agriculture than the State or the United States. Agriculture represents 8.4 percent of the total regional sales revenue, compared to about 2 percent for the State and for the United States (Reclamation's Programmatic Environmental Impact Statement [PEIS] pg. 96, 1999). Yakima County is among the leading agricultural counties in the United States. It is, or has ranked first in the Nation in the production of hops, apples, mint, peas for processing, honey, and several tree fruits. It ranked fifth in the Nation in total agricultural production.

Total employment in the region for 1993 was about 191,000 (including full and part time) as shown in table 2-1. (Reclamation's PEIS pg. 95, 1999.) Of this number, 51.1 percent were in the service (32.0%) and trade (19.1%) sectors. The service sector includes businesses that provide services to the public such as dry cleaners, barbers, automobile repair shops, bowling alleys, hospitals, lawyers, and accountants. The trade sector is an aggregation of trade industries including wholesale trade, general merchandising, food stores, apparel stores, and home furnishing stores.

The agricultural sector employed close to 18,000 workers. About 10,000 of the jobs were involved in production of fruits and vegetables, and over 80 percent of fruit and vegetable production stemmed from acres receiving project water. In addition to those directly employed in agriculture, over 5,100 are employed in processing of fruits and vegetables, an indirect contribution of agricultural production to the regional employment. Table 2-1. presents a summary of employment by sector for the region; the State and national levels are shown for comparison.

Table 2-1.–Summary of Employment Levels by Sectors for 1993

Sectors	Yakima basin	Percent	Washington	Percent	United States	Percent
Agriculture	17,874	9.3	99,343	3.3	4,311,664	3.0
Natural resources	6,040	3.2	16,115	0.5	563,071	0.4
Construction	11,141	5.8	217,084	7.2	9,235,307	6.5
Manufacturing	16,629	8.7	360,541	12.0	18,684,040	13.2
Transportation, communications, and utilities	4,954	2.6	121,217	4.0	6,135,673	4.3
Trade	36,535	19.1	650,949	21.6	30,161,940	21.2
Financial, insurance, real estate	7,549	3.9	203,970	6.8	9,640,669	6.8
Services	61,188	32.0	819,033	27.2	41,037,520	28.9
Government	29,404	15.4	518,769	17.3	22,211,622	15.7
Total	191,314	100.0	3,007,021	100.0	141,981,504	100.0

Lands in irrigated croplands have decreased from 371,096 acres in 1982, to 360,675 acres in 1992. The lands irrigated vary from year to year depending on the water supply; 1992 through 1994 were some of the drier years on record. Table 2-2. shows the irrigated acreage of crops grown in the Yakima Project from 1982 to 1992 (Reclamation's YRBWEP PEIS pg. 71, 1999).

Table 2-2.–Irrigated Acreage of Crops Grown in the Yakima Project From 1982 to 1992

Yakima Project - Irrigated Crop Production in Acres											
Crop	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Corn	14,937	13,941	21,095	18,444	13,995	10,958	8,859	14,124	12,244	13,134	13,489
Grain	52,176	48,846	43,839	35,996	32,726	27,095	26,740	27,951	31,370	19,449	27,417
Forage	136,797	139,242	135,851	146,014	134,833	135,010	134,617	136,769	140,931	139,268	139,390
Beans	7,731	1,225	2,436	2,975	2,413	2,308	2,385	3,226	3,046	2,949	3,834
Hops	28,928	27,024	23,150	21,000	20,324	23,539	23,791	23,237	26,924	28,472	29,500
Mint	15,874	14,106	16,854	18,959	15,258	13,880	15,342	16,492	19,144	19,474	18,664
Vegetables	28,267	27,521	28,587	27,655	27,296	33,045	30,041	27,185	29,818	30,108	24,158
Nursery	895	1,356	1,078	633	698	625	780	964	561	596	629
Seed crops	457	390	262	726	91	471	773	797	485	447	358
Fruits	82,071	91,566	94,080	90,570	95,000	102,231	103,281	100,017	101,146	99,580	102,226
Nuts	0	0	0	5	5	5	5	29	38	38	38
All crops	371,096	367,669	369,113	363,870	363,870	350,752	349,931	354,111	365,809	354,470	360,675

Over 45 percent of the irrigated area is used for perennial crops, including orchards, vineyards, hops, mint, and asparagus. Perennial crops require an adequate annual water supply. Plant stress in these crops attributable to water shortages can result in severe economic hardship to the grower because of lower production and reduced crop quality that may render them unmarketable, which occurred in 1994 (worst year on record), and to a lesser degree in the mid-1970s. Water shortages can also damage plants enough to require rootstock replacement, which involves high replanting costs and continuing economic losses for several years. The prevailing trend in the area is to convert from stress-tolerant crops to the higher value crops; therefore, an adequate water supply to ensure against crop stress will become more critical.

Reclamation's 1992 Summary Statistics (table 2-3.) indicates that of the 1,789,068 acre-feet of water diverted throughout the project in 1992, 1,314,713 acre-feet (73%) reached the farms (Reclamation, 1992), as shown in the table below. The other 27 percent were lost to evaporation, leakage losses, or other reasons. Deliveries averaged 73 percent, but divisions varied on the efficiency of water deliveries. Also, divisions had varied levels of on-farm water efficiency, using from 2.42 to 4.62 acre-feet per acre as shown in the table below. The average for the Yakima Project was about 3.5 acre-feet per acre.

Table 2-3.–Agricultural Irrigation by Division

Division	Total acres	Acres irrigated	(acre-feet) Water diverted from river	Water delivered to farms	Delivered water per acre
Kennewick	25,471	7,698	99,971	32,918	4.28
Kittitas	59,104	55,516	246,012	134,514	2.42
Roza	72,511	65,546	245,898	162,693	2.48
Sunnyside	103,562	80,764	423,999	373,215	4.62
Contract	47,531	38,214	156,713	133,138	3.48
Tieton	27,271	25,048	83,280	82,009	3.27
Wapato	136,000	103,337	533,195	396,225	3.83
Total	471,450	376,124	1,789,068	1,314,713	Average 3.48

Reclamation's 1992 Summary Statistics.

2.7 HYDROLOGY

2.7.1 Surface Water

The major river draining the Yakima River basin is the Yakima River, which is a tributary of the Columbia. Main tributaries include the Kachess, Cle Elum, Teanaway, Bumping, Tieton, and Naches Rivers, and Toppenish and Satus Creeks.

The surface water supply for the Yakima Project is obtained from the unregulated flows of the Yakima River and its tributaries, return flows, and stored waters. Average yearly runoff at key locations along the Yakima River and its tributaries for the period 1961 through 1990 are displayed in table 2-4.

Table 2-4.–Average Yearly Runoff at Key Locations

Site	(Acre-feet per year) 1961 - 1990[3] estimated unregulated flow	1961 - 1990[4] measured flow
Yakima River at Martin [1]	245,000	245,145
Kachess River near Easton [1]	211,000	211,406
Yakima River near Easton	651,000	342,215
Cle Elum River near Roslyn [1]	665,000	665,946
Yakima River at Cle Elum [2]	1,478,000	1,183,648
Yakima River at Umtanum	2,007,000	1,750,128
Yakima River at Pomona	2,009,000	953,861+/-
Bumping River near Nile [1]	205,000	205,872
Tieton River below Tieton Dam [1]	369,000	368,242
Naches River near Naches [2]	1,234,000	838,606*
Yakima River at Parker [2]	3,410,000	1,563,216
Yakima River at Kiona	3,970,000	2,475,950

[1] Measures reservoir outflow
[2] TWSA control points
[3] Reclamation Surface Water Hydrology Model
[4] Reclamation records
* Wapatox Power Plant diverts 257,350 acre-feet per year up-stream of gage

Water is released from the Yakima Project reservoirs during the irrigation season to meet diversion demands and target flows. In the fall, winter, and spring, releases are made in conjunction with system flood control guidelines. A flip-flop procedure of reservoir releases is used to minimize spring chinook spawning and subsequent incubation flows, and also to minimize the potential impact on irrigation water supplies. See section 5 for further details.

Basin streamflow was historically moderated by natural storage processing (Parker and Story, 1916), particularly groundwater storage and storage in natural lakes, including the large natural lakes that existed at the current sites of major storage reservoirs, Cle Elum, Kachess, Keechelus, and Bumping Lakes. These processes captured peak flows and released water gradually, sustaining river flows through extended periods of little precipitation. Pre-irrigation system maps show that, historically, the channel system in the basin was much more complex with myriad side channels and dense riparian vegetation. Without the current reservoirs capturing and regulating most of the winter and spring runoff, overbank flows were much more frequent. Flood waters infiltrated into the floodplain alluvium and were naturally released later sustaining summer flows (Parker and Story, 1916; Kinnison and Sceva, 1963) and moderating water temperatures.

Published information on the natural hydrograph of the Yakima River is found in Parker and Story (1916) and in historical streamflow records of the U.S. Geological Survey (USGS). Parker and Story estimated that natural flow at Union Gap followed a basic pattern of peak runoff during April through June in the range of 7,000-12,000 cfs. Flows receded throughout the summer with annual lows occurring in September and October. The lowest estimated mean-monthly flow was approximately 800 cfs. Flows were higher at Parker in the late summer and fluctuated less than with the current development and reservoir operations.

Major floods, historically (and presently), occur during the winter (mid-November through February), usually resulting from a rain-on-snow precipitation event coupled with a rapid thaw. Storage has reduced the frequency and limited the distribution of significant "channel forming" flood events. Major floods provide sufficient hydraulic energy to periodically reshape the river channel and associated riparian vegetation. A 25,000 cfs peak instantaneous flow at the Yakima River gaging station at Parker currently has a recurrence interval of 10 years. A 58,000 cfs event in February 1996, had a 110-year recurrence interval. Table 2-5. illustrates the effect of Yakima storage development on natural flood events. The difference between the "estimated unregulated" peak discharge (Qu) and the observed discharge reflects the "flood moderating" influence of the project reservoirs.

Table 2-5.–Yakima River Flood Flows Above 25,000 cfs @ Parker

#	Date of Crest	Water year	Gage Height Stage - feet	Reg. Inst. Peak discharge (CFS)	Event [1] Frequency in years	Inst. Unregulated (CFS)	Event[2] Mean daily unregulated (CFS)
1	Dec. 23, 1933	1934	(17.7)	65,000	150		81,662
2	Feb. 09, 1996	1996	16.21	58,150*	110	92,700	85,298
3	Dec. 30, 1917	1918	16.8	52,900	85		
4	May 29, 1948	1948	15.0	37,700	30		60,683
5	Nov. 30, 1995	1996	14.61	36,500*	25	76,300	80,777
6	Dec. 13, 1921	1922	14.7	35,800	25		
7	Nov. 26, 1990	1991	14.5	35,620*	25	56,400 [3]	
8	Nov. 25, 1909	1910	14.6	35,000	25		
9	Dec. 02, 1977	1978	13.97	34,320	25		64,460
10	Dec. 27, 1980	1981	13.44	31,675	20		65,955
11	Jan. 16, 1974	1974	13.3	27,700	10		42,351
12	Dec. 04, 1975	1976	13.3	27,600	10	61,800	56,713
13	Nov. 24, 1959	1960	13.2	27,400	10		48,440
14	June 19, 1916	1916	12.7	24,800	10		

Note: All gage height stage-feet based upon present site datum data is from Reclamation records

* Based upon Provisional Data (Calculated)

[1] Based upon cumulative frequency curve, April 1986, Brown/Merkle

[2] May not be same day as peak regulated discharge = peak PARW QD + SYS QU day before

[3] Event primarily driven by upper Yakima basin runoff

2.7.2 Groundwater

Introduction -

The groundwater regime in the Yakima River basin has been profoundly modified by operation of the Yakima Project, and irrigated agriculture in general. This section describes the geologic and hydrologic factors that influence the groundwater regime, and how the regime has been altered by large-scale agricultural development and other changes in the watershed. The section also briefly describes relationships between streamflow and groundwater, and the role of surface water-groundwater interactions in river ecology.

Previous Work -

A body of peer-reviewed literature describes the groundwater regime of the Yakima River basin. Kinnison and Sceva (1963) studied well logs and stream gaging data to describe geologic and hydraulic controls on streamflow. They subdivided the basin into 7 relatively independent groundwater basins and 25 groundwater subbasins, and identified stream reaches where appreciable groundwater discharge to streams occurs (gaining reaches) and where appreciable aquifer recharge from streamflow occurs (losing reaches).

The portion of the basin underlain by the Columbia River Basalts (approximately the eastern ⅔ of the basin) was included in the USGS Columbia Plateau Regional Aquifer System Analysis (RASA). The RASA produced many publications on subjects including groundwater levels, recharge modeling, pumpage estimates, geochemistry, geology, and numerical groundwater modeling. See Vaccaro (1999) for a summary and listing of other literature.

Groundwater studies of several portions of the basin have been published including:

The Lower Yakima River basin - Molenaar (1985);
Toppenish Creek basin - USGS (1975); Skrivan (1987); and Bolke and Skrivan (1981);
Satus Creek basin - Mundorff et al., (1977); Prych (1983); and
Ahtanum Creek basin - Foxworthy (1962).

Other studies have appeared in agency literature and proceedings articles. Pacific Northwest River Basins Commission (1970) describe the hydrogeologic framework of the basin. U.S. Army Corps Of Engineers (Corps) (1978) describe the hydrogeology of the basin by subbasin and display plots of water level contours. Hendry et al., (1992) used environmental isotopes to interpret sources and estimate ages of groundwater in Toppenish Creek basin. Ring and Watson (1999) describe changes in the spatial and temporal distribution of groundwater recharge and discharge in the basin and implications for aquatic habitat.

Hydrogeologic Setting -

The distribution and flow of groundwater and the interactions between surface and groundwater in the Yakima River basin are strongly influenced by the topography and geology of the basin (Ring and Watson, 1999).

Topography and Climate -

The Yakima River drains the eastern slope of the Cascade Range in central Washington and flows through 150 miles of semi-arid lowland valleys and canyons before joining the Columbia River. Orographic uplift and cooling of moist air from the Pacific Ocean cause high precipitation along the Cascade crest (Pacific Northwest River Basins Commission, 1970). Warming and drying of the descending air mass east of the crest causes a strong rain shadow effect (120 in/yr precipitation on the crest, <10 in/yr in most of the lower basin). Runoff and precipitation-induced groundwater recharge are low in the lower basin; 75 percent of precipitation comes from October through March, much of it as snowfall along the crest. Snowpack builds from October through April. A dry season runs from late spring through summer, with less than 5 percent of precipitation occurring in July and August. High elevation snowpack remains until June or later, causing runoff to persist well into summer. Estimates of the unregulated hydrograph in the lower basin show annual peaks in April through June in the range of 7,000 to 12,000 cfs, with annual lows in September or October of about 1,000 cfs (Parker and Storey, 1916). Record peaks, however, are rain-on-snow events occurring between November and February.

Geologic Evolution -

A sequence of geologic processes including accretion, vulcanism and plutonism, uplift and erosion, folding and faulting, glaciation, and gravel deposition created a basin characterized by numerous alluvial valleys separated by relatively short bedrock canyon reaches. In the semi-arid lowlands, these geologic controls, along with the temporal and spatial distribution of surface water delivered from the upper watershed, determine the timing and location of most groundwater recharge and discharge, and provide mechanisms that moderate streamflow and water temperature.

Yakima River basin geology and hydrogeology fall in two main regions: a Cascade Mountains province in the northwestern Yakima basin with a varied suite of older rocks; and the Columbia Plateau province, where a thick sequence of basaltic lava flows and overlying sediments cover the older rocks (Kinnison and Sceva, 1963).

The oldest rocks in the Yakima basin are Cascade province igneous and metamorphic rocks that were added to the North American continent by accretion (plate tectonic processes). These rocks occur at the surface in the Cascade and Wenatchee Mountains in the western and northern portions of the Yakima basin. Younger Cascade province rocks formed by vulcanism and by deposition of sedimentary rocks, chiefly sandstones and shales in non-marine basins.

Numerous lava flows of the Columbia River Basalt Group emanating from fissures located southeast of the Yakima basin covered the older rocks across southeastern Washington, including all of the Yakima basin except the Cascade province rocks in the northern and western part of the basin. Sediments shed from now extinct volcanoes in the vicinity of the Cascades (Ellensburg Formation) were interbedded between the uppermost basalt flows and formed thick deposits on top of the basalts. The basalt plateau was then folded and faulted into northwest-southeast trending anticlinal ridges and synclinal valleys called the Yakima Fold Belt. The Cascade Range was uplifted at about the same time. The antecedent Yakima River incised canyons and water gaps through the rising ridges. Ellensburg Formation sediments and gravels eroded from uplifting mountains and ridges were deposited in the valleys. Later, alpine glaciers draining the Cascade crest eroded broad valleys in the Cascades and delivered large volumes of gravel to the alluvial basins. Glaciation left many lakes, four of which were expanded to serve as storage reservoirs. Backwaters from the ice age Lake Missoula flood left thick silt deposits in the lower valley.

Hydrogeologic Units -

The Columbia River Basalts, interbeds, and overlying sediments form a regionally important aquifer system. The alluvial aquifers are generally quite permeable, but heterogeneous and anisotropic due to deposition in dynamic fluvial environments. Cascade Mountains province rocks generally store and transmit little water. A description of individual units follows:

> Cascade Province Rocks - The bedrock units of the Cascade province have generally low permeability, except moderate where fractured. They store and transmit relatively little groundwater. Alluvial deposits in montane valleys form local flow systems. Kinnison and Sceva (1963), and Pacific Northwest River Basins Commission (1970) describe the individual rock units and their hydraulic properties.
>
> Columbia Plateau Province Rocks - Columbia River Basalts. Total thickness of the Columbia River Basalts reaches several thousand feet and thins to the west. Individual flows range from about 20 to 100 feet in thickness. Sedimentary interbeds of the Ellensburg Formation (see below) are interbedded between some flows, particularly toward the top of the basalts.
>
> Basalt flows develop a characteristic structure as they cool. Lateral hydraulic conductivity is greatest in the rubbly interflow zones (top of one flow, interbed if present, bottom of next overlying flow), where permeability is moderate to high. Vertical hydraulic conductivity is through joints and fractures and is generally much less than lateral hydraulic conductivity. Water table conditions generally exist in the uppermost basalt flows. Wide differences between the horizontal and vertical hydraulic conductivities cause the deeper aquifers in the Columbia River Basalts to be semi-confined. Fine-grained interbeds and flow center units compose the semi-confining beds for the underlying flows. The hydraulic connection between flows is sufficient to allow some continuous vertical movement of water between them (Bauer et al., 1985).

In contrast with the relatively flat and undeformed terrain east of the Columbia River, the western part of the plateau was folded late in Columbia River Basalts time into east-west trending anticlinal ridges and broad synclinal valleys (called the Yakima Fold Belt). Many faults (both thrust and normal) occur on the ridges. This structure strongly influences groundwater flow patterns in the Yakima basin by reorienting and truncating permeable zones and creating substantial topographic relief.

Ellensburg Formation - The Ellensburg Formation consists of volcanically produced sedimentary deposits from extinct volcanoes in vicinity of Bumping Lake. Total thickness reaches up to about 2,000 feet thick in valleys, but is largely absent on the ridges except as interbeds between basalt flows. Composition is sand, clay, and conglomerate. Layers of well sorted sand due to reworking by streams form important aquifers with intervening clay aquitards. Upper and lower sand zones supply all or part of the drinking water supply for most major cities in the basin. Where occurring as interbeds between basalt flows, the Ellensburg Formation forms either aquifers or semi-confining layers depending on local properties.

Tieton Andesite - The Tieton andesite consists of young volcanic rock erupted in Goat Rocks area (upper Tieton drainage). A large lava flow descended the Tieton River canyon and covers the Naches Heights area (upland south of Naches River, west of Yakima). Structure and hydraulic properties are thought to be similar to those of the Columbia River Basalts (Kinnison and Sceva, 1963).

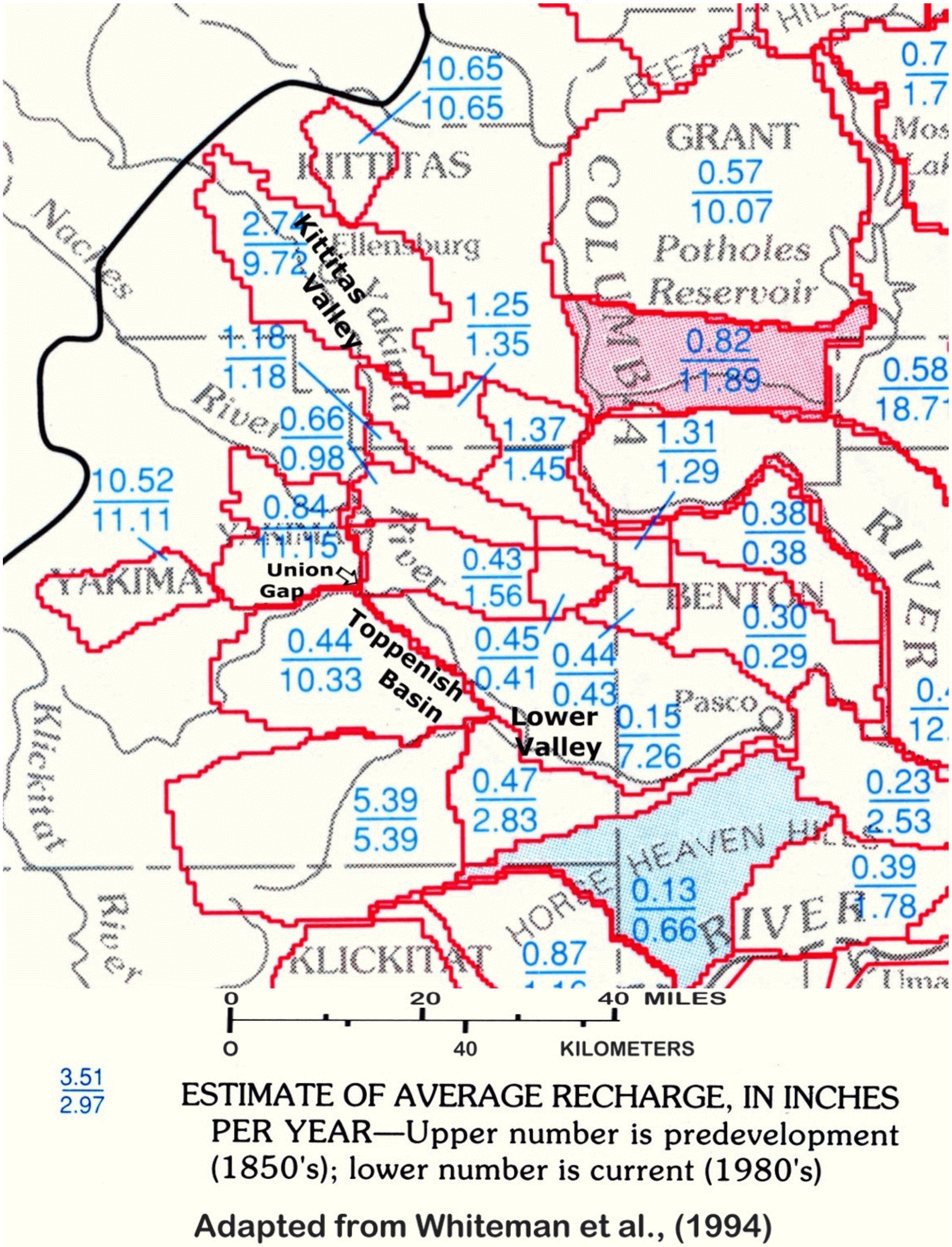
Alluvium - Gravel, sand, and silt deposited by the Yakima River and its tributaries during uplift and glaciation form an extensive alluvial aquifer system in both the Cascade and Columbia Plateau provinces. Gravels form moderate to high permeability aquifers. The alluvial aquifers provide water to domestic and irrigation wells.

Distribution of Recharge Sources -

Groundwater recharge sources include precipitation and the application of irrigation water.

Precipitation and Runoff - The strong rainshadow effect causes an uneven distribution of precipitation induced recharge. Steep, low permeability rocks in the Cascades favor runoff over infiltration. Under pre-development conditions, streamflow provided recharge to alluvial aquifers; infiltration from precipitation provided some recharge to uplands. Most precipitation falling in the unirrigated drier parts of the basin leaves as evapotranspiration.

Application of Irrigation Water - Application of irrigation water caused increases in recharge over pre-development conditions by a factor estimated to range from of about 10 in the Kittitas Valley to about 50 in the hotter, dryer lower valley (Whiteman et al., 1994, see figure 2.2.).



10.65
10.65
KITTITAS
Kittitas Valley
2.74
9.72
Ellensburg
Yakima
GRANT
0.57
10.07
Potholes Reservoir
COLUMBIA
1.25
1.35
1.18
1.18
River
0.66
0.98
0.82
11.89
0.58
18.71
1.37
1.45
1.31
1.29
10.52
11.11
0.84
11.15
River
0.43
1.56
0.38
0.38
RIVER
YAKIMA
Union Gap
BENTON
0.30
0.29
0.44
10.33
Toppenish Basin
0.45
0.41
0.44
0.43
Pasco
Lower Valley
0.15
7.26
Klickitat
0.47
2.83
5.39
5.39
0.23
2.53
HEAVEN HILLS
0.13
0.66
0.39
1.78
RIVER
River
KLICKITAT
HORSE
0.87
0 20 40 MILES
0 40 KILOMETERS
3.51
2.97
ESTIMATE OF AVERAGE RECHARGE, IN INCHES PER YEAR—Upper number is predevelopment (1850's); lower number is current (1980's)
Adapted from Whiteman et al., (1994)

Figure 2-2

Structural Control of Groundwater Flow -

Folding and faulting divided the Yakima River basin into a number of relatively independent groundwater basins and subbasins (Kinnison and Sceva, 1963). Most flow from one basin to another is by surface flow (including canals), little is groundwater underflow. Local flow systems develop within each subbasin, meaning that recharge and discharge occur locally within each subbasin. Within basins, streams are generally losing (contributing surface water to groundwater) at the upstream ends, and gaining (groundwater contributing to streamflow) at the downstream end of the basin. Seepage from streams to the alluvial aquifer system occurs at the upstream ends of the alluvial floodplain reaches within each basin. Recharge from precipitation and irrigation is distributed through the basin. At the downstream end of the basin, sedimentary aquifers pinch out, causing groundwater discharge to river and tributaries. Permeability of basalt aquifers decreases on the anticlinal ridges, so basalt aquifers discharge by upward vertical leakage through overlying strata and to the river.

The sedimentary aquifers in the basins store water during times of high precipitation, streamflow, or irrigation application, and release water to streamflow during drier, low flow times. These aquifers act “as the flywheel on an engine” sustaining streamflow during times of low precipitation and runoff (Kinnison and Sceva, 1963).

Patterns of Groundwater Flow -

Groundwater flow directions and quantities are influenced by topography, geology, distribution of recharge, and the surface water network.

Water table contours in the shallow aquifers closely mimic surface topography indicating that groundwater flow directions generally parallel the surface water drainage network. Water level contours in the deeper aquifers are more muted versions of surface topography, but show local discharge to surface water. Some interbasin underflow is inferred in deeper layers in some places.

Flow paths converge toward streams at the downgradient ends of basins. In the basalt aquifers, upward vertical hydraulic gradients (increasing water pressure with depth) drive flow from deeper to shallower layers and then to streams at the downstream end of the subbasins (Kinnison and Sceva, 1963; Foxworthy, 1962).

Local, intermediate, and regional flow systems occur simultaneously in the Columbia Plateau as a result of the structure and stratigraphy of the region.

Change Over Time -

Substantial rises in water table elevations were recorded during the early history of irrigation in the basin (Kinnison and Sceva, 1963). Agricultural drains were cut to control high water tables and prevent alkaline soils. Some drains used existing surface water channels.

Irrigation brought about a change in the seasonal patterns of groundwater recharge. Under pre-development conditions, most recharge during the winter and spring occurs when precipitation is highest and evapotranspiration is low. Current recharge follows the seasonal patterns of irrigation diversion and application. As a result, water levels in wells show two distinct seasonal patterns, depending on whether the well is influenced by surface water irrigation. Groundwater pumping for agricultural purposes also affects seasonal and long term water level change.

The frequency, duration, and a real extent of floodplain inundation has been reduced by storage, among other causes. Recharge of the alluvial aquifer system with cold freshet flows is reduced. Irrigation has increased aquifer recharge, but has also delayed it, increasing the mean temperature of infiltrating water.

Groundwater and River Ecology -

Contemporary river ecology emphasizes the influence of alluvial floodplain reaches interacting with a normative hydrograph on the production and survival of anadromous fishes and associated aquatic food webs in gravel bed river systems (Independent Scientific Group, 1996; Stanford and Ward, 1988). Under conditions of unregulated streamflow and connectivity between river and floodplain, alluvial aquifer systems in the floodplain reaches capture cold snowmelt-generated runoff from winter through early summer, and subsequent groundwater discharge during baseflow conditions moderates streamflow and temperature, creating favorable conditions for cold water fishes and associated food web components in semi-arid basins. The natural hydrograph creating and interacting with complex surface and subsurface (hyporheic) habitats formed the template that determined the distribution and abundance of aquatic species.

In the Yakima basin, bedrock constrictions between alluvial subbasins control the exchange of water between streams and the aquifer system. Under pre-development conditions, vast alluvial floodplains were connected to complex webs of braids and tributary channels. These large hydrological buffers spread and diminished peak flows, promoting infiltration of cold water into the underlying gravels. Side channels and sloughs provided a large area of edge habitat and a variety of thermal and velocity regimes. For salmon and steelhead, these side channel complexes increased productivity, carrying capacity, and life history diversity by providing suitable habitat for all freshwater life stages in close physical proximity. The hyporheic zone (zone of shallow groundwater made up of downwelling surface water) extended the functional width of the alluvial floodplain and hosted a microbe- and invertebrate-based food web that augmented the food base of the ecosystem. As snowmelt-generated runoff receded through the summer, cool groundwater discharge made up an increasing proportion of streamflow. Much of this groundwater upwelled from the gravel into complex channel networks upstream of bedrock constrictions.

Temperature is a key environmental variable for salmonids and other stenotherms. River/floodplain interactions provided cool, clear base flows during times of low flow and high air temperatures, creating thermal refugia for out-migrating smolts and returning adults moving through the hot lower basin. In winter, upwelling groundwater prevented freezing and drove the flow of oxygenated water through the gravel substrate, providing excellent conditions for incubating eggs and alevin (Ring and Watson, 1999).

2.7.3 Surface Water Quality

The Washington Administrative Code (WAC) separates waters of the State into five classes: AA, A, B, C, and Lake. "Characteristic uses" are given for each of these classifications and criteria to support the uses are specified within the WAC. The characteristic uses for Class AA and Class A waters are domestic, industrial, and agricultural water supply; stock watering; salmonid and other fish migration, rearing, spawning and harvesting; wildlife habitat; recreation; and commerce and navigation. These characteristic uses are to be maintained and protected and no further degradation is to be allowed. When there is a need to protect or improve water quality in a specific waterbody the most sensitive of the identified uses are targeted. While Class AA and Class A waters have substantially the same uses, some of the specific water quality criteria are less stringent for Class A waters. For instance, in Class AA waterbodies the criteria for dissolved oxygen is "shall exceed 9.5 mg/L," while in Class A waterbodies the criteria is "shall exceed 8.0 mg/L." For Classes B and C waters some of the characteristic uses and the standards are further reduced, as are the characteristic uses that these poorer quality waterbodies are expected to support. Criteria for Lake Class are similar to those of Class A waters. Waters within national forest and national park boundaries are designated as Class AA. All other non-lake waters are generally Class A unless specifically identified (see appendix A-1, WAC 173-201A-030).

The Yakima River from its junction with the Cle Elum River (RM 186) to its headwaters is designated as Class AA, as is the Naches River from RM 35.7 to its headwaters. Tributaries to the main stem Yakima and Naches Rivers in these upper reaches are also designated as AA. Below these points to their mouths, the Yakima and Naches Rivers and tributaries are Class A except for Sulphur Creek, an agricultural return drain (originally an ephemeral creek) that is a tributary to the lower Yakima River, which is designated as Class B. There are no Class C waterbodies within the Yakima basin.

Typically, water quality in the upper portions of the basin is high, but degrades downstream. In several reaches of the main stem Yakima River and its tributaries, water quality does not comply with one or more State water quality criteria, either seasonally or on a year-round basis. When a waterbody fails to meet State water standards it is placed on the State 303(d) list and targeted for a Total Maximum Daily Load (TMDL). The 303(d) list is prepared every 4 years by the State of

Washington and submitted to U.S. Environmental Protection Agency (EPA) in compliance with the Federal Clean Water Act. The list identifies waterbodies that are known to exceed State water quality standards. A TMDL must be completed for all water bodies on the 303(d) list unless it can be determined that the original decision was incorrect, the problem no longer exists, or "natural conditions" are being met. TMDLs (or Water Cleanup Plans) are designed to address a variety of pollution problems and provide remedies to bring the water back into compliance with standards and meet its highest targeted use.

Many river and stream reaches within the Yakima basin are included on the 303(d) list. Pollutants include turbidity, pesticides, low dissolved oxygen, elevated temperatures, metals, fecal coliform bacteria (FC), and pH (see appendix A-2, 1998 303(d) list for WRIAs 37, 38, & 39).

Sediment -

Significant suspended sediment loads have been associated with the discharge of agricultural return flows to the river during the irrigation season. The prevalence of suspended sediment from eroded farm soils has long been recognized as a problem in the tributaries and main stem of the Yakima River where furrow and flood irrigation are employed. In the lower basin, high sediment levels have been correlated with high levels of turbidity and high levels of FC, which exceed water quality standards during the irrigation season (WDOE, 1997). This is particularly apparent in the reaches below the City of Yakima. It has been observed to a lesser extent in the upper Yakima River main stem and some of the tributaries that drain the Kittitas Valley.

Suspended sediment has been directly correlated with the presence of the banned pesticide DDT in some of the drains and in the main stem Yakima. DDT and its breakdown products have been found in fish tissue well in excess of recommended human health criteria. It is suspected that the agricultural drain systems also may be associated with the transport of other pesticides, FC, and nutrients such as phosphorus and nitrites to the Yakima River.

The ongoing lower Yakima River Suspended Sediment and DDT TMDL is designed to reduce suspended sediments, improve water clarity, and reduce pesticides (most notably DDT) in the river. Turbidity standards, which are being used as a surrogate for sediment loads, have been set for the irrigation returns and tributaries discharging to the lower Yakima River. These enforceable limits, set in 5-year increments over the next 15 years, will improve water clarity and reduce the amount of sediment and pesticides entering the river. The primary implementation activities of this TMDL will be to improve irrigation water management practices and reduce tailwater runoff.

To accomplish these goals, growers are being encouraged to convert furrow and flood irrigated fields to sprinkler and drip irrigation or to install facilities to remove sediment from return water. Conversion to sprinkler and drip systems will essentially eliminate surface water runoff, its associated erosion, and suspended sediment. Water delivered to crops in this manner can be much more precisely and efficiently applied. The Roza-Sunnyside Board of Joint Control developed and is implementing policy that will require grower observance of the TMDL targets. The policies are enforced by the potential reduction or denial of service by the districts to growers who refuse to come into water quality compliance.

Temperature -

Exceeding temperature criteria is the most prevalent pollutant parameter on the1998 State 303(d) list for the Yakima basin. Of the 180 listings in the Yakima basin on the 1998 list, 73 are for failure to meet temperature criteria. The criterion for maximum allowable temperature is 18 °C for Class A waters and 16 °C for Class AA waters or "natural conditions." The main stem Yakima River below the confluence of the Cle Elum River has a special temperature criteria of 21 °C. Because many factors affect stream temperature, determining natural conditions is difficult. Modeling is generally used to estimate natural conditions and to determine the influence of proposed mitigation or restoration activities.

The highest temperatures have occurred in the lower portion of the basin, although there are numerous 303(d) listings in the upper basin tributaries. Water is usually cooler in the upper basin, but warms as it flows to the lower basin. Human activities have dramatically altered the Yakima River system in ways that may influence water temperature, such as changes to channel morphology; removal of riparian cover; and disruption of floodplain function, hyporheic flow, and flow regimes.

A prototype temperature TMDL is under way in the Teanaway basin. Implementation is focused on restoring riparian shade and reducing the width/depth ratio through improvements in sediment control. Modeling has shown that increases in flow would also help reduce temperatures. The Reclamation, under Title XII, has an ongoing project to increase flow in certain portions of the lower Teanaway through removal and relocation of irrigation diversions and the purchase or lease of irrigation water rights.

Fecal Coliform Bacteria -

There are 18 303(d) listings for FC in the Yakima basin. FC contamination is found periodically in several reaches of the Yakima River and regularly in several tributaries. These pollution problems are often noted downstream of areas where livestock operations are prevalent or failing septic systems are suspected. Activities that will reduce FC include a sediment TMDL that targets the reduction of surface water runoff from agricultural lands; recent dairy legislation including periodic compliance inspections; local irrigation district policies requiring the exclusion of livestock from drain and watercourses; and increased monitoring to identify failing septic systems. A Granger Drain FC TMDL was developed and is being implemented to specifically reduce bacterial loadings to the Granger Drain, a tributary of the lower Yakima River through best management practices directed at seducing the runoff of suspended sediment from irrigated agricultural lands.

Pesticides and Other Organic Compounds -

There are 46 listings for pesticides and organic compounds on the 1998 State 303(d) list in the Yakima basin (WDOE, 1998). Pesticides and other organic compounds continue to have a significant presence in the Yakima River system. During a 1987-91 study, USGS scientists detected more than 110 different organic compounds in Yakima River basin streams. These findings included pesticides applied to agricultural fields during that period, persistent pesticides used historically (such as DDT), and organic compounds associated with industrial and urban activities (Morace et al., 1999). Sampling and analysis by USGS in 1999 and 2000, for a large suite of pesticides and chemicals will yield more information on the prevalence of these pollutants.

Metals -

There are 16 listings for metals in the Yakima basin on the 1998 303(d) list, including arsenic, silver, mercury, cadmium, and copper. The findings of 1999 sampling and analysis by WDOE personnel will likely result in the removal of several of these listings in the upper Yakima basin.

Nutrients -

Nutrients include nitrate/nitrite nitrogen, ammonia nitrogen, and phosphorus. Giffin Lake, which receives return flows from agriculture, is 303(d) listed for phosphorus. Two waterbody segments, Selah Ditch and Granger Drain, are listed for ammonia nitrogen (WDOE, 1998).

Dissolved Oxygen and pH -

There are nine dissolved oxygen (DO) listings in the Yakima basin; all occur in areas heavily influenced by agricultural return flows. There are also four listings for pH. Both DO and pH have a tendency to react to other changes in the water quality. DO may fall out of compliance with standards as water temperature increases, and as decomposing compounds that require oxygen (biological oxygen demand) are added to the waterbody. pH may rise above criteria levels as water levels drop and aquatic plants thrive, changing the chemistry of the waterbody.

Instream Flow -

Eight stream segments are listed for insufficient instream flow in the Yakima basin. Of these, two are in the main stem of the Yakima River itself. While there are no State water quality standards for low instream flows at this time, insufficient flow can interfere with many of the characteristic uses and influence other pollutant criteria in a waterbody. The EPA and the U.S. Supreme Court have indicated that low instream flow can be considered pollution and will be addressed by increasing instream flows using such methods as buying water rights and implementing water conservation measures on agricultural lands.

2.8 NATURAL RESOURCES

2.8.1 Wildlife

The Yakima River basin contains a broad spectrum of wildlife and the habitats in which they exist. For the purposes of this document, wildlife that generally exist in similar habitat types were grouped together. Seven habitat types are described and the species that are often found in each habitat type are mentioned. No attempt was made to list all the species present, and some species are found in more than one habitat type. The species of plants and wildlife mentioned for each habitat type were ones that are usually present or ones of special interest to the Yakima River basin which may include those listed as threatened or endangered under the Endangered Species Act (ESA). The specific vegetative community typically defines the habitat types and are included in table 2-6. They are: 1) coniferous forest; 2) scrub-shrub; 3) shrub-steppe; 4) riparian; 5) wetland; 6) agricultural; and 7) vegetated urban/developed habitat.

2.8.1.1 Coniferous Forest

Coniferous forests on the east slopes of the Cascade Mountains are usually dominated by Douglas fir, grand fir, or ponderosa pine. As rainfall decreases toward the east, ponderosa pine tends to be the lone dominant species. Coniferous forests are typically used by elk, deer, furbearers, raptors, owls, herons, grouse, and many other species, including Ute ladies'-tresses. Common understory shrubs include huckleberry, Oregon grape, and snowberry. The dominant ponderosa pine forest may include bitterbrush and big sagebrush as understory species. Young regenerating coniferous forests include recently planted clearcuts dominated by Douglas fir and western hemlock.

Other conifer species may be present depending upon species planted or naturally regenerating. Understory vegetation in these forests includes young red alder, blackberry, salmonberry, sword fern, and bracken fern. Stands of old-growth forest occur in the area with patches of old growth being dominated by western hemlock or silver fir. Patches of quaking aspen are scattered in moist sites; small aspen groves and Oregon white oak occur in the area at Swauk Creek in Kittitas County.

Table 2-6.–General Habitat Type, Common Species Present and Species of Special Interest

Habitat Type	Examples of Typical Common Wildlife Species	Species of Special Interest
Coniferous forest, east of the Cascade Crest	Common raven, hairy woodpecker, Clark's nutcracker, Swainson's thrush, white-breasted nuthatch, chipping sparrow, Cassin's finch, yellow-pine chipmunk snowshoe hare, porcupine, elk, bear, long-toed salamander.	Gray wolf, Grizzly bear, fisher, Canada lynx, Marbled murrelet, Northern Spotted owl, osprey, Bald eagle, Northern goshauk, Ute ladies'-tresses.
Scrub-shrub (shrubby plant communities, usually within maintained rights-of-way or recently harvested forest)	Western fence lizard, northwestern garter snake, dark-eyed junco, song sparrow, Mac Gillivray's warbler, Townsend's mole, Townsend's vole, vagrant shrew, Nuttall's cottontail.	Peregrine falcon, Swainson's hawk, ferruginous hawk, prairie falcon, turkey vulture.
Shrub-steppe (is the predominant native habitat type dominated by native grasses and sagebrush)	Western skink, loggerhead shrike, Western meadowlark, Brewer's sparrow, Say's phoebe, red-tailed hawk, northern harrier, common raven, chukar, turkey vulture, great basin pocket mouse, bushy-tailed woodrat, Nuttall's cottontail, northern pocket gopher, yellow-bellied marmot, badger, coyote, bats, mule deer.	Swainson's hawk, ferruginous hawk, prairie falcon, turkey vulture, long-billed curlew, Sage grouse.
Riparian areas (consists of vegetation along streams and rivers)	Canada goose, mallard duck, wood duck, pintail duck, rough grouse, black-capped chickadee, yellow warbler, downey woodpecker, beaver, raccoon, Pacific tree frog.	Same as above.
Wetland areas (include wet meadows, seeps, small shallow ponds and lakes, marshes, and riparian wetlands along streams)	Great blue heron, small shorebirds, muskrat, Canada goose, mallard duck, wood duck, pintail duck, common snipe, racoon, Cascade frog, Pacific tree frog.	Same as above and Columbia spotted frog.
Agricultural areas (cropland, hay/pasture, grass/forb)	Gopher snake, European starling, Brewer's black-bird, brown-headed cowbird, ring-necked pheasant, mourning dove, horned lark, Western meadowlark, killdeer, northern flicker, red-tailed hawk, northern harrier, American kestrel, black-billed magpie, quail, long-billed curlew, Canada goose, coyote, bats, striped skunk, deer mouse.	Same as above.
Vegetated urban/developed areas (parks, golf courses)	White-crowned sparrow, northern flicker, American robin, European starling, striped skunk, bats, deer mouse.	

2.8.1.2 Scrub-shrub

Scrub-shrub vegetation primarily occurs in intensively managed areas, but also includes riparian areas adjacent to rivers and streams. Commonly occurring shrubs include vine maple, young cottonwood, salal, blackberries, salmonberry, hazelnut, rose, snowberry, young alder, and willows. Wildlife species that utilize this habitat are deer, coyote, rabbits, small rodents, raccoon, waterfowl, raptors, sparrows, warblers, and a variety of small reptiles.

2.8.1.3 Shrub-steppe

Shrub-steppe is the predominant native habitat type from approximately Ellensburg to Pasco; however, large-scale conversion to cropland and rangeland has left only about 5 percent of the historic extent of shrub-steppe in relatively undisturbed condition based on estimates by the Washington Natural Heritage Program. Examples of some species that utilize shrub-steppe habitats include loggerhead shrike, Western meadowlark, sage grouse, mule deer, coyote, rabbits, and a variety of small reptiles.

While undisturbed shrub-steppe habitat is very rare, moderately disturbed shrub-steppe communities are fairly common, being impacted to various degrees from grazing, weed infestations, and other disturbances. About 26 percent of the relatively undisturbed shrub-steppe habitat is dominated by native grasses and sagebrush, with an intact cryptogam crust (a thin layer of moss and lichen that indicates an undisturbed community), and contains mostly native shrubs (e.g., big sagebrush and bitterbrush) with a predominantly native grass understory. This habitat type, while previously disturbed by grazing, off-road vehicle use, and other disturbances, still provides cover, food, and nesting habitat for many species of wildlife. The importance of these areas is enhanced by the overall lack of vegetative cover during winter within the cultivated fields that are common in the area.

2.8.1.4 Riparian

Riparian habitat generally occurs adjacent to flowing water (e.g., streams and canals) and contains elements of both aquatic and terrestrial ecosystems that mutually benefit each other (WDFW, 1995). Riparian communities are not controlled by the surrounding vegetation community, but by available water, soil, stream channel substrate and morphology; elevation and latitude; climate; and land-use history (Brinson et al., 1981). A dynamic interaction exists between water and plants in the riparian zone such that the availability of water supports plants that could not otherwise survive in semi-arid regions, and the type of vegetation that survives reflects the water regime that supports it.

Benefits of properly functioning riparian communities include improved water quality; filtration of sediments; streambank stability; moderated streamflow (reduced flood damage); retention of water that extends late season flow; restoration of perennial streamflow; groundwater recharge; erosion protection; aggradation or maintenance of high water table; increased recreational opportunities; critical habitat for fish and wildlife; increased biological diversity; increased forage; and enhanced esthetics (Ohmart and Anderson, 1986; Bureau of Land Management [BLM], 1991a). Plants in riparian zones, and the many animals supported by it, are important to Native Americans and others.

Undisturbed riparian communities provide abundant food, cover, and water for wildlife. Riparian vegetation supplies food and cover for insects emerging from the river as well as its own resident invertebrate populations. These invertebrates, in turn, support numerous mammals, birds, reptiles and amphibians, and other invertebrates. For these reasons and others, riparian areas generally provide high-value wildlife habitat.

About 90 percent of Washington's land-based vertebrate species use riparian habitat for essential life activities. Existing riparian conditions in the Yakima River basin vary, ranging from severely degraded to nearly pristine. Good riparian habitat generally is found along some forested headwater reaches, whereas degraded riparian habitat is concentrated in the valleys and is frequently associated with agriculture, grazing, and fluctuating regulated streamflow.

The Yakima River basin still contains remnants of contiguous aquatic and riparian vegetative cover types suitable for wildlife habitat. Riparian habitats are associated with the backwaters, sloughs, and oxbows, as well as the main river channel. Higher elevation riparian forests (which typically contain cottonwood, alder, willow, and other species) are used by elk, deer, furbearers, raptors, grouse, many neotropical bird species, Pacific tree frog, and many other species. At lower elevations, the riparian forests (which typically contain cottonwood, willow, silver maple, mulberry, hackberry, and other species) are used by mule deer, furbearers, rodents, bats, raptors, owls, herons, water fowl, pheasant, quail, neotropical bird species, and many other species.

Riparian herbaceous habitat is common along many of the irrigation canals and drains, mainly because of regular disturbance (mowing, burning, pesticides) to destroy weeds. Irrigation districts have noxious weed control programs on ditchbanks and rights-of-way. Woody vegetation makes up a very small percentage of the total plant cover along canals. Oakerman (1979) found that unlined canal/drain systems had more value as wildlife habitat than lined canal/drain systems. For example, within the WIP, unlined canals and drains provide habitat (nesting, brood rearing, feeding, and thermal and escape cover) for upland game, waterfowl, furbearers, and many non-game birds (Yakama Nation, 1992).

Since no historical reference has been done on the past versus current status of riparian areas in the basin, the following discussion is based on national and State trends. Riparian areas are currently estimated to encompass less than 1 percent of the land base in the Pacific Northwest, yet they support the greatest diversity and abundance of wildlife in the arid portions of the region (FWS, 1990). For the United States as a whole, about 70 to 90 percent of the natural riparian areas have been lost because of human activities (Ohmart and Anderson, 1986). Because of the importance of riparian areas combined with the large losses that have already occurred, remaining riparian areas must be protected.

Efforts are currently being made to preserve, restore, and enhance riparian areas in the basin. BPA has funded or intends to fund projects benefitting riparian areas at Sunnyside, Wenas, and on the Yakama Indian Reservation (BPA et al., 1994; 1996). The YN has also contributed to protecting and enhancing riparian areas along the Yakima River and plans to protect and manage additional areas as well (Yakama Nation, Waterfowl Biologist, personal communication, 1996). On several wildlife areas in the basin, the Washington Department of Fish and Wildlife (WDFW) is also protecting and managing riparian areas along the Yakima, Tieton, and Naches Rivers, and Taneum, Manastash, Umtanum, Wenas, Oak, and South Fork of Cowiche Creeks. The BLM manages land along the Yakima River northwest of Yakima and is attempting to improve wildlife habitats, including riparian areas (BLM, 1991b). The Yakima Greenway Foundation protects and manages riparian forest along the Yakima River in and near Yakima.

The U.S. Department of Agriculture Wildlife Habitat Incentives Program offers an opportunity for landowners to obtain financial and technical assistance to enhance riparian habitats. The U.S. Forest Service has a variety of policies and regulations which provide protection to riparian areas.

Riparian habitats are degraded along Toppenish and Satus Creeks because of draining and excessive livestock grazing. Although current land use practices limit this type of habitat, residual vegetation remaining through the winter is necessary to provide critical early spring nesting cover for many species. Spring burning of canal banks is generally followed by herbicide applications through the summer. Late spring burning has decreased active waterfowl and pheasant nesting (Oakerman, 1979; Oliver, 1983). Ducks use the canals and drains of irrigation facilities and areas of undisturbed wetland habitat. Vegetation overhanging water channels provides valuable escape and feeding cover for waterfowl broods. Much of this type of vegetation has been removed to improve flows, eliminating many miles of channels and creeks for use by waterfowl broods.

2.8.1.5 Wetlands

Wetlands in the basin are located along the major streams and rivers, especially along the Kittitas Valley, the lower Yakima River floodplain, and Toppenish and Satus Creeks. Additional wetlands were found along smaller tributaries, at seeps and springs, higher elevation wet meadows, and along the shorelines of natural lakes. Many of these wetlands have been lost or degraded.

As a trend, the State of Washington has seen a decline of wetlands of about 30 percent (about 940,000 acres remain from about 1,350,000 acres originally). The loss of inland wetlands in Washington has been estimated at 25 percent (FWS, 1990). Losses have been attributed to agriculture conversion (drainage and leveling for crop production), floodplain gravel mining, filling for solid waste disposal, road construction; and commercial, residential, and urban development; construction of dikes, levees, and dams for flood control, water supply, and irrigation; discharges of materials (for example, pesticides, herbicides, nutrient loading from domestic sewage and agricultural runoff; and sediments from agriculture and other land development); hydrologic alteration by canals, drains, spoil banks, roads, and other structures; and groundwater withdrawal.

Aside from the direct loss of wetlands, many wetlands have been reduced in quality from some of the above factors.

Stream restoration efforts are premised on the idea that wetland and riparian area functioning is tightly linked to overall ecosystem functioning and productivity (Kauffman et al., 1997). It has been suggested by others that if activities that cause the most ecosystem damage could be altered, the system will likely restore itself to some extent.

Continuing threats to wetland functions include overgrazing, intensive adverse agricultural practices (including increased chemical uses, buffer removal, feedlots, and dairy operations in and near wetlands), erosion, high water temperature, poor water quality of irrigation return flow, exotic species (for example, carp and purple loosestrife), dessication, and fairly recently, the changes in older irrigation systems which reduced associated wetlands (for example, lining canals and changing from open waterways to piped and pressurized systems).

Efforts have been made to protect some remaining wetlands (Sunnyside Wildlife Area, Toppenish National Wildlife Refuge, Yakima Greenway, and several units managed by YN). Over 300 acres of wetland/riparian areas along the Yakima and Naches Rivers were recently acquired by the Corps and are being managed by WDFW to help fulfill mitigation for construction of Lower Snake River dams and reservoirs. Several other Federal, State, Tribal, and local agencies are involved in restoring and enhancing wetlands in the basin.

Opportunities to protect and enhance wetlands include YRBWEP's water and land acquisition program, mitigation under the Basin Conservation Program, Federal Aid in Wildlife Restoration, Migratory Bird Conservation Fund, Land and Water Conservation Fund, and the Wetland Reserve Program.

Wetlands are critical ecological systems of enormous importance to a wide range of wildlife species because they provide specialized habitat values not found in upland areas. These habitat values include providing cover, water, shade, forage habitat, rearing habitat, breeding habitat, brood-rearing habitat, loafing areas, winter habitat, relief from extreme summer or winter temperatures, and biodiversity (Weller, 1986). Wetlands are among the most productive ecosystems in nature because of the ready availability of water, nutrients, and energy in such close proximity (Weller, 1986). Wetlands also provide flood conveyance, shoreline protection, flood storage, water quality enhancement, sediment control, recreation, groundwater recharge, and esthetics.

The riverine-wetland complex would have been integral to the ecosystem that evolved in the Yakima River basin. Wetlands would have served several purposes important to wildlife such as they provide nutrients that contribute to the ecosystem and wildlife productivity; provide backwater areas for feeding; loafing and security; and provide for a productive wildlife food source.

Of the approximately 43,695 acres of wetlands in the basin, about 19,000 are palustrine herbaceous (emergent marsh, aquatic bed), and 19,000 acres are palustrine woody (shrubs and trees). These wetlands include wet meadows; seeps; small shallow ponds and lakes; marshes; and riparian wetlands along streams. Aside from natural wetlands, many wetlands have formed and been maintained from artificial water sources such as reservoirs, sewage lagoons, stock ponds, irrigation canals, and irrigated cropland runoff. Other wetland areas include lakes and streams (about 29,000 acres) and marshy unvegetated areas (about 4,000 acres). Total wetland areas equal about 2 percent of basin area.

In the semi-arid lowlands, wetlands are critical to many species of wildlife because they provide good vegetative growth for food and cover, invertebrate production, and water. Recognition of the value of wetlands has historically focused on waterfowl populations, and tens of thousands of waterfowl can be found in the lower Yakima River basin in winter and during migration. Oliver (1983) estimated that up to 300,000 ducks wintered on the Yakama Indian Reservation in the 1960s. Many wood ducks in eastern Washington are bred and raised along the Yakima and Naches Rivers. Waterfowl within just the WIP account for about 20 percent of the population in eastern Washington (Yakama Nation, Waterfowl Biologist, personal communication, 1996). Also, as many as 40,000 Canada geese use areas flooded by Toppenish and Simcoe Creeks in the spring (BPA et al., 1994). Historically, sandhill cranes and swans nested in the basin and could conceivably return if wetland restoration and enhancement efforts were to continue (Parker, 1989 as cited in FWS, 1996). Many other birds, mammals, amphibians, and reptiles depend upon riparian areas.

As in other Yakima River basin areas, most emergent wetland habitat in the Satus and Toppenish Creek areas has been removed through draining and land leveling much the same fate as befell wetlands in the Kittitas Valley, Gap to Gap reach, Wenas, Ahtanum, and other once lush riverine wetland areas. Along most of these stream reaches, remaining areas are heavily grazed during spring and summer months, further decreasing their potential as wildlife habitat. Basic protection and enhancement activities have excellent potential to increase the quality of furbearer, songbird nesting, and waterfowl brood-rearing habitat (BPA et al., 1994). Toppenish and Satus Creeks, with their low gradient, braided channels, and abundant sloughs and wetlands, provide excellent wintering habitats for wildlife. Spring floods immerse large acreages of pasture land next to the creeks. These flooded areas are heavily used by migratory waterfowl, annually attracting 20,000 to 40,000 of the Taverner's subspecies of Canada geese en route to nesting grounds on the North Slope of Alaska. Streambanks and nearby wetlands provide wintering habitats for upland game bird and waterfowl use. Refuges along Toppenish Creek provide important sanctuaries, especially for migratory and wintering waterfowl.

2.8.1.6 Agricultural

Agricultural land in the southern two-thirds of the basin contains large tracts of orchards, vineyards, and hop fields, as well as a wide variety of other crops. Pasture, hay, corn, and wheat are the primary uses of agricultural land in the northern portion of the basin. Historically, croplands provided much higher quality habitat than exists in most places today. However, more efficient irrigation practices, larger fields, changes in crops, removal of fence rows, increased herbicide use, and other changes removed much of the wildlife habitat. Cropland and pasture in the lower Yakima River basin can still be very important to large numbers of wintering waterfowl (especially mallard duck and Canada goose); however, their numbers do not approach the 300,000 recorded in the 1960s (Oliver, 1983). Irrigated agricultural valleys provide habitat for a variety of wildlife, including pheasant, quail, long-billed curlew, raptors, and small rodents. Canals and drains provide habitat for species such as muskrat, raccoon, bats, waterfowl, great blue heron, neotropical bird species, and small shorebirds. Orchards, vineyards, and hop fields provide only marginal habitat for some wildlife, including American robin, mourning dove, California quail, western meadowlark, and gopher snake.

2.8.1.7 Vegetated Urban/Developed

Vegetative urban areas have essentially the same vegetive species as described in the shrub-steppe habitat, with the addition of mostly non-native weed species. Developed areas include land which is essentially cleared of all native vegetation such as residential property, parks, and golf courses. These areas are typically dominated by lawns, shrubs, and trees that are relatively intensively managed through mowing, pruning, cultivating, and fertilizing. Vegetative urban/developed areas are important to large numbers of wintering waterfowl (especially mallard duck and Canada goose). Many State, county and city parks, and golf courses provide marginal habitat for some wildlife, including American robin, mourning dove, California quail, western meadowlark, gopher snake, and provide important sanctuaries for a myriad of other wildlife which have adapted to human presence. Non-native weed species are those species that easily invade farmland, decrease forest productivity, and alter ecosystems by out-competing native vegetation. Non-native weeds are commonly annual and perennial forbs. In eastern Washington and the Yakima River area, non-native weed species are ox-eye daisy, purple loosestrife, orange hawkweed, diffuse and spotted knapweed, yellow star-thistle, yellow toadflax, rush skeleton weed, and Canada thistle.

2.8.2 Fisheries

A diverse array of fish species inhabit the Yakima River basin including a number of exotic species (table 2-7.). For the purpose of this document, fish that exhibit similar life history and habitat characteristics were grouped together. All species were placed into one of five groups, some fish were placed into more than one (i.e., bull trout and rainbow trout). The groups include: anadromous (e.g., chinook and coho salmon); resident migratory (e.g., pikeminnow, sucker); resident local (e.g., sculpin, dace); lentic (e.g., kokanee, pigmy whitefish); and exotic (e.g., bass, catfish). Described below are the unifying characteristics of each group including a list of species present today. Current distribution and abundance patterns are presented in table 2-7.

2.8.2.1 Anadromous

Anadromous fish spend most of their adult life in the marine environment and return to freshwater streams to spawn. Egg incubation, and juvenile growth and development occur in the freshwater streams for various amounts of time depending on species and race. The Yakima River basin once supported healthy anadromous salmonid populations of spring, summer and fall chinook salmon, coho salmon, sockeye salmon, and steelhead. Species present today include: spring and fall chinook salmon, summer steelhead, and coho salmon (table 2-7.). Three species are considered functionally extinct and include sockeye and summer chinook. Coho salmon have been reintroduced via artificial propagation from efforts of the Yakima-Klickitat Fisheries Project (YKFP).[10] All anadromous salmonid populations have experienced substantial declines. Once numbering in the hundreds of thousands, the composite anadromous totals are now less than 10,000 returning to the basin (Northwest Power Planning Council [NWPPC, 1990]). In early 1999, steelhead were listed as threatened under the ESA.

Except for streams rendered inaccessible or unusable by unladdered dams or by excessive irrigation diversions or releases (e.g., Taneum, Manastash and Wenas Creeks; the lower Tieton River) the current distribution of spring chinook spawning areas is the same as it was historically (Tuck, 1995). In the Yakima River, spawning spring chinook are found upstream of Ellensburg and upstream of the Tieton River confluence in the Naches River basin. Rearing juveniles are present in and downstream of spawning areas as far as Union Gap. Historic distribution of fall chinook salmon is largely unknown, but is believed to be similar as todays where most spawning is below Sunnyside Dam (Tuck, 1995). Previously, coho spawned in the upper reaches of the Yakima (above Ellensburg) and Naches (above the confluence of the Tieton River) Rivers and numerous tributaries (Tuck, 1995). Currently, the main spawning distribution for coho extends from Marion Drain to Easton in the Yakima and the upper Naches Rivers. The majority of spawning occurs below Ahtanum Creek to Marion Drain based on the Yakama Nation's radio telemetry study (1999-2001). Steelhead once spawned broadly throughout the Yakima basin. Most adult steelhead return to and spawn in Satus (47%) and Toppenish (11%) Creeks and the Naches River basin (32%). The remaining fish spawn in Marion Drain (2%), the Yakima River below Roza Dam (4%) and the upper Yakima River basin (4%) (Hockersmith et al., 1995). For information on timing of successive freshwater life stages of Yakima basin chinook (spring and fall), coho, and steelhead as well as recent productivity estimates for those species, see appendix B.

The Pacific lamprey is another anadromous species present in the Yakima basin. Little is known about current and historic distribution and abundance of this species. In other tributaries of the mid-Columbia River, Pacific lamprey population are considered depressed (Jackson et al., 1996).

[10] The YKFP is a joint project of the YN and the WDFW, the goal of which is to rebuild stocks of spring and fall chinook salmon and coho through hatchery supplementation.

2.8.2.2 Resident Migratory

Resident migratory fish are native species that reside in the Yakima basin nearly year-round. These fish exhibit migration at certain times of the year, primarily as adults moving to spawning grounds. Species included in this group are: mountain whitefish, northern pikeminnow, largescale sucker, mountain sucker, bridgelip sucker, rainbow trout, and bull trout. Although undocumented, distribution of resident migratory species in the main stem of the Yakima River today is believed to be unchanged except for bull trout. This notion is based on the fact that resident migratory fish currently occur throughout the basin (table 2-7.) and there is reason to believe they were there previously. However, the abundance has been reduced particularly in the lower basin (Patten, 1970). Resident migratory (fluvial) bull trout grow and mature in the main stem Yakima or Naches Rivers and then migrate during the late summer into the upper tributaries to spawn. (Bull trout that display resident local and adfluvial life histories will be discussed in other sections.) The status of fluvial bull trout is considered critical in the main stem Yakima River and unknown for the Naches River (WDFW, 1997). Bull trout were considered extirpated in the lower Yakima River by the 1950s.

2.8.2.3 Resident Local

Resident local fish are native species that generally do not exhibit large scale annual migration. These fish include: western brook lamprey, rainbow trout, westslope cutthroat trout, bull trout, chiselmouth, peamouth, redside shiner, longnose dace, leopard dace, speckled dace (Umatilla Dace), three-spine stickleback, piute sculpin, torrent sculpin, and mottled sculpin. All native species are present today. Bull trout are listed as threatened under the ESA. Little is known about the population of western brook lamprey, thus warranting the concern. The only significant populations of bull trout that exhibit the resident life form exist in the Ahtanum Creek and Teanaway River where populations are considered critical (WDFW, 1997). Other populations of resident bull trout probably exist in other tributary streams, but are likely small in size and would be difficult to detect without a significant amount of effort. Little historic documentation is available on the abundance and distribution of other resident local fish. In the mid-1950s, Patten et al. (1970) suggested that abundance of native fish in the lower Yakima River have experienced declines. Information available today (table 2-7.) generally supports Pattern et al. (1970) work. Rainbow trout and westslope cutthroat trout are major game fish and considered priority species in Washington (WDFW, 1991). Special regulations are in effect to preserve the quality of the angling in the main stem Yakima River for trophy rainbow trout.

2.8.2.4 Lentic

The unifying characteristic of these fish is that they reside primarily in reservoirs. All reservoirs except Rimrock were natural lakes that have since been impounded. Primary lentic species include: pygmy whitefish, kokanee, burbot, bull trout, rainbow trout, westslope cutthroat trout, redside shiner, suckers (largescale, mountain, and longnose), pikeminnow, sculpin, and dace. Sockeye salmon historically inhabited the basin’s natural lakes, but have since been extirpated when impassable dams were built in the early 1900s to create the reservoirs. Kokanee, a resident sockeye which resides solely in fresh water, were introduced as sport fish in the mid-1900s. Most of these species utilize reservoir tributaries for spawning, incubation, and early rearing, and include pygmy whitefish, kokanee, burbot, bull trout, rainbow trout, westslope cutthroat trout, redside shiner, suckers (largescale, mountain, and longnose), pikeminnow, sculpin, and dace. Historic and current abundance estimates of reservoir fish are unavailable with the exception of bull trout. Within the last 10 years, redd counts for bull trout have been conducted by WDFW on index reaches to reservoir tributaries. Data suggests that bull trout in the reservoirs are healthy in Rimrock, depressed in Bumping, critical in Kachess and Keechelus, and unknown in Cle Elum (WDFW, 1997). Bull trout are federally listed as threatened. Concern for the pygmy whitefish and burbot stem from the lack of information on life history and population status as well as their limited range (Hallock and Mongillo, 1998; and Bonar et al., 1997).

2.8.2.5 Exotic

Exotic fish species were introduced by man from another area. Exotic species are of concern because of negative interactions with native species. Introduction of exotics began in the late 1800s with the completion of the railways. By the 1920s, the exotic species present today were pretty much established and State agencies became involved with transplants of established stocks into suitable habitats. Intense management for warm water species began with the coming of tournament bass fishing in the 1970s. Today the management objective for introduced game fish species is on maximizing long-term recreational benefits, while minimizing adverse impacts to native fish and wildlife and their habitats. Exotic species present today include: brook trout, lake trout, brown trout, largemouth bass, smallmouth bass, black crappie, white crappie, bluegill, pumpkinseed, green sunfish, walleye, yellow perch, channel catfish, brown bullhead, black bullhead, mosquitofish, goldfish, and carp. Several hatchery strains of two native fish (rainbow and cutthroat trout) have been introduced to the basin from other states. Most warm water exotic species are located in the lower river, downstream of the city of Yakima and provide for viable recreation opportunities including bass tournaments. Introduced salmonids are generally found in the cooler parts of the upper watershed including reservoirs and also provide for recreational fishing opportunities.

Table 2-7.–Current Species Distribution in the Yakima River Main stem and Reservoirs. Shaded Cells Indicate the Species is Rare (relatively few captures reported) in That Stream Section (Washington Department of Fish and Wildlife, Yakima River Species Interaction Study, Ellensburg, Personal Communication, Updated 8/21/98)

		Distance from River Mouth (km)[a]					
Group	Species	0-44	45-68	69-161	162-180	181-305	Reservoir
Anadromous	Pacific lamprey	X	X	X	X		
Anadromous	coho salmon	X	X	X	X	X	
Anadromous	spring chinook salmon	X	X	X	X	X	
Anadromous	fall chinook salmon	X	X	X	X		
Anadromous	summer steelhead	X	X	X	X	X	
Lentic	kokanee						X
Lentic	burbot		X			X	X
Lentic	bull trout		X		X	X	X
Lentic	cutthroat trout				X	X	X
Lentic	pygmy whitefish					X	X
Lentic/ Resident Migratory	northern pikeminnow	X	X	X	X	X	X
Lentic/ Resident Migratory	rainbow trout	X	X	X	X	X	X
Lentic/ Resident Local	mountain whitefish	X	X	X	X	X	X
Resident Local	three-spine stickleback	X	X	X	X	X	
Resident Local	chiselmouth	X	X	X	X	X	X
Resident Local	peamouth	X	X	X			X
Resident Local	sandroller	X		X			
Resident Local	longnose dace	X	X	X	X	X	
Resident Local	speckled dace	X	X	X	X	X	X
Resident Local	leopard dace	X	X	X			

Group	Species	0-44	45-68	69-161	162-180	181-305	Reservoir
Resident Local	Umatilla dace (subspecies)	X	X	X			
Resident Local	redside shiner	X	X	X	X	X	X
Resident Local	mottled sculpin			X	X	X	
Resident Local	torrent sculpin			X	X	X	
Resident Local	piute sculpin			X	X	X	
Resident Local	shorthead sculpin			X		X	
Resident Local	prickly sculpin	X					
Resident Local	western brook lamprey						
Resident Migratory?	white sturgeon	X	X				
Resident Migratory	bridgelip sucker	X	X	X	X	X	
Resident Migratory	largescale sucker	X	X	X	X	X	X
Resident Migratory	mountain sucker			X	X	X	
Resident Migratory	W. brook lamprey			X	X	X	
Exotic	brown bullhead	X	X	X	X		
Exotic	channel catfish	X	X	X			
Exotic	pumpkinseed	X	X	X	X	X	
Exotic	bluegill	X	X			X	
Exotic	smallmouth bass	X	X	X	X	X	
Exotic	largemouth bass	X	X	X	X	X	
Exotic	black crappie	X	X				
Exotic	white crappie	X					
Exotic	common carp	X	X	X	X	X	
Exotic	goldfish	X	X				
Exotic	yellow perch	X	X	X	X	X	

Group	Species	0-44	45-68	69-161	162-180	181-305	Reservoir
Exotic	walleye	X	X	X			
Exotic	lake trout			X	X	X	X
Exotic	brown trout	X	X	X	X	X	
Exotic	brook trout				X	X	X
Exotic	mosquitofish	X					

[a] Mouth (Tri-cities) = River km 0; Kiona (Benton City) = rkm 44; Prosser = rkm 68; Yakima = rkm 161; Roza Dam = rkm 180; Keechelus Dam = rkm 305.

3.0 RECLAMATION AUTHORITIES AND OBLIGATIONS

The Federal Acts providing the authorities and obligations in the Yakima Basin Project are cited below. For persons who wish to obtain additional information about these citations, they are further described in the Federal Reclamation and Related Laws Annotated, United States Department of the Interior, located in the Reclamation Upper Columbia Area Office library. A brief explanation is included for those acts that are most commonly used by Reclamation for contracting purposes.

3.1 AUTHORIZATIONS and PURPOSES - Irrigation, Fish & Wildlife, Hydropower, Flood Control, and Municipal and Industrial uses.

3.1.1 Water Rights

1. Act of July 26, 1866 - Recognition of Vested Water Rights

3.1.2 Project & Irrigation

1. Act of June 17, 1902 - The Reclamation Act of June 17, 1902 (32 Stat. 388) authorized the issuance of water-right applications by which individual water users contracted to repay their portion of the construction cost of a project in a period of 10 years.

2. Act of June 25, 1910 - Advances to the Reclamation Fund

3. Act of February 21, 1911 - The Warren Act (36 Stat. 925) provided for the disposition of surplus water to individuals or irrigation enterprises outside Government Reclamation projects on terms determined to be just and equitable. The terms of payment now usually run from 10 to 40 years. The Act also allows for the use of Federal facilities for conveying private waters.

4. Act of August 13, 1914 - The 20-year repayment plan, authorized by the Reclamation Extension Act of August 13, 1914 (38 Stat. 686) was designed to permit a longer term for payment than the Reclamation Act of 1902.

5. Act of February 25, 1920 - Sale of Water for Miscellaneous Purposes

6. Act of December 5, 1924 - The Fact Finders' Act of December 5, 1924 (43 Stat. 672) provided for a plan of payment based on 5 percent of the average gross crop value in a district for a 10-year period. These payments, as a general rule, will run long terms of years. Authority for additional contracts of this type was repealed in 1926.

7. Act of August 4, 1939 - The Reclamation Project Act of 1939 (53 Stat. 1187) provides for flexibility in determining the annual rate of repayment for new contracts, again on a crop-income basis, but total repayment must be made in 40 years for distribution systems. A development period not to exceed 10 years may be established, from the time water is delivered to a block of land, before payment of construction charges commences. Storage repayment contracts are authorized for storage and carriage works. It also authorizes the negotiation of amendatory contracts for old projects, under the same rules, or for submission of the most practical amendatory plan to Congress for its approval.

The Reclamation Project Act of 1939 authorizes the United States to allocate portions of the total cost of a project to be repaid from power revenues or from municipal water revenues, and to flood control and navigation on a non-reimbursable basis. This made feasible for construction many projects where the water users could not reasonably be expected to repay the entire costs.

8. Act of August 11, 1939 - Water Conservation and Utilization Act

9. Act of October 7, 1949 - A number of contracts have been entered into pursuant to the Rehabilitation and Betterment Act (63 Stat. 724). This Act provides that repayment of rehabilitation and betterment expenditures on Federal Reclamation projects is to be in installments fixed in accordance with the ability of the water users to pay, and, to the fullest practicable extent, is to be scheduled for return concurrently with the water users' existing construction repayment obligations.

10. Act of July 3, 1958 - The Water Supply Act of 1958 (72 Stat. 297) recognizes the primary responsibilities of the States and local interests in developing water supplies for domestic, municipal, industrial, and other purposes and that the Federal Government should participate and cooperate with States and local interests in developing such water supplies in connection with the construction, maintenance, and operation of Federal navigation, flood control, irrigation, or multiple-purpose projects. The Act permits storage capacity to be included in any Bureau of Reclamation or Corps of Engineers reservoir for present and/or anticipated future demand or need by States or local interests for municipal or industrial water. The maximum permissible allocation of construction costs to anticipated future demands for municipal and industrial water supply is 30 percent of the cost of the dam and reservoir project. Costs allocated to municipal and industrial water supply for any given user must be repaid within 50 years after reservoir storage capacity is first used for municipal and industrial water supply purposes or within the life of the project, whichever period is shorter. Dam and reservoir costs allocated to deferred municipal and industrial water supply are interest free for a maximum period of 10 years. This Act is an alternative to and not a substitute for the Reclamation Project Act of 1939.

11. Act of July 9, 1965 - Public Law 89-72 (79 Stat. 213), known as the Federal Water Project Recreation Act, establishes uniform policies for the inclusion of recreation and fish and wildlife enhancement developments at planned and existing Federal water resources development projects and encourages non-Federal participation in those project purposes.

In planning Reclamation projects, the Act requires that a non-Federal public body agree to administer the land and water areas and bear not less than one-half of the separable costs and all costs of operation, maintenance, and replacement. Execution of such an agreement is a prerequisite to the construction of the facilities.

Costs allocated to recreation and fish and wildlife enhancement cannot exceed one-half of the total project cost. The non-Federal share of separable costs may be provided in cash, by the provision of land, interests therein, or facilities. The non-Federal share also may be repaid, with interest, within 50 years from the first use of project facilities for recreation or fish and wildlife. In the latter case, repayment may be financed entirely from entrance and user fees collected at the project by non-Federal interests.

At existing Reclamation projects, the Act authorizes the Secretary to provide public outdoor recreation or fish and wildlife developments, but precludes reallocation of project costs. Execution of an agreement with a non-Federal public body also is required. The Federal expenditure on any one existing reservoir is limited to $100,000.

12. Water Resources Planning Act of 1966

13. Act of October 3, 1975 - Amend Rehabilitation and Betterment Act

14. Safety of Dams Act of 1978

15. Reclamation Reform Act of 1982

16. Yakama Treaty of June 9, 1855

3.1.3 Flood Control

1. Act of June 22, 1936 - Flood Control Act of 1936

2. Act of June 28, 1938 - Flood Control Act of 1938

3. Act of December 22, 1944 - Flood Control Act of 1944

4. Act of August 4, 1954 - Watershed Protection and Flood Prevention Act

5. Act of July 14, 1960 - Flood Control Act of 1960

6. Act of December 31, 1970 - River and Harbor and Flood Control Acts of 1970 (see also Acts of August 4, 1939 [Section 8b], August 11, 1939, and July 3, 1958 above)

3.1.4 Hydropower

1. Act of June 10, 1920 - Federal Water Power Act

2. Act of August 31, 1964 - Pacific Northwest Power Marketing

3. Act of December 5, 1980 - Pacific Northwest Electric Power Planning and Conservation Act (see also Act of June 12, 1948, Kennewick Division)

3.1.5 Recreation

1. Act of July 9, 1965 - Federal Water Project Recreation Act

3.1.6 Yakima Specific Authorities

1. Reclamation Act of 1902 - Tieton and Sunnyside Divisions

2. Act of June 25, 1910 - Benton, Kittitas, and Wapato Divisions

3. Act of June 25, 1910, Section 4 and December 5, 1924, Subsection B of Section 4 - Roza Division

4. Act of June 12, 1948 - Kennewick Highlands/Division

5. Act of June 12, 1948 - Kennewick Division, Yakima Project

6. Act of June 30, 1954 - Amended Contract with Roza Irrigation District

7. Act of August 25, 1969 - Kennewick Division Extension

8. Hoover Power Plant Act of 1984 - Yakima River Basin Fish Passage

9. Act of 1994 - Yakima River Basin Water Enhancement Project

3.1.7 Yakama Nation

1. Yakama Treaty of June 9, 1855

2. Act of August 1, 1914 - Partial Provision of Irrigation Water Rights of Yakama Nation

3. Act of July 1, 1940 - Ratification of Delivery of Additional Treaty Water for Wapato Indian Irrigation Project

4. Act of December 28, 1979 - Feasibility Study, Yakima River Basin Water Enhancement Project

3.1.8 Fish & Wildlife

1. Act of March 10, 1934 - Fish & Wildlife Coordination Act

2. Act of August 14, 1946 - Fish & Wildlife Coordination Act. This amendment (60 Stat. 1080) to the Fish, Wildlife and Game Act of 1934 provides for non-reimbursable allocations to the preservation and propagation of fish and wildlife for new projects.

3. Act of August 12, 1958 - Name and Amend Fish and Wildlife Coordination Act

4. Act of September 29, 1980 - Fish and Wildlife Conservation Act

5. Act of December 28, 1973 - Endangered Species Act

6. Yakama Treaty of June 9, 1855.

4.0 LEGAL & INSTITUTIONAL ASPECTS OF THE YAKIMA BASIN PROJECT

4.1 PROJECT & LEGISLATIVE BACKGROUND - Development of the Yakima River Basin Water Enhancement Project and Title XII

Initial Authorization and Objectives of the Yakima River Basin Water Enhancement Project -

The Yakima River Basin Water Enhancement Project (YRBWEP) was initially authorized by Congress by the Act of December 28, 1979, (Public Law 96-162). The Act authorized the Secretary of the Interior (Secretary) to undertake a feasibility level study of the proposed YRBWEP. Drought conditions that were prevalent throughout the Western United States at that time focused attention on the need for additional efforts to expand and assure adequate water supplies in the Yakima River basin.

Preliminary work on the feasibility study began in 1980. The YRBWEP study initially had 2 planning phases: Phase 1, preliminary identification of water needs, available resources, and potential plan elements which could meet the needs; and Phase 2, detailed studies of more promising plan elements, the formulation and evaluation of alternative plans, and the identification of a preferred plan for consideration.

Early Implementation Program -

Interest in seeking expedited congressional action for authorization of elements that would be part of an overall YRBWEP became the focus of the study in late 1985. Consequently, additional work on the detailed analysis and evaluation of the four alternative plans was placed on hold.

In 1987, a “Policy Group” was formed to oversee the YRBWEP with respect to plan proposals, guidance on policy matters, and public involvement activities. Through this activity, the decision was made to pursue several legislative proposals, including early implementation legislation and comprehensive legislation.

Comprehensive Legislation -

Comprehensive legislation dated September 2, 1988, stipulated the quantity of water to be available to the Yakama Indian Reservation, to off-reservation irrigation entities, and to instream flows. However, extensive efforts to reach an amenable solution failed, and comprehensive legislation was abandoned.

Enhancement Roundtable Group -

During December 1988, and January 1989, legislators and basin interest groups met to develop a core group representing the various parties and discuss proceeding with a Phase 2 program emphasizing water conservation. The Enhancement Roundtable Group was formed as a result of this effort. An Enhancement Technical Activities Group (TAG) consisting of representatives from the irrigators, the Yakama Nation (YN), the State, Bonneville Power Administration (BPA), and the Bureau of Reclamation (Reclamation) was formed to guide and oversee work activities. Subsequent meetings of the Enhancement Roundtable Group considered draft Federal legislation to authorize a "pilot" water conservation program to assist in determining the amount of the basin's water needs that could be met through water conservation and the amount and location of additional storage capacity that might subsequently be required as part of a comprehensive enhancement program.

On May 2, 1990, the TAG transmitted draft legislation for Phase 2 to legislators with the recommendation that they proceed with its review by legislative counsel and then submit it to the Enhancement Roundtable Group with a request that a decision be made regarding future action in seeking authorization. The TAG further recommended that the major focus of the YRBWEP at that time should be water conservation, providing a mechanism for developing, evaluating, and implementing entity specific water conservation measures and their integration into a basin-wide conservation program. Consequently, TAG recommended deferral of further activities related to additional storage, except those possibilities that could augment existing stored waters such as identified with the conveyance of Cabin Creek and Silver Creek flows for storage in the existing Kachess Lake.

Renewed interest was generated in proceeding with the Phase 2 legislative concept following the Acquavella Adjudication summary judgment ruling on the YN rights in 1990. Draft legislation was introduced in late July 1991. By resolution dated April 8, 1992, the Tribal Council indicated its support for the bill as modified by Tribal comments. The bill was passed by Congress as Title XII of the Act of October 31, 1994, Public Law 103-434.

4.2 TREATY of 1855

The Treaty of June 9, 1855, between the 14 confederated Tribes and bands later to become the YN and the United States, ceded 10.3 million acres to the United States and reserved a 1.4 million-acre homeland. In the Treaty of June 9, 1855, the Tribes of the YN retained the rights to fish, hunt, and gather native foods and medicines off the Reservation.

4.3 LIMITING AGREEMENTS

As a condition for involvement of Reclamation in the irrigation development of the Yakima River basin, the Secretary in 1905, required limitations on diversions by water claimants. This was accomplished through "Limiting Agreements" with some 50 claimants on the Yakima and Naches

Rivers agreeing to limit their diversions to the following: for August and preceding months, the amount actually diverted in August 1905; for September, two-thirds of this amount; and for October, one-half of the amount. The actual August diversion totaled about 2,000 cubic feet per second (cfs). Of this amount, nearly 1,900 cfs or 95 percent of the claimed diversion quantities were covered by limiting agreements or adjusted claims.[1]

4.4 WATER RIGHTS & CONTRACTS

The most comprehensive listing of claims and contract quantities for the Yakima basin was compiled by Mr. C.R. Lentz, Reclamation Project Superintendent, in 1974. A copy of this listing is available in the Bureau of Reclamation's Upper Columbia Area Office.

4.5 COURT DECISIONS

4.5.1 1945 Consent Decree

The 1945 Consent Decree (Decree) was the outgrowth of water supply deficiencies in 1941, 1942, and 1943, and disputes over rights to the available supply. Rather than proceed with extensive litigation, a stipulated settlement was reached by the parties and a judgement entered. In January 1945, the District Court of Eastern Washington issued a decree under Civil Action No. 21 called the 1945 Consent Decree. The Decree is a legal document pertaining to water distribution and water rights in the basin. This judgement set forth the obligations of the United States to deliver water "to the plaintiffs, to the defendants, and to the lands of the Wapato Irrigation Project." The Decree established procedures under which Reclamation should operate the Yakima Project system to meet the water needs of the irrigation districts that predated the Yakima Project, as well as the rights of divisions formed in association with the Yakima Project. The Decree provided water delivery allocations for all major irrigation system diversions down to Sunnyside in the Yakima basin. The Decree states the quantities of water to which most main stem water users were allowed (maximum monthly and annual diversion limits) and defined a method of prioritization to be placed into effect during water-deficient years. The water allocations were divided into two classes, non-proratable and proratable.[2] Non-proratable entitlements are held by those water users with the earliest filed water rights, and these entitlements are to be served first from the total water supply available (TWSA). All other water rights are proratable, which means they are of equal priority. Any shortages that may occur are shared equally by the proratable water users.

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[1] The adjusted claims included 147 cfs for the Yakima Nation and 650 cfs for the Sunnyside Canal.

[2] This included claims by others for natural flows from the Yakima River and its tributaries which were heretofore recognized by the United States whether or not they signed "Limiting Agreements" or were parties to the 1945 Consent Decree.

4.5.2 Quackenbush Decision

In 1980, spring chinook spawned in the upper portions of the Yakima River between the mouth of the Cle Elum River to the mouth of the Teanaway River during the period that reservoir releases were being made to meet downstream irrigation demands. When the irrigation season drew to a close and reservoir releases were being curtailed, about 60 redds (fish nests), a portion of which were dewatered by the reduced releases, were identified in the Yakima River reach between the mouth of the Cle Elum River and the mouth of the Teanaway River. In October 1980, Judge Justin Quackenbush of the Federal District Court directed Reclamation, acting through the Yakima Field Office Manager, to release water from Yakima Project reservoirs to keep the redds covered with water. In November 1980, the Court directed the Yakima Field Office Manager to work with fishery biologists and report back prior to the 1981 irrigation season:

> ". . . on means by which the needs of the Yakima Project water users can be met through more efficient or less extensive use of Project waters or by modification of Project operations or facilities so as to have less impact on the fisheries resource, including the possibility of management of the various Project reservoirs and releases of water so as to provide for appropriate water flows during the spawning and hatching periods that may be practicable while at the same time providing water for irrigation purposes for users within the Project."

As a result, the "flip-flop" operation was conceived and initiated in 1981, and has since been a part of the Yakima Project operation. The flip-flop term derives from the fact that the Yakima and Naches Rivers form a "Y." In this operation, water from the three reservoirs in the upper Yakima River system (right side of the "Y") is used to meet irrigation demands downstream of the confluence of the Naches and Yakima Rivers through the first week of September, and water is retained in reservoirs of the Naches River arm (left side of the "Y") to the maximum extent possible. After the first week of September, reservoir operations are flip-flopped with demands downstream of the confluence of the Naches and Yakima Rivers being met from the Naches River system reservoirs and flows from the upper Yakima River system reservoirs are reduced. This operation reduces flows in the upper Yakima River at the time that fish spawn, forcing the fish to build redds at a lower elevation in the stream channel. As a result, less water is needed to be released during the winter to keep the redds under water and maintain the fish eggs.[3]

4.5.3 Acquavella Adjudication

Water supplies in the Pacific Northwest in 1977 were inadequate to meet the needs in many areas, including the Yakima River basin. The State of Washington, October 12, 1977, filed an adjudication of the Yakima River system in the Superior Court of Yakima County (Case No. 77-

[3] A mini flip-flop operation is also conducted upstream from Easton Diversion Dam by reducing outflow of Keechelus Lake at the headwaters of the Yakima River in early September and drawing on Kachess Lake to meet downstream irrigation needs of the Kittitas Valley diverters and the Roza Irrigation District.

2-0148-5) naming the United States and all persons claiming the right to use the surface water of the Yakima River basin as defendants. Motions were filed to reopen the judgment on the 1945 Consent Decree. However, the District Court held that the Decree was being correctly interpreted by Reclamation. At the same time, the YN filed an action in Federal District Court to determine the priority and quantity of the water rights of the YN under the Treaty of 1855. Later in the same year, the State of Washington filed in State Court for a general adjudication of the Yakima River drainage basin. In March 1985, the Court ruled that this action could be limited to surface waters of the Yakima River basin and that groundwater users need not be included for a general adjudication. The Federal case was deferred to the State's case, and the prior filing by the YN did not proceed. The general adjudication remains open and in progress with orders continuing to be issued on water right claims in the Yakima River and its tributaries.

4.5.3.1 Partial Summary Judgment

Some irrigators opposed the Phase 2 legislation in view of the motion for partial summary judgment filed by several irrigation districts. An order of the Superior Court was entered on July 17, 1990, regarding the rights of the YN. In that decision, the treaty-reserved water rights of the YN were defined and those rights to flow in the mainstream Yakima were unanimously affirmed by the Washington Supreme Court on appeal. The treaty rights were divided into separate rights for fish and agriculture.

1. First, the Court determined that various acts of Congress, agencies and decisions of various tribunals had defined and limited the treaty irrigation right of the YN. This translated into existing non-proratable irrigation rights with 1855 priority, and proratable irrigation rights with a priority date of 1905.

2. The treaty right for fish had likewise been limited by various acts of Congress and agency actions and had been compensated in the proceeding before the Indian Claims Commission, (ICC) Docket No. 147. The substantially diminished instream flow right was held to be the “specific minimum instream flow necessary to maintain anadromous fish life in the river, according to the annual prevailing conditions as they occur and determined by the Yakima Field Office Manager in consultation with the Yakima River Basin System Operations Advisory Committee, Irrigation Districts and Company managers and others.” This decision was extended later to specifically include all tributaries that support fish availability at the YN’s usual and accustomed fishing locations as set forth in ICC Docket No. 147. The priority date for the treaty fishing right is “time immemorial.”

3. The Court also quantified the on-reservation tributary rights of the YN, but did not apply the Practicably Irrigable Acreage standard in doing so. The Court also found that, as to the on-reservation streams, the treaty fishing right was not diminished.

4.5.3.2 Other Rulings

In addition to determinations on thousands of adjudication claims, numerous decisions by Superior Court Judge Walter Stauffacher, have been made (and some appealed) that affect water allocation and management in the Yakima basin and thus, must be considered and included in planning documents. Some of the decisions critical to the planning process are:

1. The Court also upheld the basic TWSA concept of the Decree (discussed above) which places all water into one "bucket" and then divides that bucket between "non-proratable" and "proratable" rightholders. The Superior Court found that, although some disagreement may have existed in the early stages of the Federal project formation as to whether "natural flow" rights would be satisfied from storage during times of shortage, the judgment in the Decree settled that issue in the affirmative. Discretionary review of that decision was sought in the Washington Supreme Court. The Commissioner thought the appeal was premature and, at this time, stated: "the care and thoroughness with which (the lower court's) opinion addresses the various contentions of the parties forecloses any characterization of the decision as probable error." The Superior Court decision may be subject to another appeal at the conclusion of the adjudication.

2. During the adjudication, the Court synthesized an approach to return flows that accommodated the defined legal precedents and a vast array of factual patterns. Return flow from foreign or imported water cannot be established. The United States believes that rights to return flow that derive from Federal project water cannot be established, except by the United States or by the permission of the United States. However, as to other types of return flow water that is diverted from a stream that is returning to that same stream, a right could be established, depending on compliance with State law.

3. The Court also determined that a general adjudication could bind the United States, even though it did not include an adjudication of groundwater rights. Therefore, groundwater rights were not considered and remain unadjudicated.

As of January 1997, approximately two-thirds of the total water rights claimants had been adjudicated.

Since the partial summary judgment ruling, the following have also been ruled:

1. An irrigation district or water company which has not used its full entitlement of water shall not have its water right diminished unless it is established that the entity abandoned or voluntarily failed to use the water without just cause and there can be no relinquishment by a claimant who supplies water for municipal purposes. The

regulation of water use by the United States to enhance carry over in the storage reservoirs shall constitute just cause.

2. Flood waters are part of the natural flow of the Yakima River which were withdrawn by the United States for the Yakima Project in 1905, and the major claimants, including the United States, may upon proper proof establish a water right in such flood water.

3. No distinction exists between natural flow and storage for the purposes of providing water for the YN's treaty-reserved water right for fish.

4. No YN surface water right in the Yakima River basin is subject to State law or oversight.

5. The YN enjoys a federally reserved, treaty-based right to an undiminished instream flow for Satus, Simcoe, and Toppenish Creeks to support fish and other aquatic life.

6. The YN's minimum instream flow right for fish in those tributaries that presently and actually support anadromous fish availability at the "usual and accustomed" fishing stations shall be determined in accordance with the annual prevailing conditions as they occur. The rights have been extended to cover flows for resident fish.

7. The YN's treaty-based water right allows the Yakima Field Office Manager to release stored water for flushing flows when they are absolutely necessary to maintain fish life in the Yakima River basin.

8. The water rights of the YN are affirmed and described by the Conditional Final Order, filed with the Adjudication Court on September 12, 1996. The Conditional Final Order incorporates the water right set forth in the Partial Summary Judgment, dated November 29, 1990; the water rights established in the Final Order re: Treaty Reserved Water Rights At Usual and Accustomed Fishing Places, dated March 1, 1995; and sets forth all of the remaining water rights of the YN.

4.6 SYSTEM OPERATIONS ADVISORY COMMITTEE

The System Operations Advisory Group (SOAC) was formed in 1981, as directed by the Quackenbush decision. SOAC is an advisory board to Reclamation consisting of fishery biologists representing the U.S. Fish and Wildlife Service (FWS), the YN, the Washington Department of Fish and Wildlife (WDFW), and irrigation entities represented by the Yakima Basin Joint Board (YBJB). The group's first product was the development of the flip-flop concept, in conjunction with Reclamation.

Reclamation provides a fishery biologist as a liaison to SOAC. Since 1981, SOAC has provided information, advice, and assistance to Reclamation on fish-related issues associated with the operations of the Yakima Project. Flows for maintaining fish life in the Yakima basin are determined by the Field Office Manager, according to the annual prevailing conditions, and in consultation with SOAC, irrigation district managers, and others. Phase 2 of the Yakima enhancement legislation (see section 4.7 below) in 1994 directed SOAC to develop a report on biologically based flow needs for fish in the basin. The report is complete.

4.7 LEGISLATION AFFECTING YAKIMA BASIN PROJECT

4.7.1 Yakima River Basin Water Enhancement Project

The YRBWEP was authorized by Congress by the Act of December 28, 1979, Public Law 96-162. The Act authorized the Secretary to undertake a feasibility level study of the proposed YRBWEP. Drought conditions that were prevalent throughout the Western United States at that time focused attention on the need for additional efforts to expand and assure adequate water supplies in the Yakima River basin.

The feasibility study was initiated in 1980. The YRBWEP study was divided into two phases. Phase 1 was comprised of the preliminary identification of water needs, available resources, and potential plan elements which could meet the needs. Phase 2 was composed of detailed studies of the more promising plan elements, the formulation and evaluation of alternative plans, and the identification of a preferred plan for consideration. Phase 1 was completed in August 1982, with the release of the Phase 1 Study Team report. Phase 2 was initiated in September 1982, and by early 1987, identification and analysis of potential elements had been completed at a preliminary level.

The Congress of the United States enacted Title XII of Public Law 103-434 on October 31, 1994 (appendix C). Title XII authorized Phase 2 of YRBWEP to protect, mitigate, and enhance fish and wildlife; and to improve the reliability of the water supply for irrigation through improved water conservation and management; and other appropriate means.

The major purpose of implementing water conservation measures is to reduce out-of-stream irrigation water diversions from the Yakima River and its tributaries. Savings achieved through improvements to water delivery systems and changes in operation and management will result in more water remaining in the stream and storage system. This saved water will be used to improve streamflows for fish and wildlife, and to improve the reliability of the irrigation water supply.

As of December 2000, 6 irrigation districts applied and received YRBWEP funding to develop water conservation plans on their districts. Four of the irrigation districts have completed their water conservation plans and 3 are in the process of investigating the feasibility of the conservation measures proposed to be implemented in the next 5 years. Funding of the feasibility investigation on one of the irrigation district’s plan was deferred until it could be determined if improving instream flows in that particular reach of the river would be beneficial to fish. In 5 of the irrigation district plans, an estimated 131,000 acre-feet of water would be available for the beneficial use of improving instream flow and the reliability of irrigation water.

Another significant element of Title XII is the acquisition of habitat and water from willing sellers. This program is guided and directed through research being conducted by the University of Montana and Central Washington University.

Other elements of Title XII include increasing the storage capacity of Cle Elum Reservoir, constructing fish passage at Cle Elum reservoir, Kachess Reservoir augmentation, and Kachess Reservoir discharge modification; will further improve streamflows in the Yakima River basin. Title XII also includes some specific elements for implementation by the YN on the Yakama Indian Reservation.

Title XII also provided for the completion of two reports, with recommendations which shall provide a basis for the third phase of the YRBWEP. These reports are: 1) A report addressing the adequacy of the water supply available for sustaining the agricultural economy of the Yakima River basin, and 2) The Biologically Based Target Flow Report which has been completed by SOAC.

Title XII was modified in November 2000, to include the feasibility study for a pump exchange involving Kennewick and Columbia Irrigation Districts.

4.7.2 Endangered Species Act

Endangered Species Act (ESA) of 1973, as amended, Public Law 93-205. A species of plant or wildlife shall be presumed to be rare or endangered if it is listed in Title 50 CFR Sections 17.11 or 17.12, pursuant to the ESA as rare, threatened, or endangered. The ESA establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants, and the preservation of the ecosystems upon which they depend. Section 7(a) of the ESA requires Federal agencies to consult with the FWS, to ensure that the actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any endangered or threatened species or adversely modify or destroy their critical habitats. If such species are anadromous fish, consultation is required with the National Marine Fisheries Service (NMFS). Actions that might jeopardize listed species include direct and indirect effects, and the cumulative effects of other actions.

4.7.3 Clean Water Act

The Clean Water Act (CWA) of 1972, Public Law 92-500, as amended 1987, Public Law 100-4 had the objective "to restore and maintain the chemical, physical, and biological integrity of the Nations water." The CWA sets national goals and policies to eliminate discharge of water pollutants into navigable waters and to achieve water quality levels to protect fish, shellfish, and wildlife while providing for other uses, such as recreation, where possible.

The Act contains the following important principles:

1. Discharge of pollutants to navigable waters is not a right. A permit is required to use a public resource for wastewater disposal. Agricultural returns are exempt from permitting, but not from polluting.

2. The discharge permit limits the amount of pollutants to be discharged.

3. Wastewater must be treated with the best treatment technology, which is economically achievable, regardless of the condition of the receiving water.

4. Effluent limits are based on treatment technology, but more stringent limits may be imposed if the technology-based limits do not prevent violations of applicable water quality standards.

5. Control of non-point source (NPS) pollution is addressed by states that have approved NPS Management Plans.

6. Lists of waterbodies not meeting water quality standards must be prepared, and updated every 4 years (the “303(d) list”).

7. A Total Maximum Daily Load (TMDL) to address all listed waterbodies must be prepared (see below).

The State of Washington became one of the first states to be delegated authority by the Federal government to administer the requirements of the CWA. The Washington State Department of Ecology (WDOE) is the authorized State agency. WDOE is responsible for preparing wastewater discharge permits and for addressing NPS pollution.

WDOE is also given the statutory authority and the responsibility to set and enforce State of Washington water quality standards within the State’s jurisdictional boundaries (Section 90.48.080 of the Revised Code of Washington [RCW]). These statutes support the water quality regulations found in the Washington Administrative Code, Chapter 173-201A, which specifically identifies the water quality criteria enforced by WDOE.

Total Maximum Daily Loads -

The 303(d) list is a list of the impaired waterbody segments and associated pollutants. TMDLs are water clean-up plans prepared to address each of the listed waterbodies and each of the individual pollutant parameters. These plans include estimates of the amount of a specific pollutant that a specific waterbody could receive without impairing water quality. TMDLs also include a technical evaluation to determine pollutant loading during critical periods, pollutant sources, the capacity of a waterbody to receive pollutants without exceeding standards, and allocations of that carrying capacity to the different sources. Seasonal variation must be addressed and a margin of safety included in the final allocation. TMDLs are used to set an enforceable limit on the amount of a specific pollutant that can be discharged.

In Washington State, there are over 1,500 waterbody segments and associated pollutants on the 1998 303(d) list. For the Yakima River and many of its tributaries, pollutants include high turbidity, low dissolved oxygen, high temperature, PCBs, pesticides, metals, pH, ammonia, and fecal coliform bacteria (FC). Several reaches within the basin also are listed for low instream flow. WDOE is in the process of developing and implementing TMDLs to restore water quality throughout the State and is using the TMDL process as one mechanism to attain State water quality standards in the Yakima basin.

State Water Quality Standards -

Washington State water quality standards have two primary components - characteristic uses (e.g., salmonid migration), and criteria (e.g., pH of 6.5 to 8.5). There is also an anti-degradation provision, to prevent backsliding. Both parts of the standards are important and separately enforceable. Of these, the standard for characteristic uses may be less understood. One example is the characteristic use of "salmonid migration, rearing, spawning, and harvesting." The Environmental Protection Agency describes "full support" for cold water biota, including salmon, as that which supports "thriving, sustainable populations of species which would normally occur in cold water absent water column/habitat degradation. Full confirmation would include attainment of applicable numeric criteria and the presence of a biological community representative of what one might expect for that given ecosystem."

Current Washington State water quality standards for characteristic uses and criteria are provided in table 4-1.

Table 4-1.–Water Quality Criteria and Characteristic Uses (WAC 173-201-A) for Class AA (extraordinary), Class A (excellent) and Class B (good), Freshwater Only

	Class AA	Class A	Class B
General Characteristic:	Shall markedly and uniformly exceed the requirements for all, or substantially all uses.	Shall meet or exceed the requirements for all, or substantially all uses.	Shall markedly and uniformly exceed the requirements for all, or substantially all uses.
Characteristic Uses:	Shall include, but not be limited to, the following: domestic industrial and agricultural water supply; stock watering; salmonid and other fish migration, rearing, spawning, and harvesting; wildlife habitat; primary contact recreation, sport fishing, boating, and aesthetic enjoyment; and commerce and navigation.	Same as AA.	Same as A, with these exceptions: 1) water quality must meet or exceed requirements for most (but not all) uses, 2) water supply includes only industrial and agricultural (not domestic) uses, 3) spawning for salmonids and harvesting of shellfish are not included, and 4) recreational use includes secondary contact (e.g. fishing or wading), but not primary.
Fecal Coliform:	Shall not exceed a geometric mean value of 50 organisms/100 ml, with not more than 10% of samples exceeding 100 organisms/100 ml.	Shall not exceed a geometric mean value of 100 organisms/100 ml, with not more than 10% of samples exceeding 200 organisms/100 ml.	Shall both not exceed a geometric mean value of 200 colonies/100 ml, and not have more than 10% of all samples obtained for calculating the geometric mean value exceeding 400 colonies/100 ml.
Dissolved Oxygen:	Shall exceed 9.5 mg/L.	Shall exceed 8.0 mg/L.	Shall exceed 6.5 mg/L.
Total Dissolved Gas:	Shall not exceed 110% saturation.	Same as AA.	Shall not exceed 110% of saturation at any point of sample collection.

Water Quality Criteria:

	Class AA	Class A	Class B
Temperature:	Shall not exceed 16.0 °C due to human activities. When conditions exceed 16.0 °C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3 °C. Increases from non-point sources shall not exceed 2.8 °C.	Shall not exceed 18.0 °C due to human activities. When conditions exceed 18.0 °C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3 °C. Increases from non-point sources shall not exceed 2.8 °C.	Shall not exceed 21.0 °C due to human activities. When natural conditions exceed 21.0 °C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C. Increases resulting from non-point sources shall not exceed 2.8 °C.
pH:	Shall be within the range of 6.5 to 8.5 with a man-caused variation with a range of less than 0.2 units.	Shall be within the range of 6.5 to 8.5 with a man-caused variation with a range of less than 0.5 units.	Same as A.
Turbidity:	Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the background turbidity is more than 50 NTU.	Same as AA.	Shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20% increase in turbidity when the background turbidity is more than 50 NTU.
Toxic, Radioactive, or Deleterious Material:	Shall be below concentrations which have the potential singularly or cumulatively to adversely affect characteristic uses, cause acute or chronic conditions to the most sensitive aquatic biota, or adversely affect public health as determined by the department (see WAC 173–201A–040 and 173–201A–050).	Same as AA.	Same as AA.
Aesthetic Value:	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.	Same as AA.	Shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.

4.7.4 Northwest Power Act

The Northwest Power Planning Council (NWPPC) was directed by the Northwest Power Act of 1980, to develop a program to protect, mitigate, and enhance fish and wildlife on the Columbia River and its tributaries. The NWPPC's programs have included the Yakima River Basin Fish Passage and Protective Facilities Program, the Yakima-Klickitat Fisheries Project (YKFP), subbasin plans of the Columbia River Fish Management Plan, and several activities within the Yakima River basin. Additional information on these programs is listed below.

Yakima River Basin Fish Passage/Protective Facilities -

Beginning in the early 1980s, the Reclamation, the BPA, the YN, the State of Washington, and local irrigation entities constructed fish ladders and screens pursuant to the Columbia Basin Fish and Wildlife Program adopted by the NWPPC in 1982. Under Phase 1 of this program, improvements to existing fish passage facilities and installation of new fish ladders and screens at 16 of the largest existing diversion dams and canals were completed by the fall of 1989.

Under Phase 2 of the program, improvements are being made to existing fish screens, and new screens are being installed at approximately 66 sites. These sites include a few Federal facilities (Reclamation and Bureau of Indian Affairs), but are primarily private canal companies or individually owned diversion structures.

Yakima-Klickitat Fisheries Project -

The BPA is funding the YKFP to undertake fishery research and restoration activities in the Yakima River basin. These facilities are operated by the YN and managed jointly by the YN and the State of Washington. This effort will construct, operate, and maintain anadromous fish production facilities to facilitate research activities designed to increase knowledge of supplementation techniques. These techniques would be applied to rebuild naturally spawning anadromous fish stocks historically present in the Yakima River basin.

The YKFP is one part of a comprehensive effort to restore fisheries resources by the BPA, the YN, the State of Washington, and Reclamation.

Columbia River Fish Management Plan -

Salmon harvest management in the river remains rooted in processes developed by the ongoing litigation *United States* v. *Oregon*. In the late 1980s, the Federal District Court of Oregon approved the Columbia River Fish Management Plan, which addresses harvest allocation and production strategies.

The Columbia River Fish Management Plan currently directs fishery protection and enhancement efforts by rebuilding upper Columbia River chinook, sockeye, coho, and steelhead runs, while assuring an equitable sharing of harvestable fish between treaty and non-treaty fisheries.

Current activities sponsored by the Columbia River Fish Management Plan in the Yakima River basin include programs for both fall chinook and coho salmon. The fall chinook program includes the production and release into the Yakima River of 1.7 million smolts from the Little White Salmon National Hatchery. Between 1983 and 1994, the smolts were transported and released directly into the Yakima River. The YN has developed acclimation facilities in the vicinity of Prosser Dam for final rearing and release of these fall chinook smolts. The coho program released 700,000 early-run coho into the Yakima River. This program is part of a larger effort to redistribute coho for release in upper Columbia tributaries rather than in the lower Columbia. Federal agencies, the State, and private entities have engaged in habitat improvement work throughout the Yakima River basin.

National Water Quality Assessment Program -

The U.S. Geological Survey has selected the Yakima River basin as part of its National Water Quality Assessment Program. The objectives of the program are to: 1) describe current water quality conditions for a large part of the United States' freshwater streams, rivers, and aquifers; 2) describe how water quality is changing over time; and 3) improve understanding of the primary natural and human factors that affect water quality conditions. The first round was developed during the 1988 to 1994 period. The second round will occur from 1999 to 2004.

4.7.5 Fish & Wildlife Coordination Act

Fish & Wildlife Coordination Act (FWCA) of 1958, Public Law 85-624. The FWCA requires consultation with the FWS or NMFS when any waterbody is impounded, diverted, controlled, or modified for any purpose. These two agencies incorporate the concerns and findings of the State agencies and other Federal agencies into a report that addresses fish and wildlife affected by a Federal project. Sections 1 and 2 of the FWCA mandate that fish and wildlife receive equal consideration with other project benefits throughout planning, development, operation, and maintenance of water resources development programs. Whenever Reclamation proposes to impound, divert, channelize, or otherwise alter or modify any stream, river, or other body of water for any purpose; Reclamation must first consult and coordinate its actions and projects with these two agencies and the affected State fish and game agency wherein the diversion or other control facility is to be constructed.

4.7.6 National Environmental Policy Act

National Environmental Policy Act (NEPA) of 1969, Public Law 91-190, as amended 1975, Public Law 94-83. NEPA provides a commitment that Federal agencies will consider the environmental effects of their actions. An Environmental Impact Statement (EIS) must be prepared for any major Federal action significantly affecting the quality of the human environment. The EIS must provide detailed information regarding the proposed action and alternatives, the environmental impacts of the alternatives, potential mitigation measures, and any adverse environmental impacts that cannot be avoided if the proposal is implemented. Federal agencies are required to demonstrate that these factors have been considered by decision makers prior to undertaking any action.

4.7.7 Federal Agricultural Conservation Program

The Environmental Quality Incentives Program (EQIP) was established in the 1996 Farm Bill to provide a single, voluntary conservation program for farmers and ranchers to address significant natural resource needs and objectives. The USDA Natural Resources Conservation Service administers EQIP.

The EQIP has provided $2,406,444 in cost share to farmers in Yakima and Benton Counties in the last 4 years (1997-2000). Over 90 percent of these cost share funds improved on-farm irrigation systems with irrigation water management on 10,075 acres. On field irrigation efficiencies have been improved by an average of 35 percent. In addition, soil erosion has been reduced from 100 tons/acre/year to less than 1 ton/acre/year on about 6,000 of the 10,075 acres.

5.0 CURRENT PROJECT OPERATIONS/TOTAL WATER SUPPLY AVAILABLE

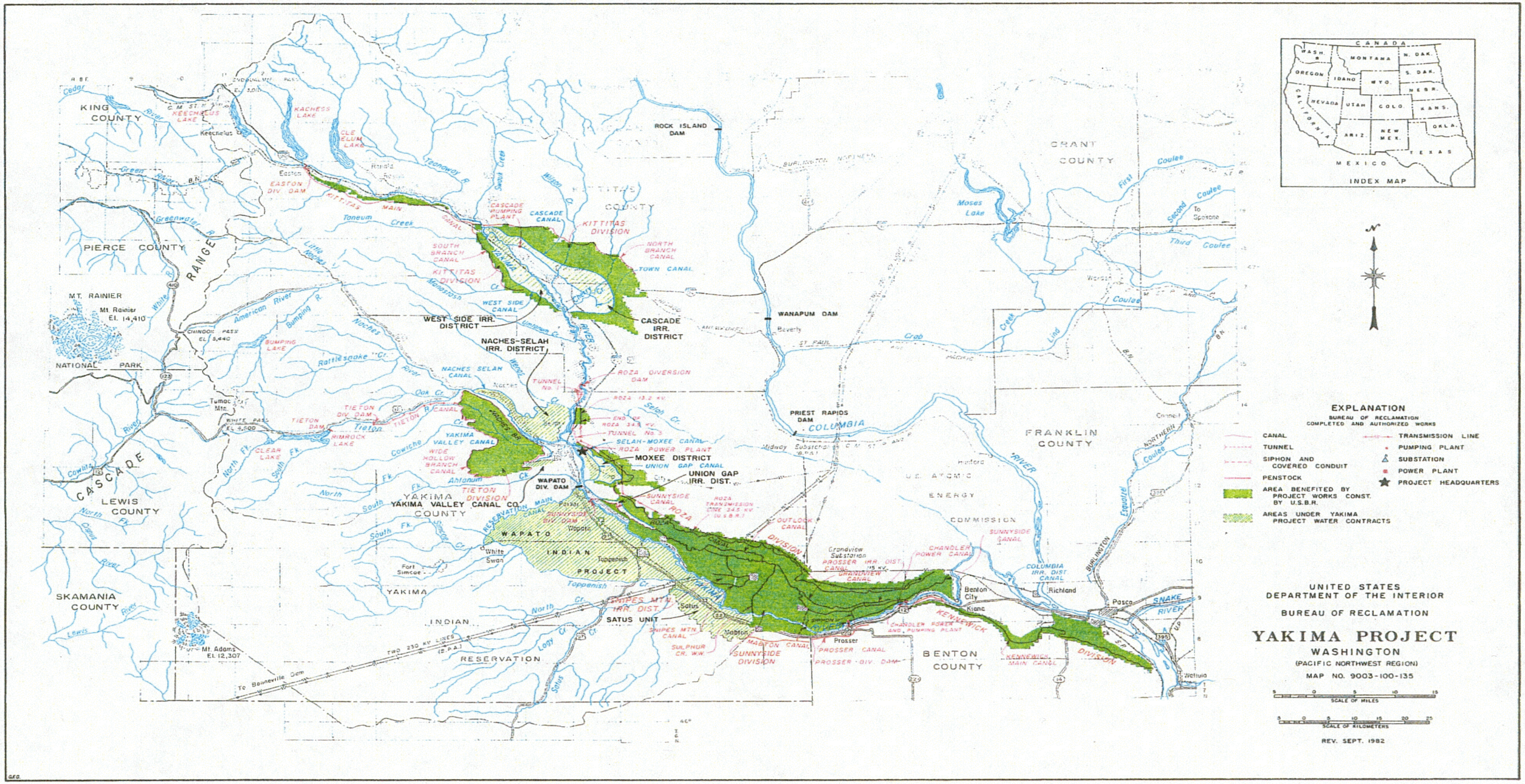
This chapter describes and summarizes the general parameters and functions–physical, contractual, environmental, political and social constraints–which affect the current project wide operation of the Yakima River basin. This is an endeavor to provide insight into the current operations of the Yakima River as managed by the Yakima Project (Project) operations. In any given year, the project, with the current yearly considerations and constraints, develops a plan to manage the Yakima River basin and attempts to provide maximum benefits to each of the water demands in the river system. In this section, a typical operational year with four seasons is described, with the considerations, constraints, and thought processes necessary for defining a year's operations.

The project provides irrigation water for a comparatively narrow strip of fertile land that extends for 175 miles on both sides of the Yakima River in south-central Washington (figure 5-1.). The irrigable lands, eligible for service under the Bureau of Reclamation's (Reclamation) Yakima Project total about 465,000 acres. There are seven divisions in the project. Reservoir storage constitutes one division. In addition, there are six water delivery divisions: Kittitas (59,123 acres), Tieton (27,271 acres), Sunnyside (103,562 acres), Roza (72,511 acres), Kennewick (19,171 acres), and Wapato. The Wapato Division is operated by the Bureau of Indian Affairs (BIA), but receives most of its water supply from the project for irrigation of 136,000 acres of land. Over 45,000 acres not included in the 7 divisions are irrigated under supplemental water supply contracts with Reclamation. Storage reservoirs on the project are Bumping Lake, Clear Creek, Tieton, Cle Elum, Kachess, and Keechelus.

Other project features include 5 diversion dams, 420 miles of canals, 1,697 miles of laterals, 30 pumping plants, 144 miles of drains, 9 power plants (3 in private ownership), plus fish passage and protection facilities constructed throughout the project.

Reclamation computes the entire river basin outflow in calculating total water supply available (TWSA) for all demands, but only physically operates the storage division of the project. The six water delivery divisions and the supplemental contract entities operate their own water delivery/distribution systems.

Reclamation operates the project to meet specific purposes: irrigation water supply, instream flows for fish, and flood control. Irrigation operations and flood control management have been the historic priorities for reservoir operations. Instream flow and requirements of anadromous fish have been incorporated as part of the current routine operation of the system, and take primary status based on legislation or judicial orders at certain times of the water year. Hydroelectric power is produced incidentally to other project purposes. Reservoir storage releases are not made to meet hydroelectric power demand and, at times, power subordination is implemented in order to meet instream flow requirements.


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA PROJECT
WASHINGTON
(PACIFIC NORTHWEST REGION)
MAP NO. 9003-100-135
SCALE OF MILES
SCALE OF KILOMETERS
REV. SEPT. 1982
EXPLANATION
BUREAU OF RECLAMATION COMPLETED AND AUTHORIZED WORKS
CANAL
TUNNEL
SIPHON AND COVERED CONDUIT
PENSTOCK
AREA BENEFITED BY PROJECT WORKS CONST. BY U.S.B.R.
AREAS UNDER YAKIMA PROJECT WATER CONTRACTS
TRANSMISSION LINE
PUMPING PLANT
SUBSTATION
POWER PLANT
PROJECT HEADQUARTERS
INDEX MAP
KING COUNTY
PIERCE COUNTY
LEWIS COUNTY
SKAMANIA COUNTY
YAKIMA COUNTY
KITTITAS COUNTY
GRANT COUNTY
FRANKLIN COUNTY
BENTON COUNTY
CASCADE RANGE
MT. RAINIER NATIONAL PARK
YAKIMA INDIAN RESERVATION
WAPATO INDIAN PROJECT
U.S. ATOMIC ENERGY COMMISSION
ROCK ISLAND DAM
WANAPUM DAM
PRIEST RAPIDS DAM
WEST SIDE IRR. DISTRICT
NACHES-SELAH IRR. DISTRICT
CASCADE IRR. DISTRICT
MOXEE DISTRICT
UNION GAP IRR. DIST.
YAKIMA VALLEY CANAL CO.
WAPATO DIV. DAM
SATUS UNIT
KITTITAS DIVISION
TIETON DIVISION
ROZA DIVISION
SUNNYSIDE DIVISION
KENNEWICK DIVISION
COLUMBIA RIVER
SNAKE RIVER

Recreational needs are considered, but are incidental to other project purposes. (It should be noted that the 1992 authorization for and the reconstruction of Clear Creek Dam was primarily based on recreational benefits provided.) The 1994 Title XII legislation provided that an additional purpose of the Yakima Project "shall be for fish, wildlife, and recreation. Also, the existing storage rights of the Yakima Project shall include storage for the purposes of fish, wildlife, and recreation. But, the above specified purposes shall not impair the operation of the Yakima Project to provide water for irrigation purposes nor impact existing contracts."

Reclamation tailors its operations to assure that public safety requirements are satisfied (flood control and recreational use), that water delivery contractual obligations are met (irrigation and power), and that instream flow targets (fish and wildlife habitat) are met. Maximizing flood control, irrigation water delivery, and meeting target streamflows requires continuous water management adjustment.

The five major project reservoirs, (Bumping Lake [1910], Kachess [1912], Keechelus [1917], Rimrock/Tieton Dam [1925], and Cle Elum [1933]), provide most of the physical operations needed to store and release water to meet irrigation demand, flood control needs, and instream flow requirements. Clear Creek Reservoir is operated primarily to maintain maximum elevation for recreational opportunities.

The average annual unregulated flow of the Yakima River basin near Parker (below Union Gap) totals about 3.4 million acre-feet (MAF), ranging from a high of 5.6 MAF (1972) and a low of 1.5 MAF (1977). The average annual irrigation diversion by entities recognized in the 1945 Consent Decree (Decree) totals approximately 2.2 MAF (period of record, 1961-1990). This does not include the other requirements for water in the basin, including instream flow, hydroelectric generation, and municipal and industrial uses. The total demand is supplied through a combination of stored water releases, unregulated flow (natural flow), and return flow. Total storage in the basin is a little over 1 MAF. The remainder of the irrigation demand is supplied through unregulated tributary flow and bypassed reservoir inflow (Note: bypassed reservoir inflow is streamflow into the reservoirs that is released rather than stored) and return flows.

Demand cannot always be met in years of below average runoff. Project operations make use of a monthly forecasting process to provide an advanced indication of water availability. On a daily basis, the project must take into account varying weather conditions, water demand, "travel time" of the flow from the reservoirs to the point of use, inflow from unregulated tributaries, return flow, and other factors to maintain appropriate flow levels at several control points (generally gaging station locations) in the basin.

The Yakima Field Office Manager is responsible for Reclamation's operational control and management of the TWSA for the Yakima River basin. According to "Memorandum Opinion": 'Flushing Flows,' December 22, 1994, Reclamation is: "an entity capable of responding to changing conditions." Each year, in light of the annual prevailing conditions and all current legal considerations, the Yakima Field Office Manager will ensure that the concerned parties are involved as part of the consultation process for operating the basin seasonally. The Yakima Field Office Manager maintains contact with the different groups on a monthly, or as needed, basis via meetings or other forms of communication, to maintain continuity on the development of the year's operation. These include System Operations Advisory Committee's (SOAC) monthly meetings for fishery-related issues, River Operations monthly meetings (future month's plans for operations) for all interested parties, and Managers' meetings (normally, starting in March or earlier if short fall is foreseen, for discussion of the water supply for the ongoing year) for the irrigation district managers and other interested parties. At such meetings, issues of significant concern to project operations in the basin may be addressed with the Yakima Field Office Manager and others, allowing public input for possible inclusion into the seasonal operations stratagem. If consensus cannot be reached, the Yakima Field Office Manager, after review of available science and data, makes the final seasonal decisions.

5.1 OPERATING SEASONS

The thought process for a single season of operations requires a minimum of a 15-month operational year, starting in August of year 1 and ending in October of year 2 (example: August 2000 to October 2001). The operation process started in August will have possible ramifications into the following year's October. All needs or operations for a given season must be evaluated and accounted for in the preceding August, with continual review throughout the season's operation to successfully satisfy the Yakima River system's competing demands. System operations can be divided into four general time segments during the year and these correspond some what closely to the seasons of the year. These segments and their relationships to the irrigation season and water measurement period (water year) are shown in table 5-1. below.

Table 5-1.–Operating Periods and Seasons Yakima River Basin 15-Month Operation Year

Fall			Winter				Spring/Summer				Summer/Fall			
Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
							Average Irrigation Season							
		Water Year												

Tables 5-2. through 5-5. which follow, demonstrate the operational considerations and constraints (CCs) during each of the respective seasons. More detailed descriptions of these can be found in the following sections. These charts are intended to show only the time periods within which the CCs are considered when making operational decisions. They do not necessarily show when releases or other changes are actually made.

5.1.1 Fall Operations (August, September, October)

In August, river operators begin the transition to fall operations (August, September, October) which establishes the demands, constraints, and operational criteria for the next season. The fall operations period overlaps summer/fall operations, as the irrigation season is brought to a close. During August, September, and October, when the reservoirs are being drawn down to meet irrigation needs, releases are coordinated to maintain system storage flexibility so that flows can be ensured and provided for spawning, incubation, and rearing of spring chinook eggs and fry operations during the next season of operations. Fishery flow needs are coordinated with SOAC.

During the late August through September 10th period, the mini flip-flop and flip-flop operations are performed, lowering releases from the Upper Yakima Reservoirs and increasing releases from Rimrock to meet irrigation demands in the lower Yakima River system. The flip-flop operation allows Reclamation to protect salmon redds during the incubation and emergence/rearing periods, while minimizing the release demands and maximizing storage. Requests for power subordination are also possible on the lower river system during this period, to maintain instream flows for migration, passage, and rearing.

Table 5-2. demonstrates the CCs during the fall operations period.

Table 5-2. –Fall Operations

Yakima River Basin 15-Month Operation Year																	
Fall Operations (Preparatory)		**Months of Operations**															
Considerations & Constraints		**August**				**September**				**October**				------------------			
1	Average Irrigation Season	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////					
2	Irrigation Supply - Flood Waters																
3	TWSA - Irrigation Supply Period	///////	///////	///////	///////	///////	///////	///////	///////								
4	OWSA - Irrigation Supply Period									///////	///////	///////					
5	Flood Control - Winter																
6	Flood Control - Spring/Summer																
7	Runoff Forecast - Monthly																
8	TWSA Compiled - Monthly																
9	OWSA Compiled - October									/////							
10	TWSA - Short - Prorationing	///////	///////	///////	///////	///////	///////	///////	///////								
11	TWSA - Short - NRP																
12	TWSA - Short - Water Bucket	///////	///////	///////	///////	///////	///////	///////	///////								
13	Storage Control - Historical & Average*	///////	///////	///													
14	YRBWEP XII Flow Period	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
15	Flip-Flop Operation					///////	///										
16	Mini Flip-Flop Operation				//////												
17	Spawning Flows					///////	///////	///////	///////	///////	///////	///////	///////				
18	Incubation Flows											/	///////				
19	Rearing Flows	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
20	Ramping Rates	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
21	Passage Flows	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
22	Flushing/Pulse Flows - Out-migration																
23	Power Subordination	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
24	Hydroelectric Power Operations	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
25	Winter Operations & Ice Watch																
26	Operations - Maintenance - Hydrology	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
27	Operations - Maint. - Dams & Diversion	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
28	Operations - Maint. - Fish Facilities	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
29	Min. Sept. 30 Storage - 76 KAF												//				
30	Maximize Storage Content																
31	Develop Storage Content																

Note: ///////// indicates time period of importance.

5.1.2 **Winter Operations** (November, December, January, February)

Streamflow into the reservoirs in excess of downstream requirements are stored. Flows are bypassed or releases are made to provide instream flow for the incubation of spring chinook eggs and fry and other fish demands. Release schedules also consider flood control requirements. Flood control operations that may occur are guided by flood control space guidelines for the reservoirs and by forecasts of future runoff. Flood control operations must consider real time streamflow downstream of the dams prior to releasing water. For example, streamflows in the Yakima River at Easton, Cle Elum, Ellensburg, Parker, and Kiona and the Naches River at Cliffdell, and in the Naches River are evaluated prior to any reservoir release. The main objective during flood control operations is to provide maximum protection against flood damage in the Yakima River basin as a whole, without jeopardizing the irrigation water supply for the following year. Other issues or constraints at this time include migration flow and possible power subordination in the lower river system.

Table 5-3. demonstrates the CCs during the winter period.

Table 5-3.– Winter Operations

Yakima River Basin 15-Month Operation Year																	
Winter Operations		**Months of Operations**															
Considerations & Constraints		**November**				**December**				**January**				**February**			
1	Average Irrigation Season																
2	Irrigation Supply - Flood Waters																
3	TWSA - Irrigation Supply Period																
4	OWSA - Irrigation Supply Period																
5	Flood Control - Winter	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
6	Flood Control - Spring/Summer																
7	Runoff Forecast - Monthly									//////				//////			
8	TWSA Compiled - Monthly																
9	OWSA Compiled - October																
10	TWSA - Short - Prorationing																
11	TWSA - Short - NRP																
12	TWSA - Short - Water Bucket																
13	Storage Control - Historical & Average*																
14	YRBWEP XII Flow Period																
15	Flip-Flop Operation																
16	Mini Flip-Flop Operation																
17	Spawning Flows	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
18	Incubation Flows	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
19	Rearing Flows	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
20	Ramping Rates	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
21	Passage Flows	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
22	Flushing/Pulse Flows - Out-migration																
23	Power Subordination	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
24	Hydroelectric Power Operations	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
25	Winter Operations & Ice Watch					//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
26	Operations - Maintenance - Hydrology	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
27	Operations - Maint. - Dams & Diversion	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
28	Operations - Maint. - Fish Facilities	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////
29	Min. Sept. 30 Storage - 76 KAF																
30	Maximize Storage Content																
31	Develop Storage Content	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////	//////

Note: ///////// indicates time period of importance.

5.1.3 Spring/Summer Operations (March, April, May, June)

Streamflow into the reservoirs in excess of downstream requirements is stored. Irrigation diversion demand is largely met from natural flow accruing below the reservoirs from unregulated tributaries. Some supplemental releases are made for instream flow maintenance for incubation and rearing where unregulated inflow downstream of the dams is inadequate. Occasionally releases are made for enhanced passage flows, spikes, or other flow enhancement needed to encourage smolt out-migration. Other issues or constraints at this time include migration flows and possible power subordination in the lower river system. Releases to maintain appropriate flood control space are provided as necessary. Spring/summer flood control operations at the five project reservoirs occur each water year, even during most dry years. The volume of runoff potential is estimated by the runoff forecast in balance with the TWSA process. The runoff forecast and the flood space guide curves are taken into account in the refill process and in the timing of attaining a full storage system. Reservoirs are generally brought to their highest level during the late May through June time period. Some of the reservoir inflow is stored and some is passed through the reservoir to supplement unregulated flows and return flows to meet downstream diversion demand. Unregulated flow and return flow are generally adequate to meet irrigation diversions through June. However, storage releases have begun as early as May in dry years and as late as August in wet years. The average date of storage control (period of record, 1926-1999) in the Yakima River basin is June 24th.

Table 5-4. demonstrates the CCs during the spring/summer period.

Table 5-4.–Spring/Summer Operations

Yakima River Basin 15-Month Operation Year																	
Spring/Summer Operations		**Months of Operations**															
Considerations & Constraints		**March**				**April**				**May**				**June**			
1	Average Irrigation Season	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
2	Irrigation Supply - Flood Waters			///////	///////	///////	///////	///////	///////	///////	///////	////					
3	TWSA - Irrigation Supply Period					///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
4	OWSA - Irrigation Supply Period																
5	Flood Control - Winter																
6	Flood Control - Spring/Summer	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
7	Runoff Forecast - Monthly	///////				///////				///////				///////			
8	TWSA Compiled - Monthly	////	////			////	///			///	////			///	///		
9	OWSA Compiled - October																
10	TWSA - Short - Prorationing					///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
11	TWSA - Short - NRP			///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
12	TWSA - Short - Water Bucket					///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
13	Storage Control - Historical & Average*					///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	*///
14	YRBWEP XII Flow Period					///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
15	Flip-Flop Operation																
16	Mini Flip-Flop Operation																
17	Spawning Flows	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
18	Incubation Flows	///////	///////	///////	///////												
19	Rearing Flows	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
20	Ramping Rates	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
21	Passage Flows	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
22	Flushing/Pulse Flows - Out-migration					///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
23	Power Subordination	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
24	Hydroelectric Power Operations	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
25	Winter Operations & Ice Watch	///////	///////	///////	///////												
26	Operations - Maintenance - Hydrology	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
27	Operations - Maint. - Dams & Diversion	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
28	Operations - Maint. - Fish Facilities	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
29	Min. Sept. 30 Storage - 76 KAF																
30	Maximize Storage Content													///////	///////	///////	//////
31	Develop Storage Content	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				

Note: ///////// indicates time period of importance.

5.1.4 Summer/Fall Operations (July, August, September, October)

During July, reservoirs are generally operated to maximize storage and still meet downstream demand. From July through the end of the irrigation season (normally October 20th), releases from stored water are required to meet both irrigation needs and Title XII instream flow targets. The system is on "storage control" when reservoir storage must be released to meet downstream demands, including the Title XII target flows. This results in a decline in total storage. Other issues or constraints at this time include passage flows and power subordination. During the summer/fall operations the system is operated to bring the current irrigation season to conclusion. Starting in August, however, operations also switches to establishing the demands, constraints, and operation criteria for the next season.

Table 5-5. demonstrates the CCs for the summer/fall period.

Table 5-5.–Summer/Fall Operations

Yakima River Basin 15-Month Operation Year																	
Summer/Fall Operations		**Months of Operations**															
Considerations & Constraints		**July**				**August**				**September**				**October**			
1	Average Irrigation Season	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////	
2	Irrigation Supply - Flood Waters																
3	TWSA - Irrigation Supply Period	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
4	OWSA - Irrigation Supply Period													///////	///////	///////	
5	Flood Control - Winter																
6	Flood Control - Spring/Summer																
7	Runoff Forecast - Monthly	///////															
8	TWSA Compiled - Monthly	///	////														
9	OWSA Compiled - October												/	////			
10	TWSA - Short - Prorationing	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
11	TWSA - Short - NRP																
12	TWSA - Short - Water Bucket	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////				
13	Storage Control - Historical & Average*	///////	///////	///////	///////	///////	///////	///									
14	YRBWEP XII Flow Period	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
15	Flip-Flop Operation									///////	///---	-----	-----	-----	-----	----//	
16	Mini Flip-Flop Operation								//////	-----	-----	-----	-----	-----	-----	----//	
17	Spawning Flows									///////	///////	///////	///////	///////	///////	///////	//////
18	Incubation Flows															/	///////
19	Rearing Flows	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
20	Ramping Rates	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
21	Passage Flows	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
22	Flushing/Pulse Flows - Out-migration																
23	Power Subordination	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
24	Hydroelectric Power Operations	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
25	Winter Operations & Ice Watch																
26	Operations - Maintenance - Hydrology	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
27	Operations - Maint. - Dams & Diversion	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
28	Operations - Maint. - Fish Facilities	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	///////	//////
29	Min. Sept. 30 Storage - 76 KAF												//				
30	Maximize Storage Content	///////	///////	///////	///////												
31	Develop Storage Content																

Note: ///////// indicates time period of importance.

5.2 OPERATIONS FUNCTIONS, CONSTRAINTS, CRITERIA, AND OBJECTIVES

This section describes the functions, constraints, criteria, and objectives that are taken into consideration during the basin's 15-month operational year. In tables 5-2. through 5-5., the "CC" (referenced in parentheses) corresponds to the number used in the tables to designate a "consideration or constraint." The main project operations are for irrigation, fisheries (fish and wildlife), flood control, hydropower, and recreation.

Glossary of Terms

Average Irrigation Season (CC1) -

The average length of the irrigation season is from mid-March through October 20th. From mid-March to the end of March, Yakima Valley irrigation systems are "primed" for operation so that actual delivery of water to individual users can begin on April 1. The major districts' main canals and lateral systems extend for hundreds of miles, requiring 1 to 2 weeks to completely "water-up" the canal system.

Irrigation Demand -

The sum of April through September "entitlement diversions" (existing contractual obligations) is about 2.31 MAF. October entitlements total about 0.12 MAF. To date, entitlement in March is not completely quantified, but some irrigation entities have rights which include flood water use. Entitlement diversions represent only the irrigation water entitlements stipulated in the Decree for the main stem Yakima River basin and do not include irrigation diversions on tributaries or adjudicated streams such as Big Creek, Little Creek, Teanaway River, Taneum Creek, Manastash Creek, Wenas Creek, Cowiche Creek, Ahtanum Creek, and others.

Runoff -

Runoff consists of water from three sources: 1) surface flow, 2) interflow, and 3) baseflow, i.e., runoff contributed by groundwater. These components depict the path of runoff. At any one time, runoff consists of a combination of the three. Generally, during wet-weather periods, surface flow and interflow are the primary contributors to runoff. Conversely, during dry-weather periods, baseflow is the major contributor. Surface flow/runoff is the product of effective precipitation, that is, the rain and snow falling on the basin. Runoff refers to all waters flowing on the surface and in through the shallow soil horizon. Runoff is expressed either in terms of volume or flow rate. The typical unit of runoff volume is acre-foot (43,560 cubic feet or 325,900 gallons) that would cover 1 acre to a depth of 1 foot. Flow rate (discharge) is the volume per unit of time passing through a given point. It is usually expressed in cubic feet per second (cfs) or gallons per minute.

Interflow and groundwater flow are two types of subsurface water runoff. Subsurface water comprises all water either in subsurface storage or flowing below the ground surface. Interflow takes place in the unsaturated zone close to the ground surface. Groundwater flow takes place in the saturated zone, which may be either close to the ground surface or deep in underground water bearing formations.

Unregulated Flow -

For the purposes of project operations, unregulated flow (represented in either the volume or the flow rate) at a given point, is that flow which would occur without the influence of reservoir storage or diversion above the given point (i.e., human interference). Note that this is not an absolute value, but is only used as an indicator of the natural flow.

Bypassed Reservoir Inflow -

Inflow into the reservoirs that is bypassed through the reservoirs rather than stored. Bypasses of flow through the reservoirs do not constitute releases of "stored" water.

Storage Control (CC13) -

The system is on storage control when the flow at the Yakima River at Parker (control point) can be controlled to the Title XII target flows only by using supplemental reservoir storage releases. Once unregulated streamflow fails to meet diversion demand and target flows downstream, reservoir storage releases must be made to meet these demands, causing a depletion of reservoir storage. A reservoir release made in order to supply water to a specific district will not necessarily place the system on storage control. Formal declaration of storage control generally signals the peaking of reservoir storage, the start of a daily demand on storage and the end of any available flood/free water to the irrigation entities. The historic average date of storage control is June 24th, with the earliest occurring on April 1st, and the latest on August 17th.

5.2.1 Runoff Forecast (CC7)

Runoff forecasts are made for the five major reservoirs: Keechelus (KEE), Kachess (KAC), Cle Elum (CLE), Bumping (BUM), and Rimrock (RIM); and at three key checkpoints on the Yakima River system. The three river forecast checkpoints are Yakima River at Cle Elum (YUMW), Yakima River near Parker (PARW), and the Naches River near Naches (NACW). Forecasts are compiled by Natural Resource Conservation Service, National Weather Service, and Reclamation. The current Reclamation forecasting process was begun in the mid-1970s, primarily for flood control purposes. Since 1977, it has been used as one of the components in the analysis of TWSA. No known forecasting process is capable of accurately predicting weather or hydrologic conditions for the upcoming water season in advance, and predictions improve as the upcoming season progresses.

While the runoff volume for a given period can be estimated, the timing of how and when the runoff will occur is usually unknown. The resulting runoff is affected by temperature variation, snowpack density, rainfall intensity, and subsequent snowfall. Warm temperatures or precipitation, especially in combination, greatly affects intensity of runoff after snowpack reaches a density of 40+ percent. Other factors that affect the forecasted runoff volume are evaporation, evapotranspiration, and sublimation.

Each year, beginning in January and normally ending in July, Reclamation develops monthly runoff forecasts. Early forecasts (January and February) are primarily used in flood control operations. By March, forecasts become more suitable for TWSA estimation. The forecasts are made for anticipated precipitation levels of 50 percent, 100 percent, and 150 percent of normal.

The data used in the forecast process include (1) antecedent (preceding) runoff (which is based upon the assumption that the past August through September runoff serves as a relative indicator of soil moisture and base flow runoff conditions that will continue into the current forecast); (2) October through March precipitation at Keechelus Lake, Kachess Lake, Stampede Pass, Cle Elum Lake, Ohanapecosh, Bumping Lake, Rimrock Lake, and Tieton Canal Intake Headworks; (3) April 1st snow water content at Bumping Lake (New), Cayuse Pass, Corral Pass, Domerie Flats at Cle Elum Lake, Stampede Pass, Tunnel Avenue at Keechelus Lake, Olallie Meadows, and Fish Lake; and (4) April through June precipitation at the sites mentioned for group (2), above.

The forecasting technique used is a “multiple regression analysis.” The multiple regression examines established correlations between selected variables and historical runoff, creating an equation which, after current condition factors are supplied, can provide a runoff volume forecast. The coefficients used in the forecast equation change slightly as each new year of data is entered into the historical data base used to establish the regressions. The current historical data base extends from 1940 to1999. When the forecast process is updated with current data, it will provide a forecasted quantity of unregulated runoff volume for the October 1st through July 31st period. Subtracting the total unregulated runoff that has passed by the forecast point from October 1st to the date of forecast calculation (current date), provides a residual unregulated runoff volume expected from the current date of forecast calculation, to July 31st.

The following is an example of the forecast of natural runoff at the PARW which is required use for the flood control allocation curves, TWSA development, and establishing the current year’s volume of Yakima River Basin Water Enhancement Project (YRBWEP) target flows.

The PARW forecast is derived using a step-wise multiple regression procedure and has the following equation (coefficients as of water year [WY] 2000):

Y_{PARW} = 0.4860 X_1 + 15.4666 X_2 + 1.5619 X_3 + 13.4801 X_4 - 1119.51

Where:

Y_{PARW} = October - July natural runoff at PARW (1,000 acre-feet).

X_1 = Antecedent July - September natural runoff at PARW (1,000 acre-feet).

X_2 = October - March precipitation. Bumping Lake + Cle Elum Lake + Keechelus Lake + Ohanapecosh + Rimrock Lake + Tieton Intake (inches).

X_3 = April 1st snow water content. Bumping Lake (New) + Cayuse Pass + Corral Pass + Domerie Flats at Cle Elum Lake + Tunnel Avenue at Keechelus Lake (inches).

X_4 = April - June precipitation. Same stations as in X_2 (inches).

1119.51 = A yearly constant (changes slightly on an annual basis as each new year of data is entered into the regressions).

Note: the precipitation and snow courses data used in the forecast process is available on the Columbia River Operational Hydrometeorological System (CROHMS) reporting network.

When precipitation and snowpack are average or above-average, the forecast is a useful tool for the management of the flood operations.

5.2.2 Flood Control

Flood control in the Yakima River basin is supported by the project's five major storage reservoirs: Keechelus, Kachess, Cle Elum, Bumping, and Rimrock. These reservoirs affect the runoff from only 578 square miles (15.8 percent) of the 3,660 square miles located above the PARW gaging station. However, the runoff volume above the reservoirs represents only approximately 50 percent of the 3.4 MAF of unregulated yearly runoff as calculated at PARW. The reservoirs began providing flood control to the lower basin immediately following their construction. Flooding has been significantly reduced each year since storage development.

Following the flood of May 1948, which virtually destroyed the city of Vanport, Washington, Congress required water resource agencies to develop plans to avert similar disasters in the future. Between 1948 and 1955, water forecasts were established for the main stem and all tributaries of the Columbia River, and formal flood operations began in the Yakima River basin. The initial written operating guideline for the Yakima Project, which included flood control, was the "Lindgren filling schedule." This filling schedule was utilized from approximately 1950 until it was superseded by the system rule curve developed in 1974. The Lindgren filling schedule simply denoted the maximum allowable end-of-month storage content for each of the system's five reservoirs. The schedule did not account for an inflow forecast, and thus directed the same maximum water surface elevation irrespective of hydrologic factors. In 1973, water was released through a portion of the winter to restrict system storage volumes to at or below the Lindgren filling schedule. Due to subsequent below normal runoff volume, the reservoirs failed to fill and rationing was required during the 1973 irrigation season.

After the 1973 irrigation season, Reclamation, recognizing the huge variability in seasonal runoff volumes and timing, developed the currently utilized system rule (guideline) curve for the Yakima Project reservoirs. The use of the "Flood Control Rule Curve (FCRC)," dated February 25, 1974, by D.R. Yribar, is relatively straightforward and is based upon the premise of attempting to maintain flows at the PARW gaging site at no more than 12,000 cfs during the non-irrigation season and 17,200 cfs, including diversions of 5,200 cfs above PARW, during the irrigation season. The generally accepted flood stage (10.0 feet) at PARW coincides with a flow rate of approximately 15,000 cfs. Inputs to the curve allow the required system storage space to be read from the curve. After determining the required system storage space, the space requirement within the individual reservoirs is determined. The required system storage space is divided as follows: Keechelus 13 percent, Kachess 12 percent, Cle Elum 42 percent, Bumping 13 percent, and Rimrock 20 percent.

Flood Control (Winter Operations) (CC5) -

During the winter months, November through February, the flood guide seeks to maintain 300 thousand acre-feet (KAF) of unfilled storage space to provide protection against a winter flood event before the spring forecasts become available. The 300 KAF of system storage space is distributed as follows: Keechelus (39 KAF) 13 percent, Kachess (36 KAF) 12 percent, Cle Elum (126 KAF) 42 percent, Bumping (39 KAF, not obtainable, normally 20 KAF) 13 percent, and Rimrock (60 KAF) 20 percent.

Flood Control (Spring/Summer Operations) (CC6) -

The flood guide requires variable system storage space of from 0 to 850,000 acre-feet to be available, depending upon forecasted runoff, from March 1st through June 30th. The spring/summer storage space distribution is based on the same percentages as described above. Current reservoir flood control and filling operations include an attempt to provide a more normative hydrographic shape in the mid-May through June runoff season. The flood control period from July to June fills the storage reservoirs in late May or early June, rather than June 30th. This requires the earlier storage of more of the March through May inflow to the reservoirs than in the past. With the reservoirs full June 1st, the inflow to the reservoirs must be bypassed downstream, resulting in a more normative shaped hydrograph for the river system during late May, June, and early July. This modification of the flood control operation requires close monitoring depending upon the current year's runoff forecast. Historically, this will hold June's downstream river flows higher, but not necessarily drive them to flood flows.

With the project being subject to heavy fall rains and/or rain-on-snow events during the winter, the FCRC provides space for regulation of these events. The general flood control operation policy is to use the space available in system storage to avoid or reduce flood events in the down river system based upon the historical flood stages. Events are forecasted by the Northwest River Forecast Center in Portland, Oregon and/or the National Weather Service in Pendleton, Oregon which provide warnings to Reclamation and the public of flood events. After the flooding below the reservoirs recedes, when necessary, storage releases are made from the reservoirs in an attempt to return to levels prescribed in the FCRC and to prepare for the next possible event. Care is taken to make releases only when downstream river stages are below flood stage, and to hold river levels below flood stage, if possible. Safety of Dams issues, however, may require releases from reservoirs for protection of dam facilities even at times when downstream flows are at or near flood state (i.e., avoidance of dam failure).

River Forecast Point – Northwest River Forecast Center	Historical Flood Stage
EASW Yakima River at Easton WA	50.3 GH @ 3,200 cfs
YUMW Yakima River at Cle Elum WA	9.0 GH @ 10,000 cfs
ELNW Yakima River at Ellensburg WA	34.0 GH @ 12,000 cfs
CLFW Naches River near Cliffdell WA	31.0 GH @ 5,000 cfs
NACW Naches River near Naches WA	17.0 GH @ 10,000 cfs
PARW Yakima River near Parker WA	10.0 GH @ 15,000 cfs
KIOW Yakima River near Kiona WA	13.6 GH @ 20,000 cfs

The project has used FCRC as a guideline since 1975. Project operations uses the FCRC as a guide, not as a rule of operation. The FCRC can cause problems when trying to fill the reservoirs to maximum storage for TWSA/irrigation use. If followed to the letter of the rule, flood storage space will be maintained to the end of forecast period and the reservoir storage system may not fill. The FCRC has no considerations built into it for meeting the currently developing "normative river system" operations to meet the fishery resource needs. In most years, project operations seeks to maximize storage in early June and hold maximized storage as long as possible. The FCRC, together with monthly Basin Runoff Forecasts, provides tools needed to operate the reservoirs for both TWSA and flood control. Attempts are made to hold the recommended distribution of flood control space for individual reservoirs, and the Upper Yakima Reach and Naches Reach of the river system.

"Surcharge" storage during any flood event is considered temporary and will be released as soon as possible at a rate that will keep downstream river channels full to capacity as long as there is surcharge in the reservoirs. Surcharge space within a reservoir represents the volume above the normal full pool. (Reservoir Surcharge Policy - 20 March 2000, PNR-Reclamation.)

Operation of the individual reservoirs to maximize storage (CC30) for TWSA requires project operations to watch for an imbalance in the runoff forecast. If the forecast-to-space ratio recommended by the rule curve is less than 5:1, reservoir outflows are reduced to maintain a greater than or equal to 5:1 forecast to space ratio. (Note: "forecast-to-space ratio" is the ratio of the remaining forecast with respect to space available in the reservoir system.) When the Parker forecast is less than 1.5 MAF, the forecast-to-space ratio is pushed to 10:1. When the Parker forecast reaches 750,000 acre-feet, project operations chooses a target fill date that allows a uniform fill and approximately 2 weeks at full storage capacity before the drafting of storage begins. This must be done while paying attention to short and long-term weather forecasts and possible flood events. Project operations currently target a June 1st fill date to provide a normative hydrographic shape for reservoir outflows during the mid-May through June runoff season.

Flood Inducing Conditions -

The biggest floods on the Yakima and Naches Rivers have occurred during the winter months from November through February. Major winter floods occur under two different sets of weather patterns: (1) When a strong westerly, slightly anticyclonic flow combines with a high freezing level and subtropical moisture, the Cascades receive tremendous amounts of rainfall. This is precisely the situation that leads to widespread, major flooding in the rivers flowing off the west slopes of the Cascades. The precipitation often does not extend very far east of the Cascades crest, but enough rain falls in the upper parts of the river basins to cause flooding on the Yakima and Naches Rivers. The November 1990 and November 1995 flood events are classic recent examples. (2) The combination of strong southerly or southwesterly flow, high freezing levels, and subtropical moisture can also lead to major floods on the Yakima and Naches Rivers. These events involve the total basin and bring heavy rain both to the Cascades and to the lower areas of the basin, and general low elevation snowmelt plays an important role in these floods. The February 1996 flood is an example. The Yakima and Naches Rivers also occasionally flood in the spring between March and June. Although more frequent than winter floods, historically, spring floods have been less severe. These floods happen when a significant rainfall event occurs during a period of rapid snowmelt. They are most common in May and June, when the mountain snowpack is melting rapidly. (National Weather Service, Pendleton, Oregon, "Hydrologic Service Area Manual" section 4.)

5.2.3 Total Water Supply Available

Reclamation prepares forecasts of the TWSA (CC8) upstream of the Yakima River near Parker beginning in March, then monthly through July. In a water-short season, forecasts may continue through to the end of the irrigation season. These forecasts are the basis for determining the adequacy of the TWSA (taking into account YRBWEP Title XII target flows) to meet irrigation water entitlements stipulated in the Decree and to assist in deciding the amount of proration, if any, that may be necessary.

The TWSA as defined in the Decree, is "That amount of water available in any year from natural flow of the Yakima River, and its tributaries, from storage in the various Government reservoirs on the Yakima watershed and from other sources, to supply the contract obligations of the United States to deliver water and to supply claimed rights to the use of water on the Yakima River and its tributaries, heretofore recognized by the United States."

Reclamation interprets the above to mean ". . . the total water supply available for the Yakima River basin above PARW, for the period April through September," expressed in a mathematical formula, reading as follows:

TWSA is equal to:
  April 1st through July 31st forecast of runoff,
+ August 1st through September 30th projected runoff,
+ April 1st reservoir storage contents,
+ Usable return flow upstream of PARW.

The sum of the above four items (TWSA) provides an estimated total water volume available for use in determining the instream flow targets for the given year in accordance with the operating criteria of the YRBWEP legislation. The total demand to be placed against this TWSA for irrigation, regulation, and flows passing Parker averages 2.7 MAF (including Title XII target flows) in a normal year. (See following table 5-6. for Historical TWSA Estimates and YRBWEP Title XII Target Flows.)

Table 5-6.–Historical TWSA Estimates by Month in KAF, Commencing WY 1977 & YRBWEP Title XII Target flows in cfs, Commencing WY 1995.

Month	**Mar's Apr**	**XII**	**Apr**	**XII**	**May**	**XII**	**Jun**	**XII**	**Jul**	**XII**	**Aug**	**Sep**
YEAR	KAF	cfs	KAF	cfs	KAF	cfs	KAF	cfs	KAF	cfs	KAF	KAF
1977	-	-	2037	-	-	-	-	-	-	-	-	-
1978	3088	-	2678	-	2341	-	-	-	1433	-	920	-
1979	2770	-	2657	-	2460	-	1964	-	-	-	-	-
1980	3268	-	3147	-	2705	-	2121	-	-	-	-	-
1981	2690	-	2367	-	2296	-	1979	-	-	-	-	-
1982	3433	-	3256	-	3005	-	-	-	-	-	-	-
1983	3453	-	3392	-	2941	-	2271	-	-	-	-	-
1984	2956	-	2786	-	2501	-	2200	-	-	-	-	-
1985	3106	-	3111	-	2868	-	2395	-	1529	-	899	-
1986	3061	-	2668	-	2284	-	1800	-	1367	-	-	-
1987	2558	-	2559	-	2297	-	1661	-	1301	-	-	-
1988	2377	-	2253	-	2065	-	1710	-	1349	-	-	-
1989	2946	-	3071	-	2666	-	2192	-	-	-	-	-
1990	3446	-	3268	-	2824	-	2417	-	1717	-	-	-
1991	2938	-	2962	-	2742	-	2261	-	1854	-	-	-
1992	2853	-	2422	-	2268	-	1497 [4]	-	1155 [1]	-	788 [1]	324 [1]
1993	2062	-	1974 [5]	-	1842 [2]	-	1405 [1,2]	-	1126 [1,2]	-	774 [1,2]	415 [1,2]
1994	2169 [2]	-	2016 [2]	-	1691 [2]	-	1191 [1,2]	-	934 [1,2]	-	593 [1,2]	283 [1,2]
1995	3284 [2]	600	3044 [2]	500	2666 [2]	500	2088 [2]	400	1572 [2]	400	-	-
1996	3268 [2]	600	2872 [2]	400	2530 [2]	400	2003 [2]	400	1463 [2]	400	-	-
1997	4055 [2]	600	4542 [2]	600	3836 [2]	600	2670 [2]	600	1935 [2]	600	-	-
1998	3193 [2]	500	2982 [2]	500	2548 [2]	400	2017 [1,2]	400	1536 [1,2]	400	-	-
1999	4179 [2]	600	4198 [2]	600	3649 [2]	600	3017 [2]	600	1913 [1,2]	600	-	-
2000	3319 [2]	604	3305 [2]	604	2691 [2]	504 [6]	2175 [2]	404 [3]	1615 [2]	404 [3]	-	-
Average	3064	(500)	2898.625	(500)	2596.3	(400)	2049.2	(400)	1487.4	(300)	794.8	340.67

XII = YRBWEP Title XII Target Flows – April (or current month) through October.

[4] Based upon adopted forecast.

[5] Does not include October's entitlements, runoff, or return flows.

[6] Includes YRBWEP lease and acquisition (L&A) water.

Water Supply Available for Irrigation -

The Water Supply Available for Irrigation (WSAI) (CC3) is the TWSA less September 30th residual storage and flows passing Yakima River near Parker below Sunnyside Dam, including YRBWEP Title XII requirements, for the period April 1st to September 30th. The WSAI is expressed in the following mathematical formula:

WSAI Estimate April 1st - September 30th is equal to:

#	
1.	+ April 1st through July 31st forecast of runoff,
2.	+ August 1st through September 30th projected runoff,
3.	+ April 1st reservoir storage contents,
4.	+ Usable return flow upstream of Parker,
5.	= **TWSA*** (Total Water Supply Available),
6.	+ YRBWEP Title XII New Acquisitions,
7.	= TWSA + New Acquisitions,
8.	- September 30th reservoir storage content,
9.	- Flow passing Sunnyside Dam,**
10.	= **WSAI** (Water Supply Available Irrigation),
11.	- Non-proratable Irrigation Entitlement,
12.	= Remaining WSAI,
13.	/ Proratable Entitlement,***
14.	= % of Proratable Entitlement.

Note: * Determines YRBWEP Title XII Target Flow.
** Quantity includes YRBWEP Title XII Target Flows and New Acquisition.
*** If the ratio "Remaining WSAI" divided by "Proratable Entitlement" is less than 100 percent, prorationing may be necessary.

TWSA values are defined as follows:

#1&2 – Forecast of runoff is estimated for 3 subsequent precipitation levels – 50 percent of normal, normal, and 150 percent of normal for the ensuing months.

#3 – Current end of month reservoir contents are added. This is the amount of water stored in the reservoirs at the end of the prior month.

#4 – Estimated irrigation return flows are added. Irrigation return flows are the amount of water that returns to the river system after diversion and application to the land. Three estimates based on diversions anticipated with the three precipitation levels are made.

#5 – **TWSA*** – Total Water Supply Available. Sum of values #1 through #4, determines YRBWEP Title XII Target Flow.

#6 – New water acquired via YRBWEP Title XII.

#7 – TWSA + new water acquired.

#8 – September 30th reservoir storage content, residual storage is anticipated carryover storage.

#9 – Estimated flow passing Sunnyside Dam (PARW). This estimate includes undiverted unregulated flow, operational spills based on historic flows in similar water years and includes quantified YRBWEP Title XII target flows and new water acquisitions.

#10 – **WSAI** – Water supply available for irrigation entitlements.

#11 – Full quantified non-proratable irrigation entitlements.

#12 – Remaining water supply available for proratable irrigation entitlements.

#13 – Total proratable entitlements.

#14 – Percent of available proratable entitlement.

Return Flow -

Return flow is the water either on the surface or seeping underground toward a stream after water has been spread overland to irrigate crops or been lost to evapotranspiration. The principal components making up return flow are percolation (to the hydraulically connected aquifer) and surface losses from irrigation, seepage losses from "on-farm" and district conveyance systems, and operational losses from these conveyance systems. The timing of the return flow and the location of the flow in the river system determine whether or not the flow can be reused again.

Return flow resulting from irrigation diversions which are usable for diversion above Sunnyside Dam (PARW) are an integral part of the TWSA estimate. The return flow is dependent upon the level of diversion which is conditioned by the amount, time, and availability of runoff. The return flow will vary from year to year, but the usable portion is a fairly uniform base flow which is generated by fairly stable upstream diversion rates. The return flow volume projected to be usable is 400,000 acre-feet in high runoff years, 375,000 acre-feet in average years, and 350,000 acre-feet in low runoff years. (See table 5-7. below)

Table 5-7.–Projected Usable Return Flow (af) for TWSA development, April through September + October

Month	Monthly Projection	Projected Accumulated Remaining Return Flow in Acre-Feet		
---------	---------	Low Runoff Year	Average Runoff Year	High Runoff Year
April	42,000	350,000	375,000	400,000
May	64,000	308,000	333,000	358,000
June	66,000	250,000	269,000	288,000
July	78,000	186,000	203,000	222,000
August	73,000	110,000	125,000	140,000
September	52,000	39,000	52,000	65,000
----------	---------	---------	----------	----------
October	21,000	16,000	21,000	26,000

(Usable return flow as used in computation of TWSA since 1980 except the extreme water-short years: 1992, 1993, 1994.)

For the daily operation decision process, it is possible to get a rough estimate of daily return flow by adding the diversions of the YTID and the Kittitas Reclamation District (KRD) to the total diversions of the small irrigation users above Sunnyside Dam (PARW) and dividing by 2 to indicate the daily volume. Note that this is only an indicator and not an absolute quantity, as it takes up to 2 months for upstream diversions to translate into the full affect of return flow. Usable quantities of return flow from the system are developed by late April or early May in most years.

1945 Consent Decree -

During years of low runoff, disputes developed over the use of water from the Yakima River. In 1945, the District Court of Eastern Washington issued a decree under Civil Action No. 21, referred to as the 1945 Consent Decree. The Decree is a legal document pertaining to water distribution and water rights in the basin. The Decree established the legal guidelines under which Reclamation should operate the Yakima Project system to meet the water needs of the irrigation districts that predated the Yakima Project, as well as the entitlements of divisions formed in association with the Yakima Project. The Decree determined water delivery entitlements for all major project irrigation systems in the Yakima basin, except for lower reaches of the Yakima River near its confluence with the Columbia River. The Decree states the quantities of water to which all water users are entitled (maximum monthly and annual diversion limits) and defines a method of prioritization for water-deficient years. The water entitlements are divided into two classes—non-proratable and proratable. See descriptions below for Non-proratable Entitlements and Proratable Entitlements.

TWSA Irrigation Entitlements -

For compilation of the TWSA, Reclamation recognizes and limits diversion entitlements, except for minor diversions and adjudicated minor tributary streams, to quantities provided by: a) the Limiting Agreements (1905-1913) signed by over 50 appropriators of natural flows; b) water delivery contracts between the United States and water user entities; c) recognized non-subscribers to 1905 limiting agreements claimants; and d) by provisions of the Decree and subsequent Acquavella rulings. During non-prorated water years, unused TWSA irrigation entitlements are not carried over to the next month's TWSA entitlements for that entity. The water supply not used from these entitlements is rolled into the next TWSA supply forecast for re-allocation to supply the demands of the river basin during the remaining months of the water supply period. See "Entitlement Summary" appendix D.

Non-proratable Entitlements -

Non-proratable entitlements are to be served first from the TWSA. The non-proratable entitlements are confirmed by the Decree, Article 18. Article 19 established that these entitlements are excepted from proration, and the sum of said amounts are to be deducted from the TWSA prior to determining the entitlements that are subject to proration.

Proratable Entitlements -

All irrigation entitlements are established in the Decree. According to Article 18, all water rights are proratable, and of equal priority. However, Article 19 provides for and lists the amounts of entitlements "excepted from proration." Thus, the remaining entitlements become proratable and any shortages that may occur are shared equally by the proratable water users. (See following table 5-8. for TWSA Irrigation Entitlements [af] recognized by the Decree.)

Table 5-8.–TWSA Irrigation Entitlements (af) recognized by 1945 Consent Decree – April 1st through September 30th

Month	Non-proratable	Accumulated Non-proratable	Proratable	Accumulated Proratable	Monthly Total	Accumulated Remaining Entitlement
April	160,973	1,070,271	93,857	1,239,199	254,830	2,309,470
May	186,637	909,298	228,463	1,145,342	415,100	2,054,640
June	182,240	722,661	258,150	916,879	440,390	1,639,540
July	189,640	540,421	268,236	658,729	457,840	1,199,150
August	186,058	350,817	257,822	390,493	443,880	741,310
September	164,759	164,759	132,671	132,671	297,430	297,430

(Irrigation entitlement as used in computation of TWSA since 1980. Note: 1992 entitlement summary shows sightly greater quantity.)

TWSA Irrigation Entitlements (af) recognized by 1945 Consent Decree – October 1st through October 31st

Month	Non-proratable	Accumulated Non-proratable	Proratable	Accumulated Proratable	Monthly Total	Accumulated Remaining Entitlement
October	115,115	115,115	44,025	44,025	159,140	159,140

(Irrigation entitlement as used in computation of TWSA since 1980 Note: 1992 entitlement summary shows sightly greater quantity)

Contractual Irrigation Water Supply

Flood Waters (CC2) -

Flood waters are those waters available in excess of contracted and scheduled amounts or otherwise appropriated waters. They are defined in the Decree as being available for irrigation diversion "when, as determined by the Yakima Project Superintendent, there is flowing over the Sunnyside Dam (passing PARW) flood water in excess of the amount deemed necessary for proper river regulation, including in said amount, the amount necessary to protect fish life, in the river below said dam." Flood waters are usually available in the early irrigation season and are typically used for priming the irrigation canal systems, frost protection, and some early irrigation demands.

Priming is the initial wetting up of the canal after an extended shutdown period. Water must be introduced into the canal systems slowly. This allows the operators time to verify the water-carrying capability of the canal, to assure that no excessive leakage occurs at turnouts, to fill pipelines, to remove accumulated debris from the trashracks, and generally to prepare the system for delivery to the water-users. It is desirable to have the whole system watered up before delivery to users begin. On a long canal system, (i.e., greater than 50 miles), this takes considerable time.

Currently, as a matter of practice, irrigation districts and canal companies divert and utilize flood waters, during the March, April, and May period. The six major irrigation districts (holders of permits, water rights claims, treaty rights) plus others, make use of this water and are claiming it in the basin adjudication process. It remains to be seen if “flood” water rights will be confirmed in all cases by the court, thereby allowing the irrigation entities to quantify the amount and retain the use of this water.

Limiting Agreements -

Due to early overuse of the available water supply, prior to development of the Yakima Project, no additional irrigation development in the Yakima basin was feasible unless two things were accomplished: first, existing claimants had to agree to restrict their water usage to beneficial use and equitable distribution, especially in the months of July, August, and September; and second, development of a water storage system was necessary to store early season runoff for supplying irrigation demands for new lands.

The limitation on water usage by existing claimants was accomplished by an adjustment of water rights, dealing with more than 50 appropriators on the Yakima and Naches Rivers. The Secretary of the Interior, on December 12, 1905, set forth several conditions that had to be met precedent to further irrigation development in the Yakima basin. One condition, the settlement of existing and vested rights, was accomplished by “Limiting Agreements” wherein the water claimants voluntarily limited their diversions to certain maximum monthly quantities. The basis of this adjustment was a limitation for August and preceding months to the amount actually diverted in August 1905, for September, the limit was two-thirds of this amount; and for October, half of this amount. Of the August diversions, nearly 95 percent of claimed supply (1,900 cfs) was covered by limiting agreements and recognized by the Decree as “non-proratable entitlements” in the TWSA compilation. See “Entitlement Summary” appendix D.

Recognized Non-Subscriber to 1905 Limiting Agreement Claimants -

Several sizable diversions did not subscribe to a limiting agreement. These larger non-subscribers account for over 130 cfs daily mean diversion out of the Yakima and Naches Rivers. The Decree recognized the “non-subscriber to 1905 limiting agreement claimants” and therefore, these are covered as “non-proratable entitlements” in the TWSA compilation. These diversions are unidentified and unquantified in the Decree; however, they are acknowledged as having “heretofore been recognized by the United States.” See “Entitlement Summary” appendix D.

Post-1905 Water Rights -

In 1905, the United States obtained a withdrawal of the remaining unappropriated waters of the Yakima River basin for the purpose of developing the Federal Yakima Reclamation Project. After the May 10, 1905 effective date of the withdrawal, Washington State issued a number of new water right certificates under the authority of Chapter 90.03 of the Revised Code of Washington (RCW), enacted in 1917. These post-1905 priority rights were based on water right applications or claims dating from 1906 to 1981, which authorized diversions from the Yakima River and its tributaries. These rights were generally granted for agricultural use. More than 250 of these post-1905 certificates were issued for water diversions from the Yakima River basin above Sunnyside Dam, with priority dates from January 1, 1906 to October 13, 1981. These post-1905 certificates authorized a cumulative maximum diversion rate total of 250 cfs (potentially equivalent to 3.5% of the average daily diversion for irrigation use in the TWSA) that is unaccounted for in the compilation of the TWSA and is not provided for in the Decree. Supplying these diversions during a water-short year impacts the proratable TWSA water users. The Adjudication Court has reviewed many of these post-1905 priority water rights and has apparently found that some of these water uses were not fully developed or have been abandoned or relinquished. The Adjudication Court has confirmed rights to some of these post-1905 certificates in a substantially reduced amount and volume of water. But, even if they represent only a 50 cfs per day diversion from the Yakima basin, the TWSA is impacted in drought years by over 18,000 acre-feet for the period from April 1st to September 30th. During the June 28, 2001 Adjudication Court hearing, Judge Stauffacher reaffirmed the basic principle of Washington Water Law, as declared in 1917 by the Washington State Legislature in RCW 90.03.010, that "as between appropriations, the first in time shall be the first in right." May 10, 1905, and earlier priority water rights take precedence and have the first right of priority over junior 1905 and subsequent priority water rights. Final determination of the total volume of water being diverted by these post-1905 water right permits, certificates, or claims awaits the completion of the Yakima Adjudication and a Final Decree from the Adjudication Court. In the future, these post-1905 water rights need to be quantified and taken into account as Reclamation develops its yearly TWSA calculation.

Storage Contracts and Stored Water -

Some major entities, such as the Roza Irrigation District (RID) and the KRD, have no natural flow rights and thus their entire water supply is contracted. Other entities needing a supplemental supply are furnished contract water under terms of the Warren Act of February 21, 1911, which authorized Reclamation to contract for the sale of supplemental water from available supplies. These contracts specify the annual and monthly entitlements (non-proratable and proratable). Construction, and operation and maintenance costs of the storage facilities are paid by the entity in proportion to their entitlement. Currently, Reclamation services storage contracts totaling 1.74 MAF, using storage of 1.06 MAF and 1.71 MAF of unregulated runoff to the storage system. Obviously, stored water must be provided as a part of TWSA without reservoir storage being assigned to any specific entity. Entities do not have carryover storage rights as all carryover from one year to the next is considered to be a part of the TWSA for the subsequent year.

Prorationing (CC10) -

When the TWSA is not adequate to meet all irrigation entitlements, prorationing is necessary. Historically, (except WY 1993) the prorationing period has not started until the date of storage control. The amount of proration is determined monthly, biweekly, or as needed, by project operations and this information is provided to water using entities at manager meetings. The non-proratable users can divert their full irrigation entitlements. This amount is deducted from the WSAI with the remainder available for the proratable irrigation entitlements. The recognized quantities of non-proratable and proratable irrigation entitlements are summarized in table 5-8. above. Prorationing has been imposed in 8 of the last 30 years (1970-1999). As examples, proratable water users received 58 percent of their proratable entitlement in 1992, 67 percent in 1993, and 37 percent in 1994. (See table 5-9. for proration levels.)

Table 5-9. - Yakima River Basin – Proration Levels in Recent Years (Starting Water Year 1970)

Percentage of Entitlement

Year	(1) Start of	(2) Storage	(3) S.C. Jul	Apr.	May	Jun	Jul	Aug	Sept	(4) End of Proration Period		
1970	N/A	1- Jul	182							N/A		
1971	N/A	16-Aug	228							N/A		
1972	N/A	17-Aug	230							N/A		
1973	6/10?	1-May	121			80%	80%	80%	80%	end of sea		
1974	N/A	1-Aug	213							N/A		
1975	N/A	20-Jul	201							N/A		
1976	N/A	20-Jul	202							N/A		
1977	1-Apr	1-Apr	91	6-26%	13-50%	50%	70%	70%	70%	end of sea		
1978	N/A	1-Jul	182							N/A		
1979	7/1?	20-Apr	111			75%	75-46%	46%	100%	end of sea		
1980	N/A	1-Jul	183							N/A		
1981	N/A	15-Apr	105							N/A		
1982	N/A	10-Jul	191							N/A		
1983	N/A	20-Jun	171							N/A		
1984	N/A	10-Jul	192							N/A		
1985	N/A	10-Jun	171							N/A		
1986	under ave	26-Apr	116	Hold	under	average	use	for	season	end of sea		
1987	1-Jun	20-May	140			73%	70%	68%	68%	16-Oct		
1988	1-Jul	24-Jun	176				82%	90%	90%	end of sea		
1989	N/A	18-Jun	169							N/A		
1990	N/A	4-Jul	185							N/A		
1991	N/A	8-Jul	189							N/A		

Year	(1) Start of	(2) Storage	(3) S.C. Jul	Apr.	May	Jun	Jul	Aug	Sept	(4) End of Proration Period		
1992	17-May	17-May	138		58%	58%	58%	58%	58%	end of sea		
1993	1-Jun	13-Jun	168	NRP* 85.8	NRP* 72.8	56%	64%	67%	71-67%	30-Sep		
1994	1-May	1-Jun	152	NRP*	47-35%	34%	39%	39%	37%	30-Sep		
1995	N/A	1-Jul	182							N/A		
1996	N/A	26-Jun	178							N/A		
1997	N/A	21-Jul	203							N/A		
1998	N/A	26-Jun	178							N/A		
1999	N/A	29-Jul	210							N/A		
2000	N/A	1-Jul	183							N/A		
2001	1-May	1-Jun	152	NRP*	29%	30%	34%	37%	37%	30-Sep		
2002												
2003												
2004												
2005												

NRP* = Natural Runoff Proportion

(1) = Start of Proration Period

(2) = Storage Control Date

(3) = Julian Date for Storage Control

(4) = End of Proration Period

Natural Runoff Proportion (CC11) -

Natural runoff proportion (NRP) attempts to maximize the use of natural runoff (the unregulated runoff below storage reservoirs) and return flow, and at the same time minimize storage releases to meet demands. The major water users above Parker voluntarily agree to share natural runoff and return flow supply proportionally based upon their entitlements. If reservoir releases are called for prior to storage control and formal prorationing, they will be deducted from the requesting entity's water bucket when prorationing formally begins.

Short Water Year Operations Policy

Based upon experience gained in previous water-short years, operations uses the following framework when faced with below average years. The basic concepts of this policy are: 1) share flood water and return flow during the main runoff period; 2) discourage storage releases during the tail end of the main runoff period (when runoff is unable to meet full demand); 3) allow waters users to shape, via requests in advance, their estimated water supply use pattern ("bucket") during the period of heavy reservoir release (after the main runoff period); and 4) maintain control during end of season (October) operations.

Constraints for Short Water Year Operations -

- April's TWSA is the sum of runoff, storage, and return flows less residual storage and flow passing Sunnyside Dam, including YRBWEP target flows, for the period April 1st to September 30th.

- The WSAI demands provided for by TWSA include only the irrigation non-proratable and proratable entitlements for the period April 1st to September 30th, as stipulated in the Decree.

- The first estimate of TWSA is provided in early March for the period April through September 30th, and thereafter monthly, biweekly, or weekly as needed.

- The water users' share of natural runoff and return flows is evaluated weekly, with minor flow fluctuations supplied out of storage to allow for consistent irrigation operations.

- Prorationing will begin on the date of storage control or earlier, as determined by the Field Office Manager. Formal prorationing will be announced by Reclamation at that time, and updated thereafter monthly, biweekly, or weekly as needed.

- Each entity's water bucket is the sum of its non-proratable entitlement and its share of proratable entitlement for the period, starting with the storage control date (or date set by the Field Office Manager) and ending September 30th.

- If requested by irrigation entities, October water demands, up to maximum entitlement, are met by the October water supply available forecast.

October Water Supply Available – Water-Short Year (CC9) -

If requested by irrigation entities during a water-short year, project operations will develop an October water supply available (OWSA) to meet October water demands (CC4) and, like in TWSA, the entitlements could be subject to prorationing. The OWSA includes natural runoff, return flow, and storage. To meet non-proratable average use for October, project storage must be operated to provide a minimum of 76,000 acre-feet storage as of the end of September (CC29). YRBWEP flows past PARW and estimated carryover storage for the end of the irrigation season are then subtracted from the OWSA. The remainder is the OWSA for requested irrigation entitlements.

Water Bucket (CC12) -

Each entity's water bucket is calculated by summing the non-proratable entitlement and the share of proratable entitlement for the period of declared prorationing, normally starting with the storage control date (or date set by the Field Office Manager) and ending September 30th. Blocking of water ("water bucket") is an excellent water management tool which provides flexibility for an individual entity's needs in water-short years.

Water Transfers During Short Water Years -

During the water-short years of 1994 and 2001, emergency water right transfers were authorized for the declared drought condition irrigation seasons. These emergency water right transfers were intended to alleviate hardships, reduce burdens on water users (irrigation), and increase efficient and maximum use of the water supply during drought conditions.

In 1994, in anticipation of water shortages for irrigation within the Yakima basin, an Emergency Inter-District Water Transfer Program was proposed by Reclamation and criteria for the transfers was developed. These transfers were voluntary, between willing lessees and lessors and only for temporary water supply during the 1994 water year. The transfers were consistent with appropriate State and Federal law, and had the concurrence of the irrigation districts in which they occurred. The rights of other water users (third parties) were not to be impaired. Such transfers were limited to lands that had legal water rights and were being irrigated in full compliance (no "Paper Water") with applicable laws, regulations, and contracts (including the Reclamation Reform Act). These legal responsibilities were not to be diminished by the transfers. Transfers had to be within the capability of Reclamation to deliver, and were considered on a first-come, first-served basis. Transfers were subject to Reclamation's responsibility to protect and maintain resources (these resources include water, fisheries, wildlife, and cultural) held in trust by the United States for the Yakama Nation (YN).

A Water Transfer Advisory Committee (Committee) was established to review transfer requests as they were received and to make recommendations on these requests to Reclamation. The Committee was composed of irrigation district managers from the transferring and receiving districts, an official from the Yakima River Basin Association of Irrigation Districts, a representative of Washington State Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (FWS), and the YN. The Committee functioned in an advisory capacity with final approval the responsibility of Reclamation. The last emergency water transfers totaled only 3,739 acre-feet, all involving transfers to the RID.

In order to facilitate processing of transfer applications more effectively during the 2001 water-short year, a water transfer process was developed involving a subcommittee of the YRBWEP Conservation Advisory Group (CAG), Washington Department of Ecology (WDOE), and Reclamation. Consultation also occurred with the fish and wildlife agencies (State, Federal, Tribal), and included a review and approval by the Adjudication Court. This expedited approval process was in place effective April 2001, and water transfers were being made May 1, starting date of prorationing. Water transfers totaled 23,039.07 acre-feet indicating that this procedure was effective in expediting the processing of transfers. Most participants appeared satisfied with the 2001 process.

The YRBWEP CAG will continue to work on improvements to the water transfer process. Using the 2001 process as baseline, they will attempt to develop a basin process that provides for voluntary water transfers on a permanent, temporary, or emergency basis. Any new water transfer process will need review and approval by the Adjudication Court.

5.2.4 YRBWEP Title XII Flows (CC14)

One of the purposes of the YRBWEP is to implement water conservation measures to reduce out-of-stream irrigation water diversions from the Yakima River and its tributaries. Savings achieved through improvements to water delivery systems, and changes in operation and management would result in more water remaining in the stream to improve streamflows for fish and wildlife, and to improve the reliability of the irrigation water supply. (See section 4.7.1.)

YRBWEP established new target flows for instream purposes to be maintained past the Sunnyside and Prosser Diversion Dams using criteria based on TWSA. The streamflow targets range from 300 cfs to 600 cfs, depending on the estimate of TWSA. The target flows to be passed at Sunnyside and Prosser Diversion Dams are not instantaneous flows to be uniformly maintained at all times, but are subject to reasonable fluctuations due to project operations. However, for any period exceeding 24 hours, flows at the Sunnyside Diversion Dam (gaging station PARW) cannot decrease to less than 65 percent of the target flow; and the flows at Prosser Diversion Dam (gaging station YRPW) cannot decrease by more than 50 cfs from the target flow. (See table 5-10.)

Table 5-10.–Title XII target flows based on TWSA

TWSA (million acre-feet)				Parker and Prosser flows (ft^3/s)	Title XII Minimum flow passed PARW July - September demand in (Acre-Feet)
Apr-Sept	May-Sept	Jun-Sept	Jul-Sept		
3.2	2.9	2.4	1.9	600	117,000.
2.9	2.65	2.2	1.7	500	100,000.
2.65	2.4	2.0	1.5	400	84,000.
Less than above TWSA				300	68,000.

YRBWEP also provides that, as conservation measures are implemented under the conservation program and irrigation water demands are thereby reduced, the target flows will be increased by 50 cfs for each 27,000 acre-feet of diversion reduction above during non-prorated water years. Such increases, however, may not diminish the amount of water that otherwise would have been diverted in years of water proration. In years when the water supply is prorated, the target flows obtained through the implementation of water conservation will be increased above 300 cfs only in those cases where the irrigation return flows previously entered the Yakima River downstream of Parker. Although diversion reductions will be accounted for, a "block of water" will not be set aside under TWSA for maintaining target flows at Parker. Title XII target flows (supplemented by conserved water) will continue to be met from TWSA in the same manner that irrigation demands are met under the Decree. Water entitlements stipulated in the Decree are not changed by Title XII.

Under Title XII, 100 percent of the protectable water acquired by purchase or lease (acquisition), including during years of prorationing, may be used to provide enhanced streamflows for short-term needs such as "flushing flows" to speed the migration of smolts from the Yakima River basin, and to meet longer term needs such as increasing instream flows above the levels currently stipulated by the project operational criteria. Instream uses of this water will be determined by Reclamation in consultation with the SOAC, and provided for in the current operation plan.

5.2.5 Project Operations for Fisheries

Project operations makes efforts to reduce impacts on the fisheries resource and to provide for appropriate water flows, while at the same time providing water for irrigation purposes for users within the project area. Operations takes into account, on a yearly, monthly, and daily basis, the requirements for spawning, incubation, rearing, passage, flushing/spike flows, ramping rates, power subordination issues, and carryover storage in the Yakima basin. The following discussion provides pertinent information on the decision process, support, criteria, and functions that are considered in designing the project operations for fisheries resource protection.

Quackenbush Decision

In September 1980, returning spring chinook salmon migrated up the Yakima River and spawned in portions of the upper main stem. Fish biologists located and identified spawning redds in the reach of the Yakima River lying between the Cle Elum and the Teanaway Rivers. In an October 1980 hearing, the Quackenbush Court directed the watermaster (or current Field Office Manager) to maintain a flow of water in that reach to protect and safeguard the spawning redds. The Court also directed that further hearing on the matter be held commencing in November 1980.

The Court, in November 1980, subsequently ordered and decreed (and the watermaster was instructed) as follows: 1) that a sufficient flow of water be maintained in the above named reach to protect and safeguard the spring chinook salmon spawning area; 2) that the watermaster regulate the flows in such amounts as the watermaster in his discretion may find consistent with protection of the spawning area, after consultation with fish biologists (SOAC); 3) that the watermaster continue to consult with SOAC to provide for the continuing monitoring of the redds and flows in the Yakima River; and 4) that the watermaster, in exercise of his informed discretion to provide for reduction in flows of the river along with the interested parties to this matter, shall study and report to the court on means by which the needs of the project water users can be met through more efficient or less extensive use of project waters, or by modification of project operations or facilities so as to have less impact on the "fisheries resource." The Court also acknowledged the potential for management of the various project reservoirs and releases of water to provide for appropriate water flows during the spawning and rearing periods while at the same time providing water for irrigation purposes for users within the project area.

Project operations continues to use the Court's Order, commonly known as the Quackenbush Decision, to provide legal justification for the management or modification of project operations or facilities to lessen impacts on the fisheries resource and to provide for water flows for fish protection. (For background on this decision, see Quackenbush Decision, section 4.5.2.)

Treaty Rights - Partial Summary Judgement and Other Rulings

Other court rulings or decisions support current operations to reduce impacts on fisheries resource. The YN's Treaty-reserved right for fish equals an amount of water necessary to maintain anadromous fish life in the river (1990). Another motion (1985) requires the Adjudication Court to coordinate management of this Treaty right with the long-standing claimed diversions of water in the basin. The Adjudication Court has ruled that it has interim jurisdictional authority over all Yakima River basin surface water rights claimants and will retain its jurisdiction over all such water rights claimants until the final order is entered and the adjudication is completed. In July 1996, Judge Stauffacher did not quantify the volume of water, but "Ordered, Adjudged, and Decreed" that this diminished Treaty-reserved water right for fish, with a priority date of time immemorial, takes precedence over all other rights in the Yakima basin. (See Partial Summary Judgment, section 4.5.3.1 and Other Rulings, section 4.5.3.2.)

Yakima River System Operations Advisory Committee

SOAC developed out of the 1980 Quackenbush Decision concerning the protection of anadromous fish in the Yakima River. In the November 28, 1980, Supplemental Instructions to the Watermaster, the Court ordered the watermaster to consult with “fish biologists of the Fish and Wildlife Service and the Yakima Tribe” concerning instream flows and the operation of the Yakima Project facilities. In the watermaster’s response of May 22, 1981, to the Court , the watermaster recommended that a “working team of biologists be authorized and established” to work on instream flow issues and decide whether an advisory group would be desirable. SOAC evolved from that team.

SOAC is an advisory committee to Reclamation consisting of fishery biologists representing the FWS, the YN, the WDFW, and irrigation entities represented by the Yakima Basin Joint Board. Reclamation provides a fishery biologist as a liaison to SOAC. Since 1981, SOAC has provided information, advice, and assistance to Reclamation on fish-related issues associated with the operation of the Yakima Project. SOAC is the primary source (as per Court Orders) of biologically based information to the Field Office Manager. Instream flows or operations are determined by the Field Office Manager with input or recommendations provided by SOAC. SOAC is not the sole provider of input to the Field Office Manager, who will also consider information and advice from other concerned irrigation district managers, entities, agencies, or others in the process of making operational decisions.

However, Title XII sets target flows for Yakima River near Parker and Yakima River near Prosser. Note: SOAC is the entity authorized by Title XII to make recommendations to project operations for flushing and other instream flows. SOAC may bring biological concerns about operating procedures to the attention of the Field Office Manager whenever needed. Project operations maintains regular contact with and provides operations information to SOAC via the Reclamation liaison fish biologist. (See System Operations Advisory Committee, section 4.6.)

Flow Modifications for Fish

The following three operational actions are related to both upper basin and system-wide operations. These actions include use of the Kittitas Canal to bypass flows around the stretch of the Yakima River from Easton to the confluence with the Teanaway River, mini flip-flop, and flip-flop. Each of these operational schemes is designed to balance the need for irrigation water delivery with the protection of spring chinook redds in the upper Yakima River basin.

Flip-Flop Operation (CC15) -

The purpose of the flip-flop operation is to encourage anadromous salmon (spring chinook) to spawn at lower river stage levels in the upper Yakima River above the mouth of the Teanaway River, so that the flows required to keep the redds watered and protected during the subsequent incubation period (November through March) are minimized from the upper Yakima reservoir storage. Historically (pre-1980), due to irrigation demands and reservoir operations, the flows in this reach would be at a higher flow level (between 300 cfs to 1,600 cfs, 38% of the time) during the September/October spawning period, which would in turn require larger storage releases to protect redds during the incubation period. That would likely reduce the ability to maximize storage for the next season's TWSA. Pre-storage natural flows during the spawning period for spring chinook in the Easton River reach would have been in the 100 to 250 cfs range, and approximately 300 cfs in the Cle Elum River reach. In order to support the flip-flop operation, project operations drafts heavily from Keechelus, and sometimes Kachess (see mini flip-flop CC16 below), and Cle Elum Lakes on the Yakima arm to meet lower basin demands during the summer (July and August) and maintains storage in Rimrock Lake on the Naches River arm to meet lower basin demands later in the year (August 25th through October 20th). The Quackenbush Decision, October 1980, directed the release of storage for protection of redds in the upper Yakima River basin. The flip-flop operation was conceived and initiated in 1981, and has been a part of the Yakima Project operations since that time.

The flow reduction process starts September 1st and is ramped down over a 10-day period. The flow in the upper Yakima River is reduced by approximately 3,000 cfs, with the majority of the cutback taking place in the Cle Elum River, which is normally reduced to 200 cfs and then reviewed by SOAC for acceptability. The Yakima River below Easton Dam, about at 400 cfs at this time, is also reduced to the 200 cfs target level starting September 1st, although this flow level may have already been obtained during the mini flip-flop operation (see below). With this reduction of flow in the upper Yakima Reach during the fall (September and October), most lower basin demands are then met with Rimrock Lake storage releases of up to 2,400 cfs to the Naches River Arm (see Systems Operation Diagram appendix E-2).

Flip-flop operation reduces flows in the upper Yakima River during the latter portion of the irrigation season. Due to the lower water levels, a number of irrigation entities must install check dams or wing dams in the Yakima River to create enough head to divert their water supply. These structures are temporarily installed rock berms in the Yakima River in a manner consistent with issued permits, with fish passage being provided both upstream and downstream. The temporary check dams are removed following the end of irrigation season. The flip-flop operation requires that power generation water for Roza Power Plant be reduced or eliminated for brief periods of time. At times, a voluntary reduction (50 to 100 cfs) in irrigation diversions (i.e., Roza Irrigation District) is required for the flip-flop to remain functional. In normal years, expected flow in the Yakima River below the Roza Diversion Dam is in the 400 to 600 cfs range, but may drop to 300 cfs or less in below average years. The flip-flop operation does not increase flows in the Yakima River reach from the confluence of the Naches River to Union Gap (see appendix E-1). In fact, there is a reduction of flow in this reach due to reduced irrigation entitlements in September, which are more than 2,000 cfs less than August entitlements, which does not mirror the dramatic increase of flow on the Naches River. The flip-flop operation is possible because of these reduced entitlements.

Kittitas Canal Bypass -

This operation makes use of some upstream storage above Easton Diversion Dam (see appendix E-3) to supply some of the lower irrigation diversion demands in the Kittitas/Ellensburg Valley, RID, and flow demands below Roza Diversion Dam while maintaining target spawning flows in the Easton reach of the Yakima River. A portion (200 cfs) of the storage released upstream from Easton Diversion Dam is passed downstream to meet spawning flow targets in the Yakima River to its confluence with the Teanaway River. The Kittitas Canal diverts from Lake Easton (RM 202.5), parallels the river, and has a number of wasteway facilities which pass water back to the river. During the period when spring chinook are spawning in this reach (September-October), irrigation water volume is less than canal capacity, so the canal is used, along with wasteway No. 1146, to carry a portion of the flow that would normally pass over Easton Diversion Dam to meet pre-flip-flop downstream demands. Wasteway No. 1146 (RM 173.9) returns a portion of water (up to 400 cfs) diverted at Easton Diversion Dam to the Yakima River above the Swauk Creek confluence. The same canal system is also used to carry water to augment flows (up to 20 cfs) in Taneum Creek. This allows the target flow below Easton Diversion Dam (about 200 cfs) to be maintained while releases from Keechelus and Kachess are continued for downstream demand, for flow totaling approximately 1,450 cfs above the Yakima River at Easton. The amount of flow bypassed via the KRD canal ranges from about 20 to a peak of 400 cfs, with an average flow of about 300 cfs. The flows bypassed through the KRD canal begin about September 1st, being fully in place by the September 10th flip-flop date, and continue until the end of the KRD irrigation season (October 15th).

Mini Flip-Flop (CC16) -

An operations strategy commonly referred to as a mini flip-flop (see appendix E-3) is performed in years of sufficient water supply (estimated 8 to 9 out of 10 years) between Keechelus and Kachess Lakes. Heavier releases are made from Keechelus during June, July, and August to meet the upper basin demands, and releases from Kachess Lake are restrained. In the fall (September and October), heavier releases are made from Kachess to meet upper basin demands, and the releases from Keechelus Lake are reduced to provide suitable spawning flows in the Yakima River reach from Keechelus Lake to the head end of Lake Easton. Target flows for this reach are: Yakima River near Martin (KEE) 60 cfs, and Yakima River near Crystal Springs (YRCW) 60 cfs. The Kachess release is increased to 1,400 cfs to supply the continuing downstream demand of about 1,450 cfs at the Easton Diversion Dam. This 1,450 cfs demand includes 200 cfs for Yakima River instream flows at Easton, 400 cfs for the Kittitas Canal bypass, and up to 850 cfs for KRD and Cascade Irrigation District (CASID) irrigation demands. This operation is initiated the last 7 days of August and continues until October 20th.

The mini flip-flop operation cannot be performed every year. The inability to perform mini flip-flop above Easton Diversion Dam results from a short water supply forecast or a reservoir maintenance operation that would require maximum water use of Kachess Lake storage. Due to the poor hydraulic capacity of the Kachess outlet works (large volume of storage af/low head outlet works), an early June drawdown start is required to maximize storage water use. An early and maximum storage withdrawal from Kachess Lake would require higher flow releases from Keechelus during the August to October period to meet irrigation demands above Easton. This would preclude the minimizing of outflow to spawning flow targets in the upper Yakima reach below Keechelus Lake, and decrease the ability to release enough water from Keechelus Lake to protect the spring chinook redds during the November through March incubation period. To reduce possible loss of redds located in the Keechelus to Easton reach, the Easton Diversion Dam ladder has been closed in such years. With the ladder closed, the spring chinook are forced to spawn in suitable spawning areas below Easton, in areas where the flows can be managed to protect the redds during the winter months. The decision to close the Easton fish ladder and not allow spring chinook passage into the Keechelus reach needs to be made in May before the spring chinook arrive at the Easton Diversion Dam. See section 5.4 “Operation of Permanent Diversion Structures in the Yakima River Basin–Easton Diversion Dam.”

Spawning Flows (CC17) -

Flows are supported by project operations to provide good quality spawning habitat for fish (usually salmonids). The flip-flop operation described above reduces flows in the upper Yakima River (see appendix E-3) for spring chinook spawning (relatively close to flow levels that would occur naturally in the spawning areas), results in the construction of redds at a lower river stage and allows for protective incubation flows (November through March) to be minimized and assured from the Yakima reservoir storage. Spawning flow levels are also provided on the Bumping River. These flow levels are determined by the Field Office Manager considering current and future water management needs, with input or recommendations provided by SOAC, irrigation district managers, Reclamation environmental staff, and others.

Where spawning activity occurs at other times and areas of the Yakima River basin, project operations considers these activities in its daily operations. While specific measures may not be taken to enhance spawning conditions in these reaches, attempts are made to minimize the impact of project operations to these spawning reaches. See “Historical Reclamation Fish-Related Operational Streamflow Targets” table 5-11. and appendix E.

Incubation Flows (CC18) -

Minimum flows are supported by project storage operations after the spawning period, which are intended to protect the eggs deposited in spring chinook, fall chinook, and coho redds in various reaches of the Yakima River, and spring chinook redds in the Bumping River. Incubation flows are set on a reach-by-reach basis depending on the salmon species. The first incubation period, for spring chinook, begins in the upper Yakima and Bumping Rivers in November, with incubation periods extending through March for all species in all spawning reaches. Incubation flows are customarily of sufficient magnitude to provide 2 inches of flowing water over the tail spill of the redds. Generally, flows between 50 to 100 percent of those provided for spawning will accomplish this. Incubation flows are determined by the Field Office Manager, with input or recommendations provided by SOAC, irrigation district managers, Reclamation environmental staff, and others.

Project operations considers site specific egg incubation needs in its daily operations. While specific measures may not be taken to enhance incubation conditions in these reaches, attempts are made to minimize the impact of project operations to the incubation activities in these reaches. See “Historical Reclamation Fish-Related Operational Streamflow Targets” table 5-11. and appendix E.

Rearing Flows (CC19) -

Sufficient flow is necessary to provide habitat for resident fish and rearing anadromous fish. The volume of rearing flows in the upper Yakima and Bumping River systems may be determined by the Field Office Manager, with input or recommendations provided by SOAC and others, considering current and future water management needs.

Where rearing activity occurs at other times and areas of the Yakima River basin, project operations takes into consideration these activities in its daily operations. Although project operations may not have a specific target flow or make storage releases to enhance rearing activity in these reaches, it does consider the constraints that these activities place on the system operations and attempts to minimize the impact of project operations to rearing fish throughout the river basin. Reference “The Yakima River Stream Catalog” Draft Copy, by Washington Department of Fish and Wildlife, March 1998, for timing of spawning, incubating, and rearing activities throughout the Yakima River Basin. See appendix E.

Ramping (CC20) -

The day to day operation of the reservoir system and hydropower facilities can cause flow fluctuations, creating the potential to strand fish and impact aquatic invertebrates that support the food chain. Reservoir or forebay maintenance drawdowns can cause fish stranding. While the project is limited in its ability to maintain stable flows in the system because of operational demands, operations seeks to minimize occurrences of fluctuation and stranding. Ramping rates have always been constrained by operational and safety concerns. Large rates of change generally are inefficient, causing flows greater than required for a short period of time and making interpretation (“reading”) of the river system difficult for operators. Several smaller changes are usually more efficient. Moreover, large rates of change, especially increases, may also endanger recreationists in the river.

As the body of biological literature developed, Reclamation recognized the need to further limit ramping rates. Since the mid-1990s, Reclamation has operated to provide a slower, gentler rate of change to implement the flip-flop operation. This currently translates to about a 225 to 300 cfs rate of flow reduction per day over a 10-day period in the upper Yakima River system. In the early years of the flip-flop operation, most adjustments were accomplished in 48 to 56 hours. Since late 1996, Reclamation has used a general ramping guideline of 2 inches per hour (stage in river) when operationally possible. Even though most concern is expressed over the possibility of stranding fish while ramping down, the guideline applies to both ramping down and up. Implementing the slower ramping rates results in increased labor cost, and during periods of flood control operations it is sometimes not possible to meet the lower ramping rates and still provide maximum flood control benefit.

Reclamation operates to the following ramping rates where controllable by project operations:

- Ramping up or down will not exceed 2 inches per hour.
- During flood control, in light of the limited impacts on the fishery resource, ramping up will be limited only by operational and safety concerns until bank full, then the 2 inches per hour limit will apply if public safety is not jeopardized.
- In the Yakima River at Easton reach, a ramping down rate of 1inch per hour will be used to help protect anadromous salmon during spawning, incubation, and rearing periods.
- If operations requires a large release of water (an increased flow fluctuation), an attempt will be made to hold the increased peak flow for 24 hours before starting ramp down.

Passage Flows (CC21) -

Flows are supported by project operations for fish movement (usually salmonids). Passage flows are flow volumes that allow fish to move un-impeded through the river system. There are three river reaches in the system with passage flow issues that are annually reviewed. Target flows for the individual river reaches are set by the Field Office Manager following consultation with SOAC and others, considering current and future water management needs. See "Historical Reclamation Fish-Related Operational Streamflow Targets" table 5-11.

River reaches for which target flows are reviewed and established, are as follows:

- Yakima River from Roza Diversion Dam to the confluence of the Naches River.

- Naches River from Tieton River to Naches River below the Wapatox Power Plant return flow.

- Yakima River from Prosser Diversion Dam to Yakima River below the Chandler Power Plant return flow.

Table 5-11.–Historical Reclamation Fish-Related Operational Streamflow Targets[4]

River Reach	Fall	Winter	Title XII Target	Power Subordination
Keechelus Outflow (KEE) from dam to Crystal Springs	60-100 cfs[2] Sep 1 - Oct 20 (1990-2000)	15-100 cfs[3, 4] Oct 21 - Mar 31 (1990-2000)		
Yakima River at Crystal Springs (YRCW) from Crystal Springs to Lake Easton	60-100 cfs[2] Sep 1 - Oct 20 (1991-2000)	30-100 cfs[3, 4] Oct 21 - Mar 31 (1991-2000)		
Kachess Outflow (KAC) from dam to Lake Easton		5-50 cfs[3] Oct 21 - Mar 31 (1989-2000)		
Yakima River at Easton (EASW) from Easton Dam to Cle Elum River	150-300 cfs[2] Sep 10 - Oct 20 (1981-2000)	80-300 cfs[3, 4] Oct 21 - Mar 31 (1981-2000)		
Cle Elum Outflow (CLE) from dam to Yakima River	150-650 cfs[2] Sep 10 - Oct 20 (1981-2000)	60-300 cfs[3, 4] Oct 21 - Mar 31 (1981-2000)		
Yakima River at Cle Elum (YUMW) from Cle Elum River to Teanaway River	400-800 cfs[2] Sep 10 - Oct 20 (1981-2000)	200-325 cfs[3, 4] Oct 21 - Mar 31 (1981-2000)		
Yakima River below Roza Diversion Dam (RBDW) from dam to below Wenas Creek	200-300 cfs minimum Jul 1 - Oct 20 (1989-1999)			300-400 cfs[5] Oct 21 - Mar 31 (1989-1999) 300-600 cfs[5] Oct 21 - Mar 15 (2000)
Bumping Outflow (BUM) from dam to American River		50-120 cfs[3, 4] Oct 21 - Mar 31 (1987-2000)		
Rimrock Outflow (RIM) from dam to YTID Diversion		15-50 cfs[6, 4] Oct 21 - Mar 31 (1990-2000)		

[4]All flows (except Title XII) are negotiated on annual basis with SOAC and at river operations meetings. Operational flows for: [2]spring chinook spawning, [3]spring chinook redd incubation, [4]this target may cause bypasses of inflow or demands upon storage, [5]passage, spawning, and incubation, [6]general aquatic needs, [7]passage and general aquatic needs, [8] fall chinook egg incubation, [9]smolt out-migration.

River Reach	Fall	Winter	Title XII Target	Power Subordination
Naches River near Naches (NACW) from PP&L Diversion Dam to below Power Return		100-125 cfs[7, 4] Oct 21 - Mar 31 (1986-2000)		125 cfs[7] Oct 1 - Sep 30 (1986-2000)
Yakima River near Parker (PARW) from SVID Diversion Dam to Granger Drain		300 cfs minimum for fish passage Mar 15 - Oct 21 (1988-1994)	300-604 cfs [4] Apr 1 - Oct 31 (1995-2000)	
Yakima River at Prosser (YRPW) from Prosser Diversion Dam to below Power Return			300-604 cfs [4] Apr 1 - Oct 31 (1995-2000)	450-1400 cfs[8] Nov 1 - Mar 31 (1995-2000) 50-200 cfs minimum for fish passage Mar 1 - Feb 28 (1958-1994) 450-1000 cfs[9] Apr 1 - Jun 30 (1994-2000)

Flushing/Pulse Flows (CC22) -

Flows are supported by project operations to facilitate the out-migration of anadromous salmonid smolts. If needed, reservoir storage releases or the bypassing of reservoir inflow can create a rapid rise in flow. These flows are intended to mimic a natural freshet, and to be useful in assisting fish out-migration. The increase has to be more than 50 percent of the base flow, peaking within 12 to 36 hours and followed by a corresponding decrease; timing is everything. Flushing/pulse flows, when deemed necessary, generally occur in the Yakima River between early April and early July, depending upon prevailing runoff conditions. The necessity for, magnitude, and timing of out-migration flushing/pulse flows are determined by the Field Office Manager, with input or recommendations provided by SOAC, irrigation district managers, Reclamation environmental staff, and others. See Memorandum Opinion Re: "Flushing Flows" No. 77-2-01484-5, dated December 22, 1994, by Judge Walter A. Stauffacher.

Power Subordination (CC23) -

Power subordination occurs when power generation is reduced or shutdown, allowing the power water diversion flows to remain in the river system to protect the fishery resources or to enhance fish passage. Currently there are three hydroelectric power plants located along the Yakima

River system which have power subordination impacts to the flow regime at their respective diversion dams:

- Wapatox Power Plant is owned and operated by PacifiCorp (parent company, Scottish Power). The Wapatox Canal has a maximum capacity of 500 cfs. This power plant diversion has a year-round natural flow right of 300 to 450 cfs. Diversion from the river (at Naches RM 17.1) is allowed up to 450 cfs so long as the flow is naturally available and the rights of senior diverters and users are satisfied, including flows to protect anadromous fish life. Reclamation is not obligated to provide storage flows at any time. During the non-irrigation season (winter) the power diversion water is informally subordinated to maintain a 125 cfs instream flow in the Naches River below the mouth of the Tieton River, as measured at the gaging station (NACW) located at Naches RM 16.8.

- Chandler Pumping & Power Plant, constructed and operated by Reclamation, uses water diverted into the Chandler Power Canal (diversion capacity - 1,500 cfs) at Prosser Dam (RM 47.1) to operate pumps to convey irrigation water across the Yakima River into the Kennewick main canal. The residual capacity remaining from irrigation needs, or if the pumps are not running for irrigation, is diverted for power production. Reclamation has the authority to subordinate Chandler Power Plant as identified in YRBWEP. Power production is subordinated to various flows throughout the year. In April through June, power is subordinated to 1,000 cfs over Prosser Dam as measured at Yakima River at Prosser (YRPW). During the remainder of the irrigation season, the subordination target is 450 cfs or the YRBWEP Title XII target flow, whichever is higher. The agreed subordination target was for 450 cfs through the non-irrigation season. For the past 2 years, however, all subordination target flows have been annually reviewed and established by the Field Office Manager, with input or recommendations provided by SOAC and others.

- Beginning in 2002, under the Conditional Final Order for Kennewick Irrigation District in the Acquavella adjudication, the flow passing Prosser Diversion Dam is to be 35 cfs higher than the Title XII flow for the period April 1 to October 31. This additional 35 cfs flow will be maintained through bypass of water that might otherwise be diverted to power generation at Chandler (April 1 through October 31). Under no circumstances will this additional 35 cfs power subordination flow call for or require storage water, nor will it jeopardize other existing water rights.

- Roza main canal, constructed and operated by Reclamation, uses up to 1,123 cfs of power water and operates year-round except for annual maintenance shutdown and ice conditions. Total diversion is limited to 2,200 cfs for irrigation, domestic supply, and power generation, with maximum power diversion of 1,123 cfs. Preference is given for irrigation. Currently, power water for electric generation at Roza Power Plant is potentially subordinated to improve fishery flows in the Yakima River below Roza

Diversion Dam (RBDW). Reclamation does not have specific direction on the authority to subordinate Roza Power Plant, but maintains an informal agreement in consultation with SOAC, Bonneville Power Administration (BPA), and others to subordinate power generation to maintain a 400 cfs minimum in the river. Reclamation operations will support a 300 cfs minimum target with water available in the river system if no power generation is occurring, but will not provide storage to maintain the 300 cfs minimum. Since the late 1990s, there have been other requests for power subordination to increase minimum flows below Roza Dam. During water year 2000, from November 8, 1999 through March 15, 2000, power was subordinated to provide a minimum flow of 600 cfs. Once, BPA agreed to cover the cost of lost power generation during the year 2000 so as not to impact the RID water supply contract. In the future, subordination target flows will be annually reviewed and established by the Field Office Manager, with input or recommendations provided by SOAC and others.

See also section 2.4.3 for additional background information on these power projects.

Target Flows -

Target flows are set for the above flow requirements (spawning, incubation, rearing, passage, power subordination) as determined by the Field Office Manager, with input or recommendations provided by SOAC, irrigation managers, and others. In addition, YRBWEP established new target flows for instream purposes to be maintained past Sunnyside and Prosser Diversion Dams using criteria based on TWSA and acquired water. Target flows are set and are to be equaled or exceeded. Due to system uncertainties such as travel time (see section 5.2.7, Travel Times), changes in runoff and changes in demand, it is technically impossible to hold a constant flow. At times, the actual instantaneous flow may be 10 percent or more below the target due to these uncertainties. River operations makes adjustments or corrections in flows as soon as possible to attain the target in these situations.

5.2.6 Hydroelectric Power Operations (CC25)

There are nine hydroelectric power plants within the Yakima basin. Of the nine power plants, only four operate with non-consumptive use, power water diversions rights (note: only three diversion dam sites - Roza, Chandler, Wapatox) out of the Yakima and Naches Rivers, the other five power plants making co-use of irrigation diversions within the irrigation districts' delivery system. The Chandler and Roza hydroelectric plants are operated by Reclamation. Pacific Power and Light Company (parent company, Scottish Power) operates the Naches, and Naches Drop hydroelectric plants (Wapatox). All of the power plants are served by water supplied via diversion dams through canal systems.

All main stem hydroelectric power plants operate as run-of-the-river plants. That is, they operate with available flows from the Yakima and Naches Rivers. Power generation at the Chandler and Roza Plants is subordinated to provide minimum fishery flows in the respective bypass reaches.

In general, power water at Roza and Chandler Power Plants is limited to any surplus amounts in excess of irrigation requirements, and in the non-irrigation season to available flows. The Wapatox hydroelectric plant has no available storage water rights. If Naches River natural flows are insufficient to maintain a 300 cfs power water diversion for the Wapatox Plant, no inflow can be stored in either Rimrock or Bumping Reservoirs. Inflow may be bypassed at the 2 reservoirs to attempt to maintain the 300 cfs natural flow minimum to satisfy the downstream Wapatox power water right. The Wapatox hydroelectric plant, having a water right priority date of 1904, has a natural flow right which is junior to most other upstream natural flow users. The Wapatox water right is senior to Yakima Project water rights, with a priority date of 1905.

5.2.7 Operations Control Points

Project operations makes use of a number of control points to monitor the system. These sites provide a window to check operations for meeting the current constraints, criteria, and objectives for the operational year. The control point data can be used as instantaneous data for set point targets or to quantify system supply demands, or use over a period of time. Current and historical data from these sites provide the knowledge needed to manage the Yakima River system with its competing demands and priorities throughout the year. The control points can be grouped into the following functions: contractual water supply, fishery flows, flood control/public safety, and hydroelectric power.

Streamflow Monitoring and Measuring -

Over time there has been an increasing demand for water use within the Yakima River basin. In order to meet this demand, project operations has had to become more efficient with management of its water. Since there appears to be no way to expand the existing water supply by new facilities or reservoirs, arguments are strong for conservation and better management of the existing water resource. To keep pace with demands, the project has had to improve its information and control system for improved water management.

An extensive real time data collection and data storage system that allows observation, monitoring, quantifying, and analysis of the river basin is in place and being updated. A remote control system is being upgraded and reinstalled at the storage reservoirs and diversion dams. These two systems will enable operations to better meet all system demands.

A hydromet system of some 60 stations has been installed over time to provide real-time data (15 minute to 1 hour intervals) on a number of parameters such as precipitation, reservoir content, streamflow, diversions, water temperature, turbidity, and weather conditions. Many of these stations can be polled from the Yakima Field Office through a radio-controlled network, and others are on a self-time reporting satellite network. For reference see appendix E showing basin wide monitoring and control points of flows included as attachments. These diagrams depict the relative positions of selected tributaries, diversions, return flows, monitoring, target, or control points and stream gaging stations.

Management and control of basin runoff; reservoirs and river operations; irrigation diversions; and liaison with fishery interests is performed and administered through the Yakima Field Office's Operations Hydrology Branch (CC26) located in Yakima, Washington. The hydrology branch is responsible for verification and review of the hydromet data. Stream gage measuring in the Yakima basin, including irrigation diversions (except for the Yakama Reservation sites) is provided largely by the Yakima Field Office's Operations Hydrology Branch. Also, the U.S. Geological Survey maintains six river or creek gaging stations in the basin.

Although records of reservoirs, rivers, and large diversions have been maintained consistently through the years, the smaller tributaries and diversions were measured only intermittently at times of desired interest. The Hydrology Branch must continue to gather current hydrologic field data as needed for hydrologic models for improved operations. Note: the Adjudication Court directed that all diversions from the Yakima, Naches, and Tieton Rivers of 1 cfs or more shall install measuring and metering devices before March 1, 1995. Diversions must be recorded and the record provided to the Yakima Field Office's Operations Hydrology Branch office on a weekly basis; this information is then provided to the WDOE.

Travel Times -

Travel times are important for river operations in order to plan and maintain balanced instream system flows at target control points. The following table represents the elapsed time (travel time) for releases made at reservoirs to pass through the river system and arrive at the control point (river gaging station). All values (hours) are average times assuming that the river reach has a fully wetted perimeter (i.e., it is not being charged up initially following a low flow condition). The flow levels represent the "total" low, average, and high flow release per reservoir during the irrigation season, and are not meant to depict flood flow travel times. River operations should note that in table 5-12. times are indicators and not absolute travel times. During day to day operations, a hydromet plot of multiple-day real time gaging station data will provide a more accurate representation of current travel time requirements.

Table 5-12.–Yakima Basin Travel Times – Elapsed time in hours during irrigation season.

Release point	Flow Levels cfs	EASW	YUMW	ELNW	UMTW	CLFW	TICW	NACW	PARW	YRPW
Keechelus	low - 400	5.5	15.5	27.	41.	-	-	-	58.	82.
	average - 900	3.	10.5	18.	29.	-	-	-	41.5	63.5
	high - 1500	2.5	9.	15.	23.	-	-	-	32.	52.
Kachess	low - 300	1.0	12.5	25.	39.	-	-	-	56.	80.
	average - 800	.5	9.	16.5	28.	-	-	-	42.	64.
	high - 1200	.5	7.5	14.	23.	-	-	-	33.5	53.5
Cle Elum	low - 500	-	4.5	15.	28.5	-	-	-	44.	68.
	average - 2000	-	2.	7.5	15.5	-	-	-	22.5	44.5
	high - 3200	-	1.5	7.	14.	-	-	-	20.5	40.5
Bumping	low - 300	-	-	-	-	5.5	-	12.	21.	45.
	average - 700	-	-	-	-	5.	-	11.	17.	39.
	high - 1100	-	-	-	-	4.5	-	10.5	15.5	35.5
Rimrock	low - 500	-	-	-	-	-	1.5	5.	12.	36.
	average - 1400	-	-	-	-	-	1.	4.	9	31.
	high - 2200	-	-	-	-	-	.5	3.5	8.5	28.5

(Last update of Travel Time Curves – 3/21/79 by Fred L. Nacke)

Yakima River near Parker WA (Below PARW) -

The major control point for operation of the Yakima Project is the Yakima River near Parker stream gage (PARW, RM 103.7), which is just downstream of Sunnyside Diversion Dam. Yakima Project operations for PARW are keyed to meet the irrigation entitlements above Sunnyside Diversion Dam, maintain instream minimum target flows for the fishery resources, and provide maximized flood control benefits for the Yakima River basin. When the system is on storage control, diversion demands below Parker are met by return flows, flows passing Parker, and tributary inflows below Parker. The instream minimum target flows at Parker are related to the fisheries resource during the April through October period, and the maximum target flows relate to flood control operations, November through June.

Since April 1995, the Yakima Project has been operated to provide streamflows over Sunnyside as specified in the YRBWEP legislation. These flows are based on the TWSA and range from 300 to 600 cfs (see YRBWEP Title XII Target Flow table 5-10) for the period April1st through October 31st. Reclamation prepares monthly TWSA forecasts from March through July, or, if conditions warrant, later into the irrigation season, which ends in mid-October. These forecasts are the basis for determining the adequacy of the TWSA to meet irrigation water entitlements stipulated in the Decree, to assist in deciding the amount of prorationing, if any, that may be necessary and for determining Title XII flow targets.

To meet system water demand requirements, including instream flows at Parker, river operators must consider many factors. The July through August flow travel time for normal operational releases between the reservoirs and the control point at Parker ranges from a minimum of

10 hours from Tieton Dam to over 40 hours from Keechelus Dam (see travel time table 5-12.). The intervening river reaches are affected by many diversions, return flows, and natural inflows. These add to the uncertainty and difficulty of maintaining a precise target at Parker. After storage control the system will normally develop a diurnal 80 to 100 cfs cycling effect from evaporation and irrigation practice, and a weekly increase (+/- 200 cfs) in return flows due to weekend irrigation practice, which greatly effects the flow available at PARW. Title XII target flows permit fluctuations up to 35 percent from the specified target for a period, not to exceed 24 hours, at Sunnyside Dam.

To remove some of the uncertainty in the system and to better meet target flows, irrigation districts and other diverters of 1 cfs or greater are to verbally inform the Yakima Project operator 48 hours in advance of any planned diversion or change in diversion (by Judicial Order in State of Washington vs. Acquavella). Unplanned changes in diversions are to be reported as soon as possible after the change has been made. Regular contact is maintained with the 5 major irrigation districts (holders of 82% of TWSA entitlements) diverting above Parker.

Yakima River Near Prosser WA (YRPW) -

The prime control point for operation of the lower Yakima River is the Yakima River near Prosser stream gage (RM 46.3), which is just downstream of Prosser Diversion Dam. Since 1995, the Yakima Project has operated to provide streamflows for fishery resources at YRPW as specified in YRBWEP. Again, these flows are based on the TWSA and range from 300 to 600 cfs (see YRBWEP Title XII Target Flow table 5-10.) for the period April 1st through October 31st. The YRBWEP target flow requirements below Prosser Diversion Dam are the same as those for the Yakima River near Parker. However, streamflow must not decrease by more than 50 cfs from the target flow.

Other fishery resource flow issues for the gage near Prosser include target flow requirements for ramping rates, incubation flows, passage flows, flushing/pulse flows, and power subordination. Ramping rates are a year around issue, passage flows and flushing/pulse flows are predominantly an April through June issue, and fall chinook egg incubation flows involve the November through March period. In 1995, Reclamation agreed to power subordination levels that provide for 1,000 cfs minimum at YRPW for April through June, and 450 cfs minimum during July through February. The power subordination level of 450 cfs takes precedence over YRBWEP flows of 300 or 400 cfs. The target flows for the other flow issues are annually reviewed and established for each time period by SOAC and the Field Office Manager.

Diversion demands of the lower Yakima River, from the Yakima River near Parker to Wanawish (Horn Rapids) Diversion Dam, are predominantly met by return flows and flows passing YRPW gage. If, after power subordination is fully implemented, YRBWEP Title XII flows are not satisfied, flow releases from storage are required to reach the target minimum flows.

Other Minimum Flow Control Points -

Minimum target flows are set at many other locations along the Yakima and Naches Rivers (see table 5-11.). Target flows are to be equaled or exceeded. These flows are determined through various means and are coordinated via SOAC and the Field Office Manager.

Flood Control Points (CC5 & 6) -

Several gages along the Yakima and Naches Rivers are also used as control points for flood control activities in the Yakima basin. Given the amount of basin runoff above the reservoirs, the storage capacity at the reservoirs, and their outlet capacities, the Yakima Project attempts to control the downstream flows to below damaging levels. Observed flood stages at these locations are listed in table 5-13. below.

Table 5-13.–Yakima Basin River Control Points - Used during flood control operations.

River forecast point	Bankfull stage	Flood stage	Moderate flooding	Major flooding	Record crest
EASW Yakima River at Easton		50.3 ft			
YUMW1 Yakima River at Cle Elum	8.5 ft	9.0 ft	9.5 ft	12.5 ft	12.50 ft Nov. 14, 1906
ELNW1 Yakima River at Ellensburg	32.0 ft	34.0 ft	37.0 ft	39.0 ft	36.76 ft Feb. 9, 1996
NACW1 Naches River near Naches	15.0 ft	17.0 ft	18.0 ft	20.0 ft	22.90 ft Dec. 23, 1933
PARW1 Yakima River near Parker	9.4 ft	10.0 ft	12.0 ft	14.0 ft	16.21 ft Feb. 9, 1996
KIOW1 Yakima River at Kiona	12.5 ft	13.0 ft	15.0 ft	17.4 ft	21.57 ft Dec. 23, 1933

(Control points & data via National Weather Service - Northwest River Forecast Center) Note Reclamation control point data.

5.3 Operational Functions of Reservoir Storage in the Yakima River Basin

The water storage facilities used to supplement the unregulated flow from the Yakima River are Keechelus, Kachess, Cle Elum, Rimrock, Bumping Lakes, and Clear Creek. The five major storage facilities/reservoirs store runoff during the winter and spring/summer seasons for later release to supply irrigation demands during the low flow periods of runoff in the summer/fall seasons. The total storage of the 5 major storage reservoirs is a little over 1 MAF. It should be noted that the combined total storage of the five major reservoirs are operated in a coordinated manner to provide the needs of the system as a whole. The releases from each reservoir are balanced to meet system-wide demands in conjunction with natural runoff and return flow available in the basin. No one reservoir is designated to supply the needs of one particular area, irrigation district, or division. The following table 5-14. provides some basic information about each of the five major storage reservoirs, followed by a summary of the important operational aspects of each reservoir and the part each plays in managing the Yakima River basin water supply. (CC29)

Table 5-14.–System Storage Capacity & Average Annual Runoff. (Plus TWSA's Sept. 30th Historical Storage)

Reservoir	Drainage Area ($mi.^2$)	Capacity (af)	Ave. Annual Runoff (af)	Ratio of Ave. Runoff to Capacity	Sept. 30 Min. Historical Storage (af)	Sept. 30 Ave. Historical Storage (af)	Sept. 30 Max. Historical Storage (af)
Keechelus	54.7	157,800	244,764	1.5:1	4,800	40,500	126,900
Kachess	63.6	239,000	213,398	.9:1	20,100	107,200	227,200
Cle Elum	203.0	436,900	672,200	1.5:1	12,900	118,000	359,500
Bumping	70.7	33,700	209,492	6.2:1	2,400	7,900	24,600
Rimrock	187.0	198,000	367,966	1.8:1	200	74,500	145,100
System	579.0	1,065,400	1,707,820	1.6:1	51,700	357,500	660,200

(Period of Record = 1920-1999)

Sixth Reservoir (snowpack) -

Because only 30 percent of the average annual total natural runoff can be stored in the storage system, the Yakima Project is very dependent upon the timing of spring/summer runoff (snowmelt and rainfall). The early spring/summer natural flow is utilized to supply most river basin demands through June in an average year. The majority of spring/summer runoff is from snowmelt, therefore snowpack is often called the 6th reservoir. In most years, the five major reservoirs are operated to peak storage in June (average mid-June, period of record 1940-1999), about the same time the major natural runoff ends.

Keechelus Lake -

Keechelus Lake and Dam, on the Yakima River 10 miles northwest of Easton, is an earthfill dam, situated at the lower end of a natural lake, that forms a reservoir with a capacity of 157,800 acre-feet, with 152,170 acre-feet available for use. Keechelus Lake is operated to meet irrigation demands, flood control, and instream flows for fish. Keechelus storage is used in conjunction with the rest of the system to provide a portion of the water supply to meet demands from Keechelus Dam to Sunnyside Diversion Dam. A larger portion of the annual runoff to Keechelus Lake, however, is used, along with that of the Kachess River, to satisfy upper basin demands. Keechelus also provides some carryover storage in normal water years. The prime flood control season extends from mid-November through mid-June. Irrigation demands are met by releases from Keechelus either through bypassed reservoir inflows (beginning in mid-March) or stored water releases. When the project is on storage control, diversions above Easton, including those for KRD, are served primarily from Keechelus through late August. During September and October those diversions are satisfied primarily out of Kachess.

Outflows from Keechelus follow an annual pattern of relatively low flows during winter and relatively high flows during the April through late August irrigation season. Beginning in late August, during mini flip-flop, Keechelus releases are reduced to meet a 60 cfs target streamflow in the Yakima River at Crystal Springs. This operation functions to keep downstream flows low so that spring chinook salmon will spawn in areas that can be kept watered throughout the winter incubation season. In October, after spring chinook spawning is complete, streamflows are reduced still further, generally to around 30 cfs (or the SOAC recommended incubation flow) in the Yakima River at Crystal Springs. The 30 cfs represents a Keechelus release of about 15 cfs with the remaining 15 cfs supplied from inflows between Keechelus Dam and Crystal Springs. If there were no inflows between Keechelus Dam and Crystal Springs the full 30 cfs would be released from Keechelus Lake. This operational scheme attempts to keep all the spring chinook redds under water throughout the winter in the reach from Keechelus Dam to Easton Dam without jeopardizing irrigation storage supplies. This operation is continued until reservoir releases are increased either due to flood control or to meet irrigation demand.

The dam is equipped with an overflow crest spillway capable of passing 8,000 cfs at elevation 2520.90 feet. The main outlet works has a single slide gate (8.5' x 8.5') with a 7 foot maximum gate opening capable of releasing 3,000 cfs, but the normal maximum would be 1,500 to 1,700 cfs. This gate (sill elevation 2426.90 ft.) has a minimum gate opening of 4 inches in the high head mode (over 33') and 1.5 inches opening the under low head mode (under 33'). Located in the same outlet works is a 20-inch valve at invert elevation of 2446.67 feet, which at 15 foot of head will bypass approximately 25 cfs through a 22-inch-diameter pipe installed in the outlet conduit to bypass minimum flows for fishery and stream enhancement when the main outlet gate is closed. The ramping rate for operations at Keechelus is 2 inches per hour as measured at the dam’s outflow gage.

In mid-1998, it was determined that dam safety deficiencies existed at Keechelus Dam due to the potential for dam failure from piping and/or internal erosion of embankment materials. A reservoir operating restriction to elevation 2510 feet was imposed, together with increased monitoring and surveillance, pending implementation of corrective actions. This operating restriction limits storage to 140,920 acre-feet. The reservoir can be operated above elevation 2510 feet only for the control of large flood events.

Kachess Lake -

Kachess Lake and Dam, on the Kachess River 2 miles northwest of Easton, is an earthfill dam, situated at the lower end of a natural lake, that forms a reservoir with a capacity of 239,000 acre-feet, with up to 222,000 acre-feet available for use. Kachess Lake is operated to meet irrigation demands, flood control, and instream flows for fish. The flood control season extends from mid-November through mid-June. Flood space control releases are normally minimal due to the poor refill ratio of .9 to 1. A refill ratio of less than 1 to 1 means a reservoir will not fill even in an average year if it starts the year empty. Kachess storage is used in conjunction with the rest of the system to provide a portion of the water supply to meet demands on the Yakima River from

Easton Diversion Dam to Sunnyside Diversion Dam. A larger portion of the annual runoff to Kachess Lake, however, is used along with that of the Keechelus Lake and Cabin Creek to satisfy upper basin demands. Kachess Lake provides some carryover storage in good water years. Upper basin irrigation demands are met by releases from Keechelus either through bypassed reservoir inflows (beginning in mid-March) or stored water releases. When the project is on storage control, diversions above Easton, including those for KRD, are still served primarily from Keechelus through late August, or the start of mini flip-flop. From the start of mini flip-flop and flip-flop, the diversions above Easton and up to 400 cfs of downstream diversion, during September and October, are provided primarily out of Kachess.

Besides supplying a large portion of the system-wide irrigation demands, storage at Kachess Lake is needed to meet fishery resource's winter (incubation and rearing) minimum target flows from Yakima River at Easton to the confluence of the Yakima and Teanaway Rivers. In addition, the high storage demand when the reservoir is operated to meet multiple instream flows, significantly reduces the ability of the reservoir to refill the following season. This is especially true of Kachess Lake, because the average annual runoff is less than reservoir capacity. Therefore, the reservoir does not fill every year even under normal runoff conditions. Kachess minimum outflow during the winter is 5 to 8 cfs (equivalent to gate leakage) unless greater releases are needed for support of the Yakima River target flows.

The dam is equipped with a gated spillway (sill elevation 2254.00 ft.), consisting of 1 radial gate (50' x 8') with capacity of 4,000 cfs at elevation 2262.00 feet. The regulating outlet works has 3 slide gates (4.5' x 8.0') with an 8.0 foot maximum gate opening capable of releasing 3,690 cfs at full lake elevation (2262.00). These gates (sill elevation 2192.75 ft.) have a minimum gate opening of .17 foot and are the main release points if supporting spawning and incubation flows in the Yakima River. Located in the same outlet works is an 18-inch butterfly valve at invert elevation of 2195.92 feet, which at 25 foot of head and 100 percent gate opening, bypasses approximately 35 cfs into the outlet conduit, through the valve installed in the outlet works downstream of the main gates. When the main outlet gate is closed, and the auxiliary low flow bypass valve is being used, it is only capable of providing minimum flows for fishery and stream enhancement in the Kachess River. Kachess Dam has no fish passage facilities. The ramping rate for operations at Kachess is 2 inches per hour as measured at the first gage below the dam.

Cle Elum Lake -

Cle Elum Lake and Dam, on the Cle Elum River 8 miles northwest of the town of Cle Elum, is an earthfill dam, situated at the lower end of a natural lake, that forms a reservoir with a capacity of 436,900 acre-feet, with 427,930 acre-feet available for use. Cle Elum Lake is operated to meet irrigation demands, flood control, and instream flows for fish. The prime flood control season extends from mid-November through mid-June. Cle Elum Lake regulates about 20 percent of the entire runoff above Parker and is the largest storage facility in the system. It is, therefore, the main resource for meeting the large irrigation demands in the lower basin. The heaviest storage releases for irrigation are during the months of July and August and it's normal for the main gates to reach hydraulic capacity in mid-August. Cle Elum also provides the majority of carryover storage in normal water years.

In most years, 40-50 percent of the spring chinook redds in the upper Yakima River basin are located in the Cle Elum River and in the Yakima River immediately upstream and downstream of the confluence of the Cle Elum and Yakima Rivers. These factors lead to conflicting needs for the operational releases from the reservoir. The lower basin diversion demands during the summer months (July and August) are mostly met from Cle Elum releases. During flip-flop the majority of the summer release (3200 cfs +/-) is cut back to a minimum flow level (200 cfs) that is adequate to support both spawning and irrigation demands on the upper Yakima River system. The larger portion of the lower basin diversion demands during the spring chinook salmon spawning period (September and October) are met from Rimrock releases. This allows Reclamation to minimize Cle Elum releases to meet a target flow (normally 150 cfs) in the Cle Elum River during the winter for spring chinook incubation and early rearing.

The dam is equipped with a gated spillway (sill elevation 2223.00 ft.), consisting of 5 radial gates (37' x 17') with capacity of 40,000 cfs at elevation 2240.00 feet. The main outlet works has 2 slide gates (5.0' x 6.5') with a 6.2 foot maximum gate opening capable of releasing 4,600 cfs, but August normal maximum would be 3,400 cfs +/-. These gates (sill elevation 2112.25 ft.) have a minimum gate opening of 0.10 foot and are the main support for the spawning and incubation flows. Located in the same outlet works are two 14-inch gate valves at invert elevation of 2127.09 feet, which at maximum head will only bypass 45 cfs each into the main outlet conduit when the main outlet gates are closed. Note that this is not enough flow to support the normal spawning or incubation flows in the Cle Elum River reach. Maintenance work to the inlet works tunnel or guard gates requires stop-logging at the headend of the outlet works. Currently this would allow no flow into the downstream river. As such, this type of required maintenance is attempted only when the lake is above spillway crest (elevation 2223.00 ft.) or pumping to maintain instream flows would be necessary. Cle Elum Dam has no fish passage facilities. The ramping rate for operations at Cle Elum is 2 inches per hour as measured at the first gage below the dam.

Bumping Lake -

Bumping Lake and Dam on the Bumping River about 29 miles northwest of the town of Naches is an earthfill dam, situated at the lower end of a natural lake, which forms a reservoir with a capacity of 33,700 acre-feet, with 31,220 acre-feet available for use. The average annual runoff at Bumping Lake is much more than the existing reservoir capacity, allowing the reservoir to fill every year. It is normally operated in the flood operations mode during the spring/summer period, except for extreme water-short years or multiple short years in a row. Depending on the timing of the runoff, the reservoir can be brought up to full pool a number of times each year. The facility is used to supplement water supply for demands in the upper Naches River during summer months and during the winter months may be called upon to bypass inflow to support the Pacific Power & Light’s (PP&L) Wapatox power diversion right. Heavy drawdown of storage for summer irrigation demand, normally starts in August and continues into early September. Bumping Lake is not used as a carryover facility, but is operated to provide 6,000 to 9,000 acre-feet of end-of-season storage needed to maintain winter incubation flows in the Bumping River.

During the early September through late October spawning period, the reservoir's outflows are kept under 200 cfs, in order to minimize the required releases for the incubation and rearing period from storage. Natural inflow to Bumping Reservoir often drops below 35 cfs and requires supplementation from the carryover storage to provide winter minimum target flows. During the winter incubation and rearing period, instream flows below Bumping Dam are kept at a minimum target of 50 cfs or more depending on past spawning flows and are coordinated between SOAC and the Field Office Manager.

Bumping Dam is equipped with an overflow crest spillway (elevation 3426.20 ft.) capable of passing 3,400 cfs at a reservoir elevation of 3429.00 feet. The main outlet works has 2 slide gates (4.5' x 5.0') with a 5.0 foot maximum gate opening capable of releasing 1,240 cfs, but August normal releases would be in the 500 to 700 cfs range. These gates (sill elevation 3389.00 ft.) have a minimum gate opening of 0.10 foot and are the only support for the spawning and incubation flow releases as there is no auxiliary low flow bypass in Bumping Dam. Any maintenance work to the inlet works or guard gates requires stop-logging at the intake of the outlet works or closing the main gates to work in the outlet tunnel. This would allow no flow into the downstream river. As such, this type of required maintenance is attempted only when the lake is above spillway crest (elevation 3426.20 ft.) or pumping to maintain instream flows would be necessary. Bumping Dam has no fish passage facilities. The ramping rate for operations at Bumping is 2 inches per hour as measured at the first gage below the dam.

Rimrock Lake -

Rimrock Lake and Tieton Dam are on the Tieton River about 40 miles northwest of Yakima. Tieton Dam is an earthfill structure with a concrete core wall that forms a reservoir with a capacity of 198,000 acre-feet, with 197,800 acre-feet available for use. Rimrock Lake is operated to meet irrigation demands, flood control, and instream flow for fish. The prime flood control season extends from mid-November through mid-June. Flood space control releases of 2,700 cfs or greater during the winter could impact residents along the Tieton River. Ice Watch (CC25) is conducted during the colder, freezing periods of winter weather (January, February, and March). When the lake surface is capable of freezing or has frozen solid, in order to prevent damage to the spillway structure and gates, the lake elevation is held below 2900.00 feet until the freezing danger is past. Releases (500 to 700 cfs) are made during the summer months to meet demands on the Tieton and Naches Rivers below Tieton Dam, downstream to the confluence of the Naches and Yakima Rivers. In support of the flip-flop operation during the fall months (September and October), much higher releases (up to 2,700 cfs) are also made to meet lower Yakima River basin irrigation needs, thereby allowing the releases from the upper Yakima arm reservoirs to be reduced to provide reduced spawning flow. Rimrock Lake will provide good carryover storage in normal or better water years. In any operation plan, unregulated flows in the

Naches River system must be made available and bypassed when required to fulfill the natural flow rights for PP&L's Wapatox power diversion. Support of maintenance work requiring river ford access to the canal or fish screens at Yakima-Tieton Diversion Dam can require outflow reductions at Tieton Dam.

Fishery interests support a minimum storage pool of from 10,000 to 30,000 acre-feet (preferably greater than 30,000 acre-feet) to maintain the viability of the fisheries resource in Rimrock Lake. With this in mind, carryover storage in Rimrock Lake is maximized. At a minimum, 30,000 acre-feet is the target for September 30th. Winter minimum instream flows below Rimrock have been between 15 and 50 cfs during the past few years (1996-2000).

Tieton Dam is equipped with a spillway weir controlled by six 65 foot by 8 foot floating drum gates (down position, invert elevation 2918.00 ft.), with capacity of 45,700 cfs at elevation 2928.00 feet. The main operating outlet works has two 60-inch-diameter jet-flow gates (invert elevation 2721.50 ft.) and with a 95 percent maximum gate opening. These gates are capable of releasing 2,760 cfs at normal full lake (elevation 2926.00 ft). When flow demands require operation of both gates at the same time, a minimum 40 percent (2 ft.) gate opening is maintained to allow rock passage. When only operating a single gate, the minimum opening is 4 inches or 5 percent, resulting in a 15 to 20 cfs discharge. These gates are the only support for minimum instream winter flow as there is no auxiliary low flow bypass located in Tieton Dam. Any maintenance work to the inlet works (sill elevation 2766.00 ft.) or guard gates requires stop-logging at the headend of the outlet works to close the outlet tunnel. This allows no flow into the river downstream. Therefore, this type of required maintenance is attempted only when the lake is above spillway crest (elevation 2918.00 ft.) or pumping to maintain instream flows would be necessary. Tieton Dam has no fish passage facilities. The ramping rate for operations at Rimrock is 2 inches per hour as measured at the first gage below the dam.

Clear Creek Lake -

The supplementing of irrigation flow and the regulation of Clear Creek Lake is negligible when considering its small storage capacity (5,300 af) and its location above Rimrock Reservoir. However, in short water years, it is possible to provide some benefit to the downstream storage demands to offset irrigation and fishery minimum storage requirements in Rimrock Lake. In normal runoff years, Clear Creek Lake is operated to maintain an elevation greater than 3011.40 feet for project uses including fish passage and recreation. Inflow and outflow are essentially equal and most all flow passes over a spillway weir crest at elevation 3011.00 feet. For the past 20 years, one 36-inch slide gate has been kept open 6 inches to prevent the outlet gate area from silting up. From mid-August to October 5th, Reclamation attempts to hold the lake at elevation 3011.40 feet for most effective fish ladder passage and to maintain stable downstream spawning flow. In years of late season high volume runoff, this elevation is nearly impossible to hold, unless large releases are made through the dam's slide gates. This is undesirable because the fish are attracted by the high flow. They are not attracted to the spillway flows which supplies the fish ladder passage.

The majority of operations functions occurring at Clear Creek Lake involve a short water year when it is possible to provide some benefit to the low storage pool in Rimrock Lake. The use of Clear Creek Lake storage occurs when Rimrock's September 30th storage drops below 34,000 acre-feet. Advance notice of intent to drawdown the lake must be given by August 10th to the United States Forest Service so that timely notification may be given to the recreation interests to protect their lake facilities. After October 5th and concluding by October 20th, it is possible to transfer 2,200 acre-feet of storage to Rimrock Lake for operational use by irrigation or fishery minimum pool demands. Increased outflows from the reservoir do not start until after October 5th because of the risk of kokanee spawning in the higher outflows. After October 20th, Clear Creek Lake can be refilled by closing the outlet gates, but lows are held below the dam to incubation flows based on September spawning flows. (Note: due to the limited storage available to supplement irrigation flows and providing only minimal support to maintain the desired low storage pool [10 KAF to 30 KAF] in Rimrock Lake, the regulation of Clear Creek Lake [upstream from Rimrock Lake] may not be acceptable to current fishery interests, due to the spawning and incubation risk created in the North Fork of the Tieton River by releases from the lake.)

Storage Carryover -

During the summer/fall period of operations, it is desirable to maximize storage carryover by end of irrigation season (October 21st). The Yakima storage system is designed only to store the current year's spring/summer runoff and deliver it to meet irrigation demands in July through October. If there is only minimal storage (52 KAF) left on October 21st, then the winter and spring/summer periods of operations require a tighter control over the reservoir releases, lower base river flows, and variability during these time periods. A maximized storage carryover helps to ease those operations and meet demands during a dry year. The impacts of the drought year of 1977 were reduced because of favorable carryover storage from 1976. The 1994 drought was disastrous because there was virtually no carryover after the drought years of 1992 and 1993. A good carryover also helps assure sufficient spring chinook incubation flow below the upper Yakima main stem dams.

5.4 Operation of Permanent Diversion Structures in the Yakima River Basin

The following list summarizes some of the operational aspects of each permanent diversion structure on the Yakima basin main stem tributaries and the part each plays in the management of the basin water operations.

Lake Easton Diversion Dam -

Lake Easton Diversion Dam (Yakima RM 202.5), is a small concrete gravity dam with an ogee-overflow-weir spillway section across the central portion of the dam and is controlled by one 64 foot by 14.5 foot drum gate with a design capacity of 13,000 cfs. The dam also has 2 sluiceways, 1 in each side of the dam below the spillway crest (elevation 2165.80 ft.), with each of these outlets (invert elevation 2135.00 ft.) controlled by a 4.8 foot by 6.0 foot gate. The vertical slot fish ladder is located on the left abutment. An irrigation diversion check structure (hydraulic height 43 ft.), with the Kittitas main canal headworks (capacity 1,320 cfs) located in the right abutment, is operated and maintained by KRD. Irrigation diversion is provided from April 20th through October 15th. The diversion dam creates a lake (N.W.S. 2180.30 ft.) for diversion head (canal invert elevation 2170.0 ft.) rather than storage, but in water-short years there is 2,000 to 3,000 acre-feet of storage that is available for irrigation demands during the last days of irrigation season. Yakima Project operations coordinates closely with KRD to accomplish a variety of operational needs including irrigation, fisheries, flood control, recreation, and maintenance to structures. Yakima Project operators monitor streamflow in the Yakima River at Easton closely because this area is vulnerable to flooding; the river reach below Easton is considered to be high value fish habitat for spawning and rearing, and the reach can become a bottleneck in terms of passing irrigation flows to areas downstream. During the past 2 years gate manipulations at Easton have ensured that ramping rates do not exceed 1 inch per hour. This minimizes adverse impacts of operations to the river reach below Easton.

Operations/activities at Easton Diversion Dam have historically been an issue to biologists, so the following operation for maintenance is described. The 64-foot-wide drum gate (movable crest) at Easton Diversion Dam is inspected once a year, at the end of the irrigation season. If the need for maintenance or repair is indicated, the work is normally scheduled for the early winter period. Normal winter operation maintains the drum gate in the down position until April 1st. The inspection requires the water level to be taken below the hinge (elevation 2164.90 ft.) of the drum gate. This is accomplished by lowering the lake elevation to the crest of the lowered drum gate (elevation 2165.80 ft.) and then opening the sluice gates to lower the lake to elevation 2164.40 feet. This provides another 6 inches below the hinge level, to prevent leakage into the drum gate float chamber. If possible, holding Lake Easton to a minimum elevation of 2164.40 reduces the risk of sediment transfer to the lower river from rainfall on the lower lake bed. After the inspection, the sluice gates are slowly closed to allow the lake elevation to rise and pass flow over the lowered drum gate crest (elevation 2165.80 ft).

In 1998, fishery biologists recommended that Reclamation and KRD attempt a timely, more fish friendly fill of Lake Easton Irrigation Diversion Dam pool that would be completed by April 1st. Reclamation efforts to implement this recommendation showed only minimum flow fluctuations in the river below the dam, and minimized turbidity changes caused by the manipulation of Easton Dam drum and sluice gates. This operation requires dropping the lake elevation down to the elevation of the drum gate in the lowered position by use of the sluice gates. (Note: the initial opening of the north/left and south/right sluice gates are checked for silt movement and turbidity activity by the KRD dam tender, and if necessary, by the FWS fisheries biologist and Reclamation fisheries biologist.) At the start of the filling operation, the lake is lowered by increasing the outflow slowly through the sluice gates. When the lake elevation reaches approximately 2165.80 feet, the drum gate float chamber is allowed to fill, floating the drum gate to elevation 2177.95 feet or more, as per the gate position indicator. The sluice gates are then cut back or closed a minimal amount to start filling the lake. Over the next few days the lake is slowly filled, while the majority of the inflow to the lake is bypassed to the river by the north/left sluice gate. When the lake has risen to full elevation or high enough to pass flow over the drum gate in the raised position, the north/left sluice gate is slowly closed to force all the flow over the floating drum gate. The ramping rate for this operation is 1 inch per hour on the declining flow as measured at Yakima River at Easton, which will minimize overall flow fluctuations in this reach of the Yakima River. This operation is the current or preferred method of filling Lake Easton Diversion Dam pool if the pool has not been filled by a large runoff event occurring in late March.

When the sluice gates are opened sediment flushes to the area downstream, which is spring chinook spawning habitat. Normally, the volume of sediment moved only creates a slight discoloration to the flow lasting for a period of minutes. In order to minimize this small movement of sediment, the sluice gates are opened periodically throughout the year to remove sediment incrementally. The sluice gates are opened in spring, when flows are high, so that the sediment can be dispersed, and then again in August, just prior to flip-flop when flows over Easton are still relatively high. As a result, when the gates are opened during the fall maintenance activity, the instantaneous movement of sediment load is very low to nonexistent. The past 2 incidents of heavy sediment movement through the dam's sluice gates (sluiceway invert elevation 2135.0 ft.) to the downstream spawning habitat occurred during unusual circumstances, with the pool drawn down below elevation 2160.5 feet to facilitate maintenance on the dam and fish passage (fish ladder flow invert elevation 2162.0 ft.), coupled with a significant rainfall event on the dewatered lake bottom. The rainfall's runoff destabilized the normally water covered lake bottom below elevation 2166.8 feet and moved silt into the reduced flow channel of the lowered lake, passing it through the sluice gates to the downstream reach. Attempts will be made to minimize future low pool operations, below elevation 2164.40 feet, for maintenance functions, by stop-logging the fish passage or other cofferdam methods for repair and maintaining the upstream functionality of Easton Diversion Dam.

Operation of the fish ladder at Easton Diversion Dam varies from year to year based on the water supply outlook. Reclamation, in consultation with SOAC, decides in May whether to keep the ladder open for spring chinook. This decision is made as soon as the first chinook arrives at the Roza Fish Facility. The decision is based on current TWSA. If water supply forecasts indicate that mini flip-flop can be executed during the coming fall, the ladders are kept open. An early decision is necessary to prevent a loss of redds in the fall. If chinook are allowed to spawn above Easton (i.e., the ladders are kept open), but mini flip-flop is not operationally possible, then a large proportion of the eggs are lost due to low streamflow conditions during the subsequent incubation period. This is why the ladder is sometimes closed and the spring chinook are forced to spawn in the suitable spawning areas below Easton. Prior to 1997, mini flip-flop was possible only about 50 percent of the time. The Kachess Dam outlet structure has since been modified and now mini flip-flop is estimated to be possible 8 to 9 years out of 10. The ladder at Lake Easton is open in all years from October 20th through mid-May. This fish ladder will operate at lake elevations between 2165.8 and 2180.3 feet.

When the KRD canal is diverting water, the fish-screen fish return passage is normally bypassing 80 cfs to the river just below the right abutment. When reducing the flows to spawning targets of 150 to 300 cfs at Yakima River at Easton, it will improve attraction to the fish ladder on the left abutment if the fish bypass flows are reduced to 40 cfs. If the 80 cfs is continued to be bypassed on the right side, the fish are attracted to cascading flows with no upstream passage. Normally, with an Easton spawning target of 200 cfs, the ladder will be passing approximately 80 to 120 cfs for upstream passage, 40 cfs on the fish bypass, 5 cfs for dam drum gate operation, 15 cfs for drum gate seal leakage, and from 60 to 20 cfs overflow at the drum gate crest. At these low flows, passage and attraction water flows through the fish ladder.

Ellensburg Town Canal Diversion Dam -

The Ellensburg Town Canal Diversion Dam (Yakima RM 161.3) is a concrete fixed crest weir (elevation 1613.35 ft.), with a fish ladder located on the right abutment. The irrigation diversion check structure (hydraulic height 3.35 ft.) is located approximately 7 miles northwest of Ellensburg, Washington and is owned, operated, and maintained by Ellensburg Water Company. This diversion (left abutment) provides water to about 12,000 acres in the Ellensburg Valley, serving the Town Canal and Olson Ditch during the irrigation season (mid-April through mid-October), and also provides supplemental water to the City of Ellensburg through a supply pipe about 300 feet downstream of the headworks. From April through October a maximum of +/- 230 cfs is diverted for irrigation and fish screen operations. From November through March water may be diverted for stock watering and/or city M&I water.

Roza Diversion Dam -

Roza Diversion Dam (Yakima RM 127.9) is a 486-foot-wide, concrete gravity ogee-weir-type (elevation 1205.00 ft.) with a variable water surface elevation (N.W.S. 1220.60 ft.) controlled by two 110 foot by 14 foot motor operated (float controlled) roller gates. It is located on the Yakima River about 12 miles north of Yakima. This irrigation and hydroelectric power diversion check structure (hydraulic height 34.0 ft.) is owned by the United States, operated and maintained by Reclamation, and provides water diversion of up to 2,200 cfs to the Roza main canal, of which up to 1,350 cfs design capacity, (actual diversion 1,260 cfs) is delivered to RID during the irrigation season (mid-March through October 20th). This canal also supplies water to the Roza Power Plant located about 10 miles downstream from the dam. The Roza Canal headworks are located on the right abutment of the diversion dam, and consist of a concrete structure with a trashrack located at the inlet end protecting the revolving fish screens in the transition section. A radial gate at the outlet end controls discharges into the canal. The main fish ladder is a concrete structure in the left abutment. An auxiliary ladder is located in the right abutment and is connected by a gallery to the main fish ladder. Operation of the fish ladder, including the auxiliary water supply, requires a minimum flow of about 120 cfs to remain within criteria.

The Roza screening facility (located in the transition section) in the forebay pool above the Roza Diversion Dam is designed to prevent fish from entering the Roza Canal, which carries up to

2,200 cfs year around for irrigation and power generation. Maximum diversion into the canal occurs from May through September in most years. The canal is usually empty for several weeks during late October and/or November for canal and fish passage maintenance. The Roza fish screen structure is the largest fish passage structure in the Yakima basin, containing 27 drum screens, each 17 feet in diameter and 12 feet long. Five 30-inch-diameter pipes with capacities of 50 cfs each are provided to return the fish that encounter the screens to the river. Operation of the fish screen facility requires a flow of 100 to 250 cfs to meet criteria with flow being pumped back to the canal. The primary components of the Roza screening facility include the trashrack, drum screens, fish bypass structure, fish return pipe, juvenile evaluation facility, and the canal juvenile pumpback system, including the secondary screening system.

The two 110 foot Roza Diversion Dam roller gates were designed to allow either gate to be operated independently, either manually, or by float controlled automation, to maintain the water surface in the reservoir at elevation 1220.60 (+4", -2") with normal flow in the river, and at elevation 1220.60 (+10-5/8", -2") for flood discharges. Excess water over the requirement for canal diversion is passed through the roller gates. Because a roller gate can be lowered approximately 5 feet past the closed position (tucked) to spill water over the top of the gate, the lower seal, instead of being mounted to bear down onto the gate sill, is mounted on the upstream face of the sector or lip and contacts an embedded steel beam, which is mounted on the downstream face of the gate sill. When the gate is in the closed position it is called “on seal.” If it is lowered below this position it is said to be “tucked.” (Note: the gate seal position is set to account for deflection of the gate caused by hydrostatic loading.) Seal damage can occur if the gate is operated in the dry. The bottom seal will not properly engage without full pressure on it, and it will be damaged if the gate is moved without the reservoir being full. Both roller gates should be opened to drain the reservoir, and if a gate is on seal it should be opened first. When refilling the reservoir the gates may not be closed tight against the seal until the reservoir is full. The submerged position (tucked) of the gates is used in clearing the surface of the reservoir of ice and debris.

During normal operations on float control, 1 gate will handle discharges from zero (80+ cfs leakage) to 7,500 cfs, with gate opening from seal to 3.0 feet, and a variation of reservoir water surface from elevation 1220.43 to 1220.65 feet. As discharge exceeds 7,500 cfs float control automation begins to become unstable and manual operation is used as needed. Normally, the left roller gate is used to bypass flows at Roza Dam. Having flows pass through the left gate reduces the sediment buildup on the upstream side of the left bank fish passage and also reduces the possibility of silting in, and becoming inoperable. Periodically, the right roller gate should be operated, allowing flows to pass for a short period of time, to wash away accumulated sediment from in front of the auxiliary ladder located in the right abutment. The 2 Roza Dam roller gates together will handle discharges up to 52,000 cfs, with both gates open to 12.5 feet. The reservoir water surface will range from elevation 1220.65 to 1221.48 feet. When the river system is on storage control the float control automation, in trying to hold reservoir level, may set up an hourly (or more) cycling effect of +/- 80 cfs, that carries all the way down the Yakima River to PARW gaging station, creating one source of variation to PARW target flows.

The Roza Diversion Dam is operated at full pool normally 11 months of the year, including the winter months of December, January, and February. Due to the power water diversion in the canal, the fish screens remain set throughout the winter (year-round) and icing problems may occur damaging the metal screens structures or freezing up the screens, and damming off the canal flow. When the river is ice bound, or the reservoir surface is vulnerable to freezing over or has frozen solid, the roller gates may be tucked (allowing ice to pass over the roller gates) to clear the surface of the reservoir of ice, or opened to keep a flowing channel through the reservoir area. This is done to prevent damage to the fish screens, roller gates, and the diversion structure. In an extreme cold weather period the river system develops thick ice. To prevent ice jamming under the roller gates and floating them out of position or structurally damaging them, Reclamation fully raises the gates, allowing all flow to pass, and drawing down the pool to protect the structure. In addition, the power plant operation is suspended due to the ice problems. Ice Watch (CC25) is conducted during the colder, freezing periods of winter weather (typically December, January, and February).

A drawdown of Roza Diversion Dam pool for maintenance (canal and fish screens) has historically created issues for the biologists. These include: stranding of fish, ramping rates, minimum pool, sediment movement, and functionality of fish passage. Whenever pool drawdown is necessary, river flows will be affected, and gate operations must be accomplished in an environmentally sound manner, with advance consultation between Yakima River operations and the Upper Columbia Area Office Biologist to avoid damage to fisheries. Drawdown of the Roza Dam Pool is held to approximately 1 to 6 inches per hour (depending upon pool elevation and current conditions) which allows time for fish movement out of the shallow areas of the pool, reduces stranding, and minimizes sediment movement from the dewatered side slopes of the pool. For screen maintenance, the pool elevation is drawn below the sill at the bottom of the transition section trashrack intake to the fish screens at elevation 1209.75 feet. A target range pool elevation between 1209.00 and 1208.50 feet allows work in the fish screen section and, at the same time, avoids scouring silt and associated downstream impacts. This pool elevation allows for the fish ladder to be adjusted for usable fish passage through the secondary low pool exit. The downstream river has a general ramping guideline of 2 inches per hour, whenever operationally possible.

A concrete transition section connects the fish screen structure to the headworks gate structure which controls deliveries to Roza Canal with a 28 foot by 15 foot radial gate. To maintain canal integrity, canal flow should not increase or decrease more than 100 cfs per hour, except in an extreme emergency. When starting the juvenile pumpback pumps, the canal radial gate should be adjusted to lower or raise the canal flow approximately 50 cfs per pump, matching the number of pumps to be started or stopped. Power flow reductions in Roza Canal Diversion may cause a 2-3 hour “hole” in Yakima River flows below the Roza power wasteway as observed at the Parker gage. This is due to travel time of flow in the canal, which requires 3 hours to the end of the power wasteway at Yakima River at Terrace Heights (YRTW) versus approximately 6 hours via the river from Roza Dam.

Power water for electric generation at Roza Power Plant is subordinated to fishery flows in the Yakima River below Roza Diversion Dam (RBDW). Reclamation maintains an informal agreement, in consultation with SOAC, BPA, and others, to subordinate power generation to maintain a 400 cfs minimum in the river. Reclamation supports a 300 cfs minimum target (with no power generation) with natural flow water available in river system, but will not provide storage to maintain the 300 cfs minimum. During water year 2000, from November 8, 1999 through March 15, 2000, power was subordinated through negotiations with BPA, to a minimum flow of 600 cfs. The power subordination target returned to the 400 cfs minimum as of March 16, 2000, that year.

Yakima Project operations monitors and coordinates closely with Roza Power Plant operators to maintain appropriate flows for instream target minimums; irrigation and hydroelectric power diversions; and to accomplish a variety of operational needs, including power subordination, fisheries, flood control, recreation, and maintenance. In the past, Reclamation has provided river flow modifications (reductions) to support maintenance on the diversion dam and fish passage structures. Instream target flows and ramping rates below Roza Diversion Dam are monitored at the Yakima River below Roza Dam gaging station (RBDW).

Yakima-Tieton Diversion Dam -

Yakima-Tieton Diversion Dam (Tieton RM 14.1) is a 110-foot-wide concrete fixed crest weir (elevation 2301.6 ft.) with fish passage located on the right abutment, located on the Tieton River about 16 miles southwest of Naches, Washington. This irrigation diversion check structure (hydraulic height 3.0 ft.) provides water diversion for the Yakima-Tieton Irrigation District (YTID) during the irrigation season (mid-March through mid-October). The diversion structure has a designed diversion capacity of 320 cfs, but in reality is capable of passing up to 350 cfs. The dam as originally built had an overall height of 5 feet. In 1990, the diversion structure was modified for recreational rafting passage with the original downstream timber apron of the structure having been replaced with a concrete ramp. The ramp is 3 feet high and extends approximately 20 feet to transition into the downstream riprap. The current vertical drop from the dam crest to the top of the ramp is 2 feet, enabling most rafters to float over the diversion dam with of safety.

In 1990, the existing sluiceway, located on the right (south) side of the dam, was also modified to include a fish ladder to aid passage under low flow conditions. In 1996, a new flat plate fish screen was installed, 1,000 feet down the YTID main canal (TIEW) with a fish return pipe to the right side of the Tieton River. As all fish protection facilities and the main canal are located on the right side of the river (no bridge access), maintenance work requires a river ford access to the canal or fish screens at Yakima-Tieton Diversion Dam and possible corresponding outflow reductions at Tieton Dam (Rimrock Lake). Operations monitors and coordinates closely with YTID to maintain appropriate flows for irrigation diversions and to accomplish a variety of operational needs, including fisheries, flood control, recreation, and maintenance to structures.

Ramping rates below Tieton Diversion Dam are monitored at the Tieton River below canal headworks gaging station (TICW).

Wapatox Diversion Dam -

Wapatox Diversion Dam (Naches RM 17.1) is a 210-foot- wide concrete fixed crest weir (elevation 1585.0 ft.) with removable flashboard capability, located on the Naches River about 4.2 miles west of Naches, Washington. This irrigation and hydroelectric power diversion check structure (hydraulic height 6.0 ft.) is owned, operated, and maintained by PacifiCorp, and diverts up to 500 cfs to the Wapatox Power Canal (PacifiCorp, Scottish Power) and Wapatox Irrigation during the irrigation season (mid-March through mid-October). This diversion has a year-round natural flow right of 300 to 450 cfs, and diversion from the river is allowed up to 450 cfs, so long as the flow is naturally available and the rights of senior diverters and users, including flows to protect anadromous fish life, are satisfied. Reclamation is not obligated to provide storage flows at any time. During the non-irrigation season (winter) the power diversion water is informally subordinated to maintain a 125 cfs instream flow in the Naches River below the Tieton River near Naches, Washington (NACW). This structure has a passage with 125 cfs flow on the left abutment, which serves as a fish ladder, with 3 pools of approximately 2 feet per jump.

Operations monitors and coordinates closely with PacifiCorp to maintain appropriate flows for instream target minimums; irrigation and hydroelectric power diversions; and to accomplish a variety of operational needs including power subordination, fisheries, flood control, recreation, and maintenance. In the past, Reclamation has provided river flow modifications (reductions) in an attempt to support maintenance and flashboard installation on the diversion dam. Instream target flows and ramping rates below Wapatox Diversion Dam are monitored at the Naches River below Tieton River near Naches, Washington gaging station (NACW).

Naches-Cowiche Diversion Dam -

Naches-Cowiche Diversion Dam (Naches RM 3.6) is a concrete gravity ogee-weir, with the crest (elevation 1190.+) having removable flashboard capability, and with fish passage located on the left abutment. An irrigation diversion check structure (hydraulic height 8.0 ft.), owned jointly by Naches-Cowiche Ditch Company and the City of Yakima, is operated and maintained by the City. The diversion provides separate water diversion for the Naches-Cowiche Ditch Company and the City of Yakima Irrigation (old City Ditch) on the right bank during the irrigation season (mid-March through mid-October). The City provides all operation needs at the site, based upon the design operation criteria. In the past, Reclamation has provided river flow modifications in an attempt to support maintenance and flashboard installation. There is no minimum flow requirement downstream of this structure.

Wapato Diversion Dam -

Wapato Diversion Dam (Yakima RM 106.6) consists of two concrete weir structures. The west branch crest (elevation 935.6 ft) and the east branch crest (elevation 936.00 ft) are about 14 feet high and located on 2 branches of the Yakima River, about 1 mile north of Parker, Washington. Just upstream from the two structures, the Yakima River separates to form an east branch and a west branch with an island between the two branches. The two structures that comprise Wapato Diversion Dam raise the level of the river to divert water to the Wapato Irrigation Project (WIP) main canal. The headworks for the main canal is on the right abutment of the west branch structure and provides diversion of up to 2,200 cfs to WIP during the irrigation season (mid-March through October). The diversion headworks and fish passages facilities are owned by the United States, with WIP-BIA operating and maintaining the dam and headworks, and Reclamation operating and maintaining the fish passages facilities.

Adult fish passage at the dam is provided by three vertical slot fish ladders. The east branch dam has fish ladders located in the center and at the right bank against the island. The west branch of the dam has a center fish ladder of the same design as the east branch center ladder. Each fish ladder is designed to operate through a broad range of river flows, with attraction water provided for each ladder. Approximately 425 cfs is needed to operate the 3 ladders to within criteria when the low flow entrances are being used. At higher river flows, the ladders use the high flow entrance, and the total water used by the ladders would be approximately 825 cfs. Operation of the fish screens bypass, whenever diversions are made to WIP main canal, uses flows of 120 to 180 cfs to remain in criteria.

For operation and maintenance of the west branch ladder, and to provide access to the ladders on the east branch diversion structure, a cable car and a cableway are provided from the right bank to the left bank (island). This cableway access provides for daily operations and light maintenance of the east branch dam and fish ladders, but heavy maintenance work requires access via a river ford downstream of the west branch diversion dam and possibly corresponding outflow reductions at reservoirs to support the fording operation. WIP has bulldozed gravel dikes into the east branch of the Yakima River, at the upstream tip of the island, to enhance flow to the west branch diversion. In the past, Reclamation has attempted to provide river flow modifications to support maintenance and dike installation.

Operations monitors and coordinates closely with WIP to maintain appropriate flows for irrigation diversions and to accomplish operational needs for fisheries and maintenance to structures. WIP attempts to follow ramping criteria for the river when making changes in canal diversion, using the target flows and ramping rates for Yakima River near Parker (PARW) as a guide. There is no minimum flow requirement downstream of this structure.

Sunnyside Diversion Dam -

Sunnyside Diversion Dam (Yakima RM 103.0) is a 500-foot-wide concrete ogee-weir (elevation 899.4 ft.) with a right embankment wing, and fish ladders located on the right and left abutments, plus a center fish ladder midway across the crest of the dam. This irrigation diversion check structure (hydraulic height 6.0 ft.) provides water diversion (maximum 1,320 cfs) for the Sunnyside Canal with headworks located on the left bank. Canal flow varies from 600 to 1,300 cfs during the irrigation season (mid-March through October 20). The diversion dam is owned by the United States, and is operated and maintained by Sunnyside Valley Irrigation District (SVID). Fish passage facilities are operated and maintained by Reclamation. Operations monitors and coordinates closely with SVID to maintain appropriate flows for irrigation diversions and to accomplish a variety of operational needs, including fisheries, flood control, recreation, and maintenance to structures. Instream target flows and ramping rates below Sunnyside Diversion Dam are monitored at the Yakima River near Parker, Washington gaging station (PARW).

Adult fish passage at the dam is provided by three vertical slot fish ladders. Each fish ladder is designed to operate through a range of river flows from 200 to 12,000 cfs, with attraction water provided for each ladder. Approximately 340 to 400 cfs is needed to operate the 3 ladders to criteria when the low flow entrances are being used. Under present operations the minimum YRBWEP Title XII flow past the dam is 300 cfs (or 65% of 300 cfs < 24 hours), with ladder operations modified to operate in these low flow conditions. At high river flows, when the high flow ladder entrances would be used, a flow of 600 to 660 cfs is required. Operation of the fish screens bypass during diversions to the canal uses flows of 80 to 120 cfs to remain in criteria. Pumpback capability at the screen site returns from 40 to 80 cfs to the canal and only 20 to 40 cfs is bypassed to the river below the PARW gage.

During modification of the fish passage facilities, an agreement was made to protect the ability of SVID to withdraw water at Sunnyside Diversion Dam. If the target flow at PARW is 400 or 300 cfs, and the left, center, and right ladders are operating in criteria, 340 to 400 cfs minimum is passing through the ladders. Thus, if the SVID is taking 1,200 cfs, 1,600 cfs must be delivered to the diversion dam, plus an additional amount to cover daily fluctuations. If any less is delivered, the level of the pool above the crest of the dam drops. When this happens, head pressure is lost across the canal head gates, and the canal flows drop. The head gates are raised to compensate, and soon the system is in the critical situation where the canal head gates are fully open, but the level of the forebay pool is too low to deliver the required water to the district. As soon as 30 cfs is lost in the canal, SVID irrigators that receive their water from turnouts set high in the canal are no longer served. Then, any water delivered to the diversion dam to compensate must first fill the lake, extending the service outage time to SVID irrigators.

Sunnyside Low Flow Automation (SLFA) was designed and built as a means of protecting both the irrigation and fishery interests. During periods of limited flows at PARW (400 cfs or less), the SLFA will attempt to maintain the SVID diversion dam forebay level and provide the best fish passage for the remaining flows at PARW by adjusting the gates on the three fish ladders. As flows drop to the first point of inability (400 cfs) to meet full irrigation deliveries and maintain the forebay level of the pool behind the dam, the left and right ladder's attraction gates are closed. At 300 cfs the left and right entrance gates are closed, effectively shutting down these ladders. At this point, most of the river channel flow is in the center of the stream, and fish ladder functionality is concentrated to the center ladder. If the flows drop another 100 cfs (to 200 cfs), the center ladder attraction gates are opened and closed as necessary in an attempt to hold the forebay pool level as close as possible to the crest level of the diversion dam. Before this, operations will have seen the shortage in river flows, and will have started compensating by releasing water out of a reservoir. However, there may be short periods of time where flows at PARW will drop below the target. When flows start to increase, the SLFA will automatically reverse this process and attempt to return the ladders to full criteria. Note: if the YRBWEP target is 300 cfs the left and right bank ladders will operate the entire July through October period with the attraction gates closed.

The Sunnyside fish screen pumpback pumps are known to have shutdown in the past, creating a quick 40/80 cfs loss at PARW and possibly starting the above described low flow sequence of events. This also adversely affects the SVID irrigators that are supplied by turnouts set high in the canal. This loss of water could be taken out of the system by motorization and utilizing local control of the fish water bypass gates, thus having the bypass gates temporarily cut back flow to offset pump shutdown and still maintain a steady flow in the Sunnyside Canal. At the same time, status warning alarms would provide a call for pump maintenance. This process drives the sweep velocities of the fish screens out of criteria for a short period of time until the pumps are repaired, but stabilizes the river flows below the diversion dam. This modification of flow procedures was presented to SOAC and was given approval and will be implemented when labor and budgets allow.

The Sunnyside Diversion forebay pool is split into two sections by an island and two riffles that are increasing in size yearly. The right side pool/channel is the dominant flow, with water passing over the dam crest between the center and right ladder, while the left side pool (SVID diversion side) is drawn below the dam crest between the left and center ladder. This causes problems in meeting deliveries to SVID due to head loss, and with the head gate fully open, an inability to compensate for the situation. This problem will most likely occur when PARW flows drop below 600 cfs. In this situation, SVID may need to remove material from the forebay and riffles to keep the diversion dam structure functional in low flow conditions after the storage control date.

Prosser Diversion Dam -

Prosser Diversion Dam (Yakima RM 47.1) is a concrete weir structure about 9 feet high and 661 feet long with a crest elevation of 633.5 feet. This irrigation and hydroelectric power diversion check structure (hydraulic height 7.0 ft.) is owned by the United States, operated and maintained by Reclamation, and provides water diversion of up to 1,500 cfs into the Chandler Canal for irrigation and power production at the Chandler Power and Pumping Plant at the end of the 11 mile canal. The Chandler Power and Pumping Plant pumps water (up to 334 cfs) across the Yakima River to the Kennewick Canal, for delivery to the Kennewick Irrigation District during the irrigation season (mid-March through mid-October). The diversion headworks is located on the left abutment of the dam; housing three 16 by 7.75 foot radial gates to control flow to the canal. The canal is usually empty for several weeks during late October and/or November for canal and fish passage maintenance.

Fish passage facilities at the dam include fish ladders located on the right and left banks, plus a centrally located ladder and the Chandler screen facility located downstream of the dam. Operation of the 3 fish ladders at lower river flows requires flows of about 350 cfs. At higher river flows, the total water use by the ladders, including attraction water, is about 450 cfs.

Due to its location in the river system, large amounts of debris accumulate at the dam. Debris removal is a major issue for operation of the Prosser facilities because; 1) passage becomes ineffective due to the trashracks and water intakes becoming clogged; 2) debris, including large trees, is swept over the dam crest and lodges at the toe of the dam streambed creating bays and obstacles which hinder the upstream movement of fish through the ladders; and 3) debris facilitates damage to the diversion dam structure. Depending on the volume of debris moved in the river system, the debris could require yearly attention and removal during a low flow period in the river.

The Chandler screen facility is located in the Chandler Canal approximately 1 mile downstream of the Prosser Diversion Dam. The primary components of the Chandler screen facility include the drum screens, the pumpback-bypass facility, and the juvenile evaluation facility. The screening facility houses twenty-four 13.5-foot-diameter by 12-foot-long rotating drum screens. Fish enter the bypass system through 3 entrances located at 100-foot intervals across the screening structure. These fish are conveyed to the pumpback-bypass facility through three 42-inch-diameter pipes. Of the total 132 cfs of bypass flow, up to 105 cfs can be returned to the canal via the pumpback-bypass facility. Two traveling screens protect fish from the pumpback bays. Bypass flows of 27 to 32 cfs are delivered from the pumpback facility to the juvenile evaluation facility. At the facility, fish can be diverted directly back to the river or to a trap where they can be sampled and inspected. Annual maintenance usually requires the screen facility to be dewatered (canal shutdown) for 2 to 3 weeks for work completion. The dewatering process places fish in the canal above the screen at risk. Coordination with WDFW occurs so that the canal head gates are shutdown in a manner that allows fish to return to the river prior to complete closure of the head gates. The YN fish acclimation ponds located in the immediate area rely on the Chandler Canal screen fish bypass water flows for refreshing the ponds. When the canal is shutdown, coordination with the YN is necessary to ensure alternate water sources for the acclimation ponds.

Due to the location in the river system, deposition of large amounts of silt accumulates at the fish screen facilities as the water velocity in the canal is slowed to the 0.5 cfs velocity required through the screen. During routine maintenance shutdown, removal of accumulated silt and dumping of the material at disposal sites is completed as necessary. Due to the power water diversion in the canal the fish screens remain set throughout the winter (year-round) and icing problems may occur damaging the screens structures or freezing up the screens, damming off the canal flow. When the river is ice bound or the canal is capable of freezing, and in order to prevent damage to the fish screens facilities and canal structure, power plant operation may be suspended and the canal shutdown until the ice problems diminish. Ice Watch (CC25) is conducted during the colder, freezing periods of winter weather (typically December, January, and February).

Reclamation subordinates power production of Chandler Power Plant to various flows passing over Prosser Diversion Dam throughout the year. In the spring, the subordination target is 1,000 cfs over Prosser Dam through the end of June. During the remainder of the irrigation season, the subordination target is 450 cfs or the YRBWEP target flow, whichever is higher. The agreed subordination target is for 450 cfs through the non-irrigation season, but for the past 2 years all subordination target flows have been annually reviewed and reestablished.

Operations monitors and coordinates closely with Chandler Power Plant operators to maintain appropriate flows for instream target minimums; irrigation and hydroelectric power diversions; and to accomplish a variety of operational needs, including power subordination, fisheries, flood control, recreation, and maintenance. In the past, Reclamation has provided river flow stabilization or modifications (reductions) in an attempt to support downstream river flow studies and maintenance on the diversion dam and fish passage structures. YRBWEP target flows, instream target flows, and ramping rates below Prosser Diversion Dam are monitored at the Yakima River at Prosser, Washington gaging station (YRPW).

Wanawish/Horn Rapids Diversion Dam -

Wanawish Diversion Dam (Yakima RM 18.0) is a 523-foot-wide concrete fixed crest weir (elevation 414.3 ft.), with fish ladders located on the right and left abutments, plus 3 fish passage notches evenly distributed across the crest of the dam. This irrigation diversion check structure (hydraulic height 3.0 ft.) provides water diversion for the Columbia Irrigation District (CID) on the right bank, and diversion for the Richland Canal (Barker Ranch Canal) on the left bank. The diversion dam is owned, operated and maintained by CID, and the district operates the site, based upon the design operation criteria for Horn Rapids right ladder and the irrigation demands of the district. There is no minimum flow requirement downstream of this structure. From mid-March through October, water is diverted for irrigation by both entities, and from November through March, the Richland Canal at times diverts water for wetland enhancement.

5.5 Operations for System Maintenance

Routine maintenance of the facilities occurs throughout the year on the Yakima Project. This routine maintenance falls into two broad categories; maintenance of the storage dams and canals; and maintenance of the fish protection facilities. Reclamation maintains the storage dams, two diversion dams, and the fish protection facilities. Maintenance at these facilities is conducted according to the Standard Operating Procedures (SOP) for each facility. There are specific SOPs, described in separate manuals, for each site: Keechelus Dam, Kachess Dam, Cle Elum Dam, Tieton Dam/Rimrock Lake, Bumping Lake Dam, Clear Creek Dam, Easton Diversion Dam, Roza Diversion Dam, Sunnyside Diversion Dam, Prosser Diversion Dam, and Tieton Diversion Dam. Copies of these manuals are kept at the Yakima Project Office.

5.5.1 Storage Dams and Diversion Dams (CC27)

Inspections of the dams, spillways, outlet works, and other facilities are followed by required maintenance and repairs, if needed. The requirement for instream flows downstream of the dams continues during all inspection, maintenance, and repair activities. Inspections and maintenance crews must consult and coordinate with the project's hydrology operations branch and Reclamation environmental programs staff prior to implementing required activities in order to minimize adverse impacts to storage, flood control, irrigation diversion, fishery, and natural resources. The instream flow requirements are coordinated with the flow requirements necessary to perform the maintenance and repair activities and to determine which month of the operating year is the most suitable time for the work. Most maintenance and repair activities are scheduled in advance (obviously an emergency is just that). Advance planning, taking into consideration storage, fishery flows, flood control, conditions of water, etc., is required to create a non-disrupted flow regime during maintenance and repair activities. A 15-month lead time is within reason, and even then, the activities may be delayed due to changing basin conditions. The flip side to advanced planning is the need to have flexibility in scheduling and manpower, so "windows of opportunity" may be used to do the activity earlier rather than later when scheduled.

5.5.2 Fish Protection Facilities (CC28)

Fish passage and protection facilities have been constructed throughout the Yakima basin. Fish ladders provide passage around dams for adult fish returning to their upstream spawning beds. Efficient fishways are vital to avoid injuries or delays in this migration. Most of the new ladders have a vertical slot design with low and high flow entrances. A jet of water flowing from the ladder attracts fish to the entrance. The fish then swim through the slots from pool to pool, resting in each before swimming to the next.

Fish screens keep juvenile fish from swimming into canals where they become trapped and may die. Most Yakima fish screens have rotating drums covered with wire mesh. These are submerged into the canal water about 80 percent of the drum diameter. The screen structure is angled to the direction of the canal flow so that the young fish are directed into a bypass pipe and back into the river.

Both screens and ladders require considerable maintenance. Reclamation is responsible for operation and maintenance of many of the screens and ladders throughout the basin. General maintenance consists of daily inspections, annual inspections, and scheduled 4-year reviews of

O&M inspections. Maintenance or repair activities are based on the inspection findings and scheduled maintenance.

Daily Inspections -

During operating periods, Reclamation employees or contractors check screens and ladders for vandalism and to ensure that the facilities are operating properly. These daily checks include; 1) determining that the screens are 80 percent submerged, 2) adjusting fish bypass flows to ensure that they are within operating criteria, 3) assuring that the ladders meet attraction flow criteria, and 4) removing debris to prevent equipment failure or impairment.

Annual Inspections -

Every year, the fish screens must be inspected and any required maintenance conducted. Most annual maintenance is accomplished during the non-irrigation season. Usually the screen site must be dewatered and the larger sites, such as Roza and Chandler, require about 2 weeks for work completion. The dewatering process places fish at risk in areas where the water pools in depressions rather than draining directly to the river. Sites where fish can be stranded include Chandler, Sunnyside, and Roza Diversion Dams. These sites are discussed in some detail in the "effects" section. Fish screen maintenance activities are coordinated with the WDFW personnel. For example, Reclamation inspects screens and bypasses and informs WDFW of potential fish issues at each site. Upon completion of annual maintenance and screen repairs WDFW re-inspects each site to ensure that the facilities are operating to meet the fish criteria for which the facilities were designed. In addition, coordination occurs with the irrigation districts so that the canal head gates are shutdown in a manner that allows fish to return to the river prior to complete closure of the head gates (WDFW, 1996).

Once the site is dewatered, screens, bays, and bypasses are inspected during the annual maintenance routine. The maintenance focuses on seal replacement, drum screen repairs, and a thorough bypass pipe inspection. Deposition of silt occurs at the screen facilities as the water velocity in the canal is slowed to the 0.5 cfs velocity required through the screen. Routine maintenance also includes the removal of accumulated silt as necessary and transport of the material to approved disposal sites. The screens and frames are washed down.

The screens are re-installed when the maintenance is completed and WDFW then inspects the screens to verify Reclamation's work and to ensure that the screens are fish tight. At these onsite inspections, coordination and information exchange occurs between Reclamation staff and WDFW staff. Repairs, general maintenance, and any unusual findings are discussed.

Four-Year Inspections -

Every 4 years, a review of O&M activities occurs at each of the fish protections facilities (e.g., about 20 sites per year are reviewed). This review includes Reclamation staff from the Yakima Field Office and the Boise Regional Office. Results are reported to the Denver Technical Service Center. Fish passage, safety, and major structural issues are examined to ensure that O&M activities are conducted efficiently and effectively.

6.0 EFFECTS OF SYSTEM OPERATIONS ON:

6.1 WATER

6.1.1 Quality

6.1.1.1 Introduction

The U.S. Environmental Protection Agency (EPA) has determined that agricultural runoff is the major source of water quality degradation in Washington State's rivers and streams, with hydrologic habitat modification considered to be the second most important cause of water quality impairment in the State (EPA, 1998).

Normal and emergency Yakima Project operations and maintenance activities alter flow volume and water levels, affect normal temperature regimes, and periodically increase suspended sediment and turbidity outside the range of State water quality criteria. Large volumes of polluted agricultural return water from the Yakima Project add a variety of contaminants to the river, including nutrients, bacteria, pesticides, and sediment. Agricultural return flows, an indirect effect of the Yakima Project, are responsible for many of the “water quality impaired” listings on the 1998 303(d) list. Recent improvements in farming practices have improved water quality by reducing sediment entering the river. (See table 6-1. for improvements on Roza-Sunnyside Board of Joint Control.)

Table 6-1. -Summary of RSBOJC Water Quality Data
1997-2001

90th% Turbidity (NTU)

	WDOE	RSBOJC Data					
	1994 Irr (June-Oct)	1995 Irr (March-Oct)	1997 Irr (June-Oct)	1998 Irr (April-Oct)	1999 Irr (April-Oct)	2000 Irr (April-Oct)	2001 Irr (April-Oct)
Granger Drain	195	345	298	125	136	42	46
Sulphur Creek	29	70	81	60	51	18	15
Spring Creek	17	106	49	49	45	25	14
Snipes Creek	15	64	21	27	20	15	9

Median Total Suspended Solids Loading (tons/day)

	WDOE	RSBOJC Data					
	1994 Irr (June-Oct)	1995 Irr (March-Oct)	1997 Irr (June-Oct)	1998 Irr (April-Oct)	1999 Irr (April-Oct)	2000 Irr (April-Oct)	2001 Irr (April-Oct)
Granger Drain	16	72	100.2	35.2	43.1	15.5	4.8
Sulphur Creek	8	87	152	86.3	108.3	44	3.7
Spring Creek	1	15	13.3	6.8	9.3	5.1	2.7
Snipes Creed	0.004		4	4.3	1.9	1.1	0.03

90th% Total Suspended Solids (mg/L)

	WDOE	RSBOJC Data					
	1994 Irr (June-Oct)	1995 Irr (March-Oct)	1997 Irr (June-Oct)	1998 Irr (April-Oct)	1999 Irr (April-Oct)	2000 Irr (April-Oct)	2001 Irr (April-Oct)
Granger Drain	408	771	894	432	543	125	100
Sulphur Creek	57	213	307	197	159	57	33
Spring Creek	45	295	165	119	132	85	38
Snipes Creed	10	224	53	87	47	37	20

Decades of water quality studies have been conducted within the Yakima basin focusing on many of the impairments that have been identified within the river system. Several of these studies have examined specific cause and effect in both a spatial and temporal view while others take a more generalized view, identifying water quality problems without fully quantifying pollutant loads or qualifying sources. It has been shown that in several circumstances Yakima Project operations, including water storage and distribution, the agricultural return flows used to satisfy total water supply available (TWSA) and the return flows from various Yakima Project Division operations, have contributed to impairment of water quality in the Yakima River. A direct correlation between some of the identified impairments within the system and the Yakima Project operation remain unquantified and under-defined; however, there are intuitive connections that can be drawn. The Yakima River is a heavily managed system and, as such, that management must be examined as a contributing factor to any known impairment within its reach. This section will identify several of the known impairments to water quality within the basin.

Effects of Normal Yakima Project Operations -

The mission of the Yakima Project operations has primarily been to supply water for irrigation in the Yakima basin. This activity often results in low water levels in the lower main stem of the Yakima River in the summer and fall and abnormally high flows in reaches of the upper main stem. Models and studies have shown that low water levels and the associated reduction in width-depth ratios can accelerate the heating of waterbodies, such as the Yakima River, which can in turn reduce the amount of available dissolved oxygen (DO) to below optimal levels. Low flows combined with high nutrient loads, as found in the lower Yakima, also promote macrophyte and phytoplankton growth in the river, which can result in increased pH levels and wide swings in DO concentrations.

While sediment and bedload movement does naturally occur within a river system, normal operation and maintenance activities of the Yakima Project have altered the timing, volume, and magnitude of sediment movement in the river. Drain maintenance, including dredging and flushing, has also contributed sediment and associated pollutants to the Yakima River system.

In years that have normal or above normal water supplies, standard Yakima Project operation has been to provide water to all Yakima Project divisions and client districts based on contract laws and State water law the amount of water available in the system. Amounts delivered to divisions and districts have averaged approximately 90 percent of the contract entitlement. This volume is not necessarily based on the precise needs of the various irrigators and their crops, but rather on the legal requirements. Instantaneous demands by individual irrigation districts can result in excess water deliveries due to inefficiencies in their system. Operational or excess water delivered to the various project divisions is returned to the river through operational spills or in drains at various locations within the division's district. During normal water years, especially during wet, cool weather, greater operational spill tends to occur in wasteways and agricultural drains.

During a normal water year with near full water entitlements delivered to growers, water from fields and drains tend to transport a greater pollutant load than during those years with less than a normal water supply. A positive correlation was shown to exist between the amount of water delivered to the districts and return flows carrying high loads of sediment and associated contaminants. In 1994, a low water year, 3 of the 4 major agricultural drains in the lower Yakima total maximum daily load (TMDL) study carried less flow volume, less sediment load, and maintained lower turbidity (lower concentration) than during the normal water year of 1995 (Joy and Patterson, 1997). During low water years greater care is given to how irrigation water is managed on-farm, which has resulted in more efficient use and less tailwater runoff.

Subsequent to the 1994-95 Department of Ecology (WDOE) study, marked changes have been seen in these same four drains in the lower Yakima basin. Dramatic improvements have been realized in sediment reduction in the lower basin since the Roza and Sunnyside Divisions began implementing a water quality program in 1997. Further reductions are expected within these divisions' boundaries and it is anticipated that they will meet sediment reduction targets set by the Lower Yakima Sediment and DDT TMDL and the fecal coliform bacteria (FC) reduction targets set by the Granger Drain FC TMDL.

Effects of Agricultural Return Water -

In the lower Yakima River, irrigation return flows and operational spills from drains and tributaries contribute up to 80 percent or more of the total flow in the main stem. As runoff from irrigated agricultural fields re-enters the Yakima River numerous water quality parameters are significantly altered. Agricultural surface drains can contribute the following to the Yakima River and its tributaries: increases in suspended sediment, turbidity, FC, pesticides, heat, and nutrients. The addition of these pollutants also facilitates a reduction in DO and an increase in pH. Several of these pollutants have caused 303(d) listings in the Yakima River and its tributaries. The relationship between return flows and temperature has not been quantified and further study is needed. The impacts of these pollutants are discussed in more detail in the following sections.

Washington State Water Quality Regulations -

Section 90.48.080 of the Revised Code of Washington (1987) states that ". . . it shall be unlawful for any person to . . . discharge into any of the waters of this state, or to cause . . . to be . . . discharged into such waters any organic or inorganic matter that shall cause or tend to cause pollution of such waters . . ."

Additionally, the State's antidegradation policy (Washington Administrative Code [WAC] 173-201A-070, WAC, 1997) declares that "existing beneficial uses shall be maintained and protected." The antidegradation policy also states that whenever waters are of a higher quality than the criteria assigned for said waters, the existing water quality shall be protected and pollution of said waters which will reduce the existing quality shall not be allowed, "except where: (a) the public interest is served, (b) all activities which result in the pollution of waters from non-point sources shall be provided with, all known, available, and reasonable methods of prevention, control, and treatment, and (c) when the lowering of water quality in high quality waters is authorized, the lower water quality shall still be of high enough quality to fully support all existing beneficial uses."

Lastly, Washington State has specific water quality criteria (WAC 173-201A-030, 1997), determined by class of waterbody, that delineate standards for all significant pollutants. Water quality assessments are compared to these criteria in the following sections.

Characteristic Uses -

The waters most affected by Yakima Project operations are Classes AA, A, and B waters. Generally, headwater streams and the upper reaches of the Yakima and Naches Rivers are Class AA, while the middle and lower Yakima and Naches Rivers and their immediate tributaries are Class A. Sulphur Creek is the only Class B waterbody in the Yakima basin. According to WAC 173-201A-030, 1997, water quality for Class A fresh waters shall meet or exceed the requirements for all or substantially all of the following characteristic uses (also called "beneficial uses"). Characteristic uses for Class A waters shall include, but not be limited to, the following:

- Water supply (domestic, industrial, agricultural).
- Stock watering.
- Fish and shellfish.
- Salmonid migration, rearing, spawning, and harvesting.
- Other fish migration, rearing, spawning, and harvesting.
- Wildlife habitat.
- Recreation (primary contact recreation [e.g., swimming, diving or water-skiing], sport fishing, boating, and aesthetic enjoyment).
- Commerce and navigation.

Characteristic uses for Class B waters are similar to those for Class A, with these differences: (1) water quality must meet or exceed requirements for most (but not all) uses; (2) water supply includes only industrial and agricultural (not domestic) uses; (3) spawning for salmonids and harvesting of shellfish are not included; and (4) recreational use includes "secondary contact" (e.g., fishing or wading), but not "primary contact."

Characteristic uses that are impaired directly by Yakima Project operations (and indirect effects such as agricultural flows) include: (1) domestic water supply; (2) migration, rearing, and spawning of salmonids and other fish species; (3) wildlife habitat; and (4) recreation. Heavy sediment loads impair the health of aquatic biota as well as affecting domestic water supply. The introduction of toxic materials such as pesticides can make the water unfit for use as a domestic water supply and recreation, and it can affect aquatic biota. High water temperature and low DO levels may also harm aquatic biota. Low flows can reduce recreational opportunities and flow fluctuation, if not managed carefully, can cause stranding of aquatic biota.

6.1.1.2 Suspended Sediment and Turbidity

Sediment delivered to streams can greatly impair or eliminate habitat for aquatic life. Additionally, the transport and fate of many constituents, including nutrients, oxygen-demanding compounds, some pesticides, trace elements, and FC, are often associated with increases in suspended sediment concentration. In the lower Yakima basin increases in turbidity have been directly correlated with increases in suspended sediment concentration.

According to the WAC (Chapter 173-201A, WAC, 1997), turbidity in Class AA and A waterbodies shall not exceed 5 nephelometric turbidity units (NTU) over background when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU. For Class B waterbodies (e.g., Sulphur Creek), turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU. Background conditions are defined in Washington as, ". . . the biological, chemical, and physical conditions of the water body, outside the area of influence of the discharge under consideration."

While the State of Washington has water quality standards for turbidity, none have been developed for total suspended solids (TSS). However, recent TMDL data indicated significant positive correlations between TSS and turbidity ($r^2 = 0.956$) during the 1995 irrigation season, allowing one to address both TSS and turbidity through the State's water quality criteria. Another significant correlation ($r^2 = 0.747$) was found during the 1995 season between TSS and total DDT (t-DDT= DDT+DDE+DDD) in the lower Yakima River, which suggests that most t-DDT (total DDT) may be transported by suspended sediment or TSS (Joy and Patterson, 1997). Because of these significant correlations the lower Yakima TMDL uses turbidity as a surrogate for both TSS and t-DDT.

From the lower Yakima TMDL study, a 90th percentile turbidity target of 25 NTU (25 NTU correlates to 56 mg/L TSS in the lower Yakima) for the tributaries and return drains was recommended by the WDOE to protect aquatic communities from TSS effects and to significantly reduce t-DDT loads. Modeling indicated that achieving a limit of 25 NTU at the mouths of the major agricultural drains in the lower Yakima River would bring the main stem into compliance with State turbidity criteria. However, further reductions will be necessary to reach Human Health Criteria for DDT. Meeting the 25 NTU target and main stem criteria will require the largest return drains to reduce TSS loads by 90 percent or more over their 1995 irrigation season levels, which were under conditions of normal water availability (Joy and Patterson, 1997).

During the 1987-91 North American Water Quality Assessment (NAWQA) study, the U.S. Geological Survey (USGS) determined that the major source of suspended sediment and turbidity in the Yakima River basin is agricultural activity. Significant contributions of suspended sediment to the main stem river during the irrigation season came from Wilson Creek, Moxee Drain, Granger Drain, Sulphur Creek, and South Drain in the lower Yakima basin. High rates of sediment transport to tributaries were generally associated with contaminated return flows from irrigated agriculture (Morace et al., 1999).

In 1994, one of the lowest water years on record, WDOE found that Sulphur, Spring, and Snipes Creeks had median turbidities below 25 NTU. In 1995, considered a "normal" water year, the median turbidities of Sulphur and Spring Creeks were above 25 NTU, while the 90th percentile turbidities for Sulphur, Spring, and Snipes Creeks exceeded 50 NTU (Joy and Patterson, 1997). Salmonid feeding and growth have been shown to be negatively affected at turbidities above 25 NTU.

As part of the formulation of the Lower Yakima River Suspended Sediment and DDT TMDL, WDOE calculated a TSS loading balance from data collected during the 1995 irrigation season. The cumulative negative impact of tributary and drain loading on reaches of the lower Yakima River was clearly seen. For example, in the later part of the irrigation season, the Moxee Drain TSS load (35 tons/day) exceeded the Naches River's load (27 tons/day), even though the average water volume of the Naches River was 14 times that of Moxee Drain. Averaged over the irrigation season, Granger Drain contributed 60 tons of suspended sediment per day. The average sediment load from Sulphur Creek was 110 tons/day, and Spring and Snipes Creeks combined sediment load averaged 46 tons/day. Ungaged tributaries and instream sources also accounted for substantial loads during the irrigation season (Joy and Patterson, 1997).

It should be emphasized that significant reductions in turbidity and sediment load in all of the targeted major agricultural return drains of the lower Yakima River have been realized since WDOE's 1997 assessment report. The Roza and Sunnyside Divisions have implemented a highly successful water quality improvement program, which is anticipated to meet the TMDL target of 25 NTU at the mouths of the major drains within their districts by the end of 2002. Continued implementation of the lower Yakima River sediment TMDL through on-farm and irrigation district improvements is expected to further reduce sediment transport and turbidity. As a corollary, this same effort is expected to also reduce contamination from organochlorine pesticides, FC, and sediment borne phosphorus.

In the upper Yakima basin, during the 1987-91 water years, the USGS found the median TSS concentrations of monthly main stem samples ranged from 3 mg/L in the Yakima River at Cle Elum to 17 mg/L in the Yakima River at Umtanum (below the contribution of TSS from Wilson Creek). In the lower Yakima basin, the median suspended sediment concentrations increased from 20 mg/L in the Yakima River at Union Gap to 28 mg/L in the Yakima River at Grandview and 25 mg/L in the Yakima River at Kiona (see table 6-2 for additional USGS TSS and turbidity findings). The suspended sediment concentration at Grandview reflects local runoff from several agriculturally affected drains, including Sulphur Creek, the basin's largest agricultural drain, in which TSS values ranged from 7 to 909 mg/L (Morace et al., 1999).

Table 6-2. –Streamflow, suspended sediment concentration, and turbidity in tributaries having predominantly agricultural sources of water, Yakima River Basin, Washington, July 26-29, 1988. After Morace et al., 1999. **[If more than one sample was collected at a site, the median concentration is shown here]**

Yakima River Mile	Site Name	Streamflow (cfs)	Suspended Sediment Concentration (mg/L)	Turbidity (NTUs)
147.0	Cherry Creek at Thrall	127	82	37
107.4	Wide Hollow Creek near mouth at Union Gap	26	8	2.7
107.3	Moxee Drain at Thorp Road near Union Gap	76	565	150
106.9	Ahtanum Creek at Union Gap	7	3	3.0
83.2	Sub-Drain Number 35 at Parton Road near Granger	34	7	8.0
82.8	Granger Drain at mouth near Granger	49	428	>100
61.0	Drainage Improvement District (DID) Number 3	26	356	>100
61.0	Sulphur Creek Wasteway near Sunnyside	159	113	- -
41.8	Spring Creek at mouth at Whitstran	24	138	33
41.0	Snipes Creek at mouth at Whitstran	24	136	>100
33.5	Corral Canyon Creek at mouth near Benton	16	27	3.6

WDOE ambient monitoring data collected at or just above the city of Yakima and at Benton City has shown regular excursions beyond State standards in recent years. It is expected that major recent reductions of sediment load in several of the lower Yakima basin return drains will result in improvement in lower Yakima main stem turbidity.

6.1.1.3 Abnormal Flows

A fundamental component of Yakima Project operations is reservoir storage and diversion of water from the main channels in the Yakima River system, often resulting in abnormal flow regimens, which can impair beneficial uses of the river.

Modeling has shown that reducing the water level in a river can cause it to be more prone to heating. Low flows can produce significantly increased surface area-to-volume ratios, which accelerate the rate of convective, conductive, and radiant heating. As temperature increases, oxygen-holding capacity of the water is decreased. Since low flows also promote the growth of aquatic plants (macrophyte and phytoplankton), the changes in stream chemistry (e.g., DO and pH) exerted by plant growth and respiration can further impair the health of the aquatic community.

Another effect of low flows is excessive sediment settling in different areas of the river system and storage of the sediment as bedload. River channels with reduced flow volume or velocity become accumulation sites for sediment delivered from the agricultural return drains. Sediment reduces higher quality salmon spawning areas, increases accumulation of toxic pollutants associated with the sediment, and encourages nuisance macrophyte growth. Stored sediment can be released only with bankfull flows or greater. The Yakima Project has generally reduced the height and the duration of these "flushing" flows in much of the river system.

6.1.1.4 Temperature

On Washington State's 1998 303(d) list of Impaired and Threatened Waterbodies, there are 15 listings for temperature in waters influenced by the Yakima Project (Ecology, 1998) (see table 6-3.).

Table 6-3.–1998 303(d) listings for temperature, in waterbodies affected by the Yakima Project (Ecology, 1998).

WRIA	Waterbody Name	Parameter	Township	Range	Section	New ID #	Old ID#
37	GRANGER DRAIN	Temperature	10N	21E	22	KO70CH	WA-37-1024
37	MOXEE (BIRCHFIELD) DRAIN	Temperature	13N	19E	16	OI57XE	WA-37-1048
37	SNIPES CREEK	Temperature	09N	25E	27	SL56UX	WA-37-1012
37	SPRING CREEK	Temperature	12N	19E	05	NO-ID	WA-37-2105
37	SPRING CREEK	Temperature	12N	19E	08	NO-ID	WA-37-2105
37	SULPHUR CREEK WASTEWAY	Temperature	09N	22E	24	YT62AF	WA-37-1030
37	YAKIMA RIVER	Temperature	08N	24E	01	EB21AR	WA-37-1010
37	YAKIMA RIVER	Temperature	09N	26E	13	EB21AR	WA-37-1010
37	YAKIMA RIVER	Temperature	09N	27E	19	EB21AR	WA-37-1010
39	CHERRY CREEK	Temperature	17N	19E	31	FT68CJ	WA-39-1032
39	COOKE CREEK	Temperature	19N	20E	19	SZ58XV	WA-39-1034
39	WILSON CREEK	Temperature	17N	19E	30	PY59BF	WA-39-1020
39	WILSON CREEK	Temperature	17N	19E	31	PY59BF	WA-39-1020
39	YAKIMA RIVER	Temperature	20N	13E	10	EB21AR	WA-39-1070
39	YAKIMA RIVER	Temperature	20N	14E	36	EB21AR	WA-39-1060

The initial stream temperatures in the headwaters of the Yakima River are generally cool enough to meet State criteria, but the waters warm as they move downstream and violations of criteria become more common. Many factors can influence water temperature in a river system such as climate, flow, groundwater infusion, streambed gradient, exposure to solar radiation, subsurface flow, irrigation return, point-source outfalls, riparian shade and associated micro-climate, width/depth ratio, flow fluctuation, and solar aspect among others. Yakima Project operations may have a direct or an indirect effect on several of these parameters. Exposure to solar radiation is increased as riparian vegetation is impaired or removed, which often occurs along the river and its tributaries. Water is further exposed to radiation as it flows through canals, delivery ditches, and return drains which are specifically managed to exclude trees and other riparian growth. Artificially decreasing flows in the main stem channel on a daily basis allows exposed banks, bars, and boulders to accumulate heat that is released to the water column when flows are increased. The temperature of diverted irrigation water is increased as it flows overland across agricultural fields to re-enter the river as surface return flows. As water levels in the river and reservoirs are reduced as the irrigation season proceeds, the width/depth ratios increase, allowing more of the water volume to be exposed to solar radiation. Lower flows, resulting from water being diverted from the river system, also increase travel times, allowing river water to further collect heat.

Additionally and conversely, Yakima Project operations have been observed to acutely reduce temperatures by as much as 15 °F when gates at storage reservoirs are opened. This observation was made at the Cle Elum fish hatchery downstream of the Cle Elum Dam and Reservoir. In other river systems such reservoir releases are used to mediate temperature extremes in lower reaches. The possibility of incorporating this activity as a tool in the Yakima system needs to be explored.

The maximum temperature standard for Class AA streams is 16 °C (WAC, 1997). The general statewide standard for Class A streams is 18 °C, however, the main stem of the Yakima River (from the confluence with the Cle Elum River to the mouth) has a special standard of 21 °C. The WAC states that stream temperatures are not to exceed the maximums due to human activities. When stream temperatures do exceed the natural condition standard because of human activity no temperature increase greater than 0.3 °C is allowed.

USGS found that 12 percent of the 1,152 water temperature measurements from 192 sites during the 1986-91 water years exceeded the applicable State standards. These measurements were above standards for 26 percent of the measurements on Class AA streams, 13 percent on Class A streams, and 5 percent on Class B streams. If exceedances result from human activities they are considered violations of the State standards. Eighty percent of the 134 Class A exceedances were in the lower Yakima basin and included mostly main stem, tributary, canal, and drain sites. Much of the summer heating of the river water was associated with, (1) low flows downstream from the Wapato and Sunnyside Canal diversions, (2) slow stream velocities due to a small stream gradient between river miles (RM) 69.6 and 47.1, and (3) low flows between Prosser Dam and Chandler Pumping and Power Plant (Morace et al., 1999).

Payne and Monk’s (2001) water temperature modeling indicated that increased flows below Prosser Diversion Dam could influence mean and maximum daily water temperature under certain conditions and Carrol and Joy’s (2001) work supported these results.

6.1.1.5 Dissolved Oxygen

The DO content of a waterbody is affected by water temperature (warmer water holds less oxygen) and by the presence of oxygen-depleting substances, most notably bacteria and decaying organic material and even some chemicals (termed chemical oxygen demand or COD).

Most of the streams in the Yakima River basin are designated as Class A, in which DO shall exceed 8.0 mg/L. In Class AA streams (headwater streams and the Tieton River), DO shall exceed 9.5 mg/L. Sulphur Creek is the only stream in the basin designated as Class B, where the DO shall exceed 6.5 mg/L (WAC 173-201A-030, 1997).

During July 14-19, 1987, the USGS performed a synoptic sampling in which instantaneous DO was measured before or near sunrise to target minimum DO concentrations. Of the 39 sites sampled, nearly one-half failed to meet the State standards for DO. Most of these failures were measured in the lower Yakima basin, where the effects of agricultural return flow were noticeable. Of particular interest were the failures in the Granger/Sunnyside area, an area largely influenced by the large numbers of confined animal feeding operations (feedlots and dairies). Feedlot waste results in increased oxygen consumption due to the breakdown of the organic waste and nitrification of ammonia. The lower DO concentrations were also partly a function of warmer water temperatures (Morace et al., 1999).

6.1.1.6 Pesticides

Pesticides have been documented in basin return flows and drains associated with irrigated agriculture and in the main stem Yakima. Yakima Project Divisions have traditionally allowed the unrestricted return flow of agricultural tailwater into drains and tributaries. The return water has often been carrying high loads of suspended sediment and associated pesticides, such as DDT. The 1998 303(d) list gives evidence of a variety of pesticides found in the Yakima River and its agriculturally influenced tributaries (see table 6-4.).

Table 6-4.–1998 303(d) listings for pesticides in the Yakima River and its agriculturally influenced tributaries (WDOE, 1998).

WRIA	Waterbody Name	Parameter	Township	Range	Section	New ID #	Old ID#
37	GRANGER DRAIN	4,4'-DDD	10N	21E	21	KO70CH	WA-37-1024
37	GRANGER DRAIN	4,4'-DDE	10N	21E	21	KO70C	WA-37-1024
37	GRANGER DRAIN	DDT	10N	21E	21	EB21AR	WA-37-1024
37	GRANGER DRAIN	DDT	10N	21E	21	KO70CH	WA-37-1024
37	GRANGER DRAIN	Endosulfan	10N	21E	21	KO70CH	WA-37-1024
37	MOXEE DRAIN	4,4'-DDD	12N	13E	09	VE21WY	WA-37-1048
37	MOXEE DRAIN	4,4'-DDE	12N	13E	09	VE21WY	WA-37-1048
37	MOXEE DRAIN	Chlorpyrifos	12N	13E	08	VE21MH	WA-37-1048
37	MOXEE DRAIN	DDT	12N	13E	08	VE21MH	WA-37-1048
37	MOXEE DRAIN	DDT	12N	13E	09	TK46RP	WA-37-1048
37	MOXEE DRAIN	Endosulfan	12N	13E	08	YE21MH	WA-37-1048
37	MOXEE DRAIN	Endosulfan	12N	13E	09	TK46RP	WA-37-1048
37	SULPHUR CREEK	4,4'-DDD	09N	22E	24	YT62AF	WA-37-1030
37	SULPHUR CREEK	4,4'-DDE	09N	22E	24	YT62AF	WA-37-1030
37	SULPHUR CREEK	DDT	09N	23E	25	ZS24RD	WA-37-1030
37	SULPHUR CREEK	Endosulfan	09N	23E	25	ZS24RD	WA-37-1030
37	WIDE HOLLOW	4,4'-DDD	12N	19E	08	DY38VO	WA-37-1047
37	WIDE HOLLOW	4,4'-DDE	12N	19E	08	DY38VO	WA-37-1047
37	WIDE HOLLOW	DDT	12N	19E	08	EB21AR	WA-37-1047
37	WIDE HOLLOW	Dieldrin	12N	19E	08	EB21AR	WA-37-1047
37	YAKIMA RIVER	4,4'-DDD	09N	27E	19	EB21AR	WA-37-1010
37	YAKIMA RIVER	4,4'-DDE	09N	27E	19	EB21AR	WA-37-1010
37	YAKIMA RIVER	4,4'-DDE	10N	27E	03	EB21AR	WA-37-1010
37	YAKIMA RIVER	4,4'-DDE	11N	20E	20	EB21AR	WA-37-1020
37	YAKIMA RIVER	Arsenic	09N	22E	18	EB21AR	WA-37-1010
37	YAKIMA RIVER	Arsenic	09N	23E	34	EB21AR	WA-37-1010
37	YAKIMA RIVER	Arsenic	09N	27E	19	EB21AR	WA-37-1010
37	YAKIMA RIVER	DDT	09N	27E	19	EB21AR	WA-37-1010
37	YAKIMA RIVER	DDT	11N	20E	20	EB21AR	WA-37-1020
37	YAKIMA RIVER	Dieldrin	09N	27E	19	EB21AR	WA-37-1010
37	YAKIMA RIVER	Dieldrin	10N	27E	03	EB21AR	WA-37-1010
37	YAKIMA RIVER	Dieldrin	11N	20E	20	EB21AR	WA-37-1020
37	YAKIMA RIVER	Endosulfan	09N	27E	19	EB21AR	WA-37-1010
39	CHERRY CREEK	4,4'-DDE	17N	19E	29	FT68CJ	WA-39-1032
39	CHERRY CREEK	DDT	17N	19E	29	FT68CJ	WA-39-1032
39	CHERRY CREEK	Dieldrin	17N	19E	29	FT68CJ	WA-39-1032
39	YAKIMA RIVER	4,4'-DDE	16N	19E	33	EB21AR	WA-39-1010
39	YAKIMA RIVER	4,4'-DDE	20N	15E	27	EB21AR	WA-39-1030
39	YAKIMA RIVER	DDT	16N	19E	33	EB21AR	WA-39-1010
39	YAKIMA RIVER	DDT	20N	15E	27	EB21AR	WA-39-1030
39	YAKIMA RIVER	Dieldrin	16N	19E	33	EB21AR	WA-39-1010

In the 1989 USGS NAWQA it was determined that bottom fish in the lower Yakima River have some of the highest tissue concentrations of DDT in the country. These findings resulted in a Washington State Department of Health advisory in 1993, recommending that people limit consumption of bottom fish from the lower basin. The findings were a strong impetus for the development of the Lower Yakima River Suspended Sediment and DDT TMDL.

USGS found that, following pesticide applications in the spring, pesticide loads in the Yakima River were the highest when the soils were being eroded and transported by irrigation return flow and storm water runoff. They found that the flushing of compounds from soil-pore water, the eroding of soil-sorbed compounds, and the dissolving of compounds from soil and sediment into surface water are major pathways for pesticides to travel from agricultural fields to streams and their aquatic biota.

USGS also found that the irrigated agricultural land east of the Yakima River and downstream from the City of Yakima was the predominant source area for suspended sediment and pesticides in the basin during the irrigation season. This area had the largest acreage of irrigated land and generally received the largest application of pesticides. They also found that concentrations of t-DDT detected in agricultural soil samples were higher than those in suspended sediment and streambed sediment samples, which suggests that eroding soils from agricultural land were a major source of t-DDT to the streams and the river.

In 1989, 54 different agricultural pesticide compounds were analyzed in the NAWQA study, and 43 of the 54 compounds analyzed (80%) were detected at trace or quantifiable concentrations in soil, bed sediment, suspended sediment, water, and (or) aquatic biota at 1 or more sampling sites (Morace et al., 1999).

In 1995, WDOE analyzed whole water samples for 46 pesticides at the Granger Drain, Spring Creek, Sulphur Creek, and the Yakima River (at Euclid Bridge) as part of the TMDL evaluation. Organochlorine, organophosphate, and nitrogen-containing pesticides were frequently detected at all sites. Azinphos methyl was detected multiple times at concentrations above criteria at all four sites. Total DDT was detected above the human health and aquatic chronic toxicity criteria at all sites on three or more sampling dates. The t-DDT samples analyzed had concentrations from 0.004 mg/L to 0.357 mg/L, and a median of 0.0083 mg/L. The median concentration, and most sample results, was similar to what has been reported in recent years for these sites (Joy and Patterson, 1997).

6.1.1.7 Nutrients

Nutrients (nitrate/nitrite nitrogen, ammonia nitrogen, and phosphorus) enter the Yakima River and its tributaries primarily via agricultural return flows, many of which originate as water from the Yakima Project. There are no State standards for phosphorus or nitrate/nitrite nitrogen in free-flowing waterbodies. There are, however, standards for these nutrients in lakes. Giffin Lake, near Sunnyside, which receives return flows from agriculture, is 303(d) listed for phosphorus. There are also 2 waterbody segments of the Yakima River and its tributaries 303(d) listed for ammonia nitrogen (WDOE, 1998), which can be a conversion product of nitrate/nitrite nitrogen at high pH levels.

USGS found that the median total nitrogen and total phosphorus concentrations were 8 and 19 times larger, respectively, at agricultural sites than at forested sites. The pattern of low concentrations from forest-dominated sites and high concentrations from agriculturally dominated sites emphasizes the significance of agricultural activities on water quality throughout the Yakima

River basin. The large downstream increase (factor of 10) in total nitrogen concentrations between Cle Elum and Kiona emphasizes the impact of agricultural practices on water quality in the lower and mid-river basin. For the most part sewage from municipal treatment plants and septic tank sources plays a less significant role. The presence of a large proportion of the total nitrogen as nitrite plus nitrate is significant because nitrite and nitrate are readily used by algae and rooted aquatic plants. Such aquatic growth was present downstream near Sunnyside (Morace et al., 1999).

Total phosphorus concentrations also increased by a factor of 10 between Cle Elum and Kiona, with concentrations ultimately ranging from 0.1 to 0.2 mg/L between Grandview and Kiona. Phosphorus associated with suspended sediment washed from agricultural fields was considered a significant source. Sulphur Creek provided a significant input of phosphorus to the main stem (Morace et al., 1999).

6.1.1.8   Fecal Coliform Bacteria

FC are used as an indicator of pathogens that cause human-borne diseases such as cholera, typhoid fever, and bacillary and amoebic dysentery. It can also be a problem in itself, with certain strains causing severe gastro-intestinal disorders. FC are generally not considered a direct by-product of irrigated agriculture. However, in the lower Yakima basin the spreading of manure from dairy operations on irrigated lands is employed as a method of waste disposal. High volumes of manure and water are often applied to lands that are directly connected to surface drains or underlain by subsurface tile drains. Irrigated pasture and rangeland that is carelessly managed can also contribute to FC contamination of surface waters. Current Yakima Project operations of the Yakima River and its irrigation delivery and return system has resulted in FC contamination of the river and its tributaries by allowing the discharge and return of contaminated waters to the river system. The WDOE's Granger Drain TMDL (publication 01-10-012) determined that increases of FC in the Granger Drain, a major irrigation return drain tributary to the lower Yakima River, were directly correlated with increases in suspended sediment concentrations.

Twelve waterbody segments in the Yakima River and in tributaries directly impacted by agricultural runoff are on the 1998 303(d) list for FC (WDOE, 1998) (see table 6-5.).

Table 6-5.–1998 303(d) listings for Fecal Coliform

WRIA	Waterbody Name	Parameter	Township	Range	Section	New ID #	Old ID #
37	Granger Drain	Fecal Coliform	10N	21E	21	EB21AR	WA-37-1024
37	Moxee Drain	Fecal Coliform	12N	13E	08	DY38VO	WA-37-1048
37	Wide Hollow Creek	Fecal Coliform	12N	19E	06	DY38VO	WA-37-1047
37	Wide Hollow Creek	Fecal Coliform	12N	19E	07	DY38VO	WA-37-1047
37	Wide Hollow Creek	Fecal Coliform	12N	19E	08	DY38VO	WA-37-1047
37	Wide Hollow Creek	Fecal Coliform	12N	19E	35	DY38VO	WA-37-1047
37	Yakima River	Fecal Coliform	09N	22E	25	EB21AR	WA-37-1010
37	Yakima River	Fecal Coliform	12N	19E	17	EB21AR	WA-37-1040
39	Cooke Creek	Fecal Coliform	17N	19E	10	SZ58XV	WA-39-1034
39	Cooke Creek	Fecal Coliform	17N	19E	11	SZ58XV	WA-39-1034
39	Wilson Creek	Fecal Coliform	17N	18E	25	EB21AR	WA-39-1020
39	Wilson Creek	Fecal Coliform	18N	19E	30	PY59BF	WA-39-1020

During a 1988 synoptic study, the USGS focused on *E. coli* contamination. They found that land use was an important correlative factor in the distribution of *E. coli* concentrations in the Yakima River basin. Median *E. coli* concentrations increased among land use categories in the following order: forest, range land, agriculture, and agricultural drains. Statistically significant differences existed among these categories (Morace et al., 1999).

The 1999 USGS Bacterial Synoptic Survey showed a significant increasing trend in bacterial densities when moving downstream in the main stem Yakima River from Cle Elum (3 cfu/100 ml) to Kiona (131 cfu/100 ml). The trend was associated to a respective land use change from forests to a highly agricultural area. The highest FC densities in all of the basin's tributaries were found within three agricultural drains in the lower basin. The Moxee Drain had 1,760 cfu/100 ml, the Granger Drain had 1,950 cfu/100 ml, and Sulphur Creek had 1,400 cfu/100 ml.

The 2000 USGS Bacterial Synoptic Survey, which occurred during both the irrigation and non-irrigation seasons, determined bacterial densities increased proportionately to the amount of agricultural activity throughout the basin.

6.1.1.9 pH

Stream pH may change with the addition of either acidic or alkaline wastes and (or) fluctuations in photosynthesis and respiration (due to the uptake and release of carbon dioxide by aquatic plants). Toxicity to freshwater aquatic life can occur whenever pH values fall outside the range of 6.5 to 8.5, which corresponds to the water quality standards set by WAC 173-201A-030 for Class AA, A, and B waterbodies. As pH increases (becomes more alkaline), the ammonium ion is dissociated to the toxic unionized ammonia form, potentially causing greater harm to aquatic life.

Normal operations of the Yakima Project may indirectly result in pH violations of State criteria. Low water volume in the Yakima River from project operations and high nutrient loading from agricultural return drains can promote plant growth in the river. As the plants grow and respire they may cause pH values to fall outside of the range normally experienced by the aquatic community. This may lead to changes in the aquatic community or avoidance areas for certain species.

There are 3 agriculturally influenced waterbodies in the lower Yakima Valley that are listed for pH on Washington State's 303(d) list; these are the Moxee Drain, the Granger Drain, and the main stem of the Yakima River (WDOE, 1998). Additionally, the USGS found that 11 percent of the 856 pH measurements from 143 sites sampled by the USGS in the Yakima basin during the 1986-91 water years did not meet State water quality criteria. Ninety-seven percent of these exceedances had pH values greater than 8.5 (those below 6.5 came from forested streams in the upper basin). Most exceedances were probably the result of increased photosynthetic activity from aquatic plants. Downstream from Satus Creek, all median pH values were greater than 8, probably due to the influence of agricultural inputs, irrigation diversions, and aquatic vegetation in this reach (Morace et al., 1999).

6.1.2 Quantity (As a relationship between regulated and natural hydrologic conditions)

All river flow derives from precipitation, either rain or snow. At any given time river flow is some combination of surface water, shallow subsurface flow (hyporheic), and groundwater. Overland and shallow subsurface flow creates hydrograph peaks, a river's normal response to storm events or snowmelt. Groundwater pathways are responsible for baseflow, the form of water delivery to river systems during periods of little rainfall and after snowmelt has dissipated.

Variability in intensity, timing and duration of precipitation, and variability in the effects of terrain, soil texture, and plant evapotranspiration on the hydrologic cycle combine to create local and regional flow patterns in river basins. High flows from rain may occur over hours or even minutes, whereas snow will melt over a period of days or weeks, more slowly building the peak snowmelt flood. Both of these processes occur in the Yakima River basin.

As one proceeds downstream within a watershed, river flow reflects the sum of flow generation and routing processes operating in multiple small tributary watersheds. The travel time of flow down the river system, combined with unsynchronized tributary inputs and larger downstream channel and floodplain storage capacities, act to attenuate and to dampen flow peaks. Consequently, annual hydrographs in large streams typically show peaks created by widespread storms or snowmelt events and broad seasonal influences that effect many tributaries together.

The natural flow regime organizes and defines river ecosystems. The availability and diversity of habitats is determined by physical processes, especially the movement of water and sediment within the channel, and between the channel and floodplain. To understand the biodiversity, production, and sustainability of river ecosystems, it is necessary to appreciate the central organizing role played by a dynamically varying physical environment. Different habitat features are created and maintained by a wide range of flows. For example, many channel and floodplain features, such as river bars and riffle-pool sequences, are formed and maintained by dominant, or bankfull discharges. These discharges are flows that can move significant quantities of bed or bank sediment and that occur frequently enough (e.g., every several years) to modify the channel continually. Over periods of years to decades, a single river can consistently provide ephemeral, seasonal, and persistent types of habitat that range from free-flowing, to standing, to no water. This predictable diversity of in-channel and floodplain habitat types promotes evolution of species that exploit the habitat mosaic created and maintained by hydrologic variability. For many riverine species, including anadromous and resident salmonids, completion of the life cycle requires an array of different habitat types, the availability of which is regulated by the flow regime.

The pattern of spatial and temporal habitat dynamics influences the relative success of a species. This habitat template, which is dictated largely by flow regime, creates both subtle and profound differences in the natural histories of species in different segments of their ranges and it also influences their distribution and abundance. Human alteration of flow regime changes the established pattern of natural hydrologic variation and disturbance, thereby altering habitat dynamics and creating new conditions to which the native species may or may not be able to adapt or to which they may poorly adapt. We will refer to these processes generally in the sections that follow as “natural flow variability.”

River basins, such as the Yakima basin, that are regulated for irrigation and flood control purposes exhibit a common set of hydrologic patterns. Natural flows, usually produced from precipitation during the early winter and snowmelt during the late winter and spring/summer operation periods, are captured for storage. Downstream of major storage facilities, winter outflows can be greatly reduced, with major variations to natural hydrologic conditions. Peaking natural flows from rain, or rain-on-snow events, causing “flood events,” are captured in available storage and bypassed later during a lower flow period in the downstream basin. Therefore, magnitude and frequency of ecologically significant discharges (overbank and channel-forming flows) are reduced.

Patterns of summer and fall flows are largely influenced by downstream irrigation demands with flows typically reaching peaks during July and August above the major diversions. Below these major diversions, streamflow can be low even to the point of being below natural flows. Unnatural fluctuations in flow and temperature may result from adjustments in reservoir releases intended to meet fluctuating irrigation demands downstream, and also, may result from the discharge of irrigation return flows to the river alone or in combination with other return flow discharges or reservoir releases (Poff et al., 1997).

Changes in the rate and magnitude of discharge that are caused by project operations will be referred to in this document as “operational fluctuations” or “ramping,” as opposed to those that occur under natural hydrologic conditions, which will be referred to as “natural flow variability.”

The effects of project operations on water quantity vary by reach locations and timing throughout the Yakima River basin (see table 6-6.). In order to describe and understand these effects, it is necessary to examine the differences between regulated and estimated unregulated (natural) flows at a number of key locations. These key locations data are represented by summary hydrographs, which break the data into two time periods. The first time period, water years 1981 to 1999, represents the data from project operations that developed out of the 1980 Quackenbush decision concerning the protection of anadromous fish in the Yakima River (the start of the flip-flop operation). The second time period, water years 1995 to 1999, represents current project operations, including meeting Title XII target flows, that have evolved during the past 5 years of operations.

It is noteworthy that for the Yakima River near Parker (PARW), period of record 1981 to 1999, water year (WY) 1996 (5,586,144 acre-feet) and WY 1997 (5,316,350 acre-feet) had the highest and second highest yearly natural unregulated streamflow (runoff) totals for the 19 year period. WY 1999 (4,382,610 acre-feet) was 1 million acre-feet above average (3,390,550 acre-feet), with WY 1995 (3,765,652 acre-feet) above average, and WY 1998 (3,373,299 acre-feet) slightly below average. Even though the majority (4 years out of 5) of the 1995-1999 period of record water years had above average runoff, 3 of the 5 water years (1995, 1996, and 1998) had below average total storage (average is 301,246 acre-feet) on September 30th. This is an indicator that other parameters or factors, such as amount of carryover storage; flood runoff timing; snowpack and melt pattern; rain fall timing; and local basin weather conditions must be reviewed in order to fully characterize a water year.

These summary hydrographs are developed using mean or average data, which tends to minimize the hydrologic flow fluctuations that occur in any given year. Therefore, some sites are provided with hydrographs plotting individual water year data that are representative of a typical (but not necessarily average) year, WY 1990; a dry year, WY 1994; and a wet year, WY 1997. These water years do not represent extreme or unusual runoff conditions, but years of typical/normal runoff patterns with only the volume of runoff being consistently uniformly greater or less than a typical/average year. We chose the most recent years that provided uniform dispersal of precipitation, snowpack, and timing of melt/runoff as representative water years. With relatively uniform wet runoff conditions, WY 1997 had the 4th highest annual runoff volume of the period of record. A typical year is represented by 1990, which had average or mean runoff conditions throughout the year, providing close to average annual runoff volume for the year. The dry year, WY 1994, had uniformly low precipitation, snowpack, and consistent low runoff, placing it 4th lowest in annual total volume for the period of record.

Table 6-6.–Examined reach locations

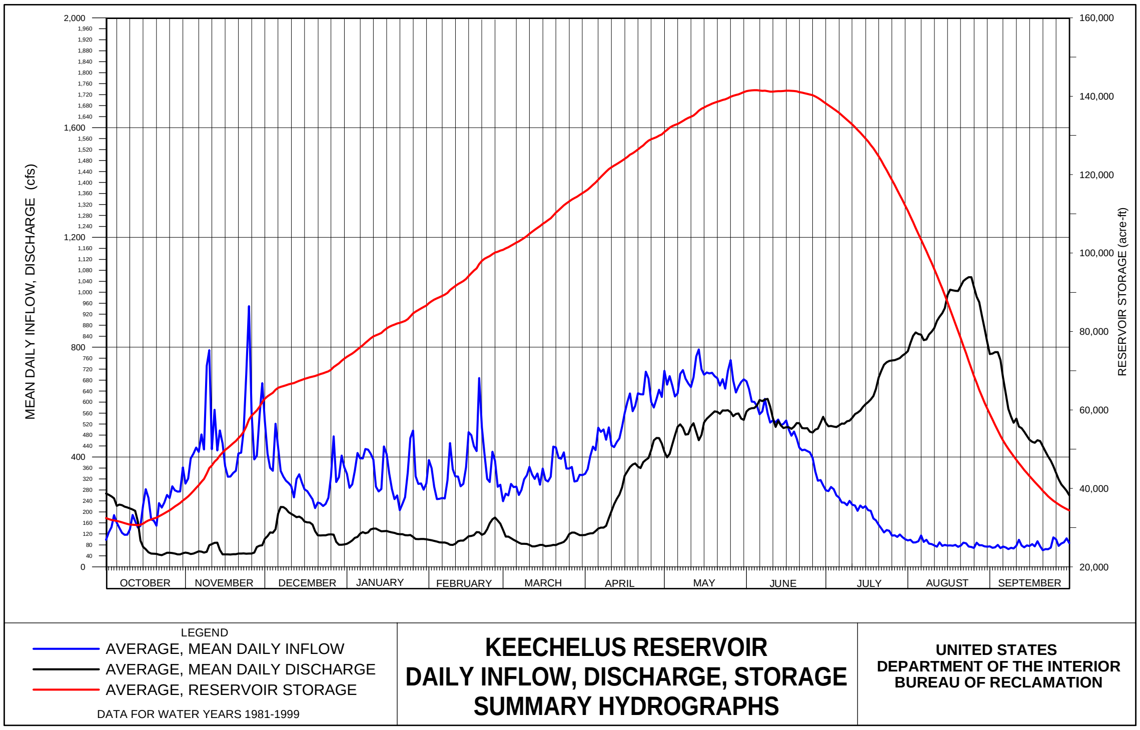
Reach Location	River Mile	Drainage Area (mi.^{2})	Drainage Area as % of Yak @ PARW	Average Annual Unregulated Flow (AF)	Ave. Annual Unreg. Flow as % of Yak @ PARW	Ave. Annual actual flow (AF)
Keechelus	214.5	54.7	1.5	247,302.	7.3	245,705.
Kachess	0.9	63.6	1.7	218,394.	6.4	215,885.
Yak. R. @ Easton	202.0	188.0	5.1	651,710.	19.2	325,499.
Cle Elum	8.2	203.0	5.5	675,373.	19.9	661,600.
Yak. R. @ Cle Elum	183.1	495.0	13.5	1,495,088.	44.1	1,164,965.
Teanaway River	9.6	172.0	4.7	245,968.	7.3	245,968.
Yak. R. nr. Umtanum	140.4	1,594.0	43.5	1,976,094.	58.3	1,731,876.
Yak. R. below Roza Dam	127.7	1,802.0	49.2	NA	NA	Incomplete
Bumping	17.0	69.3	1.9	205,461.	6.1	205,159.
Little Naches River	0.1	125.4	3.4	181,895.	5.4	181,895.
Naches R. nr. Cliffdell	36.3	394.0	10.8	NA	NA	657,167.
Rimrock	21.3	187.0	5.1	369,323.	10.9	366,647.
Tieton R. below Canal Hdwks.	14.1	239.0	6.5	NA	NA	309,915.
Naches R. nr. Naches	16.8	941.0	25.7	1,199,029.	35.4	870,067.
Yakima R. @ Terrace Heights	113.2	NA	NA	NA	NA	Incomplete
Yakima R. nr. Parker - TWSA	103.7	3660.0	100.0	3,390,551.	100.0	1,654,918.
Yakima R. nr. Grandview	55.0	5410.0	-	NA	-	1,975,288.
Yakima R. nr. Prosser	46.3	5453.0	-	NA	-	1,594,751.
Yakima R. nr. Kiona	29.9	5615.0	-	*3,970,000.	-	2,351,186.
Yakima R. @ Mouth @ Col. R.	0.0	6155.0	-	NA	-	NA
System – Total 5 Reservoirs	NA	579.0	15.8	1,713,282.	50.5	1,694,349.

(Provisional Data for Water Year -- Period of Record = 1981-1999, if available) 11/7/2000 SKF

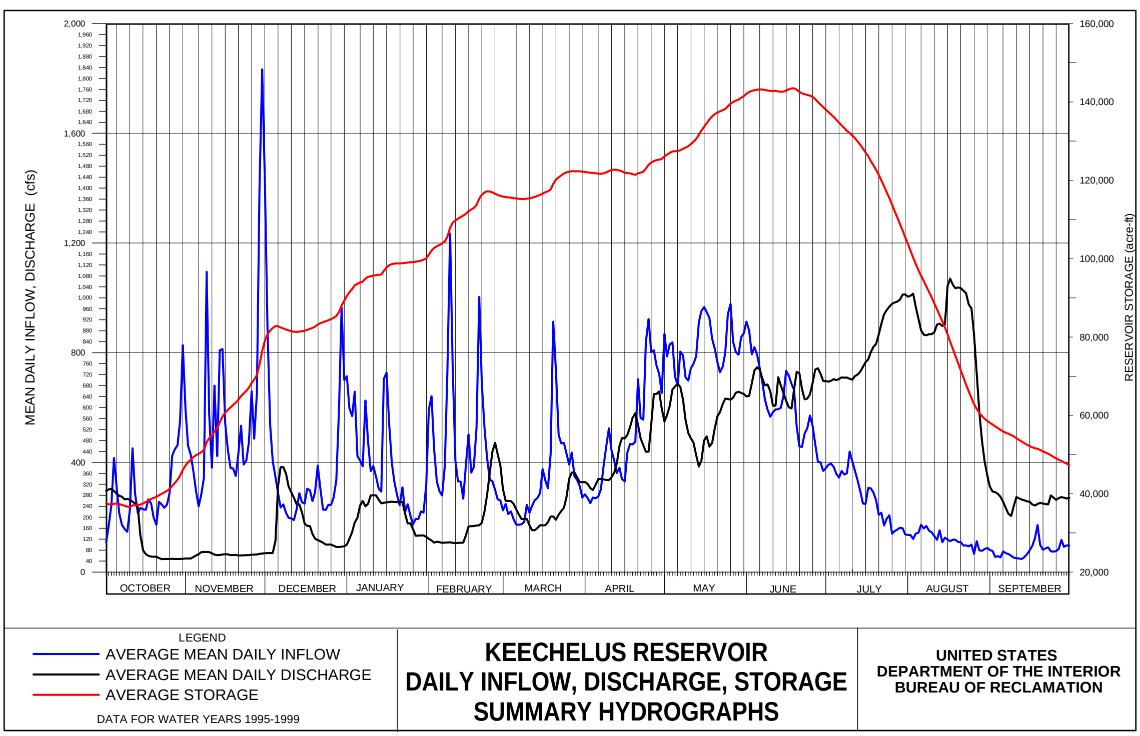
NA = Data currently Not Available. * = Period of Record = 1961-1990

Normally, Keechelus natural inflows start increasing mid-October, continuing to increase until late November. Cold weather will then lock up the rain and snowfall causing a decline and stabilizing effect on the inflow to the reservoir. In March, inflows will once again start increasing and will continue to increase until late May or June. Late June, early July, inflow will start declining to the low period of August and September. Natural flows are captured during the winter and spring/summer periods for storage, targeting June 1st for maximizing storage content of the reservoir. (Note: Keechelus is currently operating under safety of dams restriction on maximum elevation.) Discharges (reservoir outflow) are made during the winter for protection of the downstream fishery resources and to provide flood control storage space during the November to early May period. Irrigation demands on the storage/inflow will normally begin in April and continue through August when storage releases are reduced ("mini flip-flop") to provide spawning flows that are maintainable during the winter incubation period. The comparison of natural inflow and reservoir discharge reflect a lower than natural flow, but stable outflow during October and November; with December through March still reflecting a lower outflow than natural, but with more variability due to flood control operations. April through June outflows tend to mirror inflow patterns, but at a reduced quantity (due to flood control operations), with the inflow/outflow relationship coming closest to matching during June as storage is maximized and the natural runoff is peaking. Currently, the maximum discharge releases are made during July and August (95,646 acre-feet) for irrigation demands. Of the 247,302 acre-feet average annual natural (unregulated) flow generated in the Keechelus basin, 131,421 acre-feet (53%) is delivered/released during July 1st through October 20th, to meet system demands during the normal period of low natural flows. Note that 103,867 acre-feet of this delivery is from the storage component of the water supply.

Keechelus



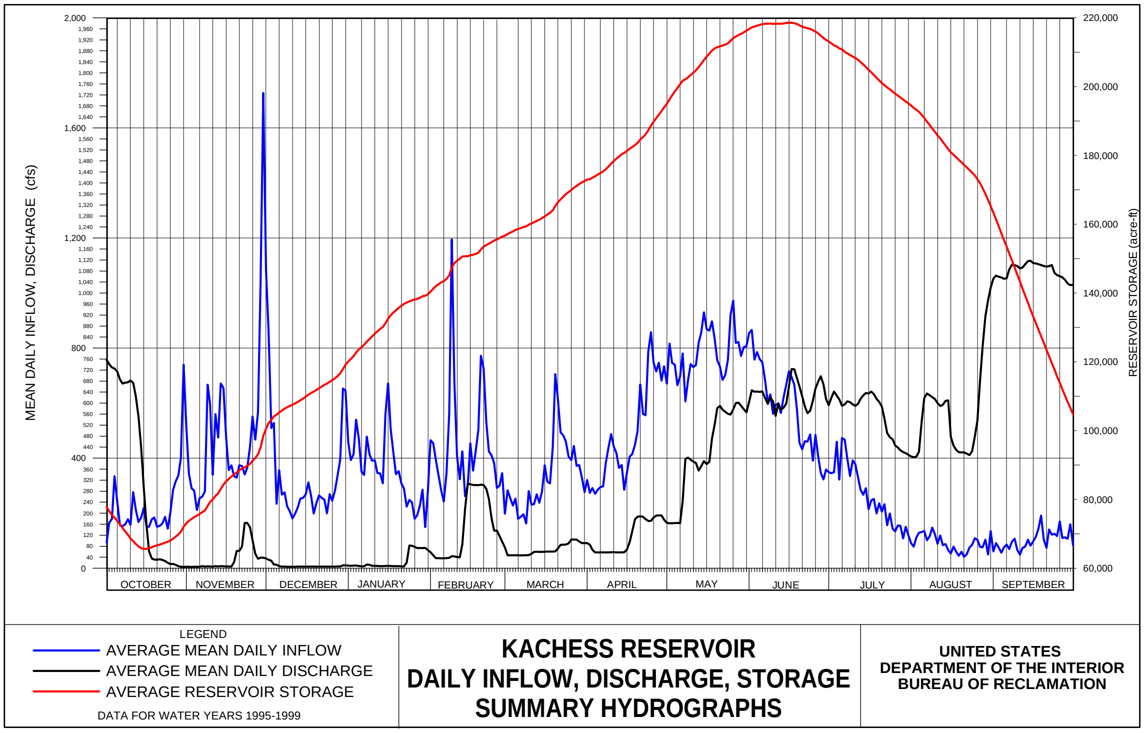
MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE, RESERVOIR STORAGE
DATA FOR WATER YEARS 1981-1999
KEECHELUS RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION



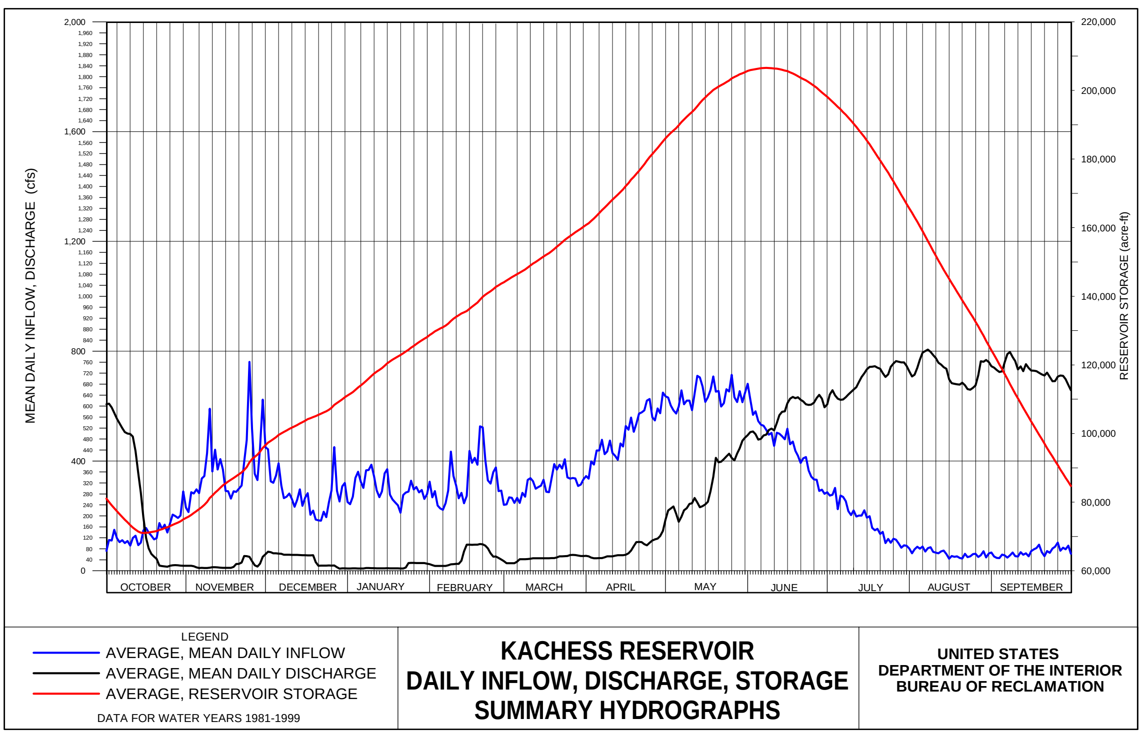
MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE MEAN DAILY INFLOW
AVERAGE MEAN DAILY DISCHARGE
AVERAGE STORAGE
DATA FOR WATER YEARS 1995-1999
KEECHELUS RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Normally, Kachess natural inflows start increasing mid-October, continuing to increase until late November. Cold weather will then lock up the rain and snowfall causing a decline and stabilizing effect on the inflow to the reservoir. In March, inflows will once again start increasing and will continue to increase until late May or June. Mid-June inflow will start declining to the low period of August and September. Natural flows are captured during the winter and spring/summer periods for storage, targeting June 1st for maximizing storage content of the reservoir. Due to the poor runoff to storage capacity (.9 to 1) discharges (reservoir outflow) are made (but minimized) during the winter for protection of the downstream fishery resources and also to provide flood control operations storage space during the November to early May period if the runoff forecast shows justification. Moderate irrigation demands on the storage/inflow will normally begin in mid-April and continue through August when storage releases are increased for irrigation demands above Easton Dam, during the mini flip-flop operation to replace cutbacks of Keechelus outflows. The comparison of natural inflow and reservoir discharge reflects a lower than natural flow, but stable outflow from mid-October through March with only minimal variability due to flood control operations. April through June outflows tend to reflect inflow patterns, but at a much reduced quantity (due to flood control operations), with the inflow/outflow relationship coming closest to matching early June as storage is maximized and the natural runoff is peaking. Currently, the maximum discharge releases are made during late August and September for irrigation demands. Of the 218,394 acre-feet average annual natural (unregulated) flow generated in the Kachess basin, over 146,477 acre-feet (67%) is delivered/released during July 1st through October 20th to meet system demands on storage during the normal period of lowest natural flows. During the July 1st through October 20th period, 124,055 acre-feet of this delivery is from the storage component of water supply.

Kachess



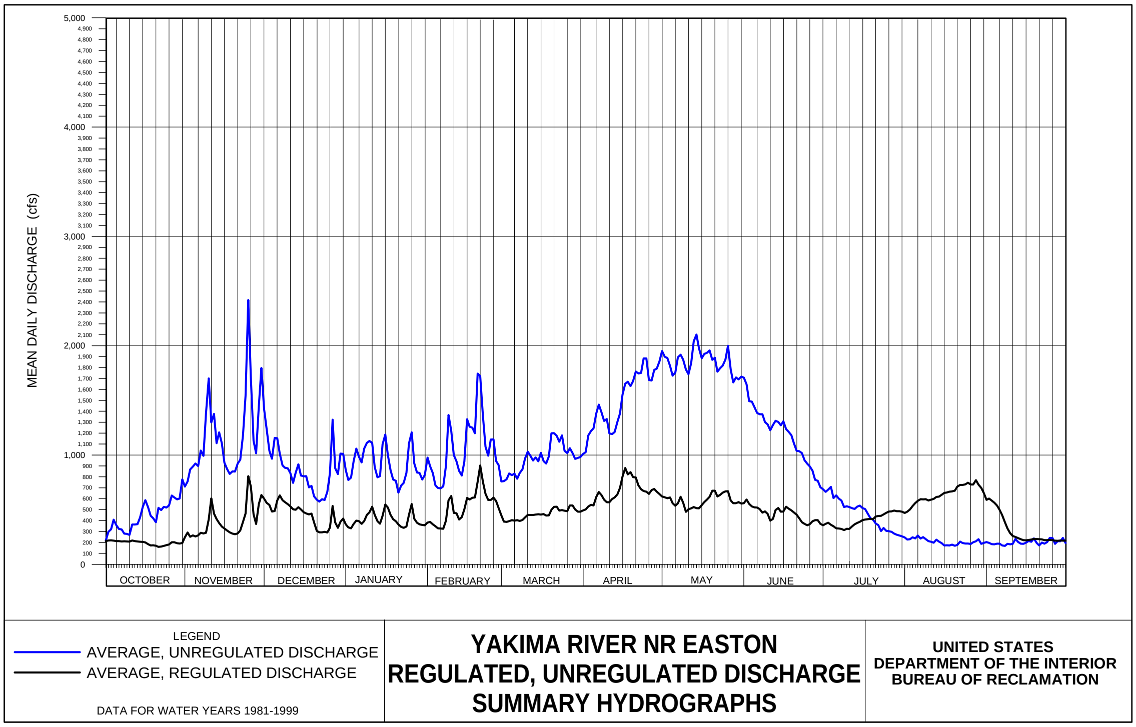
MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE MEAN DAILY INFLOW
AVERAGE MEAN DAILY DISCHARGE
AVERAGE RESERVOIR STORAGE
DATA FOR WATER YEARS 1995-1999
KACHESS RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

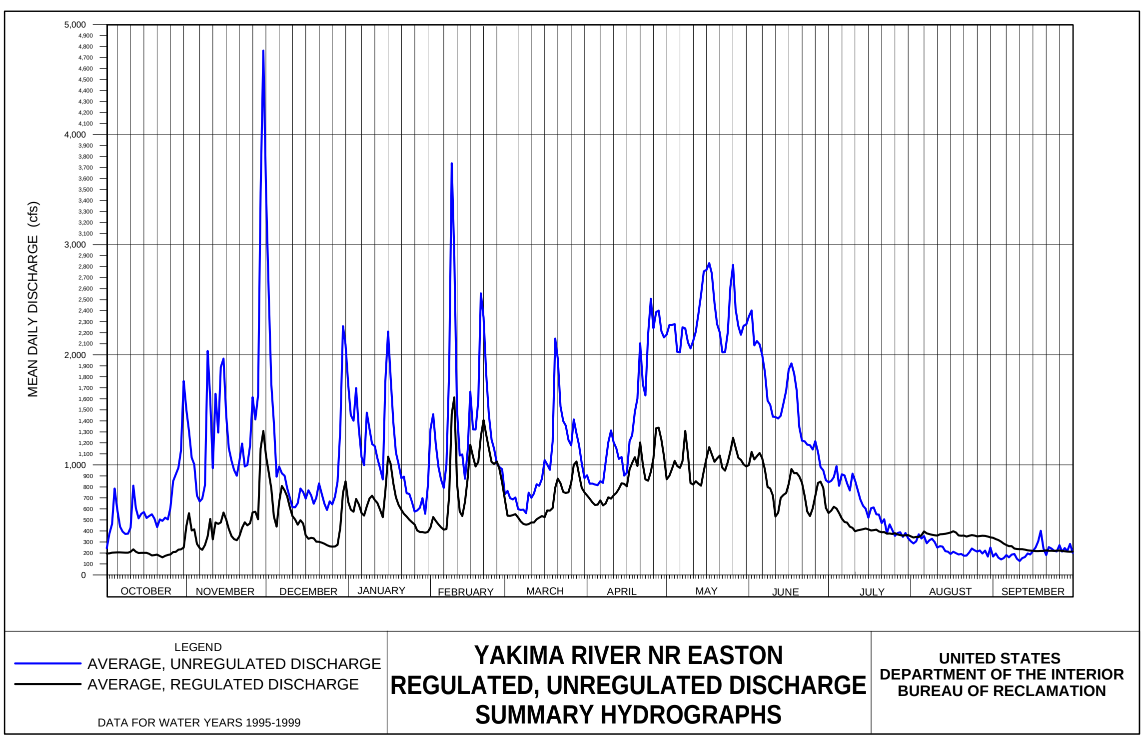


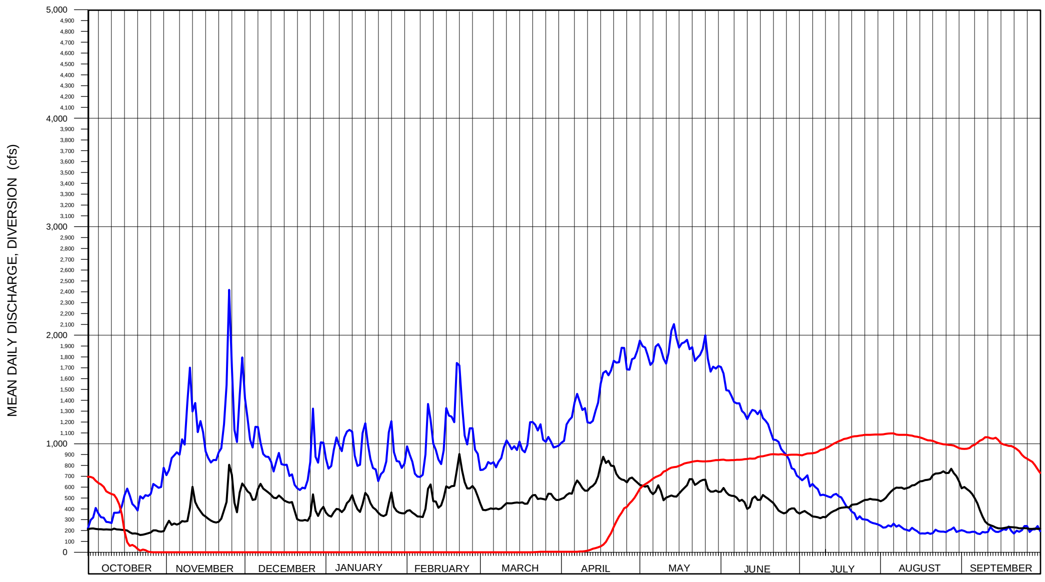
MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE, RESERVOIR STORAGE
DATA FOR WATER YEARS 1981-1999
KACHESS RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Yakima River near Easton natural unregulated streamflow starts increasing mid-October through November as fall precipitation increases. Natural flows recede to winter conditions as freezing conditions in upper watersheds reduce runoff. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. Regulated streamflow is below unregulated conditions and does not show the peaks due to reservoir inflows captured in storage. During the December through February period, the discharge is stable except for rain-on-snow events that formed the short duration, high discharges on a relatively infrequent basis. Regulated winter streamflow is lower than natural conditions and the frequency and magnitude of peak flows is reduced due to reservoir operations for flood control and storage. March natural flows begin to increase and continues through mid-May. Unregulated streamflow forms the average annual peak discharge from early April through early June. From mid-April through June, regulated streamflow shows a greatly reduced peak as Kittitas Reclamation Canal irrigation deliveries begin to increase. Current project practice for flood control operations allows for maximizing storage in late May, early June, and after this time the bypassing of reservoir natural inflows to the river system, returning some of the natural variability to the river system. Beginning early June through late July, unregulated streamflow will decline from spring freshet to baseflow conditions. Currently, regulated flow only exceeds unregulated starting in mid-July through August (or until start of flip-flop) as some storage flows are wheeled to meet downstream irrigation demands and may only be 100 to 200 cfs greater than unregulated. The estimated average natural unregulated flow from late July through early October is 200 cfs per day. From September 1st through October 20th, streamflows are held to spawning level and fluctuate very little under natural conditions, but currently regulated flows drop from highs in late August (400 cfs) to early September (200 cfs) after flip-flop. The Yakima River near Easton (EASW) basin average annual natural flow is 651,710 acre-feet, of which 465,696 acre-feet (71%) is regulated by storage reservoirs capable of modifying the timing and volume of flows at the EASW site. The Kittitas Canal Diversion (located above EASW site), diverts on the average 310,670 acre-feet of flow with the peak diversion, including water bypassed for flip-flop in September and October, of 361,450 acre-feet for the past 19 years. EASW unregulated hydrograph is compared with a typical year, WY 1990; a dry year, 1994; and a wet year, 1997, as an indicator of the effect of climatological conditions on natural unregulated flow/discharge. EASW unregulated and regulated hydrograph is compared with the diversion discharge hydrograph of the Kittitas Reclamation Canal to show the diversion demands on natural flow and storage affecting EASW discharges. Also included is a hydrograph comparing the unregulated natural flows of the two reservoir sites, Keechelus and Kachess, with the local natural inflow above EASW excluding the reservoirs outflow, and the total unregulated discharge of the EASW site.

Yakima River near Easton



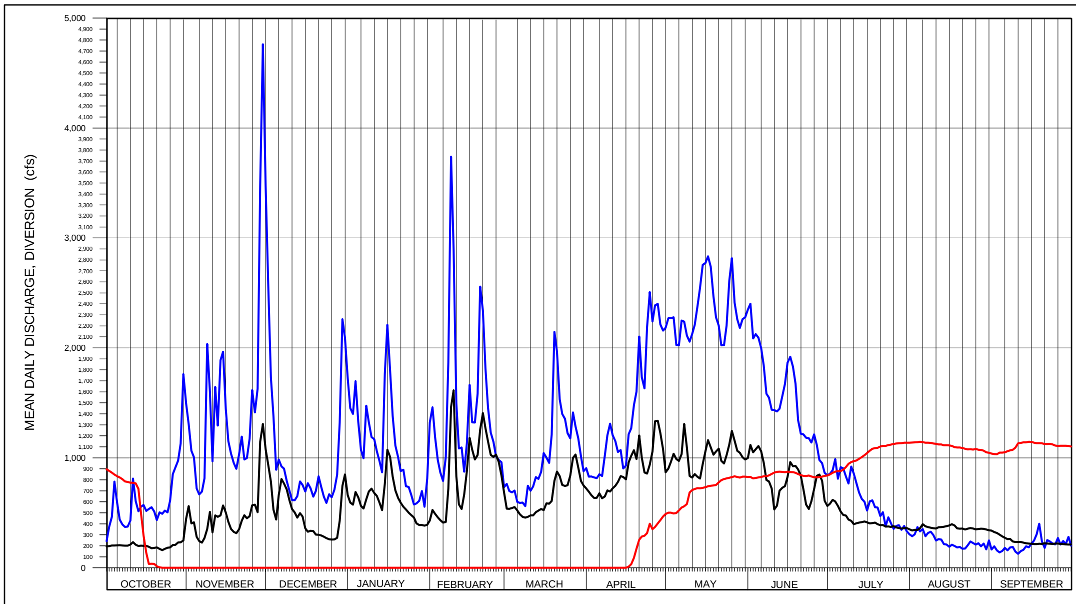




LEGEND
AVERAGE, UNREGULATED DISCHARGE
AVERAGE, REGULATED DISCHARGE
AVERAGE, KRD DIVERSION
DATA FOR WATER YEARS 1981-1999

YAKIMA RIVER NR EASTON, KRD DISCHARGES AND DIVERSON SUMMARY HYDROGRAPHS

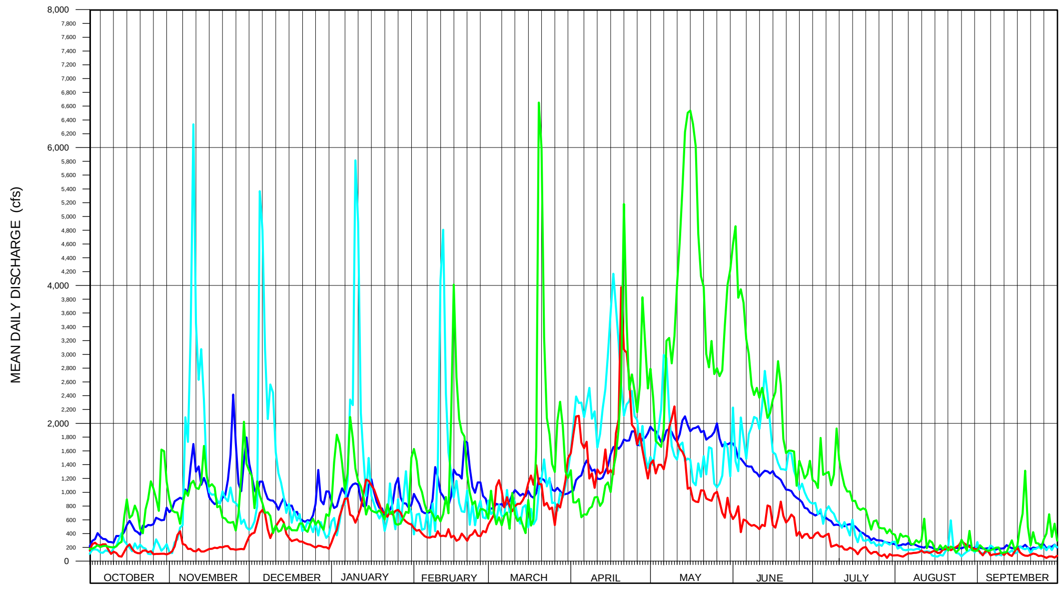
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION



LEGEND
AVERAGE, UNREGULATED DISCHARGE
AVERAGE, REGULATED DISCHARGE
AVERAGE, KRD DIVERSION
DATA FOR WATER YEARS 1995-1999

YAKIMA RIVER NR EASTON, KRD DISCHARGES, DIVERSION SUMMARY HYDROGRAPHS

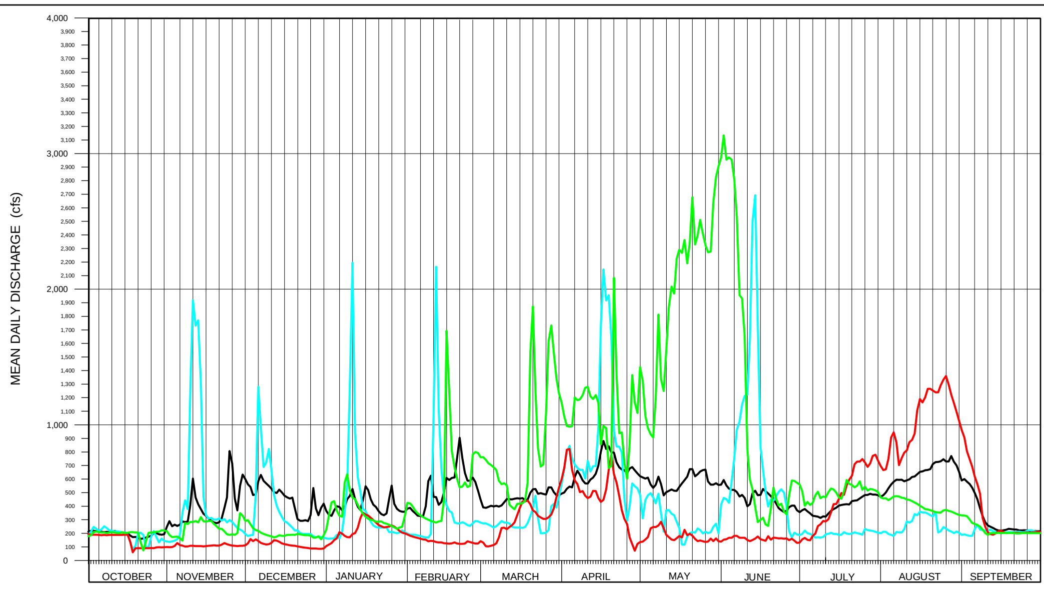
UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION



LEGEND
AVERAGE, UNREGULATED DISCHARGE, WY 1981-1999
TYPICAL YEAR, 1990
DRY YEAR, 1994
WET YEAR, 1997

YAKIMA RIVER NR EASTON
UNREGULATED DISCHARGE
SUMMARY HYDROGRAPHS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION



LEGEND
AVERAGE, REGULATED DISCHARGE, WY 1981-1999
TYPICAL YEAR, WY 1990
DRY YEAR, WY 1994
WET YEAR, 1997

YAKIMA RIVER NR EASTON
REGULATED DISCHARGE
SUMMARY HYDROGRAPHS

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DEPARTMENT OF THE INTERIOR
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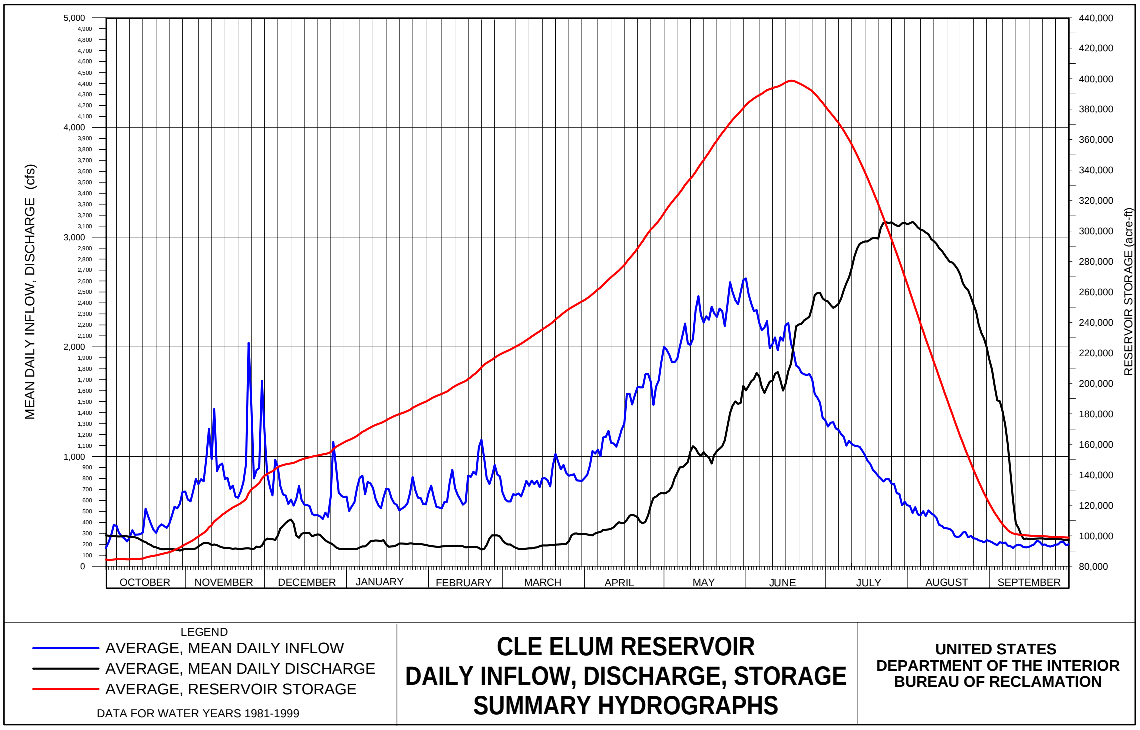
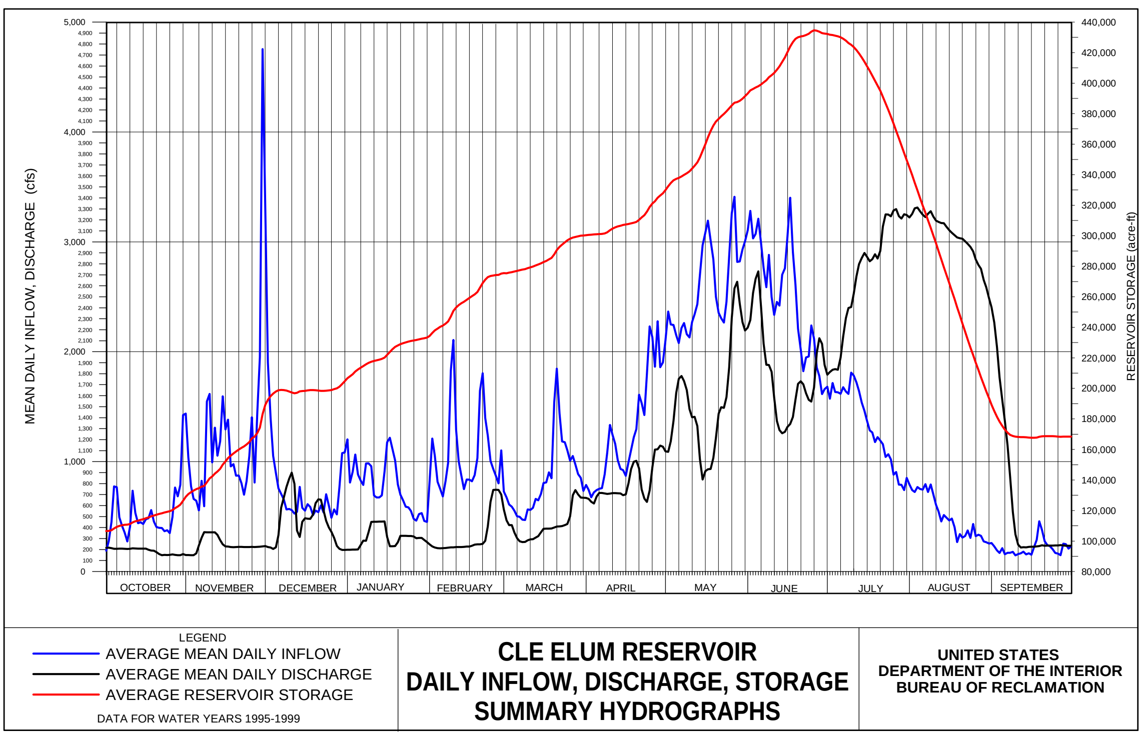
As in the other reservoir basins, Cle Elum natural inflows start increasing mid-October, continuing to increase until late November. It is common to have a rain induced flood event at the end of November or early December. Cold weather will then lock up the rain and snowfall causing a slight decline and stabilizing effect on the inflow to the reservoir. In March, inflows will once again start increasing and will continue to increase until late May or June. Late June, early July, inflow will start declining to the low period of late August and September. Natural flows are captured during the winter and spring/summer periods for storage, targeting June 1st for maximizing storage content of the reservoir. Discharges (reservoir outflow) are made during the winter for protection of the downstream fishery resources and to provide flood control operations storage space during the November to early May period. Irrigation demands on the storage/inflow will normally begin in April and continue through September 10th when storage releases are reduced (flip-flop) to provide downstream spawning flows that are maintainable during the winter incubation period. The comparison of natural inflow and reservoir discharge reflect a lower than natural flow, but stable outflow during October and November; with December through March still reflecting a much lower outflow than natural, but with more variability due to flood control operations. April through June outflows tend to mirror inflow patterns, but at a reduced quantity (due to storage and flood control operations), with the inflow/outflow relationship coming closest to matching during June as storage is maximized and the natural runoff is peaking. Currently, the maximum discharge releases are made during July through September 10th (375,872 acre-feet) for irrigation demands. Of the 675,373 acre-feet average annual natural (unregulated) flow generated in the Cle Elum basin, 385,721 acre-feet (57%) is delivered/released during July 1st through October 20th to meet system demands during the normal period of low natural flows. During the July 1st through October 20th period, 281,057 acre-feet of this delivery is from the storage component of the water supply.

Cle Elum


MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE, RESERVOIR STORAGE
DATA FOR WATER YEARS 1981-1999
CLE ELUM RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION


MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE MEAN DAILY INFLOW
AVERAGE MEAN DAILY DISCHARGE
AVERAGE RESERVOIR STORAGE
DATA FOR WATER YEARS 1995-1999
CLE ELUM RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
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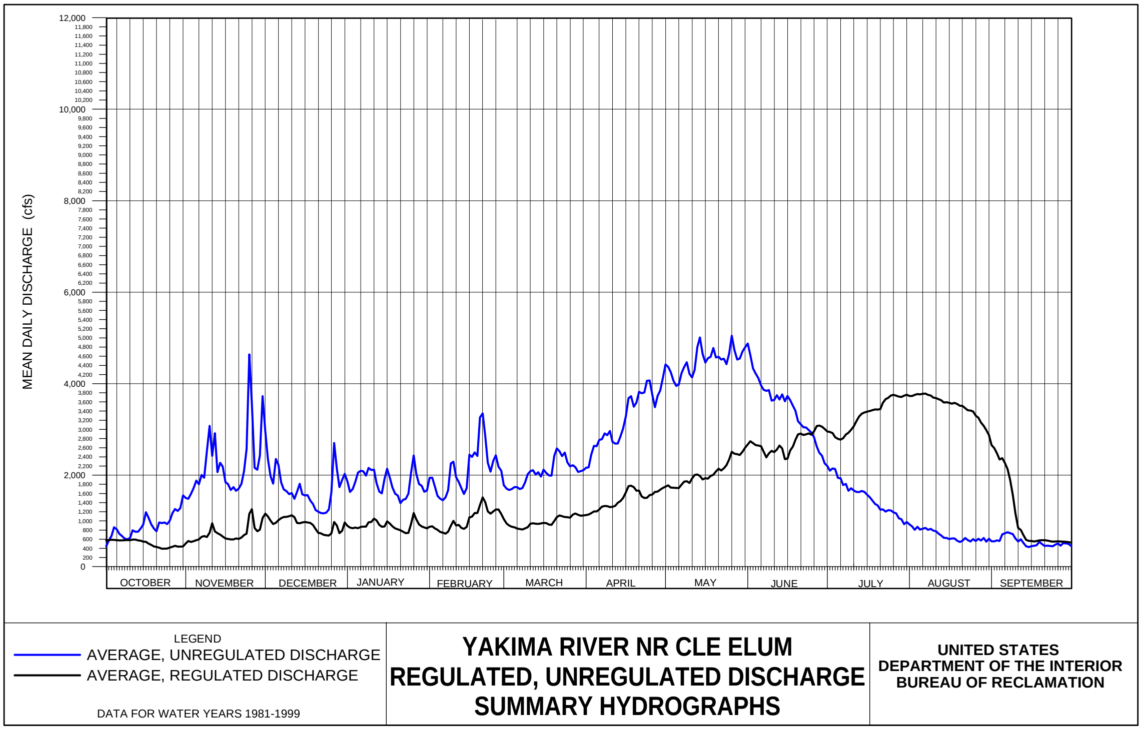
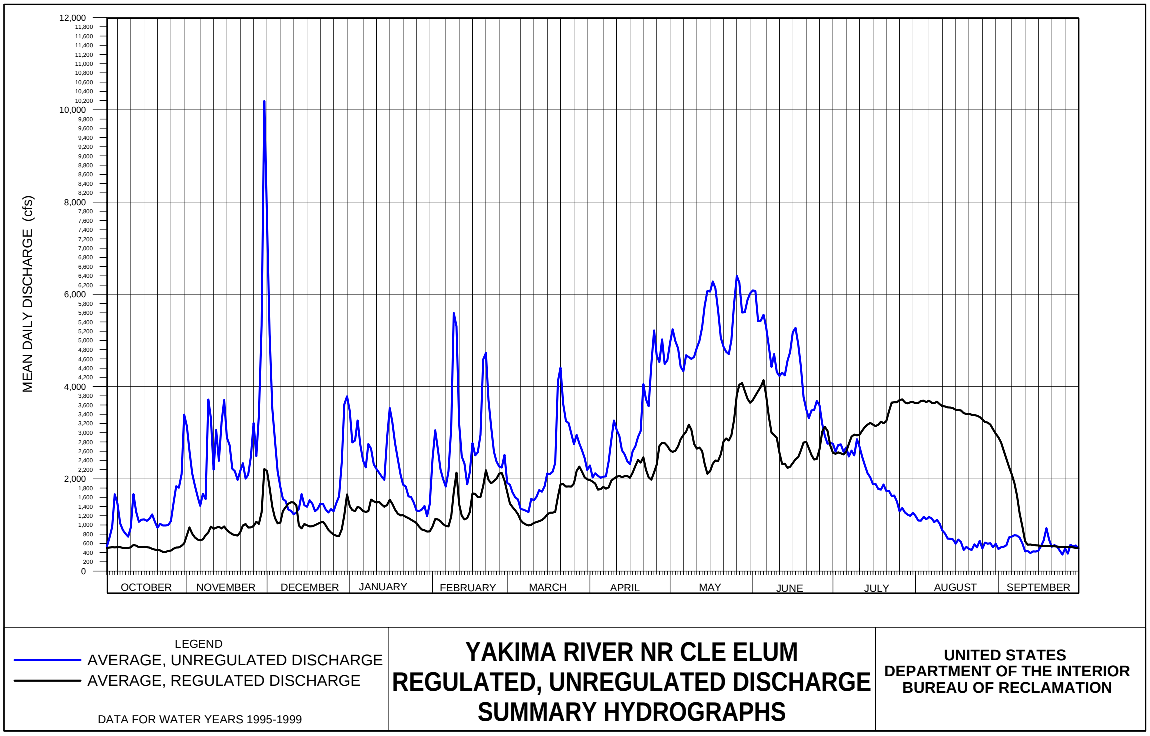
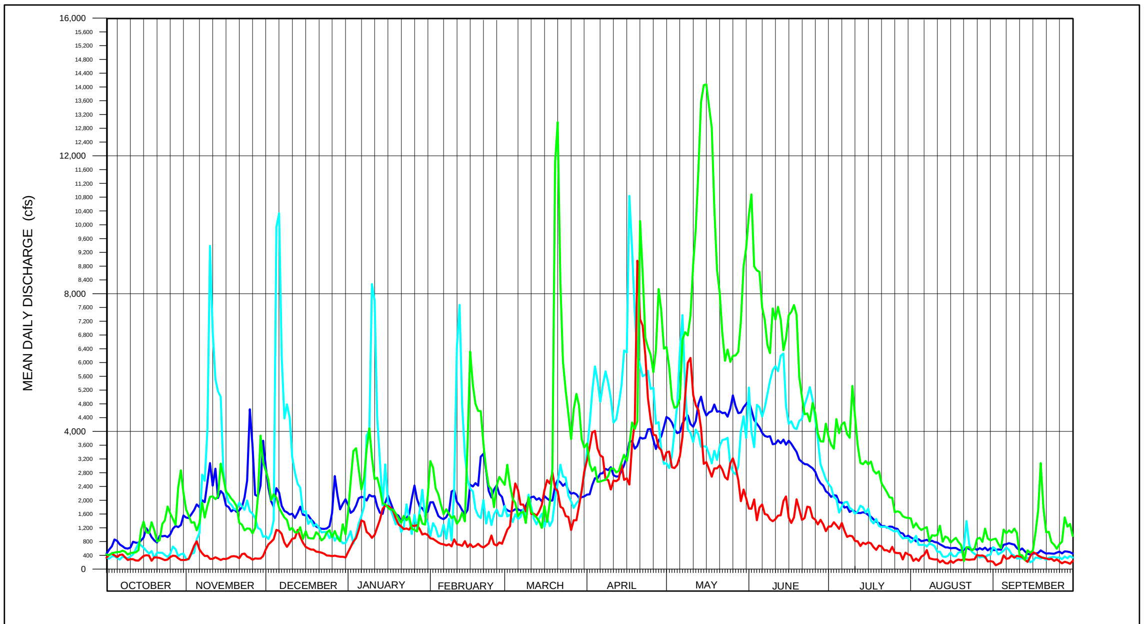
Yakima River near Cle Elum natural unregulated streamflow starts increasing mid-October through November as fall precipitation increases and evapotranspiration decreases. Natural flows will recede to winter conditions as freezing conditions in upper watersheds reduce runoff. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. Regulated streamflow is much lower than unregulated conditions and does not show the peaks due to reservoir inflows captured in storage. During the December through February period, the discharge is stable except for rain-on-snow events that formed the short duration, high discharges on a relatively infrequent basis. Regulated winter streamflow is roughly 50 percent lower than natural conditions and the frequency and magnitude of peak flows is greatly reduced due to reservoir operations for flood control and storage. In March, natural flows will increase and continue through mid-May. Unregulated streamflow forms the average annual peak discharge from April through early June. Starting in mid-April regulated streamflow shows a reduced peak as Kittitas Reclamation District (KRD) irrigation deliveries begin to increase. Current project practice for flood control operations allows for maximizing storage in late May, early June, and after this time the bypassing of reservoir natural inflows to the river system, returning some of the natural variability to the river system. Beginning early June, unregulated streamflow will decline from spring freshet to baseflow conditions by early August. Regulated flow exceeds unregulated on the average starting in late June as storage flows are wheeled to meet downstream irrigation demands. Increasing downstream demands causes the river's hydrograph to continue increasing until mid-August, then a slight decline until the start of flip-flop on September 1st. From early July until flip-flop, regulated flows are much higher (2,000 to 3,000 cfs per day) than the estimated natural unregulated flows. The estimated average natural unregulated flow from mid-August to late October is less than 600 cfs per day. From September 10th through October 20th, streamflow fluctuates very little under natural conditions, but regulated flows drop precipitously from highs in late August (3,600 cfs) to September 10th (600 cfs) after flip-flop is in place. The Yakima River near Cle Elum (YUMW) basin average annual natural flow is 1,495,088 acre-feet, of which 1,141,069 acre-feet (76%) is regulated by storage reservoirs capable of modifying the arrival time and volume of flows at the YUMW site. Yakima River near Cle Elum unregulated hydrograph is compared with a typical year, WY 1990; a dry year, 1994; and a wet year, 1997, as an indicator of the effect of climatological conditions on natural unregulated flow/discharge.

Yakima River near Cle Elum



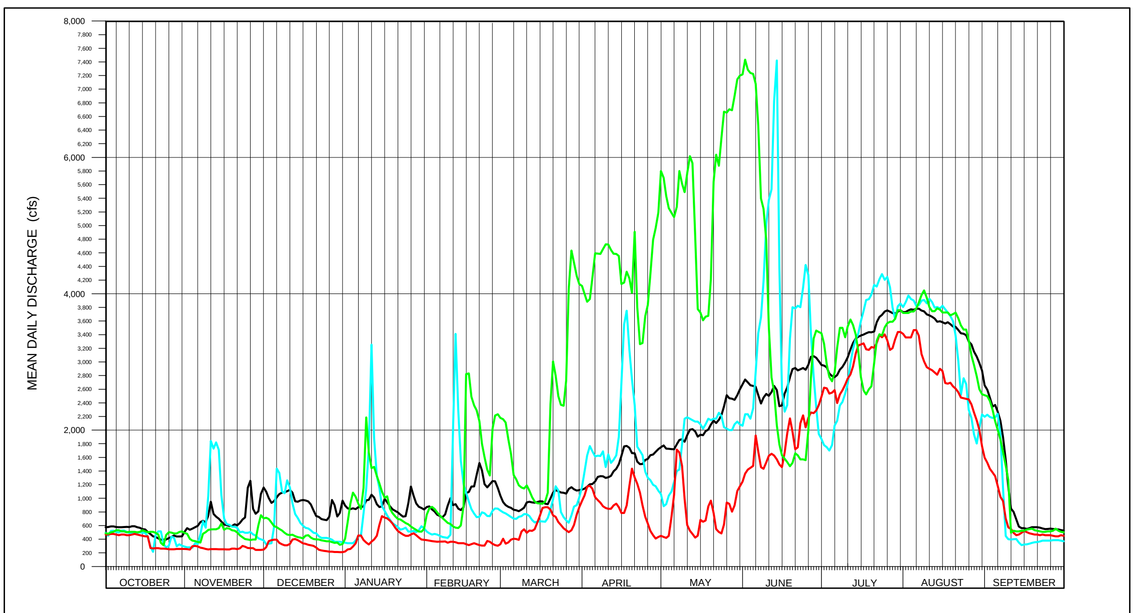




LEGEND
AVERAGE, UNREGULATED DISCHARGE, WY 1981-1999
TYPICAL YEAR, WY 1990
DRY YEAR, WY 1994
WET YEAR, WY 1997

**YAKIMA RIVER NR CLE ELUM
UNREGULATED DISCHARGE
SUMMARY HYDROGRAPHS**

**UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION**



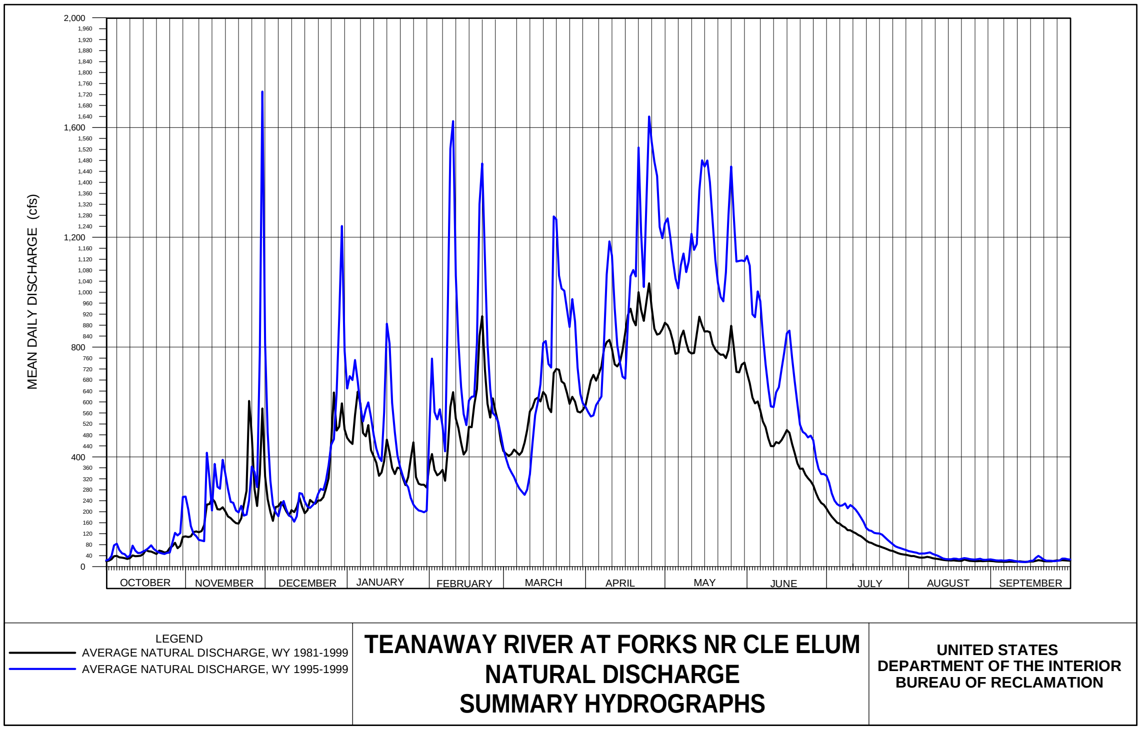
LEGEND
AVERAGE, REGULATED DISCHARGE, WY 1981-1999
TYPICAL YEAR, WY 1990
DRY YEAR, WY 1994
WET YEAR, 1997

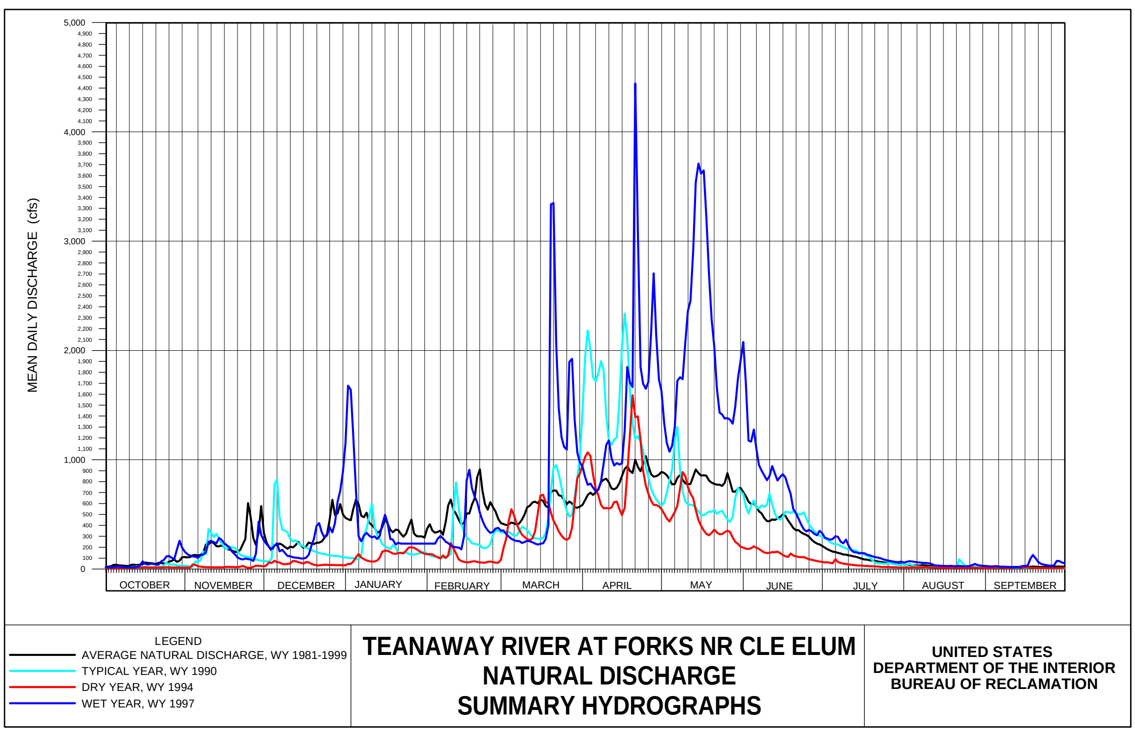
**YAKIMA RIVER NR CLE ELUM
REGULATED DISCHARGE
SUMMARY HYDROGRAPHS**

**UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION**

The Teanaway River site characterizes the unregulated runoff patterns in the upper Yakima River basin. There is little or no development or water diversions upstream from this site, but below this site from RM 9.6 to the mouth, there is significant diversion for irrigation especially during the low natural period of late July through mid-September. As in the other Yakima reservoir basins, Teanaway natural flows start increasing mid-October, continuing to increase until late November. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. December's cold weather will generally lock up the rain and snowfall causing a stabilizing effect on the outflow of the basin. In March, natural flows will increase and continue through late May or early June. Natural runoff is generally at its peak during mid-April through May period. Late June, early July, natural flow will start declining to the low period of early August through mid-October. The Teanaway basin average annual natural flow is 245,968 acre-feet, providing 134,102 acre-feet of runoff during the TWSA time period (April 1st through September 30th). The Teanaway basin only provides 10,506 acre-feet during July 1st through October 20th to meet system demands during this normal period of low natural flows.

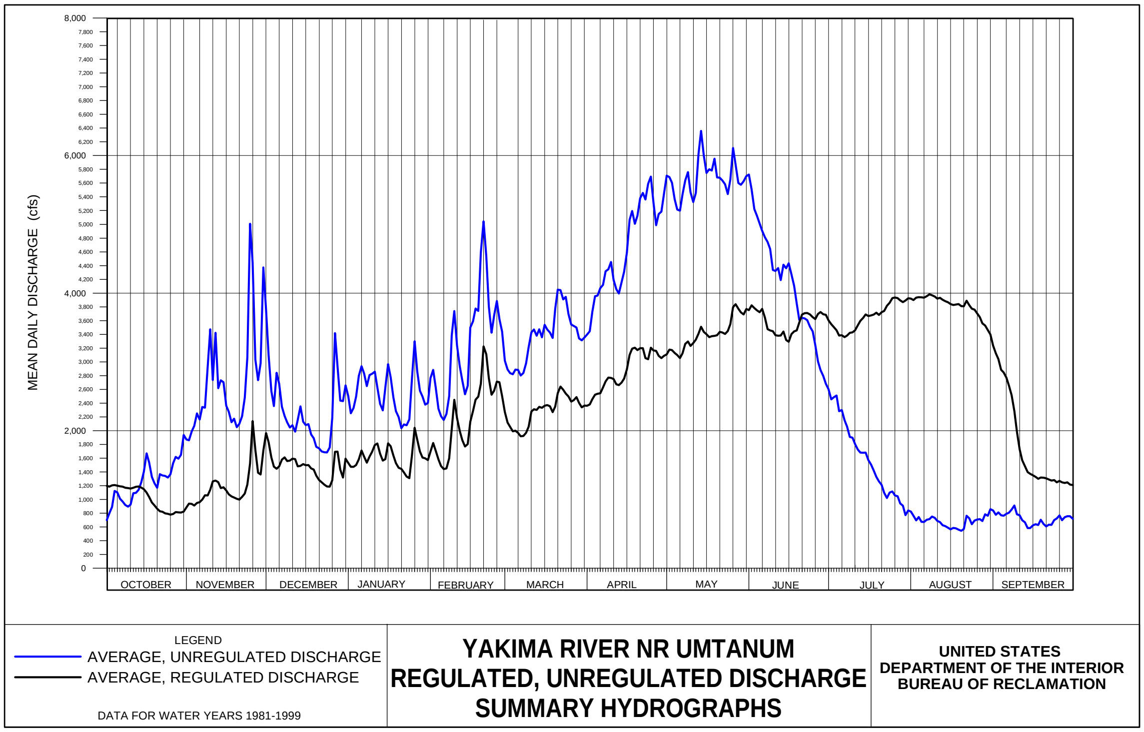
Teanaway River

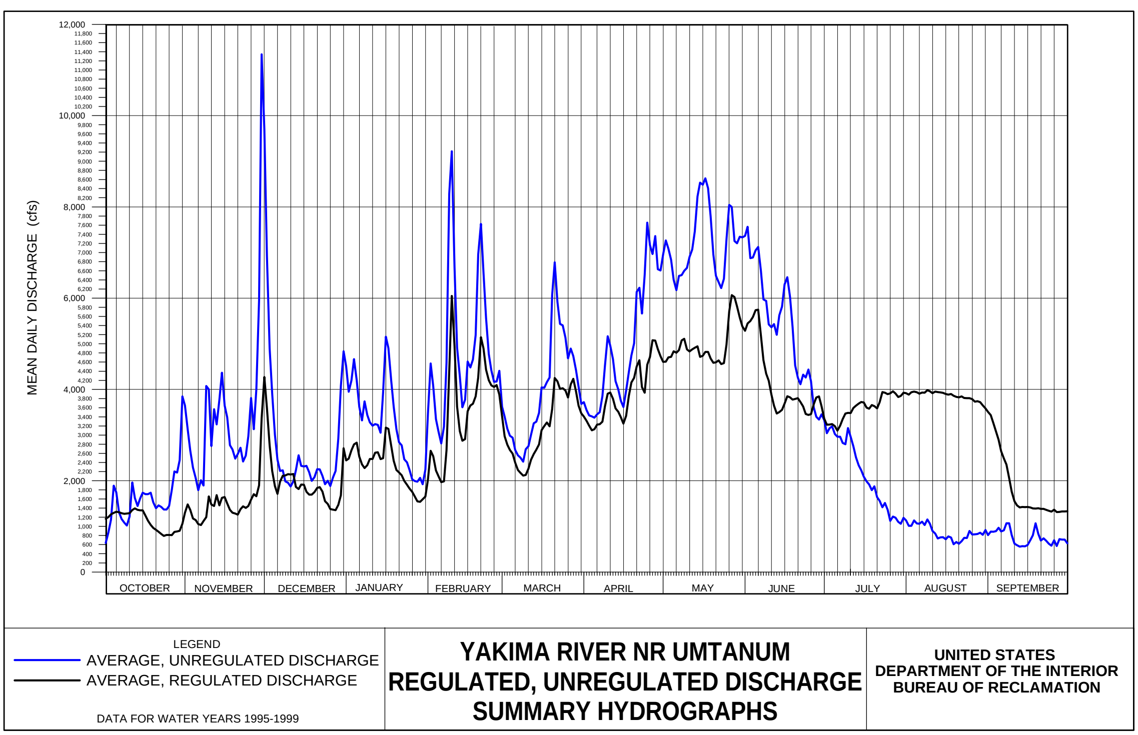


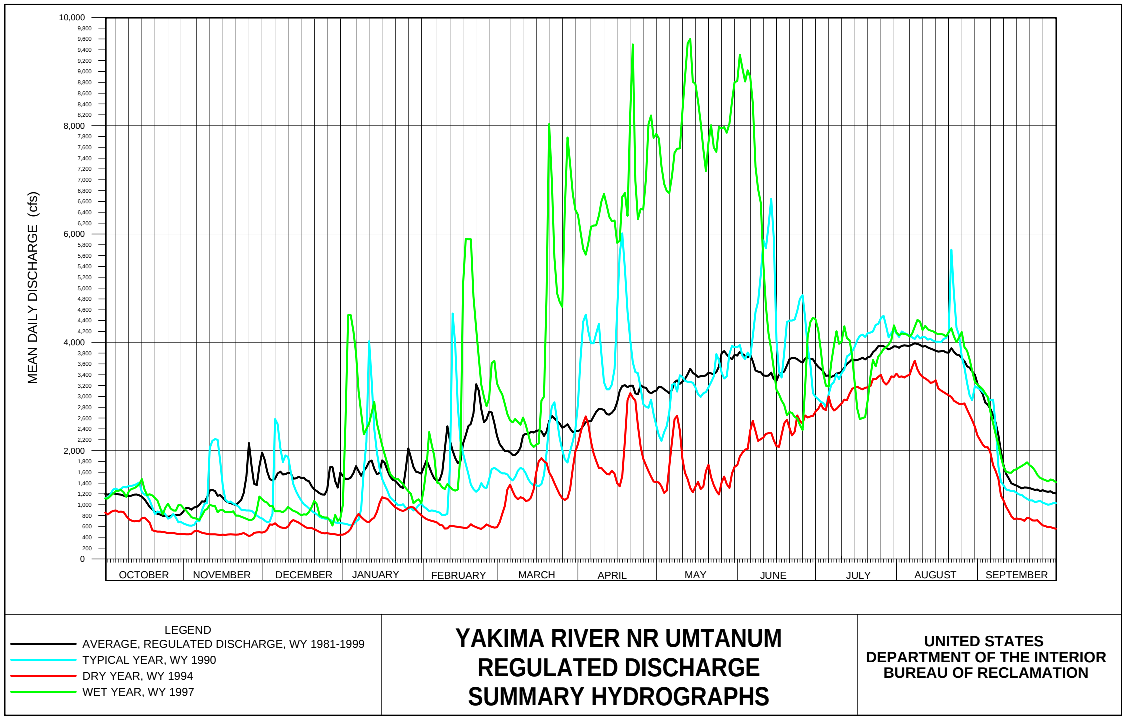


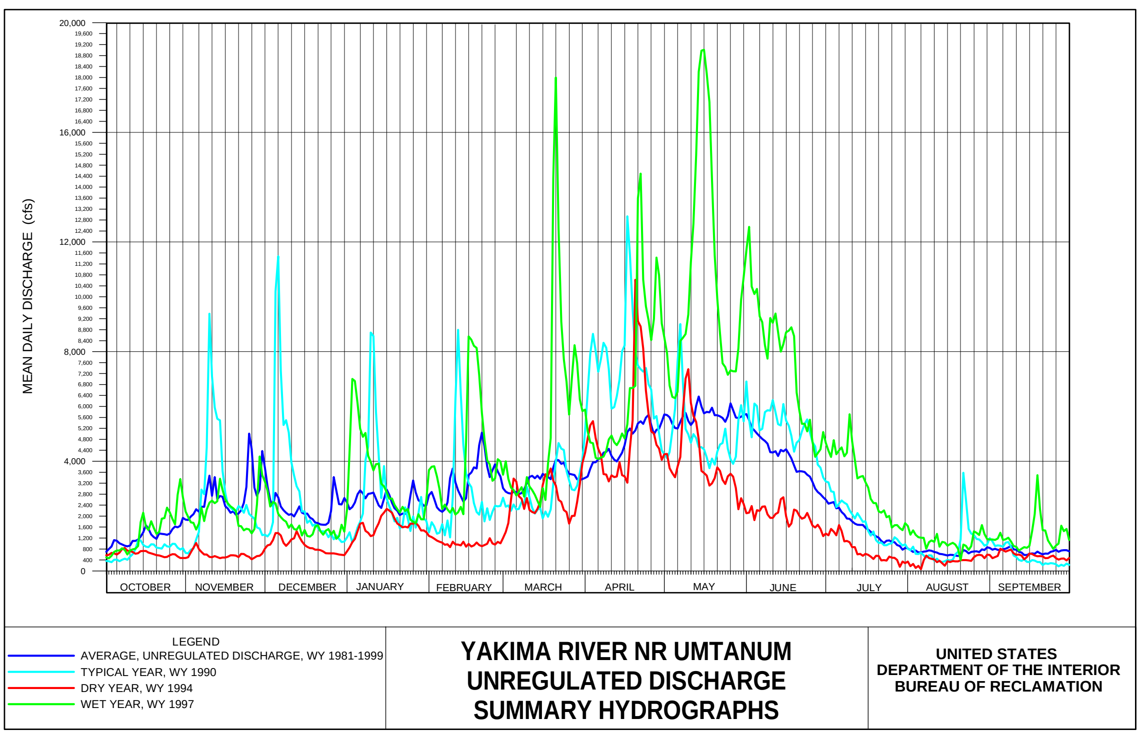
Yakima River near Umtanum natural unregulated streamflow starts increasing mid-October through November as fall precipitation increases and evapotranspiration decreases. Natural flows will recede to winter conditions as freezing conditions in upper watersheds reduce runoff. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. Regulated streamflow is below unregulated conditions and does not show the peaks due to reservoir inflows captured in storage. During the December through February period, the discharge is stable except for rain-on-snow events that formed the short duration, high discharges on a relatively infrequent basis. Regulated winter streamflow is lower than natural conditions and the frequency and magnitude of peak flows is reduced due to reservoir operations for flood control and storage. In March, natural flows will increase and continue through mid-May. Unregulated streamflow forms the average annual peak discharge from April through mid-June. From mid-April through June, regulated streamflow shows a greatly reduced peak as upper valley irrigation deliveries begin to increase. Current project practice for flood control operations allows for maximizing storage in late May, early June, and after this time the bypassing of reservoir natural inflows to the river system, returning some of the natural variability to the river system. Beginning late June, early July, unregulated streamflow will decline from spring freshet to baseflow conditions. Regulated flow exceeds unregulated on the average starting in mid-June as storage flows are wheeled to meet downstream irrigation demands. Increasing downstream demands causes the river's hydrograph to continue increasing until start of flip-flop on September 1st. From late June until flip-flop regulated flows are much higher (2,400 to 3,400 cfs per day) than the estimated natural unregulated flows. The estimated average natural unregulated flow from late July through mid-October is 700 cfs per day. From September 10th through October 20th, streamflow fluctuates very little under natural conditions, but regulated flows drop precipitously from highs in late August (4,000 cfs) to early September after flip-flop (under 1,400 cfs). The Umtanum basin average annual natural flow is 1,976,094 acre-feet, of which 1,141,069 acre-feet (58%) is regulated by storage reservoirs capable of modifying the arrival time and volume of flows at the Umtanum site. Yakima River near Umtanum unregulated hydrograph is compared with a typical year, WY 1990; a dry year, 1994; and a wet year, 1997, as an indicator of the effect of climatological conditions on natural unregulated flow/discharge.

Yakima River near Umtanum






MEAN DAILY DISCHARGE (cfs)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, REGULATED DISCHARGE, WY 1981-1999
TYPICAL YEAR, WY 1990
DRY YEAR, WY 1994
WET YEAR, WY 1997
YAKIMA RIVER NR UMTANUM
REGULATED DISCHARGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION


MEAN DAILY DISCHARGE (cfs)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
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JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, UNREGULATED DISCHARGE, WY 1981-1999
TYPICAL YEAR, WY 1990
DRY YEAR, WY 1994
WET YEAR, WY 1997
YAKIMA RIVER NR UMTANUM
UNREGULATED DISCHARGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
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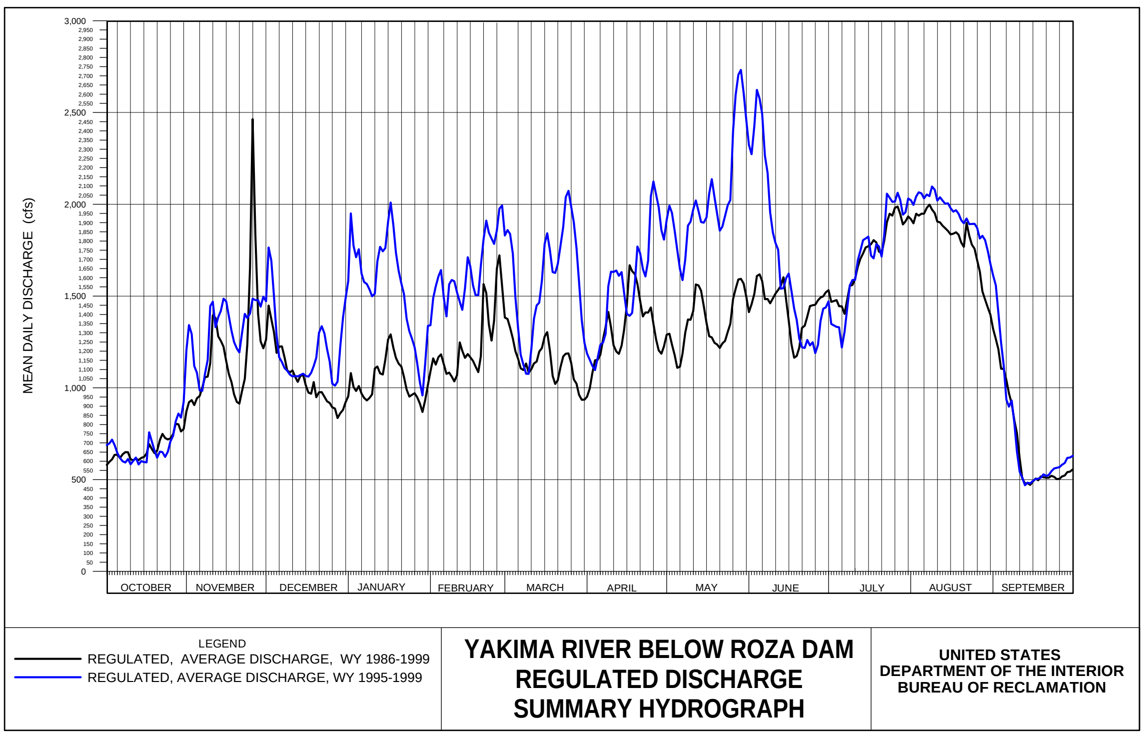
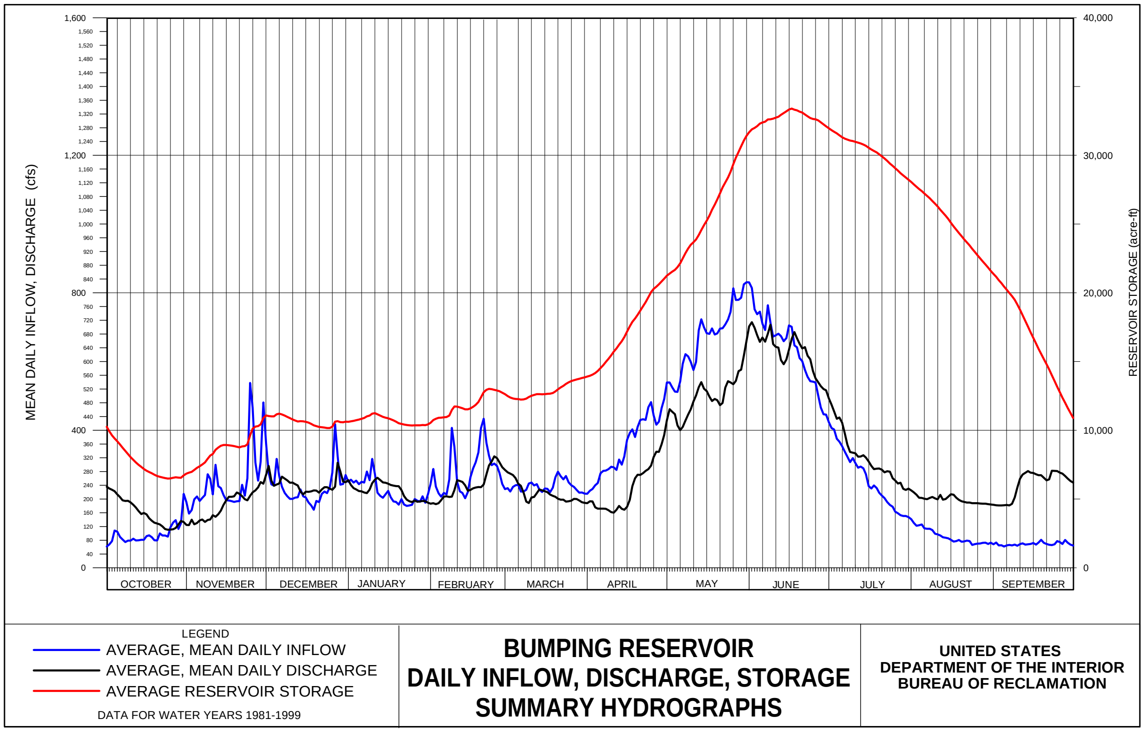
The Yakima River below Roza Dam (RBDW) regulated discharge hydrograph provides only a small clue to the relationship between unregulated and regulated flows, and provides mainly an indication of the much reduced natural variability of the hydrograph when compared to the Umtanum site located 12.5 miles upstream. Note, at this time that the stage/discharge records of RBDW are incomplete and that the site is only rated to 3,000 cfs effectively truncating all flow records greater than the rating table's 3,000 cfs. Normally RBDW hydrograph, unregulated or regulated flows matches Yakima River near Umtanum's except the volume shown is truncated or reduced due to the diversion of Roza main canal (RZCW) for irrigation and/or power production. Roza main canal's daily diversions are up to 2,200 cfs when generating power and irrigating, or up to 1,150 cfs when providing power generation only during non-irrigation season. Roza main canal's year around annual diversion is 733,478 acre-feet with a peak annual of 867,300 acre-feet during the past 19 years. Daily variability matches the upper river system, except the Roza Dam gate operation can set up hourly fluctuations which are felt all the way to the Yakima River near Parker gaging site. From September 10th through October 20th, streamflow fluctuates very little under natural conditions, but regulated flows drop precipitously from highs in late August (1,900 cfs) to early September after flip-flop (under 500 cfs).

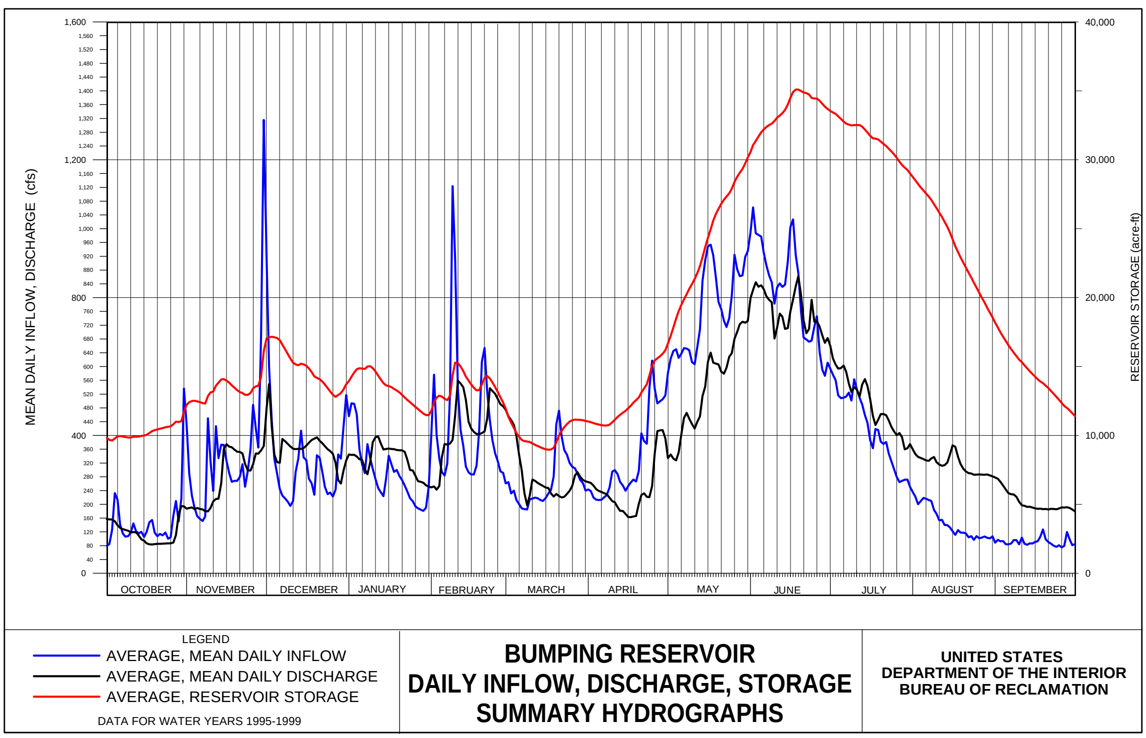
Yakima River below Roza Dam



As in the other reservoir basins, Bumping natural inflows normally start increasing mid-October, and continuing to increase until late November when it is common to have a rain induced heavy runoff event (flood) at the end of November or early December. Cold weather will then lock up the rain and snowfall causing a very slight decline with a stabilizing effect on the inflow to the reservoir. Early April inflows will increase and continue through late May or mid-June. Late June, early July, inflow will start declining to the low period of late August and September. Natural flows are captured during the late winter and spring/summer periods for storage, targeting June 1st for maximizing storage content of the reservoir. Discharges (reservoir outflow) are made during the winter for protection of the downstream fishery resources and to provide flood control operations storage space during the November to early May period. Irrigation demands on the storage/inflow will normally begin in April and continue through September 1st when storage releases are reduced to provide downstream spawning flows that are maintainable during the winter incubation period. The comparison of natural inflow and reservoir discharge reflect a slightly lower than natural flow, but stable outflow from late October through March with almost natural variability due to flood control operations. April through June outflows tend to mirror inflow patterns, but at a reduced quantity (due to storage and flood control operations), with the inflow/outflow relationship again coming close to matching during June as storage is maximized and the natural runoff is peaking. The close comparison of inflow/outflow is due to the very high ratio (6.2 to 1) of average runoff to reservoir storage capacity. The maximum discharge releases are made during flood control operations during the November through May runoff period. Of the 205,461 acre-feet average annual natural (unregulated) flow generated in the Bumping basin, only 53,437 acre-feet (26%) is delivered/released during July 1st through October 20th to meet system demands during this normal period of low natural flows. During the July 1st through October 20th period, only 24,945 acre-feet of this delivery is from the storage component of the water supply.

Bumping


MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
1,600
1,200
800
400
0
40,000
30,000
20,000
10,000
0
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE RESERVOIR STORAGE
DATA FOR WATER YEARS 1981-1999
BUMPING RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION


MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
1,600
1,200
800
400
0
40,000
30,000
20,000
10,000
0
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE, RESERVOIR STORAGE
DATA FOR WATER YEARS 1995-1999
BUMPING RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
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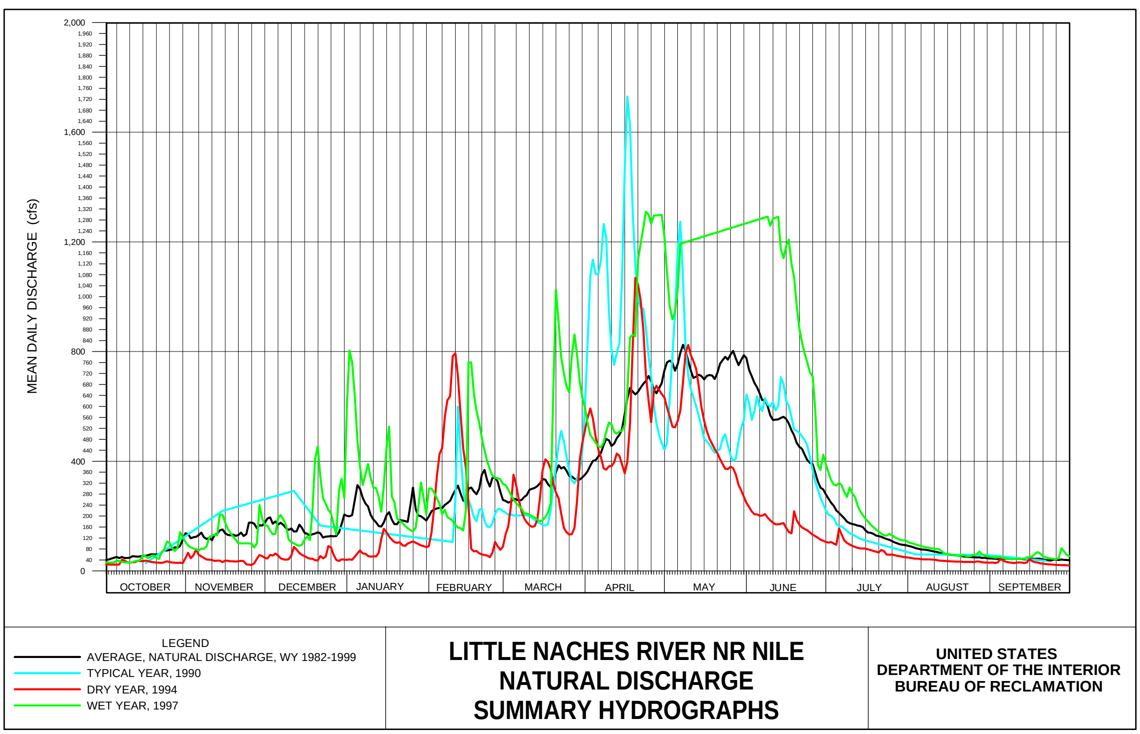
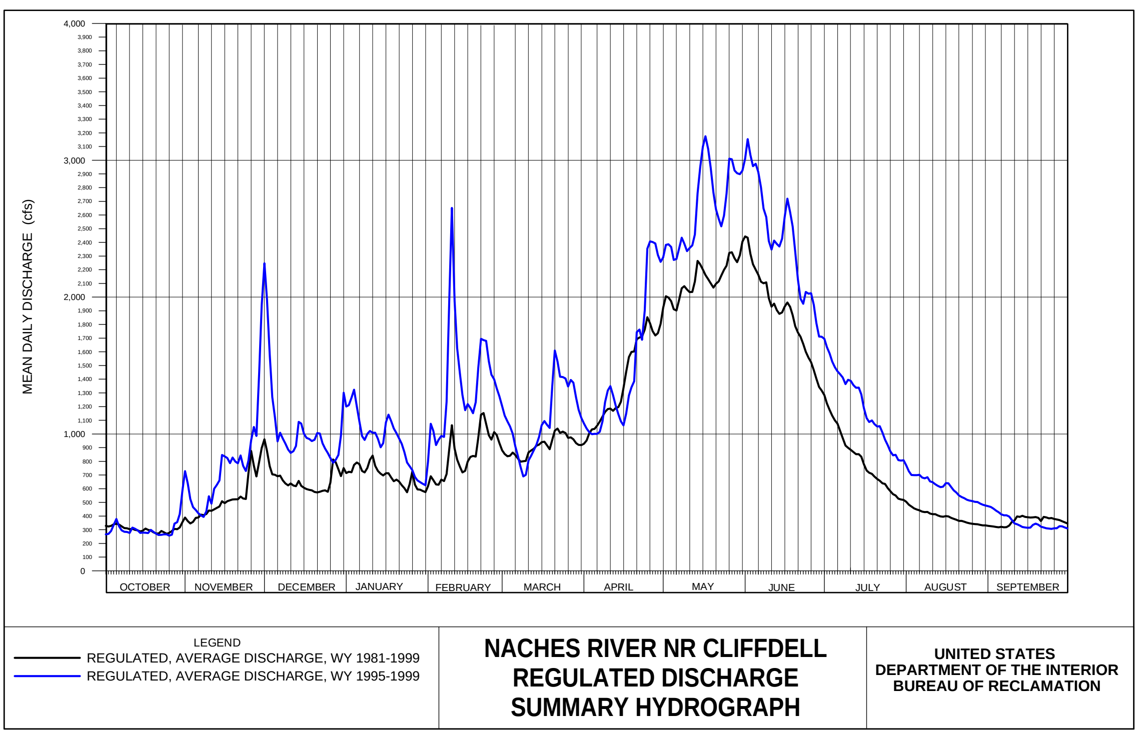
The Little Naches River site characterizes the unregulated runoff patterns in the Naches River basin. There is no development or water diversions upstream from this site. As in the other Yakima reservoir basins, Little Naches natural flows start increasing mid-October and continue through late November. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. December's cold weather will then lock up the rain and snowfall causing a stabilizing effect on the outflow of the basin. In March, natural flows start to increase and continue through late May or early June. Natural runoff is generally at its peak during mid-April through early June period. Late June, early July, natural flow will start declining to the low period of mid-August through mid-October. The Little Naches basin average annual natural flow is 181,895 acre-feet, providing 113,832 acre-feet of runoff during the TWSA time period (April 1st through September 30th). The Little Naches basin only provides 17,069 acre-feet during July 1st through October 20th to meet system demands during this normal period of low natural flows.

Little Naches River



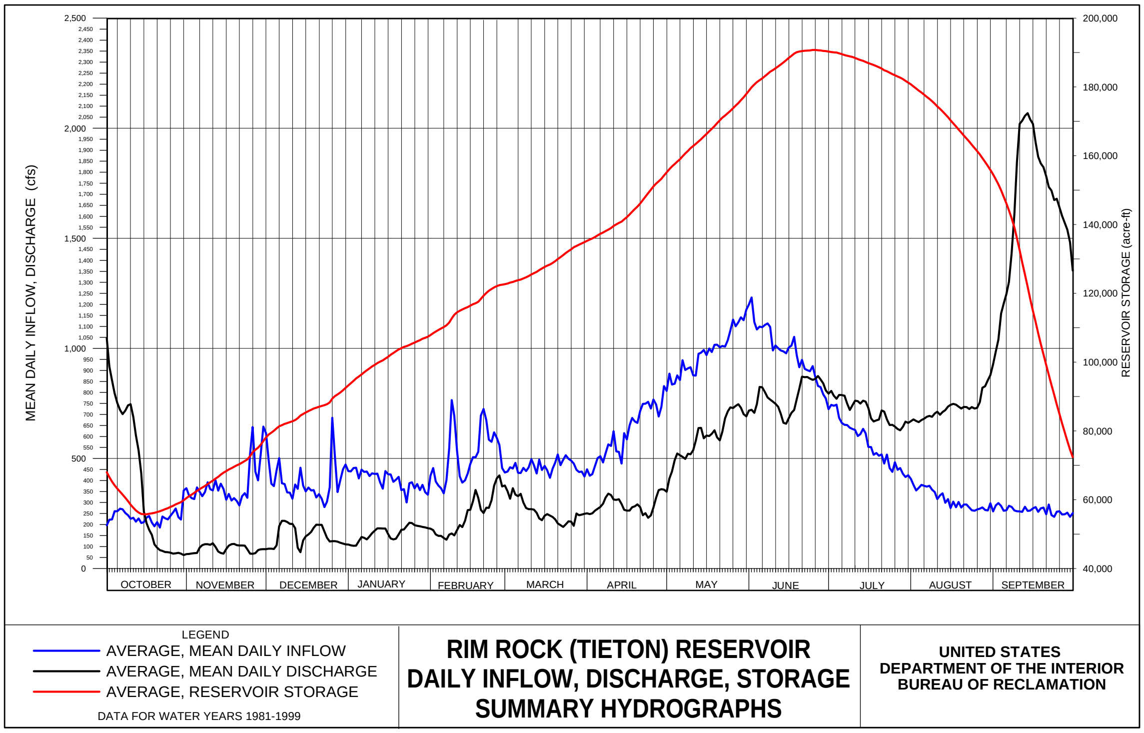
The Naches River near Cliffdell represents a river site with some development in its watershed, but not enough to completely change the natural streamflow regime. With the construction of Bumping Lake Reservoir, only 70.7 mi.[2] (17.9%) of the Cliffdell's 394 mi.[2] watershed came under a regulating influence, but with Bumping's average runoff to storage capacity ratio 6.2 to 1 the effect on Cliffdell's natural flow volume and variability was minimal. As in the other Yakima basins, Naches River near Cliffdell natural flows/discharges start increasing mid-October, continuing to increase until late November. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. December's cold weather will then lock up the rain and snowfall causing a slight decline in discharge and a stabilizing effect on the outflow of the basin. In March, natural flows will start to increase and continue through late May, early June. Natural runoff is generally at its peak during mid-April through early June period. Late June, early July, natural flow will start declining to the low period of mid-August through mid-October. Flood control space releases at Bumping have a small impact upon Cliffdell's discharges. Bumping storage releases for irrigation during the late July through August period support a higher discharge than natural flow regime for this site and continues doing so with incubation protect releases during the winter months, until flood control space release are made.

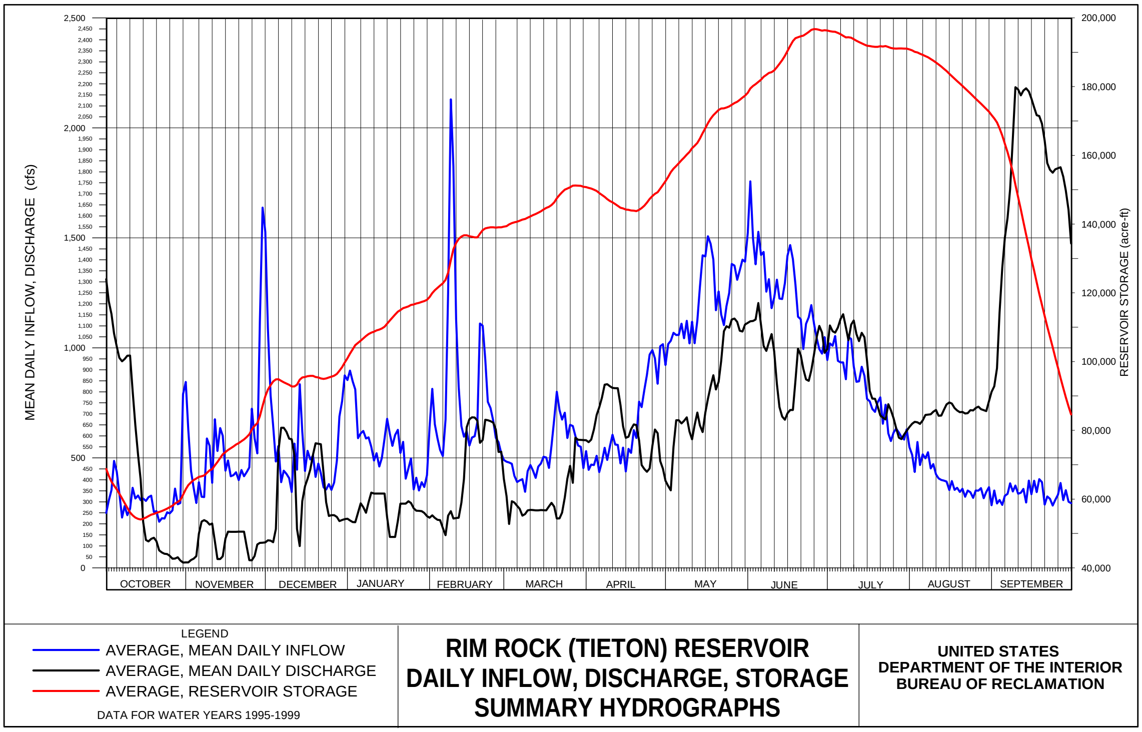
Naches River near Cliffdell



Normally, as in the other Yakima reservoir basins, Rimrock natural inflows start increasing mid-October, continuing to increase until late November. It is common to have a rain induced flood event at the end of November or early December. Cold weather will then lock up the rain and snowfall causing a slight decline and stabilizing effect on the inflow to the reservoir. In late March, inflows will start to increase and continue through late May or June. Late June, early July, inflow will start declining to the low period of late August and September. Natural flows are captured during the winter and spring/summer periods for storage, targeting June 1st for maximizing storage content of the reservoir. Discharges (reservoir outflow) are made during the winter for protection of the downstream fishery resources and to provide flood control operations storage space during the November to early May period. Moderate irrigation demands on the storage/inflow will normally begin in early April and continue through late August. Beginning September 1st (start of flip-flop) storage releases are increased four-fold to compensate for the reduction of the upper Yakima River flows, and Rimrock outflows become the primary source of irrigation water supply for the Yakima basin below Roza Dam until October 20th (end of irrigation season). The comparison of natural inflow and reservoir discharge reflect a greatly lower (less than 20%) than natural flow, but stable outflow during late October and November; with December through March still reflecting a lower outflow (less than 35%) than natural, but with more variability due to flood control operations. Mid-April through June outflows tend to mirror inflow patterns, but at a reduced quantity (due to storage and flood control operations), with the inflow/outflow relationship coming closest to matching during June as storage is maximized and the natural runoff is peaking. Currently, the maximum discharge releases (2,200 to 2,600 cfs) are made during September 10th through September 30th for irrigation demands. Of the 369,323 acre-feet average annual natural (unregulated) flow generated in the Rimrock basin, 209,373 acre-feet (57%) is delivered/released during July 1st through October 20th to meet system demands during the normal period of low natural flows. During the July 1st through October 20th period, 131,083 acre-feet of this delivery is from the storage component of the water supply. Rimrock (Tieton) Reservoir unregulated and regulated hydrographs are compared with a typical year, WY 1990; a dry year, 1994; and a wet year, 1997, as an indicator of the effect of climatological conditions on natural unregulated and regulated flow/discharge.

Rimrock


MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE, RESERVOIR STORAGE
DATA FOR WATER YEARS 1981-1999
RIM ROCK (TIETON) RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION


MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE, RESERVOIR STORAGE
DATA FOR WATER YEARS 1995-1999
RIM ROCK (TIETON) RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
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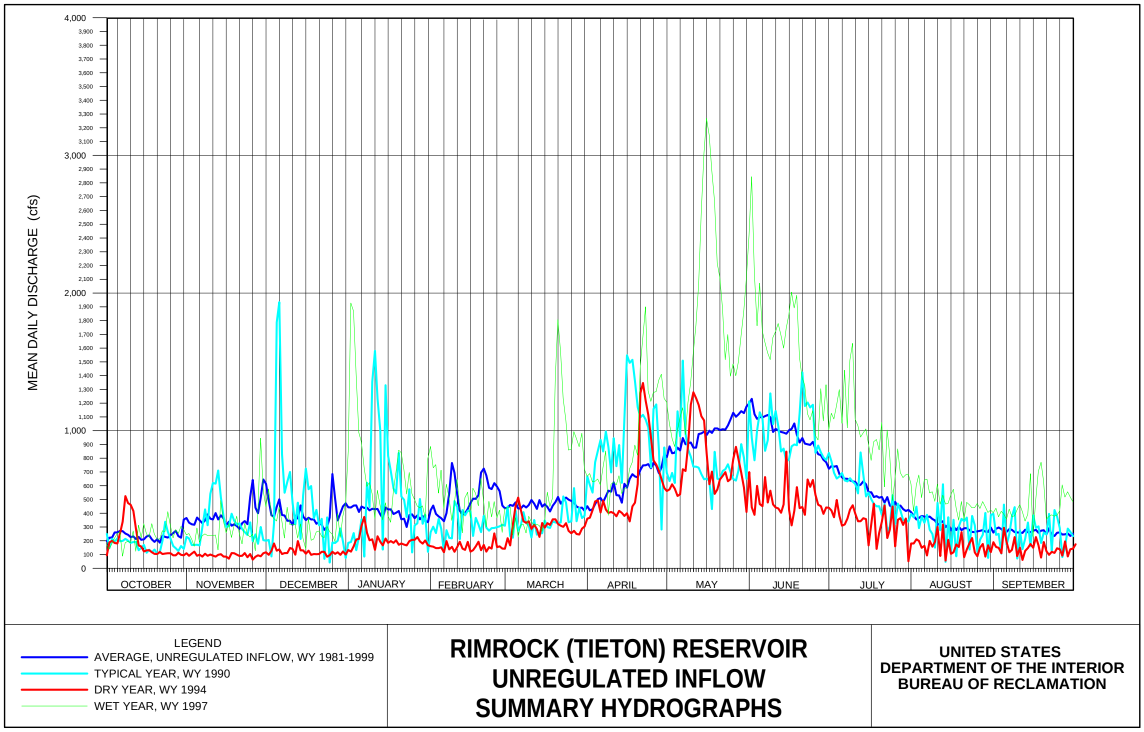
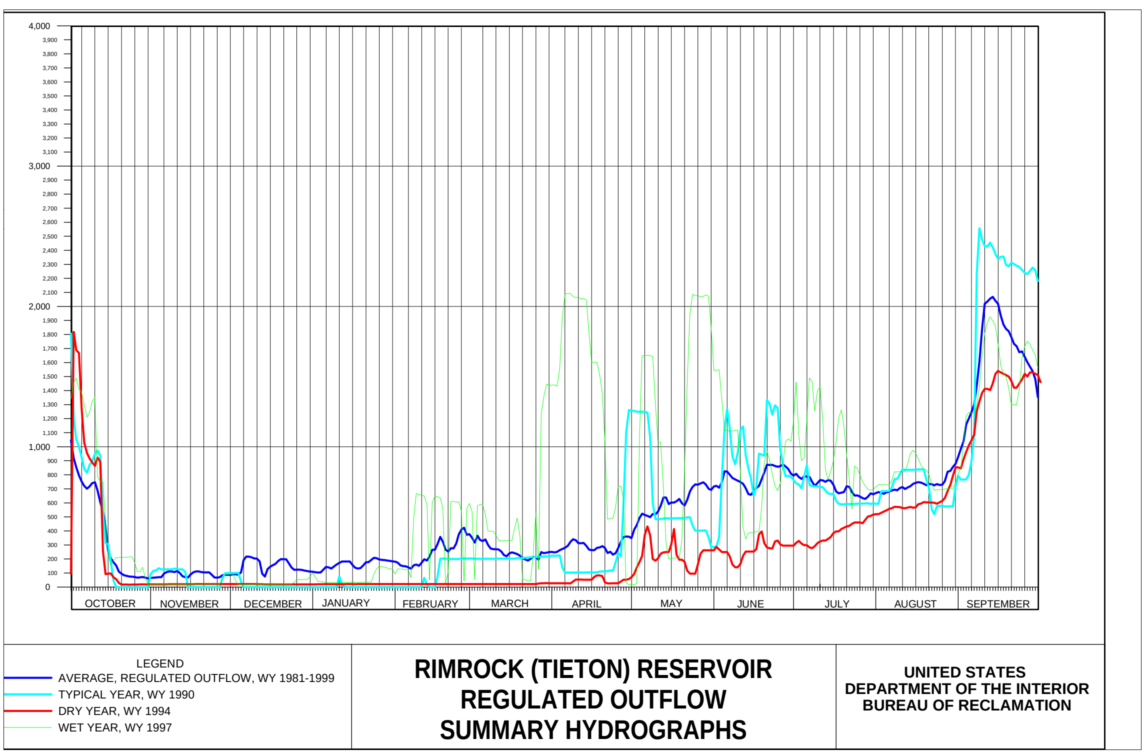

MEAN DAILY DISCHARGE (cfs)
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, UNREGULATED INFLOW, WY 1981-1999
TYPICAL YEAR, WY 1990
DRY YEAR, WY 1994
WET YEAR, WY 1997
RIMROCK (TIETON) RESERVOIR
UNREGULATED INFLOW
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION


OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, REGULATED OUTFLOW, WY 1981-1999
TYPICAL YEAR, WY 1990
DRY YEAR, WY 1994
WET YEAR, WY 1997
RIMROCK (TIETON) RESERVOIR
REGULATED OUTFLOW
SUMMARY HYDROGRAPHS
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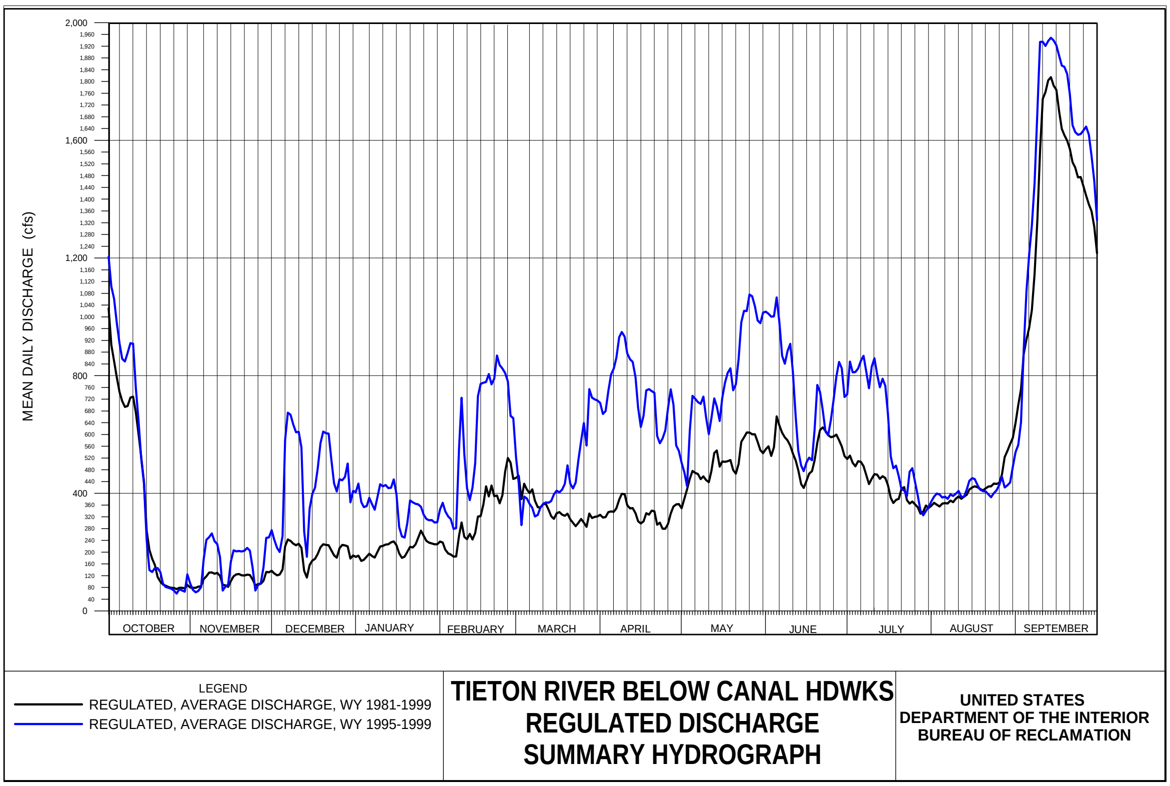
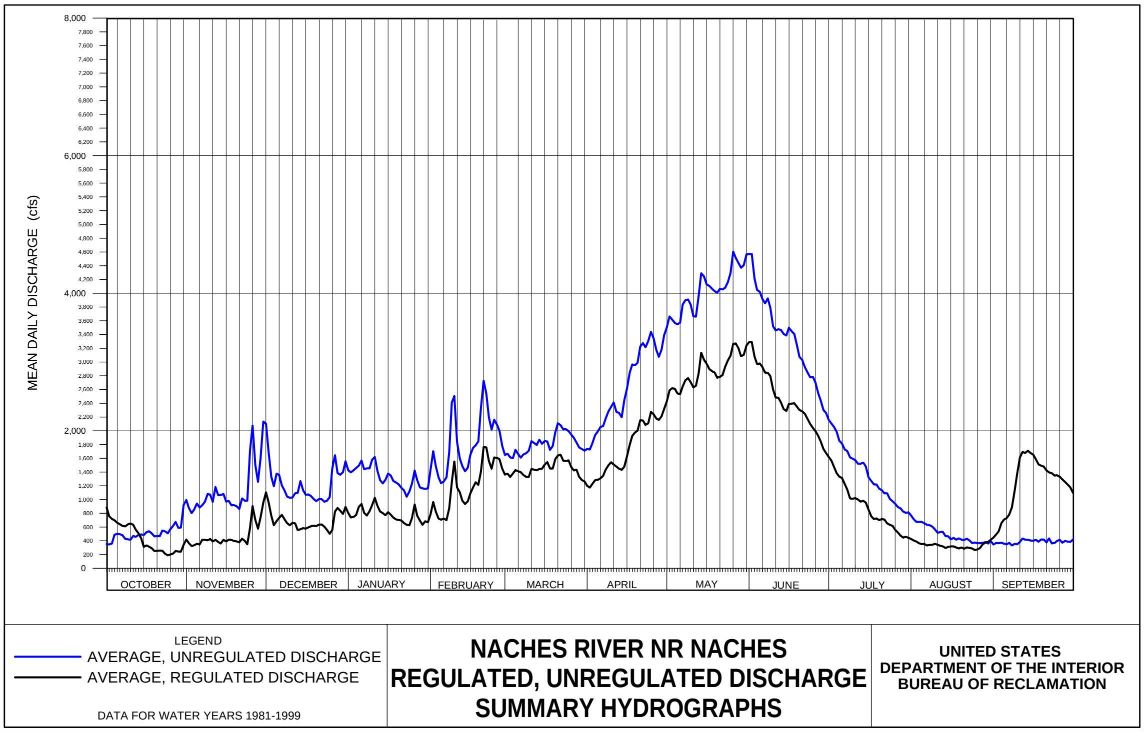
Normally, Tieton River below Canal Headworks (TICW) hydrograph, unregulated or regulated flows, closely matches Rimrock located 7.2 miles upstream, except the volume shown is reduced due to the diversion of Yakima-Tieton Canal (TIEW) for irrigation from late March through early October. Some local unregulated variability is developed by inflows to the reach below Rimrock, such as produced by Wildcat Creek. TIEW daily diversions are up to 330 cfs when irrigating with average annual diversion of 83,923 acre-feet with a peak annual of 98,852 acre-feet during the past 19 years. From September 1st through October 20th, streamflow fluctuates very little under natural conditions, but regulated flows rise precipitously from lows in late August (400 cfs) to September 10th (1,950 cfs) after flip-flop is in-place, and then starting to slowly decline to late October's 80 cfs due to reduced irrigation demands.

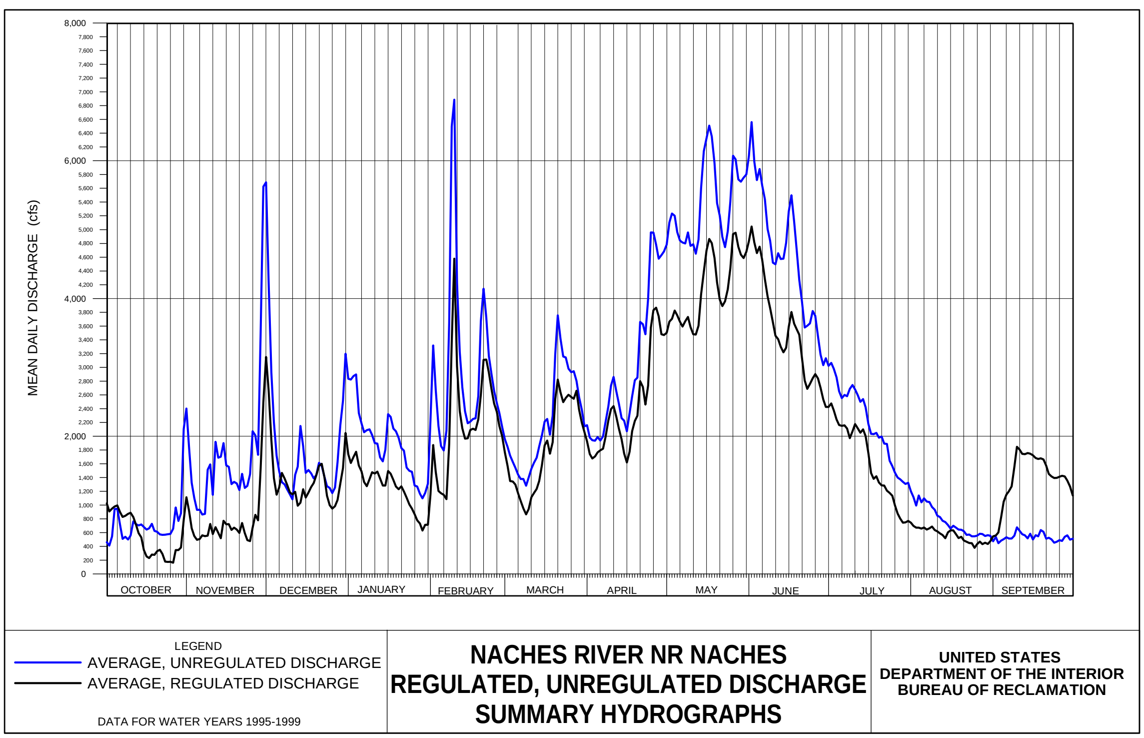
Tieton River below Canal Headworks

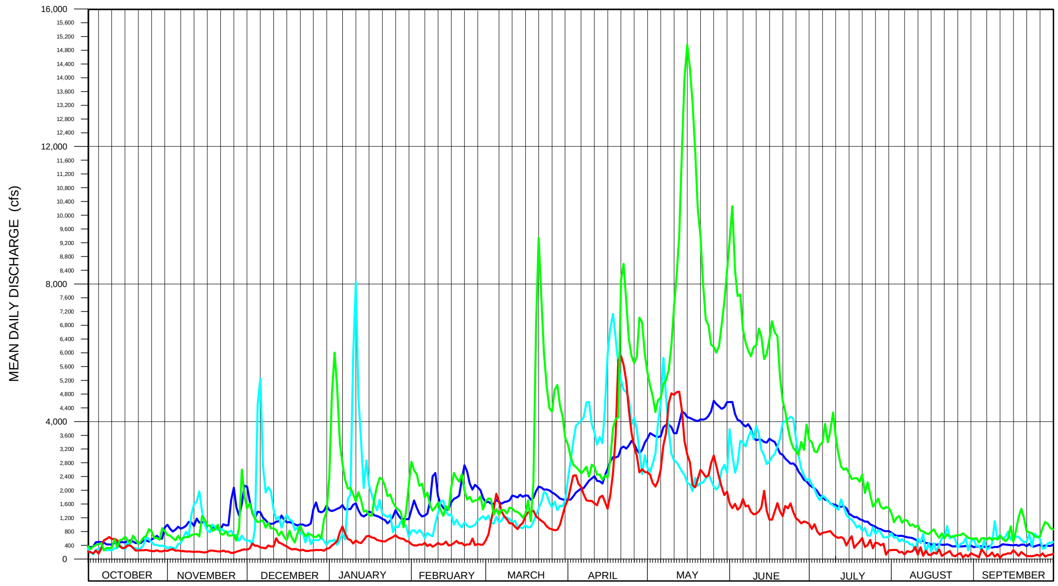


Naches River near Naches (NACW) natural unregulated streamflow starts increasing slowly, mid-October through November as fall precipitation increases and then natural flows will recede to winter conditions as freezing conditions in upper watersheds reduce runoff. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. Regulated streamflow is much lower than unregulated conditions and does not show the peaks due to reservoir inflows captured in storage. During the December through February period, the discharge is stable except for rain-on-snow events that formed the short duration, high discharges on a relatively infrequent basis. Regulated winter streamflow is roughly 43 percent lower than natural conditions, and the frequency and magnitude of peak flows is greatly reduced due to reservoir operations for flood control and storage. In March, natural flows will start to increase and continue through late May. Unregulated streamflow forms the average annual peak discharge from April through early June. Starting in April, regulated streamflow is very slightly reduced as irrigation deliveries above NACW begin to increase. Current project practice for flood control operations allows for maximizing storage in late May, early June, and after this time the bypassing of reservoir natural inflows to the river system, returning some of the natural variability to the river system. Beginning mid-June, unregulated streamflow will decline from spring freshet to baseflow conditions by late August. Based on the past 19 years, regulated flow only exceeds unregulated from the start of flip-flop in late August to the end of the irrigation season October 20th, flows are wheeled to meet downstream irrigation demands that were earlier supported from the upper Yakima reach. From early July until late August or start of flip-flop, regulated flows are lower (200 to 600 cfs per day) than the estimated natural unregulated flows. The estimated average natural unregulated flow from mid-August to late October is less than 425 cfs per day. From September 10th through October 20th, streamflow fluctuates very little under natural conditions, but regulated flows rise precipitously from lows in late August (300 cfs or less) to September 10th (1,900 cfs) after flip-flop is in place. At some time, in most years, NACW regulated flows will drop to 125 cfs or lower (80 cfs) due in part to the Wapatox Power Canal year around non-consumptive natural flow right diversion of 300 to 450 cfs. The NACW basin average annual natural flow is 1,199,029 acre-feet, of which 574,784 acre-feet (48%) is regulated by storage reservoirs capable of modifying timing and volume of flows at the NACW site, but at a reduced magnitude when compared to the upper Yakima River reach. The NACW unregulated and regulated hydrographs are compared with a typical year, WY 1990; a dry year, 1994; and a wet year, 1997, as an indicator of the effect of climatological conditions on natural unregulated and regulated flow/discharge.

Naches River near Naches







LEGEND
- AVERAGE, UNREGULATED DISCHARGE, WY 1981-1999
- TYPICAL YEAR, WY 1990
- DRY YEAR, WY 1994
- WET YEAR, WY 1997

NACHES RIVER NR NACHES
UNREGULATED DISCHARGE
SUMMARY HYDROGRAPHS

UNITED STATES
DEPARTMENT OF THE INTERIOR
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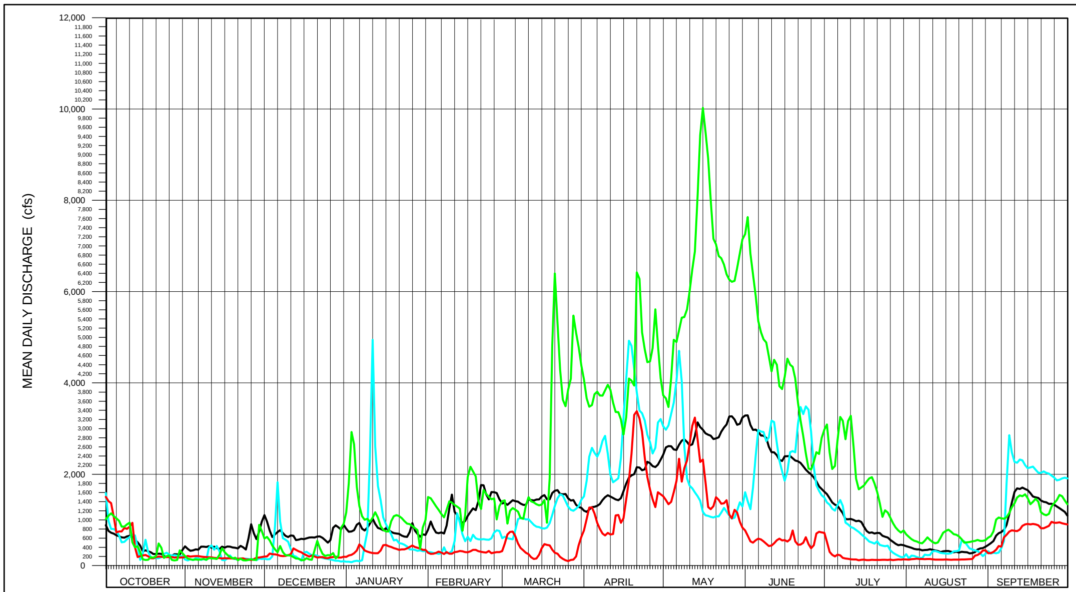

LEGEND
- AVERAGE, REGULATED DISCHARGE, WY 1981-1999
- TYPICAL YEAR, WY 1990
- DRY YEAR, WY 1994
- WET YEAR, WY 1997

NACHES RIVER NR NACHES
REGULATED DISCHARGE
SUMMARY HYDROGRAPHS

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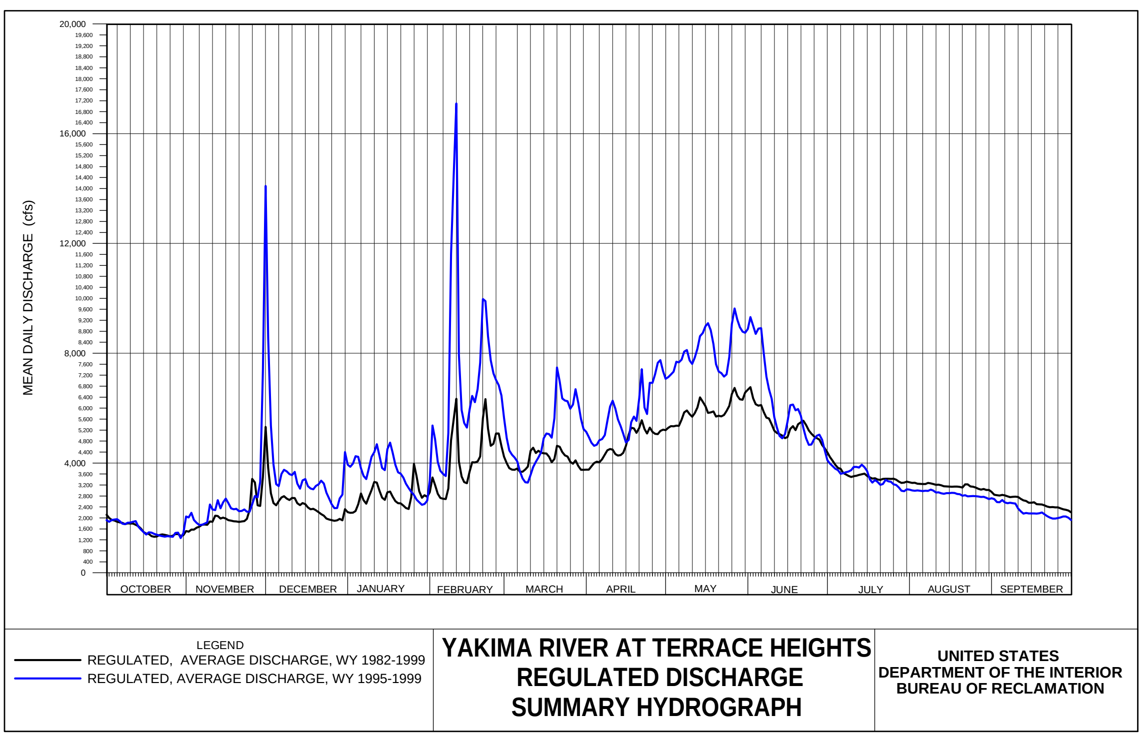
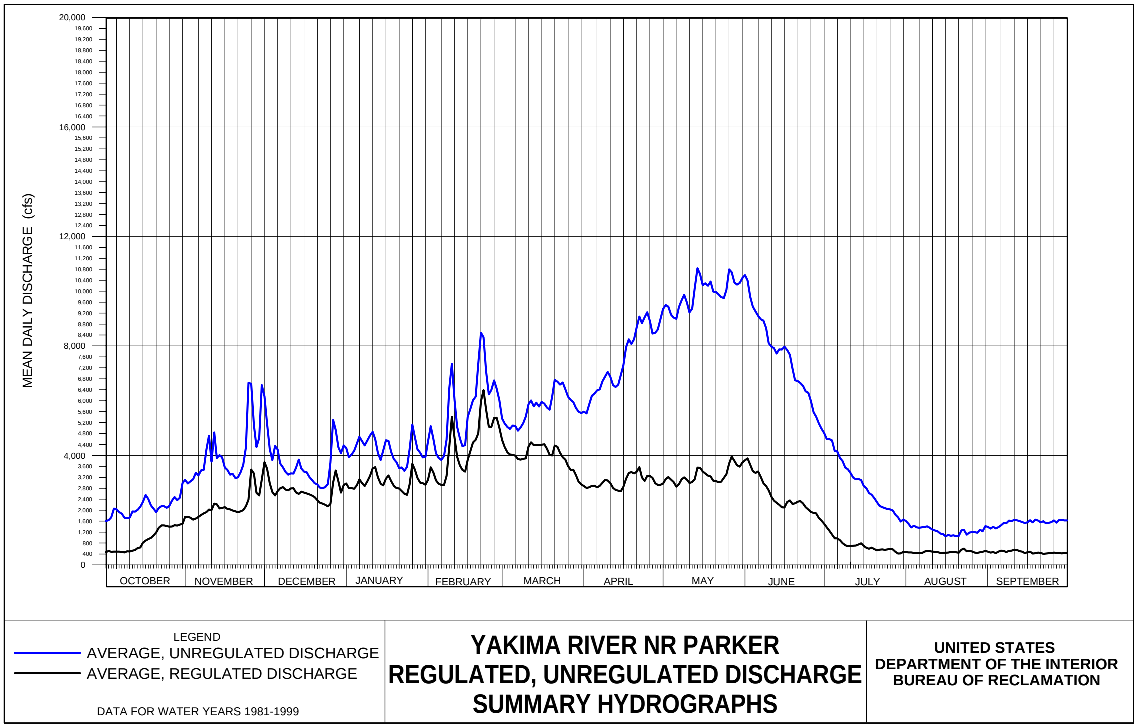
The Yakima River at Terrace Heights (YRTW) regulated discharge hydrograph provides the relationship between unregulated and regulated flows when compared to the Yakima River near the Parker (PARW) site located 9.5 miles downstream. The comparison between these two sites is valid because there is only a small percentage of PARW unregulated flow coming into the reach from Ahtanum and Wide Hollow Creeks below YRTW. YRTW is also the first gage site below the confluence of the Naches River with the Yakima River. The YRTW discharges provide an indication of the variability of the regulated hydrograph, but stage/discharge records of YRTW are provisional and may not provide an accurate representation of volume discharge. Normally, if available, YRTW unregulated flows would match PARW's unregulated hydrograph except being slightly reduced due to Ahtanum and Wide Hollow Creeks' inflows. YRTW regulated hydrograph flows come close to representing the daily variability of the combined upper Yakima River and Naches River systems, and minus irrigation diversions of up to 3,300 cfs, should closely match PARW's hydrograph. During late July until mid-October, streamflow fluctuates very little under natural conditions, but regulation of storage for irrigation demands and operating for Yakima River Basin Water Enhancement Project (YRBWEP) targets, maintains fairly constant daily flows at YRTW, and normally no perceivable change to YRTW flows from the flip-flop operation. From late July until late September, regulated flows are much higher (up to 2,000 to 2,400 cfs per day) than the estimated natural unregulated flows.

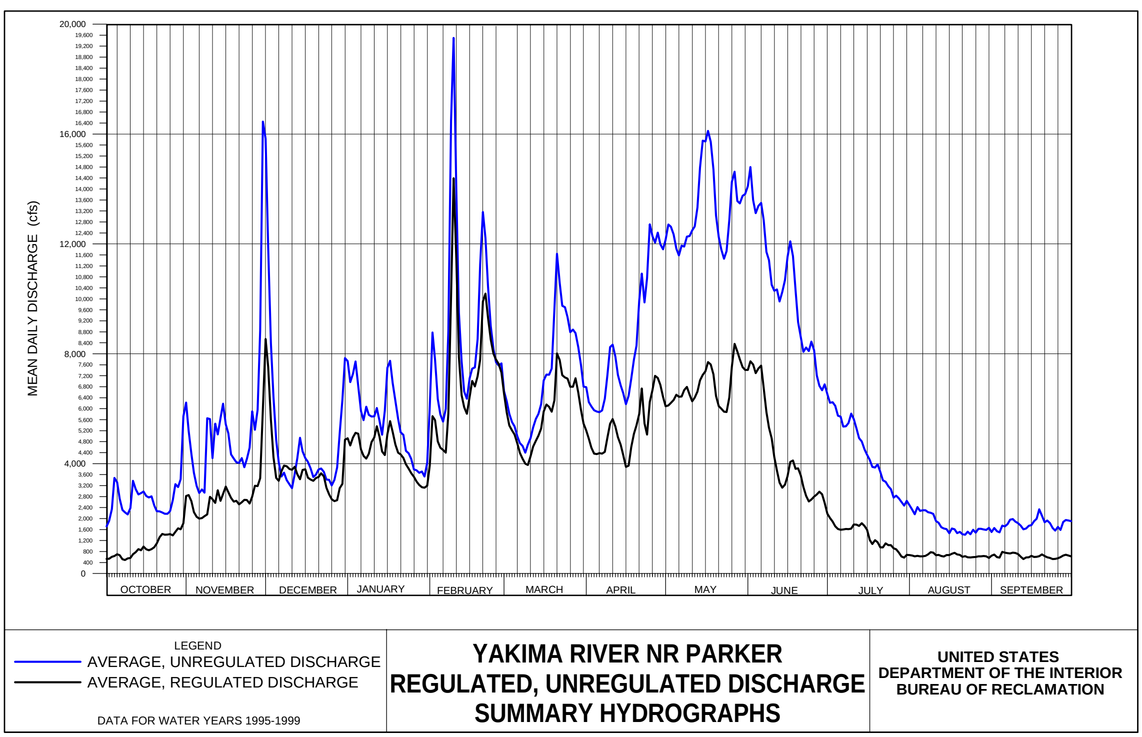
Yakima River @ Terrace Heights

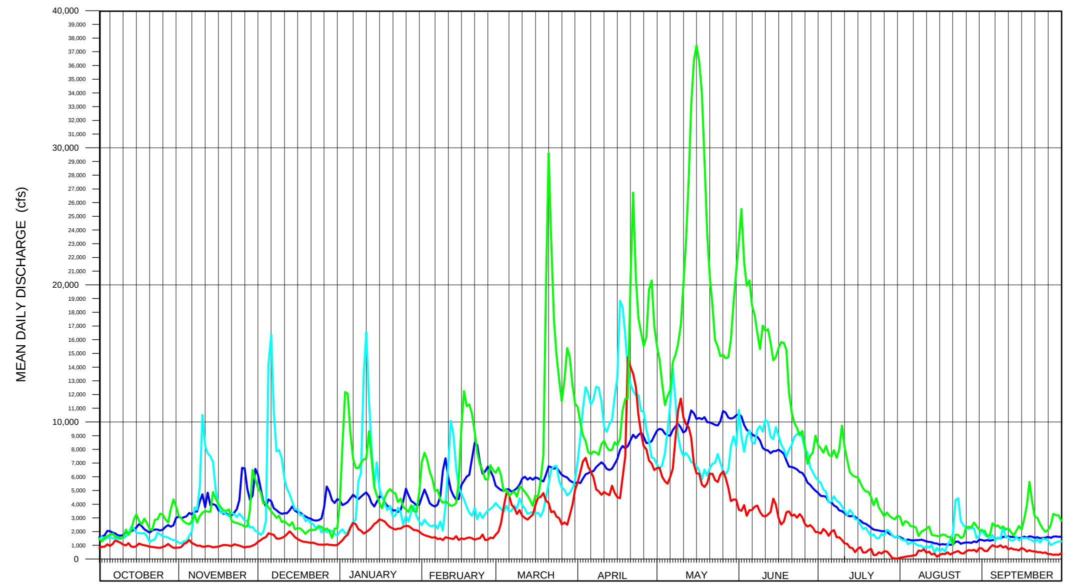


Yakima River near Parker (PARW) natural unregulated streamflow starts increasing mid-October through November as fall precipitation increases and evapotranspiration decreases. Natural flows will recede to winter conditions as freezing conditions in upper watersheds reduce runoff. It is common to have a rain induced flood event at the end of November or early December, with other major flood events resulting from a rain-on-snow event coupled with a rapid thaw occurring through February. Regulated streamflow is much lower than unregulated conditions and does not show the peaks due to reservoir inflows captured in storage. During the December through February period the discharge is relatively stable except for rain-on-snow events that formed the short duration, high discharges on an infrequent basis. Regulated winter (late December through February) streamflow is roughly 34 percent lower than natural conditions, and the frequency and magnitude of peak flows is greatly reduced due to reservoir operations for flood control and storage. In March, natural flows increase and continue through late May. Unregulated streamflow forms the average annual peak volume discharge period from April through early June. Starting in late March, regulated streamflow is reduced as irrigation deliveries above PARW begin to increase. Current project practice for flood control operations allows for maximizing storage in late May, early June, and after this time the bypassing of reservoir natural inflows to the river system, returning some of the natural variability to the river system. Beginning mid-June, unregulated streamflow will decline from spring freshet to baseflow conditions by early August. Based on the past 19 years, regulated flow never exceeds unregulated natural flow during the entire water year, even during the low natural flow period July 1st through October 20th, when peak storage is wheeled to meet TWSA irrigation demands. Note: up to 3,330 cfs is diverted at Sunnyside Valley Irrigation District (SVID) and Wapato Irrigation Project (WIP), both of which are located just upstream of the PARW gaging station. PARW is the controlling site for calculation of TWSA, which also is used to establish YRBWEP target flows for PARW and YRPW from April through October. These YRBWEP target flows (300, 400, 500, or 600 cfs based on TWSA) set the minimum instream regulated flow for this period of time. From late July until mid-October, regulated flows are lower (900 to 1,200 cfs per day) than the estimated natural unregulated flows. The estimated average natural unregulated flow from mid-August to early October is less than 1,300 cfs per day and in a dry water year this unregulated flow may approach zero. During late July until mid-October, streamflow fluctuates very little under natural conditions, but regulation of storage demands and operating for YRBWEP targets maintains fairly constant daily flows at PARW, and normally no perceivable change to PARW flows from the flip-flop operation. When the system is on storage control it is possible, due to operation of diversion faculties, to develop hourly cyclic fluctuations at PARW site. The PARW basin average annual natural flow is 3,390,551 acre-feet, of which 1,713,282 acre-feet (51%) is regulated by storage reservoirs, delaying and modifying discharge timing and volume rate of flows by as much as 112 days at the PARW site. Recognized TWSA plus post-1905 rights irrigation diverters require diversion of 52 percent of the total annual natural flow during the April through October irrigation season, and a total average annual diversion of 2,093,100 acre-feet during this same time period. Yakima River near Parker unregulated and regulated hydrographs are compared with a typical year, WY 1990; a dry year, 1994; and a wet year, 1997, as an indicator of the effect of climatological conditions on natural unregulated and regulated flow/discharge.

Yakima River near Parker – TWSA Control Site





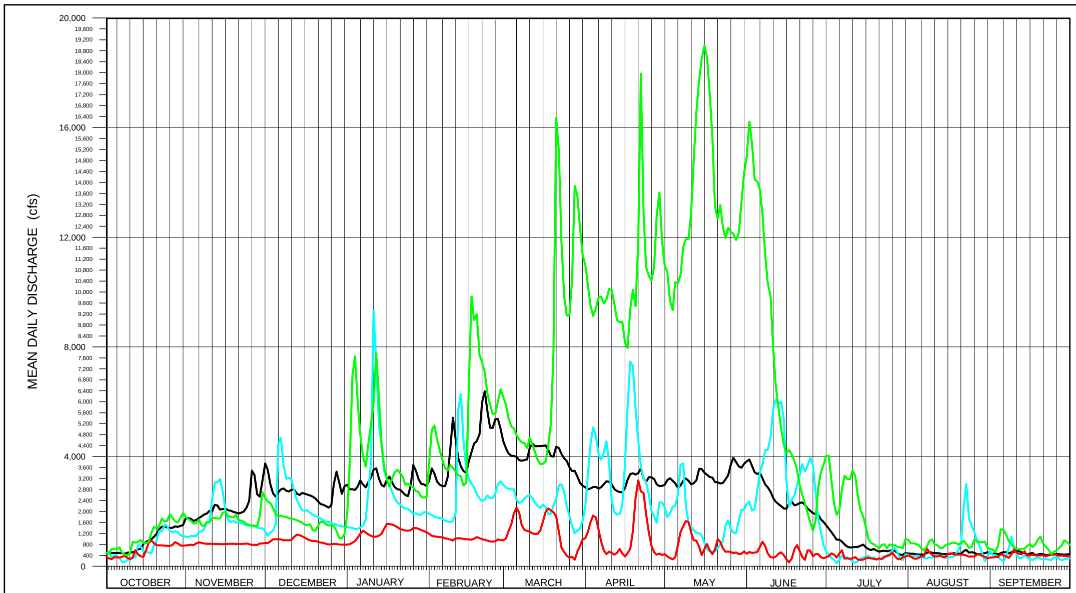


LEGEND

- AVERAGE, UNREGULATED DISCHARGE, WY 1981-1999
- TYPICAL YEAR, WY 1990
- DRY YEAR, WY 1994
- WET YEAR, WY 1997

YAKIMA RIVER NR PARKER
UNREGULATED DISCHARGE
SUMMARY HYDROGRAPHS

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION



LEGEND

- AVERAGE, REGULATED DISCHARGE, WY 1981-1999
- TYPICAL YEAR, WY 1990
- DRY YEAR, WY 1994
- WET YEAR, WY 1997

YAKIMA RIVER NR PARKER
REGULATED DISCHARGE
SUMMARY HYDROGRAPHS

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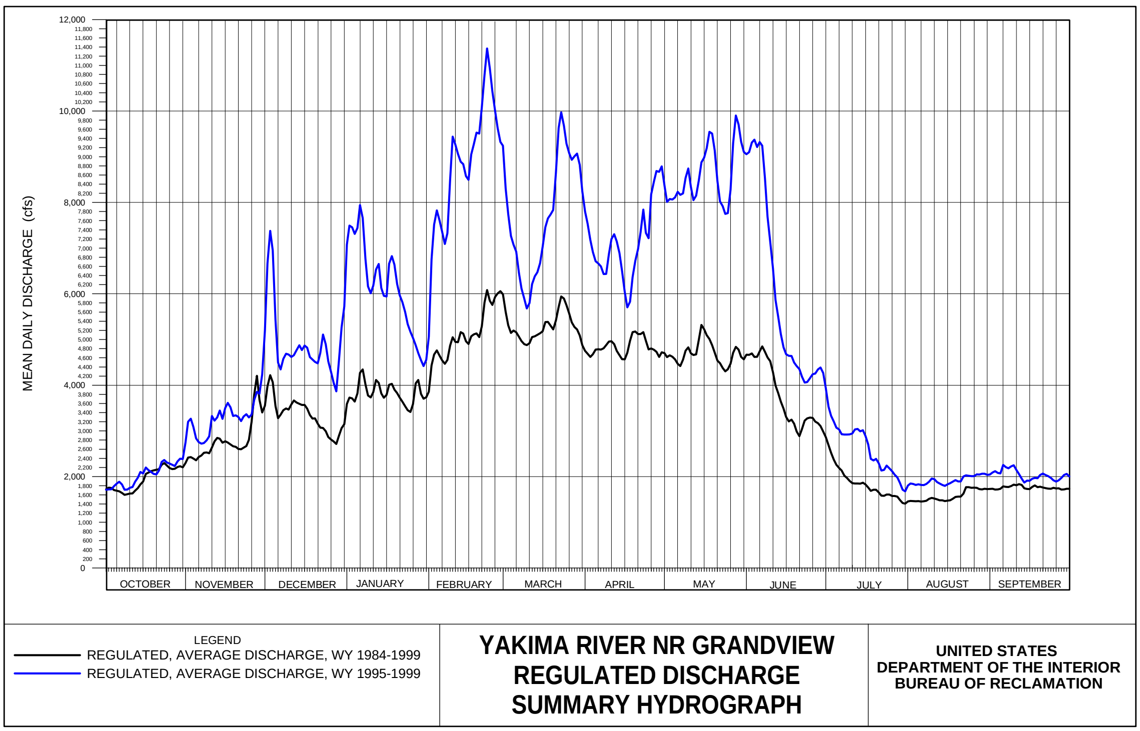
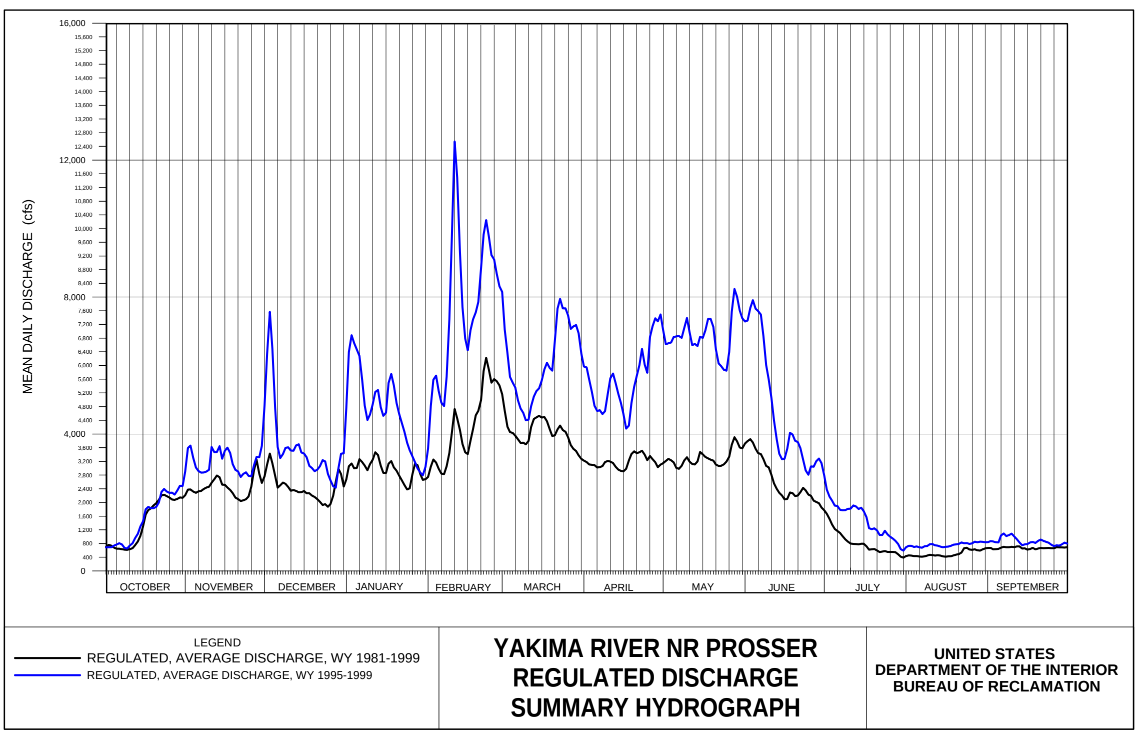
The Yakima River near Grandview (YGVW) regulated discharge hydrograph provides some representation of the natural inflow available below the PARW site. During the non-irrigation season, YGVW shows very good inflow production and variability from the Satus and Toppenish Creeks' drainage basins. During the irrigation season, a large percent of the natural runoff from these creeks is diverted for irrigation, but at the same time, the irrigation return flow drains will also begin increasing from the increased diversion of the irrigation districts. The average annual actual flow passing the YGVW site is 1,975,288 acre-feet. This is an increase of 320,370 acre-feet over PARW's 1,654,918 regulated flow, and is a representative total for natural and return flows for this reach.

Yakima River near Grandview



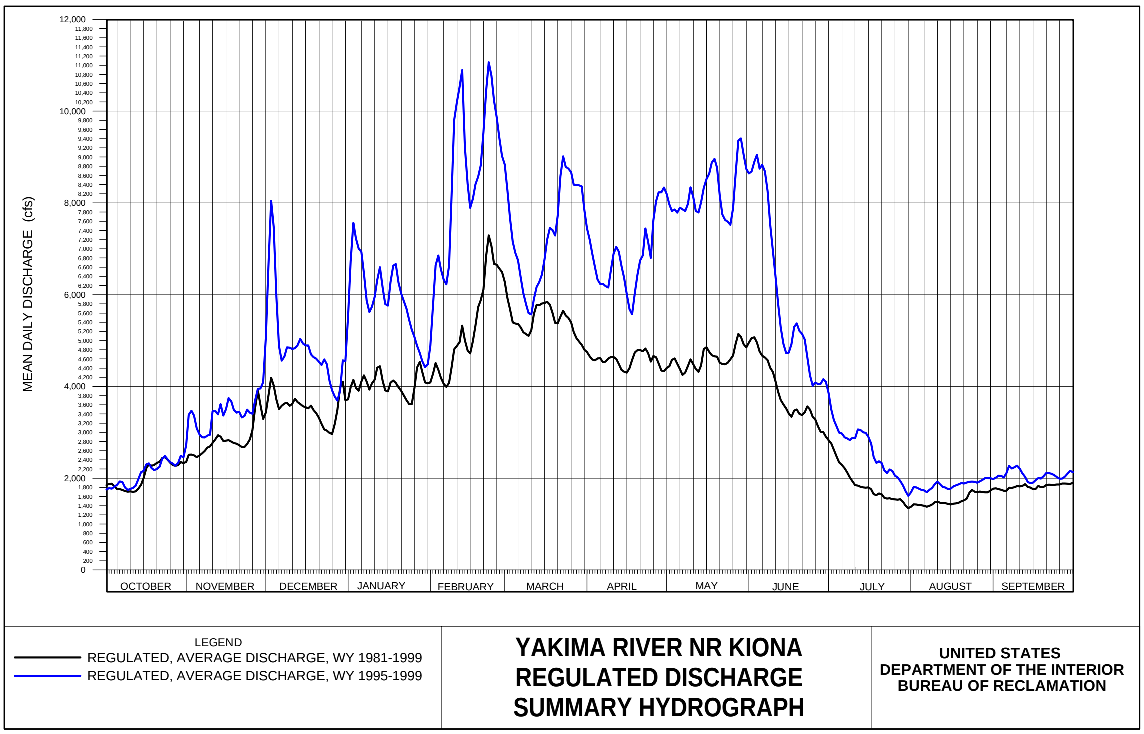
The Yakima River near Prosser (YRPW) regulated discharge hydrograph provides some representation of the natural flow available below the PARW site. During the non-irrigation season, YRPW shows very good inflow and variability from the Satus and Toppenish Creeks' drainage basins, and other creeks located between PARW and YRPW. During the irrigation season, a large percent of the natural runoff from these creeks is diverted for irrigation, but at the same time, the irrigation return flow drains will also begin increasing from the increased diversion of the irrigation districts. The average annual actual flow passing the YRPW site is 1,594,751 acre-feet. YRPW hydrograph regulated flows volume shown is reduced due to the year around annual diversion of 722,359 acre-feet, Chandler Power Canal (CHCW) for power production which includes 97,839 acre-feet annual diversion for Kennewick Irrigation District. These volumes total 2,318,110 acre-feet for this end of the reach between PARW and Prosser Diversion Dam, and is an increase of 663,192 acre-feet over PARW's 1,654,918 regulated flow, and a representative total for natural and return flows for this reach. Note: of the 722,359 acre-feet diverted by CHCW for power production and irrigation demands, 624,520 acre-feet is returned to the river system 10.5 miles below YRPW gaging site. PARW is the controlling site for calculation of TWSA, which is used to establish YRBWEP target flows for YRPW from April through October. These YRBWEP target flows (300, 400, 500, or 600 cfs based on TWSA) set the minimum instream regulated flow for this period of time. Instream flows are also established for power subordination and spawning/incubation flows.

Yakima River near Prosser

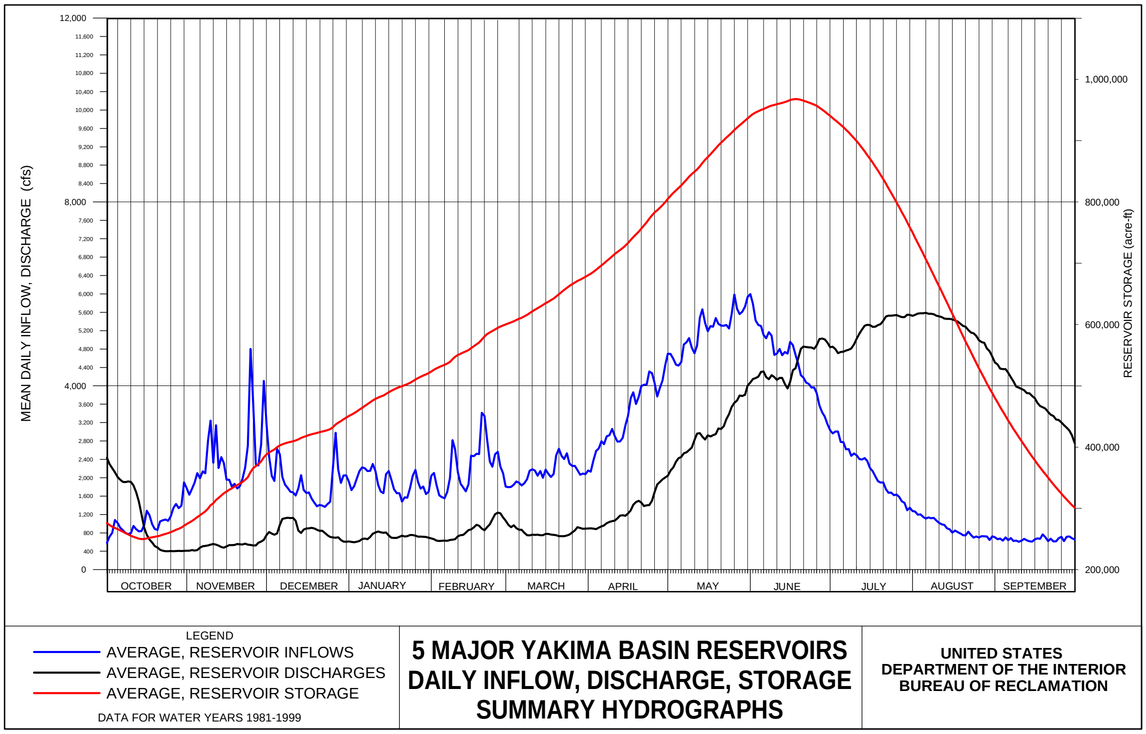


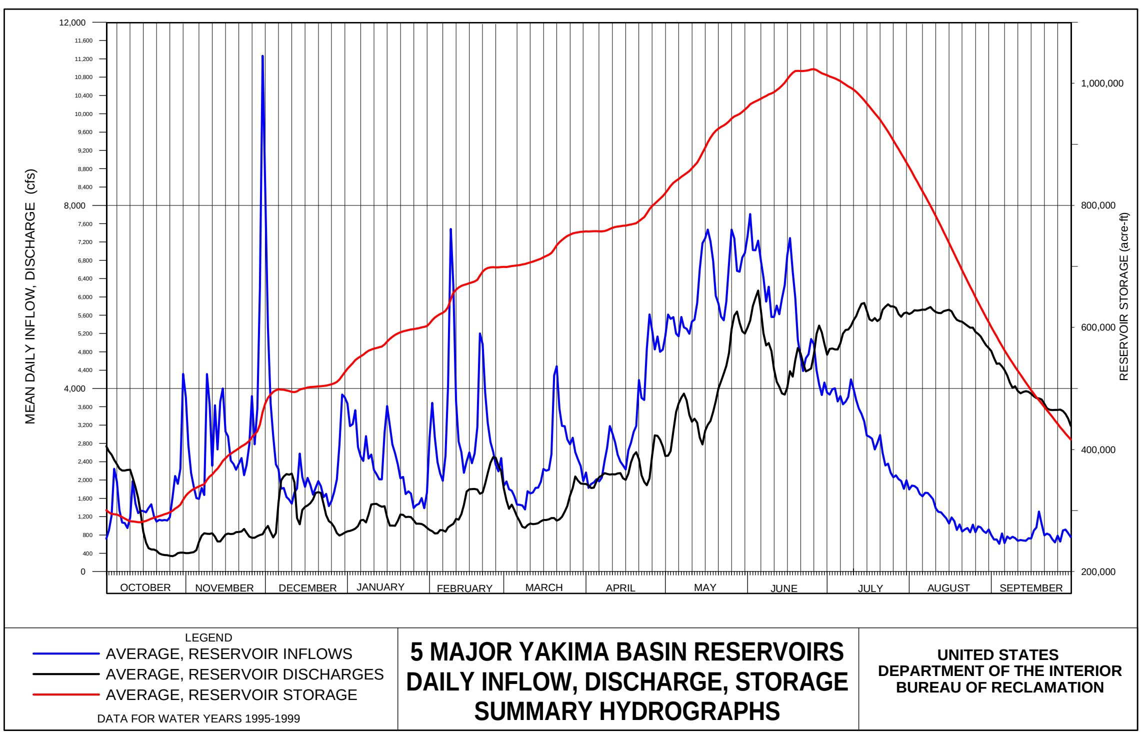
The Yakima River near Kiona (KIOW) regulated discharge hydrograph provides some representation of the natural flow variability available in the lower Yakima River basin. During the non-irrigation season, KIOW shows very good inflow and variability from the Satus and Toppenish Creeks' drainage basins, and other creeks located between PARW and KIOW. During the irrigation season, a large percent of the natural runoff from these creeks is diverted for irrigation, but at the same time the irrigation return flow drains will also begin increasing from the increased diversion of the irrigation districts. There is up to 400+ cfs of daily diversion during irrigation season below the KIOW site and the mouth of the Yakima River. The average annual natural flow passing the KIOW site is 3,970,000 acre-feet (period of record = 1961-1990) with average annual actual/regulated flow total of 2,351,186 acre-feet (59%). Of the KIOW basin average annual natural flow, 1,713,282 acre-feet (43%) is regulated by storage reservoirs, delaying and modifying discharge timing and volume rate of flows by as much as 114 days at the KIOW site.

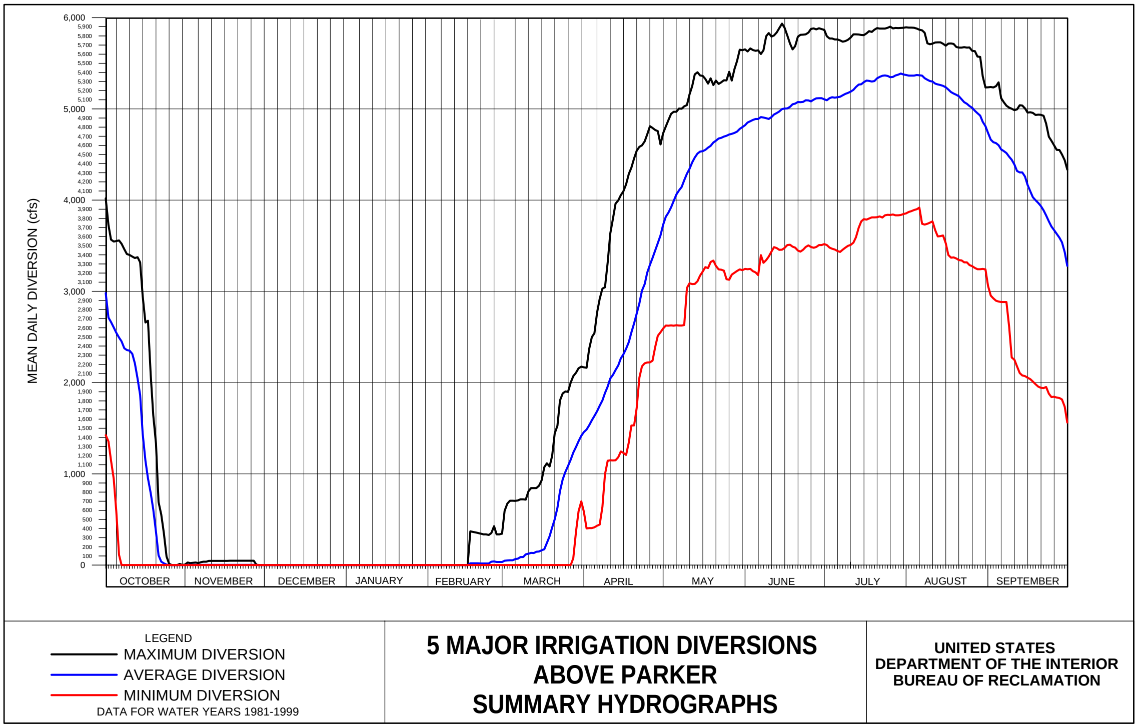
Yakima River near Kiona



System Information – Total of 5 Major Reservoirs and 5 Major Diversions







The first two of the preceding three summary hydrographs represent the combined totals of the five major Yakima basin reservoirs' (Keechelus, Kachess, Cle Elum, Bumping, and Rimrock) daily natural inflow, regulated discharge, and storage content. These graphs provide a combined storage overview of the effects of regulation by storage reservoirs, show the delaying and modifying natural flow timing and volume rate of flows by as much as 6 months. The third summary hydrograph represents the combined totals of the five major Yakima basin irrigation diversions above Parker: KRD, RID, YTID, WIP, and SVID, and shows the timing of peak irrigation demands during the normal low natural runoff season of July through mid-October.

6.2 FISHERY RESOURCES

Numerous factors have affected the fishery resources in the Yakima basin. These include out-of-basin factors such as the hydroelectric dams built on the Columbia River and commercial fishing, as well as those that have occurred within the basin associated with various land use practices (e.g., timber harvest and agriculture), floodplain development, road and railway construction, and irrigation development. Irrigation development includes the construction, operation, and maintenance of the Yakima Project and the lands it serves, the focus of this section. Many fish species are present, or were once present, in the Yakima basin (see section 2.8.2); however, the effects of the project on some species have not been well studied. Of those for which information is available, specific attention will be given to native species and include steelhead and bull trout (both currently listed as threatened under the Endangered Species Act

[ESA]), chinook salmon (fall- and spring-run), coho salmon (considered extirpated, but recently reintroduced), and sockeye and summer chinook salmon which were extirpated and continue to be absent from the basin.

Information for this section was primarily obtained from discussions with fisheries biologists working in the Yakima basin; the Biological Assessment for the Yakima Project; preliminary results of the Ecosystem Diagnostic and Treatment (EDT) model currently under development by the Yakama Nation; and the draft final report entitled "The Review and Synthesis of Ecological Studies in the Yakima River, Washington, With Emphasis on Flow and Salmon Habitat Interactions" (Snyder and Stanford, 2001). Important information is continually being collected, summarized, and reported. The material in this section attempted to incorporate the latest information available. As this is a working document, new information will be incorporated upon the receipt of the Biological Opinions for the Yakima Project by the National Marine Fisheries Services (NMFS) and the U.S. Fish & Wildlife Service (FWS), the completion of the EDT, Northwest Power Planning Counsel's Subbasin summary, and studies currently being conducted by Dr. Jack Stanford under contract to YRBWEP.

There are references in this report to models and other analytical methods for evaluating the impacts of various human activities on salmonid and other natural resources in the Yakima basin. These various tools are used by scientists and other professionals as guides to arrive at recommendations for changes in operations, studies, monitoring protocols, and other actions to improve habitat conditions for salmonids in the Yakima basin. The reference to these models and analytical methods is not meant as an unqualified endorsement of any of them specifically. Nor is the reference to these tools meant to be a recommendation for their future use by any agency or other entity. They have been included to reference the various sources from which information was gathered to arrive at the analyses in this report.

As was described in section 5, the Yakima Project is an extremely complex system which affects various reaches of the Yakima River and its major tributaries differently, even during the same time periods. For this reason, this section will assess the effects of Yakima Project operations on fishery resources reach-by-reach. Sub-reaches within each assessment reach are addressed where appropriate. The eight assessment reaches include:

1) Upper Yakima River from Keechelus Dam downstream to the Roza Diversion Dam (86.5 miles), including Keechelus and Kachess Reservoirs and their tributaries.

2) Cle Elum River from Cle Elum Dam downstream to the confluence with the Yakima River (8.2 miles) and Cle Elum Reservoir and its tributaries.

3) Middle Yakima River from the Roza Diversion Dam downstream to the Prosser Diversion Dam (80.8 miles), including any drains which were formerly natural waterways.

4) Lower Yakima River from the Prosser Diversion Dam downstream to the confluence with the Columbia River (47 miles), including any drains which were formerly natural waterways.

5) Bumping River from Bumping Dam to the confluence with the Little Naches River (16.6 miles) and Bumping Reservoir and its tributaries.

6) Upper Naches River from the Bumping River confluence downstream to the confluence of the Naches and Tieton Rivers (27 miles).

7) Tieton River from Tieton Dam, including Rimrock Reservoir and its tributaries downstream to the confluence with the Naches River (21.3 miles).

8) Lower Naches River from the Naches/Tieton confluence downstream to the confluence of the Naches and Yakima Rivers (17.5 miles).

The construction, operation, and maintenance of the Yakima Project has had a profound effect on the Yakima River ecosystem and the fish populations dependent on it. Four components of the project are considered to be the primary contributors to the decline of native fish resources. These include: 1) storage dams constructed in the upper portion of the basin; 2) diversion dams constructed throughout the basin; 3) effects of flow regulation on fish habitat availability, in-basin survival and productivity; and, 4) effects of the project on water quality. A brief overview of these components follows. Each component is discussed in detail, where applicable, within each assessment reach.

Storage Dams -

Six storage dams have been constructed in the Yakima Basin. Four of these were located at the outlets of natural lakes, including Bumping (1910), Kachess (1912), Keechelus (1917), and Cle Elum (1933). Clear Lake Dam (1914) and Tieton Dam (1925) created new reservoirs by inundating the upper Tieton River basin. Numerous fishery related impacts are associated with their construction.

The reservoirs created by the dams flooded a considerable amount of pristine, high quality fish habitat. Where natural lakes were present they were much smaller than the current reservoirs and miles of stream were lost. The habitat in these historic lake basins was utilized by sockeye, a species which spawns in flowing water, but whose young rear in lakes; and by bull trout, which are present in all of the reservoirs and spawn in tributary streams. It can be reasonably assumed that other anadromous salmonids, particularly steelhead, which are known headwater spawners, utilized this habitat as well. In the case of Tieton Dam, an extensive meadow complex was inundated. The area was almost certainly valuable habitat for bull trout and all native anadromous salmonids, with the probable exception of sockeye.

Even if this habitat were still viable, neither it nor any existing habitat upstream has been accessible to anadromous salmonids since construction of the storage dams. None of these dams is equipped with fish passage facilities. This condition has been most devastating to sockeye salmon which were extirpated in the Yakima basin following the completion of the last storage dam on the Cle Elum River in 1933, if not earlier. The absence of passage has also isolated local populations of bull trout, prohibiting the exchange of genetic material between populations, and preventing the recolonization of populations diminished by catastrophic natural events. Although bull trout populations isolated in Rimrock are considered healthy, fishery biologists addressing recovery of bull trout believe lack of passage to be a major contributing factor in the decline of this once abundant species. It should also be noted that the outlet works for all of the storage dams in the Yakima basin are unscreened. Passage through these outlets can kill and injure fish. The potential for this to be a problem is increased as reservoirs are drawn down late in the irrigation season.

The Yakima Project storage dams also impede or preclude movement of sediment and organic material (e.g., woody debris) to the river downstream. Additionally, gravel movement in the Tieton River is impeded due to the Tieton Dam. The consequential effects on channel morphology, substrate characteristics, habitat quality, and productivity are usually significant. The downstream migration of bed materials is an essential process which maintains channel complexity and thus habitat quality. The recruitment of gravels and small cobbles, essential for the construction of redds by spawning salmonids, is necessary to replace those that are inevitably washed downstream. Coarse particulate organic matter, ranging from large trees to leaf litter, is an important energy and structural component of all riverine ecosystems. Large woody debris (LWD) provides physical habitat for both fish and aquatic invertebrates, while leaf litter is an essential energy source in the food chain that drives stream productivity.

Diversion Dams -

Six major diversion dams are a part of the Yakima Project (Easton, Roza, Sunnyside, Wapato, Prosser, and Yakima-Tieton) and other non-Reclamation operated facilities (Wapatox and Wanawish) have a significant influence in the operation of the Yakima Project. Other diversion dams of note are listed in table 6-7. Reclamation operated diversion dams are maintained within NMFS criteria. However, all diversion dams effect fishery resources regardless of how well they are operated or maintained. These effects include passage/entrainment problems at ladders, screens and bypasses (this includes delays); predation below dams or at bypass returns; adverse maintenance schedules and operating protocols; disruption of bed load transport and deposition; and impediments to transport of LWD. These concerns are addressed specifically at each project diversion.

Table 6-7. – List of non-Reclamation operated diversion dams in the Yakima River basin that are considered in operation decisions.

Diversion Dam	River Mile
Yakima River	
West Side	166.1
Ellensburg Town Canal	161.3
Selah-Moxee	123.6
Moxee	115.9
Naches River	
Naches-Selah	18.9
Naches-Cowiche	3.6

Diversion dams inherently cause passage problems. However, if they are properly designed, maintained, and operated within NMFS criteria they provide passage for anadromous salmonids and most other species. The above diversion dams are now equipped with facilities that generally operate within currently accepted NMFS criteria and pass the anadromous species of fish. However, fish protection facilities were not designed to protect most native resident species and these species do experience passage problems (adult lamprey cannot ascend ladders and very small resident fish, stickleback and dace can be entrained behind screens). Additionally, several fish screens and a few bypass outfalls, particularly in the lower river, have created conditions conducive to significant avian and piscivorous fish predation mortality.

It is generally believed that minor passage delays at a diversion dam do not pose a significant problem to emigrating smolts. The cumulative effects of delays at several diversion and hydropower dams may impact smolt migration, but it is unknown at this time what those impacts are.

While Reclamation attempts to accommodate fish when performing operation and maintenance activities, non-fish related operations and maintenance issues associated with Reclamation's contractual commitments are generally treated with higher priority (i.e., installing flashboard to ensure that diverters get their full allotment of water). Additionally, some maintenance activities can essentially pit various life stages of the same species against each other. An example would be fall screen maintenance which helps protect juvenile fish, but also alters flow levels below the Roza and Prosser Diversion Dams at a time when adult fall chinook and coho are spawning. During routine maintenance, debris is sometimes removed from diversion structures, and likewise, from the river. This debris would provide important organic material for productivity. Another effect of operations and maintenance activities for irrigation and flood control is the resultant flow fluctuations and occasional release of fine sediments, both of which affect fish life and habitat.

Annual maintenance of the fish screens takes a minimum of 4 weeks per site. In many cases, it is necessary to dewater the screens before maintenance work can be completed. It takes about 3 days to dewater the large main canals in order to work on the screens. The dewatering process places fish at risk in areas where the water pools in depressions rather than draining directly to the river via the fish bypass system. Sites where water can pool during the dewatering process include the Chandler, Sunnyside, Wapato, Roza, and Easton screen sites. Sites where fish can be stranded include Chandler, Sunnyside, and Roza. As dewatering occurs, if fish are noted ahead of the screens, State biologists are requested to help with fish salvage, if possible. Maintenance and repair of hydropower facilities are generally coordinated with annual screen maintenance, however, this is not always the case and is discussed in those affected reaches.

Diversion dams affect the transportation of bed material (fine and course sediment) and LWD, which affects fishery resources. The geomorphic consequences and their effects on the fishery resources are difficult to describe. Habitat complexity is reduced downstream because key physical components are being removed or restricted.

Flow Regulation -

Project operations significantly alter the timing and magnitude of flow in most reaches of the basin. These effects vary across space and time. For example, while some reaches are subjected to much higher than natural flows from July to September, other reaches experience much lower than natural flows during this time period. Further, the manner and magnitude of project effects to the basin hydrograph varies significantly by water year. During the relatively wet year of 1997, project operations severely dampened the magnitude and extended the duration of the spring peak flow. During the dry year of 1994, project operations essentially eliminated the spring peak flow. While the ecological consequences of those deviations from the unregulated conditions have not been fully described, they are undoubtedly more pronounced during dry water years.

Fluctuation of flows related to the operation of the project has been identified as a possible concern for rearing juveniles and the food web. Significant fluctuations in the flows on a weekly, daily, or even hourly basis may cause cyclic dewatering and re-watering of the near shore habitat, which could result in reductions in biotic productivity (Perry et al., 1986; Reckendorfer et al., 1996; Schiemer et al., 1991; Travnickey et al., 1995; Weisberg et al., 1990). The effects of flow fluctuations can vary depending upon many factors, such as the physical characteristics of the river and the severity of the fluctuation. The stranding of salmonid fry during flow fluctuations has been documented in northwest streams (Stober et al., 1981; Woodin, 1984). Flow fluctuations alter macro-invertebrate production (Ward, 1976; Becker et al., 1981; Cushman, 1985; Jordonnais and Hauer, 1993) and thus could potentially reduce the food base. These fluctuations can have immediate lethal effects to fish, or indirect or delayed biological effects to fish and river productivity (Hunter, 1992).

Water flow is related to several environmental attributes such as: water quality (temperature), sediment dynamics, riparian vegetation, floodplain connectivity, and many other ecological processes. Regulation of the flow compromises these processes and inherently affects fish and other aquatic organisms. Flows mimicking a natural hydrograph result in the greatest benefit to the aquatic environment and the fisheries resources associated with them (see Snyder and Stanford, 2001; and System Operations Advisory Committee [SOAC], 1998 for summary). To affect this recovery, a normative ecosystem approach should be adopted. A normative ecosystem provides for "properly functioning conditions" (PFC), standards that are essential to maintain diverse and productive populations while accommodating uses to the extent practicable. The "normative river ecosystem" combines physical habitat with a flow regime designed to create and maintain a continuum of high quality habitat for all biota, primary production (algae), secondary production (benthic invertebrates), and the various life history stages of the native fish assemblage. Before development, the natural hydrograph interacting with the channel, floodplain, and shallow groundwater system formed the physical template within which native species evolved. The challenge of the normative ecosystem concept is to identify and recreate those key features of the natural hydrograph and physical habitat necessary to restore "properly functioning ecosystems" while continuing to meet human needs.

Hydrographs comparing unregulated runoff to regulated runoff in relation to magnitude, frequency, duration, timing, and rate of change at several locations in the basin are displayed in section 6.1.2. A larger difference in flow regime between regulated and unregulated indicates a greater negative effect on the aquatic ecosystem. Comparing regulated to unregulated hydrographs is only a starting point for describing the effects of flow manipulation. Using tools like the "Range of Variability Approach" (RVA; Richter, B.D. et al., 1997) and an ecological model such as EDT may provide greater resolution in determining relative effects on key species of concern such as salmon and steelhead. Monitoring should be conducted to assess the validity of any ecological model used.

Water Quality -

The Yakima Project affects water quality as described in section 6.1.1 of this document. Water quality has improved recently through better management of return flow from agricultural drains. The specific effects of compromised water quality on fish are sometimes difficult to describe. Some effects are direct, such as fish consumption advisories for resident fish that bio-accumulate pesticides in the lower river. Other effects are indirect such as modifying the aquatic insect community due to pesticide contamination or sedimentation, which in turn adversely affects the fish community. Project operations that affect water quality detrimental to fish are described for each reach.

6.2.1 Upper Yakima River

The upper Yakima River is broken down into several sub-reaches which are described below.

Storage Dams

Keechelus Dam and Reservoir -

The effects on the native fishery and the physical processes necessary to maintain habitat, resulting from the construction of Keechelus Dam, were generally described previously in this section. While native species distribution before construction of the dam is unknown, coho, and sockeye salmon as well as steelhead trout were all historically reported to have been present above the structure. A significant amount of spawning and rearing habitat exists in the numerous tributaries which flow into Keechelus Lake. The dam permanently blocked access to this habitat. In addition to this habitat, the reservoir inundated an additional 4-5 linear miles of habitat in the low gradient sections of these streams flowing into the lake.

An isolated population of bull trout resides in Keechelus Lake and spawns in Gold Creek. Adult spawners migrate from the lake in July and August when Gold Creek flows are usually low and the reservoir is drawn down. These fish may encounter impassable conditions in the portion of the stream flowing across the exposed lake bottom where the channel is not well-defined. During the summer of 2000, passage conditions through the inundation zone were marginal at best (Jeff Thomas, FWS, Yakima WA, personal communication, 2000). Additionally, a portion of the creek near Gold Pond generally dewaters in late summer particularly in low water years.

Kachess Dam and Reservoir -

Kachess Dam also presents general problems associated with storage dams. Approximately 1 mile of tributary habitat is seasonally inundated. While native species distribution before construction of the dam is unknown, coho and sockeye salmon as well as steelhead trout were all historically reported to have been present above the structure. Adult migration into and out of Box Canyon Creek, the primary spawning tributary, may be affected by the annual drawdown of the lake. As the lake is drawn down, the exposed stream channel on the lake bottom becomes ill-defined as it flows across the permeable lake sediments and may be too shallow for bull trout passage. In the fall of 1996, Reclamation constructed a single channel through the inundation zone. The project was successful in providing bull trout passage in 1997 and 1998 (above normal water years), but downstream passage problems may still persist particularly for adults returning to the reservoir. In a dry water year when the reservoir is drafted to a lower level, upstream passage may still be a problem.

Passage problems for bull trout also occur in the Kachess River as it annually dewaters above the inundation zone. It is not clear what processes are contributing to stream dewatering. Adfluvial adults were observed in the river above the reservoir for the first time in October 2000. These fish were observed after the river established a surface water connection with the reservoir shortly after a rain event. In late October 2000, two dead adult adfluvial bull trout were found in an isolated pool in the inundation zone (Eric Anderson, Washington Department of Fish and

Wildlife [WDFW], Yakima WA, personal communication, 2000). Kachess River had lost connection with the reservoir after adfluvial fish had entered the stream.

Diversion Dams

Lake Easton Diversion Dam -

The fish ladder at Easton was rebuilt in 1987, to meet NMFS passage criteria for anadromous salmonids. A counting and imaging device was installed in October 2000, which should help determine if bull trout are able to use the ladder. The fish ladder is operated all year except during water-short years when it may be closed from May through October. This is done to prevent spring chinook salmon from spawning in an area which cannot be protected from dewatering because of a competing need to fill Kachess Reservoir (see mini flip-flop in section 5.2.5). Reclamation generally closes the ladder after consultation with SOAC and others. Closure occurs approximately 1 out of every 10 years.

During the irrigation season, but prior to spring chinook spawning, sediment is flushed from behind Easton Dam through the sluice gates. This sediment can impact the ecosystem downstream of Easton Dam. In the past, and under certain circumstances, when the sluice gates were opened sediment flushed to the area downstream, which is spring chinook spawning habitat. This maintenance procedure has now been altered. The sluice gates are opened periodically throughout the year to remove sediment incrementally. For example, the sluice gates are opened in the spring when flows are high, so that the sediment can be dispersed. Now, when the gates are opened during the fall maintenance activity, the sediment load is relatively low and thus impacts to spring chinook redds are minimized.

There are no identified fish issues related to the screens or maintenance of them at Easton Diversion Dam.

Flow Regulation

Keechelus Sub-Reach -

The Keechelus sub-reach extends from Keechelus Dam downstream to Lake Easton (11.5 miles). Flows in this reach are largely controlled by releases from Keechelus Reservoir (hydromet gage KEE). This reach contains high quality habitat, the suitability of which is compromised by the flow regulation. Regulated summer flows, on average, exceed the estimated unregulated spring peak flow. Regulated flows based on daily average during irrigation season in June, July, and August range from 2 to 10 times greater than the estimated unregulated (natural) flows and last almost twice as long in duration (see figures on page 6-21). Flows of this magnitude and duration can displace rearing salmonids, impede the establishment and development of riparian habitat (a key provider of cover and food for all fish), and negatively affect the invertebrate community. Food may be a limiting factor for rearing salmonids in the upper Yakima River (Todd Pearson, WDFW, Ellensburg WA, personal communication, 2001). In early September, the flow is reduced over a 10-day period, from approximately 1,200 cfs to 100 cfs, with the onset of the flip-flop and mini flip-flop operation (see section 5.2.5). This can strand or displace juvenile fish, disrupt spawning bull trout, strand invertebrates, and reduce the benefits of the riparian cover as the channel moves away from its banks.

In November, following the spawning period of both spring chinook salmon and bull trout, flows are further reduced at the onset of the winter storage period. While this appears to provide protection to these redds with respect to surface flows, there are indications that subsurface (i.e., hyporheic) flow conditions are affected by reductions in surface flows (Mark Bowen, Reclamation, Denver CO, personal communication, 2001). The streamflow is set by the Field Office Manager, after consultation with SOAC, irrigation district managers, and his environmental staff and others, in an attempt to provide flowing water at a depth of no less than 2 inches over the tailspills of established redds. A study is currently underway in the Yakima basin to determine if there are any effects on salmonid egg survival resulting from flow reductions following the spawning period. It should be noted that this is not a natural hydrologic condition.

Flows usually begin to increase in December, but can be highly variable year-to-year depending on weather, carryover storage, and the need to evacuate some Keechelus storage to meet flood control guidelines. From October through March the regulated flow remains fairly steady, unlike the dynamic natural flow, and is maintained at a much lower magnitude. This reduces the amount and quality of winter rearing habitat for juvenile fish protected the previous winter during the egg/alevin life stage. Spring peak flows are also reduced.

Kachess Sub-Reach -

The Kachess sub-reach is comprised of the Kachess River from Kachess Dam to its confluence with Easton Lake (1 mile). Regulated flows from Kachess Reservoir are presented from hydromet data gathered at KAC (see figures on page 6-23). This reach is of limited value as fish habitat because of its severely altered hydrograph and short length. Regulated flows during the October through May reservoir refill period are severely reduced and lack natural fluctuation. This severely reduces the available habitat for rearing juveniles. Peak flows do not occur during the usual May through June period and are a contributing factor to poor emigration cues experienced in downstream reaches. The sustained high flows that are released from Kachess Dam in September and early October during the mini flip-flop operation, are drastically reduced in mid-October after bull trout and spring chinook salmon spawn, which could leave redds dewatered. In past years, Kachess River downstream of the dam was dewatered in the fall and winter during reservoir refill operations. With the implementation of the mini flip-flop operation, this reach has essentially been sacrificed to protect spring chinook salmon redds in other upper Yakima River reaches (Keechelus, Easton, and Cle Elum) with great amounts of high quality spawning and rearing habitat.

Yakima River at Easton Sub-Reach -

The Easton sub-reach extends from Easton Diversion Dam downstream to the confluence of the Cle Elum River (16.5 miles), and provides highly suitable spawning and rearing habitat for spring chinook salmon. This sub-reach is the most productive spring chinook spawning area in the Yakima basin. The hydrograph that depicts this reach is EASW (see figures on pages 6-25 thru 27). The regulated flows in the Easton reach match the fluctuating pattern of a natural hydrograph from November through February, although at a reduced magnitude. Starting in March, larger differences between regulated and unregulated flows begin to appear and by May peak flows are reduced by nearly two thirds. This reduction in flow is the result of reservoir storage and diversion to the KRD at Easton Diversion Dam. This affects emigration cues for anadromous smolts rearing in the upper river and downstream reaches as well. Beginning in late July, regulated flows more closely mimic that of unregulated flows in magnitude, but still slightly higher. In early September, flows are dropped for flip-flop so that spring chinook spawn at a lower flow, thus making it possible to provide incubation flows during the winter storage period. Initial spawning flows are “near-unregulated” flow levels, but as rains begin to fall in October, spawning flows remain steady whereas the unregulated flows increase and can show much variation.

Yakima River at Cle Elum Sub-Reach -

This sub-reach extends from the confluence of the Cle Elum River to Roza Dam (57.5 miles). The Ellensburg Town Diversion Dam, a channel spanning diversion dam, is located in this reach and flows are described by the hydromet gaging station UMTW (Yakima River near Umtanum; figures on pages 6-36 & 37). This upper portion of this reach is an important spawning area for spring chinook and the entire reach provides rearing habitat. It also provides a popular rainbow trout fishery. Anadromous salmonid movements are effected by seasonal flow patterns and reduced peak flow (nearly 50% unregulated) in early spring. Conversely, abnormally high flows occur from the beginning of July through early September when flip-flop is initiated. By mid-August streamflows in this reach average 600 percent of those which would occur under unregulated conditions and undoubtedly affect the feeding behavior of juvenile salmonids. Preliminary results from studies examining the stomach contents of these fish have shown that they are not feeding efficiently (Todd Pearson, WDFW, Ellensburg WA, personal communication, 2001) and suggest that this may be a factor limiting production. Another likely effect of these midsummer peak flows is the downstream displacement of juvenile salmonids. Finally, flows which diverge from the natural flow regime to this extent could be expected to alter the composition and diversity of the aquatic invertebrate community, the primary food source of juvenile salmonids. With the implementation of flip-flop in early September, streamflows are drastically reduced to a level representing a natural flow condition which persists for approximately 1 month. The sudden change in river stage strand invertebrates and thus affects the food base.

A daily pattern of river flow fluctuations are recorded at the Umtanum gaging station in the Yakima canyon reach RM 147-127 (see figure 6-1). This fluctuation appears to be related to the return flows from the Kittitas Valley above the canyon. Gaging stations above the Kittitas Valley do not show the same kind of regular, large fluctuations.

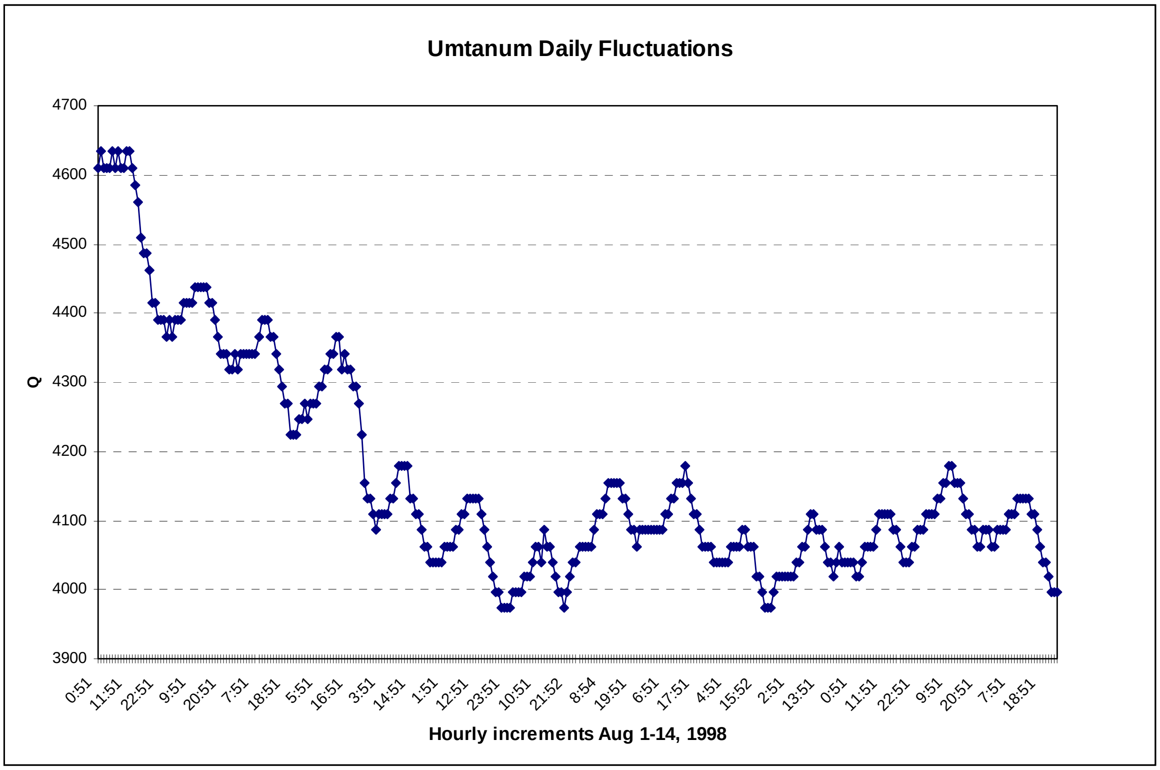


Figure 6-1

Water Quality

Water quality in the Upper Yakima River is considered good above the confluence with Wilson Creek.. Wilson Creek is used as a large agriculture return within this reach and enters the Yakima River at the head end of the Yakima Canyon (RM 147). The quality of water in Wilson Creek is degraded by FC, heavy sediment loading during the irrigation season, and pesticides.

John Vaccaro's temperature model simulations indicated that flow regulation would actually produce lower July - August temperatures in the upper Yakima River than the unregulated condition (Vaccaro, 1986). Other water quality parameters may also be affected.

6.2.2 Cle Elum River

Storage Dams

Cle Elum Dam and Reservoir -

The project effects to fish which are common to all storage dams apply to Cle Elum Dam and Reservoir. Unique effects of project operations are unknown. Very little information is available on Cle Elum bull trout populations, and it is not known definitely whether lake drawdown is impeding bull trout passage into or out of Cle Elum Reservoir. In the fall after flows have been reduced for spawning spring chinook salmon, dead burbot (*Lota lota*), a species of concern in Washington State and a lentic species, have been observed just downstream of the dam. This documents that entrainment is occurring and could be worse during high flow releases.

Diversion Dams

Project diversion dams are not in this reach.

Flow Regulation

The Cle Elum River reach is 8.2 miles long and the flow is measured at the gage below Cle Elum Reservoir (CLE). The Cle Elum River, although limited in length, is also an important spring chinook spawning and nursery area in the upper Yakima River. The river is characterized by a broad channel with several large side channel complexes that do not become connected to the main river unless the flows are above 500 cfs. Approximately a quarter mile of river from the dam downstream to the Green Bridge is channelized. The Cle Elum River is dependent on releases from the reservoir for its inflow; there is no significant inflow from tributaries downstream from the reservoir. Regulated flows in the Cle Elum River represent a major alteration to the magnitude and timing of unregulated flow (see figures on page 6-29). Spring peak flows can be less than half of unregulated, severely impacting emigration cues to fish in downstream reaches. Summer (July, August, and early September) flows are extremely elevated due to peak irrigation deliveries prior to implementation of flip-flop, up to 10 times unregulated flows and protracted. Regulated summer flows are much higher than those which would occur during the spring under unregulated conditions causing downstream displacement of juvenile fish and severely compromising their ability to feed effectively. With flip-flop in early September, flows are drastically reduced from approximately 3,000 cfs to 300 cfs or less depending on available storage in the reservoir. This reduction can strand juvenile fish which have sought refuge in side channel habitat and strands invertebrates in areas now dewatered and thus affects the food base. There is usually a slight reduction in streamflow in November following spring chinook spawning to maximize storage while still attempting to protect incubating eggs. While redds may have been dewatered following this reduction in the past, Reclamation has been attentive to the situation in recent years and redd dewatering has not been a significant problem. The incubation flow level is held fairly constant over the winter until late March when releases from the dam gradually begin to increase. Flows during this period are approximately one third of what would occur under unregulated conditions. As mentioned above, there are several large side channel complexes on the Cle Elum River which are cut off from the main channel at flows below 500 cfs. These side channels would supply highly suitable winter rearing habitat for juvenile salmonids were they accessible.

Water Quality

Water temperature is affected when the project transitions to flip-flop operations (figure 6-2). A slight decrease in water temperature is evident and is related to a drop in flow. On September 8, 1998, flows were reduced from 1,200 cfs to 950 cfs; on September 9, 1998, flows were reduced from 900 cfs to 500 cfs; and finally on September 10, 1998, flows were reduced from 500 cfs to 200 cfs where they remained the rest of the winter. Water temperature is also likely affected at other times of the year in relation to alterations to the hydrograph, but data is not available to document this. The cause for the temperature change may be related to the way in which water was drawn from the reservoir, but this is only speculative at this time.

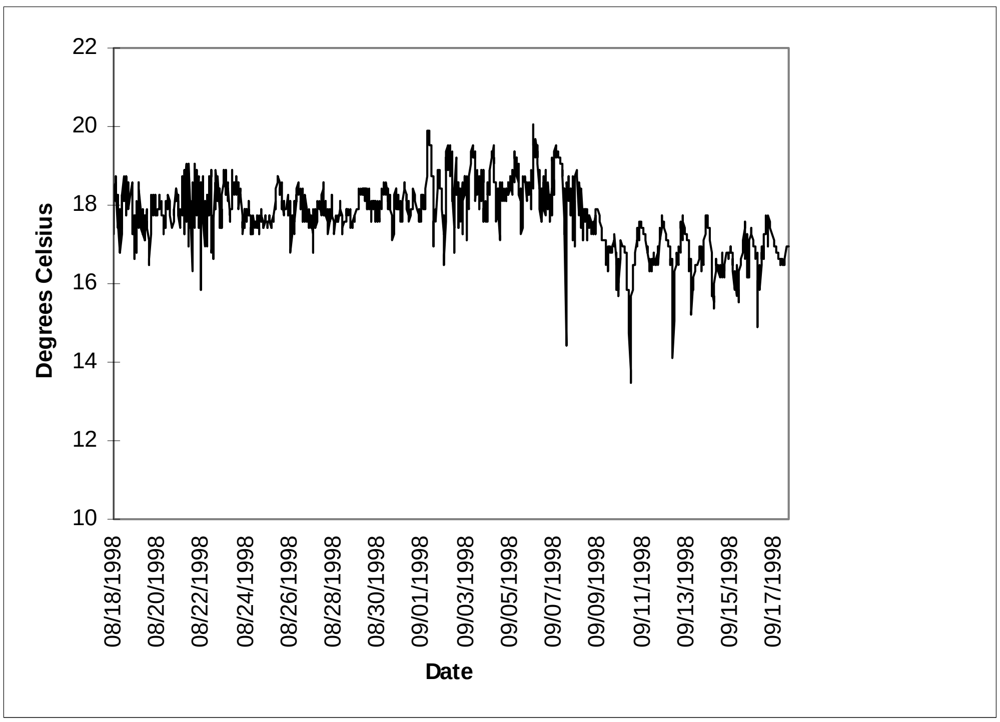


Figure 6-2. Water temperature (degrees Celsius) from August 18 through September 19, 1998, on the Cle Elum River. (Unpublished data, Pat Monk, consultant/fisheries biologist for Yakima Basin Joint Board.)

6.2.3 Middle Yakima River

The middle Yakima River is broken down into several sub-reaches which are described below.

Storage Dams are not present in this reach.

6.2.3.1 Roza Diversion Dam to Naches River Confluence

Diversion Dams

Roza Diversion Dam -

The fish ladder at Roza Diversion Dam meets current fish passage criteria for year-round operation. One atypical protocol has been employed to assist passage in the right bank fish ladder. As fish move into the entrance of the passage facility they tend to hang up or hold in a pool near the diffuser where extra attraction water is added. Occasionally the attraction water is turned off and the fish complete their assent of the ladder. Bull trout are occasionally seen passing the dam (personal communication, Mark Johnston, Fisheries Biologist, Yakama Nation, 2001). In 1990, the Yakama Nation installed a video camera in the ladder to count fish swimming past the diversion dam. The ladder is also equipped with a fish trap which is utilized to collect spring chinook salmon for the Yakima Klickitat Fisheries Project supplementation program. The fish screens and bypass also meet fish passage criteria. Large rainbow trout *(O. mykiss)* and juvenile spring chinook have been captured via electrofishing in standing pools behind the screens after the canal is dewatered for maintenance (personal communication, Mark Johnston, Fisheries Biologist, Yakama Nation, 2001). Additionally, a fyke net fished behind the screens in the spring of 1999 produced approximately one dozen rainbow trout and spring chinook salmon fry. Very little effort was afforded to this endeavor, approximately 2 weeks of effective sampling in April, due to equipment problems and poor sampling location (personal communication, Walt Larrick, Reclamation, 2001; and Mark Johnston, Fisheries Biologist, Yakama Nation, 2001). Further investigation was recommended to determine the magnitude of this occurrence.

The Roza Diversion Dam disrupts the natural sediment transport processes in this reach of the Yakima River. Prior to 1998, the gates at Roza Diversion Dam were raised prior to screen maintenance every fall season to dewater the screen site. This dramatically reduced the water in the Roza Dam forebay and released the accumulated sediment behind the dam. The released sediment resulted in the siltation of spring chinook and coho salmon redds below the dam. In 1998, a new dewatering process was utilized to prevent these adverse impacts where the dam gates are raised only enough to lower the pool to an elevation approximately 1.5 feet below the floor of the canal and fish screens. This reduced the amount of sediment flushed downstream. However, in December 2000, this established protocol was altered and resulted in a large amount of sediment being released. The specific effects to fish are unknown at this time, but the operation likely deposited sediment on spring chinook and coho redds.

Another maintenance concern associated with Roza Diversion Dam is stranding. Juvenile salmonids have been stranded in the afterbay and in the trough in front of the screens (20 to 30 juvenile salmonids were salvaged in 1998) when the canal is dewatered. The canal is not only dewatered for annual maintenance, but also to protect the screens when the river begins to freeze. The floor slab of the original screening facility has been notched and water and fish in the afterbay drain back to the river or escape through the original drum screen fish bypass slots and drains. Some fish are still stranded in the remaining pools and will die if not removed. Removal is difficult if ice builds up around the screens and covers the standing pools.

The operation of the roller gates is also a concern (see section 5.4). Operating just one gate may cause silt build up behind the passive gate and impede sediment transport. Periodic cycling of the two gates reduces or eliminates this effect.

Flow Regulation

Flows in the Yakima River from Roza Dam to the confluence of the Naches River (11.6 miles) are represented by the gaging station below Roza Dam (RBDW; see figure on page 6-38). Coho regularly spawn in this reach and occasionally steelhead, fall and spring chinook are observed. Likewise all these species also rear here. Unregulated discharge is not calculated at this site. Flows are characterized, in general, by high flows in the summer during irrigation season and low flows in the winter during reservoir storage and diversions for power production at the Roza Power Plant. The Roza Diversion Canal has the capacity to divert 2,200 cfs, approximately 1,260 cfs for irrigation and 940 cfs for power production. The non-irrigation season diversion could be up to 1,123 cfs for power production only. Water used to generate power is returned to the Yakima River 14.6 miles downstream of the diversion dam. Reclamation maintains an informal agreement (circa late 1980s), in consultation with SOAC and others, to maintain a 300 cfs minimum flow (400 cfs when power is being generated) below Roza Dam. The reach directly below Roza is confined to a large extent by canyon walls. Further downstream it is characterized by a single channel confined by dikes and bank protection.

Flow fluctuations are a concern below Roza Diversion Dam as the daily fluctuations seen at the Umtanum gage can be accentuated or dampened by the operation of the large roller gates at the Roza Diversion Dam (figure 6-3). This fluctuation in the river flow is moderated by the inflow of the Naches River at the end of the sub-reach.

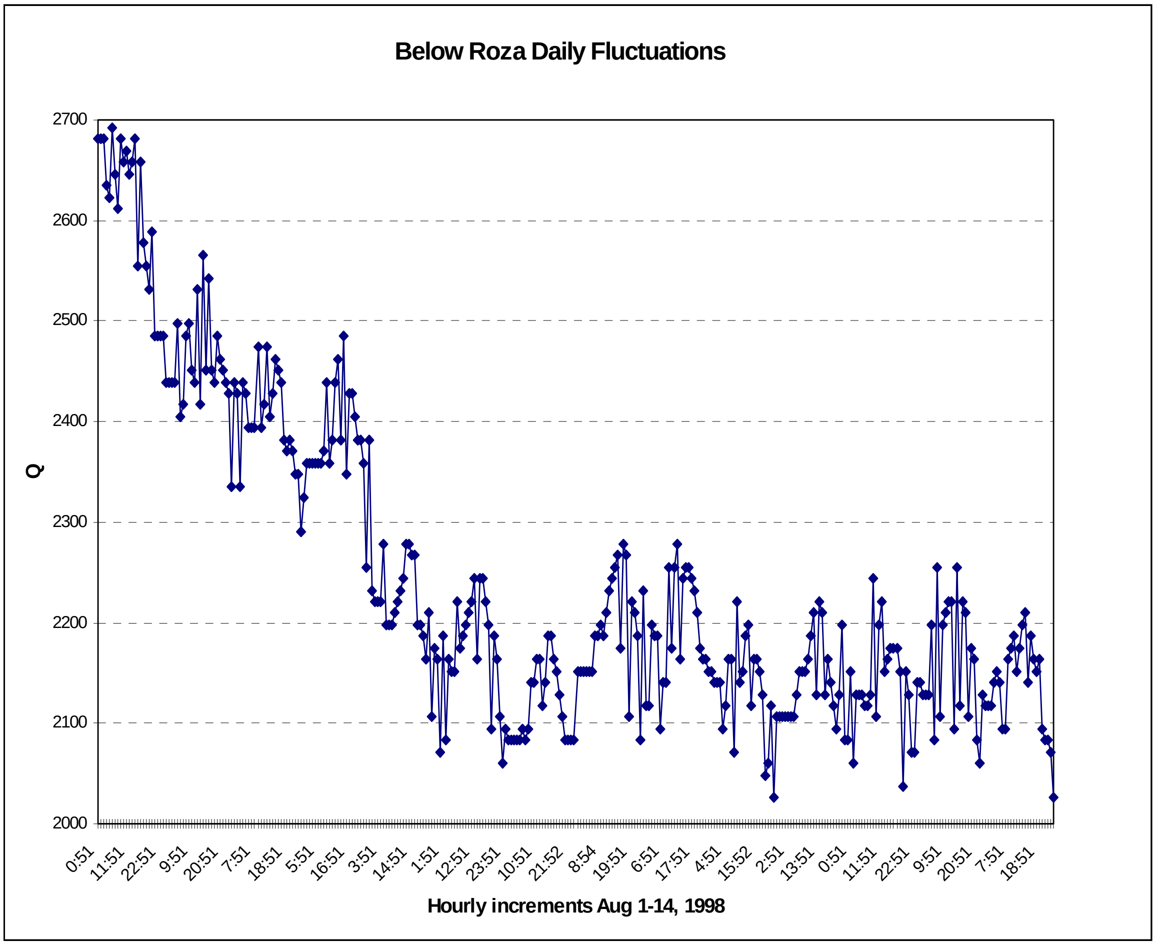


Figure 6-3. Hourly flows at the Below Roza Gage for the period of August 1-14, 1998.

In the late fall or early winter, annual screen maintenance occurs at Roza Diversion Dam. During maintenance, water is not diverted into the Roza Canal, and instream flows increase. Coho salmon and a small number of fall chinook are spawning in this sub-reach at this time (mid-October through December). When maintenance is completed, the power diversion resumes, which reduces instream flow and has resulted in dewatering of redds depending on the timing of maintenance relative to spawning activity and magnitude of power diversion.

Water Quality

The Yakima Project creates no known water quality concerns in this reach when maintenance and operation procedures are carried out properly. In December 2000, turbidity increased significantly as the Roza Pool was drained due to a change in standard protocols.

6.2.3.2 Naches River Confluence to the Roza Power Plant Return (Roza Wasteway #2)

Diversion Dams

Project diversion dams are not located in this reach.

Flow Regulation

This reach borders the city of Yakima, and the west side is generally confined by a dike. This reach is 3 miles long and contains some side channels, islands, and backwater areas. This sub-reach is known to support coho and some fall chinook spawning, and also provides rearing habitat for all salmonid species. A hydromet gage is not located in this reach and, therefore, flows in this sub-reach are deduced by looking at the hydrographs for the Naches River at Naches (NACW) and the Yakima River near Umtanum (UMTW). The inflow of water from the Naches River moderates fluctuations evident in the reach directly upstream. During the non-irrigation season (mid-October to mid-March), flows in the Naches River are substantially lower than unregulated because water is being stored in Rimrock Reservoir and flows on the Tieton River are very low as was discussed previously. Flows in the Yakima River are also quite a bit lower than unregulated due to storage operations in the reservoirs on the Yakima side. The winter low flow problem is exacerbated by the water diverted at Roza to generate power. The lower flows through the winter dewater side channels that juvenile coho salmon once inhabited.

Spring runoff flows (peak flows) are much lower than unregulated flows in this sub-reach because those on the Naches River are reduced 25-30 percent (again primarily because of reduced flows on the Tieton) and because peak flows on the Yakima arm are reduced (look at the Umtanum hydrograph). In this sub-reach the peak flows are further diminished because RID is withdrawing irrigation water and power is being generated. This affects emigration cues for smolts.

In late June, after the runoff, the situation reverses as conveyance of irrigation water drives flows to levels that are much above unregulated in the upper Yakima River. However, in this sub-reach, the diversion of water at Roza for both irrigation and power production lessens the effect considerably and one would expect the difference between regulated and unregulated flow conditions to narrow significantly. Since water is still being delivered to downstream irrigation districts, including the two biggest districts in the basin (Sunnyside and Wapato), summer flows would still be substantially higher than unregulated flows. This is unnatural, but the effects to fish are unknown.

This sub-reach is the first one on the Yakima side of the basin which does not have the huge change in flow associated with flip-flop since it is below the Naches/Yakima confluence. During the transition period flows are generally a little higher and may fluctuate more, but once the transition is complete the flows remain fairly stable.

Generally in November, maintenance of the Roza Diversion Dam fish protection facilities, Roza Canal, and Roza Power Plant occur and water is not diverted into the canal increasing flows in the river. When maintenance is complete, diversions begin and are believed to result in dewatering redds of coho salmon, which are known to spawn in the side channels between Selah to Union Gap.

Water Quality

Turbidity increases in early September as the project transitions to flip-flop. This may temporarily disrupt feeding of rearing fish. Otherwise, water quality in this reach does not appear to be impaired by project operations.

6.2.3.3 Roza Power Plant Return (Roza Wasteway #2) to Wapato Diversion Dam

Diversion Dams

Project diversion dams are not located in this reach.

Flow Regulation

Regulated flows in this reach are represented by the hydromet gage YRTW - Yakima River at Terrace Heights Bridge (see figure on page 6-50). No unregulated flow is estimated in this 7.6 mile long reach.

Summer and fall flows in this reach are higher than unregulated as a result of storage releases to supply water to Wapato and Sunnyside Diversion Dams. Under this operational scenario, the many side channels within this reach are connected to the river, offering access to relatively good quality rearing habitat. However, as flows recede at the end of the irrigation season, many of these side channels dry up, potentially stranding fish. Flows during the spring are also lower than unregulated flows, potentially disrupting emigration.

Another concern with flows in this reach is the effect of return flows from the Roza Power Plant. Adult salmon are attracted to the Roza Power Plant return flows at Roza Wasteway #2. The canal is screened at its confluence with the main stem Yakima River to prevent migrating adults from entering while still allowing smaller fish passage. In December 2000, a few hundred coho salmon were observed holding in the pool at the Yakima River and Roza Wasteway #2 confluence. A few attempts were made to drive fish away from this area with moderate success. This was the first year that this problem has been documented with the coho salmon.

Water Quality

This reach also experiences an increase in turbidity during the transition to flip-flop operation and feeding of rearing fish may temporarily be disrupted. Additionally, Moxee Drain, a Roza Canal drain, enters this reach and compromises water quality.

6.2.3.4 Wapato Diversion Dam to Sunnyside Diversion Dam

Diversion Dams

Wapato Diversion Dam -

Fish ladders, screens, and bypass at Wapato Diversion Dam meet the current NMFS standards for fish protection. However, passage of adults is of some concern. Hockersmith et al., (1995) identified passage delays at all project diversion dams by radio tagging steelhead. They measured the median number of days it took adult steelhead to pass Wapato Diversion Dam was 6.9 (N = 19) and Sunnyside Diversion Dam was 0.4 (N = 40). This indicates ongoing passage problems associated with the Wapato Diversion Dam. Additionally, the Wapato Diversion Dam tailwater is the most productive salmon fishing area for tribal members, most likely because of the delay and concentration of fish. Predation by gulls and northern pikeminnow has been identified as a potential source of fish loss at the Wapato main canal fish screen bypass return.

Flow Regulation

In this short reach (1.9 miles), up to 2,200 cfs is diverted at the Wapato Diversion Dam or nearly 50 percent of the water entering this reach when the system is under storage control. This withdrawal moves this reach closer to the expected natural flow at this time of year.

There is no hydromet gage located in this reach; the estimated unregulated flow is the same as the calculated unregulated flow at Parker (no tributary inflow). During the non-irrigation season, the effects of the Yakima Project are believed to be similar to those experienced in the downstream reach, Sunnyside Diversion Dam to Marion Drain, where a hydromet gage is located (PARW) and differences between regulated flow and estimated unregulated are calculated.

Water Quality

The Yakima Project creates no known water quality concerns in this reach.

6.2.3.5 Sunnyside Diversion Dam to Marion Drain

Diversion Dams

Sunnyside Diversion Dam -

Fish ladders, screens, and juvenile fish bypass at Sunnyside Dam meet the current NMFS standards for fish protection. This includes times when flows are less than 400 cfs and the ladder operation is modified (see section 5.4). When flows approaching the dam are less than 400 cfs a gravel bar is exposed in the forebay. This is not believed to impact fish passage, but it should be monitored.

Additionally, a problem exists as the canal is shutdown for the season. Juvenile and adult fish, including salmonids, are stranded in pools just upstream of the screens. Water does not completely drain in the area and standing pools of water remain. In 1998, approximately 15 adult salmon and many juvenile salmonids were salvaged. The salvage process can be difficult and juveniles may be harmed or could die during the process. Non-target taxa are left in the standing pools. Predation by gulls and northern pikeminnow has been identified as a source of fish loss at the bypass return.

Flow Regulation

The reach between the Sunnyside Diversion Dam and Marion Drain is approximately 21.2 miles long and is considered one of the most structurally complex and diverse sections of the Yakima River. For most of this reach Interstate 82 defines the north and east floodplain boundary, whereas the south-west side of the river is in a semi-unconstrained state. Numerous side channels, braids, and backwater areas exist. Larger project agricultural drains enter into the river in this reach and increase the flow, particularly during the irrigation season. This reach is considered one of the main areas where the anadromous salmonid pre-smolts spend the winter before migrating out of the Yakima River. It is also an important area for fall chinook and coho spawning, and adult steelhead holding through the winter. The Sunnyside Diversion Dam is the main control point in the river system for the project, and since 1995, the flow below the dam has been managed for a target based on TWSA. The target flow can range from 300 to 600 cfs during the irrigation season depending on the water supply for that year. Flows are managed to meet the specific target during the irrigation season.

The annual hydrograph for the Parker gage (PARW), located just below the Sunnyside Diversion Dam is displayed in figures on pages 6-52 & 53. In the fall and winter during the non-irrigation season, flows display the natural pattern, but are reduced in magnitude by nearly a third. During the late winter and early spring, anadromous salmonid smolts are moving into this area for rearing, and fall chinook and coho fry are beginning to emerge. Reduced flows limit the habitat availability at a time of high anadromous salmonid abundance. Spring peak flows are also substantially reduced (50+%) affecting emigration cues for anadromous salmonid smolts and limiting rearing habitat. During the irrigation season flows are low, less than half of unregulated flows, and impact rearing habit for salmonids and other native fish particularly. Flow regulation also resulted in an earlier onset and longer duration of this low flow period also. At Granger irrigation return water enters the river (35-60 cfs in the summer).

Flow fluctuations from river operations upstream are amplified below the Sunnyside Diversion Dam (figure 6-4). At times, the hourly flow fluctuation can exceed 20 percent of the base flow, which may be great enough to cause stranding of juvenile steelhead, dewatering of invertebrate habitat, and increase water temperatures to lethal levels in some areas (figure 6-5). Inflows below the Sunnyside Diversion Dam gradually dampen the fluctuations so that, by Grandview, fluctuations are negligible (figure 6-6).

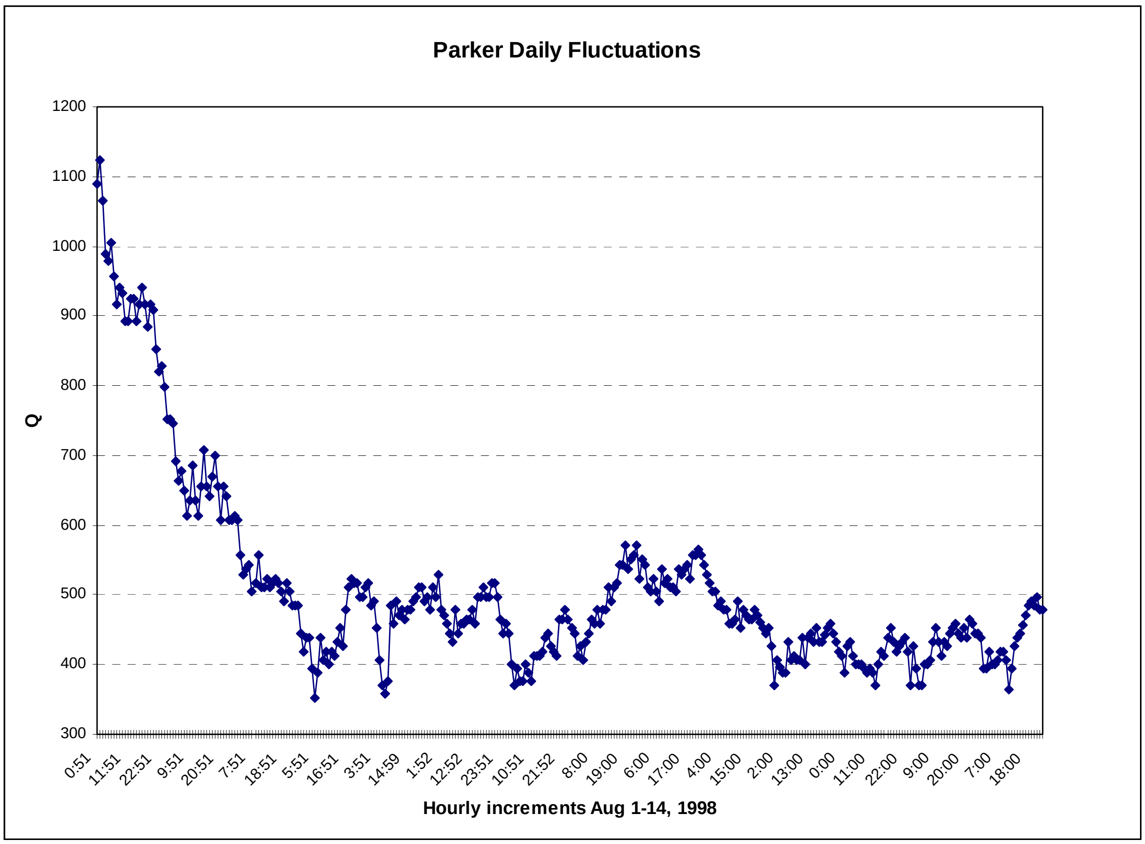


Figure 6-4. Hourly flows at the Parker Gage for the period August 1-14, 1998.

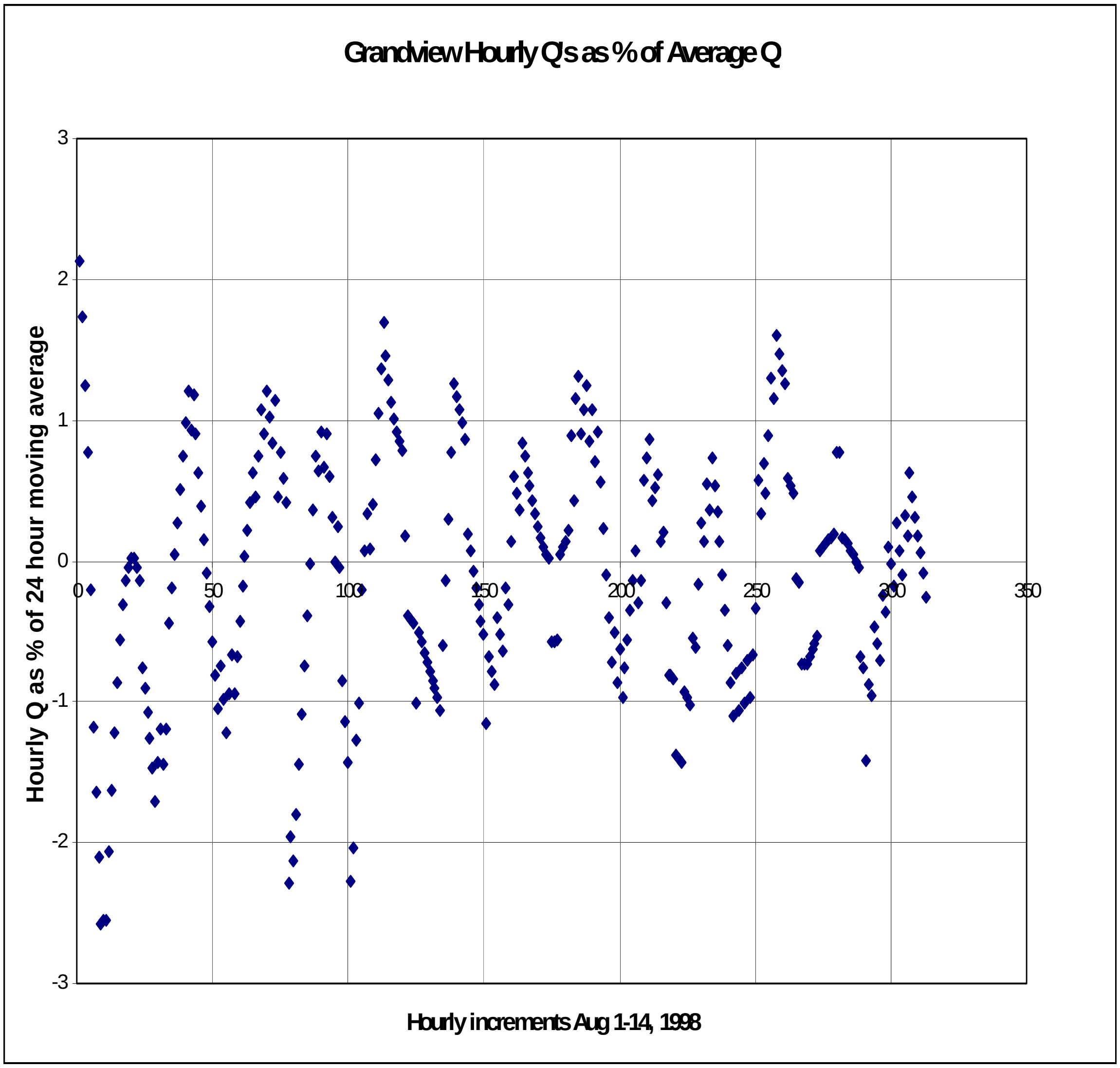


Figure 6-5. Fluctuations at Grandview Gage measured as percent deviation of hourly discharge from the running 24 hour average discharge.

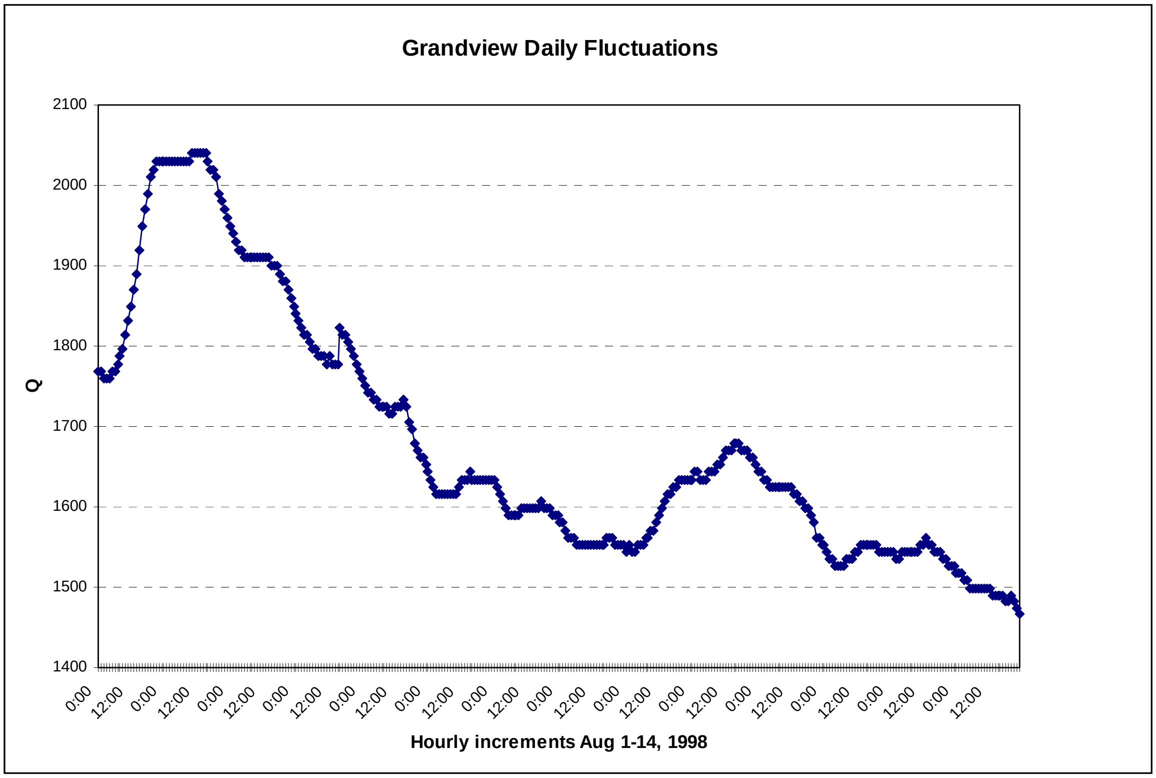


Figure 6-6. Hourly flows at the Grandview Gage for the period of August 1-14, 1998.

Juvenile salmonids have been observed in the lower end of Granger Drain, but a series of culverts prevents passage a short distance upstream (Pat Monk, consulting fisheries biologist for Yakima Basin Joint Board, personal communication, 2001). It is unknown whether salmonids inhabit East Toppenish Drain or other drains in this reach.

Water Quality

This section of the Yakima River is listed on the Washington State's 303(d) list for violating several water quality parameters including: pesticides, PCBs, temperature, FC, pH, DO, and turbidity (Morace et al., 1999). Low river flows and agricultural return flows are a main source of degraded water quality. Pesticides and PCBs are lethal to fish and also bio-accumulate, and result in human consumption advisories for fish captured in this reach. Elevated water temperatures are lethal to salmonids and other cold water fish, and limit the amount of time this reach is suitable for salmonid rearing. In most years, the water temperatures get too warm to support salmonid rearing in this reach of the river during the summer months. However, groundwater inflows do provide some cool water refuges that provide some very limited rearing habitat for salmonids. High water temperatures and elevated pH can also exacerbate the effects of toxic chemicals and either stress fish, which may result in death from secondary causes, or kill them directly. Elevated turbidity indicates high sediment loading and results in the armoring of spawning gravel, siltation of redds, and decreased macro-invertebrate production. The high nutrient loading along with warmer water temperatures create habitat conditions more favorable to non-native species, some of which are predators upon anadromous salmonids. Recent improvements to farming practices have improved water quality in this reach, especially for turbidity and total suspended sediments. See section 6.1.1 for effects of water quality on fish.

6.2.3.6 Marion Drain to Prosser Dam (35.5 miles)

Diversion Dams

Project diversion dams are not located in this reach.

Flow Regulation

The upper 17 miles of this reach includes side channels, back water areas, and diverse habitat types. Satus and Toppenish Creeks enter in this reach, along with significant inflow from groundwater and drains. The downstream 18 miles are low gradient with a single meandering channel and lower habitat diversity. The flows are represented by the Grandview gage (YVGW), approximately midway through the reach. Unregulated discharge is not estimated at this site. It is believed that flows measured at the Parker gage are similar in pattern here; however, substantial return flow (around 700 cfs minimum) enters this reach in the lower portion. The larger drains include Marion Drain (RM 82.6), Coulee Drain (RM 77), South Drain (RM 69.3), DID #7 (65.1), Sulphur Creek Wasteway (RM 61), and Satus Drain (RM 60.2).

Marion Drain is the major drain for WIP and flows range from approximately 500 cfs during the irrigation season to 200 cfs during the winter. Fall chinook salmon naturally reproduce in Marion Drain. The drain parallels Toppenish Creek and is straight, deeply incised, and lacks riparian vegetation.

Sulphur Creek Wasteway enters the Yakima River from the north and is a combined wasteway for the RID and the SVID. Several county drainage districts and the city of Sunnyside’s storm water system and sewage treatment plant drain into Sulphur Creek Wasteway. The creek is channelized and considered poor habitat. Today, year-round flows attract salmonids and spawning and rearing of salmonids have been observed. However, it is unknown whether the rearing fish were successfully produced in this system or if they produced elsewhere and entered for rearing only. It is believed that salmon entering this creek are falsely attracted. Hatchery coho are released at sites above Roza Diversion Dam; however, based on radio tagging studies conducted in 2000, few coho passed Roza Diversion Dam and most were observed at Roza Project irrigation returns (Sulphur Creek Wasteway and Roza Power Plant return).

It is likely that other drains provide seasonal rearing habitat for salmonids and other native fish. Adult salmonids may also be attracted to these drains and spawn with unknown success.

Water Quality

The water quality problems in this reach are essentially the same or worse than the reach immediately upstream (Sunnyside Diversion Dam to Marion Drain) because of the numerous large irrigation return drains entering this reach.

This section of the Yakima River is listed on the Washington State's 303(d) list for violating several water quality parameters including: pesticides, PCB, temperature, FC, pH, DO, and turbidity (Morace et al., 1999). Low river flows and agricultural return flows are a main source of compromised water quality. Pesticides and PCBs are lethal to fish and also bio-accumulate, and result in consumption advisories for fish captured in this reach. Elevated water temperatures are lethal to salmonids and other cold water fish, and limit the amount of time this reach is suitable for salmonid rearing. In most years, the water temperatures get too warm to support salmonid rearing in this reach of the river during the summer months. However, groundwater inflows do provide some cool water refuges that provide some very limited rearing habitat for salmonids. High water temperatures can also exacerbate the effects of toxic chemicals and either stress fish, which may result in death from secondary causes, or kill them. Elevated pH can also result in death or stress which can eventually lead to death from secondary causes. Excessively high or low pH exacerbates the effects of toxic chemicals. Elevated turbidity indicates high sediment loading and results in the armoring of spawning gravel, siltation of redds, and decreased macro-invertebrate production. The high nutrient loading along with warmer water temperatures create habitat conditions more favorable to non-native species, some of which are predators upon anadromous salmonids. Recent improvements to farming practices have improved water quality in this reach especially for turbidity. See section 6.1.1 for effects of water quality on fish.

6.2.4 Lower Yakima River

This reach is separated into two sub-reaches and storage dams are not present in either.

6.2.4.1 Prosser Diversion Dam to Chandler Canal Return

Diversion Dams

Prosser Diversion Dam -

Fish protection facilities at Prosser Diversion Dam meet NMFS criteria; however, there are still serious concerns associated with passage at this dam. Downstream migrant mortality in the Chandler Canal and in the Chandler Smolt Enumeration Facility is generally 10 percent (Bruce Watson, Yakama Nation, personal communication) and can be much higher during certain times of the year. Data provided by the NMFS PIT-tag study of spring chinook smolts in 1992, indicated that in the latter half of May, at relatively high river temperatures (16 to 22 °C), smolt mortality in the upper canal (between the head gates and the fish diversion screens) could be in the order of 40 percent (Sanford and Ruehle, 1996). Significant loss of smolts was also associated with passage through the Smolt Enumeration Facility. Though no comparable data have been presented for other anadromous species, it is reasonable to suspect that similar mortality rates occur for them. McMichael and Johnson (2001) suggested that loss of fish in the canal likely resulted from a combination of factors, such as damaged seals and predation.

Another major concern with this facility occurs in the fall of each year when the canal is dewatered for screen inspection and Chandler Power Plant maintenance. Adult fish, including numerous salmonids, are entrained in the canal and stranded between the point of diversion and the trashracks. Adult fish are unable to pass through the trashracks. Smaller fish are able to pass through the trashracks and are returned to the river via a 30-inch drain pipe. In 1998, about 200 adult fall chinook and 2 steelhead were salvaged during the dewatering process that occurred prior to screen maintenance; no bull trout were found. Other fishes (e.g., northern pikeminnow, suckers) are also stranded, but are not salvaged. The Yakama Nation coordinates with Reclamation on canal drawdown so they can use stranded adult salmon as broodstock for their hatchery propagation program.

Adult passage may be compromised as LWD builds up on the rock ledge apron below the dam. This potentially blocks the entrances and exits to the fish ladders. The center ladder is most susceptible to this occurrence. Although a standard protocol for timing of debris removal is not established, it is generally removed when a large amount is present.

Hockersmith et al., (1995) determined passage delay of radio tagged steelhead at Prosser Dam ranged from 0.1 to 128.3 days for 100 fish (median 5.9 days). The median days to pass was higher than all other project diversions except Wapato (6.9). As water temperatures decreased, fish passage also decreased.

Predation at the fish bypass return has warranted enough concern to have two studies evaluating it. The WDFW's Ecological Interaction Team is evaluating fish predation in the lower river and considers the Chandler Canal fish bypass return to be one of the "hot spots" for predation on salmonids. A fish predation index or percent mortality has yet to be developed for this site. In the 1998 annual report, Pearsons (1998) estimated 1.1 percent of the salmon passing through the Chandler Canal fish bypass return were consumed by avian predators.

Flow Regulation

Flows from Prosser Diversion Dam to the Chandler Canal return (11.3 miles) are depicted by the hydromet station (YRPW). This may be a major fall chinook spawning area and rearing area for all anadromous species. Unregulated discharge is not available for this site, therefore, comparisons are made to the unregulated flow pattern at Parker (PARW) understanding the difference in magnitude (i.e., larger volumes downstream). At Prosser Diversion Dam up to 1,500 cfs is diverted into the Chandler Canal which serves the Kennewick Irrigation District (KID) and the Chandler Power Plant. Power water (about 1,175 cfs) returns to the river approximately 11 miles downstream and the remaining 325 cfs is used to serve KID's irrigation needs. The bypass reach suffers from severely low flows in the summer and early fall. This is a result of diversions at Prosser Diversion Dam and Title XII target flows at PARW and YRPW. This flow regime creates conditions favorable to non-salmonid fish reproduction and survival (lower, more stable flows; warmer, nutrient rich water). Non-salmonids, both native and introduced species, compete for food and habitat and prey on juvenile salmonids.

After the irrigation season, flow patterns more closely match that of the unregulated hydrograph, but at a much reduced magnitude. Diversion for power continues at Prosser Diversion Dam, but can be partially subordinated to protect fish resources. In the fall, annual maintenance is performed on the Chandler screening facility and Power Plant. These activities usually require about 2 weeks. Unfortunately, maintenance typically occurs when fall chinook are at the peak of their spawning activity and some coho are spawning in the reach as well. When the canal is shutdown and dewatered, the water which had been diverted for power production remains in the river and instream flows increase significantly, and many salmon excavate their redds at the elevated flow level. When maintenance is completed and the power diversion resumes, instream flows are reduced and redds can, and have been, dewatered. In recent years, Reclamation, after consultation with SOAC and their environmental staff, has attempted to coordinate Chandler maintenance to reduce or eliminate the effects on spawning salmon. The effort has been successful for the most part, but some problems remain. Redds are usually incubated at a lower flow which affects the hydrology within the redd.

In the spring, regulated flow is significantly lower than estimated unregulated to the point where a spring peak flow may be nonexistent, depending on the water supply. This affects smolt emigration to the Columbia River, especially in drought years. Movement is stalled and smolts may remain in this reach into the summer when conditions threaten survival. Water temperatures are elevated, water quality is compromised, and predator abundance is higher (smallmouth bass and channel catfish migrate from the Columbia River). Additionally, the amount of habitat is decreasing at a time when more smolts are using this reach.

Spring and Snipes Creeks enter into this reach and serve as drains for the Sunnyside and Roza Canals respectively. These streams were once ephemeral, but now flow year-round with low flow periods in February and March prior to the start of the irrigation season. Adult and juvenile salmonids have been observed in these creeks/wasteways (Pat Monk, consulting fisheries biologist for Yakima Board of Joint Control, personal communication, 2001). Adult salmonid spawning poses some concern because these fish may be responding to false attraction flows. It is unknown if habitat conditions are conducive to successful reproduction.

Water Quality

Water quality entering this reach is already of compromised quality. The additional withdrawal at Prosser Diversion Dam has minimal or no effect on water quality (Carrol and Joy, 2001). These investigations also found that irrigation returns in this reach do not appear to further compromise water quality. This reach experiences the same effects as those immediately upstream. The high water temperatures delay the migration of adult fall chinook from the Columbia River into the Yakima River, and combined with low flows create unsuitable conditions for rearing anadromous salmonids in the Yakima River below Prosser Dam from July to September.

6.2.4.2 Chandler Canal Return to Confluence With Columbia River (35.8 miles)

Diversion Dams

Wanawish Dam -

The biggest concern with Wanawish Diversion Dam, a non-Reclamation operated facility, is predation. This has been identified as a "hot spot" for fish and avian predation on salmonids. In the 1998 annual report, Pearsons (1998) estimated 1.7 percent of the juvenile salmon passing Wanawish Diversion Dam were consumed by avian predators. Predation loss to fish is significant and a study is being conducted to develop a predation index for this site. A large number of smallmouth bass congregate below the dam in the spring when salmonids are emigrating. It is believed that smallmouth bass and other predator fish, such as channel catfish and northern pikeminnow consume the disoriented salmonids as they pass over the dam.

The ladders, fish screens, and bypass were designed to meet NMFS criteria.

Flow Regulation

Flows in this reach are measured near KIOW and unregulated flow is not calculated here. Flow improves as Chandler Power Plant water returns, but is still lower than the estimated unregulated flow, particularly in the spring and summer. These low flows affect emigration cues and likely increase predation as a large concentration of non-native predator (bass and catfish) inhabit this reach. These non-native fish benefit from the lower more stable flows which are nutrient rich and warmer. An additional withdrawal of approximately 300 cfs at Wanawish Diversion Dam (Columbia Irrigation District 220 and Richland Canal 80 cfs) exacerbates the low flow problems. In late summer and early fall, low flows and resultant warm temperatures may delay migration of steelhead, fall chinook, and coho salmon into the Yakima River. Fortunately, salmon spawning in this reach are not affected by screen, dam, and canal maintenance at Prosser Diversion Dam or in Chandler Canal. Flows in the late fall and most of the winter are lower than expected due to reservoir storage which reduces the amount of available habitat.

Water Quality

Water quality entering this reach is already of compromised quality. The additional withdrawal at Wanawish Diversion Dam has minimal or no effect on water quality (Carrol and Joy, 2001). Minor irrigation returns in this reach do not appear to further compromise water quality. This reach experiences the same effects as those immediately upstream. The high water temperatures also delay the migration timing of adult fall chinook from the Columbia River into the Yakima River.

6.2.5 Bumping River

Storage Dams

Bumping Dam and Reservoir -

The effects of Bumping Dam and Reservoir on the fishery resource were generally described at the beginning of this section. Approximately 1 mile of lotic habitat is inundated by this reservoir, substantially less than other project reservoirs due to its small size and the narrow range of fluctuation in the reservoir pool. When Bumping Reservoir level is very low, it is possible for fish to move freely downstream through the outlet works because there is little head difference at the outlet structure. However, there has been no documentation of fish migrating from the reservoir through the outlet works. It also does not seem likely that fish can migrate from the river to the reservoir when reservoir levels are low because of the high water velocity barrier in the tailrace flume. Little is known about passage conditions on Deep Creek, the primary bull trout spawning tributary to Bumping Lake. WDFW (1998) reported that low flows in the creek combined with low reservoir elevation can limit access to some spawning areas and that rearing juveniles have become stranded in dry channels. These low flow conditions have been observed about 1 mile above the mouth of Deep Creek (Eric Anderson, WDFW, Yakima, personal communication, 1999), but low reservoir elevations do not effect this low flow condition.

Diversion Dams

No project diversion dams are located in this reach.

Flow Regulation

The Bumping River is 16.6 miles long from the dam to its confluence with the Little Naches River. Spring chinook salmon spawn in the river and it is possible that steelhead and bull trout do as well, although this has not been documented (these species have been found in the American River which enters the Bumping 3.5 miles above the Little Naches confluence). Because of the reservoir's small size, water releases from Bumping Reservoir are more normative than larger storage reservoirs (see figure on page 6-40). Regulated releases are lower from April through June as water is being stored and higher flows result in July through October to meet irrigation demands. The most critical flow problem on the Bumping River concerns the issue of incubation flows. Spring chinook salmon spawn in September when, as a direct result of flip-flop, regulated flows in the Bumping are at least twice the level of those which would occur under unregulated conditions. This results in a large percentage of redds being established near the margins of the river and requires incubation flows at, or very near, those provided for spawning to ensure that these redds are not dewatered. In most years this is not a problem as Bumping Reservoir is relatively small and refills quickly in a normal or wet winter. In dry and/or abnormally cold winters however, it can become impossible to provide protective incubation flows. Such was the case in the winter of 2000/2001. Over 275 spring chinook redds were constructed on the Bumping in September 2000, at a flow of 200 cfs. By mid-November it became obvious that Reclamation would be unable to provide adequate incubation flows and by the first of the year the flow release from Bumping Reservoir was only 70 cfs, the inflow to the reservoir. Although it is likely redds were dewatered, production of spring chinook was documented in the river (Pat Monk, fish consultant for Yakima Basin Joint Board, personal communication 2001).

Water Quality

The Yakima Project creates no water quality concerns in this reach.

6.2.6 Upper Naches River

Storage Dams

Storage dams are not present in this reach.

Diversion Dams

No project diversion dams are located in this reach.

Flow Regulation

The upper Naches River reach is 27 miles long extending from the confluence of the Bumping and Little Naches Rivers to the confluence of the Naches and Tieton Rivers. Spring chinook salmon and steelhead are known to spawn and rear in the reach, and bull trout are present as well. The extent to which the latter species uses the reach for various life stage activities is unknown, but fluvial bull trout spawn in tributaries of the Naches River (e.g., American River, Rattlesnake Creek, Crow Creek) and have been harvested (illegally) in the main stem Naches as recently as last year. Flows in this reach are represented by the hydromet gage CLFW (Naches River at Cliffdell, figure on page 6-42). The regulated hydrograph of the Bumping River closely resembles unregulated conditions, more so than any other regulated reach in the basin. Alterations to the unregulated flow as a result of Bumping Reservoir releases are evident, but relatively insignificant.

Water Quality

The Yakima Project creates no water quality concerns in this reach.

6.2.7 Tieton River

Storage Dams

Rimrock Reservoir and Tieton Dam -

Tieton Dam presents the complete set of problems associated with storage dams. A much larger amount of lotic habitat was inundated with the construction of Rimrock Reservoir because it was not associated with a natural lake. McAllister Meadows, which was inundated, was considered high quality habitat for spring chinook, coho, steelhead, and bull trout.

Unique concerns associated with Rimrock Reservoir and the Tieton Dam are passage into and out of the South Fork of the Tieton River and entrainment in the outlet works, both of which are affected by Reclamation operations. On the South Fork of the Tieton River, a seasonally submerged falls creates a migration barrier at times. This falls is located near the main Tieton River Road where it intersects the South Fork Tieton River. This falls is a result of realigning the river so a bridge could be built over the South Fork Tieton River. The new channel went over a cliff and creates a barrier falls when the reservoir recedes. This falls is submerged when Rimrock Reservoir is at full pool (2926 feet above mean sea level [msl]; reservoir volume 198,000 acre-feet). The elevation at the top of the falls is approximately 2899 feet msl (127,000 acre-feet) and when reservoir levels drop below that, passage problems arise for all species. In most years, because of the run timing of bull trout in the South Fork Tieton and pre flip-flop reservoir operations that hold the reservoir elevation high (above 2899 feet msl), this barrier most likely affects this species as they move back to Rimrock Lake when the falls can exceed a 20-foot drop. On October 10, 1999, Scott Craig of the FWS, Lacey, Washington found two dead bull trout and two dead suckers (*Catostomus* spp) at Rimrock Reservoir below this falls (2868.67 msl, 81,761.88 acre-feet).

Although every reservoir experiences severe drawdown, a minimum conservation pool (historical lake bed) still remains at all the reservoirs except Rimrock Reservoir, for which a minimum pool level has not been established. Rimrock Lake has not been drafted below 21,988 acre-feet (end-of-month September) or 10,730 acre-feet (end-of-month October) since 1987. Fish can be entrained through the outlet works, which is exacerbated at lower pool levels. It has been documented that kokanee were killed, as a result of, or while passing through the outlet works at Tieton Dam (Mongillo and Faulconer, 1980). It is also possible that bull trout could be directly harmed in going through the outlet structure. Studies began in September 2000, to evaluate bull trout entrainment into the Tieton River. Preliminary information identified that one sub-adult bull trout was captured in fyke nets positioned below the dam outlet. The range of reservoir levels sampled was 165,718 acre-feet to 85,996 acre-feet, thus the gravity of this problem under more severe conditions remains unknown.

Because Rimrock Dam was built on a river and not an existing lake, gravel recruitment has been greatly impacted in the Tieton River. The dam has not only affected the availability of gravels and cobbles suitable for spawning, but has also affected the channel form and pattern. The existing channel is degraded and incised resulting in a loss of habitat diversity.

Clear Lake Dam and Reservoir -

Clear Lake Dam does not provide adequate upstream passage for bull trout migrating into the North Fork Tieton. The fish ladder was constructed in the early 1990s and evaluated for one season (mid-August through October) in 1994. Researchers found that whitefish and small rainbow trout were able to negotiate the upper portion of the ladder, but bull trout were never trapped at the top of the ladder (Paul James, Central Washington State University, personal communication, 1998). It appeared that fish were attracted to the base of the dam, rather than to the ladder entrance, which is isolated from the dam and reservoir outlet works. This may have been because flows down the ladder were relatively warm due to the surface diversion, insufficient attraction flows, or both. Further investigations should be conducted to determine the efficiency of the ladder. Routine maintenance of the ladder is also lacking and needs to be addressed by project fish facility personnel.

Diversion Dams

Yakima-Tieton Diversion Dam -

The Yakima-Tieton Diversion Dam was rebuilt in 1990, to facilitate river rafters going over the dam and to provide fish passage. The fish passage facility is a chute type structure with stop-log guides to create a pool and step type facility. It is difficult to manage the stop-logs and fish have been observed jumping at the dam. The ladder does not meet current passage standards and Reclamation is working with the Fish Passage Technical Work Group to address this issue. Fish screens and juvenile bypass facilities meet current standards. However, during major rain events the screens at this diversion tend to clog up quickly impeding their performance.

Routine operation of this diversion results in little fluctuations to the river flow downstream because of coordination of diversions and releases from Tieton Dam. Flow reductions from Rimrock Dam are requested for maintenance at Yakima-Tieton Diversion Dam during the irrigation season. This reduction in flow is undesirable, and fortunately, does not happen often.

Flow Regulation

Flows in the Tieton River are measured by hydromet gages at Rimrock Reservoir (RIM) and downstream of the Yakima-Tieton Diversion Dam (TICW). This reach is 21 miles long and has no minimum flow standard. The flow regime of the Tieton River represents the most extreme alterations to the natural hydrograph of any location in the basin (see figures on pages 6-44 & 45). Flows from mid-October to July are profoundly below those that would occur under unregulated conditions. Winter flows on the Tieton River are frequently less than 30 cfs for extended periods and have on numerous occasions dropped below 20 cfs. Peak flows during the spring runoff are substantially reduced, approximately 33 percent, which reduces emigration cues for salmonids rearing in the middle and lower Yakima River reaches. With the inception of flip-flop in early September, releases from Tieton Dam increase dramatically from about 650 cfs to over 2,000 cfs until they are abruptly reduced at the end of the irrigation season in mid-October. During this time, when unregulated flows would typically be at their lowest levels of the year, Tieton River flows are up to five times higher than would occur naturally. These peak flows are nearly twice the magnitude of those which would occur under unregulated conditions during the runoff period in May and June. The physical and biological effects of the regulated flow regime on the Tieton River have been more than significant. Anadromous and resident salmonid reproduction has not been observed for decades in the river. The aquatic invertebrate community is depressed, the result primarily of stranding which occurs when invertebrate habitat is dewatered in the winter. Spawning gravels have been washed downstream with no source for replacement. The lack of bedload recruitment from above the dam has affected the channel morphology as well with a resultant decline in habitat complexity.

Flows from Rimrock Reservoir tend to fluctuate more when the reservoir is at or near full capacity. Rain and wind (which pushes water over the spillway) are generally the causes for the fluctuations. Releases through the main gates have been made to avoid water passing over the spillway and tend to create a more abrupt hydrograph (quicker increases and decreases to the hydrograph).

Water Quality

Water temperature may be a concern in the Tieton River below the dam. Summer releases appear to be cooler than expected when compared to the onset of flip-flop operations, when the water temperature increases by approximately 5 °C (figure 6-7) before declining. This can disrupt spawning of anadromous salmonids and bull trout and effect feeding ecology of rearing juveniles. Additionally, this may temporarily increase water temperature in the lower Yakima River because of the large amount of water being released, and delay migration of adult fall chinook salmon and steelhead into the basin. These temperature concerns are speculative because it is based on only 1 year of data, but it suggests that further investigation is warranted. Other water quality parameters have not been measured during flip-flop.

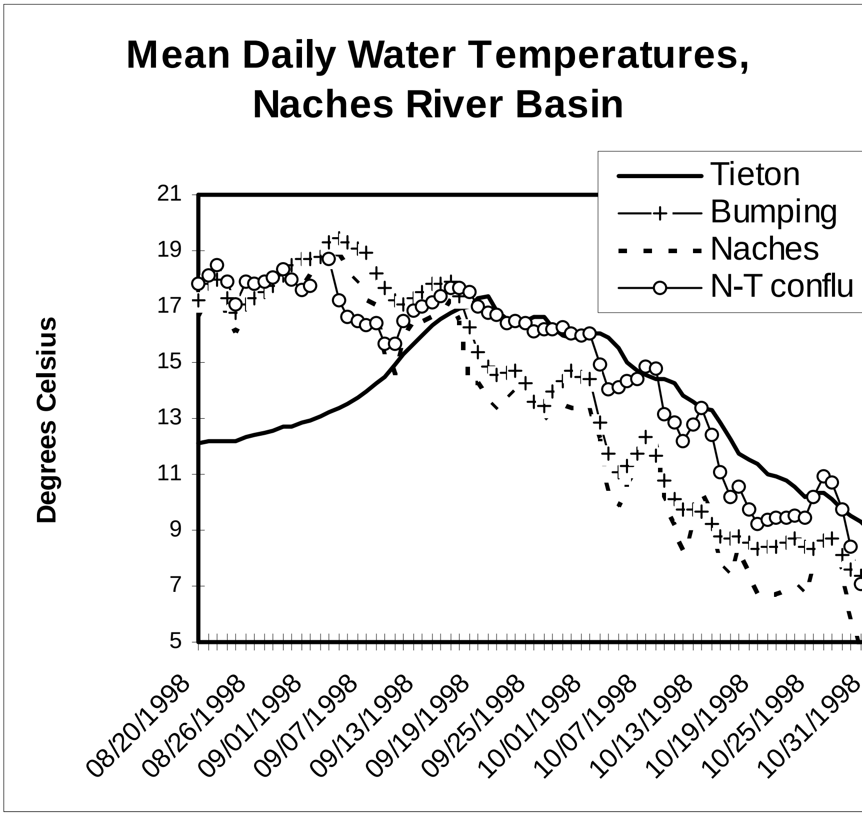


Figure 6-7. Water temperature (degrees Celsius) from August 20 through October 29, 1998, on the Tieton, Bumping Naches (upstream of confluence with Tieton) and Naches (downstream of confluence with Tieton) Rivers. (Unpublished data, Pat Monk, consultant/fisheries biologist for Yakima Basin Joint Board.)

6.2.8 Lower Naches River

Storage Dams

Storage dams are not present in this reach.

Diversion Dams

Wapatox Diversion Dam -

The Wapatox Diversion Dam, a non-project facility, was built by Pacific Power and Light and is now owned by Scottish Power. The existing concrete dam was constructed in 1978, with a pool and weir fishway. The upstream fish passage facility has been identified as a potential problem at certain flows. Spring chinook have been observed jumping at the dam and exhibiting possible delays in crossing the dam. The NMFS radio-telemetry study for steelhead did not indicate a problem for steelhead at this site (Hockersmith et al., 1995). The original diversion fish screens and bypass were replaced in 1993 with a modern facility.

Flows are rarely altered for maintenance which usually occurs during lower flows. Relatively stable power diversions mean that diversion-related flow fluctuations are not a major concern below this dam.

Naches Cowiche Diversion Dam -

Naches-Cowiche Diversion Dam, a non-Reclamation operated facility, at Naches RM 3.6, is a low head structure of approximately 6 feet. Salmon and steelhead can leap and swim over the structure at medium to high flows. A fish ladder was constructed in 1987, which meets NMFS criteria. The ladder is being modified to enhance the exit of the ladder and supply additional auxiliary water at the entrance. The fish screens and bypass present no problems to fish.

When conducting maintenance or installing flashboards, the irrigation district coordinates with Reclamation so flows can be reduced to provide a safe working environment. These procedures do not occur that often and are considered of minimal consequence to fish.

Flow Regulation

This reach extends from the confluence of the Tieton River downstream to the confluence of the Yakima River and is 17 miles long. This is an important reach for rearing chinook, coho, and steelhead. An occasional bull trout is also observed. Flows in this reach are described using flow data collected at NACW - Naches River near Naches. The pattern of regulated flows in the lower Naches River generally follows the unregulated hydrograph except for the unnatural flow spike in September (see figures on pages 6-48 & 49), when high flows released from Tieton Dam for flip-flop more than quadruple the discharge. This abrupt and significant fluctuation is a cause for concern because juvenile fish can be displaced or stranded. All flows, except during flip-flop, are reduced in magnitude, but of particular concern is the reduction in the spring peak flow by nearly 25 to 30 percent, the result of water storage at Tieton Dam.

The other major flow impact to this reach is the Wapatox Diversion Dam at RM 17.1, that diverts water for hydropower production for PacifiCorp and irrigation. The diversion can reduce natural flows in this reach by as much as 300-450 cfs. Most of this water, less 50 cfs during irrigation season, is returned to the river at the hydropower plant outfall at RM 9.7. There is an approximate 8 mile reach of the Naches River that is affected. The project works closely with PacifiCorp to provide a minimum flow of 125 cfs over the diversion dam year-round. Downstream of the dam, flows can be much lower during the irrigation season due to downstream diversions. There are times during cold winters, and during dry summers, when the flows stay at or a little below the target. At a flow of 130 cfs, nearly all side channels are cut off or reduced to a trickle. At a flow of 630 cfs, the flow that would be present if water was not diverted for power generation, suitable flow was available to connect nearly all side channels (preliminary data, Steve Croci, FWS, Yakima, Washington, personal communication, 2000). Side channels appear to be preferred habitat for rearing juvenile salmonids in this reach (preliminary data, Steve Croci, FWS, Yakima, Washington, personal communication, November 2000). There are other non-Reclamation operated diversions below the Wapatox Diversion that also affect the low flows in this reach and in combination can withdraw a significant portion of the river when flows are near 125 cfs.

Water Quality

The main water quality concerns with this reach are in regards to water temperature from flip-flop operations and diversions at Wapatox Diversion Dam. As stated in the Tieton River reach, during flip-flop operations water temperatures increase by 5 degrees and are evident in this reach also (see figure 6-7). Water temperature increase below the Wapatox Diversion Dam during the summer when air temperatures are high and flows low is a major concern. Low flows occur because the project is holding back releases from Tieton Dam in preparation for flip-flop, and the numerous diversions, including Wapatox Diversion Dam, reduce flows below 125 cfs. Although the elevated water temperatures are not directly lethal to fish, the cumulative effects of elevated water temperatures and flows stress fish.

6.3 WILDLIFE

The development of irrigated agriculture, including the Yakima Project, has affected wildlife in several ways. This section focuses on the impacts to wildlife due to project development and not project operations. Effects described in this section include: 1) effects of conversion of habitat to agricultural and other purposes; 2) effects of alteration of the hydrologic cycle in the basin; 3) effects of project structures; and 4) indirect effects. Development of agricultural land and construction and operation of associated facilities, combined with other changes in the basin, have altered numbers, diversity, and distribution of native and non-native wildlife species. Physical habitat, mobility, food supply, and interspecies interactions have been affected across a variety of habitat types.

6.3.1 Conversion of Habitat

Conversion of shrub-steppe and riparian habitat to agricultural use has directly eliminated about a half million acres of native habitat. Shrub-steppe associated species such as sage and sharp-tailed grouse, sage sparrow, brewers sparrow, etc., are now significantly low levels. Sage grouse have been proposed for listing as a threatened species under the ESA. Native plants and animals have been directly replaced by domestic plant and animal species dependent on irrigated agriculture.

Conversion has introduced weeds and other non-native plant and animal species which have competed with and replaced natives. Irrigated agricultural land favors different assemblages of species than the native habitats it displaces.

Natural stream side channels and tributaries have been converted to canals and drains, causing loss of these habitats. Timing of flow and morphology in these channels has been highly altered, causing loss of natural function.

Unbroken agricultural development, along with other development, has interrupted connectivity of habitats e.g., riparian to upland. This is particularly evident with big-game species that are unable to reach winter range in lowland and riparian areas, and are thus dependent on feeding programs. Conflicts between wildlife and agricultural uses of land have been addressed by fencing out, trapping, or killing the wildlife.

Reclamation project canals often intersect natural watercourses in a manner which precludes upstream movement of fish and other aquatic organisms (i.e., marginal or impassable water crossing structures). In addition, these crossings sometimes also create a barrier to movement of terrestrial organisms in the riparian areas (consider, for example, the KRD canal crossing of Taneum Creek).

6.3.2 Alteration of Hydrologic Cycle

Interruption of flood cycles by impoundment along with structural exclusion of river from floodplain has reduced riverine wetland habitats, which were the predominant pre-development wetlands in the Yakima Valley. Loss of floodplain inundation has altered habitats by removing ability of native vegetation (e.g., cottonwoods) to reproduce and survive; and reducing nutrient cycling and productivity of aquatic invertebrates; and other plant and animal species that form important components of the food web.

Loss of channel-forming flows, which through created cut-and-fill alluviation, created a complex floodplain mosaic of channels, backwater areas, islands, pools, and riffles. This mosaic provided substantial habitat for fish and wildlife. Approximately 80 percent of Washington’s terrestrial species use wetlands, riparian areas, and their buffer areas.

Delivery of irrigation water has created upland wetlands, both in the delivery systems and in tailwater wetlands. Some wildlife has taken to artificial wetlands in lieu of lost natural riverine wetlands.

Construction of agricultural drains has dewatered/eliminated natural floodplain wetlands, as well as wetlands associated with alluvial fans and non-floodplain wetlands. This eliminated wetland habitat and adversely affected (impoverished) adjacent upland habitats by removing diversity of plant communities and habitat structure. (High percentage of native wildlife in Central Washington use wetlands during some life stage.)

Hydrologic alteration has caused loss of native vegetation and replacement by non-native vegetation.

Irrigation related changes in sediment dynamics have affected sediment delivery to wetlands, side channels, and main channels, in turn affecting the amount and type of submersed macrophyte growth. Many species of wildlife are dependent on healthy native stands of submersed macrophytes.

Release and/or delivery of water to stream channels has resulted in adverse changes in channel geometry/pattern, substrate, floodplain, and vegetation. Unnatural high flows scour the bed and flush out spawning gravels. The timing of these summer-long high flows favors development of exotic plants such as reed canary grass, and hinders establishment and growth of native plants such as black cottonwood. This flow pattern also adversely affects native salmonid fishes and aquatic mammals such as beaver.

Flow Regime -

Dam construction and operation drastically altered the natural flow regime of the Yakima River. The current flow regime produces flows which: 1) are unnaturally low during fall and winter; 2) reduce available fall and winter rearing habitat for salmonids; 3) fail to produce "freshet" flows or spring flood flows, which formerly helped flush smolts through the system; 4) have unnatural fluctuations which strand and kill fish or displace them to suboptimal habitat; and 5) have unnaturally high flows all summer which result in channel erosion and loss of habitat structure such as LWD.

6.3.3 Effects of Project Structures

Canals block migration corridors, especially for big-game species which may be unable to cross or may suffer mortality. Dams block fish passage, in turn reducing the value of these blocked areas to wildlife species that are dependent on these fish for foraging.

Impacts of Reservoir Level on Fish Passage Into Reservoir Tributary Streams and Fish Utilization of These Tributaries - Both Within and Above the Elevation of the Reservoir -

Construction of Keechelus, Kachess, Cle Elum, Bumping, and Rimrock Dams inundated the lower reaches of the tributary streams of the natural lakes and Tieton River. The clearing during the original dam construction coupled with Reclamation's operation of the dam (period and timing of inundation) has eliminated the riparian zone of these streams and destabilized the channels. During periods when the channels are exposed above the surface of the lake, they lack the shade and cover normally provided by shoreline vegetation, and the instream habitat provided by LWD.

The lack of shoreline and instream structure leads to channel instability, a lack of pools, and impairment of fish passage during years of low flow. In particular, the ability of bull trout and kokanee to access Gold Creek can be affected. Tributary access may also be a problem for other fish. Tributary access has not been investigated for spring spawning fish which ascend tributary streams during low pool while the reservoir is filling. A lower reservoir level or different operating pattern could allow restoration of stable stream channels that provide functional habitat for fish and ensure upstream passage of fish to spawning and rearing habitat.

Fish Passage Over Dams -

The original dams were constructed without providing for fish passage, resulting in significant impacts to resident and anadromous fish species. Sockeye and coho salmon spawned in the headwaters of the Yakima River and sockeye reared in the natural lakes until the dams were constructed. Subsequently, sockeye have been extirpated from the Yakima basin. Steelhead/rainbow trout access to upper tributary streams was also blocked by the dams. Bull trout and pigmy whitefish populations in the Yakima basin are isolated by Keechelus and other dams in the basin.

The large runs of anadromous fish were the underpinnings of the food chain/energy flow in the Yakima basin. The loss of this annual source of nutrients contributed to the decline of top level carnivores (e.g., bald eagle, grizzly bear) and lowered the productivity of the basin for all wildlife. Recovery of bald eagles and grizzly bears depends upon the restoration of an abundant, easily available food supply such as fish runs.

Wildlife Movements -

North-south wildlife movements are restricted across the Snoqualmie Pass Corridor. The inundation of the original Lake Keechelus shoreline eliminated riparian and forested areas which could serve as north-south connecting corridors. The inundation, combined with highways and urban development, has restricted wildlife movement.

Wildlife Associated With Late Successional Forest -

The area surrounding all of the Reclamation reservoirs was once habitat for late seral-associated wildlife such as spotted owl, pileated woodpecker, pine martin, goshawk, etc. Populations of these species are now all at very low levels because of habitat loss throughout the Yakima basin. The clearing/inundation of terrestrial habitat by Reclamation dam projects permanently removed habitat and contributed to these population declines.

Habitats Lost -

Creation of the reservoirs inundated areas of several habitat types (old growth forests, wetland, riparian, instream, etc.) that are now severely limited and are listed as Priority Habitats within WDFW's Priority Habitats and Species Program. Priority wildlife species that were probably impacted by the loss of these habitats include: cascade frog, Larch Mountain salamander, bald eagle, common loon, spotted owl, Harlequin duck, great blue heron, fisher, pine marten, and Townsend's big eared bat.

Large Woody Debris -

Dam construction blocked recruitment of LWD from the upper basins to the Yakima River, Naches and Tieton Rivers, and reduced habitat diversity downstream in the Yakima River. Currently, LWD is captured by the dam and subsequently piled and burned.

6.3.4 Indirect Effects

The native wildlife populations in the Yakima basin were extremely dependent on the constant energy sources brought up from the oceans by the fish runs. The loss of the runs caused a large loss in energy to the system, altering wildlife population dynamics by causing less vegetation, less invertebrates, and less wildlife dependent on eating salmon (bears, eagles, 137 species; see report on Salmon and Wildlife).

6.4 RIPARIAN VEGETATION

Introduction

Riparian areas are lands directly adjacent to creeks, rivers, streams, ponds, or lakes where surface water influences the surrounding vegetation. The riparian zone is the transition between uplands, where there is seldom standing water, and the waterbody where free-flowing or standing water is common. Riparian ecosystems are wetland ecosystems, which have a high water table (where saturated soils [hydric soils] are relatively close to the ground surface) because of proximity to an aquatic ecosystem or subsurface water. At a minimum, the width of the natural vegetation zone extends one active channel width on each side of a free-flowing waterbody, from the edge of the active channel out onto the floodplain.

Riparian vegetation filters sediments and can absorb nutrients, chemicals, and other pollutants that might otherwise be released into surface waters or aquifers. Riparian vegetation also decreases erosion and stabilizes streambanks by binding soils. Shade caused by overhanging riparian vegetation or by a riparian canopy cools a stream by reducing heating by solar radiation. Vegetation further reduces erosion by providing roughness at the interface between the streambank and the water. Water velocity, and thus the energy available for transport of sediment, is decreased. Streambank building may occur during high flow periods as sediments are deposited. Deposits of fine fertile soils on floodplains are due to the filtering effect of riparian vegetation and the slowing of flow velocity. Additionally, riparian vegetation provides critical habitat in the aquatic food web, as well as habitat and forage for many wildlife species.

Reservoirs -

There is essentially no true riparian vegetation surrounding the reservoirs that supply water to the Yakima Project. Most natural riparian vegetation was removed prior to construction of the reservoirs, and no new riparian vegetation has developed due to extreme fluctuations of the water levels in the reservoirs. The primary function of these reservoirs is to collect and release water for irrigation supplies during the year. Current operations can cause the water level within the reservoir to fluctuate dramatically, as much as 100 feet or more in some cases (e.g., Lake Cle Elum). As the water table rises and falls, different portions of the potential riparian area are either inundated or dewatered, often for months at a time, preventing the growth of riparian vegetation.

Main Stem of the Yakima River -

Flow fluctuations within the Yakima River that occur as part of Yakima Project operations may exacerbate erosion of riverbanks, harming native riparian vegetation. Pollution from agricultural return waters may impair the riparian vegetation along the river. Impaired riparian vegetation is especially evident in the lower Yakima basin. Pesticides, sediment, and unnatural nutrient balances may deter native plant growth, possibly promoting the growth of non-native species. In the late summer in the lower basin, very low water levels in the Yakima River may cause the water table to drop below the potential root zones of native riparian vegetation, preventing the growth of these plants.

A by-product of the Yakima Project that has become a key element in Yakima basin water management is flood control. Flood control reduces both flood frequency and the extent of flooding, allowing counties to permit the development of the floodplain for other uses (agricultural, home building, etc.), that often results in diminishing riparian vegetation. Grazing livestock can damage riparian vegetation, as can the development of home sites along the river or tributaries, as new residents clear areas adjacent to the waterbody. However, not all development is necessarily detrimental to local riparian vegetation. For instance, upslope irrigation may actually raise a surface water table and increase the water available to some natural riparian areas, thereby increasing the growth of riparian vegetation.

Tributaries of the Yakima River -

Development of irrigated agricultural areas made possible by Reclamation projects such as the Yakima Project have reduced riparian areas by encouraging development of farmland in riparian and adjacent arid zones.

Additionally, some natural stream channels are used to deliver irrigation water. In the upper Yakima basin many of the natural streambeds are used as delivery canals. Water is put into these waterbodies upstream to provide water to downstream irrigators. The flow fluctuations that occur as a result of these practices may erode streambanks and destroy natural riparian vegetation.

Canals and Delivery Ditches -

Very little riparian vegetation exists along canals and ditches. Because canals and delivery ditches are man-made, they originally had no native riparian vegetation. Generally, vegetation along these conveyances is removed by irrigation district personnel or by irrigators to simplify maintenance. Delivery canals must be kept free of large plant growth for proper operation. Both mechanical and chemical measures are used to remove vegetation.

Drains -

Drains in the Yakima basin generally have little, if any, riparian vegetation. Some of the drains were developed in natural watercourses. Their function has been to remove irrigation tailwater from cultivated areas and to lower the water table in areas of shallow groundwater. Because drains often rapidly fill with sediment carried by agricultural return water, they must be frequently cleaned with heavy equipment. Riparian vegetation is destroyed during maintenance activities. Additionally, the numerous pesticides and inappropriate nutrient levels carried in the agricultural return water can be harmful to native riparian plants. It should be noted that some water will reach riparian areas through and because of irrigation return flows. Some of these return flows can create wetlands in areas where none existed before.

6.5 FLOODPLAIN FUNCTIONS/CHANNEL MORPHOLOGY

Introduction: Importance of Floodplain Function to River Ecology

Reaches associated with alluvial floodplains have been shown to be centers of biological productivity and ecological diversity in gravel bed rivers (Stanford and Ward, 1988; Independent Scientific Group, 1996). Properly functioning floodplain reaches extend the functional width of the river well beyond the main channel and provide key benefits to cold water fish. Floodplain reaches contribute to baseflows; thermal moderation; nutrient cycling and food web production; off-channel habitats; and are vital to sustain healthy fish populations in gravel bed river systems such as the Yakima. Proper floodplain function requires an appropriate flow regime (normative hydrograph) interacting with accessible floodplains. In the Yakima River basin, a mix of project and non-project alterations of both the hydrograph and physical floodplain structure impairs floodplain functions.

Properly functioning floodplains capture flood flows, decreasing downstream flood damage to instream and out-of-stream resources. As overbank flow spreads and slows down on the floodplain, a portion of the water infiltrates into permeable floodplain alluvium, reducing peak flows and storing in the shallow aquifer oxygenated, thermally moderate water that later contributes to baseflow. The alluvial aquifer system associated with floodplain reaches has been said to function “as the flywheel on an engine,” sustaining streamflow through times of little precipitation and runoff (Kinnison and Sceva, 1963).

Temperature is a key environmental variable for salmonids and associated organisms. By storing flood waters in subsurface alluvium, insulated from the thermal influences of atmospheric and solar heating, floodplains moderate river temperature, both through bulk cooling and by creating localized thermal refugia at groundwater discharge areas. In addition to providing protection against summer heating, groundwater provides warmer water at discharge areas and prevents icing in winter.

Properly functioning alluvial floodplains provide abundant, complex, diverse habitats for cold water fishes. Flood flows form and maintain the channel network including side channels. Spring brooks receiving discharging groundwater provide low velocity, thermally moderate, food rich habitat for juvenile fish.

Floodplain alluvial aquifers generate food web support in the hyporheic zone. Interspatial spaces in gravel are habitat for invertebrates. Dissolved and particulate organic matter are broken down by bacteria which form algal mats on cobble surfaces. Larval stages of aquatic invertebrates spend most of their life histories consuming the mats, putting on mass before a brief flighted stage during which they breed and die.

Pre-development Conditions -

Pre-development and current conditions are summarized in Ring and Watson (1999). In the Yakima basin, bedrock constrictions between alluvial subbasins control the exchange of water between streams and the aquifer system. Under pre-development conditions, vast alluvial floodplains were connected to complex webs of braids and tributary channels. These large hydrological buffers spread and reduce peak flows, promoting infiltration of cold water into the underlying gravels. Side channels and sloughs provided a large area of edge habitat and a variety of thermal and velocity regimes. For salmon and steelhead, these side channel complexes increased productivity, carrying capacity, and life history diversity by providing suitable habitat for all freshwater life stages in close physical proximity. The hyporheic zone (zone of shallow groundwater made up of downwelling surface water) extended the functional width of the alluvial floodplain and hosted a microbe- and invertebrate-based food web that augmented the food base of the ecosystem. As snowmelt-generated runoff receded through the summer, cool groundwater discharge made up an increasing proportion of streamflow. Much of this groundwater upwelled from the gravel into complex channel networks upstream of bedrock constrictions.

River/floodplain interactions provided cool, clear base flows, possibly including times of low flow and high air temperatures, creating thermal refugia for out-migrating smolts and returning adults moving through the hot lower basin. In winter, upwelling groundwater prevented freezing and drove the flow of oxygenated water through the gravel substrate, providing excellent conditions for incubating eggs and alevin.

Current Conditions -

Floodplain isolation and channel simplification, combined with inversion and truncation of the natural hydrograph, have dramatically reduced river floodplain interactions and degraded the aquatic environment. The floodplain is isolated from the river by diking, channelization, wetland draining, gravel mining, and highway and railroad building. Many of these same activities have eliminated or isolated vast areas of side channels and sloughs. River operations for irrigation and flood control alter the natural hydrograph by impounding spring freshets, substantially increasing summer flow, and decreasing winter flow. A common effect of these developments is a sharp reduction in the frequency with which spring floods recharge the alluvial floodplain aquifer system. Water temperatures in the lower river are therefore higher in the summer, and the number and extent of thermal refugia are reduced.

Effects of Project Operations -

Truncation of flood peaks by capture in reservoirs reduces the frequency, duration, magnitude, and spatial extent of floodplain inundation. This decreases the size of the regulatory floodplain, thus project operations have indirectly allowed commercial and residential development of floodplains.

By reducing recharge from overbank flow and increasing irrigation induced recharge, which has different timing and location, project operations have altered the quantity, quality, and timing of groundwater discharge to the river and floodplain spring brook habitats.

6.6 IRRIGATION

Although the original purpose of the Yakima Project was irrigation, the Yakima Project is currently operated as a multi-purpose project. The priority for the various purposes depends on contracts, court decisions, policy, time of year, and the status of the water supply. Project purposes fall into five categories: fish and wildlife, irrigation, flood control, power generation, and recreation. Since the various project purposes have competing demands, it is inevitable that compromises must be made in one or more areas to maximize benefits for all purposes. This section will attempt to highlight compromises made in the area of irrigation to benefit other uses. Compromises made in other purposes to benefit irrigation are highlighted in other sections.

6.6.1 Recreation

Most project facilities are not operated to directly benefit recreation. Project recreation benefits are generally incidental to other project purposes. The one exception is that the project is operated to benefit recreation at Clear Lake. To maximize benefits for recreation, Clear Lake Reservoir must be full. The Forest Service must be notified by August 10th of Reclamation's intent to drawdown the reservoir to meet irrigation demands. If the reservoir is used for irrigation, Clear Lake storage must be released between about October 5th and October 20th to avoid impacts to spawning kokanee. This constraint can create difficulty in fully utilizing Clear Lake storage for irrigation purposes.

6.6.2 Flood Control

To maximize use of a reservoir for flood control, it must be empty prior to a flood event, but to maximize its use for irrigation it must be full at the beginning of the peak delivery period. These two goals are often in direct conflict. In 1995, flood control operations caused Keechelus Reservoir to be short by 10,000 acre-feet.

6.6.3 Power

Power generated in the Yakima valley is used to pump water to lands above the Roza Canal and to provide power for use outside the Yakima valley. Power generation has no detrimental effect on irrigation.

6.6.4 Fish & Wildlife

The flip-flop operation creates stress on the storage system by causing extreme imbalances in reservoir storage near the end of the irrigation season. The flip-flop operation also causes some reservoir outlet gates to be operated at near full capacity for extended periods of time. Cle Elum Reservoir is near empty and Rimrock Reservoir is near full in early September. This has the effect of "putting all your eggs in one basket." To provide maximum flexibility in operations, multiple reservoirs are preferably drawn down at a near equal rate. Then, if a gate failure limits access to one reservoir, other reservoirs can be drawn upon to meet demand. In 1979, gate repairs at Cle Elum Reservoir limited access to Cle Elum storage creating a water-short year for irrigation.

In some cases, higher target flows reduce the amount of TWSA for irrigation. Increases in winter incubation flows at times reduce the ability to refill the reservoirs in the winter. Increases in target flows at Parker reduce TWSA for other uses. In water-short years any decrease to TWSA is felt directly by proratable irrigation districts in the form of harsher rationing. If 1977 flow targets were used during the 1994 irrigation season, the rationing level for proratable irrigation districts would have been about 45 percent rather than 37 percent due to the increase of Title XII target flows.

6.6.5 Irrigation

Since the project started, the irrigated acres increased from 121,000 acres in 1902, to approximately 465,000 acres today. A quote from C.R. Lentz 1974, helps illustrate the effect of the project on irrigation. "By 1902, there were an estimated 121,000 acres under irrigation in the Yakima Basin, representing about 25 percent of the present irrigable development. This acreage was served by natural flows in the river and tributaries, with none of the present large storage dams and reservoirs in existence. The natural runoff was inadequate to insure a dependable water supply for the development even at the turn of the century." Even with the reservoirs in place, some level of rationing is still required in about 1 out of every 4 years. In the Yakima valley $500,000 million to $1 billion worth of irrigated crops are raised annually.

6.7 HYDROELECTRIC POWER

Competing water uses limit the extent to which water may be managed for power production. There are presently nine hydroelectric power plants within the Yakima basin. Of the nine power plants, only four are operating with non-consumptive use, power water diversion rights, generating marketable power production. The Chandler and Roza hydroelectric plants are operated by Reclamation, and PacifiCorp (parent company, Scottish Power) operates the Naches, and Naches Drop hydroelectric plants (Wapatox). The YTID's two hydroelectric plants, Cowiche and Orchard Avenue, are in-line plants operating only during the irrigation season, selling the generated power to PacifiCorp. The other three hydroelectric plants include two units that are in use by WIP and one unit operated by a private party (J. Leishman), all of which make electrical power for within-system pump use or domestic service. These last five power plants make co-use of the irrigation water diversions within the irrigation districts' systems for power production. All of the power plants are served by water supplied from diversion dams via canal systems.

All main stem hydroelectric power plants operate as run-of-the-river plants. That is, they operate with available flows from the Yakima and Naches Rivers. Power generation at the Chandler and Roza plants is subordinated to provide minimum fishery flows in the respective bypass reaches. In general, power water at Roza and Chandler Power Plants is limited to any surplus amounts in excess of irrigation requirements, and in the non-irrigation season to available flows. The Wapatox hydroelectric plant has no available storage water rights. If Naches River natural flows are insufficient to maintain a 300 cfs power water diversion for the Wapatox plant, no inflow can be stored in either Rimrock or Bumping Reservoirs. Inflow may be bypassed at the 2 reservoirs to attempt to maintain the 300 cfs natural flow minimum to satisfy the downstream Wapatox power water right. The Wapatox hydroelectric plant, having a water right priority date of 1904, has a natural flow right which is junior to most other upstream natural flow users. The Wapatox water right is senior to many Yakima Project water rights, many of which have a priority date of 1905.

6.7.1 Federal Columbia Rivers Power System - Power Production & Irrigation Assistance

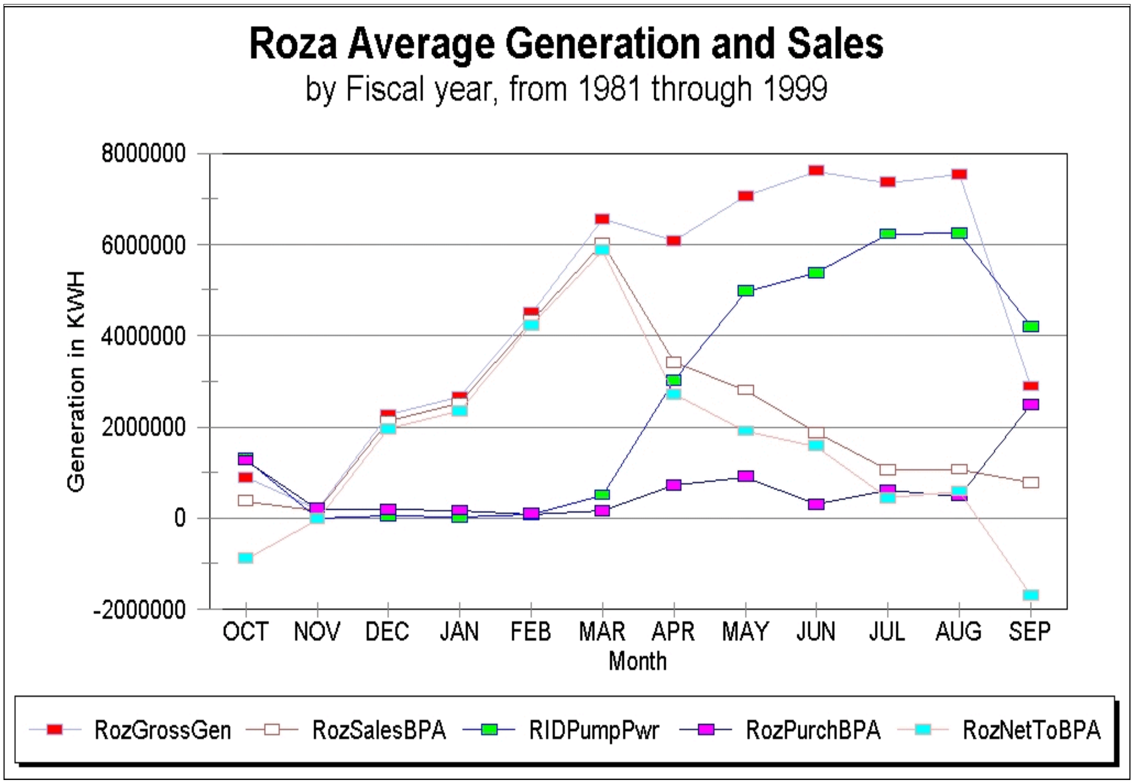
The Reclamation's Yakima Project has 2 of the 30 operational, federally owned and operated, hydroelectric facilities within the Columbia River Basin. The power generated by these Federal facilities is marketed by the Bonneville Power Administration (BPA), a Federal agency under the Department of Energy. The financial organization under which the power is marketed is known as the Federal Columbia River Power System (FCRPS). In addition to marketing the power from these Federal facilities, BPA also operates and maintains about 80 percent of the region's high-voltage transmission lines.

BPA is a self-funding agency that covers its costs by selling the power generated at the Federal dams wholesale to the region's public utilities, municipalities, investor-owned utilities, and some large industries. The revenues received from power sales are used to fund BPA's operations and maintenance. These revenues are also used to repay annually the Federal Treasury for the "power share" of the capital investments in hydroelectric facilities of the Columbia River Basin funded through appropriations that are owned and operated by Reclamation and the U.S. Army Corps of Engineers (Corps). The power share of the Federal capital investment in each dam was determined at the time the dam or facility was authorized. The other purposes for which a dam may be authorized by Congress are, for example, flood control or navigation. BPA also repays the Treasury for the power share of the annual operations and maintenance expenses of these agencies.

6.7.1.1 Power Production

Roza Power Plant -

The Yakima Project generates power at the Roza Power Plant and at the Chandler Power Plant. The primary purpose for the power generation at Roza is to supply power to pumps for the delivery of irrigation water to RID members. At any time the power generated by the Reclamations's Roza facility that is excess to Roza load demands and project usage (including station service), the excess power is marketed through BPA under the FCRPS. This is accomplished through an operating agreement between Reclamation and BPA. During the irrigation season, when the irrigation district's demand for power exceeds the power supply available from the Roza Power Plant, the district receives additional power from BPA. This annual exchange of power between the Yakima Project and BPA is defined in a shaping agreement between the two agencies. The amount of energy BPA is required to supply under this agreement is capped at 40,000,000 kWh per year. The Roza Power Plant has generated a gross annual average of 55,535,289 kWh during the past 19 years. A graph illustrating the annual average generation of power at the Roza Power Plant is shown below.

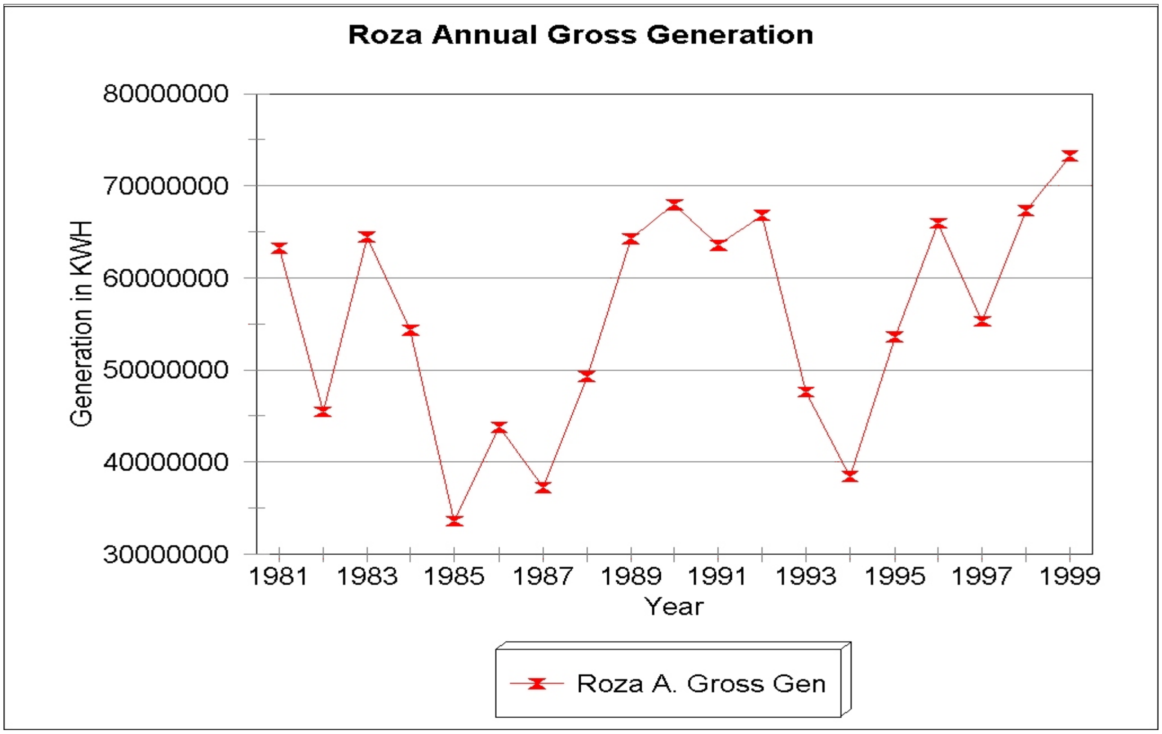


The Roza graph displays the average annual generation at the Roza Power Plant for the period 1981 through 1999. The categories identified in the analysis are Roza gross generation (RozGrossGen), Roza power delivery to BPA (the power deliveries are tracked as credits - no funds are exchanged) (RozSalesBPA), Roza demand for make-up pump power (RozPurchBPA), RID pump requirements (RIDPumpPwr), and Roza net power for BPA marketing (RozaNetToBPA). The graph shows that over the past 19 years, BPA has marketed a net annual average of 18,974,147 kWh from the Roza Power Plant.

Power Subordination -

Roza Power Plant

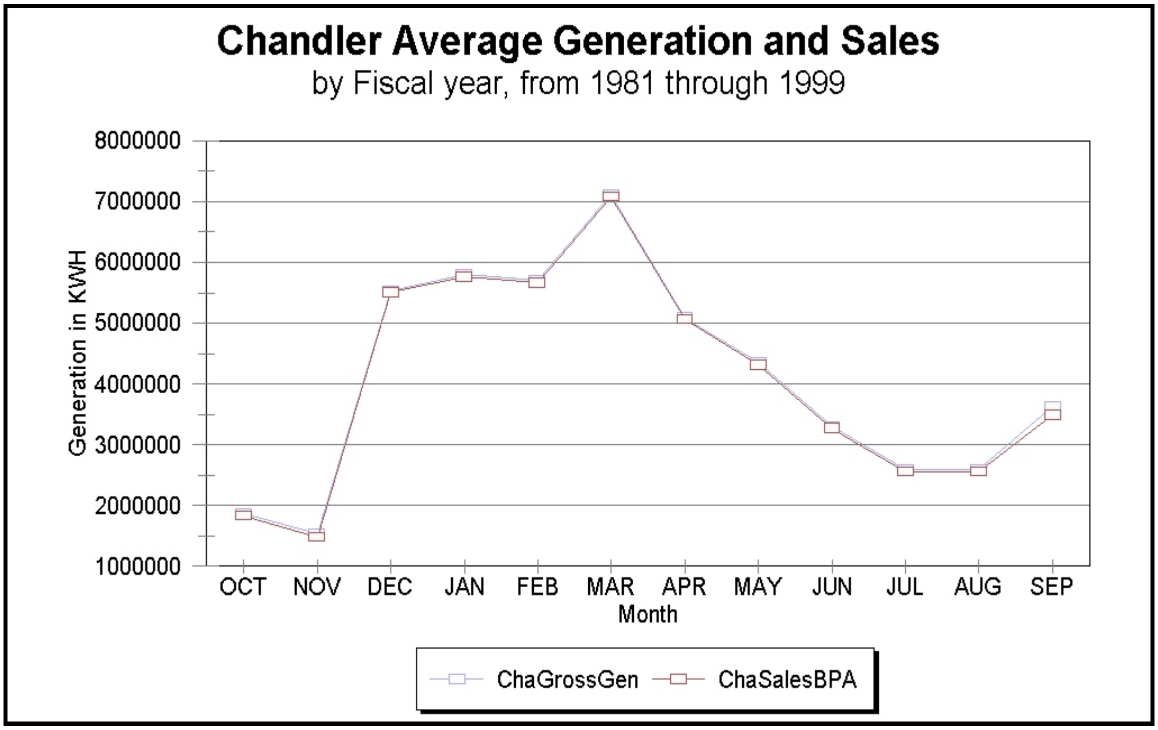
Power subordination occurs when power generation is reduced or shutdown, allowing the power water diversion flows to remain in the river system to protect the fishery resources or to enhance fish passage. Currently, power water for electric generation at Roza Power Plant is subordinated slightly to improve fishery flows in the Yakima River below Roza Diversion Dam (RBDW). Reclamation does not have specific direction on the authority to subordinate Roza Power Plant, but maintains an informal agreement in consultation with SOAC, BPA, and others to subordinate power generation to maintain a 400 cfs minimum in the river. A graph illustrating the gross yearly generation of power at the Roza Power Plant is shown below for the period 1981 through 1999. The total loss of power production due to subordination is difficult to quantify, as no daily records are currently kept of the actual amount of daily subordinated power. Therefore, the gross yearly generation totals do not portray an accurate picture of the effects of power subordination as the daily amounts of subordination are washed out in the yearly totals. Power is being subordinated as a rule at the rate of, for every 100 cfs per hour left in the river or reduction of canal flows, costs 1 MW (1,000 kWh) of power generation. The needed rate of power subordination can change hourly and should be tracked accordingly.



6.7.1.2 Power Production

Chandler Power Plant -

The Yakima Project generates power at the Chandler Power Plant with the use of two hydroelectric generation units. All of the power generated by these units, except for station service, is marketed by BPA. The Chandler Power Plant has generated a gross annual average of 49,052,684 kWh during the past 19 years. A graph illustrating the annual average generation of power at the Chandler Power Plant is shown below.

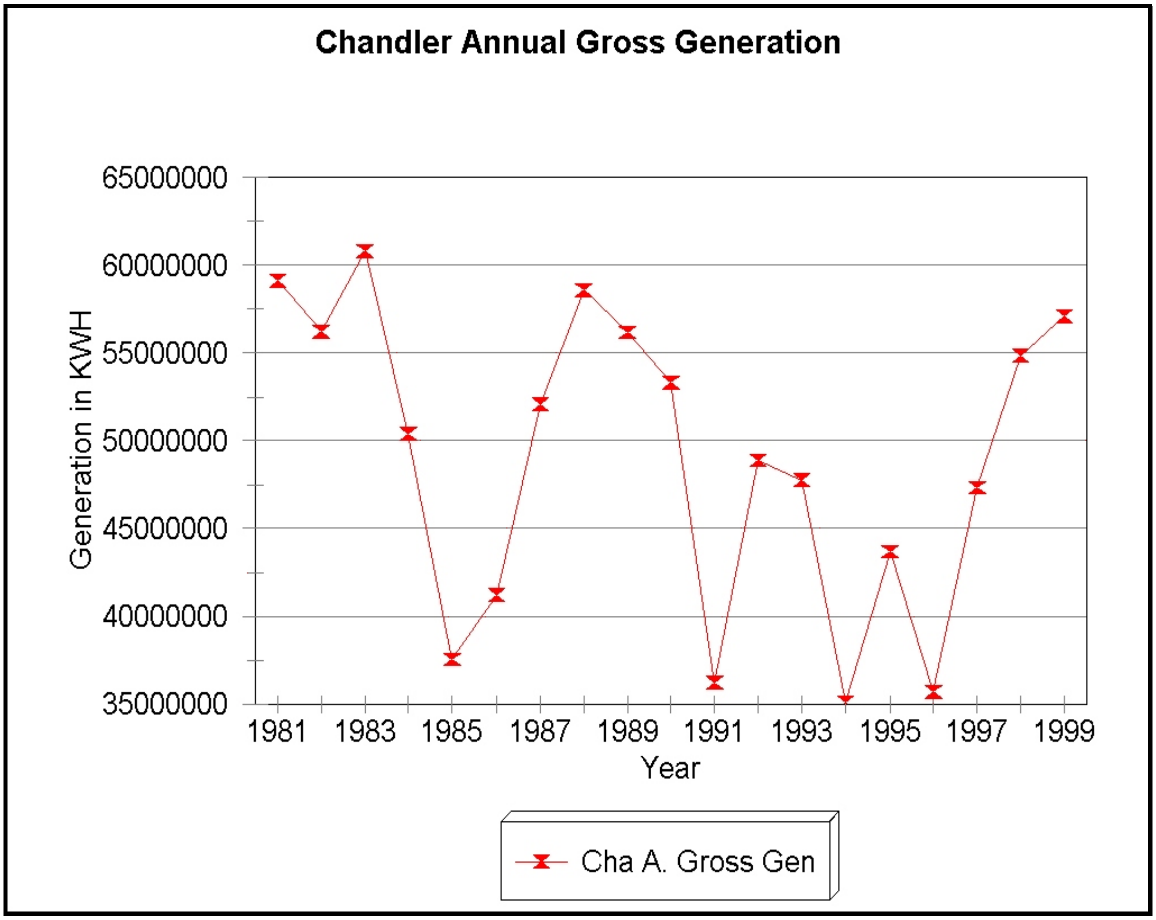


The Chandler graph displays the average annual generation at the Chandler Power Plant for the period 1981 through 1999. The categories identified in the analysis are Chandler gross generation (ChaGrossGen) and Chandler marketable power delivery (sales) to BPA (ChaSalesBPA). The graph shows that over the past 19 years, BPA has marketed a net annual average of 48,544,837 kWh from the Chandler Power Plant.

Power Subordination -

Chandler Power Plant

Power subordination occurs when power generation is reduced or shutdown, allowing the power water diversion flows to remain in the river system to protect the fishery resources or to enhance fish passage. Reclamation has the authority to subordinate Chandler Power Plant as identified in YRBWEP. Power production is subordinated to various flows throughout the year. In April through June, power is subordinated to 1,000 cfs over Prosser Dam as measured at Yakima River at Prosser (YRPW). During the remainder of the irrigation season, the subordination target is 450 cfs or the YRBWEP Title XII target flow, whichever is higher. The agreed subordination target was for 450 cfs through the non-irrigation season. A graph illustrating the gross yearly generation of power at the Chandler Power Plant is shown below for the period 1981 through 1999. The total loss of power production due to subordination is difficult to quantify, as no daily records are currently kept of the actual amount of daily subordinated power. Therefore, the gross yearly generation totals do not portray an accurate picture of the effects of power subordination as the daily amounts of subordination are washed out in the yearly totals. Power is being subordinated as a rule at the rate of, for every 100 cfs left in the river or reduction of canal flows, costs 1 MW (1,000 kWh) of power generation. The needed rate of power subordination can change hourly and should be tracked accordingly.



6.7.1.3 Irrigation Assistance

Under Reclamation law, irrigation districts that benefit from the construction of federally funded irrigation systems are usually under an obligation to repay the U.S. Treasury for a portion of the original construction cost for their facilities. As part of the Yakima River Basin Project, approximately $140 million in Federal funds were invested to construct the irrigation systems. Based on several Acts of Congress (1902 Reclamation Act; 1939 Reclamation Act; Third Power Plant, Grand Coulee Dam), Reclamation law has evolved over time, modifying the repayment responsibilities for irrigation districts. One of the changes that occurred over time was the extension of the repayment period from 10 years up to 66 years.

Current Reclamation law authorizes Reclamation, based on a standard “farm budget” analysis of an irrigation district’s ability to repay, to assign a portion of a district’s U.S. Treasury repayment liability to the FCRPS. This repayment is called “irrigation assistance.” Under the authority of the Third Power Plant, Grand Coulee Dam Act, the FCRPS is authorized to repay the irrigation assistance from "net revenues" of power sales of the FCRPS. ("Net revenues" are defined as those revenues over and above the amount needed to recover all FCRPS' costs allocated to power, including the cost of acquiring power by purchase or exchange, and previously authorized irrigation assistance.) Total irrigation assistance due the U.S. Treasury as of September 30, 1997, was $10.6 million. The final payment is due in 2026.

6.7.2 Private Power Production

Private power production is represented in the Yakima basin by several small hydroelectric power plants with marketable power production that is marketed by a private utility company, such as PacifiCorp. Yakima-Tieton Irrigation, PacifiCorp, and possibly the Leishman facility, all develop private (non-BPA) marketable power.

6.7.2.1 Private Power Production

Wapatox Power Plants -

The Wapatox Drop Power Plant and Naches Plant were constructed by Northwest Light and Water Company, and are now operated by PacifiCorp, via Pacific Power & Light Company, the successor to Northwest Light and Water Company. The plants are located on the Wapatox Power Canal (diversion point is located on the Naches River at RM 17.1 with 500+ cfs canal capacity), downstream and east of the town of Naches. The plant capacity of the single Drop Power Plant unit is approximately 1,100 kW. The Naches Plant capacity is approximately 5,200 kW, being 2,200 kW from one unit, and 3,000 kW from the second unit. The total generation capacity of the 2 plants is 6,300 kW. The canal and power plant are operated year-round, except for 2 to 4 weeks of maintenance shutdown, with generation becoming a part of and marketed by PacifiCorp's commercial power service. Based on available data, PacifiCorp's average annual generation exceeds 36,264,000 kWh of marketable power.

Power Subordination -

Wapatox Power Plants

Power subordination occurs when power generation is reduced or shutdown, allowing the power water diversion flows to remain in the river system to protect the fishery resources or to enhance fish passage. This power plant diversion has a year-round natural flow right of 300 to 450 cfs, and diversion from the river (at Naches RM 17.1) is allowed within this range so long as the flow is naturally available and the rights of senior diverters and users are satisfied, including flows to protect anadromous fish life. Reclamation is not obligated to provide storage flows at any time. During non-irrigation season (winter), the power diversion water is informally subordinated to maintain a 125 cfs instream flow in the Naches River below the Tieton River below the mouth of the Tieton River. The total loss of power production due to subordination is difficult to quantify as no daily records are currently kept of the actual amount of daily subordinated power.

6.7.2.2 Private Power Production

Yakima-Tieton Irrigation District Power Plants -

The YTID operates the Cowiche and Orchard Avenue hydroelectric plants as pressure-reducing stations for the pressurized pipeline distribution system completed in 1986. The generators at the 2 plants have a combined capacity of 3,000 kW, operating only during the irrigation season, April through October. The operation of the plants is contingent upon the water demand with the district during the irrigation season. From WY 1987 to WY 2000, the yearly gross generation ranged from a low of 6,665,572 kWh to a high of 8,154,605 kWh, with an average of 7,533,143 kWh of marketable power that was sold to and marketed by PacifiCorp's commercial power service.

6.7.2.3 Private Power Production

Leishman Power Plant -

The Leishman Power Plant serves as energy dissipators on an irrigation pipeline system, making use of 2 generating units with rated capacities of 25 kW and 7.5 kW to reduce line pressure, and supply electrical power for a farming and ranching operation. The power plant utilizes an existing irrigation tailwater collection system to supply water for the generation units during irrigation season. This non-consumptive use of water is permitted for use from April 1st to October 1st. Note: the power generation excess to farming and ranching operation may be sold to Puget Power & Light Company. Currently, the volume of marketable power is unconfirmed.

6.8 FLOOD DAMAGE REDUCTION

Project operation of the reservoir system yields over $5 million worth of flood control benefits as assigned by the Corps. According to the Columbia River Management Group Annual Report for 1999, the value of accumulated flood control benefits for the period 1950-1998 is $252,550,000 and the estimate for 1999 alone was $5,756,000. The benefit in 1996, the last big flood year, was $32 million.

Because the system is drawn down in the autumn of the year, there is flood control space available in late fall and early winter every year. Most flood benefits are from winter flood control because spring floods are historically lesser events in this basin. Springtime flood benefits accrue as the reservoirs are filled on a schedule to track the runoff, with the goal of having a full system in late May or early June. The flood space schedule is defined by a family of flood rule curves tracking runoff forecast and reservoir space.

The system is not fully controlled. Project reservoirs can only affect the timing of the peak event, and depending on the event and space available, can decrease the magnitude. For instance, in February of 1996, project regulation diminished a natural peak of 92,700 cfs at the Yakima River at Parker to an observed peak of 58,150 cfs.

7.0 RESOURCE OBJECTIVES

This section identifies the resource objectives of the multi-agency members of the Interim Operating Plan (IOP) committee. Some, but not necessarily all of these objectives, are not within the authorities of the Yakima Field Office.

7.1 WATER

7.1.1 Quality

Resource Goal -

To obtain water quality in the Yakima River and its tributaries that fully supports designated uses and meets narrative and numerical criteria of Washington State water quality standards.

Explanation: Water quality standards are composed of two parts: designated uses (fishable, swimmable) and criteria, either narrative or numeric, to protect the uses. (An anti-degradation provision also prevents backsliding.) Both parts of the standards are important and separately enforceable. Of the two, the attainment and maintenance of designated uses is probably the least understood. An example of designated uses for class AA and A waters in the State of Washington, which are the classifications that apply to almost all of the Yakima River and its tributaries, is salmonid spawning, rearing, migration, and harvest. This use is also sometimes described as the use of cold water biota. The Environmental Protection Act (EPA) describes "full support" for cold water biota, including salmon life cycles, as that which supports "thriving, sustainable populations of species which would normally occur in cold water absent water column/habitat degradation. Full confirmation would include attainment of applicable numeric criteria and the presence of a biological community representative of what one might expect for that given ecosystem."

Our understanding of standards is evolving and numeric criteria, while important, does not fully describe the ecological conditions necessary to support the uses of water and the "fishable, swimmable" standard. The resource goal is, therefore, most appropriately expressed both in terms of the water quality that fully supports the designated uses of water quality standards as well as meeting numeric and other narrative standards.

Interim Measures of Success -

Total Maximum Daily Loads

When it is demonstrated that these standards are not being met in any waterbody defined as a "water of the state," the Department of Ecology (WDOE) includes that waterbody on the "303(d) list of impaired waterbodies." The Clean Water Act (CWA) requires the State to prepare and submit this list to the EPA every 4 years, the most recent year being 1998. In the Yakima basin, 57 waterbodies with 22 pollutant parameters were included on the 1998 303(d) list. It is expected that several more listings on the 2002 list will result from recent monitoring. Pollutant listings in the Yakima basin include high turbidity, low dissolved oxygen, high temperature, PCBs, pesticides, metals, pH, ammonia, and fecal coliform bacteria. Several reaches within the basin are also listed for low instream flow. As required by the Federal CWA, 303(d) listed waterbody segments must be addressed for all identified pollutant parameters through the development of a Total Maximum Daily Load (TMDL), or "water clean-up plan," by WDOE. TMDLs are submitted to EPA for approval. A component of the TMDL process is performing a technical evaluation that determines pollutant loading during critical periods; identifies known and potential pollutant sources; defines the maximum pollutant carrying capacity possible for the waterbody without exceeding standards; and allocates that carrying capacity to the sources. Sources of the pollutant may include point, non-point, and natural sources. Seasonal variation and a margin of safety are included in the allocation. The "clean-up plan" describes activities, participants, and schedules necessary to meet water quality standards. The TMDL will often use a phased implementation process, setting defined and measurable interim targets while working toward State standards. A monitoring plan set up to determine effectiveness and success of the implementation activities is an essential component of the TMDL process.

In 1997, a lawsuit was filed against EPA and WDOE for failure to develop TMDLs on 303(d) listed waterbodies in compliance with the Federal CWA. As a settlement to the suit, WDOE signed a three party Memorandum of Agreement (MOA) with the plaintiffs and EPA and agreed, among other requirements, to develop TMDLs for all waterbodies on the 1996 303(d) list by the year 2014. Fulfilling the requirements of this MOA and addressing all listed waterbodies within the State is a priority project for the WDOE.

Several TMDLs are under development in the basin and it is expected that several of the other 303(d) listings may be eliminated with after verification monitoring. WDOE will prioritize the remaining 303(d) listings and develop a time line to address all impaired waters within the next several years. Specific interim measures of success will include the continuing decline of 303(d) listings within the basin and the increase of TMDL implementation activities; the development of TMDLs for all 1996 303(d) listed waterbodies in the basin and/or the removal of those waterbodies from the 303(d) list by June 30, 2013; the attainment of human health criteria for t-DDT (total DDT) in fish tissue and the removal of fish consumption advisories; and the reduction of known pollutant loads in the water column and the attainment of State standards. Activities and water quality indicators will be monitored and tracked by WDOE and other entities within the basin.

Index of Biological Integrity

The Index of Biological Integrity (IBI) offers resource managers an ecologically based method for assessing the health of aquatic ecosystems. The original IBI developed for midwestern streams (Karr 1981; Karr et al., 1986) consisted of 12 fish community parameters, or metrics, divided into categories of species richness, trophic structure, and fish abundance and condition. The 12 metrics were selected to evaluate different aspects of the health of stream ecosystems, and were, therefore, used to reflect changes in community structure or function that might not be assessed by measures of water chemistry or contaminant levels alone. The IBI provides a tool for quantifying changes in ecosystem health as a result of habitat degradation or flow alteration, in addition to chronically poor chemical water quality (Karr and Dudley, 1981).

IOP members believe that the IBI is one tool that can be used as an indicator of progress toward the long-term resource goal for water quality.

The National Water Quality Assessment

The National Water Quality Assessment (NAWQA) is a program of the United States Geological Survey (USGS) designed to describe the status and trends in the quality of the Nation's ground and surface water resources, and to provide a sound understanding of the natural and human factors that affect the quality of these resources. As part of the program, investigations are being conducted in 59 areas called "study units" throughout the nation. These investigations will provide a framework for national and regional water quality assessment. Regional and national synthesis of information from study units will consist of comparative studies of specific water quality issues using nationally consistent information. The Yakima River basin is one of the NAWQA study units, and water quality information developed in that program has been and will continue to be extremely useful in assessing progress toward this long resource objective.

7.1.2 Quantity

Resource Goal -

To develop streamflows in the Yakima River that mimic the unregulated hydrograph in frequency, duration, timing, magnitude; and rate of change to the extent necessary to restore riverine ecosystem processes that support healthy, sustainable native aquatic plant and animal communities; and which also provide for the efficient implementation of other legitimate project purposes.

Explanation: Streamflow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems. Indeed, streamflow which is strongly correlated with many critical physicochemical characteristics of rivers, such as water temperature, channel geomorphology, and habitat diversity, can be considered a “master variable” that limits the distribution and abundance of riverine species and regulates the ecological integrity of flowing water systems. (Poff et al., 1997; Power et al., 1995; Resh et al., 1988.)

Interim Measures of Success -

The Range of Variability Approach

The Range of Variability Approach (RVA) derives from aquatic ecology theory concerning the critical role of hydrological variability, and associated characteristics of timing, frequency, duration, and rates of change in sustaining aquatic ecosystems. The method is intended for application on rivers where the conservation of native aquatic biodiversity and protection of natural ecosystem functions are primary river management objectives, which is also a primary goal of the Yakima River Basin Water Enhancement Project, Title XII. The RVA uses the unregulated hydrograph (or reconstructions of it) to characterize 32 different hydrological parameters, comparing unregulated and current conditions for each. The RVA can be used as a tool in arriving at initial flow targets for the river as well as to measure progress toward this resource objective. (In Freshwater Biology, 1997, 37, 231-249, Richter, et al.)

Ecosystem Indicators

Using various measures of ecological health and integrity, such as those set out in the IBI and those in the Report on Biologically Based Flows for the Yakima River Basin (SOAC, May 1999) (e.g., materials and energy flux, hydrologic connectivity, and biophysiology of main stem, edge and groundwater habitats) measure the success of changes in operations in moving toward positive values in those indicators.

7.2 FISHERY

Resource Goal -

To recover and maintain self-sustaining, harvestable populations of native fish, both anadromous and resident species, throughout their historic distribution range in the Yakima basin.

Explanation: Fish populations in the Yakima basin have been greatly affected by the construction, operation, and maintenance of the Yakima Project as previously described in this document. While the project has recently been operated to reduce impact to native fish, many problems persist which limit their productivity. The storage dams remain impassible, denying access to miles of instream habitat and isolating local populations of bull trout. Summer water temperatures in the lower river are too warm to support salmonid fishes and are conducive to the proliferation of non-native species which prey on salmonids. The availability and quality of fish habitat is compromised by regulated flows, which are at times unnaturally high and at other times unnaturally low. As a result of all of these factors, some native species have been extirpated in the Yakima basin (sockeye, summer chinook, and coho)[1], the populations of some species that remain have precipitously declined (steelhead and bull trout), and other species are lower in abundance and productivity than they would otherwise be without the effects of the project (spring chinook, fall chinook, and resident trout).

It is reasonable to expect that substantial recovery can occur if substantial changes occur in the operations of the Yakima Project. The recovery of fish populations and subsequent maintenance of these populations is inextricably linked to the health of the aquatic ecosystem as a whole of which instream flows are an integral component. A normative ecosystem approach should be adopted to effect this recovery. A normative ecosystem provides for "properly functioning conditions," standards that are essential to maintain diverse and productive populations while accommodating current multiple uses to the extent practicable. The "normative river ecosystem" combines physical habitat with a flow regime designed to create and maintain a continuum of high quality habitat for all native biota; primary production (algae), secondary production (benthic invertebrates), and the various life history stages of the native fish assemblage. Before development, the natural hydrograph interacting with the channel, floodplain, and shallow groundwater system formed the physical template within which native species evolved. The challenge of the normative ecosystem concept is to identify and recreate those key features of the natural hydrograph and physical habitat necessary to restore "properly functioning ecosystems" while continuing to meet human needs.

Interim Measures of Success -

Fish population success or failure should be measured in terms of abundance, distribution, and productivity, i.e., smolts per adult or adults per spawner for both resident and anadromous fishes. Our objective is to achieve the following interim measures of success within 10 years upon completion of the IOP:

- Maintain an increase in population productivity for both anadromous and resident fish populations in the Yakima basin (i.e., smolts per adult and/or adult per adult recruitment).

- Increase the effective population size of local bull trout populations and re-establish connectivity between at least two currently isolated populations.

- Maintain or increase spring chinook salmon abundance at or above the 2000-2002 average run size to provide increased fishing opportunity and natural production.

[1] Note: The coho escapement past Prosser Dam has averaged 4,221 fish for the period of 1997-2001, and the 2001 run was comprised of 1,500 naturally produced adults. Therefore, coho are no longer considered functionally extinct in the Yakima basin.

- Increase fall chinook salmon abundance above the 1998-2002 average run size to maintain fishing opportunity while increasing natural production to at least 50 percent of the total adult return.

- Maintain or improve the species diversity for native fish assemblages throughout the basin.

- Increase the average size and the catch per unit effort for resident game fish in project reservoirs.

- Decrease mortality of juvenile anadromous salmonids in the Yakima River associated with predation by exotic warm water game fish (smallmouth bass and catfish) and avian predators.

- Restore salmonid populations to at least six functionally disconnected tributaries and provide passage over at least two project storage dams.

7.3 WILDLIFE

Resource Goal -

To protect existing wildlife habitats and restore high value habitats. Also reduce project impact to terrestrial wildlife migration.

7.4 RIPARIAN VEGETATION

Resource Goal -

To restore and/or protect a healthy and functional riparian system within the waterbodies serving and affected by the Yakima Project.

Explanation: A healthy, functional riparian zone is a necessary component of the overall health of the Yakima River system. A restoration strategy that improves the riparian system will benefit other objectives, such as enhancing fish habitat, lowering stream temperatures, increasing groundwater recharge, supporting the food web, and other important functions. Riparian vegetation filters sediments and can absorb nutrients, chemicals, and other pollutants that might otherwise be released into surface waters or aquifers. Riparian vegetation also decreases erosion and stabilizes streambanks by binding soils and substrate. Shade provided by overhanging riparian vegetation or by a riparian canopy reduces heating by solar radiation. Vegetation further reduces erosion by providing roughness at the interface between the streambank and the water. Water velocity, and thus the energy available for transport of sediment, is decreased. Streambank building may occur during high flow periods as sediments are deposited. Deposits of fine fertile soils on floodplains are due to the filtering effect of riparian vegetation and the slowing of flow velocity. Additionally, riparian vegetation provides critical habitat for macro-invertebrate and amphibian populations important in the aquatic food web, as well as habitat and forage for a high percentage of terrestrial wildlife species.

Ideally, the main stem of the Yakima River system, its tributaries and lakes, should have a healthy riparian area free from polluted waters that can impair the riparian vegetation along these waterbodies. Much of the Yakima basin riparian areas have been degraded by the location of roads; railroad beds; agricultural uses; urban, recreational and residential development; and gravel mining. Yakima Project development and operation has also resulted in some deterioration of functional riparian areas. Restoration or improvement of the function of those areas lost are an essential element of this IOP.

Lists of characteristics are provided below as a guide to understanding the terms “healthy riparian vegetation,” “healthy riparian area,” and “degraded riparian area.”

Characteristics of healthy riparian vegetation:

- Diverse age-class distribution of riparian vegetation.
- Diverse species composition of riparian vegetation.
- Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events.
- Riparian plants exhibit high vigor.
- Adequate riparian vegetative cover is present to protect banks and dissipate energy during high flows.
- Plant communities are an adequate source of coarse and/or large woody material.

Characteristics of a healthy riparian zone:

- Good shade, cool water.
- Abundant woody and organic debris in stream.
- Abundant vegetation and roots to protect and stabilize banks.
- Gravelly, narrow, deep channel.
- Good fish and wildlife habitat.

- Good water quality.
- High forage production.
- High water table and increased storage capacity.
- Width of the riparian zone is determined by site physical characteristics and sub-irrigation provided by adjacent waterbody.

Signs of riparian degradation:

- Shallow-rooted vegetation and a lack of woody species.
- A wide stream channel with shallow and/or muddy water.
- Stream channel is straight and lacks meander.
- Exposed soil on bank of stream or lake suggesting bank collapse and lack of root structure.
- Invasion of undesirable plants.

Interim Measures of Success -

- Provide hydrology for the establishment of cottonwoods and other native riparian vegetation.
- Develop or adopt models, measurement tools, etc., to describe, qualify, and quantify the functionality of the existing riparian areas.
- Multi-agency participation and partnerships in riparian restoration projects.
- Identify areas of riparian degradation and prioritize for focused attention.
- Continue land and water acquisition program.
- Temperature TMDL in place by 2013.
- Increase in and improvement in health of riparian areas.
- Land use planning and development recognizes the value and need for functional riparian areas.

- Continued project implementation of programs like the Conservation Reserve Enhancement Program and the Wildlife Incentives Program that focus on riparian restoration.

7.5 FLOODPLAIN FUNCTIONS/CHANNEL MORPHOLOGY

Resource Goal -

To restore and maintain properly functioning floodplains.

Explanation: Storing water in reservoirs truncates the flood peaks; reducing the frequency, duration, magnitude, and spatial extent of floodplain inundation. Floodplain reaches contribute to baseflows; thermal moderation; nutrient cycling and food web production; off-channel habitats; and are vital to sustain healthy fish populations in gravel bed river systems such as the Yakima.

7.6 IRRIGATION

Resource Goal -

To transform irrigation in the Yakima basin to 21st century standards by encouraging the best available irrigation technologies and management practices; and by adopting policies that allow efficient use of water, including a water brokerage or other means of promoting water transfers among districts and users; and conservation-based tiered water pricing structures to support irrigation of Yakima Project lands and other lands authorized to receive Yakima Project benefits.

Explanation: The project must be operated to satisfy various contracts, water rights, Tribal rights, endangered species obligations, and court decisions.

7.7 HYDROELECTRIC POWER

Resource Goal -

To operate and maximize generation of the Yakima basin existing hydroelectric power facilities in a manner consistent with and subordinate to other resource objectives as provided for in section 7.0. Further, pursue development of additional generation capacity only where it can be accomplished without negatively affecting the attainment of other section 7.0 resource objectives.

7.8 FLOOD DAMAGE REDUCTION

Resource Goal -

To restore floodplain functions and prevent the unnecessary loss of storage capacity to flood control operation while minimizing damage to infrastructure.

Explanation: Flood control operations are not a specific authorized purpose of the Yakima Project, but rather have been implemented in the Yakima basin under the general authorizing statutes applicable to all Reclamation projects. Flood control operations were not discussed by the Congress in Title XII, the latest enactment of the Congress specific to the Yakima Project, let alone as a priority of that legislation, as were anadromous fish; wetlands and water quality restoration; and the firming up of irrigation water supplies. Flood control operations can be incompatible with storing water for irrigation purposes, if stored water is released to create storage space for flood events and the reservoirs do not refill. Flood control operations can also be incompatible with the recovery of anadromous fish, wetlands, and water quality, because natural flooding cycles are key to restoring these river resources. Flood control operations have the secondary impact of creating an expectation in the public that Reclamation will provide protection from flooding, which tends to encourage development in the floodplain. This makes it difficult, if not impossible, for Reclamation to modify its operations to meet the natural resource restoration goals of Title XII because of potential liability for damage to development in the floodplain.

By gradually shifting from operational flood control to non-structural alternatives (e.g., moving structures and people out of harm’s way, acquiring critical floodplain areas, making buildings flood proof), Reclamation can achieve significant public (economic) benefits as well as move toward several of the resource goals of the IOP. Development in floodplains (building homes and businesses, cutting down trees for farmland, and paving over wetlands for roads and parking lots) destroys fish and wildlife habitat; increases the damage caused by floods; and eliminates the natural (and free) flood storage and water quality benefits of wetlands and floodplains.

Interim Measures of Success -

- Incrementally reduce flood control operations, depending less on project operations for flood control over time as non-structural alternatives are implemented.

- Increase the frequency of flow magnitudes designed to restore floodplain functions.

- Report annually on the impact on and cost of flood control operations on storage refill.

8.0 ANALYSIS OF OPERATIONAL ALTERNATIVES

8.1 INTRODUCTION

In determining the content of this chapter, the group summarized the “Project Effects” and the “Resource Objectives” developed in sections 6 and 7, respectively, into the worksheets that follow. The “Alternatives” shown in the tables were then developed through a series of “brainstorming” sessions, designed to identify all available ideas from the individual group members without regard to legal, institutional or financial constraints or any other issues affecting the practicality of the alternatives. No attempt was or has been made to prioritize, edit, or censor this list in any way.

The group then reviewed the following list of alternatives thoroughly in the process of developing the final recommendations found in section 9.

WORKSHEET
for
ALTERNATIVE DEVELOPMENT

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
<u>WATER QUALITY 6.1.1</u>		
Temperature	To obtain water quality in the Yakima River and its tributaries that fully supports designated uses and meets narrative and numerical criteria of Washington State water quality standards.	1. Release reservoir water from various depths to manage temperatures. Reservoir outlet works will need to be modified. 2. Collect data and develop a comprehensive temperature model. 3. Restore riparian areas on lands acquired by Reclamation. 4. Restore river/floodplain interactions on lands acquired by Reclamation. 5. Reduce overland surface return flows. 6. Increase flows in bypass reaches with conservation. 7. Increase flows with acquisition. 8. Request a review of temperature standards for selected drains.
Sediment Pesticides/Herbicides	Meet State standards. Support the irrigation district and conservation district efforts to reduce sediment and nutrient loading in return flows.	1. Promote water conservation to improve irrigation efficiencies on-farm and reduce return flows. 2. Adopt policies to encourage clean water return flows. 3. Reclamation to report any observed water quality problems to the WDOE for enforcement. 4. Complete the process of developing SOPs for reducing fine sediment discharges from main stem diversion dams. 5. Reclamation, in cooperation with client irrigation districts, develops/utilizes a drain maintenance manual to promote clean water return flows. 6. Reclamation to actively support and participate in (1) NAWQA studies; (2) TMDL workgroups; (3) IBI assessments; and (4) Data collection/ modeling.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
WATER QUALITY 6.1.1 - continued		
		7. Develop and implement a monitoring program that is sensitive to changes in operations affecting cold water biota. 8. Report the results of Reclamation's water quality monitoring on the Yakima Project web page for the Bureau of Reclamation's Pacific Northwest Region. In addition, provide links to other relevant Yakima water quality monitoring and progress reports, prepared by the irrigation districts, NRCS, NAWQA, WDOE's 303(d) listing and TMDL program; Washington Trout (e.g., its IBI assessment), and other relevant water quality information that comes to its attention.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
<u>WATER QUANTITY 6.1.2</u>		
Altered Hydrograph	Establish streamflows in the Yakima River that mimic the unregulated hydrograph to the extent and frequency necessary to restore riverine ecosystem processes that support healthy, sustainable native aquatic plant and animal communities and which also provide for the efficient implementation of other legitimate project purposes.	1. Reshape the hydrograph during flood release periods. 2. Implement CAG's recommendations on water metering, enforcement, and the use of stream patrols/Federal Watermasters. 3. Develop reach-by-reach flow targets. 4. Establish interim or initial target flows for the main stem Yakima, Naches, and Tieton Rivers, for dry, wet, and average years with the RVA computer model and other existing biological and physical data. 5. Adopt a set of ecosystem indicators to measure the effectiveness of the interim flow targets in achieving conditions necessary to recover biodiversity and natural ecosystem functions, and take baseline data on all of the hydrological, biological, and other ecosystem indicators prior to implementing the initial target flows. 6. Adjust the interim target flows as indicated by monitoring data collected with the monitoring program that is sensitive to changes in operations affecting cold water biota. 7. Use the RVA on a regular basis to measure progress towards an unregulated hydrograph. 8. Monitor the ecosystem indicators on a regular basis to measure progress in attaining positive values of those indicators. 9. Combine monitoring information from the RVA and the ecosystem indicators, and other relevant information obtained from ongoing studies, adapt system management to achieve the long-term goal.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
<u>WATER QUANTITY 6.1.2 - continued</u>		
Fluctuating base flows (hourly). Roza gate does not allow for minor adjustments in water flows.	Stabilize base flows below Roza Diversion Dam, Prosser, Chandler, Parker, Naches at Naches, and Sunnyside.	1. Develop reregulation reservoirs. 2. Automate diversions/canals/check structures. 3. Install remote controls on all reservoirs. Provide attended staffing at each reservoir until remote controls are installed. 4. Evaluate reducing ramping rates from 2 inches/hour to 1 inch/hour and monitor established ramping rates. 5. Pass the flow fluctuations down the irrigation district's canal in conjunction with the development of reregulation reservoirs.
Excessive summer flows in some reaches.	Establish a normative hydrograph.	1. Revisit and analyze flip-flop alternatives. 2. Construct storage in mid-basin. 3. Decrease deliveries with water conservation & shorter water seasons. 4. Conjunctive use of floodplain recharge, groundwater, & surface water, including aquifer storage & recovery.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
FISHERY RESOURCES 6.2	To recover and maintain self-sustaining, harvestable populations of native fish, both anadromous and resident species, throughout their historic distribution range in the Yakima basin.	
Extirpation of native anadromous sockeye salmon, summer-run chinook salmon, and coho salmon.	1. Reestablish sockeye as passage is restored at storage dams. 2. Reestablish self-sustaining coho populations. 3. Determine the feasibility of restoring summer chinook.	1. Perform a feasibility study to provide passage at all five storage reservoirs (exclude Clear Lake). 2. Provide passage for at 2 reservoirs within the next 10 years. 3. Provide passage opportunities as a project reaches the end of useful economic life (e.g., Keechelus). 4. Operate the Yakima Project to support reintroduction efforts, consistent with other uses, for sockeye, summer-run chinook, and coho salmon, considering recommendations from SOAC and River Operations groups.
Eliminated access for native salmonids to tributary and headwater habitats above storage dams. Isolation of local bull trout populations.	Provide fish passage at all storage dams.	1. Perform a feasibility study to provide passage at all five storage reservoirs (exclude Clear Lake). 2. Provide passage for at least 2 reservoirs within the next 10 years. 3. Provide passage opportunities as a project reaches the end of useful economic life (e.g., Keechelus). 4. Redesign and/or repair fish ladder at Clear Lake.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
FISHERY RESOURCES 6.2 - continued		
Loss of instream habitat inundated by reservoirs and/or rendered inaccessible by storage dams.	Fully mitigate for lost habitat from inundation and inaccessibility.	1. Restore habitat/passage to tributaries above reservoirs (e.g., Cold Creek, Mill Creek, and the South Fork Tieton River). 2. Operate reservoirs at lower maximum elevation. 3 Remove one or more dams and mitigate impact to TWSA by reducing demand and/or off-channel storage. 4. Improve habitat/passage conditions downstream of reservoirs including tributaries.
Fish mortality and/or injury as a result of entrainment in the outlet works of the Rimrock and Clear Lakes storage dams.	Reduce mortality or injury as a result of entrainment in outlet works to a level that has negligible impact on recreational fisheries and no impact to sexually mature adult bull trout.	1. Install exclusion devices on intakes at the outlet works of Rimrock and Clear Lakes. 2. Reclamation develops and maintains prescribed minimum reservoir elevations at Rimrock and Clear Lakes.
Loss of gravel recruitment below Tieton Dam.	Mitigate for loss of gravel recruitment and hastened downstream transport.	1. Following revisions to flip-flop, determine appropriate gravel augmentation locations, then supplement the gravel. 2. Modify flow regime to maintain desired substrate.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
<u>FISHERY RESOURCES 6.2 - continued</u>		
Substantial reduction in large woody debris recruitment.	Operate project to have no net negative effect on large woody debris recruitment and transport.	1. Pass/relocate large woody debris around diversions and storage facilities. 2. Stabilize or manage reservoirs to facilitate development of riparian areas around them. 3. Provide flow regimes that promote the health of riparian habitat. 4. Acquire wetlands, marginal farmland, or floodplains, and restore ecosystem functions of hydrograph and connectivity.
Upstream passage delays at diversion dams for adult anadromous salmonids. Entrainment and delay of migrating adult anadromous salmonids in diversion canals.	Configure and operate project to have no net negative effect on pre-spawning survival and eliminate need to salvage adults from project facilities.	1. Operate facilities within established NMFS and WDFW criteria at all times. 2. Replace diversion dams with pump stations. 3. Install adult exclusion devices in headworks of canals, with possible exception of Prosser, which involves potentially different circumstances. 4. Assure canals drain properly from the canal headworks to the fish bypass facility.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
FISHERY RESOURCES 6.2 - continued		
Substantial smolt mortality associated with passage at diversion facilities.	Substantially improve smolt survival at diversion facilities.	1. Operate facilities within established NMFS and WDFW criteria at all times. 2. Study bypass return structures to determine the best design to reduce predation. 3. Provide more water over diversion dams with acquisition or conserved water. 4. Replace facilities with pump stations. 5. Assure canals drain properly from the canal headworks to the fish bypass facility.
Disruption of sediment transport dynamics.	Resolve to the extent practicable, associated problems downstream of diversion dams.	1. Place gravel below dams. 2. Suction dredge fine sediment from reservoir pool. 3. Where possible, conduct sediment generating maintenance activities so they occur during higher flows. 4. Complete Reclamation sediment transport study. Complete additional studies as determined necessary. Upon verification of gravel transport problem, initiate actions to resolve the problem.
Drains and wasteways that attract adult salmonids and present lethal or injurious conditions for all salmon life stages.	Improve water quality and physical habitat to a point where waterways are capable of supporting appropriate life history stages.	1. Restore physical habitat. 2. Inventory drains to determine which ones have potential to support salmon and steelhead production. 3. Restore riparian habitat. 4. Support irrigation districts' water quality improvement efforts. 5. Reduce or eliminate drain flow (prevent salmonids from entering). 6. Place exclusion devices on waterways to prevent salmonids from entering.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
FISHERY RESOURCES 6.2 - continued		
Severe alteration of the natural hydrographs (streamflows) of the Yakima, Cle Elum, Bumping, Tieton, and lower Naches Rivers.	Manage for normative hydrograph for all regulated reaches of the Yakima River.	1. Conduct analysis to determine normative hydrograph. 2. Reshape delivery schedules. 3. Build basin-wide canal system to convey water. 4. Additional storage. 5. Additional water from other basins. 6. Water conservation. 7. Reduce demand. 8. Purchase water rights. 9. Implement the recommendations in the Yakima River Basin Conservation Advisory Group "ESTABLISHMENT OF A PERMANENT PLAN FOR MEASURING AND REPORTING" report. 10. Adopt a set of ecosystem indicators to measure the effectiveness of target flows, establish target flows, and monitor them to measure progress towards positive values. 11. Use existing biological and physical data to arrive at interim/initial target flows for the Yakima, Naches, and Tieton Rivers, for dry, wet, and average years.
Excessive and unnatural short-term flow fluctuations below diversions and Tieton Dam.	Manage for normative hydrograph below diversion dams and Tieton Dam in reference to short-term (hourly, daily, and weekly) flow fluctuations.	1. Automate system with gates sensitive to minor changes in pool elevations. 2. Schedule deliveries. 3. Reregulation reservoirs. 4. Reduce ramping rates. 5. Pass fluctuation down canals.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
FISHERY RESOURCES 6.2 - continued		
Altered water temperature regimes, particularly in the middle and lower reaches of the Yakima River.	Provide water temperatures throughout the basin capable of supporting salmonids.	1. Use storage water to meet temperature needs downstream. 2. Recharge groundwater aquifers during non-irrigation season. 3. Expedite travel times through diversion pools. 4. With the acquisition program, acquire areas of riparian zones/floodplains that correspond to areas that historically or effectively produced cold surface and groundwater discharge.
Facilities operations and maintenance activities that result in fish mortality.	Conduct operations and maintenance activities in time and space that minimize or avoids fish mortality to the maximum extent practicable.	1. Develop long-term planning perspective for operations and maintenance activities, with capital improvements, structured to prevent catastrophic system failures.
High predation of smolts in middle and lower river.	Reduce smolt predation mortality by 50%.	1. Level canal floors to move fish faster and reduce predator holding areas. 2. Design bypass return structures with a manifold design (multiple discharges). 3. Aim sprinklers at bypass outfall returns. 4. Exclusion structures for larger (predator) fish. 5. More water over diversion. 6. Provide a more normative flow regime. 7. Determine feasibility of a predation control program.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
WILDLIFE 6.3		
Conversion of habitats to agriculture and project infrastructure.	Protect existing wildlife habitats & restore high value habitats.	1. Acquire wetlands, marginal farmland, or floodplains, and restore ecosystem functions of hydrograph and connectivity. 2. Promote wildlife incentives for irrigation districts to provide nesting cover, wetland restoration or development, and sediment retention. 3. Promote wildlife considerations as part of conservation planning for irrigation districts. 4. Hire project wildlife specialist.
Create migration barriers/mortality. Loss of winter range.	Reduce project impacts to terrestrial wildlife migration.	1. Bury pipe or bridge to reduce barriers in many canals. 2. Put in escape ramps for animals trapped in canals off-season. 3. Fence out big game where pipe, bridges, etc., are not effective. 4. Perform a wildlife assessment that identifies and prioritizes areas where wildlife mortality is a problem.
Loss of food nutrient energy source with fish runs (salmon related) indirect effect. Loss of passage over dams.		1. Remove one or more dams and mitigate impact to TWSA by reducing demand and/or off-channel storage. 2. Improve habitat/passage conditions downstream of reservoirs including tributaries.
Loss of large woody debris. Loss of wildlife food base associated with decreased abundance & distribution of salmon. Mortality caused by project structures.		1. Pass/relocate large woody debris around diversions and storage facilities. 2. Stabilize or manage reservoirs to facilitate development of riparian areas around them. 3. Provide flow regimes that promote the health of riparian habitat. 4. Acquire wetlands, marginal farmland, or floodplains, and restore ecosystem functions of hydrograph and connectivity.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
RIPARIAN VEGETATION 6.4		
Lack of riparian vegetative growth around reservoirs due to water level fluctuations. Lack of riparian vegetative growth along the main stem and tributaries of the Yakima River. Lack of riparian vegetative growth in drains developed in the natural water courses.	The restoration and protection of a healthy and functional riparian system within the water bodies serving and affected by the Yakima Project.	1. Develop a riparian inventory. 2. Complete Reaches Study. 3. Within 3 years after funding, have enough information on cottonwood and other riparian regeneration. 4. Operate Yakima Project in a manner that facilitates regeneration of riparian revegetation. 5. Develop method of monitoring health and extent of riparian areas, such as IBI, EDT, and Habitat Evaluation Procedures (HEP). 6. Develop and implement a native riparian revegetation and retention program for Yakima Project facilities. 7. Develop a YFO review process to examine activities that may have an effect on riparian quality.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
<u>FLOODPLAIN FUNCTIONS/ CHANNEL MORPHOLOGY 6.5</u>		
Storing water in reservoirs truncates the flood peaks reducing the frequency, duration, magnitude, and spatial extent of floodplain inundation. Reduces the recharge of floodplains from overbank flow. Irrigation recharge of floodplains and groundwater changes timing, quantity, quality, and location.	Maintain properly functioning floodplains.	1. Accept more risk in the springtime operations. Change flood control guidelines. Instead of 12,000 cfs, protect Parker at 15,000 or 16,000 cfs. Involves building new flood control guidelines. 2. Go to operations that fill the reservoirs earlier.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
IRRIGATION 6.6		
	To transform irrigation in the Yakima basin to 21st century standards by encouraging the best available irrigation technologies and management practices, and by adopting policies that allow efficient use of water, including a water brokerage or other means of promoting water transfers among districts and users, and conservation-based tiered water pricing structures to support irrigation of Yakima Project lands and other lands authorized to receive Yakima Project benefits. The Project will be operated to satisfy various contracts, water rights, and court decisions.	

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
IRRIGATION 6.6 - continued		
Fish & Wildlife operation concerns stress the irrigation facilities & operations.	Revisit and analyze flip-flop alternatives.	1. Perform a reconnaissance level study of possible intra-basin transfers, e.g., the Black Rock proposal. 2. Simultaneously adopt a set of ecosystem indicators to measure the effectiveness of the interim flow targets in achieving conditions necessary to recover biodiversity and natural ecosystem functions; and take baseline data on all of the hydrological, biological, and other ecosystem indicators prior to implementing the initial target flows. 3. Provide mid-basin storage (e.g., Wymer).
Irrigation operation concerns.	Support irrigation of Yakima Project lands and other lands authorized to receive Yakima Project benefits.	1. Provide a Federal Watermaster to enforce water rights not directly managed by Reclamation. This is necessary to protect Yakima Project beneficiaries from unauthorized water withdrawals. Specifically post-1905 water rights that are junior to all Yakima Project irrigation water rights (contracts) and natural flow rights on tributaries not currently managed by a Reclamation or WDOE Watermaster.
Facilities operations and maintenance activities that would result in fish mortality in the event of a catastrophic system failure.	Develop long-term planning perspective for operations and maintenance activities, with capital improvements, structured to prevent catastrophic system failures.	1. Develop long-term planning perspective for operations and maintenance activities, with capital improvements, structured to prevent catastrophic system failures, such as Rimrock outlet works, spillway releases, and operating gates on all reservoirs during flip-flop.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
IRRIGATION 6.6 - continued		
Flood control operation concerns. Overuse of flood control operation may result in failure to fill.	Prevent unnecessary loss of storage.	1. Obtain improved runoff forecasts that would benefit TWSA & flood control predictions. 2. Accept more risk in the springtime operations. Change flood control guidelines. Instead of 12,000 cfs, protect Parker at 15,000 or 16,000 cfs. This alternative involves building new flood control guidelines. 3. Establish a flood corridor that will not be encroached on by development. (Needs cooperation from others.) 4. Perform a flood control/flood storage analysis to investigate reducing flood storage space, particularly in the spring, to allow earlier storage reservoir fill operations. Revise flood control curves to implement the analysis.
Recreation operation concerns.	Identify where it happens and minimize operations where recreation affects TWSA.	1. Continue to consider drafting Clear Lake in critical water supply years (timing may be critical).
Wapatox power operation concerns.	Wapatox Irrigation Diversion must be accommodated. Ensure there is no affect (neutral) to TWSA.	1. Fully implement court orders pertaining to use of storage water. 2. Implement studies to determine flow needed to benefit reach. Then perform a partial buyout or full buyout of Wapatox Power Plant as necessary.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
<u>HYDROELECTRIC POWER - 6.7</u>		
Provide water for existing power generation facilities.	Maximize generation of existing hydroelectric power facilities in a manner consistent with and subordinate to other resource objectives provided in section 7.0.	1. Continue to coincidentally generate power at existing facilities and subordinate power production as necessary to reduce environmental impacts. 2. Change time of releases to support power production.
Provide water for new power generation facilities.	Pursue development of additional generation capacity only where it can be accomplished without negatively affecting the attainment of other section 7.0 resource objectives.	1. Explore additional coincidental power production only where it would not hinder achieving other water management (or resource) objectives.

Project Effects - Section 6	Objectives - Section 7	Alternatives - Section 8
FLOOD DAMAGE REDUCTION 6.8		
Effects timing of peak events and depending on the event and space available, can decrease the magnitude of flood events.	Minimize flood damage through methods other than conventional flood control reservoir operations. To restore floodplain functions and prevent the unnecessary loss of storage capacity to flood control operations while minimizing damage to infrastructure.	1. Get improved forecasts and use them with an early warning system to reduce flood damage. 2. Establish a flood corridor that will not be encroached on by development. (Needs cooperation from others.) 3. Perform a flood control/flood storage analysis to investigate reducing flood storage space, particularly in the spring, to allow earlier storage reservoir fill operations. Revise flood control curves to implement the analysis. 4. Meet with the Corps, Federal Emergency Management Agency (FEMA), and county government to encourage them to implement non-structural flood control alternatives in the Yakima basin. 5. Match flood prone areas with high priority wetland and floodplain habitat areas, and prioritize for acquisition or other protective status such as conservation easements that would allow periodic flooding. 6. After the establishment of a flood corridor, fund, through this partnership, using existing Reclamation, Corps, FEMA, and other available Federal and State authorities and authorizations, the relocation or flood proofing of homes and businesses (e.g., gravel mining), removal of flood control structures, and acquisition of title or conservation easements for priority lands.

9.0 OPERATIONAL RECOMMENDATIONS

9.1 INTRODUCTION

The final recommendations for this Interim Operating Plan (IOP) were developed from the list of alternatives in section 8. The following worksheets show the project effect, the list of alternatives that were developed in the group's brainstorming sessions, and the 67 dissimilar recommendations the IOP Committee chose to recommend for further action or follow-up.

Many of the resulting recommendations are repetitive in an effort to maintain the integrity and thorough nature of the group's efforts and to demonstrate that many of the recommendations address multiple project effects. For example, recommendations numbered 2 and 50 are essentially the same, but appear under the 2 project effects categories which the group felt would be improved by the recommendation. The first occurrence of repetitive recommendations are in bold font and any reoccurring recommendations are in regular font.

Because this operating plan is comprehensive in nature, it necessarily includes recommendations affecting other agencies and their activities, which may be only indirectly related to project operations. In those cases, the recommendations generally provide for partnership development with those agencies.

Unlike the list of alternatives in section 8, the general view of the group was such that prior to any implementation, each recommendation should be reviewed with respect to legal/institutional constraints and scientific foundation. The group did not, however, spend much time (at least not for everyone) determining the financial implications of any particular recommendation or whether sufficient scientific data is currently available to allow the precise recommendation to be implemented without further study, modeling, or data collection.

The list of recommendations reflects the general agreement of all members of the group who participated in its development, though not necessarily the complete consensus of every group member. As has been previously pointed out, this IOP is indeed "interim." It is anticipated that the Yakima Field Office staff or other basin interests will determine if the plan (recommendation's section) needs to be updated within a few years to reflect new knowledge gained from any number of sources. Experience in implementation of the recommendations or new scientific findings relative to the needs of the fish in the basin are two examples of developments which would prompt the need to update the IOP.

The scope of the recommendations is recognized to be quite large. Due to financial constraints combined with legal and contractual issues, it is likely that the Yakima Field Office will be able, practically, to implement only some of these recommendations. It is anticipated that the selected recommendations will be implemented over a period of many years. Some recommendations could require environmental impact statements prior to implementation. In addition, those recommendations that serve to directly improve Reclamation's ability to meet Endangered Species Act responsibilities or Yakama Nation trust responsibilities would likely be given priority.

The recommendations involving large dollar modifications, such as the construction of large structures or fish ladders at major dams, will require congressional authorization and appropriations. Typically those modifications would require a full feasibility level study prior to congressional action. Constituents will need to initiate the needed congressional actions on a collaborative basis prior to any Reclamation implementation. As a Federal agency, Reclamation is by law not allowed to participate in any lobbying activity for such projects.

Each recommendation should be monitored or evaluated to document its benefits. The type of monitoring/evaluation should be specific to the action implemented. However, a long-term baseline monitoring plan should be considered as a means to evaluate the overall achievements of the implemented actions. The monitoring/evaluation plan should seek to obtain baseline information, determine the effectiveness of the action, and identify areas for improvement. Adaptive management should be applied based on the results of monitoring. The Yakama Nation, Washington Department of Fish & Wildlife (WDFW), Reclamation, and others have active monitoring and research projects ongoing in the basin and, where possible, information from those studies should be incorporated into monitoring/evaluation plans for the implements actions (appendix H, list of current monitoring projects).

Any recommendations to investigate storage options in the basin carry with them the follow caveat: The natural hydrograph has been significantly modified by the current reservoir system and the operation of the Yakima Project for irrigation. Additional storage in the basin could further adversely affect the natural flow regime. The existing flow regime does not serve the needs of the fishery and other natural resource objectives, and, in significantly water-short years, even the interests of irrigation, at least in its current configuration and management practices.

All members of IOP agree that a better balance must be struck in favor of the aquatic ecosystem, including the native fish resource, and water quality, among other natural resources. Finding the correct balance of options to advance the legitimate water needs of all interest will require a much more disciplined and complete analysis of options than has occurred in the past. Any proposed storage must be designed to meet critical needs, which must be clearly delineated and justified.

If a legitimate need is identified and the extent of that need carefully circumscribed, a range of alternatives to meeting the need must be carefully assessed. The members of IOP are committed to least cost options, and cost analyses must include quantification of the environmental costs and benefits of various alternatives and mixes of alternatives. Some water conservation options, for instance, carry with them not only the potential to increase flows in reaches between diversion and return flows, but also to reduce the consumptive use of water (e.g., no longer watering vegetation along canals), water quality improvements, the benefits of increased crop production from more efficient on-farm systems, and the like, which must be taken into consideration in analyzing the costs and benefits of other options to increase the flexibility of the water supply, such as new storage.

Another extremely important factor for analysis of alternatives if the extent of water use by each crop in the basin relative to the market value of water in the Yakima basin. In 2001, the price of water for irrigation (and instream flows) varied from $50/acre-foot to almost $500/acre-foot, depending on the time, place, and duration of delivery. None of these leases was for longer than the irrigation season and several were for a shorter period. The market value of water relative to crop values is thus a critical factor in the analysis of water supply and must be taken into consideration when evaluating the efficacy of the current storage system and any purported need for new storage.

WORKSHEET
for
RECOMMENDATION DEVELOPMENT

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
WATER QUALITY 6.1.1		
Temperature	1. Release reservoir water from various depths to manage temperatures. Reservoir outlet works will need to be modified. 2. Collect data and develop a comprehensive temperature model. 3. Restore riparian areas on lands acquired by Reclamation. 4. Restore river/floodplain interactions on lands acquired by Reclamation. 5. Reduce overland surface return flows. 6. Increase flows in bypass reaches with conservation. 7. Increase flows with acquisition. 8. Request a review of temperature standards for selected drains.	1 **With the acquisition program, acquire areas of riparian zone/floodplain** that historically produced or are capable of producing cold surface and groundwater discharge. 2 **Investigate structural and non-structural ways to recharge the floodplain on lands acquired by Reclamation.** 3 **Develop a comprehensive surface water temperature model that includes ambient air temperature, water velocity, water quantity, surface/groundwater interaction, reservoir temperature stratification and release, and drain discharge temperature and amount.** 4 **Use the developed temperature model for operational changes that the model demonstrates are most likely to achieve temperature standards.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
WATER QUALITY 6.1.1 - continued		
Sediment Pesticides/Herbicides	1. Promote water conservation to improve irrigation efficiencies on-farm and reduce return flows. 2. Adopt policies to encourage clean water return flows. 3. Reclamation to report any observed water quality problems to the WDOE for enforcement. 4. Complete the process of developing SOPs for reducing fine sediment discharges from main stem diversion dams. 5. Reclamation, in cooperation with client irrigation districts, develops/utilizes a drain maintenance manual to promote clean water return flows. 6. Reclamation to actively support and participate in (1) NAWQA studies; (2) TMDL workgroups; (3) IBI assessments; and (4) Data collection/modeling. 7. Develop and implement a monitoring program that is sensitive to changes in operations affecting cold water biota. 8. Report the results of Reclamation's water quality monitoring on the Yakima Project web page for the Bureau of Reclamation's Pacific Northwest Region. In addition, provide links to other relevant Yakima water quality monitoring and progress reports, prepared by the irrigation districts, NRCS, NAWQA, WDOE's 303(d) listing and TMDL program; Washington Trout (e.g., its IBI assessment), and other relevant water quality information that comes to its attention.	5 **Complete the process of developing and using standard operating procedures for reducing fine sediment discharges from main stem diversion dams.** 6 **Report any observed water concerns problems to the WDOE or the appropriate enforcing agency for follow-up enforcement actions.** 7 **Reclamation, in cooperation with client irrigation districts, develops/utilizes a drain maintenance manual to promote clean water return flows.** 8 **Reclamation to actively support and participate in (1) NAWQA studies; (2) TMDL workgroups; and (3) IBI assessments; and (4) Data collection/modeling.** 9 **Report the results of Reclamation's water quality monitoring project on its web page. Provide links to other relevant Yakima water quality monitoring and progress reports being prepared by the irrigation districts, NRCS, NAWQA, WDOE's 303d listing and TMDL programs; Washington Trout (its IBI assessment), and any other water quality information that comes to its attention.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
WATER QUALITY - 6.1 - continued		
		10 **Investigate with WDFW and other regulatory agencies the benefits of doing instream work during higher water flows rather than the low water flows.**
Altered Hydrograph	1. Reshape the hydrograph during flood release periods. 2. Implement CAG's recommendations on water metering, enforcement, and the use of stream patrols/Federal Watermasters. 3. Develop reach-by-reach flow targets. 4. Establish interim or initial target flows for the main stem Yakima, Naches, and Tieton Rivers, for dry, wet, and average years with the RVA computer model and other existing biological and physical data. 5. Adopt a set of ecosystem indicators to measure the effectiveness of the interim flow targets in achieving conditions necessary to recover biodiversity and natural ecosystem functions, and take baseline data on all of the hydrological, biological, and other ecosystem indicators prior to implementing the initial target flows. 6. Adjust the interim target flows as indicated by monitoring data collected with the monitoring program that is sensitive to changes in operations affecting cold water biota. 7. Use the RVA on a regular basis to measure progress towards an unregulated hydrograph.	11 **Advocate the implementation of the Recommendations in the Yakima River Basin Conservation Advisory Group's "ESTABLISHMENT OF A PERMANENT PLAN FOR MEASURING AND REPORTING" report.** Appendix F 12 **Adopt a set of ecosystem indicators to measure the effectiveness of target flows, establish target flows, and monitor them to measure progress towards positive values.** 13 **Use existing biological and physical data to arrive at interim/initial target flows for the Yakima, Naches, and Tieton Rivers, for dry, wet, and average years** (See Recommendation #4 in the May 1999, "REPORT ON BIOLOGICALLY BASED FLOWS FOR THE YAKIMA RIVER BASIN" for an expanded explanation).

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
WATER QUALITY 6.1.1 - continued		
	8. Monitor the ecosystem indicators on a regular basis to measure progress in attaining positive values of those indicators. 9. Combine monitoring information from the RVA and the ecosystem indicators, and other relevant information obtained from ongoing studies, adapt system management to achieve the long-term goal.	
Fluctuating base flows (hourly). Roza gate does not allow for minor adjustments in water flows.	1. Develop reregulation reservoirs. 2. Automate diversions/canals/check structures. 3. Install remote controls on all reservoirs. Provide attended staffing at each reservoir until remote controls are installed. 4. Evaluate reducing ramping rates from 2 inches/hour to 1 inch/hour and monitor established ramping rates. 5. Pass the flow fluctuations down the irrigation district's canal in conjunction with the development of reregulation reservoirs.	14 **Install remote controls on all reservoirs. Provide additional staffing at each reservoir to manage ramping rates until remote controls are installed.** 15 **Evaluate the placement of reregulation reservoirs to transfer demand and other operationally induced fluctuations from the river to the districts.** 16 **Continue current ramping rates with annual review of monitoring data to determine if adjustments in rates are necessary at specific locations to reduce stranding of fish or macro-invertebrates.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
WATER QUALITY 6.1.1 - continued		
Excessive summer flows in some reaches.	1. Revisit and analyze flip-flop alternatives. 2. Construct storage in mid-basin. 3. Decrease deliveries with water conservation & shorter water seasons. 4. Conjunctive use of floodplain recharge, groundwater, & surface water, including aquifer storage & recovery.	17 **Review alternatives to the current flip-flop operations to determine whether other operational scenarios would better serve multi-species recovery strategy and to lessen impacts on critical aquatic habitat in the basin.** 18 **Investigate to locate off-channel mid-basin storage sites.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FISHERY RESOURCES 6.2		
Extirpation of native anadromous sockeye salmon, summer-run chinook salmon, and coho salmon.	1. Perform a feasibility study to provide passage at all five storage reservoirs (exclude Clear Lake). 2. Provide passage for at least 2 reservoirs within the next 10 years. 3. Provide passage opportunities as a project reaches the end of useful economic life (e.g., Keechelus). 4. Operate the Yakima Project to support reintroduction efforts, consistent with other uses, for sockeye, summer-run chinook, and coho salmon, considering recommendations from SOAC and River Operations groups.	19 **Perform a feasibility study to provide passage at all five storage reservoirs (exclude Clear Lake).** 20 **Operate the Yakima Project to support reintroduction efforts, consistent with other uses, for sockeye, summer-run chinook, and coho salmon, considering recommendations from SOAC and River Operations groups.** 21 **Provide passage at 2 reservoirs within the next 10 years**.
Eliminated access for native salmonids to tributary and headwater habitats above storage dams. Isolation of local bull trout populations.	1. Perform a feasibility study to provide passage at all five storage reservoirs (exclude Clear Lake). 2. Provide passage for at 2 reservoirs within the next 10 years. 3. Provide passage opportunities as a project reaches the end of useful economic life (e.g., Keechelus). 4. Redesign and/or repair fish ladder at Clear Lake.	22 Perform a feasibility study to provide passage at all five storage reservoirs (exclude Clear Lake). 23 **Redesign and/or repair fish ladder at Clear Lake.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FISHERY RESOURCES 6.2 - continued		
Loss of instream habitat inundated by reservoirs rendered inaccessible by storage dams.	1. Restore habitat/passage to tributaries above reservoirs (e.g., Cold Creek, Mill Creek, and the South Fork Tieton River). 2. Operate reservoirs at lower maximum elevation. 3. Remove one or more dams and mitigate impact to TWSA by reducing demand and/or off-channel storage. 4. Improve habitat/passage conditions downstream of reservoirs including tributaries.	24 **Restore habitat/passage to tributaries above reservoirs (such as Cold and Mill Creeks in the Keechelus basin and the South Fork Tieton River in the Rimrock basin)**. 25 **Improve habitat/passage conditions downstream of reservoirs including tributaries.**
Fish mortality and/or injury as a result of entrainment in the outlet works of the Rimrock and Clear Lakes' storage dams.	1. Install exclusion devices on intakes at the outlet works of Rimrock and Clear Lakes. 2. Reclamation develops and maintains prescribed minimum reservoir elevations at Rimrock and Clear Lakes.	26 **Install exclusion devices on intakes at the outlet works of Rimrock and Clear Lakes.**
Loss of gravel recruitment below Tieton Dam.	1. Following revisions to flip-flop, determine appropriate gravel augmentation locations, then supplement the gravel. 2. Modify flow regime to maintain desired substrate.	27 **Following revisions to flip-flop, determine appropriate gravel augmentation locations, then supplement the gravel.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FISHERY RESOURCES 6.2 - continued		
Substantial reduction in large woody debris recruitment.	1. Pass/relocate large woody debris around diversions and storage facilities. 2. Stabilize or manage reservoirs to facilitate development of riparian areas around them. 3. Provide flow regimes that promote the health of riparian habitat. 4. Acquire wetlands, marginal farmland, or floodplains, and restore ecosystem functions of hydrograph and connectivity.	28 **Pass/relocate large woody debris around diversions and storage facilities.** 29 **Provide flow regimes that promote the health of riparian habitat.** 30 Acquire wetlands, marginal farmland, and floodplain habitats to restore hydrologic connectivity.
Upstream passage delays at diversion dams for adult anadromous salmonids. Entrainment and delay of migrating adult anadromous salmonids in diversion canals.	1. Operate facilities within established NMFS and WDFW criteria at all times. 2. Replace diversion dams with pump stations. 3. Install adult exclusion devices in headworks of canals, with possible exception of Prosser, which involves potentially different circumstances. 4. Assure canals drain properly from the canal headworks to the fish bypass facility.	31 **Operate fish screen facilities within established NMFS and WDFW criteria at all times. The criteria is described in appendix G 1 & 2.** 32 **Install adult exclusion devices in headworks of canals, with possible exception of Prosser, where fish are gathered for the hatchery.** 33 **Assure canals drain properly from the canal headworks to the fish bypass facility to prevent stranding when the canals are shut down for the season.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
<u>FISHERY RESOURCES 6.2 - continued</u>		
Substantial smolt mortality associated with passage at diversion facilities.	1. Operate facilities within established NMFS and WDFW criteria at all times. 2. Study bypass return structures to determine the best design to reduce predation. 3. Provide more water over diversion dams with acquisition or conserved water. 4. Replace facilities with pump stations. 5. Assure canals drain properly from the canal headworks to the fish bypass facility.	34 Operate fish screen facilities within established NMFS and WDFW criteria at all times. The criteria is described in appendix G 1 & 2. 35 **Study bypass return structures to determine the best design to reduce predation.** 36 **Provide more water over diversion dams with acquisition or conserved water.** 37 Assure canals drain properly from the canal headworks to the fish bypass facility to prevent stranding when the canals are shut down for the season.
Disruption of sediment transport dynamics.	1. Place gravel below dams. 2. Suction dredge fine sediment from reservoir pool. 3. Where possible, restrict sediment generating activities so they occur during high flows. 4. Complete Reclamation sediment transport study. Complete additional studies as determined necessary. Upon verification of gravel transport problem, initiate actions to resolve the problem.	38 **Complete Reclamation sediment transport study. Complete additional studies as determined necessary. Upon verification of gravel transport problem, initiate actions to resolve the problem.** 39 **Where possible, conduct sediment generating maintenance activities so they occur during higher flows.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FISHERY RESOURCES 6.2 - continued		
Drains and wasteways attract adult salmonids and present lethal or injurious conditions for all salmon life stages.	1. Restore physical habitat. 2. Inventory drains to determine which ones have potential to support salmon and steelhead production. 3. Restore riparian habitat. 4. Support irrigation districts' water quality improvement efforts. 5. Reduce or eliminate drain flow (prevent salmonids from entering). 6. Place exclusion devices on waterways to prevent salmonids from entering.	40 **Inventory drains to determine which ones are supporting or have potential to support salmon and steelhead production.** 41 **Reduce or eliminate false attraction impacts on drains that have little potential to support salmon and steelhead production.** 42 **Support efforts to improve or maintain habitat where possible in drains that support or have potential to support salmon and steelhead production.** 43 **Support efforts of irrigation districts to improve water quality.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FISHERY RESOURCES 6.2 - continued		
Severe alteration from the natural hydrographs (streamflows) of the Yakima, Cle Elum, Bumping, Tieton, and lower Naches Rivers.	1. Conduct analysis to determine normative hydrograph. 2. Reshape delivery schedules. 3. Build basin-wide canal system to convey water. 4. Additional storage. 5. Additional water from other basins. 6. Water conservation. 7. Reduce demand. 8. Purchase water rights. 9. Implement the recommendations in the Yakima River Basin Conservation Advisory Group "ESTABLISHMENT OF A PERMANENT PLAN FOR MEASURING AND REPORTING" report. 10. Adopt a set of ecosystem indicators to measure the effectiveness of target flows, establish target flows, and monitor them to measure progress towards positive values. 11. Use existing biological and physical data to arrive at interim/initial target flows for the Yakima, Naches, and Tieton Rivers, for dry, wet, and average years.	44 Implement the Recommendations in the Yakima River Basin Conservation Advisory Group "ESTABLISHMENT OF A PERMANENT PLAN FOR MEASURING AND REPORTING" report. 45 Adopt a set of ecosystem indicators to measure the effectiveness of target flows, establish target flows, and monitor them to measure progress towards positive values. 46 Use existing biological and physical data to arrive at interim/initial target flows for the Yakima, Naches, and Tieton Rivers, for dry, wet, and average years. 47 Review alternatives to the current flip-flop operations to determine if other operational scenarios would better serve a multi-species recovery strategy and to lessen impacts on critical aquatic habitat in the basin.
Excessive and unnatural short-term flow fluctuations below diversions.	1. Automate system with gates sensitive to minor changes in pool elevations. 2. Schedule deliveries. 3. Reregulation reservoirs. 4. Reduce ramping rates. 5. Pass fluctuation down canals.	48 Investigate to locate off-channel mid-basin storage reservoir sites, scheduling deliveries, automate delivery systems, reregulation reservoirs, and increase target flows by ⅔ of the saved water, as applicable.

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
<u>FISHERY RESOURCES 6.2 - continued</u>		
Altered water temperature regimes, particularly in the middle and lower reaches of the Yakima River.	1. Use storage water to meet temperature needs downstream. 2. Recharge groundwater aquifers during non-irrigation season. 3. Expedite travel times through diversion pools. 4. With the acquisition program, acquire areas of riparian zone/floodplain that correspond to areas that historically or effectively produced cold surface and groundwater discharge.	49 With the acquisition program, acquire areas of riparian zones/floodplains that correspond to areas that historically or effectively produced cold surface and groundwater discharge. 50 Investigate structural and non-structural ways to recharge the floodplain. 51 Develop a comprehensive surface water temperature model that includes ambient air temperature, water velocity, water quantity, surface/groundwater interaction, reservoir temperature stratification and release, and drain discharge temperature and amount. 52 Use the developed temperature model for operational changes that the model demonstrates are most likely to achieve temperature standards.
Facilities operations and maintenance activities that would result in fish mortality in the event of a catastrophic system failure.	1. Develop long-term planning perspective for operations and maintenance activities, with capital improvements, structured to prevent catastrophic system failures.	53 **Develop long-term planning perspective for operations and maintenance activities, with capital improvements, structured to prevent catastrophic system failures, (such as Rimrock outlet works, spillway releases, and operating gates on all reservoirs during flip-flop).**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FISHERY RESOURCES 6.2 - continued		
High predation of smolts in middle and lower river.	1. Level canal floors to move fish faster and reduce predator holding areas. 2. Design bypass return structures with a manifold design (multiple discharges). 3. Aim sprinklers at bypass outfall returns. 4. Exclusion structures for larger (predator) fish. 5. More water over diversion. 6. Provide a more normative flow regime**.** 7. Determine feasibility of a predation control program.	54 Assure canals drain properly from the canal headworks to the fish bypass facility to prevent stranding when the canals are shut down for the season. 55 Study bypass return structures to determine the best design to reduce predation. 56 **Aim sprinklers at bypass outfall returns to discourage the presence of predator fish.** 57 Install adult exclusion devices in headworks of canals, with possible exception of Prosser where fish are gathered for the hatchery. 58 **Continue to work with SOAC to provide managed out-migration flows to facilitate timely emigration of smolts from the basin.** 59 **Provide a more normative flow regime**. 60 **Determine feasibility of a predation control program**.

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
WILDLIFE 6.3		
Conversion of habitats to agriculture and project infrastructure.	1. Acquire wetlands, marginal farmland, or floodplains, and restore ecosystem functions of hydrograph and connectivity. 2. Promote wildlife incentives for irrigation districts to provide nesting cover, wetland restoration or development, and sediment retention. 3. Promote wildlife considerations as part of conservation planning for irrigation districts. 4. Hire project wildlife specialist.	61 Acquire wetlands, marginal farmland and floodplain habitats to restore hydrologic connectivity. 62 **Promote wildlife incentives for irrigation districts to provide nesting cover and wetland restoration or development.** 63 **Promote wildlife considerations as part of conservation planning for irrigation districts.** 64 **Obtain wildlife expertise for project activities by hiring a wildlife specialist or contracting with other agencies.** 65 **Design in wildlife functions where possible on new Yakima Project installations.**
Creates migration barriers causing mortality. Loss of winter range.	1. Bury pipe or bridge to reduce barriers in many canals. 2. Put in escape ramps for animals trapped in canals off-season. 3. Fence out big game where pipe, bridges, etc., are not effective. 4. Perform a wildlife assessment that identifies and prioritizes areas where wildlife mortality is a problem.	66 **Bury pipe or construct bridges to reduce barriers in many canals.** 67 **Put in escape ramps for animals trapped in canals off-season.** 68 **Fence out big game where pipe, bridges, etc., are not effective.** 69 **Perform a wildlife assessment that identifies and prioritizes areas where wildlife mortality is a problem.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
<u>WILDLIFE 6.3 - continued</u>		
Loss of wildlife food base associated with decreased abundance & distribution of salmon.	1. Remove one or more dams and mitigate impact to TWSA by reducing demand and/or off-channel storage. 2. Improve habitat/passage conditions downstream of reservoirs including tributaries.	70 Improve habitat/passage conditions downstream of reservoirs including tributaries on land acquired by YRBWEP.
Loss of large woody debris.	1. Pass/relocate large woody debris around diversions and storage facilities. 2. Stabilize or manage reservoirs to facilitate development of riparian areas around them. 3. Provide flow regimes that promote the health of riparian habitat. 4. Acquire wetlands, marginal farmland, or floodplains, and restore ecosystem functions of hydrograph and connectivity.	71 Pass/relocate large woody debris around diversions and storage facilities. 72 Provide flow regimes that promote the health of riparian habitat.

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
RIPARIAN VEGETATION 6.4		
Lack of riparian vegetative growth around reservoirs due to water level fluctuations. Lack of riparian vegetative growth along the main stem and tributaries of the Yakima River. Lack of riparian vegetative growth in drains developed in the natural water courses.	1. Develop a riparian inventory. 2. Complete Reaches Study. 3. Within 3 years after funding, have enough information on cottonwood and other riparian regeneration. 4. Operate Yakima Project in a manner that facilitates regeneration of riparian revegetation. 5. Develop method of monitoring health and extent of riparian areas, such as IBI, EDT, and HEP. 6. Develop and implement a native riparian revegetation and retention program for Yakima Project facilities. 7. Develop a YFO review process to examine activities that may have an effect on riparian quality.	73 **Develop a riparian inventory, including: (1) the development of a method for monitoring the health and extent of riparian areas; and (2) an examination of Reclamation activities that affect riparian quality within the project area.** 74 **Develop a revegetation and retention program at project facilities where the assessment shows the need.** 75 Provide flow regimes that promote the health of riparian habitat

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FLOOD PLAIN FUNCTIONS/ CHANNEL MORPHOLOGY 6.5		
Storing water in reservoirs truncates the flood peaks reducing the frequency, duration, magnitude, and spatial extent of floodplain inundation. Reduces the recharge of floodplains from overbank flow. Recharges floodplains and groundwater with irrigation water which changes the timing, quantity, quality, and location of the recharging action.	1. Accept more risk in the springtime operations. Change flood control guidelines. Instead of 12,000 cfs, protect Parker at 15,000 or 16,000 cfs. Involves building new flood control guidelines. 2. Go to operations that fill the reservoirs earlier.	76 **Analyze flood control/flood storage and based on the analysis, begin fill operations earlier in the year, shifting operations to bypass inflow once the reservoirs are filled.** 77 Complete Reclamation sediment transport study. Complete additional studies as determined necessary. Upon verification of gravel transport problem, initiate actions to resolve the problem.

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
<u>IRRIGATION 6.6</u>		
Fish & Wildlife operation concerns stress the irrigation facilities & operations.	1. Perform a reconnaissance level study of possible intra-basin transfers, e.g., the Black Rock proposal. 2. Simultaneously adopt a set of ecosystem indicators to measure the effectiveness of the interim flow targets in achieving conditions necessary to recover biodiversity and natural ecosystem functions; and take baseline data on all of the hydrological, biological, and other ecosystem indicators prior to implementing the initial target flows. 3. Provide mid-basin storage, e.g., Wymer.	78 **Perform a reconnaissance level study of possible intra-basin transfers** (such as the Black Rock proposal). 79 **Provide mid-basin storage** (such as groundwater storage, reregulation reservoirs, off stream storage such as Wymer, etc.).
Irrigation operation concerns.	1. Provide a Federal Watermaster to enforce water rights not directly managed by Reclamation. This is necessary to protect Yakima Project beneficiaries from unauthorized water withdrawals. Specifically post-1905 water rights that are junior to all Yakima Project irrigation water rights (contracts) and natural flow rights on tributaries not currently managed by a Reclamation or WDOE Watermaster.	80 **Provide a Federal Watermaster to enforce water rights not directly managed by Reclamation.**
Facilities operations and maintenance activities that would result in fish mortality in the event of a catastrophic system failure.	1. Develop long-term planning perspective for operations and maintenance activities, with capital improvements, structured to prevent catastrophic system failures.	81 Develop long-term planning perspective for operations and maintenance activities, with capital improvements, structured to prevent catastrophic system failures (such as Rimrock outlet works, spillway releases, and operating gates on all reservoirs during flip-flop).

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
IRRIGATION 6.6 - continued		
Flood control operation concerns. Overuse of flood control operation may result in failure to fill.	1. Obtain improved runoff forecasts that would benefit TWSA & flood control predictions. 2. Accept more risk in the springtime operations. Change flood control guidelines. Instead of 12,000 cfs, protect Parker at 15,000 or 16,000 cfs. This alternative involves building new flood control guidelines. 3. Establish a flood corridor that will not be encroached on by development. (Needs cooperation from others.) 4. Perform a flood control/flood storage analysis to investigate reducing flood storage space, particularly in the spring, to allow earlier storage reservoir fill operations. Revise flood control curves to implement the analysis.	82 Analyze flood control/flood storage and based on the analysis, begin fill operations earlier in the year, shifting operations to bypass inflow once the reservoirs are filled. 83 **Work with Reclamation, Corps, FEMA, and counties in establishing a flood corridor that will not be encroached on by future development.**
Recreation operation concerns.	1. Continue to consider drafting Clear Lake in critical water supply years (timing may be critical).	84 **Continue to consider drafting Clear Lake in critical water supply years. Timing is critical**.
Wapatox power operation concerns.	1. Fully implement court orders pertaining to use of storage water. 2. Implement studies to determine flow needed to benefit reach. Then perform a partial buyout or full buyout of Wapatox Power Plant as necessary.	85 **Implement studies to determine flow needed to benefit reach. Then perform a partial buyout or full buyout of Wapatox Power Plant as necessary.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
HYDROELECTRIC POWER 6.7		
Provide water for existing power generation facilities.	1. Continue to coincidentally generate power at existing facilities and subordinate power production as necessary to reduce environmental impacts. 2. Change time of releases to support power production.	86 **Continue to operate existing facilities, subordinating as necessary to minimize or avoid environmental impacts.** 87 **Continue to refine subordinations criteria.**
Provide water, data or support for new power generation facilities.	1. Explore additional coincidental power production only where it would not hinder achieving other water management (or resource) objectives.	88 **Develop new facilities only where it would not hinder achieving other water management (or resource) objectives.**

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
<u>FLOOD DAMAGE REDUCTION 6.8</u>		
Effects timing of peak events and depending on the event and space available, can decrease the magnitude of flood events.	1. Get improved forecasts and use them with an early warning system to reduce flood damage. 2. Establish a flood corridor that will not be encroached on by development. (Needs cooperation from others.) 3. Perform a flood control/flood storage analysis to investigate reducing flood storage space, particularly in the spring, to allow earlier storage reservoir fill operations. Revise flood control curves to implement the analysis. 4. Meet with the Corps, FEMA, and county government to encourage them to implement non-structural flood control alternatives in the Yakima basin. 5. Match flood prone areas with high priority wetland and floodplain habitat areas, and prioritize for acquisition or other protective status such as conservation easements that would allow periodic flooding. 6. After the establishment of a flood corridor, fund, through this partnership, using existing Reclamation, Corps, FEMA, and other available Federal and State authorities and authorizations, the relocation or flood proofing of homes and businesses (e.g., gravel mining), removal of flood control structures, and acquisition of title or conservation easements for priority lands.	89 Analyze flood control/flood storage and based on the analysis, begin fill operations earlier in the year, shifting operations to bypass inflow once the reservoirs are filled. 90 **Meet with the Corps, FEMA, and county governments to encourage them to implement non-structural flood control alternatives in the Yakima basin.** 91 **Request Corps and FEMA to update the 100-year floodplain maps using recent flood information.** 92 Work with Reclamation, Corps, FEMA, and counties in establishing a flood corridor that will not be encroached on by future development. 93 Match flood prone areas with high priority wetland and floodplain habitat areas and prioritize for acquisition or other protective status such as conservation easements that would allow periodic flooding.

Project Effects - Section 6	Alternatives - Section 8	Recommendations - Section 9
FLOOD DAMAGE REDUCTION 6.8 - continued		
		94 **Through the partnership and using existing Reclamation, Corps, FEMA, and other available Federal, State, and local authorities, authorizations, appropriations, and other funding vehicles, fund the relocation or flood proofing of homes and businesses, removal of flood control structures, and acquisition of title or conservation easements for priority lands.**

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WAC 173-201A-030 - General water use and criteria classes. The following criteria shall apply to the various classes of surface waters in the state of Washington:

(1) **Class AA (extraordinary).**

(a) General characteristic. Water quality of this class shall markedly and uniformly exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, spawning, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam, oyster, and mussel rearing, spawning, and harvesting.

Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organisms:

(A) Freshwater - fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

(B) Marine water - fecal coliform organism levels shall both not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.

(ii) Dissolved oxygen:

(A) Freshwater - dissolved oxygen shall exceed 9.5 mg/L.

(B) Marine water - dissolved oxygen shall exceed 7.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 7.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature shall not exceed 16.0 °C (freshwater) or 13.0 °C (marine water) due to human activities. When natural conditions exceed 16.0 °C (freshwater) and 13.0 °C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C.

Incremental temperature increases resulting from point source activities shall not, at any time, exceed $t=23/(T+5)$ (freshwater) or $t=8/(T-4)$ (marine water). Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8 °C.

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a human-caused variation within the above range of less than 0.2 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(2) **Class A (excellent).**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, spawning, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam, oyster, and mussel rearing, spawning, and harvesting.

Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organisms:

(A) Freshwater - fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.

(B) Marine water - fecal coliform organism levels shall both not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.

(ii) Dissolved oxygen:

(A) Freshwater - dissolved oxygen shall exceed 8.0 mg/L.

(B) Marine water - dissolved oxygen shall exceed 6.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 6.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature shall not exceed 18.0 °C (freshwater) or 16.0 °C (marine water) due to human activities. When natural conditions exceed 18.0 °C (freshwater) and 16.0 °C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C.

Incremental temperature increases resulting from point source activities shall not, at any time, exceed t=28/(T+7) (freshwater) or t=12/(T-2) (marine water). Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8 °C.

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a human-caused variation within the above range of less than 0.5 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(3) **Class B (good).**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for most uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (industrial and agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam, oyster, and mussel rearing and spawning.

Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (secondary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organisms:

(A) Freshwater - fecal coliform organism levels shall both not exceed a geometric mean value of 200 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 400 colonies/100 mL.

(B) Marine water - fecal coliform organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.

(ii) Dissolved oxygen:

(A) Freshwater - dissolved oxygen shall exceed 6.5 mg/L.

(B) Marine water - dissolved oxygen shall exceed 5.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 5.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature shall not exceed 21.0 °C (freshwater) or 19.0 °C (marine water) due to human activities. When natural conditions exceed 21.0 °C (freshwater) and 19.0 °C (marine water), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C.

Incremental temperature increases resulting from point source activities shall not, at any time, exceed $t=34/(T+9)$ (freshwater) or $t=16/(T)$ (marine water). Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8 °C.

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) and 7.0 to 8.5 (marine water) with a human-caused variation within the above range of less than 0.5 units.

(vi) Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.

(4) **Class C (fair).**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements of selected and essential uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (industrial).

(ii) Fish (salmonid and other fish migration).

(iii) Recreation (secondary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(iv) Commerce and navigation.

(c) Water quality criteria - marine water:

(i) Fecal coliform organism levels shall both not exceed a geometric mean value of 200 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 400 colonies/100 mL.

(ii) Dissolved oxygen shall exceed 4.0 mg/L. When natural conditions, such as upwelling, occur, causing the dissolved oxygen to be depressed near or below 4.0 mg/L, natural dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.

(iii) Temperature shall not exceed 22.0 °C due to human activities. When natural conditions exceed 22.0 °C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 °C.

Incremental temperature increases shall not, at any time, exceed T=20/(T+2).

For purposes hereof, "t" represents the maximum permissible temperature increase measured at a mixing zone boundary; and "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

(iv) pH shall be within the range of 6.5 to 9.0 with a human-caused variation within a range of less than 0.5 units.

(v) Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vi) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(vii) Aesthetic values shall not be interfered with by the presence of obnoxious wastes, slimes, aquatic growths, or materials which will taint the flesh of edible species.

(5) **Lake Class.**

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but not be limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Stock watering.

(iii) Fish and shellfish:

Salmonid migration, rearing, spawning, and harvesting.

Other fish migration, rearing, spawning, and harvesting.

Clam and mussel rearing, spawning, and harvesting.

Crayfish rearing, spawning, and harvesting.

(iv) Wildlife habitat.

(v) Recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment).

(vi) Commerce and navigation.

(c) Water quality criteria:

(i) Fecal coliform organism levels shall both not exceed a geometric mean value of 50 colonies/100 mL, and not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

(ii) Dissolved oxygen - no measurable decrease from natural conditions.

(iii) Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature - no measurable change from natural conditions.

(v) pH - no measurable change from natural conditions.

(vi) Turbidity shall not exceed 5 NTU over background conditions.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department (see WAC 173-201A-040 and 173-201A-050).

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(6) **Establishing lake nutrient criteria.**

(a) The following table shall be used to aid in establishing nutrient criteria:

(Table 1) The ecoregional and trophic state action values for establishing nutrient criteria:

Coast Range, Puget Lowlands, and Norther Rockies Ecoregions:		
Trophic State	If Ambient TP (mg/l) Range of Lake is:	Then criteria should be set at:
Ultra-oligotrophic	0-4	4 or less
Oligotrophic	>4-10	10 or less
Lower mesotrophic	>10-20	20 or less
	Action value >20...........	lake specific study may be initiated.
Cascades Ecoregion:		
Trophic State	If Ambient TP (mg/l) Range of Lake is:	Then criteria should be set at:
Ultra-oligotrophic	0-4	4 or less
Oligotrophic	>4-10	10 or less
	Action value >10.............	lake specific study may be initiated.
Columbia Basin Ecoregion:		
Trophic State	If Ambient TP (mg/l) Range of Lake is:	Then criteria should be set at:
Ultra-oligotrophic	0-4	4 or less
Oligotrophic	>4-10	10 or less
Lower mesotrophic	>10-20	20 or less
Upper mesotrophic	>20-35	35 or less
	Action value >35..........	lake specific study may be initiated.

Lakes in the Willamette, East Cascade Foothills, or Blue Mountain ecoregions do not have recommended values and need to have lake-specific studies in order to receive criteria as described in (c)(i) of this subsection.

(b) The following actions are recommended if ambient monitoring of a lake shows the epilimnetic total phosphorus concentration, as shown in Table 1 of this section, is below the action value for an ecoregion:

(i) Determine trophic status from existing or newly gathered data. The recommended minimum sampling to determine trophic status is calculated as the mean of four or more samples collected from the epilimnion between June through September in one or more consecutive years. Sampling must be spread throughout the season.

(ii) Propose criteria at or below the upper limit of the trophic state; or

(iii) Conduct lake-specific study to determine and propose to adopt appropriate criteria as described in (c) of this subsection.

(c) The following actions are recommended if ambient monitoring of a lake shows total phosphorus to exceed the action value for an ecoregion shown in Table 1 of this section or where recommended ecoregional action values do not exist:

(i) Conduct a lake-specific study to evaluate the characteristic uses of the lake. A lake-specific study may vary depending on the source or threat of impairment. Phytoplankton blooms, toxic phytoplankton, or excessive aquatic plants, are examples of various sources of impairment. The following are examples of quantitative measures that a study may describe: Total phosphorus, total nitrogen, chlorophyll-a, dissolved oxygen in the hypolimnion if thermally stratified, pH, hardness, or other measures of existing conditions and potential changes in any one of these parameters.

(ii) Determine appropriate total phosphorus concentrations or other nutrient criteria to protect characteristic lake uses. If the existing total phosphorus concentration is protective of characteristic lake uses, then set criteria at existing total phosphorus concentration. If the existing total phosphorus concentration is not protective of the existing characteristic lake uses, then set criteria at a protective concentration. Proposals to adopt appropriate total phosphorus criteria to protect characteristic uses must be developed by considering technical information and stakeholder input as part of a public involvement process equivalent to the Administrative Procedure Act (chapter 34.05 RCW).

(iii) Determine if the proposed total phosphorus criteria necessary to protect characteristic uses is achievable. If the recommended criterion is not achievable and if the characteristic use the criterion is intended to protect is not an existing use, then a higher criterion may be proposed in conformance with 40 CFR part 131.10.

(d) The department will consider proposed lake-specific nutrient criteria during any water quality standards rule making that follows development of a proposal. Adoption by rule formally establishes the criteria for that lake.

(e) Prioritization and investigation of lakes by the department will be initiated by listing problem lakes in a watershed needs assessment, and scheduled as part of the water quality program's watershed approach to pollution control. This prioritization will apply to lakes identified as warranting a criteria based on the results of a lake-specific study, to lakes warranting a lake-specific study for establishing criteria, and to lakes requiring restoration and pollution control measures due to exceedance of an established criterion. The adoption of nutrient criteria are generally not intended to apply to lakes or ponds with a surface area smaller than five acres; or to ponds wholly contained on private property owned and surrounded by a single landowner; and nutrients do not drain or leach from these lakes or private ponds to the detriment of other property owners or other water bodies; and do not impact designated uses in the lake. However, if the landowner proposes criteria the department may consider adoption.

(f) The department may not need to set a lake-specific criteria or further investigate a lake if existing water quality conditions are naturally poorer (higher TP) than the action value and uses have not been lost or degraded, per WAC 173-201A-070(2).

[Statutory Authority: Chapter 90.48 RCW and 40 CFR 131. 97-23-064 (Order 94-19), § 173-201A-030, filed 11/18/97, effective 12/19/97. Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-030, filed 11/25/92, effective 12/26/92.]

APPENDIX A-2

SECTION 303(d) 1998 LIST

WATERBODY SEGMENT NUMBER[1]	WATERBODY NAME	PARAMETERS EXCEEDING STANDARDS
WA-37-1010	Yakima River	4,4'-DDD, 4,4'-DDE, Arsenic, Cadmium, Copper, DDT, Dieldrin, Dissolved Oxygen, Endosulfan, Fecal Coliform, Instream Flow, Mercury, PCB-1254, PCB-1260, pH, Temperature, Turbidity
WA-37-1012	Snipes Creek	Dieldrin, Dissolved Oxygen, Temperature, DDT
WA-38-1014	Spring Creek	DDT, DDD, DDE
WA-37-1020	Yakima River	4,4'-DDE, Ammonia-N, Chlorine, DDT, Dieldrin, Instream Flow, Temperature
WA-37-1024	Granger Drain	4,4'-DDD, 4,4'-DDE, Ammonia-N, DDT, Dieldrin, Dissolved Oxygen, Endosulfan, Fecal Coliform, pH, Temperature
WA-37-1025	Marion Drain	On Yakama Nation lands and is not under State's jurisdiction
WA-37-1030	Sulphur Creek Wasteway	4,4'-DDD, 4,4'-DDE, Arsenic, DDT, Dieldrin, Endosulfan, Mercury, Silver, Temperature
WA-37-1035	Satus Creek	On Yakama Nation lands and is not under State's jurisdiction
WA-37-1040	Yakima River	Ammonia-N, Chlorine, Fecal Coliform, Mercury, Silver
WA-37-1047	Wide Hollow Creek	4,4'-DDD, 4,4'-DDE, DDT, Dieldrin, Dissolved Oxygen, Endosulfan, Fecal Coliform, Temperature
WA-37-1048	Moxee (Birchfield) Drain	4,4'-DDD, 4,4'-DDE, Chlorpyrifos, DDT, Dieldrin, Dissolved Oxygen, Endosulfan, Fecal Coliform, Malathion, pH, Temperature
WA-37-1050	Toppenish Creek	On Yakama Nation lands and is not under State's jurisdiction
WA-37-2000	Ahtanum Creek	
WA-37-2105	Spring Creek	Temperature
WA-37-9030	Giffin Lake	Total Phosphorus

SECTION 303(d) 1998 LIST

WATERBODY SEGMENT NUMBER[1]	WATERBODY NAME	PARAMETERS EXCEEDING STANDARDS
WA-38-1010	Naches River	pH, Silver, Temperature
WA-38-1015	Cowiche Creek	Fecal Coliform, Instream Flow, Temperature
WA-38-1016	Cowiche Creek, N.F.	Fecal Coliform, Temperature
WA-38-1017	Cowiche Creek, S.F.	Fecal Coliform, Temperature
WA-38-1018	Reynolds Creek	Temperature
WA-38-1020	Tieton River	
WA-38-1035	Rattlesnake Creek	Temperature
WA-38-1036	Little Rattlesnake Creek	Temperature
WA-38-1037	Rattlesnake Creek	Temperature
WA-38-1041	Gold Creek	Temperature
WA-38-1060	American River	Temperature
WA-38-1070	Bumping River	Temperature
WA-38-1080	Little Naches River	Temperature
WA-38-1081	Crow Creek	Temperature
WA-38-1086	Mathew Creek	Temperature
WA-38-1088	Bear Creek	Temperature
WA-38-1091	Blowout Creek	Temperature
WA-38-2110	Nile Creek, N.F.	Temperature
WA-38-3000	Tieton River, S.F.	Temperature
WA-38-9080	Myron Lake	Ammonia-N

SECTION 303(d) 1998 LIST

WATERBODY SEGMENT NUMBER[1]	WATERBODY NAME	PARAMETERS EXCEEDING STANDARDS
WA-39-1010	Yakima River	4,4'-DDE, DDT, Dieldrin, Silver
WA-39-1012	Wenas Creek	Instream Flow
WA-39-1020	Wilson Creek	Temperature, Fecal Coliform
WA-39-1025	Naneum Creek	Temperature
WA-39-1030	Yakima River	4,4'-DDE, Ammonia-N, Cadmium, Copper, DDT, Mercury
WA-39-1032	Cherry Creek	Temperature, DDT, 4,4'-DDE, Dieldrin
WA-39-1034	Cooke Creek	Dissolved Oxygen, Temperature, Fecal Coliform
WA-39-1037	Crystal Creek	pH
WA-39-1050	Cle Elum River	Temperature
WA-39-1051	French Cabin Creek	
WA-39-1053	Thorp Creek	Temperature
WA-39-1055	Cooper River	Temperature
WA-39-1057	Waptus River	Temperature
WA-39-1060	Yakima River	Temperature, Dissolved Oxygen
WA-39-1070	Yakima River	Temperature
WA-39-1073	Big Creek	Temperature, Instream Flow
WA-39-1075	Cabin Creek	Temperature
WA-39-1077	Log Creek	Temperature
WA-39-1110	Selah Ditch	Ammonia-N, Chlorine, Dissolved Oxygen
WA-39-1300	Gale Creek	Temperature
WA-39-1350	Meadow Creek	Temperature
WA-39-1390	Gold Creek	Temperature
WA-39-1400	Swauk Creek	Temperature
WA-39-1425	Williams Creek	Temperature
WA-39-1435	Blue Creek	Temperature

SECTION 303(d) 1998 LIST

WATERBODY SEGMENT NUMBER[1]	WATERBODY NAME	PARAMETERS EXCEEDING STANDARDS
WA-39-1440	Iron Creek	Temperature
WA-39-1500	Taneum Creek	Instream Flow
WA-39-1520	Taneum Creek	Temperature
WA-39-1558	Lookout Creek	Temperature
WA-39-1570	Taneum Creek, S.F.	Temperature
WA-39-2000	Teanaway River	Instream Flow, Temperature
WA-39-2100	Teanaway River, N.F.	Temperature
WA-39-2150	Teanaway River, N.F.	Temperature
WA-39-2155	Stafford Creek	Temperature
WA-39-2200	Teanaway River, M.F.	Temperature
WA-39-2250	Teanaway River, M.F.	Temperature
WA-39-2300	Teanaway River, W.F.	Temperature
WA-39-2350	Teanaway River, W.F.	Temperature
WA-39-3000	Manastash Creek	Instream Flow
WA-39-3020	Manastash Creek, S.F.	Temperature
WA-39-3025	Manastash Creek, S.F.	Temperature

[1] See pages 5-8

STATE OF WASHINGTON
WATERBODY SEGMENT IDENTIFICATION LIST

SEGMENT NUMBER	WATERBODY NAME	SEGMENT DESCRIPTION
WA-37-1010	YAKIMA RIVER	MOUTH AT COLUMBIA (RM 335.2) TO TOPPENISH CREEK (RM 80.4). (RM 59.8 TO TOP OF SEGMENT IS PARTIALLY UNDER THE JURISDICTION OF THE YAKAMA NATION)
WA-37-1012	SNIPES CREEK	MOUTH AT YAKIMA (RM 41.8 DOWNSTREAM OF PROSSER) TO HEADWATERS
WA-37-1014	SPRING CREEK	MOUTH AT YAKIMA (RM 41.8) TO HEADWATERS
WA-37-1020	YAKIMA RIVER	TOPPENISH CREEK (RM 80.4) TO SUNNYSIDE DAM BRIDGE (RM 103.8). (THIS ENTIRE SEGMENT IS PARTIALLY UNDER THE JURISDICTION OF THE YAKAMA NATION)
WA-37-1024	GRANGER DRAIN	MOUTH AT YAKIMA (RM 83 AT GRANGER) TO HEADWATERS
WA-37-1025	MARION DRAIN	MOUTH AT YAKIMA (RM 82.9 NEAR GRANGER) TO HEADWATERS NEAR LABBEE AIRPORT. (THE SEGMENT IS ENTIRELY UNDER THE JURISDICTION OF THE YAKIMA NATION)
WA-37-1030	SULPHUR CREEK	MOUTH AT YAKIMA (RM 61.0) TO WASTEWAY HEADWATERS
WA-37-1035	SATUS CREEK	MOUTH AT YAKIMA (RM 69.6) TO DEADWATERS. (THE SEGMENT IS ENTIRELY UNDER THE JURISDICTION OF THE YAKIMA NATION)
WA-37-1040	YAKIMA RIVER	SUNNYSIDE DAM BRIDGE (RM 103.8) TO NACHES RIVER (RM 116.3). (THE SEGMENT FROM RM 103.8 TO 106.9 IS PARTIALLY UNDER THE JURISDICTION OF THE YAKIMA NATION)
WA-37-1047	WIDE HOLLOW CREEK	MOUTH AT YAKIMA (RM 104.7) TO HEADWATERS
WA-37-1048	MOXEE (BIRCHFIELD) DRAIN	MOUTH AT YAKIMA (RM 107.6 NEAR UNION GAP) TO HEADWATERS ALONG BIRCHFIELD ROAD
WA-37-1050	TOPPENISH CREEK	MOUTH AT YAKIMA (RM 80.4 SOUTH OF GRANGER) TO HEADWATERS. (THE SEGMENT IS ENTIRELY UNDER THE JURISDICTION OF THE YAKIMA NATION)
WA-37-2000	AHTANUM CREEK	MOUTH AT YAKIMA (RM 106.9) TO CONFLUENCE OF N.F. AND S.F. (RM 23.1). (THE SEGMENT IS PARTIALLY UNDER THE JURISDICTION OF THE YAKIMA NATION)
WA-37-2105	SPRING CREEK	MOUTH AT BACHELOR CREEK (RM 2.0 NEAR HATCHERY) TO HEADWATERS
WA-37-9030	GIFFIN LAKE	LAT/LONG = 461439/1210148 TRS = 09N-22E-23 ELEV = 0 FT MEAN DEPTH - 4 FT MAX DEPTH = 7FT VOLUME = 377 AF
WA-38-1010	NACHES RIVER	MOUTH AT YAKIMA (RM 116.3) TO TIETON RIVER (RM 17.5)
WA-38-1015	COWICHE CREEK	MOUTH AT NACHES (RM 2.7) TO HEADWATERS (INCLUDES BOTH N.F. (19.1 MILES) AND S.F. (22.2 MILES))

STATE OF WASHINGTON
WATERBODY SEGMENT IDENTIFICATION LIST

SEGMENT NUMBER	WATERBODY NAME	SEGMENT DESCRIPTION
WA-38-1016	COWICHE CREEK, N.F.	MOUTH AT COWICHE CREEK (RM 7.5) TO HEADWATERS
WA-38-1017	COWICHE CREEK, S.F.	MOUTH AT COWICHE CREEK (RM 7.5) TO HEADWATERS
WA-38-1018	REYNOLDS CREEK	MOUTH AT S.F. COWICHE (RM 11.8) TO HEADWATERS ON STORBACH MOUNTAIN
WA-38-1020	TIETON RIVER	MOUTH AT NACHES (RM 17.5) TO RIMROCK LAKE DAM
WA-38-1035	RATTLESNAKE CREEK	MOUTH AT NACHES (RM 27.8) TO NATIONAL FOREST BOUNDARY (RM 1.2)
WA-38-1036	LITTLE RATTLESNAKE CREEK	MOUTH AT RATTLESNAKE CREEK (RM 1.1) TO NATIONAL FOREST BOUNDARY (RM 5.0)
WA-38-1037	RATTLESNAKE CREEK	NATIONAL FOREST BOUNDARY (RM 1.2) TO HEADWATERS
WA-38-1041	GOLD CREEK	MOUTH AT NACHES (RM 38.2) TO HEADWATERS, INCLUDES N.F. (RM 3.0)
WA-38-1060	AMERICAN RIVER	MOUTH AT BUMPING (RM 3.5) TO HEADWATERS
WA-38-1070	BUMPING RIVER	AMERICAN R. (RM 3.5) TO BUMPING LAKE DAM (RM 17.0)
WA-38-1080	LITTLE NACHES RIVER	MOUTH AT NACHES (RM 44.6) TO CONFLUENCE OF M.F. AND N.F. (RM 13.2)
WA-38-1081	CROW CREEK	MOUTH AT LITTLE NACHES (RM 3.2) TO HEADWATERS NEAR HAYDEN PASS
WA-38-1086	MATHEW CREEK	MOUTH AT LITTLE NACHES (RM 9.5) TO HEADWATERS
WA-38-1088	BEAR CREEK	MOUTH AT LITTLE NACHES (RM 10.9) TO HEADWATERS
WA-38-1091	BLOWOUT CREEK	MOUTH AT N.F. LITTLE NACHES (RM 0.6) TO HEADWATERS
WA-38-2110	NILE CREEK, N.F.	MOUTH AT NILE CREEK (RM 4.0) TO HEADWATERS
WA-38-3000	TIETON RIVER, S.F.	MOUTH AT RIMROCK LAKE TO HEADWATERS NEAR GILBERT PEAK
WA-38-9080	MYRON LAKE	ALONG HIGHWAY 12 IN NORTH YAKIMA, TRS = 13N-18E-10, MEAN DEPTH = 9.1 METERS, MAX DEPTH - 13.9 METERS
WA-39-1010	YAKIMA RIVER	NACHES RIVER (RM 116.3) TO WILSON CREEK (RM 147.0)
WA-39-1012	WENAS CREEK	MOUTH AT YAKIMA (RM 122.4) TO OUTLET OF WENAS LAKE
WA-39-1020	WILSON CREEK	MOUTH AT YAKIMA (RM 147.0) TO HEADWATERS
WA-39-1025	NANEUM CREEK	MOUTH AT WILSON CREEK (RM 20.0) TO HEADWATERS AT HANEY MEADOW
WA-39-1030	YAKIMA RIVER	WILSON CREEK (RM 147.0) TO CLE ELUM RIVER (RM 185.6)

STATE OF WASHINGTON
WATERBODY SEGMENT IDENTIFICATION LIST

SEGMENT NUMBER	WATERBODY NAME	SEGMENT DESCRIPTION
WA-39-1032	CHERRY CREEK	MOUTH AT WILSON CREEK (RM 1.1 AT THRALL) TO HEADWATERS
WA-39-1034	COOKE CREEK	MOUTH AT CHERRY CREEK (RM 3.0) TO HEADWATERS
WA-39-1037	CRYSTAL CREEK	MOUTH AT YAKIMA (RM 183.1) TO CONFLUENCE OF WEST FORK AND MIDDLE FORK (RM 3.0)
WA-39-1050	CLE ELUM RIVER	CLE ELUM LAKE (RM 15.9) TO OUTLET OF HYAS LAKE
WA-39-1051	FRENCH CABIN CREEK	MOUTH AT CLE ELUM (RM 15.9) TO HEADWATERS NEAR SOUTH PEAK
WA-39-1053	THORP CREEK	MOUTH AT CLE ELUM (RM 17.2) TO OUTLET OF THORP LAKE
WA-39-1055	COOPER RIVER	MOUTH AT CLE ELUM (RM 19.2) TO HEADWATERS AT CHIMNEY ROCK
WA-39-1057	WAPTUS RIVER	MOUTH AT CLE ELUM (RM 21.5) TO OUTLET OF IVANHOE LAKE
WA-39-1060	YAKIMA RIVER	CLE ELUM RIVER (RM 185.6) TO LAKE EASTON DAM (RM 202.5)
WA-39-1070	YAKIMA RIVER	LAKE EASTON DAM (RM 202.5) TO KEECHELUS DAM (RM 214.5)
WA-39-1073	BIG CREEK	MOUTH AT YAKIMA (RM 195.8) TO HEADWATERS
WA-39-1075	CABIN CREEK	MOUTH AT YAKIMA (RM 205.0) TO HEADWATERS
WA-39-1077	LOG CREEK	MOUTH AT CABIN CREEK (RM 5.3) TO HEADWATERS NEAR BLOWOUT MOUNTAIN
WA-39-1110	SELAH DITCH	MOUTH AT GOLF CLUB CREEK (RM 0.1) TO HEADWATERS NEAR SELAH
WA-39-1300	GALE CREEK	MOUTH AT KACHEES LAKE TO OUTFLOW FROM SWAN LAKE
WA-39-1350	MEADOW CREEK	MOUTH AT KEECHELUS LAKE TO HEADWATERS NEAR MEADOW MOUNTAIN
WA-39-1390	GOLD CREEK	MOUTH AT KEECHELUS LAKE TO HEADWATERS NEAR CHIKAMIN PEAK
WA-39-1400	SWAUK CREEK	MOUTH AT YAKIMA (RM 169.9) TO NATIONAL FOREST BOUNDARY (RM 9.1)
WA-39-1420	SWAUK CREEK	NATIONAL FOREST BOUNDARY (RM 9.1) TO HEADWATERS
WA-39-1425	WILLIAMS CREEK	MOUTH AT SWAUK CREEK (RM 11.0) TO HEADWATERS
WA-39-1435	BLUE CREEK	MOUTH AT SWAUK CREEK (RM 15.1) TO HEADWATERS
WA-39-1440	IRON CREEK	MOUTH AT SWAUK CREEK (RM 17.3) TO HEADWATERS

STATE OF WASHINGTON
WATERBODY SEGMENT IDENTIFICATION LIST

SEGMENT NUMBER	WATERBODY NAME	SEGMENT DESCRIPTION
WA-39-1500	TANEUM CREEK N.F.	MOUTH AT YAKIMA (RM 166.1) TO NATIONAL FOREST BOUNDARY (RM 8.2)
WA-39-1520	TANEUM CREEK	NATIONAL FOREST BOUNDARY (RM 8.2) TO CONFLUENCE OF N.F. AND S.F. (RM 12.7)
WA-39-1558	LOOKOUT CREEK	MOUTH AT N.F. TANEUM CREEK (RM 8.5) TO HEADWATERS
WA-39-1570	TANEUM CREEK, S.F.	MOUTH AT TANEUM CREEK (RM 12.7 CONFLUENCE WITH N.F.) TO HEADWATERS
WA-39-2000	TEANAWAY RIVER	MOUTH AT YAKIMA (RM 176.1) TO N.F. TEANAWAY RIVER (RM 10.6)
WA-39-2100	TEANAWAY RIVER, N.F.	MOUTH AT TEANAWAY (RM 10.6) TO NATIONAL FOREST BOUNDARY (RM 7.0)
WA-39-2150	TEANAWAY RIVER, N.F.	NATIONAL FOREST BOUNDARY (RM 7.0) TO HEADWATERS
WA-39-2155	STAFFORD CREEK	MOUTH AT N.F. TEANAWAY (RM 8.3) TO HEADWATERS
WA-39-2200	TEANAWAY RIVER, M.F.	MOUTH AT TEANAWAY (RM 11.7 CONFLUENCE WITH W.F.) TO NATIONAL FOREST BOUNDARY (RM 5.0)
WA-39-2250	TEANAWAY RIVER, M.F.	NATIONAL FOREST BOUNDARY (RM 5.0) TO HEADWATERS
WA-39-2300	TEANAWAY RIVER, W.F.	MOUTH AT TEANAWAY (RM 11.7 CONFLUENCE WITH M.F.) TO NATIONAL FOREST BOUNDARY (RM 6.6)
WA-39-2350	TEANAWAY RIVER, W.F.	NATIONAL FOREST BOUNDARY (RM 6.6) TO HEADWATERS
WA-39-3000	MANASTASH CREEK	MOUTH AT YAKIMA (RM 154.5) TO CONFLUENCE OF N.F. AND S.F. (RM 8.5)
WA-39-3020	MANASTASH CREEK, S.F.	MOUTH AT MANASTASH (RM 8.5 CONFLUENCE WITH N.F.) TO WENATCHEE NATIONAL FOREST BOUNDARY
WA-39-3025	MANASTASH CREEK, S.F.	WENATCHEE NATIONAL FOREST BOUNDARY TO HEADWATERS

SPRING CHINOOK

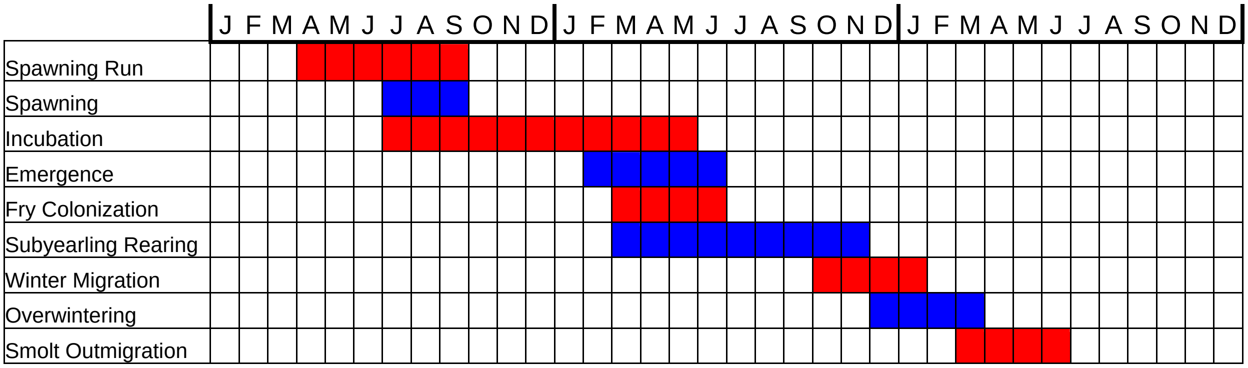

Figure 1. Mean timing of successive freshwater life stages of Yakima Basin spring chinook

SPRING CHINOOK

Table 1. Annual basin-wide smolt and adult productivity of Yakima Basin spring chinook

BROOD YEAR	SMOLT YEAR	SMOLTS[a]	SMOLTS PER SPAWNER	SMOLT TO ADULT SURVIVAL[b]	ADULT RECRUITMENT RATE[b]
1981	1983	245,921	201	2.5%	5.1
1982	1984	365,755	256	2.1%	5.4
1983	1985	140,755	104	3.3%	3.4
1984	1986	218,321	96	1.7%	1.6
1985	1987	252,165	70	1.8%	1.2
1986	1988	260,932	33	1.7%	0.6
1987	1989	72,460	19	3.3%	0.6
1988	1990	134,162	44	4.2%	1.8
1989	1991	104,405	26	2.6%	0.7
1990	1992	123,041	34	1.0%	0.3
1991	1993	87,844	31	0.6%	0.2
1992	1994	162,989	38	2.2%	0.8
1993	1995	168,471	44	2.0%	0.9
1994	1996	207,365	181	0.8%	1.4
1995	1997	49,524	84	3.4%	2.9
1996	1998	278,706	103	8.4%	8.7
1997	1999	291,982	135		
1998	2000	84,821	71		

a. Estimated as the sum of “spring smolts”, counted from March 1 through the end of the outmigration, and one half of the “winter migrants” – subyearlings passing Prosser the winter preceding the spring of outmigration.

b. Figures for brood year ’96 estimated: the historical proportion of age-5 to age-4 returns was assumed.

Information is from: Fast, D. 2001. Draft Yakima Subbasin Summary. August 3, 2001. Prepared for the Northwest Power Planning Council. Laura Berg, editor. Available at: http://ykfp.org/publications/index.htm

FALL CHINOOK

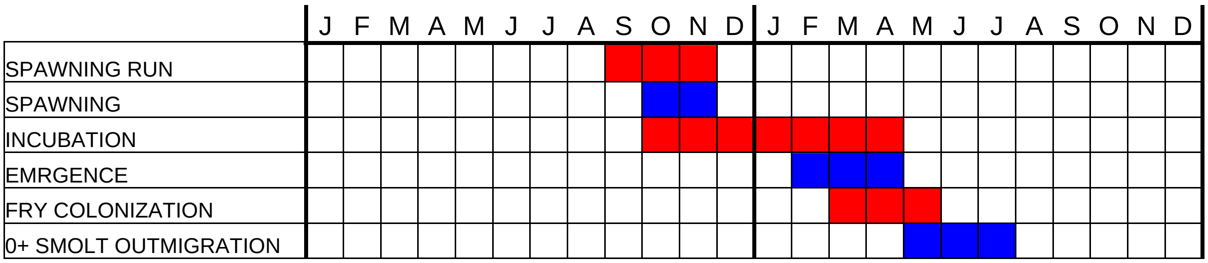

Figure 2. Mean timing of successive freshwater life stages of Yakima Basin fall Chinook

FALL CHINOOK

Table 2. Estimated natural production productivity parameters for the combined mainstem and Marion Drain Yakima fall chinook population spawning above Prosser Dam, 1983 – 2000

YEAR	WILD SMOLTS	ALL WILD SPAWNERS	SMOLT-TO-ADULT SURVIVAL	SMOLTS PER SPAWNER	ADULT RECRUITMENT RATE	MEAN TEMP (^oF)[a]
1983	103,521	380	0.58%		1.34	
1984	43,586	1331	1.17%	115	0.49	
1985	68,181	273	0.96%	**51**	1.39	
1986	33,380	731	1.14%	122	0.97	
1987	154,307	486	0.46%	210	2.23	69.7
1988	76,205	220	1.42%	142	6.35	69.5
1989	27,841	576	5.01%	120	1.74	67.6
1990	110,792	1161	0.91%	165	0.96	68.2
1991	55,083	823	2.03%	**37**	1.41	65.9
1992	253,455	1442	0.46%	261	0.83	74.2
1993	148,709	855	0.81%	92	1.34	69.0
1994	195,613	976	0.59%	184	1.20	72.3
1995	33,386	1241	3.51%	**22**	1.33	65.7
1996	6,512	1190		**5**		64.3
1997	35,578	992	5.02%	**26**		59.7
1998	406,814	1081		363		67.6
1999	45,702	1880		**40**		61.7
2000	175,912	1980		93		69.5
MEAN	**109,699**	**979**	**1.72%**	**120**	**1.66**	**67.5**

Mean water temperature at Prosser Dam over the period June 15 – July 15. A continuous thermal record of Prosser water temperature does not exist prior to 1987.

Information is from: Fast, D. 2001. Draft Yakima Subbasin Summary. August 3, 2001. Prepared for the Northwest Power Planning Council. Laura Berg, editor. Available at: http://ykfp.org/publications/index.htm

STEELHEAD

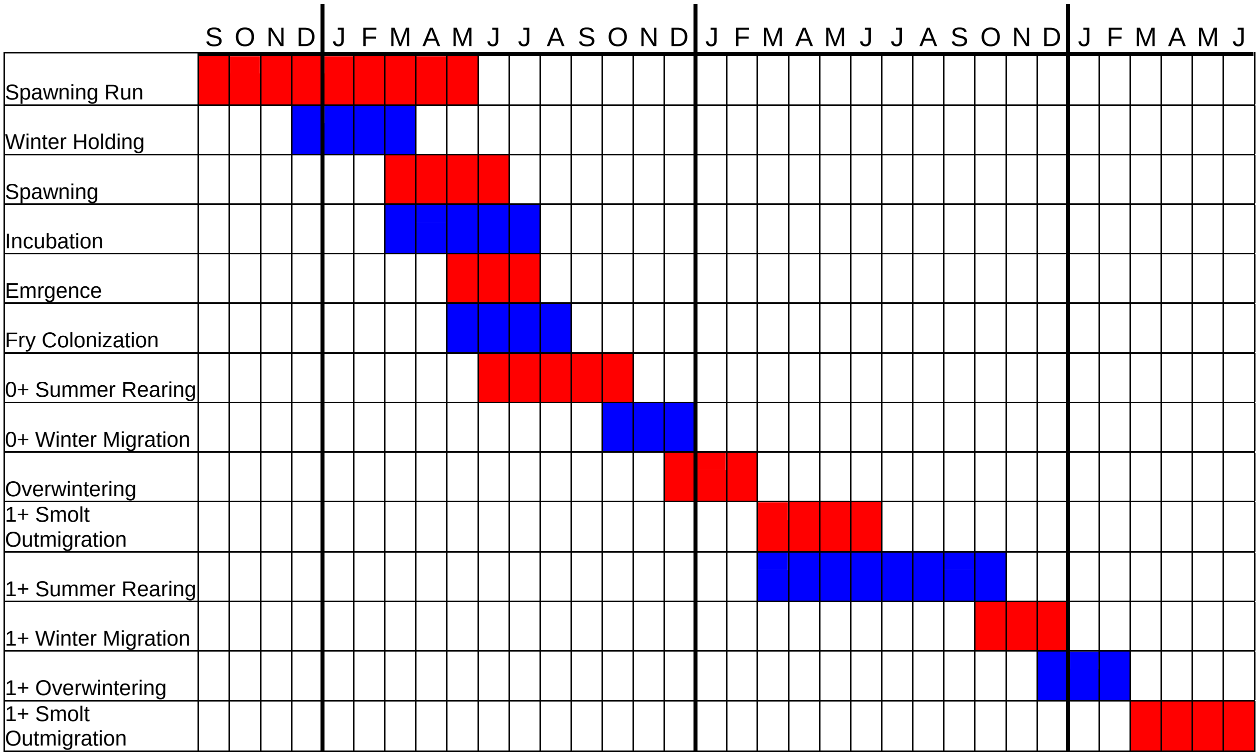

Figure 3. General duration of successive life stages in for Yakima Basin summer steelhead (all stocks)

Information is from: Fast, D. 2001. Draft Yakima Subbasin Summary. August 3, 2001. Prepared for the Northwest Power Planning Council. Laura Berg, editor. Available at: http://ykfp.org/publications/index.htm

STEELHEAD

Table 3. Steelhead smolt production, adult return and spawning escapement, smolts/returnees and returnees/smolt estimates

Year	Total Smolts	Adult Return			Wild Adults from Smolts Yr X	Brood Year Escapement (Wild + Hatch)	Smolts from Brood Year Escapement	Smolt to Adult Survival	Smolts per Spawner	Adult Recruitment Rate
		Hatchery	Wild	Total						
1983	81,640	N.D.	N.D.	N.D.	1,818			2.23%		
1984	97,920	N.D.	N.D.	N.D.	2,987			3.05%		
1985	65,735	0	2,194	2194	2,249	689	107,329	3.42%	155.78	1.44
1986	120,591	0	2,235	2235	1,858	1408	101,232	1.54%	71.90	0.67
1987	109,934	0	2,465	2465	879	1822	39,168	0.80%	21.50	0.42
1988	70,961	239	2,601	2840	925	2496	31,330	1.30%	12.55	0.75
1989	26,620	96	1,066	1162	1,040	864	22,654	3.91%	26.22	1.06
1990	23,075	87	727	814	1,697	539	31,169	7.36%	57.83	1.28
1991	22,983	104	730	834	845	782	20,054	3.68%	25.64	0.84
1992	36,225	251	2,014	2265	661	2095	16,824	1.82%	8.03	0.31
1993	17,339	80	1,104	1184	657	1089	20,017	3.79%	18.38	0.78
1994	18,738	14	540	554	630	551	30,115	3.36%	54.66	1.79
1995	17,715	98	820	918	881	918	63,729	4.98%	69.42	1.29
1996	45,814	54	451	505	996	485	108,036	2.17%	222.76	
1997	69,450	145	816	961	1,215	961	91,962	1.75%	95.69	
1998	117,765	165	948	1113		1,113	36,697		32.97	
1999	70,293	52	1,018	1070		1,070				
2000	41,361	52	1,448	1500		1,500				
MEAN	**58,564**	**86**	**1357**	**1444**	**1,289**	**1,149**	**51,451**	**3.01%**	**62**	**0.97**
MAX	**120,591**	**251**	**2601**	**2840**						
MIN	**17,339**	**0**	**451**	**505**						

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COHO
No life history table available.

Table 2. Smolt-to-smolt and smolt-adult survival rates for hatchery coho (Cascade) in the Yakima Basin, 1985-2000.

Year	Smolt Survival To Chandler (%)	Smolt To Adult Survival (%)
1985	45.1	.088
1986	57.0	.100
1987	39.4	.004
1988	73.3	.035
1989	32.1	.043
1990	31.3	.053
1991	23.4	.036
1992	17.6	.034
1993	15.5	.100
1994	52.3	.088
1995	58.9	.142
1996	64.5	.118
1997	70.0 (based on Mc Nary)	.451
1998	33.8	.256
1999	11.7	N/A
2000	19.8	N/A

Information is from: Fast, D. 2001. Draft Yakima Subbasin Summary. August 3, 2001. Prepared for the Northwest Power Planning Council. Laura Berg, editor. Available at: http://ykfp.org/publications/index.htm

SEC. 1201. PURPOSES.

The purposes of this title are--

(1) to protect, mitigate, and enhance fish and wildlife through improved water management; improved instream flows; improved water quality; protection, creation and enhancement of wetlands; and by other appropriate means of habitat improvement;

(2) to improve the reliability of water supply for irrigation;

(3) to authorize a Yakima River basin water conservation program that will improve the efficiency of water delivery and use; enhance basin water supplies; improve water quality; protect, create and enhance wetlands; and determine the amount of basin water needs that can be met by water conservation measures;

(4) to realize sufficient water savings from the Yakima River Basin Water Conservation Program so that not less than 40,00 acre-feet of water savings per year are achieved by the end of the fourth year of the Basin Conservation Program, and not less than 110,000 acre-feet of water savings per year are achieved by the end of the eighth year of the program, to protect and enhance fish and wildlife resources; and not less than 55,000 acre-feet of water savings per year are achieved by the end of the eighth year of the program for availability for irrigation;

(5) to encourage voluntary transactions among public and private entities which result in the implementation of water conservation measures, practices, and facilities; and

(6) to provide for the implementation by the Yakama Indian Nation at its sole discretion of (A) an irrigation demonstration project on the Yakama Indian Reservation using water savings from system improvements to the Wapato Irrigation Project, and (B) a Toppenish Creek corridor enhancement project integrating agricultural, fish, wildlife, and cultural resources.

SEC. 1202. DEFINITIONS.

As used in this title:

(1) The term “Basin Conservation Plan” means a plan for implementing water conservation measures found in the various water conservation plans developed under the Basin Conservation Program.

(2) The Term “Basin Conservation Program”: means the Yakima River Basin Water Conservation Program established under section 1203(a).

(3) The term “comprehensive basin operating plan” means a plan that will provide guidance to the Yakima Project Superintendent for operation of the existing Yakima Project as modified by actions taken pursuant to this title.

(4) The term “Conservation Advisory Group” means the Yakima River Basin Conservation Advisory Group established under section 1203(c).

(5) The term “conserved water” means water saved and attributable to the program established under the Basin Conservation Program.

(6) The term "Irrigation Demonstration Project" means the Yakama Indian Reservation Irrigation Demonstration Project authorized in section 1204(b).

(7) The term "non-proratable water" means that portion of the total water supply available under provisions of sections 18 and 19 of Civil Action No. 21 (Federal District Court Judgment of January 31, 1945) that is not subject to proration in times of water shortage.

(8) The term "on-district storage" means small water storage facilities located within the boundaries of an irrigation entity, including reregulating reservoirs, holding ponds, or other new storage methods which allow for efficient water use.

(9) The term "proratable water" means that portion of the total water supply available under provisions of sections 18 and 19 of Civil Action No. 21 (Federal District Court Judgment of January 31, 1945) that is subject to proration in times of water shortage.

(10) The term "Secretary" means the Secretary of the Interior.

(11) The term "System Operations Advisory Committee" means a group of fishery biologists--

(A) created by the Yakima Project Superintendent in response to the supplemental instructions entitled "Supplementary Instructions to the Water Master," and dated, November 28, 1980, in the case of Kittitas Reclamation District, et al., vs. the Sunnyside Valley Irrigation District, et al. (E.D. Wash., Civil No. 21.);

(B) who advise the Yakima Project Superintendent on operations of the Yakima Project for fish and wildlife purposes; and

(C) who, together with others, were identified for consultation on November 29, 1990, in the amended partial summary judgment entered in the basin adjudication (Yakima County superior Court No. 77-2-01484-5).

(12) The term "Toppenish Enhancement Project" means the Toppenish Creek corridor enhancement project authorized by section 1204(c).

(13) The term "Yakama Indian Nation" means the Confederated Tribes and Bands of the Yakama Indian Nation as redesignated under section 1204(g).

(14) The term "Yakima Project Superintendent" means the individual designated by the Regional Director, Pacific Northwest Region, Bureau of Reclamation, to be responsible for the operations and management of the Yakima Federal Reclamation Project, Washington.

SEC. 1203. YAKIMA RIVER BASIN WATER CONSERVATION PROGRAM.

(a) ESTABLISHMENT- (1) The Secretary, in consultation with the State of Washington, the Yakama Indian Nation, Yakima River basin irrigators, and other interested parties, shall establish and administer a Yakima River Basin Water Conservation Program for the purpose of evaluating and implementing measures to improve the availability of water supplies for irrigation and the protection and enhancement of fish and wildlife resources, including wetlands, while improving the quality of water in the Yakima Basin. The Secretary may make grants to eligible entities for the purposes of carrying out this title under such terms and conditions as the Secretary may require. Such terms and conditions shall include requirements that all water districts, irrigation districts, individuals, or other entities eligible to participate in the Basin Conservation Program must equip all surface water delivery systems within their boundaries with volumetric water meters or equally effective water measuring methods within 5 years of the date of enactment of this Act.

(2) Conserved water resulting in whole or in part from the expenditure of Federal funds shall not be used to expand irrigation in the Yakima Basin, except as specifically provided in section 1204(a)(3) on the Yakama Indian Reservation.

(3) The provision of this section shall not apply to the Yakama Indian Nation except as to any funds specifically applied for from the Basin Conservation Program.

(b) FOUR PHASES OF PROGRAM- The Basin Conservation Program shall encourage and provide funding assistance for four phases of water conservation, which shall consist of the following:

(1) The development of water conservation plans, consistent with applicable water conservation guidelines of the Secretary, by irrigation districts, conservation districts, water purveyors, other area wide entities, and individuals not included within an area wide entity.

(2) The investigation of the feasibility of specific potential water conservation measures identified in conservation plans.

(3) The implementation of measures that have been identified in conservation plans and have been determined to be feasible.

(4) Post-implementation monitoring and evaluation of implemented measures.

(c) CONSERVATION ADVISORY GROUP- (1) Not later than 12 months after the date of enactment of this Act, the Secretary, in consultation with the State of Washington, the Yakama Indian Nation, Yakima River basin irrigators, and other interested and related parties, shall establish the Yakima River Basin Conservation Advisory Group.

(2) Members of the Conservation Advisory Group shall be appointed by the Secretary and shall be comprised of--

(A) one representative of the Yakima River basin non-proratable irrigators,

(B) one representative of the Yakima River basin proratable irrigators,

(C) one representative of the Yakama Indian Nation,

(D) one representative of environmental interest,

(E) one representative of the Washington State University Agricultural Extension Service,

(F) one representative of the Department of Wildlife of the State of Washington, and

(G) one individual who shall serve as the facilitator.

(3) The Conservation Advisory Group shall--

(A) provide recommendations to the Secretary and to the State of Washington regarding the structure and implementation of the Basin Conservation Program,

(B) provide recommendations to the Secretary and to the State of Washington regarding the establishment of a permanent program for the measurement and reporting of all natural flow and contract diversions within the basin,

(C) structure a process to prepare a basin conservation plan as specified in subsection (f),

(D) provide annual review of the implementation of the applicable water conservation guidelines of the Secretary, and

(E) provide recommendations consistent with statutes of the State of Washington on rules, regulations, and administration of a process to facilitate the voluntary sale or lease of water.

(4) The facilitator shall arrange for meetings of the Conservation Advisory Group, provide logistical support, and serve as moderator for the meetings.

(5) The Conservation Advisory Group shall consult an irrigation district when considering actions specifically affecting that district. For the purposes of this paragraph, an irrigation district includes the Yakama Reservation Irrigation District.

(6) The Conservation Advisory Group shall be nonvoting, seeking consensus whenever possible. If disagreement occurs, any member may submit independent comments to the Secretary. The Conservation Advisory Group shall terminate 5 years after the date of its establishment unless extended by the Secretary.

(d) COST-SHARING- (1) Except as otherwise provided by this title, costs incurred in the four phases of the Basin Conservation Program shall be shared as follows:

	Non-Federal		
Program Phase	State Grant	Local	Federal Grant
1. Development of water conservation plans	50% but not more than $200,000 per recipient	(Residual amount if any)	50%
2. Investigation of specific water conservation measures	50% but sum of 1 and 2 not greater than $200,000 per recipient	20% after deducting State funds for Item 2	Residual amount after deducting State and local funds for Item 2
3. and 4. Implementation and post-implementation monitoring and evaluation	17.5%	17.5%	65.0%

(2) The Yakima River Basin Water Enhancement Project is a Federal action to improve streamflow and fish passage conditions and shall be considered part of a comprehensive program to restore the Yakima River basin anadromous fishery resource. Related fishery resource improvement facilities which utilize funding sources under the Pacific Northwest Electric Power Planning and Conservation Act of 1989, (94 Stat. 2697) and independent water-related improvements of the State of Washington and other public and private entities to improve irrigation water use, water supply, and water quality, shall be treated as non-Federal cost-share expenditures and shall be consolidated in any final calculation of required cost-sharing. Within one year of the date of enactment of this Act, the Secretary shall enter into a binding cost-sharing agreement with the State of Washington. The agreement shall describe the

terms and conditions of specific contributions and other activities that may, subject to approval by the Secretary, qualify as non-Federal cost-share expenditures.

(3) Costs of the Basin Conservation Program related to projects on the Yakama Indian Reservation are a Federal responsibility and shall be non-reimbursable and not subject to the cost-sharing provisions of this subsection.

(e) ENTITY WATER CONSERVATION PLANS- To participate in the Conservation Basin Program an entity must submit a proposed water conservation plan to the Secretary. The Secretary shall approve a water conservation plan submitted under this subsection if the Secretary determines that the plan meets the applicable water conservation guidelines of the Secretary.

(f) BASIN CONSERVATION PLAN- The Conservation Advisory Group shall, within 2½ years after the date of enactment of this Act, submit a draft basin conservation plan to the Secretary.

(g) PUBLIC COMMENT- The Secretary shall distribute the draft basin conservation plan and the entity water conservation plans submitted under subsections (e) and (f), respectively, for public comment for a 60-day period.

(h) PUBLICATIONS OF BASIN CONSERVATION PLAN- Within 60 days after the close of the comment period under subsection (g), the Secretary shall publish the Basin Conservation Plan which plan will provide the basis--

(1) for prioritizing and allocating funds to implement conservation measures under this title; and

(2) for preparing an interim comprehensive basin operating plan under section 1210 of this title as provided for in Public Law 96-162 (93 Stat. 1241).

(i) CONSERVATION MEASURES- (1) Measures considered for implementation in the Basin Conservation Program may include, among others, conveyance and distribution system monitoring, automation of water conveyance systems, water measuring or metering devices and equipment, lining and piping of water conveyance and distribution systems, on-district storage, electrification of hydraulic turbines, tail-water recycling, consolidation of irrigation systems, irrigation scheduling, and improvement of on-farm water application systems. Basin Conservation Program funds may also be used throughout all four phases of the Basin Conservation Program to mitigate for adverse impacts of program measures.

(2) In addition to implementing existing technologies, the Secretary shall encourage the testing of innovative water conservation measures. The Secretary shall, to the maximum extent possible under applicable Federal, State, and tribal law, cooperate with the State of Washington to facilitate water and water right transfers, water banking, dry year operations, the sale and leasing of water, and other innovative allocation tools used to maximize the utility of existing Yakima River basin water supplies.

(3) The Secretary may, consistent with applicable law, use funds appropriated to carry out this section for the purchase or lease of land, water, or water rights from any entity or individual willing to limit or forego water use on a temporary or permanent basis. Funds used for purchase or lease under this paragraph are not subject to the cost-sharing provisions of subsection (d). Efforts to acquire water should be made immediately upon

availability of funds to meet the three-year goal specified in section 1205(a)(4) to provide water to be used by the Yakima Project Superintendent under the advisement of the System Operations Advisory Committee for instream flow purposes. The use of Basin Conservation Program funds under this paragraph are in addition to those specifically authorized to be appropriated by subsection (j)(4).

(4) On-farm water management improvements shall be coordinated with programs administered by the Secretary of Agriculture and State conservation districts.

(j) AUTHORIZATION OF APPROPRIATIONS- There is hereby authorized to be appropriated to the Secretary, at September 1990 prices, plus or minus such amounts as may be justified by reason of ordinary fluctuations of applicable cost indexes, the following amounts for the Basin Conservation Program:

(1) $1,000,000 for the development of water conservation plans.

(2) $4,000,000 for investigation of specific potential water conservation measures identified in conservation plans for consideration for implementing through the Basin Conservation Program.

(3) Up to $67,500,000 for design, implementation, post-implementation monitoring and evaluation of measures, and addressing environmental impacts.

(4) Up to $10,000,000 for the initial acquisition of water from willing sellers or lessors specifically to provide instream flows for interim periods to facilitate the outward mitigation of anadromous fish flushing flows. Such funds shall not be subject to the cost-sharing provisions of subsection (d).

(5) $100,000 annually for the establishment and support of the Conservation Advisory Group during its duration. Such funds shall be available for travel and per diem, rental of meeting rooms, typing, printing and mailing, and associated administrative needs. The Secretary and the State of Washington shall provide appropriate staff support to the Conservation Advisory Group.

SEC. 1204. YAKAMA INDIAN NATION.

(a) WAPATO IRRIGATION PROJECT IMPROVEMENTS AND APPROPRIATIONS-

(1) The Yakama Indian Nation’s proposed system improvements to the Wapato Irrigation Project, as well as the design, construction, operation, and maintenance of the Irrigation Demonstration Project and the Toppenish Creek corridor enhancement project, pursuant to this title shall be coordinated with the Bureau of Indian Affairs.

(2) There is authorized to be appropriated to the Secretary not more than $23,000,000 for the preparation of plans, investigation of measures, and following the Secretary’s certification that such measures are consistent with the water conservation objectives of this title, the implementation of system improvements to the Wapato Irrigation Project. Funding for further improvements within the Wapato Irrigation Project may be acquired under the Basin Conservation Program or other sources identified by the Yakama Indian Nation.

(3) Water savings resulting from irrigation system improvements shall be available for the use of the Yakama Indian Nation for irrigation and other purposes on the reservation and

for protection and enhancement of fish and wildlife within the Yakima River basin. The conveyance of such water through irrigation facilities other than the Wapato Irrigation Project shall be on a voluntary basis and shall not further diminish the amount of water that otherwise would have been delivered by an entity to its water users in years of water proration.

(b) IRRIGATION DEMONSTRATION PROJECT APPROPRIATIONS-

1(A) There is hereby authorized to be appropriated to the Secretary--

(i) at September 1990 prices, plus or minus such amounts as may be justified by reason of ordinary fluctuations of applicable cost indexes, $8,500,000 for the design and construction of the Yakama Indian Reservation Irrigation Project; and

(ii) such sums as may be necessary for the operation and maintenance of the Irrigation Demonstration Project, including funds for administration, training, equipment, materials, and supplies for the period specified by the Secretary, which sums are in addition to operation and maintenance funds for wildlife and cultural purposes appropriated to the Secretary under other authorization.

(B) Funds may not be made available under this subsection until the Yakama Indian Nation obtains the concurrence of the Secretary in the construction, management, and administrative aspects of the Irrigation Demonstration Project.

(C) After the end of the period specified under subparagraph (A)(ii), costs for the operation and maintenance of the Irrigation Demonstration Project, including funds for administration, training, equipment, materials, and supplies referred to in that subparagraph, shall be borne exclusively by the lands directly benefitting from the Irrigation Demonstration Project.

(2) The Irrigation Demonstration Project shall provide for the construction of distribution and on-farm irrigation facilities to use all or a portion of the water savings, as determined by the Yakama Indian Nation, resulting from the Wapato Irrigation Project system improvements for--

(A) demonstration cost-effective state of the art irrigation water management and conservation,

(B) the training of tribal members in irrigation methods, operation, and management, and

(C) upgrading existing hydroelectric facilities and construction of additional hydroelectric facilities on the reservation to meet irrigation pumping power need.

(c) TOPPENISH CREEK CORRIDOR ENHANCEMENT PROJECT APPROPRIATIONS- There is here by authorized to be appropriated to the Secretary $1,500,000 for the further investigation by the Yakama Indian Nation of measures to develop a Toppenish Creek corridor enhancement project to demonstrate integration of management of agricultural, fish, wildlife, and cultural resources to meet tribal objectives and such amount as the Secretary subsequently determines is necessary for implementation. There is also authorized to be appropriated to the Secretary such sums as may be necessary for the operation and maintenance of the Toppenish Enhancement Project.

(d) REPORT- Within 5 years of the implementation of the Irrigation Demonstration Project and the Toppenish Enhancement Project, the Secretary, in consultation with the Yakama Indian Nation, shall report to the Committee on Energy and Natural Resources of the Senate, the Committee on Natural Resources of the House of Representatives, and the Governor of the State of Washington on the effectiveness of the conservation, training, mitigation, and other measures implemented.

(e) STATUS OF IMPROVEMENTS AND FACILITIES- The Wapato Irrigation Project system improvements and any specific irrigation facility of the Irrigation Demonstration Project (excluding on-farm irrigation facilities) and the Toppenish Enhancement Project shall become features of the Wapato Irrigation Project.

(f) TREATMENT OF CERTAIN COSTS- Costs related to Wapato Irrigation Project improvements, the Irrigation Demonstration Project, and the Toppenish Enhancement Project shall be a Federal responsibility and are nonreimbursable and nonreturnable.

(g) REDESIGNATION OF YAKIMA INDIAN NATION TO YAKAMA INDIAN NATION-

(1) REDESIGNATION- The Confederated Tribes and Bands of the Yakima Indian Nation shall be know and designated as the “Confederated Tribes and Bands of the Yakama Indian Nation.”

(2) REFERENCES- Any reference in a law, map, regulation, document, paper, or other record fo the United States to the Confederated Tribes and Bands of the Yakima Indian Nation referred to in subsection (a) shall be deemed to be a reference to the “Confederated Tribes and Bands of the Yakama Indian Nation.”

SEC. 1205. OPERATION OF YAKIMA BASIN PROJECTS.

(a) WATER SAVINGS FROM BASIN CONSERVATION PROGRAM-

(1) The Basin Conservation Program is intended to result in reductions in water diversions allowing for changes in the present operation of the Yakima Project to improve stream flow conditions in the Yakima River basin. Except as provided by paragraph (5) of this subsection and section 1209, commencing with the enactment of this title, and nothwithstanding that anticipated water savings are yet to be realized, the Secretary, upon the enactment of this title and acting through the Yakima Project Superintendent, shall (A) continue to estimate the water supply which is anticipated to be available to meet water entitlements; and (B) provide instream flows in accordance with the following criteria:

Water Supply Estimate for Period (million acre-feet):				Target Flow from date of Estimate thru October Downstream of (cubic feet per second):	
April thru September	May thru September	June thru September	July thru September	Sunnyside Diversion Dam	Prosser Diversion Dam
(1) 3.2	2.9	2.4	1.9	600	600
(2) 2.9	2.65	2.2	1.7	500	500
(3) 2.65	2.4	2.0	1.5	400	400
Less than line 3 water supply				300	300

(2) The initial target flows represent target flows at the respective points. Reasonable fluctuations from these target flows are anticipated in the operation of the Yakima Project, except that for any period exceeding 24 hours--

(A) actual flows at the Sunnyside Diversion Dam may not decrease to less than 65 percent of the target flow at the Sunnyside Diversion Dam; and

(B) actual flows at the Prosser Diversion Dam may not decrease by more than 50 cubic feet per second from the target flow.

(3) The instream flows shall be increased for interim periods during any month of April through October to facilitate when necessary the outward migration of anadromous fish. Increased instream flows for such interim periods shall be obtained through voluntary sale and leasing of water or water rights or from conservation measures taken under this title.

(4)(A)(i) Within the three-year period beginning when appropriations are first provided to carry out the Basin Conservation Program, the instream flow goal in the Yakima River is as follows: to secure water which is to be used for instream flows to facilitate meeting recommendations of the System Operations Advisory Committee for flushing flows or other instream uses.

(ii) In addition to any other authority of the Secretary to provide water for flushing flows, the water required to meet the goal specified in clause (i) shall be acquired through the voluntary purchase or lease of land, water, or water rights and from the development of additional storage capability at Lake Cle Elum provided for in section 1206(1).

(iii) In addition to water required to meet the instream flow goal specified in clause (i), the System Operations Advisory Committee may recommend additional water to meet instream flow goals pursuant to judicial actions.

(B) After the period referred to in subparagraph (A), such instream flow goal is modified as follows:

(i) The goal increases so that the instream target flows specified in the table in paragraph (1) increase by 50 cubic feet per second for each 27,000 acre-feet of reduced annual water diversions achieved through implementation of measures under the Basin Conservation Program. Such increases do not apply to actions taken pursuant to section 1204. Such increases shall not further diminish the amount of water that otherwise would have been delivered by an entity to its water users in years of water proration.

(ii) The goal changes directly with the availability of water resulting from Federal expenditures under this title for purchase or lease of water under this title.

(C) The Yakima Project Superintendent shall maintain an account of funded and completed conservation measures taken under the Basin Conservation Program.

(D) No later than March 31 of each calendar year, the Yakima Project Superintendent shall meet with the State of Washington, Yakama Indian Nation, and Yakima River basin irrigators to mutually determine total diversion reductions and respective adjustments to the target flows referred to in this subsection. The Yakima Project Superintendent shall announce such adjustments with the announcements of Total Water Supply Available. For the purposes of this subparagraph, conserved water will be considered available for adjusting target flows in the first year following completion of a measure or following a result from the post-implementation monitoring and evaluation program, as the case may be.

(5) Operational procedures and processes in the Yakima River basin which have or may be implemented through judicial actions shall not be impacted by this title.

(6)(A) Within three years after the date of enactment of this Act, the Secretary shall conduct a study and submit a report with recommendations to the appropriate committees of the Congress on whether the water supply available for irrigation is adequate to sustain the agricultural economy of the Yakima River Basin.

(B) The target flows provided for under this subsection shall be evaluated within three years after the date of enactment of this Act by the Systems Operations Advisory Committee for the purpose of making a report with recommendations to the Secretary and the Congress evaluating what is necessary to have biologically-based target flows.

(C) The recommendations and reports under subparagraphs (A) and (B) shall provide a basis for the third phase of the Yakima River Basin Water Enhancement Project.

(b) WATER FROM LAKE CLE ELUM- Water accruing from the development of additional storage capacity at Lake Cle Elum, made available pursuant to the modifications authorized in section 1206(a), shall not be part of the Yakima River basin's water supply as provided in subsection (a)(1). Water obtained from such development is exclusively dedicated to instream flows for use by the Yakima Project Superintendent as flushing flows or as otherwise advised by the System Operations Advisory Committee. Water may be carried over from year-to-year in the additional capacity to the extent that there is space available. Releases may be made from other Yakima Project storage facilities to most effectively utilize this additional water, except that water deliveries to holders of existing water rights shall not be impaired.

(c) STATUS OF BASIN CONSERVATION PROGRAM FACILITIES-

Measures of the Basin Conservation Program which are implemented on facilities currently under the administrative jurisdiction of the Secretary, except as provided in section 1204, shall be considered features of the Yakima Project. The responsibility for operation and maintenance and the related costs shall remain with the current operating entity. As appropriate, the Secretary shall incorporate the operation and maintenance of such facilities into existing agreements. The Secretary shall assure that such facilities are operated in a manner consistent with Federal and State law and in accordance with water rights recognized pursuant to State and Federal law.

(d) WATER ACQUIRED BY PURCHASE AND LEASE- Water acquired from voluntary sellers and lessors shall be administered as a block of water separate from the Total Water Supply Available, in accordance with applicable Federal and State law.

(e) YAKIMA PROJECT PURPOSE- (1) An additional purpose of the Yakima Project shall be for fish, wildlife, and recreation.

(2) The existing storage rights of the Yakima Project shall include storage for the purposes of fish, wildlife, and recreation.

(3) The purposes specified in paragraph (1) and (2) shall not impair the operation of the Yakima Project to provide water for irrigation purposes nor impact existing contracts.

SEC. 1206. LAKE CLE ELUM AUTHORIZATION OF APPROPRIATIONS.

(a) MODIFICATIONS AND IMPROVEMENTS- There is hereby authorized to be appropriated to the Secretary--

(1) at September 1990 prices, plus or minus such amounts as may be justified by reason of ordinary fluctuation of applicable indexes, $2,934,000 to--

(A) modify the radial gates at Cle Elum Dam to provide an additional 14,600 acre-feet of storage capacity in Lake Cle Elum,

(B) provide for shoreline protection of Lake Cle Elum, and

(C) construct juvenile fish passage facilities at Cle Elum Dam, plus

(2) such additional amounts as may be necessary which may be required for environmental mitigation.

(b) OPERATION AND MAINTENANCE APPROPRIATIONS- There is hereby authorized to be appropriated to the Secretary such sums as may be necessary for that portion of the operation and maintenance of Cle Elum Dam determined by the Secretary to be a Federal responsibility.

SEC. 1207. ENHANCEMENT OF WATER SUPPLIES FOR YAKIMA BASIN TRIBUTARIES.

(a) GENERAL PROVISIONS- The following shall be applicable to the investigation and implementation of measures to enhance water supplies for fish and wildlife and irrigation purposes on tributaries of the Yakima River basin:

(1) An enhancement program authorized by this section undertaken in any tributary shall be contingent upon the agreement of appropriate water right owners to participate.

(2) The enhancement program authorized by this section shall not be construed to affect

(A) the water rights of any water right owners in the tributary or other water delivering entities; (B) the capability of tributary water users to divert, convey, and apply water: and (C) existing water and land uses within the tributary area.

(3) The water supply for tributary enhancement shall be administered in accordance with applicable State and Federal laws.

(4) Any enhancement program authorized by this section shall be predicated upon the availability of a dependable water supply.

(b) STUDY- (1) The Secretary, following consultation with the State of Washington, the tributary water right owners, and the Yakama Indian Nation, and agreement of appropriate water right owners to participate, shall conduct a study concerning the measures that can be implemented to enhance water supplies for fish and wildlife and irrigation purposes on Taneum Creek, including (but not limited to)--

(A) water use efficiency improvements;

(B) the conveyance of water from the Yakima Project through the facilities of any irrigation entity willing to contract with the Secretary without adverse impact to water users;

(C) the construction, operation, and maintenance of ground water withdrawal facilities;

(D) contracting with any entity that is willing to voluntarily limit or forego present water use through lease or sale of water or water rights on a temporary or permanent basis;

(E) purchase of water rights from willing sellers; and

(F) other measures compatible with the purposes of this title, including restoration of stream habitats.

(2) In conducting the Taneum Creek study, the Secretary shall consider–

(A) the hydrologic and environmental characteristics;

(B) the engineering and economic factors relating to each measure; and

(C) the potential impacts upon the operations of present water users in the tributary and measures to alleviate such impacts.

(3)The Secretary shall make available to the public for a 45-day comment period a draft report describing in detail the findings, conclusions, and recommendations of the study. The Secretary shall consider and include any comment made in developing a final report. The Secretary's final report shall be submitted to the Committee on Energy and Natural Resources of the Senate, the Committee on Natural Resources of the House of Representatives, and the Governor of the State of Washington, and made available to the public.

(c) IMPLEMENTATION OF NONSTORAGE MEASURES- After securing the necessary permits the Secretary may, in cooperation with the Department of Ecology of the State of Washington and in accordance with the laws of the State of Washington, implement nonstorage measures identified in the final report under subsection (b) upon fulfillment of the following conditions:

(1) The Secretary shall enter into an agreement with the appropriate water right owners who are willing to participate, the State of Washington, and the Yakama Indian Nation, for the use and management of the water supply to be provided by proposed tributary measures pursuant to this section.

(2) The Secretary and the State of Washington find that the implementation of the proposed tributary measures will not impair the water rights of any person or entity in the affected tributary.

(d) OTHER YAKIMA RIVER BASIN TRIBUTARIES- Enhancement programs similar to the enhancement program authorized by this section may be investigated an implemented by the Secretary in other tributaries contingent upon the agreement of the appropriate tributary water right owners to participate. The provisions set forth in this section shall be applicable to such programs.

(e) AUTHORIZATION OF APPROPRIATIONS- (1) There is hereby authorized to be appropriated to the Secretary $400,000 for the study of the Taneum Creek Project and such amount as the Secretary subsequently determines is necessary for implementation of tributary measures pursuant to this section.

(1) There is also authorized to be appropriated to the Secretary such funds as are necessary for the investigation of enhancement programs similar to the enhancement program authorized by this section in other Yakima River basin tributaries contingent upon the agreement of the appropriate water right owners to participate. Funds for the implementation of any such similar enhancement program may not be appropriated until after the Secretary submits an investigation report to the appropriate congressional committees.

SEC. 1208. CHANDLER PUMPING PLANT AND POWERPLANT-OPERATIONS AT PROSSER DIVERSION DAM.

(a) AUTHORIZATION OF APPROPRIATIONS FOR ELECTRIFICATION- In order to provide for electrification to enhance instream flows by eliminating the need to divert water to operate the hydraulic turbines which pump water to the Kennewick Irrigation District, there is authorized to be appropriated--

(1) $50,000 to conduct an assessment of opportunities for alternative pumping plant locations;

(2) $4,000,000 for construction; and

(3) such sums as may be necessary for the pro rata share of the operation and maintenance allocated to fish and wildlife as determined by the Secretary.

(b) POWER FOR PROJECT PUMPING- (1) The Administrator of the Bonneville Power Administration shall provide for project power needed to effect the electrification as provided in subsection (a).

(2)(A) There is authorized to be appropriated for the Bureau of Reclamation for each fiscal year in which the Administrator provides power under this subsection, an amount equal to the cost to the Bonneville Power Administration of providing power under this subsection during such fiscal year. The rate to be utilized by the Administrator in determining the cost of power under this paragraph in a fiscal year shall be the rate for priority firm power charged by the Bonneville Power Administration in that fiscal year under section 7(b) of the Pacific Northwest Electric Power Planning and Conservation Act (16 U.S.C. 834e(b)).

(B) The Bureau of Reclamation shall, using funds appropriated pursuant to the Authorization of appropriations in subparagraph (A), reimburse the Bonneville Power Administration for the costs of the project power provided under this subsection. Such funds shall be available for sue purpose without fiscal year limitation.

(c) SUBORDINATION- Any diversions for hydropower generation at the Chandler Powerplant shall be subordinated to meet the flow targets determined under subsection (f).

(d) WATER SUPPLY FOR KENNEWICK IRRIGATION DISTRICT- The Secretary shall ensure that the irrigation water supply for the Kennewick Irrigation District shall not be affected by conservation, electrification, or subordination pursuant to this title and any reduction in its irrigation water supply resulting from conservation measures adopted or implemented by other entities pursuant to this title shall be replaced by water developed through subordination, electrification, or a combination of the two.

(e) TREATMENT OF CERTAIN FUNDS- Funds appropriated and project power provided pursuant to this section shall be nonreimbursable since such funds are used for fish and wildlife purposes and such funds are not subject to cost-share under section 1203(d).

(f) TARGET FLOWS- Target flows measured at appropriate biological and hydrological location or locations shall be determined by the Yakima Project Superintendent in consultation with the System Operations Advisory Committee.

SEC. 1209. AUGMENTATION OF KACHESS RESERVOIR STORED WATER.

(a) AUTHORIZATION OF APPROPRIATIONS- In order to augment Kachess Reservoir stored water supplied from flows of Cabin Creek and Silver Creek which are excess to system demands, there is authorized to be appropriated–

(1) such sums as may be necessary to carry out a feasibility study, including the benefits, costs, and environmental aspects, of the facility described in paragraph (2);

(2) for the construction of facilities to convey such flows to Kachess Reservoir, $20,000,000; and

(3) such sums as may be necessary for the pro rata share of the operation and maintenance allocated to fish and wildlife determined by the Secretary.

(b) LIMITATION- Construction of the facilities described in subsection (a)(1) is contingent on the completion of the feasibility study referred to in subsection (a)(2).

(c) USE OF ADDITIONAL WATER- The stored water supply resulting from the construction of facilities under this section shall be used by the Secretary to–

(1) enhance the water supply available to the Kittitas Reclamation District and the Roza Irrigation District in years of proration; and

(2) facilitate reservoir operations in the Easton Dam to Keechelus Dam reach of the Yakima River for the propagation of anadromous fish.

(d) TREATMENT OF COSTS- The construction and operation and maintenance costs of the facilities under this section shall be allocated to irrigation and fishery enhancement, as follows:

(1) The portion of such costs allocated to irrigation is reimbursable, with the construction costs to be paid prior to initiation of construction by the Kittitas Reclamation District and the Roza Irrigation District.

(2) The portion of such costs allocated to fishery enhancement is nonreimbursable.

(e) KACHESS DAM MODIFICATIONS- There is authorized to be appropriated $2,000,000 for the modification of the discharge facilities of Kachess Dam to improve reservoir operations for anadromous fish enhancement. Amounts appropriated under this subsection are nonreimbursable.

SEC. 1210. INTERIM COMPREHENSIVE BASIN OPERATING PLAN.

(a) DEVELOPMENT- The Secretary shall, in consultation with the State of Washington, Yakama Indian Nation, Yakima River basin irrigation districts, Bonneville Power Administration, and other entities as determined by the Secretary, develop an interim comprehensive operating plan for providing a general framework within which the Yakima Project Superintendent operates the Yakima Project, including measures implemented under the Yakima River Basin Water Enhancement Project, Including (but not limited to)--

(1) operating capability and constraints of the system;

(2) information on water supply calculations and water needs;

(3) system operations and stream flow objectives; and

(4) the System Operations Advisory Committee activities.

(b) PROCESS REQUIREMENTS- A draft of the interim comprehensive basin operating plan shall be completed within 18 months after the completion of the Basin Conservation Plan under section 1203(f) and, upon completion, published for a 90-day public review period. The Secretary shall complete and publish the final interim comprehensive operating plan within 90 days after the close of the public review period. The Secretary shall update the plan as needed to respond to decisions from water adjudications relating to the Yakima River basin.

(c) AUTHORIZATION OF APPROPRIATIONS- There is authorized to be appropriated $100,000 to carry out this section.

SEC. 1211. ENVIRONMENTAL COMPLIANCE.

There are hereby authorized to be appropriated to the Secretary $2,000,000 for environmental compliance activities including the conduct, in cooperation with the State of Washington, of an inventory of wildlife and wetland resources in the Yakima River basin and an investigation of measures, including “wetland banking,” which could be implemented to address potential impacts which could result from the activities taken under this title.

SEC. 1212. SAVINGS AND CONTINGENCIES.

(a) IN GENERAL- Nothing in this title shall be construed to–

(1) affect or modify any treaty or other right of the Yakama Indian Nation;

(2) authorize the appropriation or use of water by any Federal, State, or local agency, the Yakama Indian Nation, or any other entity or individual;

(3) impair the rights or jurisdictions of the United States, the States, the Yakama Indian Nation, or other entities over waters of any river or stream or over any ground water resource:

(4) alter, amend, repeal, interpret, modify, or be in conflict with any interstate compact made by the States;

(5) alter, establish, or impair the respective rights of States, the United States, the Yakama Indian Nation, or any other entity or individual with respect to any water or water-related right;

(6) alter, diminish, or abridge the rights and obligations of any Federal, State, or local agency, the Yakama Indian Nation, or other entity, public or private;

(7) affect or modify the rights of the Yakama Indian Nation or its successors in interest to, and management and regulation of, those water resources arising or used, within the external boundaries of the Yakama Indian Reservation;

(8) affect or modify the settlement agreement between the United States and the State of Washington filed in Yakima County Superior Court with regard to Federal reserved water rights other than those rights reserved by the United States for the benefit of the Yakama Indian Nation and its members;

(9) affect or modify the rights of any Federal, State, or local agency, the Yakama Indian Nation, or any other entity, public or private with respect to any unresolved and unsettled claims in any water right adjudications, or court decisions, including State against Acquavella, or constitute evidence in any such proceeding in which any water or water-related right is adjudicated; or

(10) preclude other planning studies and projects to accomplish the purposes of this title by other means, funded publicly, privately, or by a combination of public and private funding.

(b) CONTINGENCY BASED ON APPROPRIATIONS- The performance of any activity under this title which requires accomplishment within a specified period that may require appropriation of money by Congress of the allotment of funds shall be continent upon such appropriation or allotment being made.

ENTITLEMENT SUMMARY *(SUBJECT TO REVISION) SEE ORIGINAL CONTRACTS FOR DETAILED INFORMATION - MARCH-OCTOBER
AS ESTABLISHED JULY 8, 1992

	TOTAL APRIL-OCTOBER			TWSA IRRIGATION ENTITLEMENT																			OWSA ENTITLEMENTS	
									MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
DISTRICT USER (ABOVE PARKER)	NON-PRORATABLE AF	PRORATABLE AF	TOTAL AF	WARREN ACT/STORAGE CONTRACT	CLAIM FLOOD WATERS	LIMITING AGREEMENTS	NON SIGNATORY AGREEMENTS	ADJUDICATED WATER RIGHTS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS	AF	CFS
KITTITAS		336000	336000	Yes	Yes				**ND		6720	308.0	57120	930.0	70560	1186.0	70560	1147.0	67200	1093.0	43680	734.0	20160	726.0
CITY OF CLE ELUM M&I	1260		1260								180	3.0	180	3.0	180	3.0	180	3.0	180	3.0	180	3.0	180	3.0
YOUNGER	3010		3010								40	1.0	440	7.0	780	13.0	790	13.0	740	12.0	180	3.0	40	0.6
O'CONNOR	3100		3100				Yes						330	5.0	660	11.0	830	13.5	740	12.0	450	7.5	90	1.5
[1]CASCADE	49525		49525	Yes		Yes					8925	150.0	9223	150.0	8925	150.0	8452	150.0	5600	150.0	5600	150.0	2800	150.0
WESTSIDE	31128										4760	80.0	4919	80.0	4760	80.0	4919	80.0	4919	80.0	4760	80.0	2091	34.0
		8200	39328	Yes		Yes					550	25.0	1550	25.0	1500	25.0	1550	25.0	1550	25.0	1500	25.0	0	0.0
KNOKE (ELLISON-BURTON)	1600		1600								110	1.8	300	4.9	350	5.9	370	6.0	330	5.4	120	2.0	20	0.3
MILLS & SON	7530		7530								1190	20.0	1230	20.0	1190	20.0	1230	20.0	1230	20.0	1190	20.0	270	4.4
ELLENSBURG TOWN	47758		47758			Yes					7438	125.0	7686	125.0	7438	125.0	7686	125.0	7686	125.0	5950	100.0	3874	63.0
WOLDALE (OLSON)	12973		12973			Yes					2023	34.0	2091	34.0	2023	34.0	2091	34.0	2091	34.0	1547	26.0	1107	18.0
CITY/ELLENSBURG M&I		6000	6000	Yes							120	2.0	1020	16.6	1260	21.0	1260	20.0	1200	19.5	780	13.0	360	10.0
ELLENSBURG POWER	6031		6031								928	15.6	959	15.6	928	15.6	959	15.6	959	15.6	928	15.6	370	6.0
ELLENSBURG MILL & FEED	4804		4804				Yes				702	11.8	726	11.8	702	11.8	726	11.8	726	11.8	702	11.8	520	8.5
BULL	6471		6471				Yes				1012	17.0	1045	17.0	1012	17.0	1045	17.0	1045	17.0	1012	17.0	300	4.9
FOGARTY & DYER	3690		3690	Yes							108	1.8	638	10.4	717	12.0	794	12.9	733	11.9	480	8.1	220	3.6
VERTREES #1	2164		2164				Yes				181	3.0	407	6.6	400	6.7	551	9.0	428	7.0	177	3.0	20	0.3
VERTREES #2	704		704				Yes				107	1.8	111	1.8	107	1.8	111	1.8	111	1.8	107	1.8	50	0.8
T JOSSEM	4771		4771								756	12.7	781	12.7	756	12.7	781	12.7	781	12.7	756	12.7	160	2.6
FARREL (STANFIELD)	1600		1600								30	0.5	280	4.6	370	6.0	430	7.0	330	5.4	100	1.7	60	1.0
ROZA ID		375000	375000	Yes	Yes				18000		37500	630.0	56250	915.0	71250	1198.0	71250	1159.0	71250	1159.0	45000	756.0	22500	567.0
TERRACE HEIGHTS ID	2208										357	6.0	369	6.0	357	6.0	369	6.0	369	6.0	250	4.2	137	2.2
AT ROZA DAM		1354	3562								136	2.3	216	3.5	257	4.3	284	4.6	271	4.5	190	3.2	0	0.0
SELAH/MOXEE	27493										4284	72.0	4427	72.0	4284	72.0	4427	72.0	4427	72.0	3320	55.8	2324	37.8
ID		4281	31774	Yes		Yes					427	7.2	685	11.1	814	13.1	898	14.6	857	14.4	600	9.8	0	0.0
TAYLOR	8000		8000			Yes					1190	20.0	1230	20.0	1190	20.0	1230	20.0	1230	20.0	1190	20.0	740	11.5
MOXEE DITCH	4245										595	10.0	615	10.0	595	10.0	615	10.0	615	10.0	595	10.0	615	10.0
CO		960	5205	Yes		Yes					86	1.4	144	2.3	182	3.1	182	3.0	182	3.0	125	2.1	59	1.0
HUBBARD-GRANGER	11165		11165			Yes					1785	30.0	1845	30.0	1785	30.0	1845	30.0	1845	30.0	1250	21.0	810	13.0
BOISE CASCADE	9159										1354	23.0	1399	23.0	1354	23.0	1399	23.0	1399	23.0	1354	23.0	900	14.8
		100	9259	Yes							15	0.3	15	0.3	15	0.3	15	0.3	15	0.3	15	0.3	10	0.3
UNION GAP ID	20697										3273	55.0	3382	55.0	3273	55.0	3382	55.0	3382	55.0	2279	38.3	1726	29.0
OLD "FOWLER DITCH"		4588	25339	Yes		Yes					571	9.7	734	11.9	785	12.9	812	12.9	872	13.9	582	9.9	250	4.0
RICHARTZ	6364		6364				Yes				892	15.0	922	15.0	892	15.0	922	15.0	922	15.0	892	15.0	922	15.0
BLUE SLOUGH	4245		4245								595	10.0	615	10.0	595	10.0	615	10.0	615	10.0	595	10.0	615	10.0
BROADWAY ID		700	700	Yes							70	1.2	105	1.7	133	2.2	133	2.2	133	2.2	84	1.4	42	0.7
WAPATO I.P.	305613										42843	720.0	44271	720.0	42843	720.0	44271	720.0	44271	720.0	42843	720.0	44271	720.0
		350000	655613	Yes	Yes	Yes			**ND		31500	529.0	73500	1195.0	70000	1176.0	80500	1309.0	73500	1195.0	21000	353.0	0	0.0
SUNNYSIDE	315836										47070	791.0	48636	791.0	47066	791.0	48637	791.0	48637	791.0	47070	791.0	28720	724.0
DIVISION		142684	458520	Yes	Yes	Yes			**ND		7840	132.0	27874	453.0	31234	525.0	31443	511.0	31443	511.0	12850	216.0	0	0.0
YAKIMA-TIETON	75868											0.0	15372	250.0	14876	250.0	15372	250.0	15372	250.0	14876	250.0	0	0.0
ID		38181	114049	Yes	Yes				**ND		6000	101.0	6641	108.0	7141	120.0	6641	108.0	6641	108.0	5117	86.0	0	0.0
COBB - UPPER SIDE	727		727			Yes					119	2.0	123	2.0	119	2.0	123	2.0	123	2.0	60	1.0	60	1.0
SINCLAIR & COBB	786		786			Yes					119	2.0	123	2.0	119	2.0	123	2.0	123	2.0	119	2.0	60	1.0
TENANT	1570		1570								110	1.8	210	3.4	220	3.7	410	6.7	320	5.2	230	3.9	70	1.1
ANDERSON	1570		1570								140	2.4	330	5.4	270	4.5	260	4.2	310	5.0	130	2.2	130	2.1
EMERICK	687		687								119	2.0	123	2.0	119	2.0	123	2.0	123	2.0	60	1.0	20	0.3
NILE	4350		4350				Yes				230	3.9	470	7.6	730	12.2	980	15.9	970	15.8	670	11.2	300	4.9
CARMACK & PARKER	639		639			Yes					95	1.6	98	1.6	95	1.6	98	1.6	98	1.6	95	1.6	60	1.0
FREDERICKS & HUNTING	950		950								120	2.0	130	2.1	170	2.9	170	2.8	180	2.9	140	2.4	40	0.7
STEVENS	1950		1950								60	1.0	410	6.7	350	5.9	410	6.7	320	5.2	290	4.9	110	1.8
NACHES	49658										7080	119.0	7263	118.0	7080	119.0	7321	119.0	7321	119.0	6884	116.0	6709	109.0
SELAH		4486	54144	Yes		Yes					674	11.3	811	13.2	901	15.1	1050	17.0	1050	17.0	0	0.0	0	0.0
WAPATOX (IRR.-U&L)	20230		20230			Yes					3064	51.5	3167	51.5	3064	51.5	3167	51.5	3167	51.5	3064	51.5	1537	25.0
"OLD JOHNCOX" FOSTER NACHES	1510		1510			Yes					100	1.7	280	4.5	300	5.0	320	5.2	270	4.4	200	3.4	40	0.7
CLARK	4562		4562			Yes					714	12.0	739	12.0	714	12.0	739	12.0	739	12.0	536	9.0	381	6.2

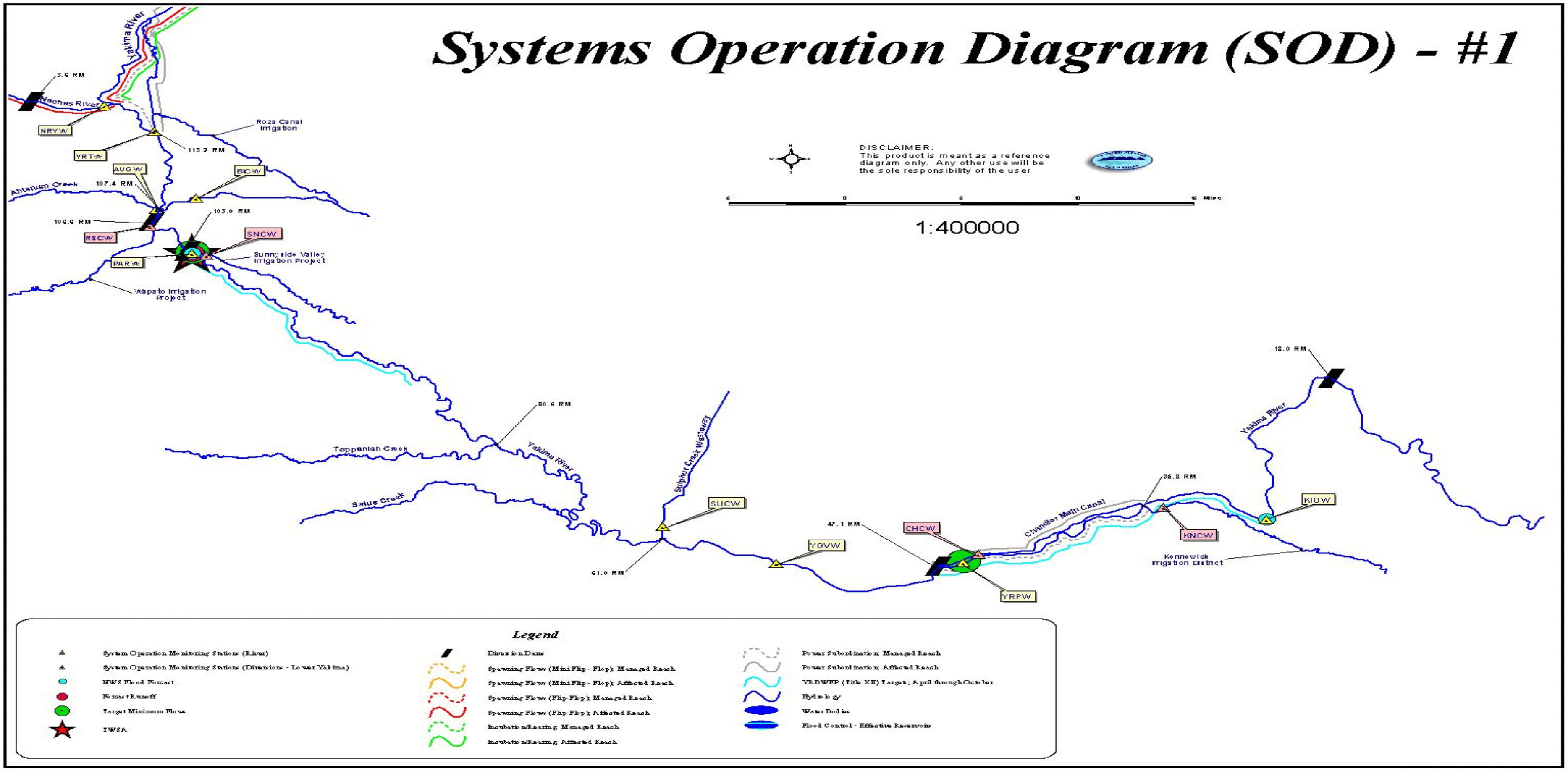
APPENDIX D

ENTITLEMENT SUMMARY *(SUBJECT TO REVISION) SEE ORIGINAL CONTRACTS FOR DETAILED INFORMATION - MARCH-OCTOBER
AS ESTABLISHED JULY 8, 1992

	TOTAL APRIL-OCTOBER		TWSA IRRIGATION ENTITLEMENT																				OWSA ENTITLEMENTS	
DISTRICT USER (ABOVE PARKER)	NON-PRORATABLE AF	PRORATABLE AF	TOTAL AF	WARREN ACT/STORAGE CONTRACT	CLAIM FLOOD WATERS	LIMITING AGREEMENTS	NON SIGNATORY AGREEMENTS	ADJUDICATED WATER RIGHTS	MARCH AF	MARCH CFS	APRIL AF	APRIL CFS	MAY AF	MAY CFS	JUNE AF	JUNE CFS	JULY AF	JULY CFS	AUGUST AF	AUGUST CFS	SEPTEMBER AF	SEPTEMBER CFS	OCTOBER AF	OCTOBER CFS
SOUTH NACHES CHANNEL	22946		22946			Yes					3689	62.0	3812	62.0	3689	62.0	3812	62.0	3812	62.0	3272	55.0	860	20.0
KELLY & LOWRY	8490		8490				Yes				1190	20.0	1230	20.0	1190	20.0	1230	20.0	1230	20.0	1190	20.0	1230	20.0
YAKIMA CITY	4859										681	11.4	704	11.4	681	11.4	704	11.4	704	11.4	681	11.4	704	11.4
(M&I)		4500	9359	Yes		Yes					675	11.3	788	12.8	1028	17.3	652	10.6	652	10.6	495	8.3	210	3.5
YAKIMA CITY	8805										1232	20.7	1273	20.7	1232	20.7	1273	20.7	1273	20.7	1232	20.7	1290	21.0
(IRR)		1500	10305	Yes		Yes					225	3.8	262	4.3	342	5.7	218	3.5	218	3.5	165	2.8	70	1.1
NACHES UNION ID (FORMERLY GLEED DITCH)	22819		22819			Yes					3618	60.8	3738	60.8	3618	60.8	3738	60.8	3738	60.8	2475	41.6	1894	30.8
MORRISSEY	1206		1206			Yes					178	3.0	184	3.0	178	3.0	184	3.0	184	3.0	178	3.0	120	2.0
YAKIMA VALLEY	23720										3808	64	3935	64	3808	64	3935	64	3935	64	2469	41.5	1830	30.8
CANAL - CONGDON		4305	28025	Yes		Yes					690	11.6	713	11.6	690	11.6	713	11.6	713	11.6	446	7.5	340	5.7
CHAPMAN & NELSON	7641		7641			Yes					1071	18.0	1107	18.0	1071	18.0	1107	18.0	1107	18.0	1071	18.0	1107	18.0
NACHES COWICHE	15096		15096			Yes					2380	40.0	2460	40.0	2380	40.0	2460	40.0	2460	40.0	1726	29.0	1230	20.0
FRUITVALE POWER	17708		17708			Yes					2791	46.9	2884	46.9	2791	46.9	2884	46.9	2884	46.9	2011	33.8	1463	23.8
OLD UNION	17675		17675			Yes					2813	47.3	2907	47.3	2813	47.3	2907	47.3	2907	47.3	1875	31.5	1453	23.6
[2] OTHERS		336	336	Yes							50	0.8	50	0.8	50	0.8	51	0.8	51	0.8	50	0.8	34	0.6
	- - - - -	- - - - -	- - - - -								- - - - -		- - - - -		- - - - -		- - - - -		- - - - -		- - - - -		- - - - -	
IRRIGATION ENTITLEMENTS	1219166	1283175	2502395								262098		420607		445351		461719		447809		304090		160685	
KENNEWICK ID	18000			Yes					**ND		1800	50.0	3330	50.0	3330	50.0	3330	50.0	3330	50.0	2160	50.0	720	?
		91275	109275								9128	134.0	16886	279.0	16886	290.0	16886	279.0	16886	279.0	10953	170.0	3650	?

[1] JULY 20 TO OCT. 15 USE 16800 AF -- NOT TO EXCEED FLOW OF 150 CFS
[2] DEPT. OF AGRICULTURE (20) MUOTH (22.9) FUNKHOUSE (13.1) COVEY CANCELLED (120) WAYNE (160)
9/19/94 - THIS AGREES WITH CONTENT MINUS WATER THAT HAD BEEN TRANSFERRED TO CITY OF YAKIMA FOR USE BY CITY AT CHANGED POINT OF DIVERSIC

*Final determination of the total volume of entitlement water awaits the completion of the "Final Order" of this Adjudication Court
**ND - NOT DEFINED



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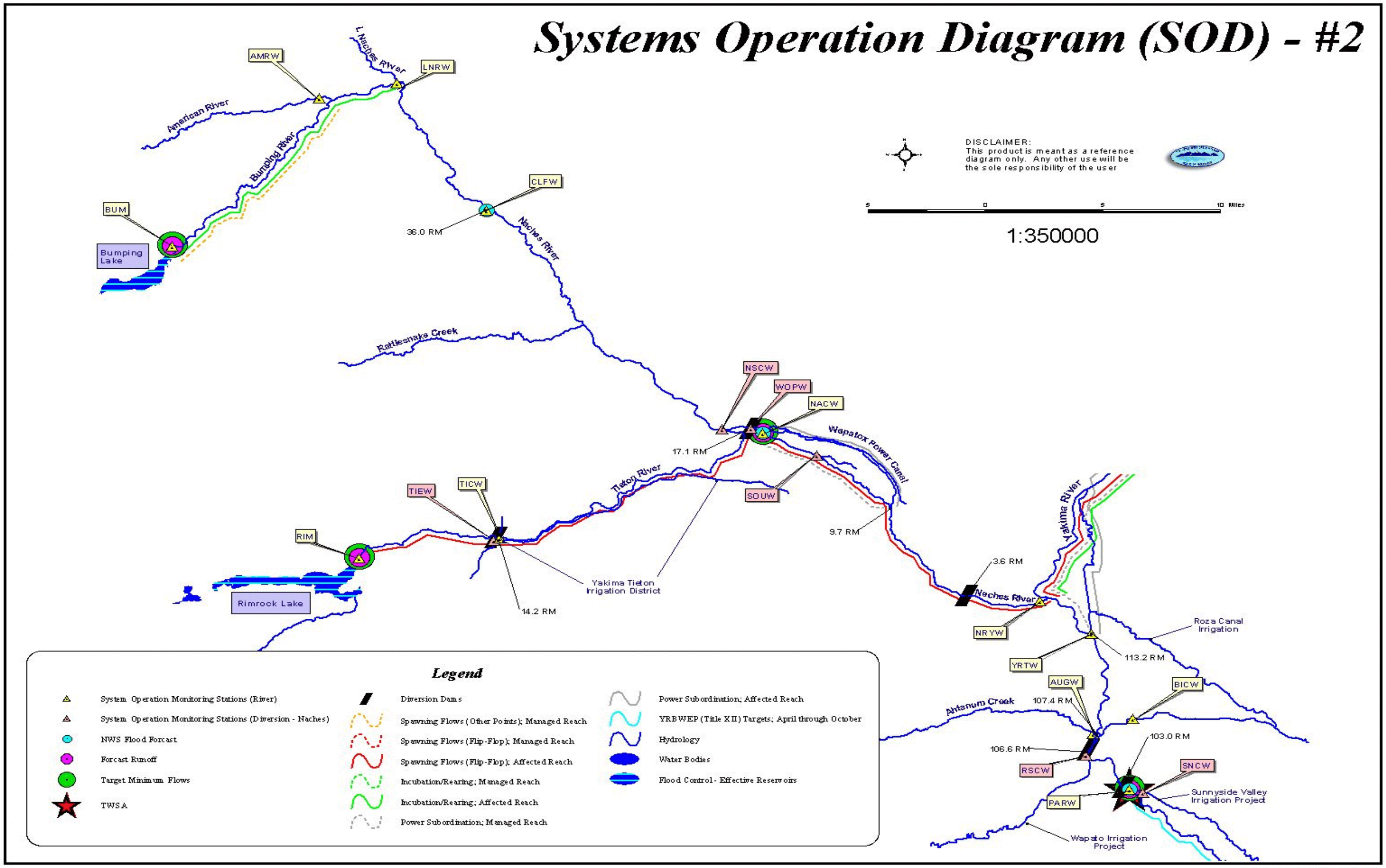
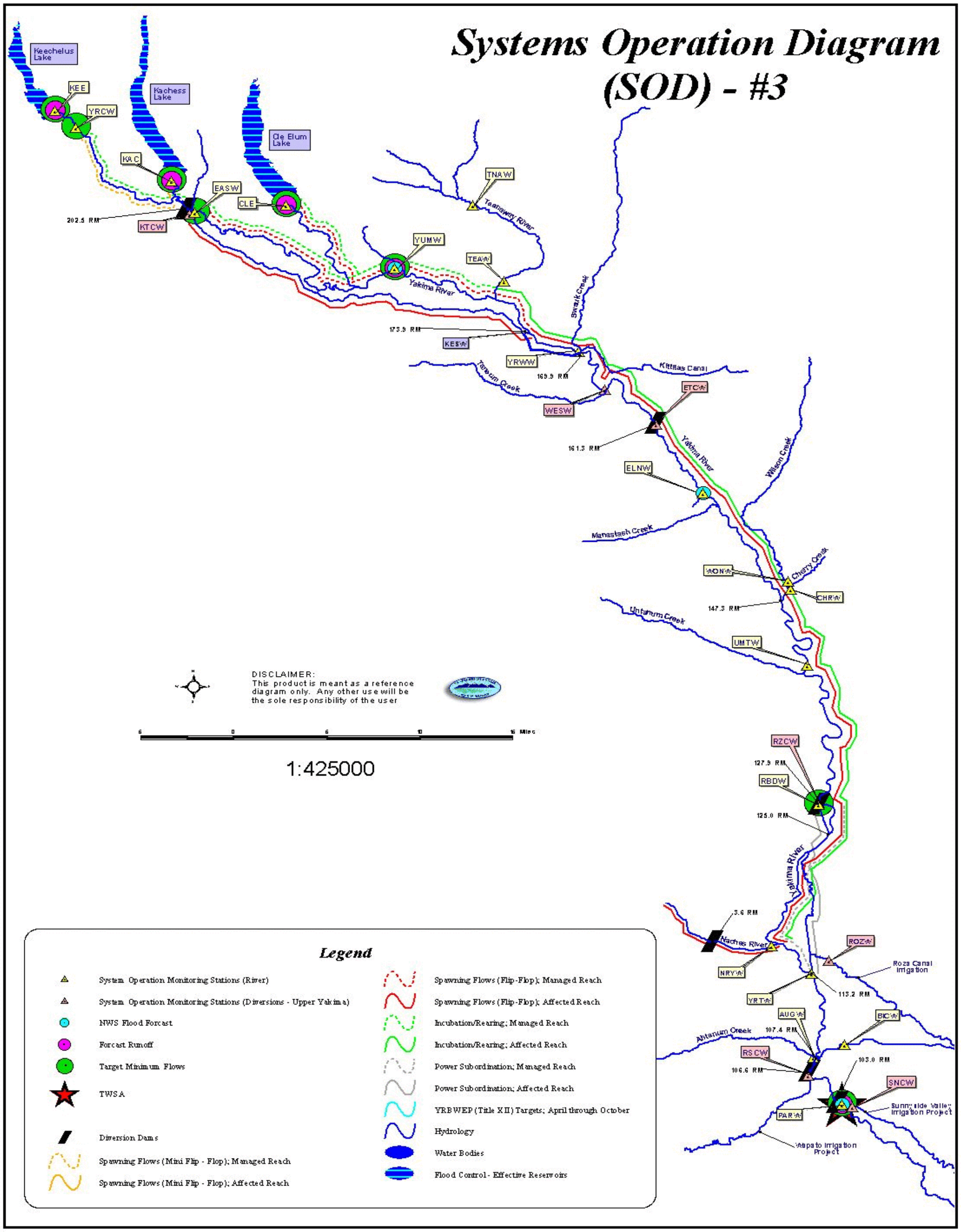


Created on: December 03, 2001



Created on: December 03, 2001

APPENDIX F

ESTABLISHMENT OF A PERMANENT PLAN FOR MEASURING & REPORTING

Yakima River Basin
Washington

Report to
Secretary of the Interior

and

State of Washington

From:

Yakima River Basin
Conservation Advisory Group

November 16, 1998

REPORT ON MEASURING & REPORTING
Yakima River Basin
Washington

Report To: Secretary of the Interior and State of Washington

From: Yakima River Basin Conservation Advisory Group

Members

Yakama Indian Nation	**Environmental Interests**
(Carroll E. Palmer)	(Katherine P. Ransel)
Non-Proratable Irrigators	**Proratable Irrigators**
(James W. Trull)	(Ron Van Gundy)
Washington State Department of Fish and Wildlife	**Washington State University Cooperative Extension**
(Brent D. Renfrow)	(Robert G. Stevens)

November 16, 1998

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November 16, 1998

ESTABLISHMENT OF A PERMANENT PLAN FOR MEASUREMENT AND REPORTING
Yakima River Basin, Washington

The Yakima River Basin Water Enhancement Project (YRBWEP) Conservation Advisory Group (CAG) was directed by Title XII of Pub. Law 103-434 to provide "recommendations to the Secretary and the State of Washington regarding the establishment of a permanent program for the measurement and reporting of all natural flow and contract diversions within the basin."

CAG recognizes the jurisdictional complexities relating to water resource management within the Yakima River basin, including the sovereignty of the Yakama Indian Nation. Implementation of these recommendations will have to be tailored to each different jurisdictional situation. Nothing herein implies State jurisdiction over the water rights of the Yakama Indian Nation.

I. Background

A. Water Supply Problems and Needs

Out of Stream Water Use

Water supplies are not adequate in all years to meet the needs of all Yakima Basin water users. During poor water years, junior-priority water right holders receive a prorated portion of their normal-year water delivery. The amount of proration is determined by the US Bureau of Reclamation (Reclamation) using the total water supply available (TWSA) formula. In 1994, a year of severe shortfall, proratable water users received just 38% of their Federal contract water amount. In the tributaries of the Yakima River, junior-priority water right holders are subject to regulation and curtailment every year to satisfy senior water rights in those subbasins.

An effective program of measuring and reporting of diversion quantities and enforcement is necessary to eliminate illegal water use, to ensure that water users do not exceed their diversion limits, and to curtail junior-priority water rights to satisfy senior water rights, according to the basin's schedule of rights.

Instream Issues

Many of Washington's streams and rivers have insufficient instream flow to support adequate aquatic habitat for fish. In 1996, pursuant to the Federal Clean Water Act, the State Department of Ecology (Ecology) identified 48 stream segments in Washington that have insufficient instream flows to satisfy state water quality standards for, among other things, the provision of adequate fish habitat. Among those listed were the Yakima mainstem and several of its tributaries, as reported in CAG's Basin Conservation Plan.

In 1992, the Washington State Department of Fish and Wildlife found that 42% of the fish stocks in Washington, whose status could be determined, were either depressed or critical. A depressed fish stock is one whose production is below natural rates. A critical fish stock is one whose production level is so low that permanent damage to the stock is likely or has already occurred. Each of the stream segments in the Yakima Basin listed as having flows too low to support designated salmonid uses under the Clean Water Act was also listed by the Washington Department of Fish and Wildlife as depressed or critical. In addition, the U.S. Fish and Wildlife Service has listed bull trout in the Yakima Basin under the Federal Endangered Species Act. The National Marine Fisheries Service will act on a proposal to list steelhead in the Yakima Basin under the Endangered Species Act in the spring of 1999.

Thus, measuring and reporting water use and effective enforcement against illegal and unauthorized use of water are critical components of the YRBWEP's efforts to improve instream flow conditions in the Yakima River basin.

B. Washington Law on Water Metering

To manage and regulate public waters, the Washington legislature amended RCW 90.03.360 in 1993, requiring that "[t]he owner or owners of any water diversion shall maintain, to the satisfaction of the department of ecology, substantial controlling works and a measuring device constructed and maintained to permit accurate measurement and practical regulation of the flow of water diverted." RCW 90.03.360(1). To implement this mandate, the statute directs Ecology to require metering under certain conditions. Subsection (1) of RCW 90.03.360 provides: "Metering of diversions or measurements by other approved methods <u>shall be required</u> as a condition for all new surface water right permits, and except as provided in subsection (2) of this section, may be required as a condition for all previously existing water rights." Subsection (2) of RCW 90.03.360 provides that "[w]here water diversions are from waters in which the salmonid stock status is depressed or critical, as determined by the department of fish and wildlife, or where the volume of water being diverted exceeds one cubic foot per second, <u>the department shall require</u> metering or measurement by other approved methods as a condition for all new <u>and previously existing</u> water rights or claims."

Subsection (1) makes metering mandatory for all new permits. Metering for existing rights is discretionary unless the diversion falls within the categories described in subsection (2). Subsection (2) mandates metering for all existing rights where diversions are from streams containing depressed or critical salmonid stocks or exceed one cfs. The statute further provides that Ecology's enforcement of the metering requirement for such rights must be prioritized ahead of Ecology's existing compliance workload "where a delay may cause a decline of wild salmonids." RCW 90.03.360(2). In addition, the statute authorizes Ecology to require the owner of a permit or right to file reports documenting the amounts being diverted. RCW 90.03.360.

The metering requirements of RCW 90.03.360 would appear to apply equally to surface and groundwater appropriations. The statutory provisions regulating groundwater, found in RCW 90.44, incorporate and apply the surface code provisions to the groundwater code. RCW 90.44.020 states that "[t]his chapter regulating and controlling groundwaters of the state of Washington shall be supplemental to chapter 90.03 RCW, which regulates the surface waters of the state, and is enacted for the purpose of extending the application of such surface water statutes to the appropriation and beneficial use of ground waters within the state."

Indeed, when Ecology adopted rules to implement the metering statute (WAC 508-64), it explicitly recognized that the metering requirements of RCW 90.03.360 apply equally to both surface and groundwater appropriations. WAC 508-64-010 (Ecology vested with the power to require metering of "those diverting and/or withdrawing waters of the state, both surface and ground") (citing RCW 90.03.360 and RCW 90.44.020).

The rules state that conflicts arising from increased competition for limited water resources make it "necessary to . . . insure that those entitled to make beneficial use of water neither waste water in exercising their rights nor use waters by withdrawal or diversion thereof in amounts in excess to which they are entitled. . . . It has been increasingly apparent that a satisfactory water management program can be carried out only if surface and ground water withdrawals are closely monitored and accurately measured." WAC 508-64-010 (emphasis added).

C. Court Actions in the Yakima Basin Adjudication Concerning Water Metering

The surface water rights in the Yakima River basin are being adjudicated in the State Superior Court of Yakima County. The Court retains jurisdiction, including regulatory jurisdiction, over all claimants to surface water rights in the Yakima River basin, during the adjudication.

Mainstem

The Court ordered, on October 14, 1994 and March 9, 1995, that all persons/entities with diversions of 1 cubic foot per second (cfs) or more from the Yakima, Naches, and Tieton Rivers, install an approved measuring or metering device at each diversion of 1 cfs or greater before March 1, 1995. The Court orders require these mainstem water diverters to measure and report diversion quantities and changes in diversion quantities to Reclamation. The March 9, 1995, order specifically provides for enforcement by Ecology of the measuring requirements. Reclamation or any other party with legal standing in the adjudication could also petition the Court requesting enforcement of these orders (by issuance of a temporary restraining order or other appropriate relief).

Tributary Subbasins

On August 27, 1998, the Court issued another order requiring metering, measuring, and reporting of all diversions from Big Creek, within Subbasin No. 2, and from the Teanaway River and its tributaries, within Subbasin No. 3. This order was patterned directly after the 1994 and 1995 mainstem orders but includes some modifications. The Court order requires all of these water diverters to measure and report diversion quantities and changes in diversion quantities to Reclamation, commencing in 1999. Reporting requirements do not apply to single families diverting less than 1 cfs of water for purely domestic purposes. The Court appointed a stream patrolman to enforce the provisions of the order.

Effect of the Adjudication on Water Metering, Reporting and Enforcement

The adjudication Court retains jurisdiction over all adjudication claimants during the adjudication. After completion of the adjudication, jurisdiction will return to Ecology (water rights administration) and Reclamation (water contract and Yakima Project administration). The 1994, 1995, and 1998 Court Orders on Metering, Measuring, and Reporting Requirements will expire upon completion of the adjudication.

D. Principles of Effective Enforcement Programs

The way to achieve voluntary compliance in a regulated community is by implementing a strategic enforcement program designed to make the cost of non-compliance greater than that of compliance. Without such an enforcement strategy, voluntary compliance by the vast majority of those subject to the law should neither be expected nor will it be achieved. Government's failure to enforce against illegal water use not only promotes non-compliance in the regulated community at large, but it is simply unfair to those who do comply with the law because it puts them at an economic disadvantage. Moreover, it is important to remember that a fine that is less than the cost of compliance will also promote more widespread non-compliance rather than stem it.

The classic example of an effective enforcement program is that of the Internal Revenue Service. Against their economic interests, millions of Americans voluntarily meet their tax obligations each year. They do so primarily because they hold the belief that if they do not, there is a reasonable chance that their delinquency will be uncovered and the consequences will be vastly more burdensome in economic terms than simply paying their taxes.

An effective enforcement program should be designed to achieve the maximum net benefit for every action taken. An effective strategy is one that induces those subject to legal obligations to fulfill them completely, timely, and at the lowest possible cost to the government. In order to induce that behavior, the government must create a reasonable expectation in those legally obligated that fulfillment of their legal obligations will be less costly than failure to fulfill them. The components of an effective enforcement strategy include:

- Educate the public and obligated community to the importance of its mission and the requirements of the law;

- Effectively detect those who violate those requirements;

- Penalize those individuals so that the cost of non-compliance is greater than the cost of compliance; and

- Effectively publicize the consequences of non-compliance.

By following these principles, the agencies can minimize their enforcement costs and promote fairness among water users, resulting in widespread voluntary compliance.

II. Discussion and Recommendations

CAG believes that a combination of the approaches outlined above is essential to the success of the Yakima River Basin Water Enhancement Project.

A. Recommendation One

CAG believes that all surface water diversions in the Yakima Basin and its tributaries should be metered, monitored, and regulated by stream patrolmen, watermasters, or other regulatory personnel sufficient to ensure that compliance is maintained throughout the irrigation season basin-wide. Compliance staff must:

1) identify all water users not complying with Court ordered measuring and reporting requirements;

2) monitor water use reports to identify users who are exceeding their water rights;

3) take enforcement actions against targeted non-compliers that are designed to promote and maintain voluntary compliance in the rest of the regulated community, consistent with the enforcement principles outlined above in Section ID.

B. Recommendation Two

CAG agrees with the Department of Ecology that "a satisfactory water management program can be carried out only if surface and ground water withdrawals are closely monitored and accurately measured." WAC 508-64-010. Thus, CAG believes that all non-exempt groundwater withdrawals (those requiring water right permits under RCW 90.44.050) in the Yakima Basin should be metered, monitored and reported.

C. Recommendation Three

CAG also believes that good water management requires the ability to meter and monitor water use to allow for the adoption of incremental water pricing structures. Thus, CAG recommends that metering be extended to each farm delivery point and/or to each individual ownership, where practicable.

D. Recommendation Four

CAG believes that streamflow gages must be adequate to measure progress in complying with YRBWEP needs as well as a number of other Federal and State laws and obligations that Reclamation and Ecology are subject to (e.g. the Clean Water Act and the Endangered Species Act). CAG recommends that Ecology and Reclamation cooperate in quickly assessing where additional streamflow gages are necessary to insure that streamflow can be measured to meet the needs of these various Federal and State obligations.

E. Recommendation Five

Reclamation and Ecology should jointly petition the adjudication Court to extend its 1998 Order on Metering, Measuring, and Reporting Requirements as necessary, to other subbasins or water users, consistent with the recommendations above.

F. Recommendation Six

Because after the completion of the adjudication, jurisdiction over water use metering, reporting and enforcement returns to Ecology and Reclamation, they should petition the Court to issue an Order on Metering, Measuring, and Reporting Requirements as indicated above, applicable basin-wide, as part of the final Yakima Adjudication Decree.

G. Recommendation Seven

Both during and after the completion of the Adjudication, Ecology and Reclamation should cooperate in establishing an effective water use metering, monitoring and enforcement program with effective deterrents to non-compliance consistent with the enforcement principles outlined in Section ID above. The agencies should give this program the highest priority, as it protects those water users who comply with their water rights from harm by those who may not, and puts them on an equal economic footing. Allowing non-compliance to go undetected and unpunished puts those who comply at an economic disadvantage, and thus promotes more widespread non-compliance.

These agencies have several tools available for designing such an enforcement strategy. For instance, Section 90.03.600 RCW provides Ecology authority to issue civil penalties for violations of the surface water code or of regulatory orders issued by Ecology; Section 90.44.500 RCW applies the civil penalty authority granted to Ecology by 90.03.600 RCW to the ground water code; Section 43.27A.190 RCW authorizes Ecology to issue regulatory orders where it finds violations of the state surface and ground water codes; and Chapter 90.08 RCW authorizes Ecology to appoint a stream patrolman for adjudicated streams and establishes procedures for compensation of the stream patrolman by the water users. Reclamation has the authority to enforce the provisions of its Federal water delivery contracts with Yakima Project water users.

LEGAL

REFERENCES

WASHINGTON STATE

LAWS & REGULATIONS

LAWS AND REGULATIONS – WATER RESOURCES
PART OF CHAPTER 43.27A RCW
WATER CODE

RCW 43.27A.190 Water resource orders. Notwithstanding and in addition to any other powers granted to the department of ecology, whenever it appears to the department that a person is violating or is about to violate any of the provisions of the following:

(1) Chapter 90.03 RCW; or
(2) Chapter 90.44 RCW; or
(3) Chapter 86.16 RCW; or
(4) Chapter 43.37 RCW; or
(5) Chapter 43.27A RCW; or
(6) Any other law relating to water resources administered by the department; or
(7) A rule or regulation adopted, or a directive or order issued by the department relating to subsections (1) through (6) of this section; the department may cause a written regulatory order to be served upon said person either personally, or by registered or certified mail delivered to addressee only with return receipt requested and acknowledged by him. The order shall specify the provision of the statute, rule, regulation, directive or order alleged to be or about to be violated, and the facts upon which the conclusion of violating or potential violation is based, and shall order the act constituting the violation or the potential violation to cease and desist or, in appropriate cases, shall order necessary corrective action to be taken with regard to such acts within a specific and reasonable time. The regulation of a headgate or controlling works as provided in RCW 90.03.070, by a watermaster, stream patrolman, or other person so authorized by the department shall constitute a regulatory order within the meaning of this section. A regulatory order issued hereunder shall become effective immediately upon receipt by the person to whom the order is directed, except for regulations under RCW 90-.03.070 which shall become effective when a written notice is attached as provided therein. Any person aggrieved by such order may appeal the order pursuant to RCW 43.21B.310. [1987 c 109 § 11; 1969 ex.s. c 284 § 7.]

RCW 90.03.360 Controlling works and measuring devices--Metering of diversions--Impact on fish stock. (1) The owner or owners of any water diversion shall maintain, to the satisfaction of the department of ecology, substantial controlling works and a measuring device constructed and maintained to permit accurate measurement and practical regulation of the flow of water diverted. Every owner or manager of a reservoir for the storage of water shall construct and maintain, when required by the department, any measuring device necessary to ascertain the natural flow into and out of said reservoir.

Metering of diversions or measurement by other approved methods shall be required as a condition for all new surface water right permits, and except as provided in subsection (2) of this section, may be required as a condition for all previously existing surface water rights. The department may also require, as a condition for all water rights, metering of diversions, and reports regarding such metered diversions as to the amount of water being diverted. Such reports shall be in a form prescribed by the department.

(2) Where water diversions are from waters in which the salmonid stock status is depressed or critical, as determined by the department of fish and wildlife, or where the volume of water being diverted exceeds one cubic foot per second, the department shall require metering or measurement by other approved methods as a condition for all new and previously existing water rights or claims. The department shall attempt to integrate the requirements of this subsection into its existing compliance workload priorities, but shall prioritize the requirements of this subsection ahead of the existing compliance workload where a delay may cause the decline of wild salmonids. The department shall notify the department of fish and wildlife of the status of fish screens associated with these diversions.

This subsection (2) shall not apply to diversions for public or private hatcheries or fish rearing facilities if the diverted water is returned directly to the waters from which it was diverted. [1994 c 264 § 85; 1993 sp.s. c 4 § 12; 1989 c 348 § 6; 1987 c 109 § 92; 1917 c 117 § 37; RRS § 7389. Formerly RCW 90.28.070.]

NOTES:

Findings--Grazing lands--1993 sp.s. c 4: See RCW 79.01.2951.

Severability--1989 c 348: See note following RCW 90.54.020.

Rights not impaired--1989 c 348: See RCW 90.54.920.

Purpose--Short title--Construction--Rules--Severability--Captions--1987 c 109: See notes following RCW 43.21B.001.

Instream flows: RCW 90.22.060.

LAWS AND REGULATIONS – WATER RESOURCES
PART OF CHAPTER 90.03 RCW
WATER CODE

RCW 90.03.600 Civil penalties. Except as provided in RCW 43.05.060 through 43.05.080 and 43.05.150, the power is granted to the department of ecology to levy civil penalties of up to one hundred dollars per day for violation of any of the provisions of this chapter and chapters 43.83B, 90.22, and 90.44 RCW, and rules, permits, and similar documents and regulatory orders of the department of ecology adopted or issued pursuant to such chapters. The procedures of RCW 90.48.144 shall be applicable to all phases of the levying of a penalty as well as review and appeal of the same. [1995 c 403 § 635; 1987 c 109 § 157; 1977 ex.s. c 1 § 8. Formerly RCW 43.83B.335.]

NOTES:

Findings--Short title--Intent--1995 c 403: See note following RCW 34.05.328.

Part headings not law--Severability--1995 c 403: See RCW 43.05.903 and 43.05.904.

Purpose--Short title--Construction--Rules--Severability--Captions--1987 c 109: See notes following RCW 43.21B.001.

LAWS AND REGULATIONS – WATER RESOURCES
PART OF CHAPTER 90.44 RCW
WATER CODE

RCW 90.44.020 **Purpose of chapter.** This chapter regulating and controlling ground waters of the state of Washington shall be supplemental to chapter 90.03 RCW, which regulates the surface waters of the state, and is enacted for the purpose of extending the application of such surface water statutes to the appropriation and beneficial use of ground waters within the state. [1945 c 263 § 1; Rem. Supp. 1945 § 7400-1.]

RCW 90.44.050 **Permit to withdraw.** After June 6, 1945, no withdrawal of public ground waters of the state shall be begun, nor shall any well or other works for such withdrawal be constructed, unless an application to appropriate such waters has been made to the department and a permit has been granted by it as herein provided: EXCEPT, HOWEVER, That any withdrawal of public ground waters for stock-watering purposes, or for the watering of a lawn or of a noncommercial garden not exceeding one-half acre in area, or for single or group domestic uses in an amount not exceeding five thousand gallons a day, or for an industrial purpose in an amount not exceeding five thousand gallons a day, is and shall be exempt from the provisions of this section, but, to the extent that it is regularly used beneficially, shall be entitled to a right equal to that established by a permit issued under the provisions of this chapter: PROVIDED, HOWEVER, That the department from time to time may require the person or agency making any such small withdrawal to furnish information as to the means for and the quantity of that withdrawal: PROVIDED, FURTHER, That at the option of the party making withdrawals of ground waters of the state not exceeding five thousand gallons per day, applications under this section or declarations under RCW 90.44.090 may be filed and permits and certificates obtained in the same manner and under the same requirements as is in this chapter provided in the case of withdrawals in excess of five thousand gallons a day. [1987 c 109 § 108; 1947 c 122 § 1; 1945 c 263 § 5; Rem. Supp. 1947 § 7400-5.]

NOTES:

Purpose--Short title--Construction--Rules--Severability--Captions--1987 c 109: See notes following RCW 43.21B.001.

RCW 90.44.500 **Civil penalties.** See RCW 90.03.600.

Chapter 90.08 RCW
STREAM PATROLMEN

Sections

RCW 90.08.040 Stream patrolmen——Appointment——Powers. Where water rights of a stream have been adjudicated a stream patrolman shall be appointed by the director of the department of ecology upon application of water users having adjudicated water rights in each particular water resource making a reasonable showing of the necessity therefor, which application shall have been approved by the district water master if one has been appointed, at such time, for such stream, and for such periods of service as local conditions may indicate to be necessary to provide the most practical supervision and to secure to water users and owners the best protection in their rights.

The stream patrolman shall have the same powers as a water master appointed under RCW 90.03.060, but his district shall be confined to the regulation of waters of a designated stream or streams. Such patrolman shall be under the supervision of the director or his designated representative. He shall also enforce such special rules and regulations as the director may prescribe from time to time. [1977 c 22 § 1; 1925 ex.s. c 162 § 1; RRS § 7351–1.]

Water masters
- appointment, compensation: RCW 90.03.060.
- duties: RCW 90.03.070.
- power of arrest: RCW 90.03.090.

RCW 90.08.050 Stream patrolmen——Compensation, travel expenses. Each stream patrolman shall receive a wage per day for each day actually employed in the duties of his office, or if employed by the month, he shall receive a salary per month, which wage or salary shall be fixed in the manner provided by law for the fixing of the salaries or compensation of other state officers or employees, plus travel expenses in accordance with RCW 43.03.050 and 43.03.060 as now existing or hereafter amended, to be paid by the county in which the work is performed. In case the service extends over more than one county, each county shall pay its equitable part of such wage to be apportioned by the director. He shall be reimbursed for actual necessary expenses when absent from his designated headquarters in the performance of his duties, such expense to be paid by the county in which he renders the service. The accounts of the stream patrolman shall be audited and certified by the director and the county auditor shall issue a warrant therefor upon the current expense fund. [1977 c 22 § 2; 1975–'76 2nd ex.s. c 34 § 180; 1947 c 123 § 1; 1925 ex.s. c 162 § 2; Rem. Supp. 1947 § 7351–2.]

Effective date——Severability——1975–'76 2nd ex.s. c 34: See notes following RCW 2.08.115.

Public officers, salaries and fees: Chapter 42.16 RCW.

State government, salaries and expenses: Chapter 43.03 RCW.

RCW 90.08.060 Stream patrolmen——Users to share in payment of compensation. The salary of the stream patrolman shall be borne by the water users receiving the benefits and shall be paid to the county or counties in the following manner:

The county or counties may assess each water user for his proportionate share of the total stream patrolman expense in the same ratio that the amount of water diverted by him bears to the total amount diverted from the stream during each season, on an annual basis, to recover all such county expenses. The stream patrolman shall keep an accurate record of the amount of water diverted by each water user coming under his supervision. On the first of each month the stream patrolman shall present his record of water diversion to the county or counties for the preceding month. Where the water users are organized into an irrigation district or water users' association, such organization may enter into an agreement with the county or counties for direct payment to the stream patrolman in order to minimize administrative costs. [1977 c 22 § 3; 1925 ex.s. c 162 § 3; RRS § 7351–3.]

Irrigation districts generally: Chapter 87.03 RCW.

RCW 90.08.070 Right of county to sue user for unpaid share of expenses. Upon failure of any water user to pay his proportionate share of the expense referred to in RCW 90.08.050 and 90.08.060, the county or counties shall be entitled to sue for and recover any such unpaid portion in any court of competent jurisdiction. [1977 c 22 § 4; 1925 ex.s. c 162 § 4; RRS § 7351–4.]

Chapter 508-64 WAC
MEASURING DEVICES FOR WATER DIVERSION AND WITHDRAWAL FACILITIES

WAC

WAC 508-64-010 Background and purpose of regulation. With the passage of time and issuance of an additional number of water rights in each year, competition for rights to use of our limited water resources increases. Conflicts also develop where uses presently authorized compete for water supplies which may vary on seasonal or annual bases, due to changes in hydrologic conditions. For these reasons it becomes necessary to manage our state's water resources so as to insure that those entitled to make beneficial use of water neither waste water in exercising their rights nor use waters by withdrawal or diversion thereof in amounts in excess to that which they are entitled.

One of the tolls of water management vested in the department of ecology is the power to require that those diverting and/or withdrawing waters of the state, both surface and ground, provide a measuring device so as to provide for accurate measurement of waters so utilized. See RCW 90.03.360 and 90.44.020. It has been increasingly apparent that a satisfactory water management program can be carried out only if surface and ground water withdrawals are closely monitored and accurately measured.

Under RCW 43.27A.090(11), the department of ecology is authorized to adopt such regulations as are necessary to carry out the provisions of the surface and ground water statutes of chapters 90.03 and 90.44 RCW. Acting under the authority of RCW 43.27A.090(11) and 90.03.360, the following regulation is adopted for the purpose of setting forth:

(1) The specifications for meters installed on water withdrawal facilities for pressure systems;

(2) The installation requirements for a meter;

(3) The operation and maintenance requirements for a meter; and

(4) The procedures the department of ecology will follow in determining when installation of a meter shall be required and how notification of this requirement shall be given to the water user. [Statutory Authority: Chapters 43.21A, 43.27A and 90.44 RCW. 88-13-037 (Order 88-11), § 508-64-010, filed 6/9/88; Order DWR 69-9, § 508-64-010, filed 11/6/69.]

WAC 508-64-020 Meter specifications. All meters required to be installed, as provided under WAC 508-64-010, shall meet the following requirements:

(1) Meters shall be of the velocity propeller type with enclosed propeller made of noncorrosive materials. Positive displacement and other types of meters may be used with the express approval of the department of water resources. All meters shall be line meters. For pressures in excess of 100 pounds per square inch, high pressure welded saddle or tube type meters shall be required. Meters shall be complete with meter head, register box with locking hasp, and straightening vanes for attachment to existing pipe or contained within a tube. The saddle or tube-type meters shall be of a construction such that any part of the propeller gears, shafts, totalizer, or any other moving part can be removed for repair with relative ease. The saddle-type meter shall be designed and constructed so as to be suitable for welding to the existing or installed steel pipe but with removable meter-head or designed so that it may be secured to the pipe by anchor bars welded to the pipe with U-bolts, or with threaded straps. All meters shall have the size, serial number, and direction of the flow through the meter properly and clearly indicated.

(2) The meter shall have a rated accuracy of plus or minus 2 percent of actual flow for all rates of flow within the range of flow for which the meter is designed. The meter shall register the full range of discharge from the source of water for which it is to be used.

(3) The meter shall have a visual, mechanical, digital totalizer located on or adjacent to the meter. The register shall be protected.

(4) Units of measurement for irrigation uses shall be in acre-feet. The totalizer shall read directly in acre-feet with six digits to read to the nearest hundredths (0000.00). Both the register and meter unit shall be provided with a method of sealing with a wire or lead seal to prevent unauthorized tampering. For other uses, different units of measurement may be used with the express approval of the department of water resources. All totalizers or registers shall be equipped with a sweep hand with adequate markings or divisions for test purposes.

(5) Register boxes – the register box shall have a protective hinged cover over the window glass. Register box screws shall be drilled for seal wire holes.

(6) Propeller – the propeller shall be made of polyethylene or equivalent corrosion-resistant material and such that it will operate effectively and without distortion at temperatures between 32 degrees and 100 degrees Fahrenheit. The propeller shall be located in the center of the pipe and normal to the centerline of flow.

The measuring propeller, together with its spindle, shall be the same specific gravity as water or less. [Order DWR 69-9, § 508-64-020, filed 11/6/69.]

WAC 508-64-030 Meter installation requirements. Meters required to be installed, as provided under WAC 508-64-010, shall meet the following installation requirements:

(1) The meter shall be installed in accordance with manufacturer specifications and in such a manner that there shall be a full pipe of water at all times when water is being withdrawn.

(2) Straightening vanes shall be installed in the pipe in the manner recommended by the manufacturer of the meter, or vanes may be part of the tube furnished with tube-type meters or separate units for installation in the discharge pipe upstream of the meter.

(3) There shall be no turnouts or diversions between the source of water and the meter installation, except for faucet or other similar small outlets.

(4) The meter shall be placed in the pipe not less than five pipe diameters downstream from any valves, elbows, or other obstructions which might create turbulent flow, or as recommended by the meter manufacturer. There shall also be at least one pipe diameter of unobstructed flow on the downstream side of the meter.

(5) The meter and register shall not be enclosed in a building or structure in such a manner as to prevent access to the register. The register or meter shelter may be equipped with a lock to prevent tampering or breakage, provided that a key is made available to authorized employees of the department of ecology at the place of business during normal working hours or at the residence in case of private parties.

(6) Provisions shall be made for removal and rating of the meter in accordance with the manufacturer's specifications.

(7) In those cases where wells are authorized for the purpose of supplementing surface waters with water from combined sources not to exceed a total quantity, both sources of water shall be metered.

(8) In the case of artesian wells which flow at times, the meter shall be installed in a manner which will measure both pumped and flowing discharge.

(9) The owner shall cause the department of ecology to be notified within ten days from the installation of the meter.

(10) The meter installation shall be inspected and approved by the department of ecology. [Statutory Authority: Chapters 43.21A, 43.27A and 90.44 RCW. 88-13-037 (Order 88-11), § 508-64-030, filed 6/9/88; Order DWR 69-9, § 508-64-030, filed 11/6/69.]

WAC 508-64-040 Meter operation and maintenance. Meters installed hereunder shall be operated and maintained in accordance with the following:

(1) No withdrawal or diversion of water shall be made unless the meter installation has been inspected and approved by the department of ecology and is in proper operating condition.

(2) Meters shall be repaired and returned to operation as soon as possible upon discovery of a malfunctioning meter. The department of ecology shall be notified immediately of such malfunctioning meter. In all cases the meter reading immediately prior to repair and the reading of the new or repaired meter shall be submitted to the department of ecology on forms provided within ten days following reinstallation of the meter and/or meter head.

(3) Water use data shall be submitted to the department of ecology on forms provided for that purpose at such times as may be required by the department.

(4) Meters shall be kept clear of debris or any other material or vegetative growth which would impede their operation. All meters shall be lubricated as specified by the manufacturer.

(5) Meters which are not properly operated and maintained shall be repaired or replaced upon order of the department of ecology within the time specified within said order. [Statutory Authority: Chapters 43.21A, 43.27A and 90.44 RCW. 88-13-037 (Order 88-11), § 508-64-040, filed 6/9/88; Order DWR 69-9, § 508-64-040, filed 11/6/69.]

WAC 508-64-050 Meter—When required. Meters shall be installed on water diversion and/or withdrawal facilities existing prior to or constructed subsequent to the effective date hereof whenever it shall appear to the department of ecology that one of the following conditions exist:

(1) The need exists to accurately measure the instantaneous rate of diversion (withdrawal) and/or the total water use by a facility operating over a specified period of time, for purposes of determining if the quantities of water utilized are within the limits of the established rights, or

(2) Studies, inventories and investigations of stream and/or aquifer systems are being conducted by the department of ecology for purposes of determining location, extent, depth, volume and flow of said waters for planning, utilization and management purposes; and accurate determination of existing diversion and/or withdrawals is necessary for proper conduct of such studies, inventories and investigations, or

(3) When it has been established by the department of ecology, or there is reasonable reason to believe that a mining of ground waters is taking place within a defined area and that an accurate determination as to the extent of existing use of ground waters is necessary to properly manage such use for the purpose of maintaining a reasonable or feasible pumping lift (or reasonable or feasible reduction of artesian pressure) within the defined area, or

(4) Conflict in use under established rights exist and accurate determination of the rate of diversion (withdrawal) and/or volumetric use over a given period of time is necessary for a proper resolution of the conflict.

The requirement that a meter shall be installed on an existing facility shall be given by written notice served upon the owner or person having control thereof, as appropriate, personally or by registered or certified mail.

COURT

ORDERS

9-192-D (Rev. Dec. 1994) Diversion Code ________

Daily Diversion, in Cubic Feet, per Second, of ______________________________

for the Water Year commencing October 1, 19____ , ending September 30, 19______

IN THE SUPERIOR COURT OF THE STATE OF WASHINGTON
FOR YAKIMA COUNTY

NO. 77-201484-5

ORDER PENDENTE LITE
REGARDING METERING,
MEASUREMENT AND
REPORTING REQUIREMENTS

THIS matter having come before the Court on the Plaintiff's Petition for Pendente Lite Regarding Reporting Requirements, the Court having heard from all interested parties and being fully advised; now, therefore, it is hereby

ORDERED, ADJUDGED, AND DECREED that all persons/entities with diversions of 1 cfs or more from the Yakima, Naches, and Tieton Rivers, shall install an approved measuring or metering device at each diversion of 1 cfs or greater before March 1, 1995. An approved metering or measurement device shall be a (1) standard weir structure, (2) parshall flume(s), (3) velocity type meter, (4) pump flow-meter (5) stable rated section with a rating table, provided the rated section has a stable control, the staff gage is readable throughout the full range of flows experienced in a water year, and monthly flow measurements are made to verify the rating table and to determine shifts if necessary; or (6) other device capable of measuring flow within plus or minus 5%.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that records of the diversions shall be kept on a Standard Form 192 (attached and incorporated as part of this order) showing the average daily gage height and flow for each day of the water season.

IT IS FURTHER ORDERED, ADJUDGED AND DECREED that diversion records required to be kept by this order shall be provided to the Bureau of Reclamation weekly, and the Bureau of Reclamation shall provide the records to the Department of Ecology.

IT IS FURTHER ORDERED, ADJUDGED AND DECREED that an annual summary of diversions shall be provided to the Bureau of Reclamation by November 1 of each year.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that all persons/entities with diversions of 2 cfs or more from the Yakima, Naches, and Tieton Rivers shall report to the Bureau of Reclamation any planned diversions, either plus or minus, in excess of 23 cfs or 2% whichever is greater, by telephoning (509)454-5621 or (509) 575-5854 (from 8:00 a.m. - 4:30 p.m. weekdays and 8:00 a.m. - 10:00 a.m. on weekends) at least 48 hours prior to making said changes.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that all persons/entities with diversions of 2 cfs or more from the Yakima, Naches, and Tieton Rivers shall report any unplanned changed in diversions, which are either plus or minus, 2 cfs or 2% whichever is greater by telephoning (509)454-5621 or (509)575-5854 (from 8:00 a.m. - 4:30 p.m. weekdays and 8:00 a.m. - 10:00 a.m. on weekends) as soon as possible after the change.

IT IS FINALLY ORDERED, ADJUDGED AND DECREED that this order is not intended to apply to diversions within the Yakima Reservation.

DONE IN OPEN COURT this 13th day of October, 1994.

/s/ Honorable Walter A. Stauffacher

9-192-D (Rev. Dec. 1994) Diversion Code ______

Daily Diversion, in Cubic Feet, per Second, of ______________________

for the Water Year commencing October 1, 19____ and ending September 30, ____

Gage/meter read to ______ once/twice a day by ______________________ (Observer)

Phone: ______________

Day	October		November		December		January		February		March		Day
	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	
1													1
2													2
3													3
4													4
5													5
6													6
7													7
8													8
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31													31
Total													
Mean													
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Minimum													
Acre-feet													

9-192-D (Rev. Dec. 1994) Diversion Code ______

Daily Diversion, in Cubic Feet, per Second, of ______

for the Water Year commencing October 1, 19____ , ending September 30, 19____

ADJUDICATION
Yakima River Drainage Basin
Sub-basin

RCW 90.03.360 Controlling works and measuring devices --- Metering of diversions. The owner or owners of any ditch or canal shall maintain to the satisfaction of the Department of Ecology, substantial controlling works, and a measuring device at the point where water is diverted, and these shall be so constructed and maintained as to permit accurate measurement, practical regulation of the flow of water diverted into said ditch or canal. Every owner or manager of a reservoir for the storage of water shall construct and maintain, when required by the Department, any measuring device necessary to ascertain the natural flow into and out of said reservoir.

Metering of diversions or measurement by other approved methods may be required as a condition for all new water right permits. The Department may also require, as a condition for such permits, reports regarding such metered diversions as to the amount of water being diverted. Such reports shall be in a form prescribed by the Department [1989 c 348 ¶ 6: 1987 c 109 ¶ 92: 1989 c 117 ¶ 37; RRS ¶ 7389. Formerly RCW 90.28.070.]

Severability — 1989 c 348: See note following RCW 90.54.020.
Rights not impaired — 1989 c 348: See RCW 90.54.920.
Purpose — Short title — Construction — Rules —Severability — Captions — 1987 c 109: See notes following RCW 43.21B.001.

WAC 508-12-030 Regulation of water right diversions --- Controlling works --- Measuring devices. Where controlling works or measuring devices are not installed or maintained to the satisfaction of the Department of Ecology, proper notice shall be given to the owner to install or repair such controlling works or measuring device. This notice shall allow not less than ten days time to make necessary repairs or installations. In the event the work outlined in the notice is not completed in the specified time, the diversion shall be closed to further flow of water, until such time as the notice has been fully/complied with. [Statutory Authority: Chapter 43-.27A RCW. 88-13-037 (Order 88-11), ¶ 508-12-030. filed 6/9/88: Rule 3, filed 3/23/60. Formerly WAC 134-12-030.]

WAC 508-12-040 Regulation of water right diversions--Controlling works--Headgates. Controlling works or headgates shall be so constructed that they can be regulated and locked in place by the watermaster or stream patrolman. [Rule 4, filed 3/23/60. Formerly WAC 134-12-040.]

Diversion's measuring device must be located within a minimal distance from initial point of diversion from the river/creek/canal, below fishscreen return flow, above diversion's consumptive use, and above any significant system conveyance loss. Site approved by project hydrologic engineer.

Diversion records (copy of Form 192) shall be provided/mailed weekly to the Bureau of Reclamation, Yakima Field Office, Hydrology, P.O. Box 1749, Yakima, WA 98907.

Diversion changes shall be reported at least 48 hours prior to making said changes. Report changes by telephoning (509)454-5621 (from 08:00 a.m. - 4:30 p.m. weekdays and 8:00 - 10:00 a.m. on weekends) or after hours at (509) 575-5854 (leave message on recorder).

9-192D (Rev. Dec. 1994)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
HYDROLOGY

Diversion Code ____________
Diversion ____________
Water Year ____________

Day	April		May		June		July		August		September		Day
	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	
1													1
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Fourth
Third
Second
First
Quarter — Computed — Checked

Fourth
Third
Second
First
Quarter — Disch. applied — Disch. checked

Fourth
Third
Second
First
Quarter — G.H. copied — G.H. checked

Period
Year

ORIGINAL

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MAR 9 1995

KIM M. EATON, YAKIMA COUNTY CLERK

IN THE SUPERIOR COURT OF THE STATE OF WASHINGTON

FOR THE COUNTY OF YAKIMA

IN THE MATTER OF THE DETERMINATION OF THE RIGHTS TO THE USE OF THE SURFACE WATERS OF THE YAKIMA RIVER DRAINAGE BASIN, IN ACCORDANCE WITH THE PROVISIONS OF CHAPTER 90.03, REVISED CODE OF WASHINGTON, STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, vs. JAMES J. ACQUAVELLA, et al., Defendants.	NO.: 77-2-01484-5 ~~[PROPOSED]~~ ORDER ON PENDENTE LITE RE: ENFORCEMENT OF ORDER PENDENTE LITE REGARDING METERING, MEASURING AND REPORTING REQUIREMENTS

This matter having come before the Court on the Petitioners', State of Washington, Department of Ecology, and United States, Bureau of Reclamation, Petition for Order Pendente Lite Re: Enforcement of Order Pendente Lite Regarding Metering, Measuring and Reporting Requirements, the Court having heard from all interested parties and being fully advised; now, therefore, it is hereby

ORDERED ADJUDGED, AND DECREED that in the event that any person/entity that diverts 1 cfs or more water from the Yakima, Naches or Tieton Rivers fails to install an approved measuring

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 438-7743

or metering device at the diversion by March 1, 1995, the Department of Ecology shall notify the person/entity that they must install an approved metering or measurement device as identified in the Court's Order Pendente Lite Regarding Metering, Measurement and Reporting Requirements within one (1) month of the date of the Notice. The Notice shall be in writing and be posted at the person/entity's point of diversion or personally delivered to the person or any individual who represents the entity. A copy of the Notice shall be filed with the Department of Ecology and the Bureau of Reclamation at the agency offices in Yakima; and,

IT IS FURTHER ORDERED, ADJUDGED AND DECREED that any person/entity who fails to comply within one (1) month of the date of the Notice shall be considered to be in violation of the Court's Order dated October 14, 1994. The Department of Ecology shall issue a cease and desist order to the person/entity ordering them to terminate the diversion unless and until the person/entity installs an approved metering or measuring device and notifies Ecology of such installation. The cease and desist order shall be served by registered mail or personally upon the person, or any individual who represents the entity to whom the order is directed. A copy of the cease and desist order shall be filed with the Department of Ecology and with the Bureau of Reclamation at the agency offices in Yakima. Any person/entity who fails to comply with the cease and desist order will be subject to all enforcement and penalty orders available to

ATTORNEY GENERAL OF WASHINGTON
Ecology Division
PO Box 40117
Olympia, WA 98504-0117
FAX (360) 438-7743

Ecology, including penalties issued pursuant to RCW 90.03.600. The order may be appealed only to the Pollution Control Hearings Board as provided in RCW 43.21B.310. *During the pendency of this action, any appeal from a decision of the Pollution Control Hearings Board shall be heard by the Presiding Judge of this case.*

DONE IN OPEN COURT this 9th day of March, 1995.

Walter Stauffacher
WALTER A. STAUFFACHER, JUDGE

Presented by:

CHRISTINE O. GREGOIRE
Attorney General

Mary E. McCrea

MARY E. McCREA, WSBA #20160
Assistant Attorney General
Attorneys for Plaintiff
State of Washington
Department of Ecology
(360) 459-6155

Mary E. McCrea for

CHARLES O'CONNELL
Attorney for Defendant
U.S. Department of Justice
Land & Natural Resources Div.
Indian Resources Section
(202) 272-4210

[t2\acquavella\metering.ord]

IN THE SUPERIOR COURT OF THE STATE OF WASHINGTON
IN AND FOR THE COUNTY OF YAKIMA

IN THE MATTER OF THE DETERMINATION OF THE RIGHTS TO THE USE OF THE SURFACE WATERS OF THE YAKIMA RIVER DRAINAGE BASIN, IN ACCORDANCE WITH THE PROVISIONS OF CHAPTER 90.03 REVISED CODE OF WASHINGTON, STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. JAMES J. ACQUAVELLA et al., Defendants.	NO. 77-2-01484-5 CERTIFICATE OF SERVICE

The undersigned hereby certifies that she is an employee at the Bureau of Reclamation, of the United States Department of the Interior, 1917 Marsh Road, Yakima, Washington, 98901; over the age of eighteen years, not a party to or interested in the above-entitled action and competent to be a witness therein.

I certify that on this 2nd day of September 1998, I caused to be served a true and correct copy of the following:

1) **Order Pendente Lite Re: Metering, Measuring, and Reporting Requirements,** Teanaway River and Big Creek, Kittitas County; and,
2) **Letter from Jim Esget transmitting Order Pendente Lite and introducing Stan Isley, Court Appointed stream patrolman** for Teanaway River and Big Creek, Kittitas County,
3) **Photograph of Stan Isley;** and,
4) **SF-192,** form for reporting diversion quantities.

by causing said copies to be served on all necessary parties pursuant to the requirements of PRETRIAL ORDER NO. 6.

I have provided, by certified mail, a copy of the above documents to:

Each of the water right claimants of record for Subbasin #2.
Each of the water right claimants of record for Subbasin #3.
All Major Claimants.

I have provided, by regular mail, a copy of this set of documents to each of the attorneys and agents of record in the above entitled matter.

Sally LeBeau
for the US Bureau of Reclamation
September 2, 1998

IN THE SUPERIOR COURT OF THE STATE OF WASHINGTON IN AND FOR THE COUNTY OF YAKIMA

IN THE MATTER OF THE DETERMINATION OF THE RIGHTS TO THE USE OF THE SURFACE WATERS OF THE YAKIMA RIVER DRAINAGE BASIN, IN ACCORDANCE WITH THE PROVISIONS OF CHAPTER 90.03, REVISED CODE OF WASHINGTON, STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. JAMES J. ACQUAVELLA, ET AL., Defendant.	NO. 77-2-01484-5 **ORDER PENDENTE LITE RE: METERING, MEASURING AND REPORTING REQUIREMENTS, TEANAWAY RIVER AND BIG CREEK, KITTITAS COUNTY** FILED AUG 27 1998 KIM M. EATON, YAKIMA COUNTY CLERK

THIS MATTER having come before the Court on the Petitioner's, United States Bureau of Reclamation, Petition for Order Pendente Lite Re: Metering, Measuring, and Reporting Requirements, Teanaway River and Big Creek, Kittitas County, the Court having heard from all interested parties and being fully advised; now, therefore,

IT IS ORDERED, ADJUDGED, AND DECREED that all persons diverting water from the Teanaway River or its tributaries (Subbasin No. 3) or from Big Creek (within Subbasin No. 2) shall install an approved metering or measuring device at each of their diversion points by May 1, 1999. An approved metering or measuring device shall be a: 1) standard weir structure; 2) Parshall flume; 3) velocity type meter; 4) pump flow meter; 5) stable rated section with a rating

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Ecology Division
PO Box 40117
Olympia, WA 98504-0117
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table, provided the rated section has a stable control, the staff gage is readable throughout the full range of flows experienced in a water year, and monthly flow measurements are made to verify the rating table and to determine shifts if necessary; or 6) other device capable of measuring flow within plus or minus five percent (5%).

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that records of the diversions shall be kept on a Standard Form 192 (attached and incorporated as part of this Order) showing the average daily gage height and flow for each day of the water use season. This record keeping requirement does not apply to single families diverting less than 1 cfs for purely domestic purposes.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that diversion records required to be kept by this Order as to all diversions greater than 1 cfs shall be provided to the Bureau of Reclamation weekly, and the Bureau of Reclamation shall provide the records to the Department of Ecology. This reporting requirement does not apply to single families diverting less than 1 cfs for purely domestic purposes.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that an annual summary of diversions shall be provided to the Bureau of Reclamation by November 1 of each year. This reporting requirement does not apply to single families diverting less than 1 cfs for purely domestic purposes.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that all persons/entities with diversions of 2 cubic feet per second (cfs) or more from the Teanaway River or its tributaries or from Big Creek, shall report to the Bureau of Reclamation any changes in diversion quantities, either plus or minus, of 2 cfs or more, by telephoning (509) 575-5848 ext. 219 or (509) 575-5854 (from 8:00 AM to 4:30 PM weekdays and 8:00 AM to 10:00 AM on weekends). Planned diversion changes shall be reported at least 48 hours prior to making said changes. Unplanned diversion changes shall be reported as soon as possible after the change.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that each diversion metering or measuring device shall be located within a minimal distance from the point of diversion from the river/water source; below the fish screen return flow point, if applicable; above the diversion's consumptive use; and above any significant system conveyance loss. The site must be approved by the Department of Ecology and the Bureau of Reclamation.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that in the event that any person/entity who diverts water from the Teanaway River or its tributaries or from Big Creek fails to install an approved metering or measuring device at each diversion point by May 1, 1999, the Department of Ecology shall notify the person/entity that he/she shall install an approved metering or measuring device within one (1) month of the date of the notice. The notice shall be in writing and be posted at the person/entity's point of diversion or personally delivered to the person or any individual who represents the entity. A copy of the notice shall be filed with the Department of Ecology and the Bureau of Reclamation at the agency offices in Yakima.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that any person/entity who fails to comply within one (1) month of the date of the notice shall be considered to be in violation of this Court Order.

The Bureau of Reclamation or the Department of Ecology may request a temporary restraining order or other appropriate relief from this Court against any person/entity who fails to comply with the provisions of this Court Order Re: Metering, Measuring, and Reporting Requirements, or against any diverter who is exceeding the term or limits of his/her water right or diverting water to the injury of senior water right holders, including the Bureau of Reclamation under its leases of instream flow water rights.

IT IS FURTHER ORDERED, ADJUDGED, AND DECREED that Stan Isley shall perform necessary stream patrolman duties for the diversions from Big Creek to ensure compliance with this order and to ensure compliance with the terms and limits of the water rights appurtenant to each diversion. The water rights for the Big Creek diversions are as defined by the

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February 13, 1997, Conditional Final Order for Subbasin No. 2. Big Creek water users may be required to hire a stream patrolman for 1999 and subsequent water years to ensure compliance with this Court Order and with the terms and limits of their water rights, pursuant to a future order of this Court, or pursuant to RCW 90.08.

IT IS FINALLY ORDERED, ADJUDGED, AND DECREED that Stan Isley shall perform necessary monitoring and enforcement duties for the diversions from the Teanaway River Subbasin to ensure compliance with this Court Order and to ensure compliance with the terms and limits of the water rights appurtenant to each diversion. The water rights for the Teanaway River Subbasin diversions are as defined in the June 16, 1921, Amosso Decree and the January 25, 1996, Report of Referee for Subbasin No. 3 (as modified by the upcoming Supplemental Report of Referee for Subbasin No. 3); pending issuance of a Conditional Final Order for the Teanaway River Subbasin No. 3. After a Conditional Final Order is entered for Subbasin No. 3, Teanaway River Subbasin water users may be required to hire a stream patrolman for 1999 and subsequent water years to ensure compliance with this Court Order and with the terms and limits of their water rights, pursuant to a future order of this Court, or pursuant to RCW 90.08.

DONE IN OPEN COURT this 27th day of August, 1998.

Walter A. Stauffacher

THE HONORABLE WALTER A. STAUFFACHER

Presented by:

CHRISTINE O. GREGOIRE
Attorney General

Deborah Mull

ALAN M. REICHMAN, WSBA #23874
Assistant Attorney General
Attorneys for Plaintiff
State of Washington
Department of Ecology
(360) 459-6161

F:\CASES\ARJ\ACQUAVELLA\ORDER PENDENTE LITE TEANAWAY

9-1920 (Rev. Dec. 1994)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
HYDROLOGY
Po Box 1749
Yakima, WA 98907-1749

Diversion Code ____________
Diversion ____________
Water Year ____________

Day	April		May		June		July		August		September		Day
	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	
1													1
2													2
3													3
4													4
5													5
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Quarter			
Fourth			
Third			
Second			
First			
Quarter	Computed	Checked	Date
Fourth			
Third			
Second			
First			
Quarter	Disch. applied	Disch. checked	Date
Fourth			
Third			
Second			
First			
Quarter	G. H. cojd.	G. H. ckhd.	Date

Period
Year

...and must be approved by a hydrologic engineer from Reclamation or Ecology.

9-192-D (Rev. Dec. 1994)

Diversion Code ________

Daily Diversion, in Cubic Feet, per Second, of ______________________________

for the Water Year commencing October 1, 19____ and ending September 30, _____

Gage/meter read to _____ once/twice a day by ______________________________ (Observer)

Phone: ______________

Diversion records (copy of Form 192) shall be provided/mailed weekly to the US Bureau of Reclamation, Yakima Field Office, Hydrology, PO Box 1749, Yakima, WA 98907-1749.

Planned diversion changes of 2 cfs or more shall be reported at least 48 hours prior to making said changes. Unplanned diversion changes of 2 cfs or more shall be reported as soon as possible after the change. Report changes by telephoning (509) 575-5848, ext. 219 (from 8:00 AM to 4:30 PM weekdays and 8:00 AM to 10:00 AM on weekends) or after hours at (509) 575-5854 (leave message on recorder).

Day	October		November		December		January		February		March	
	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
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2												
3												
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25												
26												
27												
28												
29												
30												
31												
Total												
Mean												
Maximum												
Minimum												
Acre-feet												

United States Department of the Interior

BUREAU OF RECLAMATION
Upper Columbia Area Office
1917 Marsh Road
P.O. Box 1749
Yakima, Washington 98907-1749

IN REPLY REFER TO:
UCA-1205
WTR-1.10

SEP 2 1998

Water Users in Subbasins Two and Three
Kittitas County, Washington

Subject: Metering, Measuring and Reporting Requirements, Teanaway River and Big Creek

To All Interested Parties:

The Bureau of Reclamation is enclosing with this letter a copy of the Order Pendente Lite Re: Metering, Measuring and Reporting Requirements, Teanaway River and Big Creek, Kittitas County which was recently signed by the Honorable Walter Stauffacher, the judge presiding over the adjudication, In the Matter of the Determination of the Rights to Use of the Surface Waters of the Yakima River Drainage Basin, otherwise known as State of Washington, Department of Ecology v. James J. Acquavella, No. 77-2-01484, in the Superior Court of the State of Washington for Yakima County.

A copy of the Proposed Order was previously sent to you on June 22, 1998. The relevant provisions of the Final Order are as follows:

1. All persons diverting water from the Teanaway River or its tributaries (Subbasin No. 3) or from Big Creek (within Subbasin No. 2) are required to have in place by May 1, 1999, an approved metering or measuring device.

2. Records of diversions exceeding 1 cfs must be kept on a Standard Form 192, a copy of which is enclosed.

3. Such diversion records shall be provided to the Bureau of Reclamation weekly and the Bureau will, in turn, provide copies to the Department of Ecology. Diversion records must be mailed to the Bureau of Reclamation, Yakima Field Office, Hydrology, PO Box 1749, Yakima, Washington 98907-1749.

4. Those individuals who divert less than 1 cfs and use such water purely for domestic purposes are exempt from these provisions.

5. Stan Isley, an employee of the Department of Ecology, currently on detail to the Bureau of Reclamation, has been authorized to monitor diversions on the lands covered by this Order. Such monitoring requires Mr. Isley to go onto your property for the sole purpose of monitoring diversions. Mr. Isley will be making such visits on a regular basis, somewhere between a week and ten days.

6. If it is found that any individual is exceeding the terms or limits of his or her water right and diverting water to the injury of senior water rights, appropriate action may be taken including action by the Superior Court enjoining such diversions which exceed water rights.

7. Similarly, the failure to install an approved measuring or metering device by May 1, 1999, can also result, after appropriate notice and opportunity of one month to install a device, in an action by the Superior Court.

The Bureau of Reclamation and Mr. Isley appreciate your cooperation and look forward to working with you and answering questions you might have. We plan to continue with the cooperative working relationships we have experienced with local landowners in both Subbasins No. 2 and No. 3, and will work with you to continue successful irrigation as we try to bring the fisheries back together. Mr. Isley can be reached at this office at (509) 575-5848, extension 281. Enclosed is a photocopy of a photograph of Mr. Isley to help you recognize him as he conducts his monitoring inspections.

Sincerely,

James A. Esget

James A. Esget, Manager
Yakima River Basin Water Enhancement Project

Enclosures - 3

cc: The Honorable Walter A. Stauffacher
Yakima County Superior Court
128 N 2nd Street
Yakima WA 98901-2614
(w/copy of SF-192 and photo)

APPENDIX G-1

JUVENILE FISH SCREEN CRITERIA

Developed by
National Marine Fisheries Service
Environmental & Technical Services Division
Portland, Oregon

Revised February 16, 1995

I. GENERAL CONSIDERATIONS:

This document provides guidelines and criteria to be utilized in the development of functional designs of downstream migrant fish passage facilities for hydroelectric, irrigation, and other water withdrawal projects. This material has been prepared by the National Marine Fisheries Service (NMFS) as a direct result of responsibilities for prescribing fishways (including fish screen and bypass systems) under Section 18 of the Federal Power Act, administered by the Federal Energy Regulatory Commission (FERC). This material is also applicable for projects that are undergoing consultation with the NMFS, pursuant to responsibilities for protecting fish under the Endangered Species Act (ESA).

Since these guidelines and criteria are general in nature, there may be cases where site constraints or extenuating circumstances dictate that certain criteria be waived or modified. Conversely, where there is a need to provide additional protection for fish, site-specific criteria may be added. These circumstances will be considered by NMFS on a project-by-project basis. In designing an effective fish screen facility, the swimming ability of the fish is a primary consideration. Research has shown that swimming ability of fish varies and may depend upon a number of factors relating to the physiology of the fish, including species, size, duration of swimming time required, behavioral aspects, migrational stage, physical condition and others, in addition to water quality parameters such as dissolved oxygen concentrations, water temperature, lighting conditions, and others. For this reason, screen criteria must be expressed in general terms.

To minimize risks to anadromous fish at some locations, the NMFS may require investigation (by the project sponsors) of important and poorly defined site-specific variables that are deemed critical to development of the screen and bypass design. This investigation may include factors such as fish behavioral response to hydraulic conditions, weather conditions (ice, wind, flooding, etc.), river stage-discharge relationships, seasonal operational variability, potential for sediment and debris problems, resident fish populations, potential for creating predation opportunity, and other information. The size of salmonids present at a potential screen site usually is not known, and can change from year to year based on flow and temperature conditions. Thus, adequate data to describe the size-time relationship requires substantial sampling efforts over a number of years. The NMFS will assume that fry-sized salmonids and low water temperatures are present at all sites and apply the appropriate criteria listed below, unless adequate biological investigation proves otherwise. The burden-of-proof is the responsibility of the owner of the screen facility.

Proposed facilities which could have particularly significant impacts on fish, and new unproven juvenile fish protection designs, frequently require: 1) development of a biological basis for the concept; 2) demonstration of favorable fish behavioral response in a laboratory setting; 3) an acceptable plan for evaluating the prototype installation; and 4) an acceptable alternate plan developed concurrently for a screen and bypass system satisfying these criteria, should the prototype not adequately protect fish. Additional information on unproven juvenile fish protection devices can be found in "Experimental Fish Guidance Devices," Position Statement of the National Marine Fisheries Service, Northwest Region, January 6, 1995.

Screen and bypass criteria for juvenile salmonids are provided below. Specific exceptions to these criteria occur in the design of small screen and bypass systems (less than 25 cubic feet per second). These are listed in Section K, Modified Criteria for Small Screens.

Striped bass, herring, shad, and other anadromous fish species may have eggs and/or very small fry which are moved with any water current (tides, streamflows, etc.). Installations where these species are present may require special screen and/or bypass facilities, including micro-screens and require individual evaluation of the proposed project. In instances where local regulatory agencies require more stringent screening requirements for species of resident or anadromous fish, the NMFS will generally defer to the more conservative criteria.

II. GENERAL PROCEDURAL GUIDELINES

A functional design should be developed that defines type, location, size, hydraulic capacity, method of operation, and other pertinent juvenile fish screen facility characteristics. In the case of applications to be submitted to the FERC and consultations under the ESA, a functional design for juvenile (and adult) fish passage facilities must be developed and submitted as part of the application. It must reflect the NMFS input and design criteria and be acceptable to the NMFS. Functional design drawings must show all pertinent hydraulic information, including water surface elevations and flows through various areas of the structures. Functional design drawings must show general structural sizes, cross-sectional shapes, and elevations. Types of materials must be identified where they will directly affect fish. The final detailed design shall be based on the functional design, unless changes are agreed to by the NMFS.

All juvenile passage facilities shall be designed to function properly through the full range of hydraulic conditions in the lake, tidal area, or stream and in the diversion, and shall account for debris and sedimentation conditions which may occur.

III. SCREEN CRITERIA FOR JUVENILE SALMONIDS

A. Structure Placement

1. Streams and Rivers:

a. Where physically practical and biologically desirable, the screen shall be constructed at the diversion entrance with the screen face generally parallel to river flow. Physical factors that may preclude screen construction at the diversion entrance include excess river gradient, potential for damage by large debris, and potential for heavy sedimentation. For screens constructed at the bankline, the screen face shall be aligned with the adjacent bankline and the bankline shall be shaped to smoothly match the face of the screen structure to prevent eddies in front, upstream, and downstream of the screen. If trash racks are used, sufficient hydraulic gradient is required to route juvenile fish from between the trash rack and screens to safety.

b. Where installation of fish screens at the diversion entrance is not desirable or impractical, the screens may be installed in the canal downstream of the entrance at a suitable location. All screens installed downstream from the diversion entrance shall be provided with an effective bypass system approved by NMFS, designed to collect juvenile fish and safely transport them back to the river with minimum delay. The angle of the screen to flow should be adequate to effectively guide fish to the bypass (see Section F, Bypass Layout).

2. Lakes, Reservoirs and Tidal areas:

a. Intakes shall be located offshore where feasible to minimize fish contact with the facility. Water velocity from any direction toward the screen shall not exceed allowable approach velocities (see Section B, Approach Velocity). When possible, intakes shall be located in areas with sufficient sweeping velocity to minimize sediment accumulation in or around the screen and to facilitate debris removal and fish movement away from the screen face (see Section C, Sweeping Velocity).

b. If a screened intake is used to route fish past a dam, the intake shall be designed to withdraw water from the most appropriate elevation based on providing the best juvenile fish attraction and appropriate water temperature control downstream of the project. The entire range of forebay fluctuation shall be accommodated in design, unless otherwise approved by the NMFS.

B. Approach Velocity - Definition: Approach velocity is the water velocity component perpendicular to and approximately three inches in front of the screen face.

1. Salmonid fry [less than 2.36 inches {60.0 millimeters (mm)} in length]: The approach velocity shall not exceed 0.40 feet per second (fps) {0.12 meters per second (mps)}.

2. Salmonid fingerling {2.36 inches (60.0 mm) and longer}: The approach velocity shall not exceed 0.80 fps (0.24 mps).

3. The total submerged screen area required (excluding area affected by structural components) is calculated by dividing the maximum diverted flow by the allowable approach velocity (also see Section K, Modified Criteria for Small Screens).

4. The screen design must provide for uniform flow distribution over the screen surface, thereby minimizing approach velocity. This may be accomplished by providing adjustable porosity control on the downstream side of screens, unless it can be shown unequivocally (such as with a physical hydraulic model study) that localized areas of high velocity can be avoided at all flows.

C. Sweeping Velocity - Definition: Sweeping velocity is the water velocity component parallel and adjacent to the screen face.

1. Sweeping velocity shall be greater than the approach velocity. This is accomplished by angling the screen face at less than 45 degrees; relative to flow (also see Section K, Modified Criteria for Small Screens). This angle may be dictated by site specific canal geometry, hydraulic, and sediment conditions.

D. Screen Face Material

1. Fry criteria - If biological justification can not be provided to demonstrate the absence of fry-sized salmonids {less than 2.36 inches (60.0 mm)} in the vicinity of the diversion intake leading to the screen, fry will be assumed present and the following criteria apply for screen material:

a. Perforated plate: Screen openings shall not exceed 3/32 or 0.0938 inches (2.38 mm).

b. Profile bar screen: The narrowest dimension in the screen openings shall not exceed 0.0689 inches (1.75 mm) in the narrow direction.

c. Woven wire screen: Screen openings shall not exceed 3/32 or 0.0938 inches (2.38 mm) in the narrow direction (example: 6-14 mesh).

d. Screen material shall provide a minimum of 27% open area.

2. Fingerling criteria - If biological justification can be provided to demonstrate the absence of fry-sized salmonids {less than 2.36 inches (60.0 mm)} in the vicinity of the diversion intake leading to the screen, the following criteria apply for screen material:

a. Perforated plate: Screen openings shall not exceed 1/4 or 0.25 inches (6.35 mm).

b. Profile bar screen: The narrowest dimension in the screen openings shall not exceed 1/4 or 0.25 inches (6.35 mm) in the narrow direction.

c. Woven wire screen: Screen openings shall not exceed 1/4 or 0.25 inches (6.35 mm) in the narrow direction.

d. Screen material shall provide a minimum of 40% open area.

3. The screen material shall be corrosion resistant and sufficiently durable to maintain a smooth uniform surface with long term use.

E. Civil Works and Structural Features

1. The face of all screen surfaces shall be placed flush (to the extent possible) with any adjacent screen bay, pier noses, and walls to allow fish unimpeded movement parallel to the screen face and ready access to bypass routes.

2. Structural features shall be provided to protect the integrity of the fish screens from large debris. Provision of a trash rack, log boom, sediment sluice, and other measures may be needed. A reliable, ongoing preventative maintenance and repair program is necessary to assure facilities are kept free of debris and that screen mesh, seals, drive units, and other components are functioning correctly.

3. Screen surfaces shall be constructed at an angle to the approaching flow, with the downstream end of the screen terminating at the entrance to the bypass system.

4. The civil works shall be designed in a manner that eliminates undesirable hydraulic effects (such as eddies and stagnant flow zones) that may delay or injure fish or provide predator habitat or predator access. Upstream training wall(s), or some acceptable variation thereof, shall be utilized to control hydraulic conditions and define the angle of flow to the screen face. Large facilities may require hydraulic modeling to identify and correct areas of concern.

F. Bypass Layout

1. The screen and bypass shall work in tandem to move out-migrating salmonids (including adults) to the bypass outfall with a minimum of injury or delay. The bypass entrance shall be located so that it can easily be located by out-migrants. Screens placed in diversions shall be constructed with the downstream end of the screen terminating at a bypass entrance. Multiple bypass entrances (intermediate bypasses) shall be employed if the sweeping velocity will not move fish to the bypass within 60 seconds, assuming fish are transported at this velocity.

2. The bypass entrance and all components of the bypass system shall be of sufficient size and hydraulic capacity to minimize the potential for debris blockage.

3. In order to improve bypass collection efficiency for a single bank of vertically-oriented screens, a bypass training wall shall be located at an angle to the screens, with the bypass entrance at the apex and downstream-most point. This will aid fish movement into the bypass by creating hydraulic conditions that conform to observed fish behavior. For single or multiple vee screen configurations, training walls are not required, unless a intermediate bypass is used (see Section F, Bypass Layout, Part 1).

4. In cases where there is insufficient flow available to satisfy hydraulic requirements at the bypass entrance (entrances) for the main screens, a secondary screen may be required. This is a screen located in the main screen bypass which allows the prescribed bypass flow to be used to effectively attract fish into the bypass entrance(s) and then allow for all but a reduced residual bypass flow to be routed back (by pump or gravity) for the primary diversion use. The residual bypass flow (not passing through the secondary screen) would then convey fish to the bypass outfall location or other destination.

5. Access is required at locations in the bypass system where debris accumulations may occur.

6. The screen civil works floor shall be designed to allow fish to be routed back to the river safely, if the canal is dewatered. This may entail a sumped drain with a small gate and drain pipe, or similar provisions.

G. Bypass Entrance

1. Each bypass entrance shall be provided with independent flow-control capability, acceptable to NMFS.

2. The minimum bypass entrance flow velocity must be greater than or equal to the maximum flow velocity vector resultant upstream of the screens. A gradual and efficient acceleration of flow into the bypass entrance is required to minimize delay by out-migrants.

3. Ambient lighting conditions are required at, and inside of, the bypass entrance and should extend downstream to the bypass flow control.

4. The bypass entrance must extend from the floor to the canal water surface.

H. Bypass Conduit Design

1. Bypass pipes shall have smooth surfaces and be designed to provide conditions that minimize turbulence. Bypass conduits shall have a smooth joint design to minimize turbulence and the potential for fish injury and shall be satisfactory to the NMFS.

2. Fish shall not be pumped within the bypass system.

3. Fish shall not be allowed to free-fall within a confined shaft in a bypass system.

4. Pressures in the bypass pipe shall be equal to or above atmospheric pressures.

5. Bends shall be avoided in the layout of bypass pipes due to the potential for debris clogging. Bypass pipe center-line radius of curvature (R/D) shall be greater than or equal to 5. Greater R/D may be required for super-critical velocities.

6. Bypass pipes or open channels shall be designed to minimize debris clogging and sediment deposition and to facilitate cleaning as necessary. Therefore, the required pipe diameter shall be greater than or equal to 24 inches {0.610 meters (m)}, and pipe velocity shall be greater than 2.0 fps (0.610 mps), unless otherwise approved by the NMFS, for the entire operational range (also see Section K, Modified Criteria for Small Screens, Part 4).

7. Closure valves of any type are not allowed within the bypass pipe, unless approved by NMFS.

8. The minimum depth of open-channel flow in a bypass conduit shall be greater than or equal to 0.75 feet (0.23 m), unless otherwise approved by the NMFS (also see Section K, Modified Criteria for Small Screens, Part 5).

9. Sampling facilities installed in the bypass conduit shall not impair normal operation of the facility.

10. The bypass pipe hydraulics should not produce a hydraulic jump within the pipe.

I. Bypass Outfall

1. Bypass outfalls should be located such that ambient river velocities are greater than 4.0 fps (1.2 mps).

2. Bypass outfalls shall be located to minimize avian and aquatic predation in areas free of eddies, reverse flow, or known predator habitat.

3. Bypass outfalls shall be located where the receiving water is of sufficient depth (depending on the impact velocity and quantity of bypass flow) to ensure that fish injuries are avoided at all river and bypass flows.

4. Maximum bypass outfall impact velocity (including vertical and horizontal velocity components) shall be less than 25.0 fps (7.6 mps).

5. The bypass outfall discharge into tailrace shall be designed to avoid adult attraction or jumping injuries.

J. Operations and Maintenance

1. Fish screens shall be automatically cleaned as frequently as necessary to prevent accumulation of debris. The cleaning system and protocol must be effective, reliable, and satisfactory to the NMFS. Proven cleaning technologies are preferred.

2. Open channel intakes shall include a trash rack in the screen facility design which shall be kept free of debris. In certain cases, a satisfactory profile bar screen design can substitute for a trash rack.

3. The head differential to trigger screen cleaning for intermittent type cleaning systems shall be a maximum of 0.1 feet (0.03 m) or as agreed to by the NMFS.

4. The completed screen and bypass facility shall be made available for inspection by NMFS, to verify compliance with the design and operational criteria.

5. Screen and bypass facilities shall be evaluated for biological effectiveness and to verify that hydraulic design objectives are achieved.

K. Modified Criteria for Small Screens (Diversion flow less than 25 cfs)

The following criteria vary from the criteria listed above and apply to smaller screens. Twenty-five cfs is an approximate cutoff; however, some smaller diversions may be required to apply more universal criteria listed above, while some larger diversions may be allowed to use the "small screen" criteria listed below. This will depend on site constraints.

1. The screen area required is shown in Section B, Approach Velocity, Parts 1, 2 and 3. Note that "maximum" applies to the greatest flow diverted, not necessarily the water right.

2. Screen orientation:

a. For screen lengths less than or equal to 4 feet, screen orientation may be angled or perpendicular relative to flow.

b. For screen lengths greater than 4 feet, screen-to-flow angles must be less than or equal to 45 degrees (see Section C, Sweeping Velocity, Part 1).

c. For drum screens, the design submergence shall be 75% of drum diameter. Submergence shall not exceed 85%, nor be less than 65% of drum diameter.

3. The minimum bypass pipe diameter shall be 10 inches, unless otherwise approved by NMFS.

4. The minimum allowable pipe depth is 0.15 feet (1.8 inches or 4.6 cm) and is controlled by designing the pipe gradient for minimum bypass flow.

Questions concerning this document can be directed to NMFS Environmental and Technical Services Division Engineering staff, at 503-230-5400.

Adopted,

William Stelle, Jr. Date
Regional Director

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
Screening Requirements For Water Diversions

Washington State Laws (RCW 77.16.220; RCW 77.55.040 (formerly RCW 75.20.040), RCW 77.55.070 (formerly RCW 75.20.061)) require all diversions from waters of the state to be screened to protect fish.

These laws and the following design criteria are essential for the protection of fish at surface water diversions. Fish drawn into hydropower, irrigation, water supply, and other diversions are usually lost from the fish resources of the state of Washington.

The following criteria are based on the philosophy of physically excluding fish from being entrained in water diverted without becoming impinged on the diversion screen. The approach velocity and screen mesh opening criteria are based upon the swimming stamina of emergent size fry in low water temperature conditions. It is recognized that there may be locations at which design for these conditions may not be warranted. Unless conclusive data from studies acceptable to Washington Department of Fish and Wildlife indicate otherwise, it is assumed that these extreme conditions exist at some time of the year at all screen sites.

Additional criteria may be required for unique situations, large facilities or intakes within marine waters.

I. Screen Location and Orientation

A. Fish screens in rivers and streams shall be constructed within the flowing stream at the point of diversion and parallel to the stream flow. The screen face shall be continuous with the adjacent bankline. A smooth transition between the screen and bankline shall be provided to prevent eddies in front, upstream and downstream of the screen.

   Where it can be thoroughly demonstrated that flow characteristics or site conditions make construction or operation of fish screens at the diversion entrance impractical, the screens may be installed in the canal downstream of the diversion.

B. Diversion intakes in lakes and reservoirs shall be located offshore in deep water to minimize the exposure of juvenile fish to the screen. Salmon and trout fry generally inhabit shallow water areas near shore.

C. Screens constructed in canals and ditches shall be located as close as practical to the diversion. They shall be oriented so the angle between the face of the screen and the approaching flow is no more than 45. All screens constructed downstream of the diversion shall be provided with an efficient bypass system.

II. Approach Velocity

The approach velocity is defined as the component of the local water velocity vector perpendicular to the face of the screen. Juvenile fish must be able to swim at a speed equal or greater than the approach velocity for an extended length of time to avoid impingement on the screen. The following approach velocity criteria are maximum velocities that shall not be exceeded anywhere on the face of the screen. A maximum approach velocity of 0.4 feet per second is allowed.

The approach velocity is calculated based on the gross screen area not the net open area of the screen mesh.

The intake structure and/or fish screen shall be designed to assure that the diverted flow is uniformly distributed through the screen so the maximum approach velocity is not exceeded.

III. Minimum Screen Area

The minimum required screen area is determined by dividing the maximum diverted flow by the maximum allowable approach velocity. To find the screen area in square feet, divide the diverted flow in cubic feet per second (450 gpm = 1.0 cubic foot per second) by the approach velocity 0.4 feet per second):

$$\text{Minimum Screen Area} = \frac{\text{Diverted Flow (cubic feet /second)}}{\text{Approach Velocity (feet per second)}}$$

The minimum required screen area must be submerged during lowest stream flows and may not include any area that is blocked by screen guides or structural members.

Diversions less than or equal to 180 gallons/minute (0.4 cfs) require a minimum submerged screen area of 1.0 square foot, which is the smallest practical screening device.

IV. Sweeping Velocity

The sweeping velocity is defined as the component of the water velocity vector parallel to and immediately upstream of the screen surface. The sweeping velocity shall equal or exceed the maximum allowable approach velocity. The sweeping velocity requirement is satisfied by a combination of proper orientation (angle of screen 45 to the approaching flow) of the screen relative to the approaching flow and adequate bypass flow.

Screen bay piers or walls adjacent to the screen face shall be flush with screen surfaces so the sweeping velocity is not impeded.

V. Screen Mesh Size, Shape, and Type of Material

Screen openings may be round, square, rectangular, or any combination thereof, provided structural integrity and cleaning operations are not impaired.

Screen mesh criteria is based on the assumption that steelhead and/or resident trout fry are ubiquitous in the state of Washington and will be present at all diversion sites.

Following are the maximum screen openings allowable for emergent salmonid fry. The maximum opening applies to the entire screen structure including the screen mesh, guides, and seals. The profile bar criteria is applied to the narrow dimension of rectangular slots or mesh.

Woven Wire Mesh	Profile Bar	Perforated Plate
0.087 inch (6-14 mesh)	1.75 mm (0.069 inch)	0.094 inch (3/32 inch)

The allowable woven wire mesh openings is the greatest open space distance between mesh wires. An example allowable mesh specifications is provided; there are other standard allowable openings available. The mesh specification gives the number of mesh openings per lineal inch followed by the gauge of the wires. For example, 6-14 mesh has six mesh openings per inch of screen. It is constructed with 6, 14-gauge (0.080 inch diameter) wires per inch.

The profile bar openings are the maximum allowable space between bars. The allowable perforated plate openings are the diameter of circular perforations. Perforated slots are treated as profile bars.

Screens may be constructed of any durable material; woven, welded, or perforated. The screen material must be resistant to corrosion and ultraviolet damage.

For longevity and durability, minimum wire diameter for woven mesh shall be 0.060 inch (18 gauge) on fixed panel screens, where they are not subjected to impact of debris. Minimum wire diameter for woven mesh shall be 0.080 inch (14 gauge) for rotary drum screens, traveling belt screens, and in areas where there is a potential for damage from floating debris or cleaning operations.

VI. Bypass

All screens constructed downstream of the diversion shall be provided with an efficient bypass system to rapidly collect juvenile fish and safely transport them back to the river. The downstream end of the screen shall terminate at the entrance to the bypass system. It is the water diversion owner's responsibility to obtain necessary water rights to operate the fish bypass; failure to do so may be considered failure to meet state screening law requirements.

VII. Cleaning

Fish screens shall be cleaned as frequently as necessary to prevent obstruction of flow and violation of the approach velocity criterion. Automatic cleaning devices will be required on large screen facilities.

Additional detailed information is available explaining the background and justification of these criteria and showing standard details of flow distributors, acceptable bypass designs, and screen areas required for various flows.

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Partial List of Research Projects in Yakima Basin

8/2000

Washington Department of Fish and Wildlife (Pearson's Group)
Long-term monitoring of multiple species
Lower river predator studies
Competition for space and food among species in the upper Yakima
Behavior interactions - dominance relationships among spring chinook and other species
Percocialism and residualism in spring chinook
Impacts of gravel pit mines on fishes
Effects of nutrient additions (salmon carcass analogues) on fishes (proposed)

WDFW studies (Easterbrook group)

- spawning surveys for several species
- monitor catch rates for various species
- conducting fish surveys in the drains

State Salmon board Projects - limiting factors analysis

Ecology

- water quality studies
- fish tissue study in upper Yakima
- water quality study in Granger Drain
- Teanaway temperature and TMDL study
- metals assessment in the upper Yakima River
- sediment studies in the Upper Yakima basin
- water quality studies in the lower river

SOAC

- application of RVA for Yakima River
- EDT model
- studies to investigate appropriate spawning and incubation flow
- studies related to fish issues and maintenance activities at Roza and Chandler

Yakima-Klickitat Fisheries Program (Natural Production/Genetics/Harvest/Eco Interactions)
Ecosystem Diagnosis and Treatment modeling effort
Yakima River fall chinook fry survival study
Yakima River coho life history study
Yakima River juvenile spring chinook microhabitat utilization study (monitor carry capacity)
Juvenile wild/hatchery pit spring chinook PIT tag study to estimate wild and hatchery survivals
Yakima River fall chinook optimal raring treatment
Yakima River coho optimal stock, temporal, and geographic
Yakima spring chinook juvenile behavior

Yakima spring chinook juvenile morphomentric/coloration
Yakima spring chinook smolt physiology
Adult salmonid enumeration at Prosser
Adult salmonid enumeration and broodstock collection at Roza and Cowiche Dams
Spawning ground surveys (redd counts)
Yakima spring chinook spawning behavior observations
Yakima spring chinook residual/precocials studies
Yakima River relative hatchery/wild spring chinook and coho reproductive success
Yakima spring chinook gamete quality monitoring
Scale analysis
Fish health monitoring
Habitat monitoring lights and ground truthing
Out-of-basin environmental monitoring
Trophic enhancement research
Sediment impacts on habitat
Predator avoidance training
Population viability analysis for all YKFP target stocks
Allozyme/DNA data collection and analysis
Stray recovery on Naches and American River spawning grounds
Avian predation index
Fish predation index
coho/chinook predation study
Indirect predation
Yakima River spring chinook competition/prey index
Upper Yakima spring chinook non target taxa monitoring
Pathogen sampling

Other YN research

- Toppenish and Satus Creeks
- Habitat coordination efforts (restoring rearing habitat by dike breaching, installing screens, etc.) Scott Nicolai

USFWS

- working throughout basin with various entities
- developing survey protocols for bull trout

USGS

- NAWQA study (various water quality studies focusing on pesticides)
- fall chinook spawning study

Forest Service studies

- routine spawning and fish distribution studies
- genetic studies on rainbow trout and cutthroat trout
- water temperature monitoring in both upper Yakima and Naches, including the Teanaway, Taneum, Manastash, Cle Elum, Swauk, Box canyon
- sediment monitoring
- culvert passage inventories

Reclamation

Synthesis (Stanford/Esget/YRBWEP)
Reaches study (Stanford/Esget/YRBWEP)
Pumping plant studies (Stanford/Croci/Esget/YRBWEP)
Wapatox studies (Stanford/Croci/Esget/YRBWEP)
Gold Creek Study (Didrickson/Puckett/ESA)
Incubation flow study (Bowen/Larrick/UCAO)
Population status/life history of bull trout (James/Puckett/ESA)
Clear Creek Ladder Evaluation (Harza/Larrick/ESA)
Limnology studies (Hiebert/Puckett/ESA)
Non salmonid fish surveys (Karp/Puckett/UCAO)
Rimrock entrainment study (Hiebert/Larrick/ESA)
Steelhead spawning distribution study above Roza (Karp/Larrick/ESA) (Proposed)
Bull trout surveys - Easton - Keechelus and above Cle Elum (FWS-Thomas/Croci/ Kaumheimer/ ESA)
Survey of habitat above Keechelus Dam)FWS-Thomas/Kaumheimer/Keechelus SOD)
Topographic/ortho-photo data collection in Yakima basin (Sharp/Young/UCAO) (proposed)

Central Washington University

- mapping studies with Stanford
- various fish studies; Paul James and others

Districts

- temperature monitoring/modeling
- water quality monitoring

Various other entities

Kittitas Conservation District - various land use mapping activities