Draft Report

Preliminary Integrated Water Resource Management Plan for the Yakima River Basin

Yakima Project
Washington

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Bureau of Reclamation
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Department of Ecology
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Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The mission of the Department of Ecology is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations

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1 Introduction and Purpose

The Bureau of Reclamation (Reclamation) and Washington State Department of Ecology (Ecology) convened the Yakima River Basin Water Enhancement Project (YRBWEP) 2009 Workgroup to develop a recommendation for advancing a preliminary Integrated Water Resource Management Plan (IWRMP) to restore fisheries and improve water supply in the Yakima basin. The Workgroup has developed the general outline of a preliminary IWRMP and narrowed down a list of potential actions for further study and evaluation.

The 2009 Workgroup is composed of representatives of the Yakama Nation; Federal, Washington state and local governments; an environmental organization; and irrigation districts. Staff representing the state's Congressional delegation has also attended to observe Workgroup discussions. All meetings have been open to the public with opportunities for public input. A list of the Workgroup membership and organizations represented is provided in Attachment A.

1.1 Previous YRBWEP Activities and More Recent Studies

The Workgroup activities build on previous state and federal YRBWEP feasibility study activities. YRBWEP was initiated by Congress in 1979 with the following objectives: develop a plan that would provide 1) supplemental water for presently irrigated lands, 2) water for new lands within the Yakama Indian Reservation, 3) water for increased instream flows for aquatic life, and 4) a comprehensive plan for efficient management of basin water supplies.

Initial efforts in the mid-1980s (Phase 1) focused on improving fish passage by rebuilding fish ladders and constructing fish screens at existing diversions. Phase 2 in the 1990s focused on water conservation/water acquisition activities and tributary fish screens, and long-term management needs. Efforts under these earlier phases were hindered by the ongoing uncertainties associated with adjudication of the basin surface waters that began in 1978. With the adjudication process now largely completed, most of these water-right uncertainties have been addressed.

More recently, additional studies have been conducted to evaluate potential solutions to meet long-term basin water resource needs. In 2003, Reclamation and Ecology initiated the Yakima River Basin Water Storage Feasibility Study to examine the feasibility and acceptability of storage augmentation in the Yakima River basin. Evaluation of the Black Rock Dam Alternative, along with other storage alternatives, was presented in Reclamation's Final Planning Report/Environmental Impact Statement in December 2008.

Narrowly focused legislation and comments on the Storage Study DEIS prompted Ecology to separate from the federal process. In mid-2008, Ecology began a separate evaluation of solutions to the Yakima basin's water supply problems, including consideration of habitat and fish passage needs. This study was completed and a Final Environmental Impact Statement (FEIS) issued in June 2009. The FEIS proposed an Integrated Water Resource Management Alternative using a range of water management and habitat improvement approaches comprised of seven major elements to resolve long-standing water resource problems in the basin. The following are the seven elements from the FEIS: reservoir fish passage, structural/operational changes, surface storage, groundwater storage, fish habitat enhancements, enhanced water conservation, and market based reallocation of water resources. This alternative is the framework or outline for the YRBWEP Workgroup's deliberations and recommendations.

The Workgroup has considered much of the information developed from these 30+ years of studies and evaluations in conducting its work and developing its recommendations. A more complete listing of these sources is provided at the Reclamation website: http://www.usbr.gov/pn/programs/yrbwep/index.html.

1.2 Workgroup Efforts and Recommendation

The Workgroup has articulated a bold, far-reaching set of potential investments that would affect the entire Yakima Basin. The preliminary IWRMP would:

- Be one of the most comprehensive ecological restorations in the United States
- Provide supply reliability to irrigators from varied drought effects
- Provide an economic stimulus to the Yakima Basin that would benefit the entire Central Washington area
- Improve the ability of water managers to respond to climate changes, as the Yakima Basin is heavily dependent on snowpack for meeting in and out of stream water supply needs.

The Workgroup held 12 days of meetings from June through December 2009 to review elements of the preliminary IWRMP and develop their recommendation. The group formed two subcommittees, the fish passage subcommittee and habitat enhancement subcommittee, which met several times to develop recommendations on reservoir fish passage and habitat enhancement actions and projects. Subcommittee input has been incorporated into the Workgroup recommendation.

The Workgroup developed a consensus recommendation as follows: (subject to final action by the group).

The YRBWEP 2009 Workgroup finds that the elements and actions outlined below merit further analysis and evaluation as the Workgroup continues its work to identify a final package of actions for IWRMP inclusion that would provide water for irrigated agriculture and future municipal needs, and improve habitat for anadromous and resident fish.

Water Supply

1. Programs and policies (e.g., mandatory adoption of conservation and efficiency BMPs) to reduce water demand through extensive water conservation and efficiency measures for agricultural and municipal water users, as well as for residential water users not connected to a municipal delivery system.
2. Additional water supply through a suite of at least some of the following actions: Wymer Dam, Cle Elum Dam (Pool Raise), Kachess Reservoir (Inactive Storage), enlarged Bumping Reservoir, and direct pumping from the Columbia River with (or without) storage (e.g. Wymer, Burbank and Selah Creek locations). Explore possibilities for additional power generation opportunities. Provide for a tributary enhancement project such as the Ahtanum Creek Watershed Restoration Program, including a Pine Hollow Reservoir Project.
3. Groundwater storage including infiltration prior to storage control (or whenever feasible in light of fish and irrigation needs) and municipal aquifer storage and recovery, including transfer of agricultural water to municipalities for aquifer storage and recovery (ASR), and improved monitoring, management, and mitigation of permit exempt wells.
4. Market-based reallocation of water rights through a water market and modification of existing laws and regulations, as necessary.

Modifications to Existing Operations

5. Modification of existing facilities and operations including completion of the Wapatox canal piping, subordination of some or all of the Roza and Chandler power plants for fish flows during spring (and/or removal of the Roza Diversion dam and power plant), and improvement of the Kittitas Reclamation District canals through measures, including piping, to improve flow in tributaries.

Fish Passage

6. Fish passage at all six Yakima Project reservoirs

Habitat Enhancement

7. Habitat enhancement program addressing reach-level floodplain restoration priorities and tributaries with emphasis on passage and screening and upper and middle Yakima tributaries restoration. Will include analysis and identification of a plan to provide tributary passage for fish and key long-term protections for habitat utilizing federal, state and local legal or policy tools and funding sources to protect important river reaches, potentially in coordination with land and water trusts.

As part of this analysis and evaluation, we recommend:

- Testing assumptions regarding in and out of stream water needs to be met by an IWRMP.
- Improving cost estimates for actions receiving further analysis and evaluation. Actions should be able to be compared on a same cost-basis.
- Improving understanding of the joint effects of the various projects alone and in combination with potential packages of actions drawn from other elements receiving further study. Utilize a scorecard to display benefits and costs for all elements in the IWRMP, including quantifying fish escapement numbers. Include in the scorecard the "bookends": doing nothing and Black Rock reservoir.
- Identify, evaluate, and recommend project mitigation strategies for affected habitats, impacts to operating costs (e.g. power subordination), or other project-specific effects requiring mitigation.

The Workgroup recommends it continue to meet in 2010 at key milestones to provide input as these further evaluations are carried out.

Efforts will continue in 2010 with the Yakima River Basin Study, when more detailed evaluation of the actions and projects in the preliminary IWRMP will be further evaluated, leading to a recommended final IWRMP and implementation approach that will be used to seek authorization and funding. It is expected that during this process some of the current recommended projects may be revised or deleted and new projects may be added. The Workgroup identified the following key concepts for promoting a preliminary plan:

- The IWRMP includes benefits for all involved interests.
- The IWRMP projects are interrelated: therefore, individual pieces cannot be removed without compromising desired outcomes.
- The IWRMP needs to be adaptable and flexible to accommodate future unknowns, such as climate change or population growth.

- The IWRMP needs to address funding, including local participation.

1.3 Document Organization

The remainder of this document is organized as follows:

- Section 2 summarizes the water resources problems that prompted development of the preliminary IWRMP.
- Section 3 describes the IWRMP as currently envisioned: project summaries; water supply, flow, habitat and other benefits; adaptive management considerations; and available cost information.
- Section 4 describes the Yakima River Basin Study Summary Plan of Study and schedule.

2 Water Resources Needs in the Yakima Basin

The Yakima River Basin is affected by a variety of water resource problems that affect agriculture, anadromous and resident fish, and municipal and domestic water supply. Ecology's FEIS listed the following factors contributing to water resource problems in the basin:

- Demand for irrigation water cannot always be met in years with below-average runoff, leading to reduced (prorationed) irrigation water for junior water-rights holders in drought years.
- Farming and related income are reduced in dry years.
- Dams and other obstructions block fish passage to upstream tributaries and spawning grounds.
- Diking, channelization, wetland draining, gravel mining, and road construction have prevented proper floodplain functions.
- Riparian habitat has been degraded by past and present land-use practices.
- In most years, spring flows in the middle and lower Yakima River are not sufficient to optimize survival of outmigrating smolts.
- In most years, summer flows in the Wapato reach and immediately downstream from Prosser Diversion Dam to Chandler Power Plant are too low to maintain riparian function.
- Unnaturally high summer flows persist in the upper Yakima and Cle Elum rivers, impacting rearing habitat for juvenile salmonids.
- The annual late summer river operation disrupts salmonid habitat and has negative impacts on aquatic insect populations.

- Winter flows in the upper Yakima and Cle Elum rivers are low and controlled for water storage, potentially impacting the survival of overwintering juvenile salmonids.
- Water rights in most of the basin are fully appropriated, making it difficult to acquire water rights to meet future municipal and domestic water demand.
- Pumping groundwater for irrigation and municipal uses may reduce surface-water flows in some locations, which may affect existing water rights.
- The potential for hydraulic continuity between groundwater and surface water in the basin creates uncertainty over the status of groundwater rights and exempt wells within the basin's appropriated water rights system (first in time, first in right), potentially making groundwater use junior to nearly all surface-water use.

The Yakima River historically supported large runs of anadromous salmonids, estimated to be 300,000 to 960,000 fish a year in the 1880s. Those numbers have declined drastically, and three salmon species were extirpated from the basin – sockeye, summer Chinook, and coho; however, reintroduction efforts by the Yakama Nation have established natural and hatchery populations for these species throughout a large portion of the basin. The causes for the declines and extirpations are many, including the following:

- In the 1900s, crib dams on the four natural glacial lakes contributed to the extirpation of sockeye.
- Construction of Reclamation's five storage dams eliminated access to previously productive spawning and rearing habitat for spring Chinook, coho salmon, steelhead, and resident fish populations, especially bull trout.
- Irrigation operations have altered streamflows, resulting in flows at certain times of the year that are too high in some reaches and too low in others to provide good fish habitat.
- Land development, including road construction, diking, gravel mining, and agriculture has degraded riparian habitat and increased sediment in streams and rivers.
- Irrigation diversions have reduced flows and created fish passage barriers in tributary streams.

On the water-supply side, shortages in drought years lead to reductions in water available for proratable irrigators. Over half of the surface-water entitlements in the basin are pro-ratable under a 1945 Consent Decree, including all of the surface water supply for Roza Irrigation District and Kittitas Reclamation District, over half of the Yakama Nation's Wapato Irrigation Project, a large share of the Sunnyside Division, and many irrigation

water-right holders. Hydrologic modeling performed by Reclamation for the Final Planning Report/EIS (2008) indicated that proratable users received 40 percent or less of their normal supplies in 1994 (28 percent), 2001 (40 percent), and 2005 (38 percent). There is a concern that climate change will further reduce available supplies and increase the frequency of drought conditions and multiple-year droughts, like the one in 1992-1994. In addition to economic losses, droughts limit the crops that can be grown and cause conflicts over water use for growth and development in the basin because proratable entitlements for surface water predate newer urban and domestic needs and water rights.

The purpose of an integrated approach to resolving these water problems is to provide both environmental and economic sustainability in the basin. Ecology's FEIS describes the benefits of an integrated plan, as provided below:

> *Implementing the different elements of the Integrated Water Resource Management Alternative as a total package is intended to result in greater benefits than implementing any one element alone. Many studies have indicated that ecosystem-level resource management provides greater opportunities for efficiency, synergy, and cooperation between stakeholders which then result in greater overall benefits. For example, providing fish passage at existing reservoirs will open up new habitat for fish, which would benefit fish populations. By also implementing fish habitat improvements and improving flows basin-wide through additional storage and other actions, fish would have improved conditions for survival generally, contributing to increased abundance and productivity. If fish habitat enhancements are implemented without providing fish passage at existing reservoirs and improving flows, the habitat enhancements would have more limited benefits to fish.*
>
> *New storage projects will provide water to reduce proration of irrigators and help meet future municipal needs. It may also provide additional flows for fish and allow existing reservoir operations to be modified to benefit fish. Enhanced water conservation would provide opportunities to reduce water demand and improve water supply. Market-based reallocation of water resources would provide flexibility to meet the water needs of fish, irrigators, and especially domestic water users. These combined elements may improve the reliability of water supply in drought years and reduce the amount of new storage needed. Ground water storage presents an opportunity to develop storage without the traditional impacts associated with above-ground storage.*

An integrated approach that contains water storage and facility improvement projects that also meet fish management needs will have the highest likelihood of implementation and success over the long-term. The combined elements presented in this Integrated Water Resource Management Alternative would provide Yakima River basin water and fish managers as well as water users the variety of tools needed to meet their water supply needs and significantly improve conditions for fish.

3 Preliminary Integrated Water Resource Management Plan

3.1 Preliminary IWRMP Projects and Actions Summary

The Workgroup has reviewed seven elements (reservoir fish passage, structural/ operational changes, surface storage, groundwater storage, fish habitat enhancements, enhanced water conservation, and market based reallocation of water resources) and specific projects and actions for further consideration and evaluation in 2010. The Workgroup also identified a programmatic approach for agricultural conservation, floodplain restoration, and tributary habitat enhancements. A summary of the preliminary IWRMP actions is provided below and a more detailed description of each action is provided in Attachment B.

The preliminary IWRMP has been organized into two phases: Phase I is for the first 10 years of implementation and Phase II is for years 11 to 30+.

3.1.1 Phase I Projects (Near-term: 0 to 10 Years)

Phase I is for the first 10 years of implementation. Projects and actions were included in this phase based on readiness to proceed, cost-effectiveness, a desire to maximize supply and flow benefits from efficiencies in existing supplies, a preference for developing inbasin storage first, and other factors. Actions and projects from all seven elements are implemented in Phase I. Additionally, evaluations are specified for several projects.

Reservoir Fish Passage

- **Fish Passage at Cle Elum, Bumping, and Clear Lake[1] Dams** – Install upstream and downstream passage for fish.

Structural/Operational Changes

- **Conveyance Improvements at Wapatox** – Modify the conveyance to reduce water needed to convey irrigation water.

[1] Provide for upstream bull trout passage only.

- **Subordinate Power at Roza Dam**[2] – Reduce or eliminate flows diverted from Roza Dam March through May to supply Roza Powerplant during smolt migration. May also need to replace power for Roza pumping if Bonneville Power Administration (BPA) determines power generation is no longer economically viable.
- **Subordinate Power at Chandler** – Reduce or eliminate flows diverted from Prosser Dam from March through May to supply Chandler Powerplant during smolt migration. May also need to replace power for Kennewick Irrigation District (KID) pumping if BPA determines power generation is no longer economically viable.
- **Modifications to Kittitas Reclamation District (KRD) Main Canal and South Branch** – Replace open laterals on the Main Canal and South Branch Canal with pressurized pipe systems to allow water discharge directly to tributary creeks or to supply water users currently diverting from tributary creeks.
- **Cle Elum Dam Pool Raise** – Raise Cle Elum Reservoir 3 feet by modifying the spillway gates. Use additional supply (approximately 15 thousand acre feet [kaf]) to enhance instream flows.
- **Keechelus-to-Kachess Pipeline** – Transfer water from Keechelus Reservoir to Kachess Reservoir through approximately 5 miles of pipeline.

Surface Storage

- **Wymer Reservoir** –162-kaf off-channel reservoir on Lmuma Creek, filled by a pump station located at the dam and/or near Thorp with a canal/pipeline around Kittitas Valley, including power generation.
- **Bumping Reservoir Enlargement –** Replace existing Bumping Reservoir Dam with an enlarge dam to impound 160- to 190-kaf.
- **Reservoir Inactive Storage** – Extract up to 100 kaf of inactive storage from one existing reservoir during drought years.

Groundwater Storage

- **Municipal Aquifer Storage and Recovery** – Inject treated water to replace current surface-water diversions.
- **Groundwater Infiltration Prior to Storage Control** – Use stored water in the winter and early spring (prior to "storage control") to recharge groundwater

[2] Roza Roller Gate project is not included because it is currently being implemented. This project may also help reduce a portion of the smolt outmigration flow need that would be met through subordination.

aquifers. Water would be conveyed to recharge locations using existing canals. This technique may offer opportunities to increase streamflow and augment water supply. This concept requires further development and pilot studies.

Fish Habitat Enhancements

- **Mainstem Floodplain Restoration Program** – Finalize reach-level priorities and implement projects.
- **Tributaries Habitat Enhancement Program** – Implement projects with emphasis on passage and screening on the upper and middle Yakima tributaries, Wilson/Naneum Creeks, and the Yakama Reservation. Implement headwaters restoration and capitalize on emergent habitat project opportunities.

Enhanced Water Conservation

- **Agricultural Water Conservation** – Implement YRBWEP and enhanced water conservation program to reduce water demands for irrigators and improve stream flows in targeted reaches.
- **Municipal Water Conservation –** Reduce water used by municipal water systems and rural households through projects and programs that promote water-use efficiency.

Market Based Reallocation of Water Resources

- **Institutional Improvements to Facilitate Market-Based Water Transfers** – Continue existing programs and policies and take additional steps to reduce impediments to water transfers between, and out of, irrigation districts and participating individual irrigators.

3.1.2 Phase II Projects (Mid-term: 11 to 30+ Years)

Phase II is for years 11 to 30+. Projects included in Phase II include all the elements of Phase I, plus the projects listed below. Phase II projects are subject to results and findings from the Phase I evaluations, implementation of water market enhancements, and pilot-testing results for aquifer recharge. Agricultural water conservation, floodplain restoration, and tributary habitat enhancement programs would continue.

Reservoir Fish Passage

- **Fish Passage at Tieton, Keechelus and Kachess Dams** – Provide upstream and downstream passage for adult and juvenile salmonids, depending on Phase I study findings.

Surface Storage

- **Reservoir Inactive Storage** – Extract and additional 100 kaf (for a total of 200 kaf including Phase I) of inactive storage from one or more existing reservoirs during drought years.
- **Columbia River Pumping and Storage** – Pump water from the Columbia River, contingent on demonstrated need from climate change or other factors (options with storage or direct pump without storage).

Groundwater Storage

- **Additional Groundwater Infiltration Prior to Storage Control** – Implement groundwater recharge in feasible locations. Infiltrate water through irrigation conveyance systems and land application. Use surface water available prior to storage control.

Fish Habitat Enhancement

- **Mainstem Floodplain Restoration Program** – Continue to implement projects with emphasis on Tier II and III reaches.
- **Tributaries Habitat Enhancement Program** – Continue to implement enhancement program and headwaters restoration and capitalize on emergent habitat project opportunities.

Enhanced Water Conservation

- **Enhanced Water Conservation** – Implement additional enhanced water conservation projects consistent with program.

Market Based Reallocation of Water Resources

- **Institutional Improvements to Facilitate Market-Based Water Transfers** – Continue programs developed in Phase 1 and take additional steps to reduce impediments to water transfers between and out of irrigation districts and participating individual irrigators.

3.2 Preliminary Path Forward and Schedule

Figure 1 outlines the steps for developing and implementing the integrated plan. Figure 2 shows the general schedule, starting with the Workgroup and development of this report, followed by the Basin Study and program implementation through 2040.

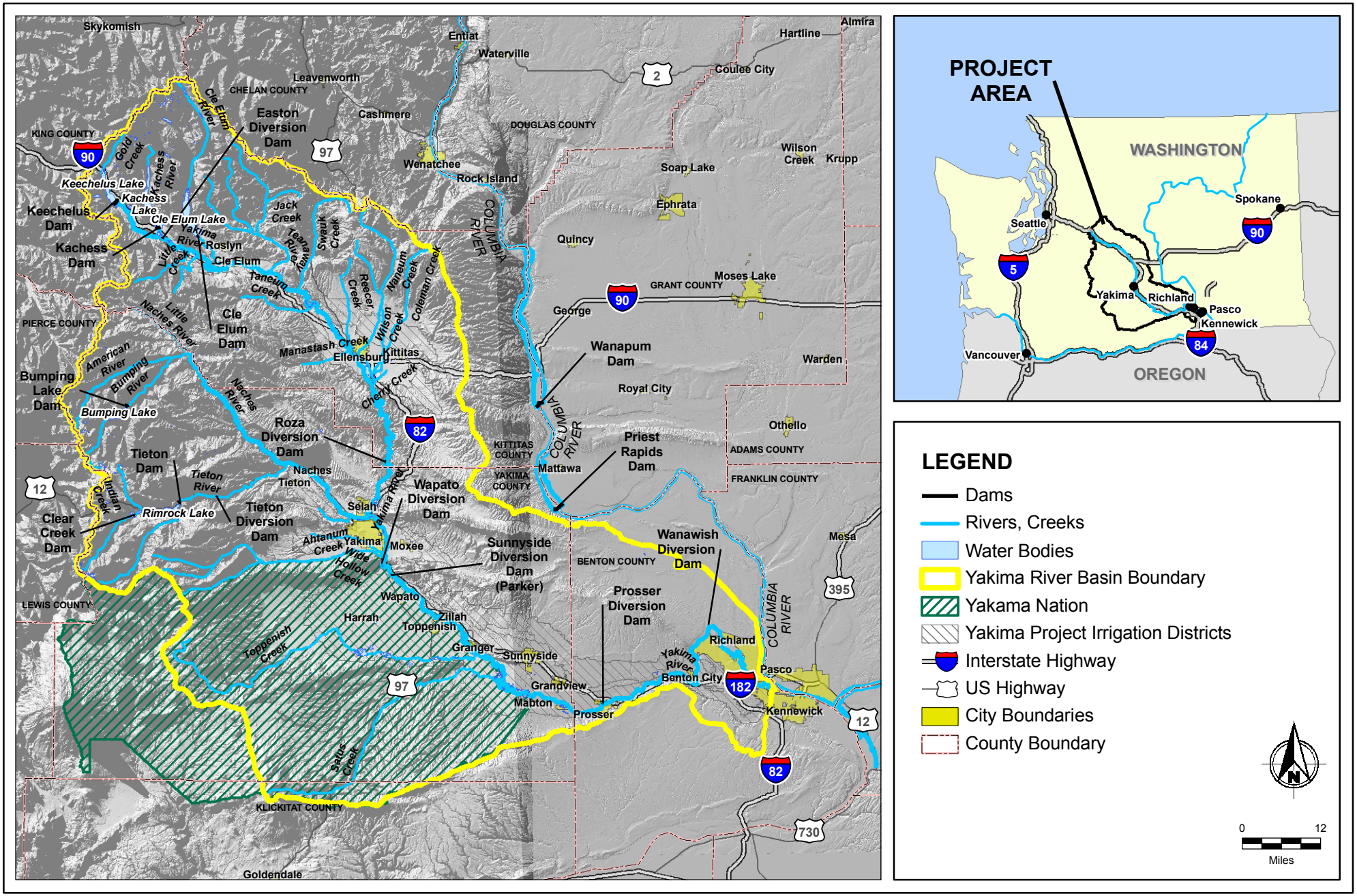

Exhibit 1
Yakima River Basin

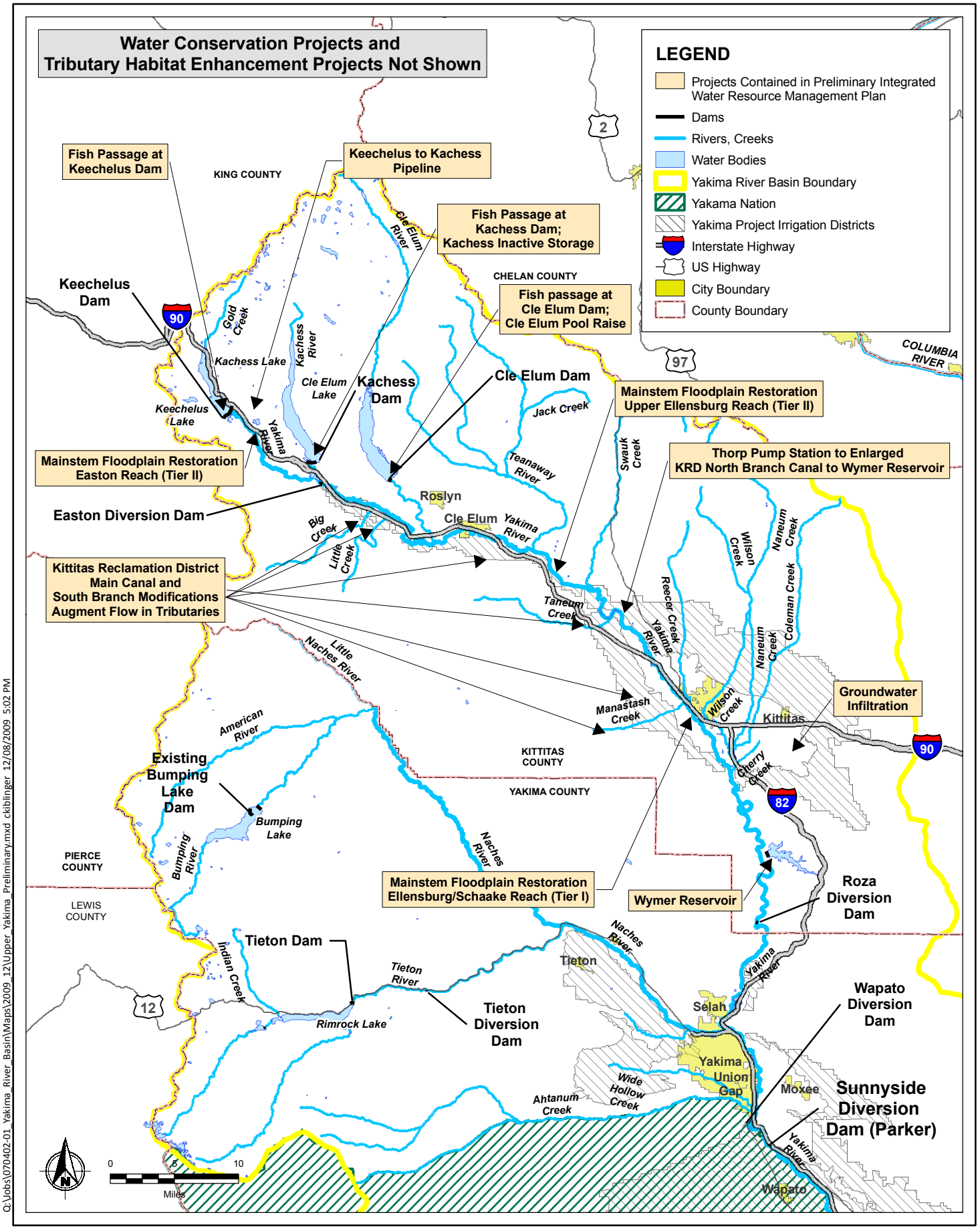

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Exhibit 2
Projects in Preliminary Integrated Water Resource Management Plan
Upper Yakima River

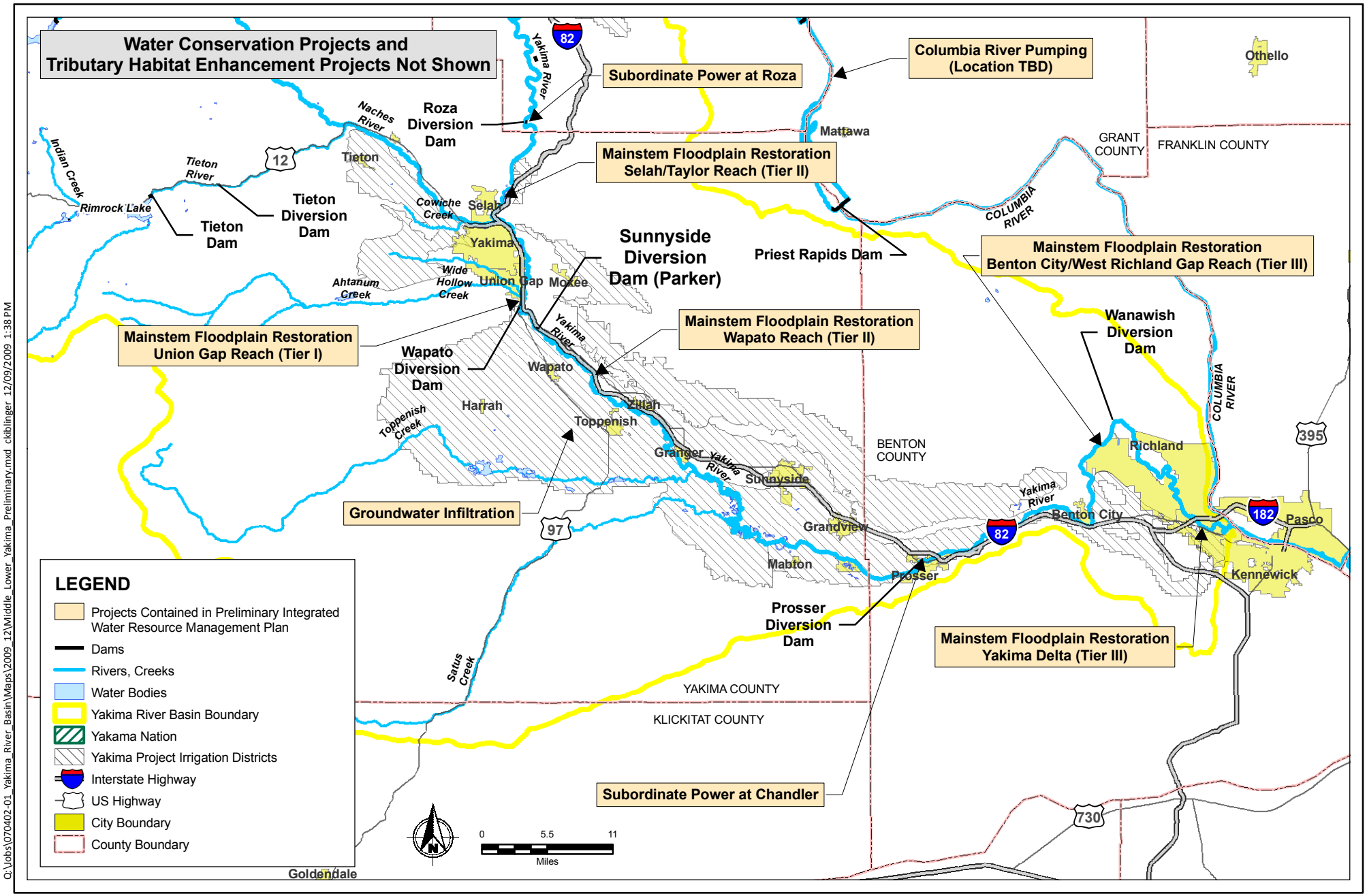


Exhibit 3
Projects in Preliminary Integrated Water Resource Management Plan
Middle and Lower Yakima River

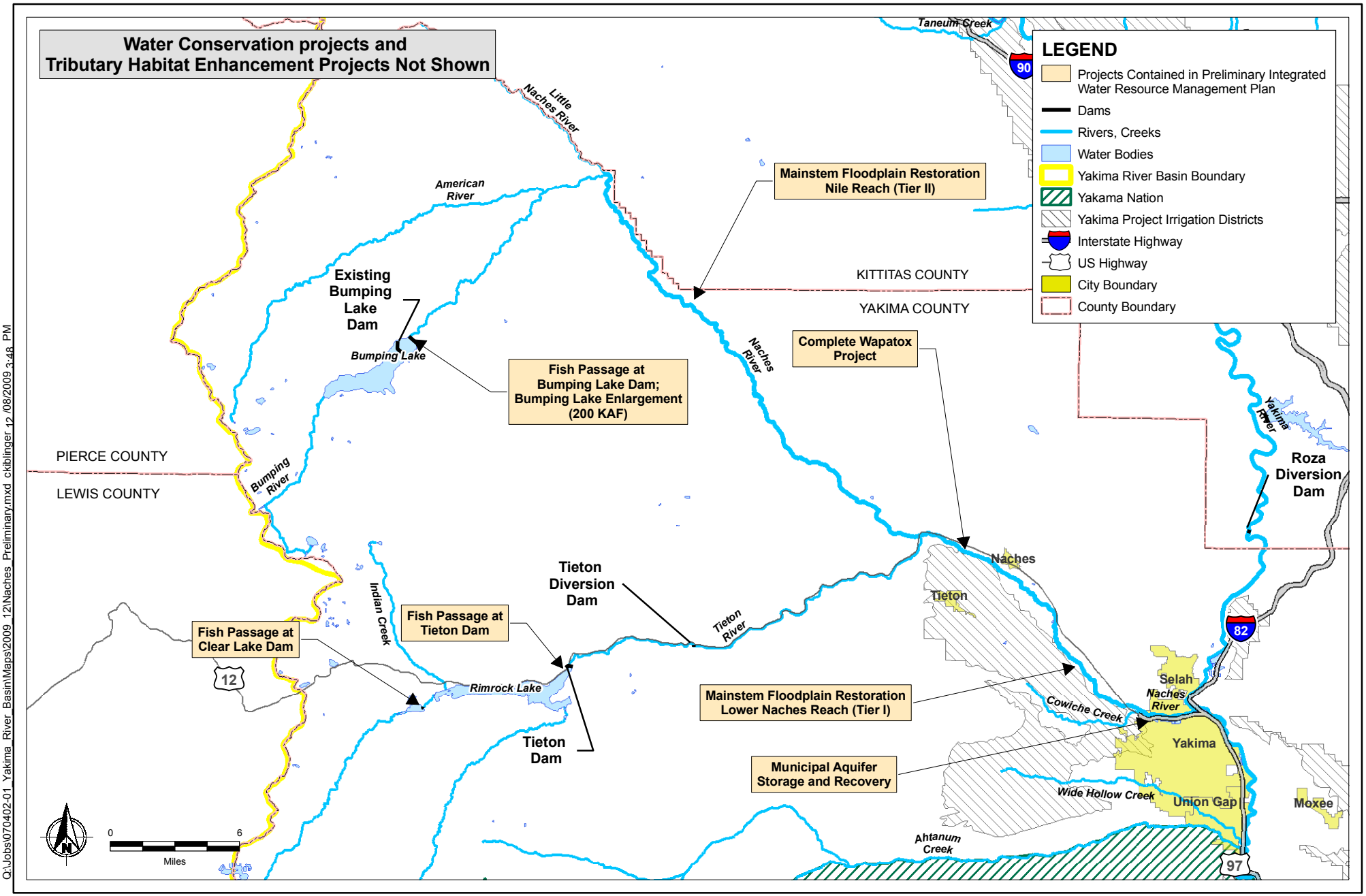


Exhibit 4
Projects in Preliminary Integrated Water Resource Management Plan
Naches River Basin

Figure 1: IWRMP Development and Implementation Flowchart

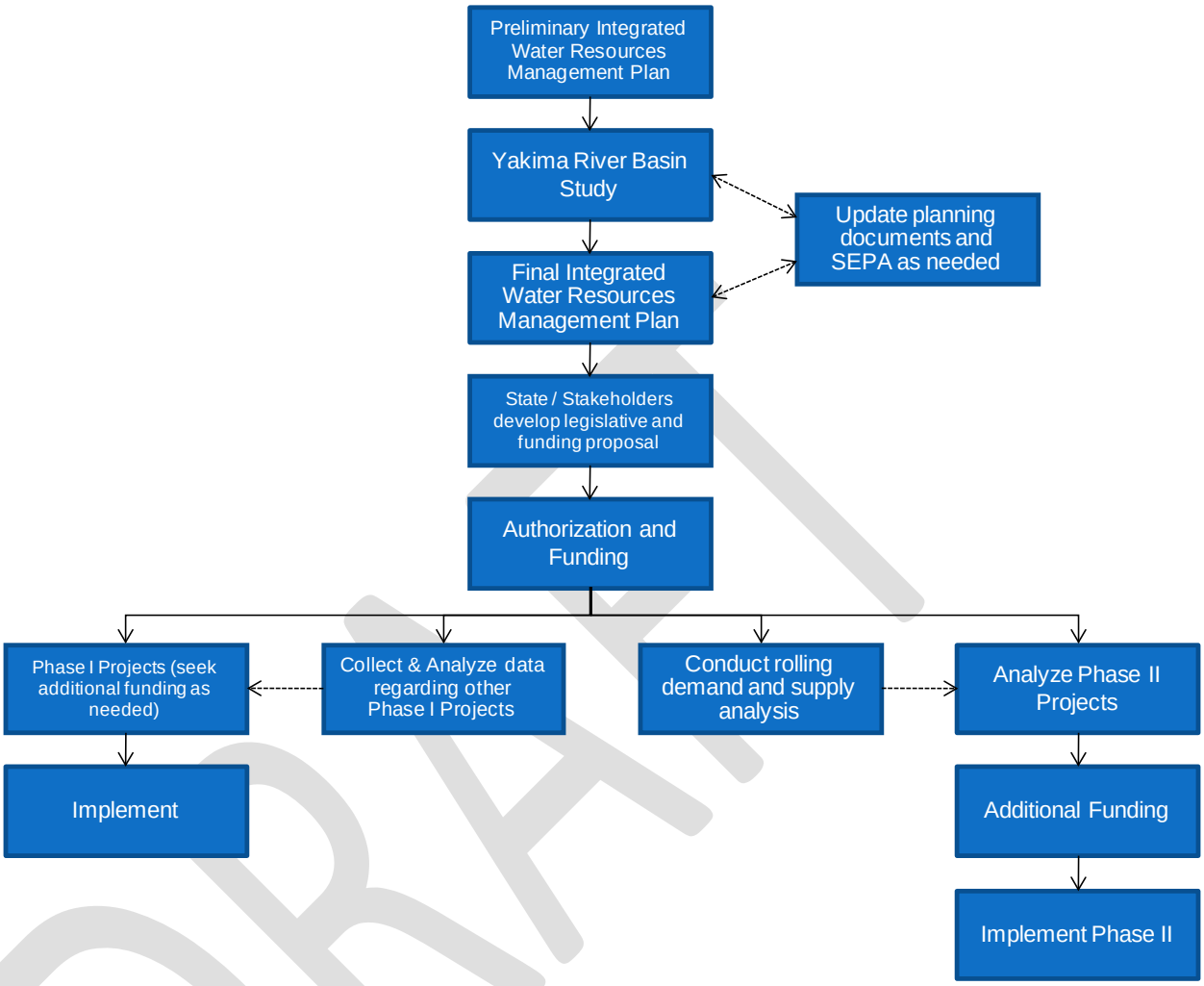
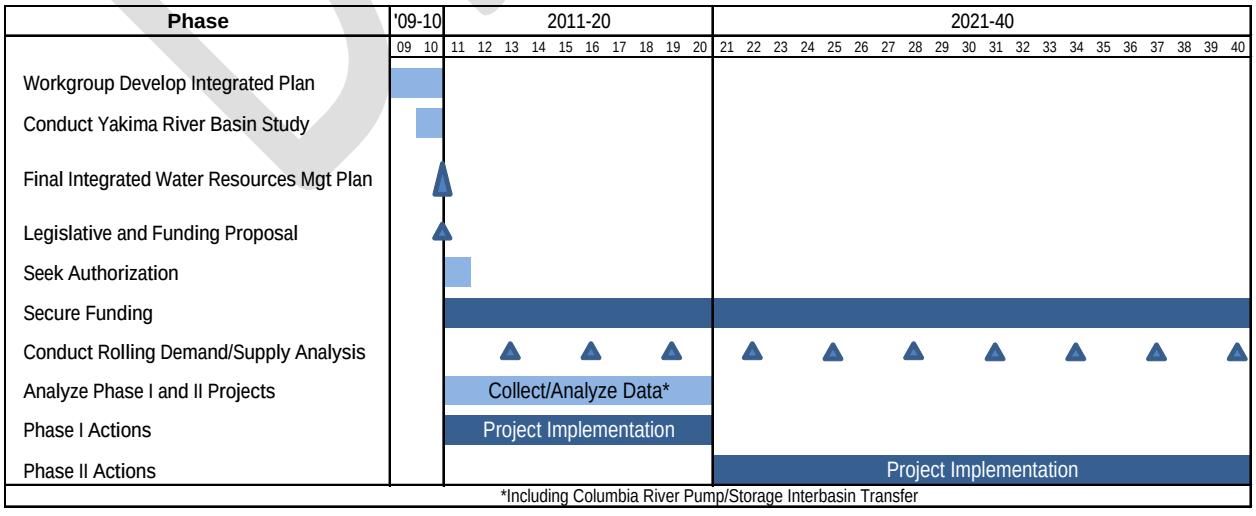


Figure 2: Project Schedule



3.3 Benefits

3.3.1 Water Supply and Flow Benefits

The preliminary IWRMP offers significant progress in meeting the needs outlined in Section 2. It would significantly improve water supply reliability in single and multiyear drought conditions. It would also offer additional flexibility in managing storage releases to meet instream flow needs, providing reductions and increases in flows to benefit spawning, rearing and migration conditions. The additional flow, coupled with habitat enhancements, would improve fish habitat conditions and significantly improve prospects for recovering fish populations to levels that can sustain harvest and are resilient to catastrophic events and the potential impacts of climate change.

The following tables (Tables 1-4), bar graphs (Figures 3-5) and maps (Exhibits 5-10) identify the estimated preliminary IWRMP benefits under 1992-1994 and 2005 drought conditions for Total Water Supply Available (TWSA), showing improved supply for proratable water-right holders and instream flows. Benefits are described for Phase I, and Phases I and II combined. In some cases, flow and TWSA benefits have been understated because the simplified modeling approach used to calculate these benefits does not account for return-flow increases and other secondary benefits.

Table 1
Estimated Water Supply Benefits for 1992–1994
Phase I Projects (0–10 Years)
(Note: kaf = 1,000 acre-feet)

	Estimated Increase in Total Water Supply Available in Historical Drought Years (Proration Increase)			Add'l Muni Supply	Estimated Flow Benefits for 1994 (3rd Year of Drought)			
Plan Element	**1992**	**1993**	**1994**	**Add'l Volume Supplied**	**April-Sept. Flow @ Parker**	**April-Sept. Flow @ Yakima Mouth**	**July-Oct. Flow @ Umtanum**	**Flow Benefits**
Agricultural Conservation	36 kaf (2%)	16 kaf (1%)	0	n/a	Large increase (64 kaf)	Small increase	0	Improve flow in portions of Yakima and Naches rivers
Municipal Conservation	To be determined	n/a	To be determined	n/a	n/a	n/a	n/a	Assume conserved water used for demands associated with growth
Wymer Reservoir w/Thorp Pump Station (162 kaf)	0	0	80 kaf (7%)	n/a	Large increase (0-80 kaf)	Large increase (0-80 kaf)	Large decrease (67-135 kaf)	Improve flow in portions of Yakima River, Cle Elum River, and tributaries (Reecer, Wilson, Naneum, Cherry, Coleman creeks)
Bumping Reservoir Enlargement (160- to 190-kaf)	40 kaf (3%)	0	66 kaf (6%)	n/a	Increase (28 kaf)	Increase (28 kaf)	Small increase	Increase flows through Bumping, Naches, and Yakima rivers
Keechelus-to-Kachess Pipeline	n/a (included below)	n/a (included below)	n/a (included below)	n/a	n/a (included below)	n/a (included below)	n/a (included below)	Improve summer flows below Keechelus (11 miles)
Reservoir Inactive Storage (100 kaf extracted)	33 kaf (3%)	0	33 kaf (3%)	n/a	Increase (17 kaf)	Increase (17 kaf)	Small increase	Improve flow in portions of Yakima River
Conveyance Improvements at Wapatox	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Improve flows below Wapatox diversion (70 cfs for 7.4 miles); or below Naches-Selah Irrigation District diversion (1.3 additional miles)
Subordinate Roza Power	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Improve spring flows below Roza Dam (50 to 300 cfs, 14.6 miles)

Table 1
Estimated Water Supply Benefits for 1992–1994
Phase I Projects (0–10 Years)
(Note: kaf = 1,000 acre-feet)

	Estimated Increase in Total Water Supply Available in Historical Drought Years (Proration Increase)			Add'l Muni Supply	Estimated Flow Benefits for 1994 (3rd Year of Drought)			
Plan Element	**1992**	**1993**	**1994**	**Add'l Volume Supplied**	**April-Sept. Flow @ Parker**	**April-Sept. Flow @ Yakima Mouth**	**July-Oct. Flow @ Umtanum**	**Flow Benefits**
Subordinate Chandler Power	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Improve spring flows below Chandler (zero to 300 cfs, 11.3 miles)
Raise Cle Elum Dam Pool 3 ft. (assume 15 kaf)	0	0	0	n/a	0	0	0	Improve flow in portions of Yakima River 15 kaf
Modify KRD Main Canal/South Branch	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Improve flows in Big, Little, and/or Manastash creeks
Market-based Water Transfers	0 (Redistribute 20-50 kaf to water-right buyers)	0 (Redistribute 20-50 kaf to water-right buyers)	0 (Redistribute 20-50 kaf to water-right buyers)	n/a	0	0	Small increase	n/a
Municipal ASR – City of Yakima	n/a	n/a	n/a	5-10 kaf	n/a	n/a	n/a	n/a
Groundwater Infiltration	20-50 kaf (2-4%)	20-50 kaf (2-4%)	20-50 kaf (2-4%)	n/a	No change or small increase	0	Small increase (10-20 kaf)	Small reduction in flip-flop releases; improve flow in some tributaries (Wilson/Naneum), potential temperature improvements in lower Yakima
COMBINED BENEFITS OF PHASE 1 PROJECTS	**129-159 kaf (+20-50 kaf through water marketing) (10-12%)**	**36-66 kaf (+20-50 kaf through water marketing) (3-5%)**	**199-229 kaf (+20-50 kaf through water marketing) (18-20%)**	**5-10 kaf increase**	**Large increase (109-189 kaf)**	**Large increase (Approx. 50 to 130 kaf)**	**Large decrease (47-125 kaf)**	**Improve flows through Bumping River, Naches River, portions of upper and lower Yakima River, upper Yakima tributaries**

1

Table 2
Estimated Water Supply Benefits for 1992–1994
Phase II Projects (11–30+ Years)
(Note: kaf = 1,000 acre-feet)

	Estimated Increase in Total Water Supply Available in Historical Drought Years (Proration Increase)			**Estimated Flow Benefits for 1994 (3rd Year of Drought)**			
	1992	**1993**	**1994**	**April-Sept. Flow @ Parker**	**April-Sept. flow @ Yakima Mouth**	**July-Oct. Flow @ Umtanum**	**Flow Benefits**
Phase I Benefits	129-159 kaf (+20-50 kaf through water marketing) (10-12%)	36-66 kaf (+20-50 kaf through water marketing) (3-5%)	199-229 kaf (+20-50 kaf through water marketing) (18-20%)	Large increase (109-189 kaf)	Large increase (Approx. 50-130 kaf)	Large decrease (47 to 125 kaf)	Improve flows through Bumping River, Naches River, portions of upper and lower Yakima River, upper Yakima tributaries
Additional Water Conservation	59 kaf (4%)	26 kaf (3%)	8 kaf (1%)	Small increase (4 kaf)	Small increase	Small decrease	Increased flow in portions of Yakima and Naches rivers
Draw Water from Inactive Storage (200 kaf used)	0	0	66 kaf (6%)	Increase (33 kaf)	Increase (33 kaf)	Small increase	Improve flow in portions of Yakima River
Additional Water Markets and Water Banking (total 60-130 kaf)	0 (Redistribute 40 to 80 kaf additional to water-right buyers)	0 (Redistribute 40-80 kaf additional to water-right buyers)	0 (Redistribute 40-80 kaf additional to water-right buyers)	0	0	Small increase	n/a
Additional Groundwater Infiltration (total 80-100 kaf)	50-60 kaf additional (4-5%)	50-60 kaf additional (4-5%)	50-60 kaf additional (4-5%)	No change or small increase	0	Small decrease	Small reduction in flip-flop releases; improve flow in some tributaries (Wilson/Naneum); potential temperature improvements in lower Yakima
Pump Water from Columbia River (50-250 kaf)	33-167 kaf (3-13%)	33-167 kaf (3-13%)	33-167 kaf (3-13%)	Increase (17-83 kaf)	Increase (17-83 kaf)	0	Improve flow in portions of Yakima River
COMBINED BENEFITS OF PHASE I and II PROJECTS	**271-445 kaf (+60-130 kaf through water marketing) (21-34%)**	**145-319 kaf (+60-130 kaf through water marketing) (13-26%)**	**356-530 kaf (+60-130 kaf through water marketing) (32-45%)**	**Large increase (163-309 kaf)**	**Large increase (Approx. 105-245 kaf)**	**Large decrease (47-125 kaf)**	**Improve flows through Bumping River, Naches River, portions of upper and lower Yakima River, upper Yakima tributaries**

Table 3
Estimated Water Supply Benefits for 2005
Phase I Projects (0–10 Years)
(Note: kaf = 1,000 acre-feet)

	Overall Supply (Drought Year – 2005)		Additional Muni Supply	Flow (Drought Year – 2005)			
Plan Element	**Total Water Supply Available (estimated or assumed)**	**% Proration**	**Add'l Volume Supplied**	**April-Sept. Flow @ Parker**	**April-Sept. Flow @ Yakima Mouth**	**July-Oct. Flow @ Umtanum**	**Flow Benefits**
Agricultural Conservation	54-83 kaf increase	4-7% increase	n/a	Large increase (62 kaf)	Small increase	Small decrease	Improve flow in portions of Yakima and Naches rivers
Municipal Conservation	To be determined	n/a	To be determined	n/a	n/a	n/a	Assume conserved water used for growth
Wymer Reservoir w/Thorp Pump Station (162 kaf)	60 kaf increase	5% increase	n/a	Large increase (60 kaf)	Large increase (60 kaf)	Large decrease (67-135 kaf)	Improve flow in portions of Yakima River, Cle Elum River, and tributaries (Reecer, Wilson, Naneum, Cherry, Coleman creeks); would provide improvement to north-side tributaries
Bumping Reservoir Enlargement (160- to 190-kaf)	66 kaf (assuming 100 kaf withdrawal, 2/3 water supply, 1/3 fish flow)	5% increase	n/a	Increase (33 kaf) (used at discretion of fish agencies)	Increase (33 kaf) (used at discretion of fish agencies)	Small increase (assuming add'l releases from upper reservoir)	Increase flows through Bumping, Naches, and Yakima rivers
Keechelus-to-Kachess Pipeline	n/a (included below)	n/a (included below)	n/a	n/a (included below)	n/a (included below)	n/a (included below)	Improve summer flows below Keechelus (11 miles)
Reservoir Inactive Storage (100 kaf extracted)	66 kaf increase	5% increase	n/a	Increase (33 kaf)	Increase (33 kaf)	Small increase	Improve flow in portions of Yakima River
Conveyance Improvements at Wapatox	n/a	n/a	n/a	n/a	n/a	n/a	Improve flows below Wapatox diversion (70 cfs for 7.4 miles); or below Naches-Selah Irrigation District diversion (1.3 additional miles)

Table 3
Estimated Water Supply Benefits for 2005
Phase I Projects (0–10 Years)
(Note: kaf = 1,000 acre-feet)

	Overall Supply (Drought Year – 2005)		Additional Muni Supply	Flow (Drought Year – 2005)			
Plan Element	**Total Water Supply Available (estimated or assumed)**	**% Proration**	**Add'l Volume Supplied**	**April-Sept. Flow @ Parker**	**April-Sept. Flow @ Yakima Mouth**	**July-Oct. Flow @ Umtanum**	**Flow Benefits**
Subordinate Roza Power	n/a	n/a	n/a	n/a	n/a	n/a	Improve spring flows below Roza Dam (50 to 300 cfs, 14.6 miles)
Subordinate Chandler Power	n/a	n/a	n/a	n/a	n/a	n/a	Improve spring flows below Chandler (zero to 300 cfs, 11.3 miles)
Raise Cle Elum Dam 3 ft. (assume 15 kaf)	0	0	n/a	Small increase (15 kaf)	Small increase (15 kaf)	0	Improve flow in portions of Yakima River
Modify KRD Main Canal/South Branch	n/a	n/a	n/a	n/a	n/a	n/a	Improve flows in Big, Little, and/or Manastash creeks
Market-based Water Transfers	0 (Redistribute 20-50 kaf to water-right buyers)	0	n/a	No change	No change	Small increase	n/a
Municipal ASR – City of Yakima	n/a	n/a	5-10 kaf	n/a	n/a	n/a	n/a
Groundwater Infiltration	20-50 kaf	2-4% increase	n/a	No change or slight increase	No change	Small increase (10-20 kaf)	Small reduction in flip-flop releases; improve flow in some tributaries (Wilson/Naneum); potential temperature improvements in lower Yakima
COMBINED BENEFITS OF PHASE 1 PROJECTS	**266-325 kaf increase (additional 20-50 kaf redistributed through water marketing)**	**21-26% increase**	**5-10 kaf increase**	**Large Increase (203 kaf)**	**Large increase (141 kaf)**	**Large decrease (47-125 kaf)**	**Improve flows through Bumping River, Naches River, portions of upper and lower Yakima River, upper Yakima tributaries**

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Table 4
Estimated Water Supply Benefits for 2005
Phase II Projects (11–30+ Years)
(Note: kaf = 1,000 acre-feet)

	Overall Supply (Drought Year – 2005)		**Additional Muni Supply**	**Flow (Drought Year – 2005)**			
	Total Water Supply Available (estimated or assumed)	**% Proration**	**Add'l Volume Supplied**	**April-Sept. Flow @ Parker**	**April-Sept. Flow @ Yakima Mouth**	**July-Oct. Flow @ Umtanum**	**Flow Benefits**
Phase I Benefits	266-325 kaf increase (additional 20-50 kaf redistributed through water marketing)	21-26% increase	5-10 kaf increase	Large Increase (203 kaf)	Large increase (141 kaf)	Large decrease (47-125 kaf)	Improve flows through Bumping River, Naches River, portions of upper and lower Yakima River, upper Yakima tributaries
Additional Water Conservation	15-54 kaf increase	2-4% increase	n/a	Increase (3 kaf)	Small increase	Small decrease	Increased flow in portions of Yakima and Naches rivers
Municipal Conservation	To be determined	n/a	To be determined	n/a	n/a	n/a	Assume conserved water used for growth
Draw Water from Inactive Storage (200 kaf used)	66 kaf increase	7% increase	n/a	Increase (33 kaf)	Increase (33 kaf)	Small increase	Improve flow in portions of Yakima River
Market-based Water Transfers	0 (Redistribute 40-80 kaf to water-right buyers)	0	n/a	No change	No change	Small increase	n/a
Additional Groundwater Infiltration (total 80-100 kaf)	50-60 kaf	4-5% increase	n/a	No change or slight increase	No change	Increase (25-30 kaf)	Small reduction in flip-flop releases, improve flow in some tributaries (Wilson/Naneum), potential temperature improvements in lower Yakima
Pump Water from Columbia River (50-250 kaf)	33-167 kaf increase	3-13% increase	n/a	Increase (17-83 kaf)	Increase (17-83 kaf)	0	Improve flow in portions of Yakima River
COMBINED BENEFITS OF PHASE I & II PROJECTS	**430-672 kaf increase (additional 60-130 kaf redistributed through water marketing)**	**37-55% increase**	**5-10 kaf increase**	**Large Increase (256-322 kaf)**	**Large increase (191-257 kaf)**	**Decrease (17-80 kaf)**	**Improve flows through Bumping River, Naches River, portions of upper and lower Yakima River, upper Yakima tributaries**

Figure 3: Estimated TWSA Benefits during Historical Drought Years in Thousands of Acre-feet (kaf)

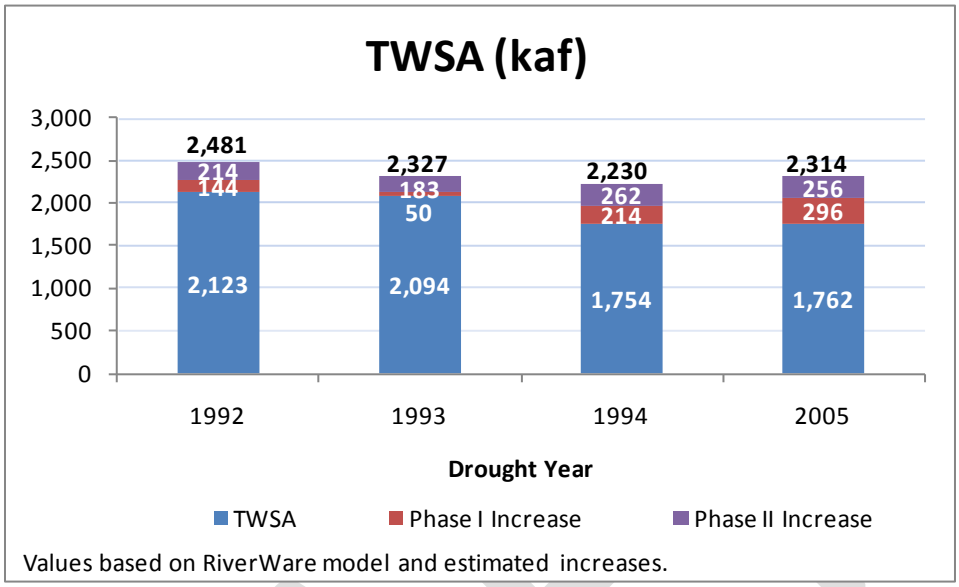


Figure 4: Estimated Prorated Supply Benefits during Historical Drought Years

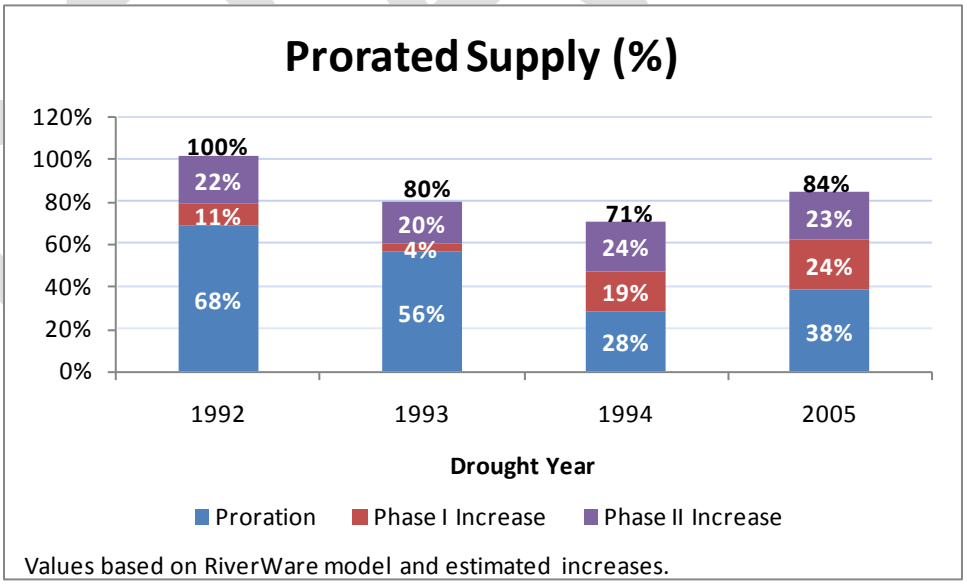
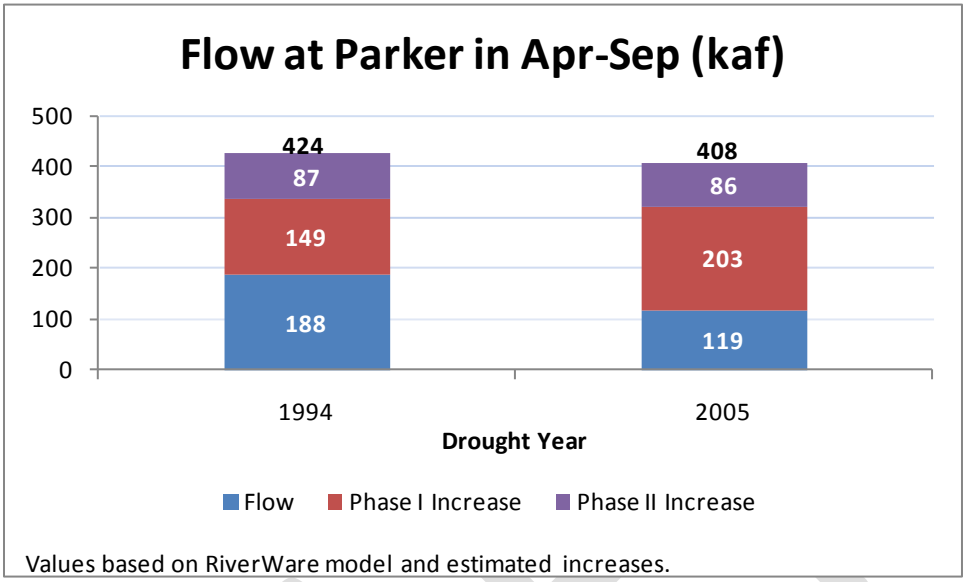


Figure 5: Estimated Flow Benefits at the Gauge at Parker during Historical Drought Years



Values based on RiverWare model and estimated increases.

3.3.2 Habitat Benefits

In addition to flow benefits, the preliminary IWRMP would provide significant benefits to fish populations. This includes unimpeded adult and juvenile fish migration past existing Yakima Basin storage dams, which would increase the extent of coho, steelhead, and Chinook habitat in the basin; allow reintroduction of extirpated sockeye runs; and allow expanded migration and genetic interchange for listed bull trout and other native fish. The abundance, life history, and genetic diversity of these and other focal species should increase after fish passage is provided. The program would significantly improve prospects for recovering fish populations to levels that can sustain harvest and are resilient to catastrophic events and the potential impacts of climate change.

Reclamation estimated potential coho production capacity of habitat above Bumping Reservoir at 422 to 486 adults annually (Reclamation 2007a), while passage at Cle Elum Reservoir would provide access to habitat capable of supporting 1,540 adult coho (Reclamation 2007b). Reclamation estimated that Cle Elum Reservoir could produce 30,000 to 50,000 adult sockeye (Reclamation 2007c), while Bumping Reservoir could produce 10,000 to 17,000 adult sockeye (Reclamation 2007d).

Restoring connectivity among currently isolated populations of bull trout would allow dispersion of fish among local populations, providing a mechanism to support weaker populations or reestablish population connectivity. It would also allow gene flow among populations, which prevents the loss of genetic variation important for survival in variable environments and decreases the probability of local extirpations.

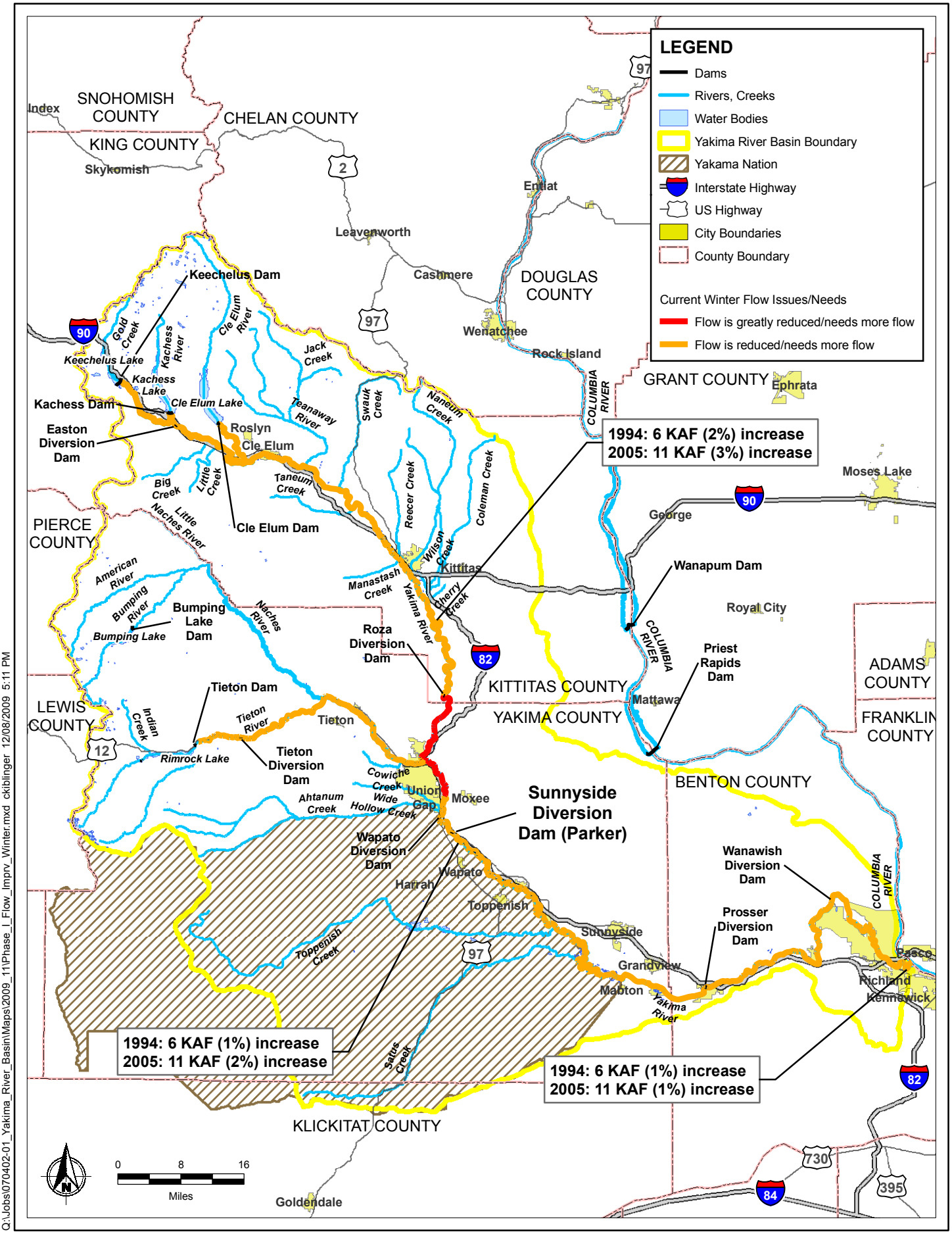


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Exhibit 5
Winter Existing Flow Conditions
and Phase I Improvements

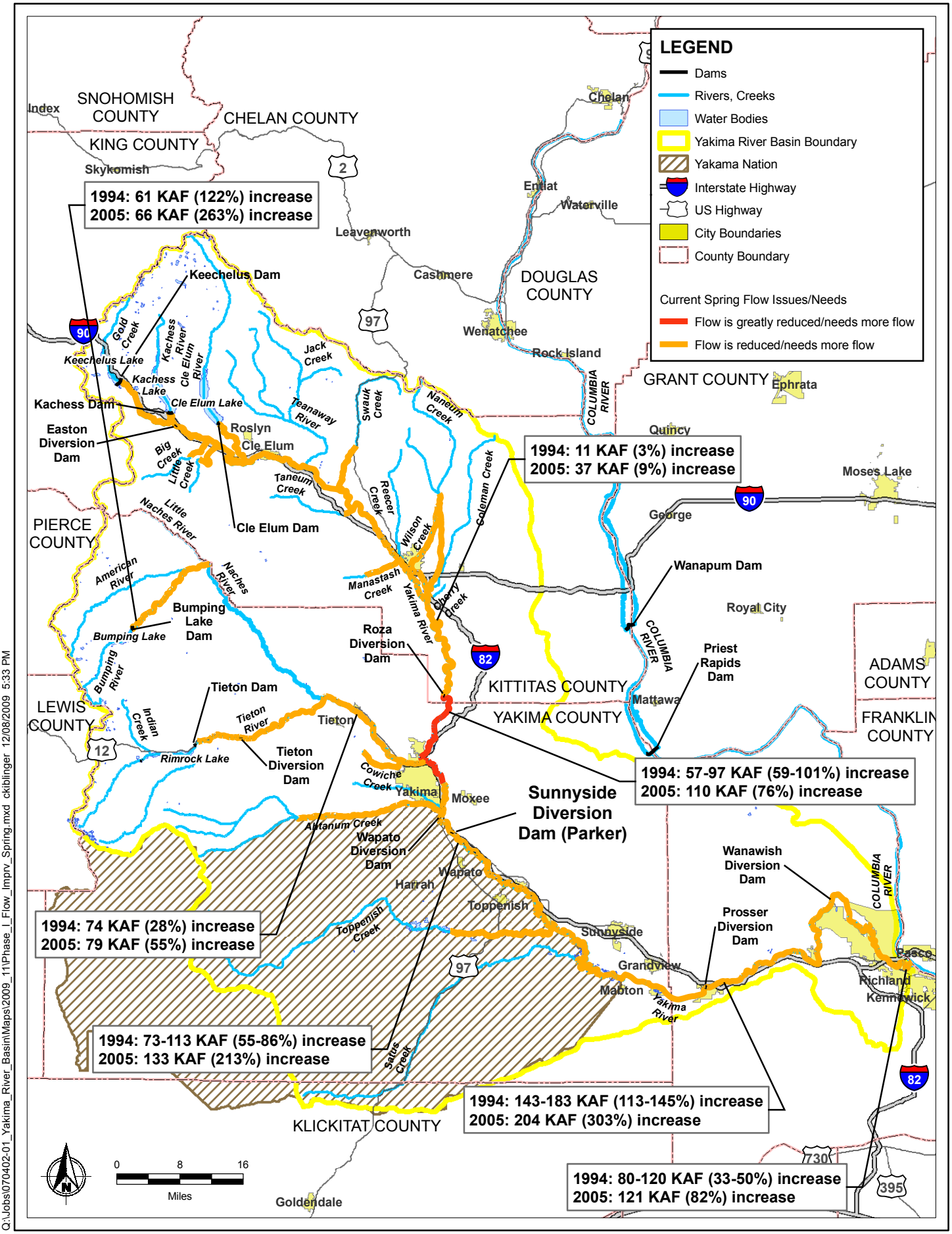

Exhibit 6
Spring Existing Flow Conditions
and Phase I Improvements

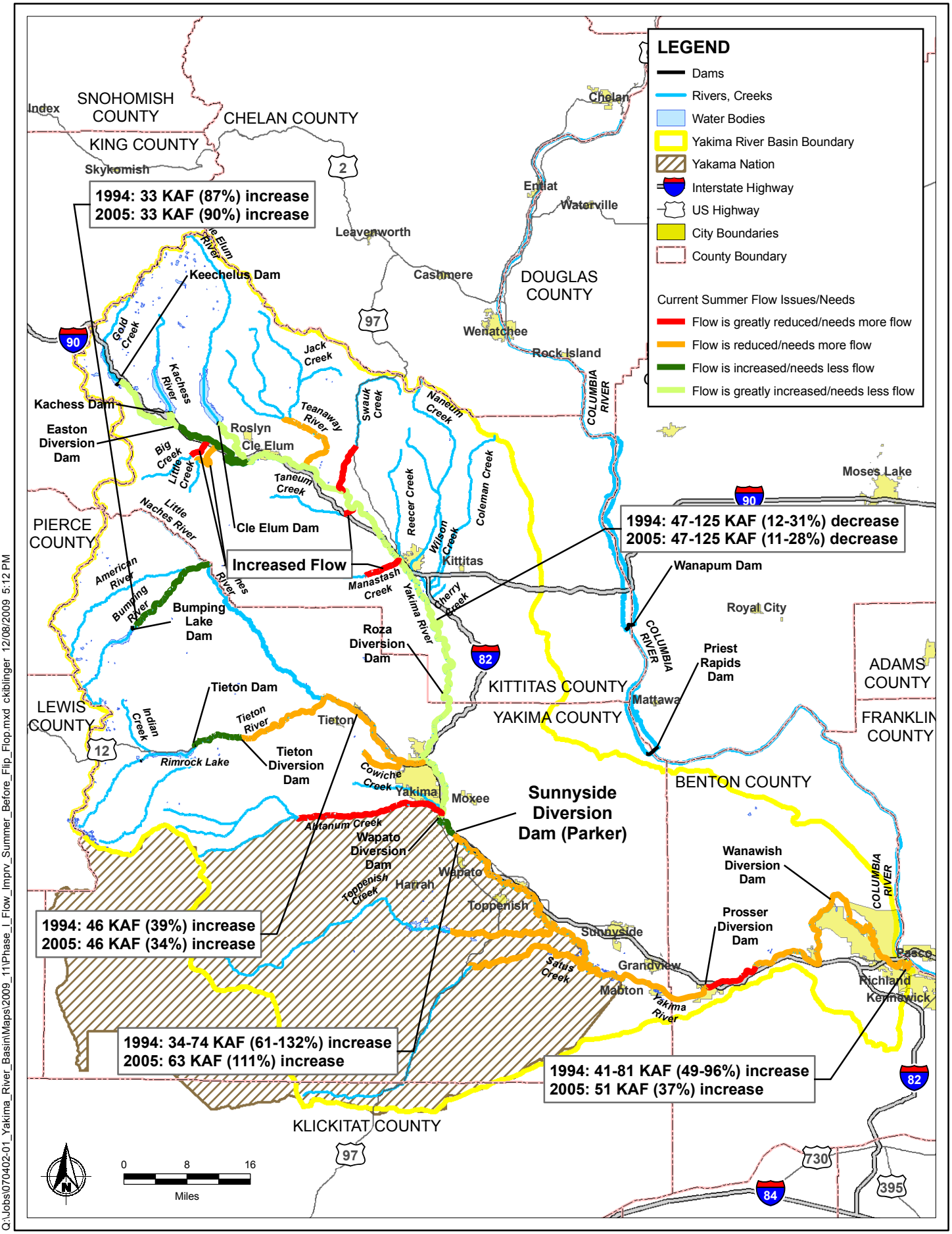

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Exhibit 7
Summer Existing Flow Conditions
and Phase I Improvements

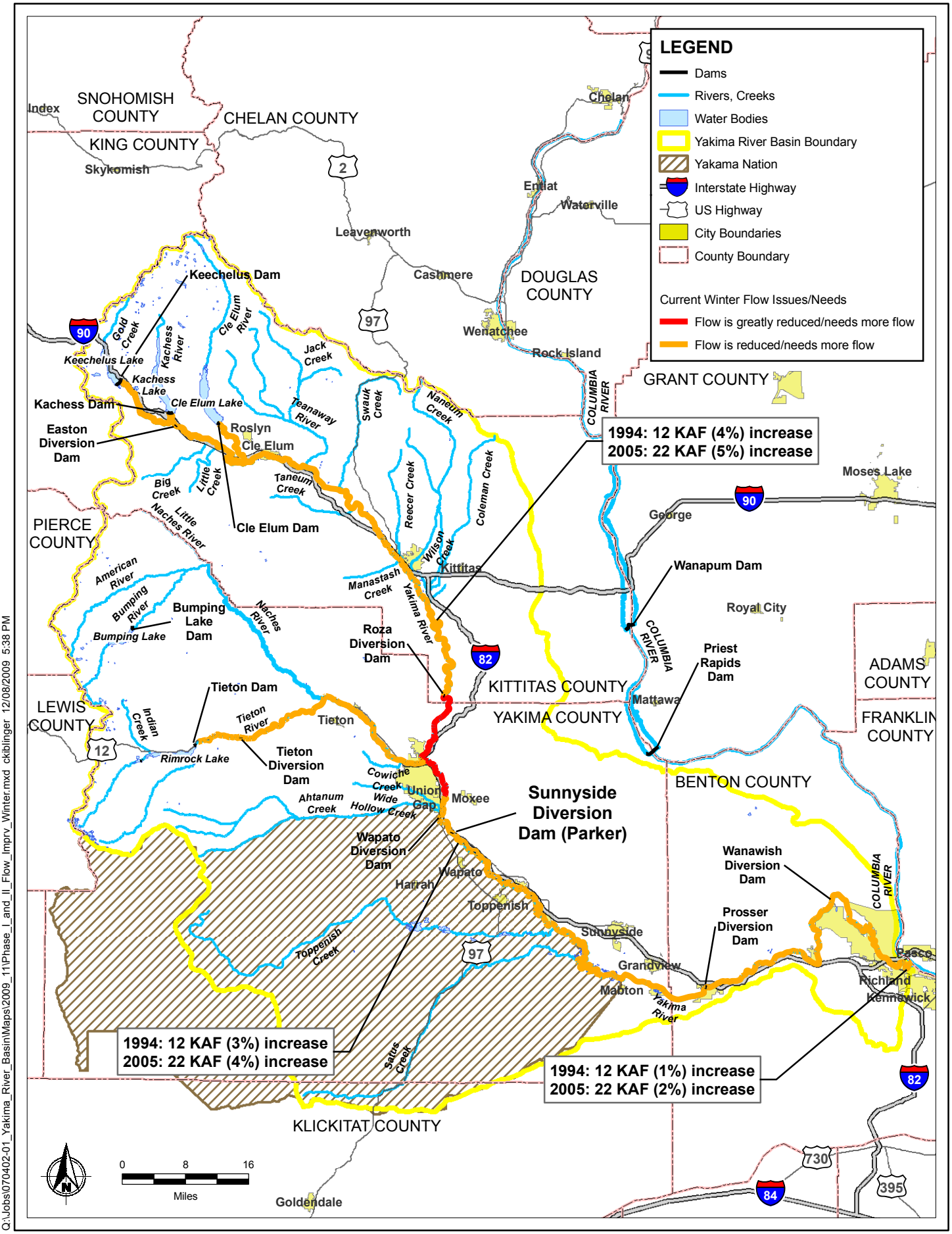

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Exhibit 8
Winter Existing Flow Conditions and Phase I and II Improvements

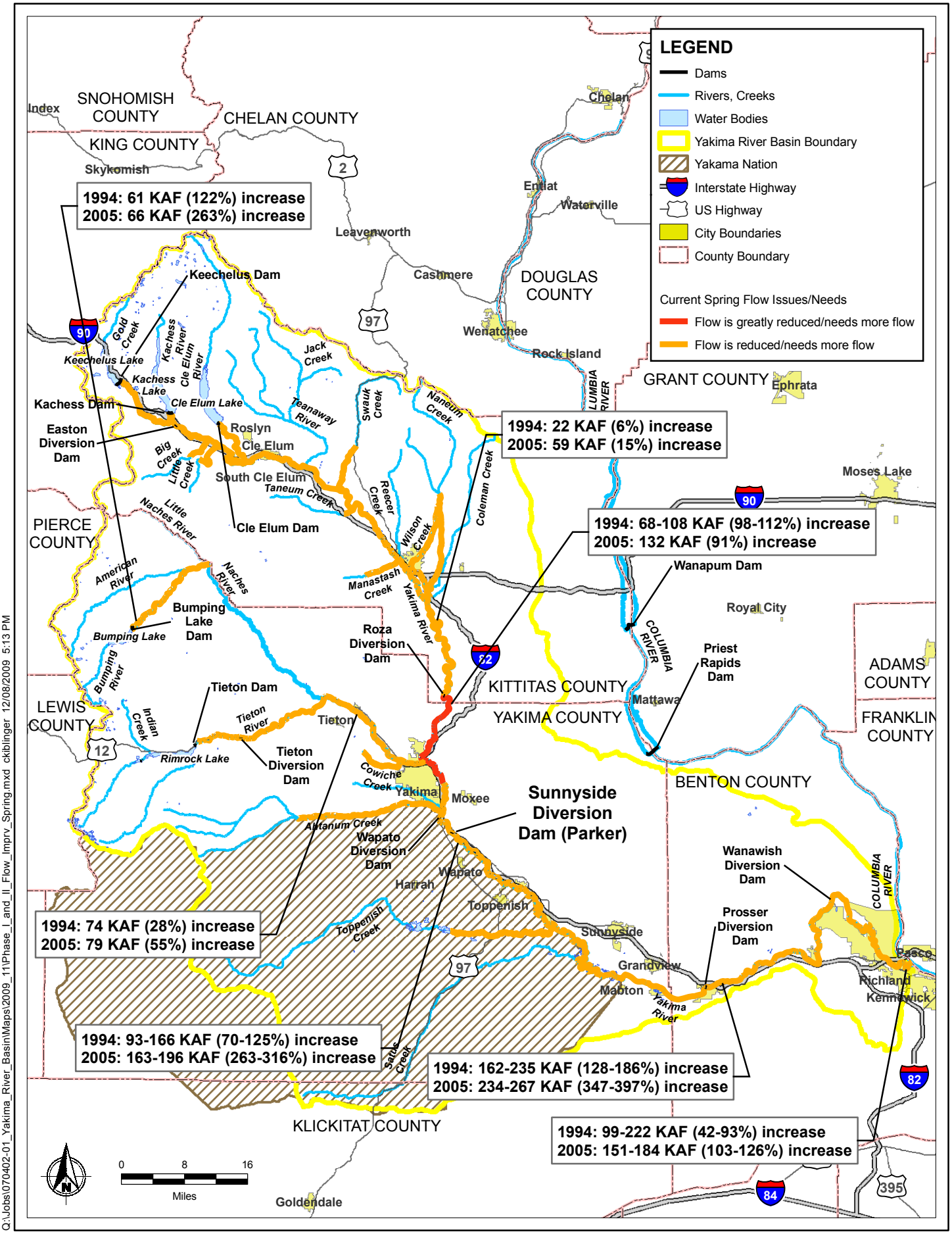

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Exhibit 9
Spring Existing Flow Conditions
and Phase I and II Improvements

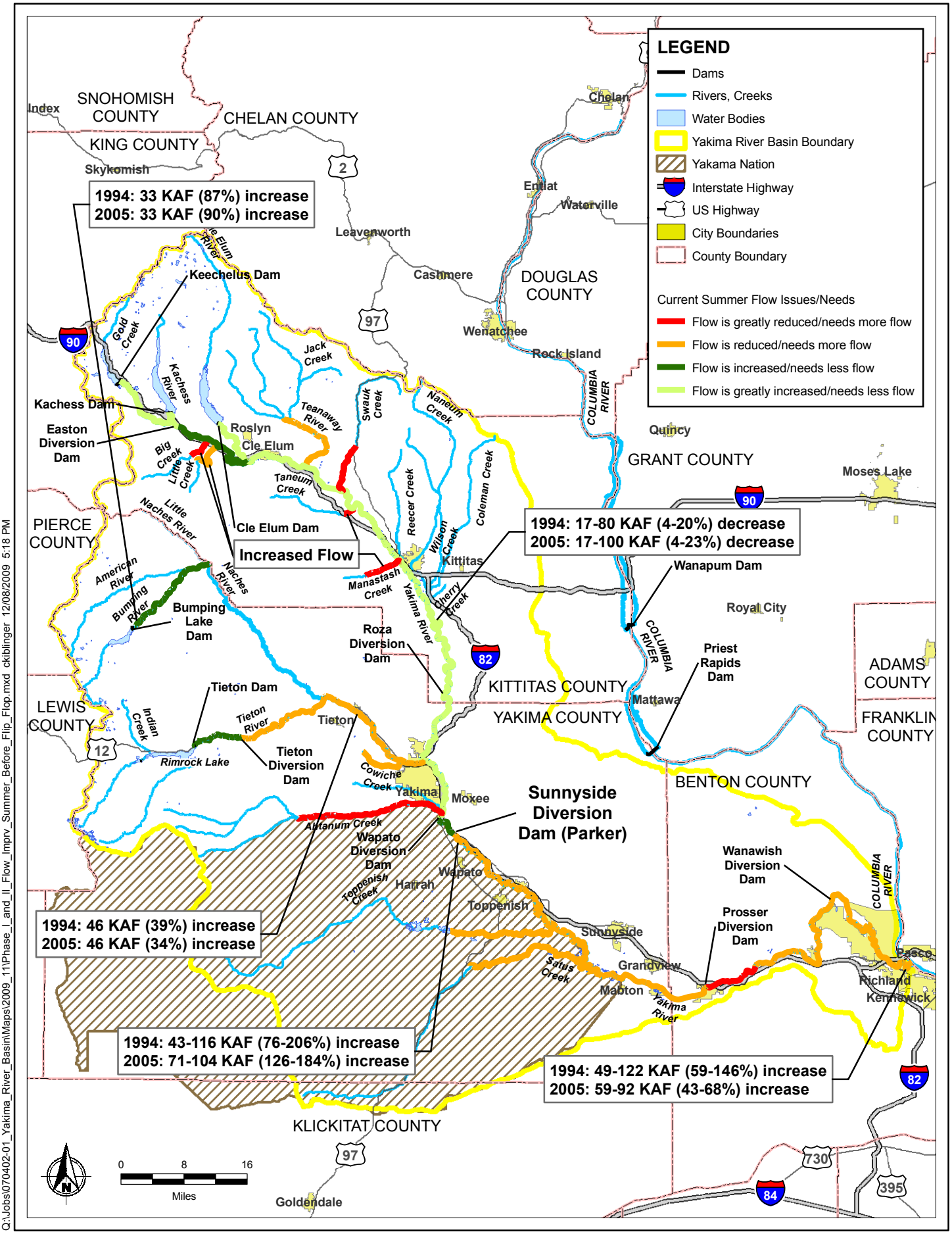

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Exhibit 10
Summer Existing Flow Conditions
and Phase I and II Improvements

The floodplain restoration and habitat enhancements in the preliminary IWRMP would accelerate ongoing efforts to protect existing high-value habitats, improve fish passage, enhance flows, improve habitat complexity, and reconnect side channels and off-channel habitat to stream channels. These enhancements would result in significant positive impacts, including the following:

- Enhance efforts to meet delisting goals for ESA-listed steelhead and bull trout
- Increase Chinook production
- Improve prospects for recovering fish populations to levels that can sustain harvest and are resilient to catastrophic events and potential impacts of climate change
- Help create improved spawning/incubation, rearing, and migration conditions for all salmonid species in the Yakima Basin
- Implement key strategies described in the Yakima Subbasin Plan
- Complete most of the actions described in the Yakima Steelhead Recovery Plan

3.3.3 Other (Multipurpose) Benefits

Other benefits of the preliminary IWRMP, such as recreation (additional fishing and perhaps boating opportunities) and benefits associated with hydropower and flood control, will be characterized in more detail in the 2010 evaluation.

3.3.4 Sample Scorecard

A scorecard can be helpful in describing expected benefits and comparing or measuring results. Table 5 is a sample scorecard for Phase I of the preliminary IWRMP. The scorecard lists results for important quantitative criteria. The scorecard describes water quantity, fisheries, power production, adaptability to future climate conditions, cost, and job creation benefits, as available. There are other criteria that are also important, which are more qualitative in nature, but are not included in the sample scorecard. For example, a criterion may be the improved ability to obtain permits to construct a project or withdraw water when ecosystem benefits from the IWRMP are factored into permitting decisions.

Table 5 Sample Scorecard[1]	
Criteria	**Phase I**
Water Supply and Instream Flow	
• Total Water Supply Available	Estimated 266 to 325 kaf increase during drought years
• Proratable Water Supply Increase (%)	Estimated 23% increase during drought years
• Reductions in Diversions through Water Conservation	110 kaf in average years (less during drought years)
• Instream Flow below Parker (middle and lower Yakima River)	Increased in spring and summer; estimated increase in drought years = 100-200 kaf
• Instream Flow at Umtanum (Ellensburg Reach in upper Yakima River)	Decreased in summer by estimated 47-125 kaf to improve rearing conditions
• Instream Flow in Upper Yakima River and Cle Elum River	Increased by TBD cfs (TBD kaf) during fall and winter time to improve spawning and rearing
• Instream Flow in Tributaries	Increased flow in Little, Big, Taneum and Manastash Creeks; improved flow regime in Reecer, Wilson/Naneum Creeks
Fisheries	
• New spawning and rearing habitat opened above existing dams	29.4 miles above Cle Elum Dam; 6.6 miles above Bumping Reservoir; TBD above Clear Lake
• New spawning and rearing habitat opened on tributaries	TBD miles on Swauk, Taneum, Jack, Indian, Manastash, Reecer, Wilson/Naneum, Cowiche, Ahtanum Creeks
• Acres of floodplain habitat improved	TBD on Upper, Middle and Lower Yakima River, tributaries
• Species benefitted	Steelhead, coho, Chinook, sockeye, bull trout, estimated numbers TBD
Power Production	
• Additional Hydropower Produced	Increase TBD
• Additional Power Required for Pumping	Slight increase TBD
Adaptability to Future Climate Conditions	
• Ability to adapt to changing flow conditions/Store higher winter flows	Can store winter flow in Wymer Reservoir, capture additional flow in Bumping Reservoir, use inactive storage in Kachess Reservoir
• Sustainability of fish runs under future climate conditions	Access to headwater areas and improved rearing habitat will improve sustainability
Cost	
• Implementation Cost (Construction, Engineering, Land Acquisition, etc.)	$2.6 to 3.5 billion
• Operations Cost	TBD
Job Creation	
• Short-term	TBD
• Long-term	TBD

1. TBD – To be developed. These items will be assessed as part of the Basin Study in 2010.

3.3.5 Mitigation

Implementation of many of the projects identified in the preliminary IWRMP will depend on developing successful mitigation strategies. The IWRMP offers substantial benefits that include restoring access to tens of miles of salmonid stream habitat above existing reservoirs, increasing flows to support all salmonid life-stages, providing bull trout connectivity between populations above and below the reservoirs, and improving riparian and floodplain functionality throughout the basin.

However, a few projects would impact important habitats (i.e., late-succession (old growth) forest, shrub-steppe and bull trout habitat), or irrigation district operational costs (i.e., Roza and KID power subordination). These impacts would have to be offset through mitigation acceptable to project sponsors, permitting agencies, and other affected stakeholders. Several mitigation ideas have been identified during Workgroup meetings in addition to the IWRMP benefits. Mitigation strategies for each project in the preliminary plan will be identified in 2010.

3.4 Plan Adjustments Based on Need during Implementation

The preliminary IWRMP is based on the understood needs, available information, and expected benefits. Projects have been included to provide flexibility to meet a variety of conditions. However, when factors such as population growth, fish flows, anticipated timing, and effects of climate change result in changed needs, the IWRMP will need to be adjusted. To account for these adjustments, an adaptive management program will be developed in 2010 that will outline the approach for periodically reviewing and verifying needs and measured benefits and identifying recommended plan adjustments in response to findings.

3.5 Preliminary Appraisal-Level Costs

Table 6 identifies available estimated costs for projects and programs. Costs are not provided in cases where more information and analysis is needed to develop appraisal-level costs. These estimates will be developed in 2010.

Table 6 Compilation of Preliminary Implementation Cost Estimates[1]			
	Costs ($M)		
Phase/Project	**Low**	**High**	**Source**
Phase I			
Fish Passage (Cle Elum, Bumping, Clear)	125	150	Estimate based on Reclamation's 2008 Fish Passage Draft PR, indexed costs to October, 2009 (assume Clear Lake = $5M)
Conveyance Improvements at Wapatox	2	4	Estimate based on 2008 Yakima Steelhead Recovery Plan
Roza Power Subordination			No capital cost; lost revenue would be incurred
Chandler Power Subordination			No capital cost; lost revenue would be incurred
KRD Main Canal/South Branch Modifications	8	12	Estimate based on CH2M Hill 1999 report, indexed costs to October, 2009
Cle Elum 3' Pool Raise	20	40	Estimate based on 2000 Cle Elum Improvements Project Cost Estimate Summary Report, indexed costs to October, 2009
Keechelus-to-Kachess Pipeline	55	65	Doubled Reclamation estimate from 2006 to account for twice capacity, indexed costs to October, 2009
Wymer Reservoir (162 kaf)	1,200	1,600	Estimate from Reclamation FEIS and Ecology FEIS
Wymer Mitigation	10	10	Preliminary Ecology Estimate
Bumping Reservoir Enlargement (160-190 kaf)	600	1,000	Estimate $3,000-5,000/AF new storage
Bumping Reservoir Enlargement Mitigation	20	20	Preliminary Ecology Estimate
Reservoir Inactive Storage (100 kaf)	25	50	Estimate, assumed pump station
Municipal Aquifer Storage	4	6	Estimate
Groundwater Infiltration	40	100	20-50 kaf x $2,000/AF (assumes implementation, not just pilot)
Mainstem Floodplain Restoration	90	110	
Habitat Enhancement Projects	50	70	Habitat Enhancement Subcommittee Recommendations
Agricultural Conservation (YRBWEP+ Enhanced)	300	300	Estimate from Reclamation and Ecology FEIS
Municipal Conservation	1	3	Estimate from Anchor (2007)
Facilitate Market Transfers			No capital cost; $4-10M annual cost during drought (20-50 kaf x $200/AF)
Phase I & II Evaluations	25	50	
Subtotal: Phase I	**2,575**	**3,590**	

Table 6
Compilation of Preliminary Implementation Cost Estimates[1]

Phase/Project	Costs ($M) Low	High	Source
Phase II			
Mainstem Floodplain Restoration	25	40	Habitat Enhancement Subcommittee Recommendations
Habitat Enhancement Projects	40	60	Habitat Enhancement Subcommittee Recommendations
Fish Passage (Tieton, Keechelus, Kachess)	80	150	Fish Passage Phase I Assessment Report (assumed Trap-and-Haul with New Fish Spillway)
Enhanced Water Conservation	270	270	Estimates from selected Enhanced Conservation projects indexed to October, 2009; includes KID Pump Exchange Project
Additional Reservoir Inactive Storage (100 kaf)	25	50	Estimate, assumed pump station
Additional Measures to Facilitate Market Transfers			No capital cost; $8-16M annual cost during drought (40-80 kaf x $200/AF)
Additional Groundwater Infiltration	TBD[2]	TBD	
Columbia River Pump/Storage (50-300 kaf)	TBD	TBD	
Subtotal: Phase II	**TBD**	**TBD**	

1. There is variability between previously prepared cost estimates. Costs provided in this table should only be used as an "order of magnitude" estimate for the preliminary IWRMP. More detailed project descriptions will be developed through the Yakima River Basin Study process to allow more accurate and comparable cost estimates to be formulated.
2. Projects listed as "TBD" in Table 6 are not adequately defined to support development of cost estimates at this time.

4 Summary and Schedule of the Yakima River Basin Plan of Study

Reclamation and Ecology will conduct a Basin Study to further develop the technical basis and decision support for an IWRMP. The IWRMP is being developed under authority provided to Reclamation by the existing YRBWEP Act (P.L. 103-434, October 31, 1994, as amended by P.L. 105-62, October 13, 1997, and P.L. 106-372, October 27, 2000). This effort, in effect, constitutes the next phase of YRBWEP. The study will supplement information provided through previous efforts to evaluate water supply and aquatic resource problems as well as to identify potential remedies.

During 2010, the Basin Study effort will evaluate potential actions (or subgroups of those tools) identified by the YRBWEP Workgroup for addressing the water and aquatic resource needs of the Yakima River Basin. Upon completion of the Basin Study, the YRBWEP Workgroup will be asked to provide recommendations concerning the content of a Final IWRMP. It is anticipated that such recommendations will include identification of specific elements and projects to be included in the Final IWRMP as well as the timing (phasing) of those elements and projects.

The Basin Study and Final IWRMP are intended to accomplish the following objectives:

1) Achieve stakeholder consensus around a well defined set of strategies for resolving water supply and stream flow imbalances as well as other aquatic resource issues,
2) Delineate a clear pathway for short-term and long-term IWRMP implementation, and
3) Provide the basis for a request by Ecology and stakeholders for Congressional and State Legislative authorization and appropriations for the IWRMP.

The scope of the Basin Study is summarized as follows:

- **Task 1** – Characterize and quantify the water resources of the basin.
- **Task 2** – Determine the current and future water needs for out-of-stream uses for defined planning periods (phases). This includes the following water use components: municipal and industrial uses, domestic (exempt) well uses, domestic use not connected to municipal systems (i.e., rural residential), and demand for irrigated agriculture, particularly focusing on quantifying additional supplies needed to provide various levels of dry year/drought relief for proratable irrigation districts. The study shall identify the difference in demand that results from a "no action" scenario for conservation, efficiency, water markets, and groundwater management and one that incorporates the actions identified to date by the Workgroup as well as implementation of best management practices in

agricultural, domestic, and municipal water use throughout the Basin. It shall also identify the benefits and costs of providing various levels of drought relief to the local and national economies, specifically comparing the cost of water management alternatives, including demand reduction, with the benefits accruing from those alternatives. Future irrigation needs will be predicated on no increase in irrigated acreage, which is consistent with YRBWEP legislation.

- **Task 3** – Quantify instream resource needs by major reach, by season.
- **Task 4** – Develop detailed descriptions for elements and projects identified in the preliminary IWRMP.
- **Task 5** – For each element and project, conduct an analysis of potential environmental, engineering, policy, and/or legal barriers to implementation and estimated costs. At the end of this task, the YRBWEP Workgroup may decide to modify or eliminate certain actions that it submitted for study at the outset of the Basin Study process. At the completion of this task, the Workgroup may decide to modify the preliminary IWRMP before proceeding to subsequent tasks.
- **Task 6** – Using models such as Yakima RiverWare and other analytical tools, evaluate the efficacy of various strategies for meeting out-of-stream and instream needs, including both storage (above ground and aquifer storage) and non-storage options [demand reduction; agricultural, municipal, non-municipal domestic (including exempt wells and rural residential) conservation measures; and water banking/marketing]. Evaluations will consider the cumulative effect of multiple water supply options implemented in combination, and will do so under different operation scenarios to optimize the IWRMP.
- **Task 7** – Using models and other analytical tools, evaluate the total ecosystem benefits of implementing instream water supply strategies in conjunction with efforts to achieve other aquatic resources objectives, including fish passage at major Reclamation reservoirs in the Basin and habitat restoration.
- **Task 8** – Using models and other analytical tools, evaluate the manner in which potential climate impacts might affect the selection and timing of elements and projects that may be included in the Final IWRMP. Such evaluations will also address means by which flexible approaches and adaptation to climate change and other uncertainties (such as population growth or changes in land use or land management) could be built into the IWRMP.
- **Task 9** – Based on the evaluations conducted as part of Tasks 6-8, develop recommendations for timing and sequencing of projects, including identification of triggers for commencing projects contained in the second phase of the IWRMP and identification of any projects that clearly lack merit in light of the Basin Study analysis.

- **Task 10** – Assist the Workgroup in developing final recommendations for the IWRMP. The final package of actions submitted by the Workgroup may be informed by the Basin Study findings, and the sensitivity of these to action-specific environmental and socioeconomic concerns and uncertainties.
- **Task 11** – Assuming the Workgroup agrees on a final package of actions, prepare Basin Study Report and Final Yakima River Basin IWRMP.

Milestones for Workgroup Meetings:

- **Meeting 1 (March 2010)** – Report on quantified out-of stream and instream needs by reach
- **Meeting 2 (April 2010)** – Detailed description of projects
- **Meeting 3 (May 2010)** – Engineering/environmental/legal constraints to implementation
- **Meetings 4-8 (as needed, June-Sept 2010)** – Analytical outputs, optimization – modeling and combination of alternatives synergy and linkages – resulting in most effective IWRMP.
- **Meeting 9 (October-November 2010)** – Formal recommendation

5 References

U.S. Bureau of Reclamation. December 2008. Yakima River Basin Water Storage Feasibility Study. Final Planning Report/Environmental Impact Statement.

U.S. Bureau of Reclamation. 2007a. Coho Salmon Production Potential in the Bumping River Basin, Storage Dam Fish Passage Study, Yakima Project, Washington, Technical Series No. PN-YDFP-009, Boise, Idaho.

U.S. Bureau of Reclamation. 2007b. Coho Salmon Production Potential in the Cle Elum River Basin, Storage Dam Fish Passage Study, Yakima Project, Washington. Technical Series No. PN-YDFP-007. Boise, Idaho.

U.S. Bureau of Reclamation. 2007c. Assessment of Sockeye Salmon Production Potential in the Cle Elum River Basin, Storage Dam Fish Passage Study, Yakima Project, Washington, Technical Series No. PN-YDFP-008. Boise, Idaho.

U.S. Bureau of Reclamation. 2007d. Assessment of Sockeye Salmon Production Potential in the Bumping River Basin, Storage Dam Fish Passage Study, Yakima Project, Washington, Technical Series No. PN-YDFP-010. Boise, Idaho.

U.S. Fish and Wildlife Service. 2002. Chapter 21, Middle Columbia Recovery Unit, Washington. 86p. *In*: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

Washington Department of Ecology. June 2009. Yakima River Basin Integrated Water Resource Management Alternative. Publication No. 09-11-012.

Attachment A
Workgroup Members

This attachment provides the names of the Yakima River Basin Water Enhancement Project (YRBWEP) workgroup members and their alternates.

Agency	Workgroup Member Name and Title	Workgroup Member Alternate Name and Title
American Rivers	Michael Garrity Washington Conservation Director	Steve Malloch National Wildlife Federation Senior Water Program Manager
Benton County	Max Benitz Benton County Commissioner	Adam Fyall Community Development Coordinator
Bureau of Reclamation – Columbia-Cascades Area Office	Dawn Wiedmeier Acting Area Manager	Wendy Christensen Technical Projects Program Manager
City of Yakima	Bill Lover City Councilman	Dave Brown Water/Irrigation Manager
Kennewick Irrigation District	Scott Revell Planning Manager	n/a
Kittitas County	Mark McClain County Commissioner	Paul Jewell County Commissioner
Kittitas Reclamation District	Urban Eberhart Board Member	Ken Hasbrouck Manager
NOAA Fisheries Service	Dale Bambrick Eastern Washington Director	n/a
Roza Irrigation District	Ron VanGundy Policy Director	Ric Valicoff Director – Division No. 1
Sunnyside Valley Irrigation District	Jim Trull Secretary/Treasurer	n/a
USFWS – Mid-Columbia River Fishery Resources Office	Jeff Thomas Fisheries Biologist	n/a
Washington Department of Agriculture	Brad Avy Policy Assistant to the Director	Lee Faulconer Policy Assistant to the Director
Washington Department of Ecology – Office of Columbia River	Derek Sandison Director	n/a
Washington Department of Fish and Wildlife	Jeff Tayer Regional Director	John Easterbrooks Fisheries Biologist
Yakama Nation	Phil Rigdon Director, Natural Resources	Tom Ring Hydrogeologist
Yakama Nation – Yakama/Klickitat Fisheries Project	David Fast Fisheries Biologist	Mark Johnston Fisheries Biologist
Yakima Basin Fish & Wildlife Recovery Board	Alex Conley Recovery Office Manager	n/a
Yakima Basin Storage Alliance	Sid Morrison Chairman	Charlie de la Chapelle Vice Chair
Yakima County	Mike Leita County Commissioner	Rand Elliott County Commissioner
Yakima-Tieton Irrigation District	Rick Dieker Secretary/Treasurer/Manager	Jim Milton Director

Attachment B
Preliminary Integrated Water Resource Management Plan
Project Descriptions

This attachment was prepared as an element of the YRBWEP 2009 Workgroup Report. It summarizes each project or program included in the preliminary IWRMP. At this time, none of the projects or programs have been fully defined, and some are at a conceptual stage only. The summaries below present current status of the following:

Section B1 – Fish Passage at Storage Reservoirs

Section B2 – Structural/Operational Changes

- Conveyance Improvements at Wapatox
- Subordinate Diversions for Power at Roza and Chandler
- Kittitas Reclamation District (KRD) Main Canal and South Branch Modifications
- Raise Pool Level at Cle Elum Dam
- Keechelus-to-Kachess Pipeline

Section B3 – Surface Storage

- Wymer Reservoir
- Bumping Reservoir Enlargement
- Reservoir Inactive Storage
- Columbia River Pump/Storage

Section B4 – Groundwater Storage

- Municipal Aquifer Storage and Recovery
- Groundwater Infiltration Prior to Storage Control

Section B5 – Fish Habitat Enhancements

- Mainstem Floodplain Restoration Program
- Tributaries Habitat Enhancement Program

Section B6 – Enhanced Water Conservation

- Agricultural Water Conservation
- Municipal/Domestic Conservation

Section B7 – Market Based Reallocation of Water Resources/Transfers

Section B1 Fish Passage at Storage Reservoirs

Summary

Construct fish-passage facilities for adult and juvenile salmonids and/or bull trout at all major dams in the Yakima basin.

Phases

Phase 1 – Cle Elum, Bumping, and Clear Lake Dams.
Phase 2 – Tieton, Keechelus, and Kachess Dams.

Purpose

Restore anadromous salmonid access to habitat above the five existing large storage reservoirs and provide upstream and downstream passage for resident fish, including bull trout. Provide upstream passage for bull trout above Clear Lake. Passage would be constrained by the following:

- There would be no changes to current operations (i.e., quantity and timing of flow releases), but the flow pathway(s) would change to accommodate operation of the new downstream fish passage facilities
- Fish-passage facilities could be designed and operated within the existing operational considerations and constraints
- There would be no impacts on "total water supply available" (TWSA)
- Operations would continue to serve existing Reclamation contracts

Description

Phase 1 – Cle Elum, Bumping, and Clear Lake Dams--Install upstream and downstream passage for adult and juvenile salmonids (except Clear Lake – upstream passage for bull trout only).

Phase 2 – Tieton, Keechelus, and Kachess Dams--Install upstream and downstream passage for adult and juvenile salmonids based upon evaluation studies.

Benefits (Preliminary Estimate)

Providing for unimpeded adult and juvenile fish migration past the existing storage dams in the Yakima basin would increase the extent of coho, steelhead, and Chinook habitat in the basin, allow for the reintroduction of extirpated sockeye runs, and allow expanded migrations and genetic interchange for listed bull trout and other native fish. The abundance, life history, and genetic diversity of these and other focal species should increase after fish passage is provided. This would significantly improve prospects for recovering fish populations to levels that can sustain harvest and are resilient to catastrophic events and the potential impacts of climate change.

Estimates of potential anadromous fish production have been made for Bumping and Cle Elum Reservoirs. Reclamation (2007a) estimated potential coho production capacity of habitat above Bumping Reservoir at 422 to 486 adults annually. Passage at Cle Elum would provide access to habitat capable of supporting 1,540 adult coho (Reclamation 2007c). Reclamation estimated that Cle Elum Reservoir could produce 30,000 to 50,000 adult sockeye (Reclamation 2007d), while Bumping Reservoir could produce 10,000 to 17,000 adult sockeye (Reclamation 2007b).

Restoring connectivity among isolated populations of bull trout would allow for dispersion of fish among local populations, providing a mechanism to support weaker populations, or reestablishing those that have been extirpated. It would also allow gene flow among populations, which prevents the loss of genetic variation. This is important for survival in variable environments and decreases the probability of local extirpations.

Cost (Preliminary Estimate)

Cle Elum Reservoir – $96 million (based on January 2008 cost estimate and pending update from Value Engineering study underway)

Bumping Reservoir – $27 million (based on January 2008 cost estimate) for providing passage at existing dam. If Bumping small enlargement proceeds, then passage at the new or enlarged dam would be included as part of this project.

Clear Lake – $2 million (preliminary estimate). This estimate needs further definition and refinement in 2010.

Subtotal - $125 million. Could range up to $150 million with contingencies.

Tieton, Keechelus, and Kachess – Not developed. Preliminary costs range from $80 to 150 million. Substantial work is needed to improve this estimate.

Issues/Uncertainties

- More detailed evaluations are needed at Tieton, Keechelus, and Kachess Dams, including design option, costs, and expected benefits to fish.
- Use initial experiences at Cle Elum and Bumping Reservoirs to evaluate:
  1) The success and scale of sockeye reintroduction.
  2) The extent to which steelhead, Chinook, and coho successfully make use of the reservoirs and upstream habitats. All of these species may perform better or worse than anticipated, and monitoring will be required to track this.
  3) The degree to which provision of passage at Bumping Dam facilitates changes in migratory patterns and genetic connectivity for bull trout. Evaluating the outcomes of passage at Bumping Reservoir on bull trout should include baseline monitoring prior to improving passage.

The design and cost of providing passage at Clear Lake Dam will be determined based on the currently ongoing evaluation of bull trout passage conditions.

Section B2 Structural/Operational Changes

Conveyance Improvements at Wapatox

Summary

Modify the conveyance system for the former Wapatox Power Plant to reduce water needed to convey irrigation water.

Phase

Phase 1.

Purpose

Improve streamflow in a 7- to 9-mile reach of the lower Naches River and possibly improve floodplain function.

Description

Reclamation acquired the Wapatox Power Plant and diversion in 2003 in order to devote the associated 350 cfs water right to streamflow purposes. The Wapatox diversion also supplies water to several irrigators, and therefore the diversion and associated conveyance system remain active. The conveyance system requires substantial flow to deliver water to irrigators, limiting streamflow benefits of the acquisition. Modifying the conveyance system would allow the full Reclamation water right to be left in the Naches River, while enabling irrigators to receive their supplies.

Options also include consolidating the Wapatox diversion with the Naches-Selah Irrigation District diversion and using the Wapatox diversion to supply the City of Yakima water treatment plant and the Gleed ditch. Each of these options would increase the environmental benefits of the project.

Benefits (Preliminary Estimate)

Improve flows below the Wapatox diversion by approximately 70 cfs in a 7.4-mile reach (the benefitted reach would be 1.3 miles longer if the Wapatox diversion is also consolidated with the Naches-Selah Irrigation District diversion).

An additional benefit would include floodplain function enhancement if the project includes replacement of the existing City of Yakima water treatment plant and Gleed ditch diversions.

Cost (Preliminary Estimate)

Cost is estimated at $2 to 4 million.

Issues/Uncertainties

This is a relatively simple project with project features that are well understood. The primary uncertainties are related to potential consolidation with the additional diversions described above.

Subordinate Diversions for Power at Roza and Chandler Power Plants

Summary

Reduce or eliminate irrigation district diversions used for power production for Roza and Kennewick Irrigation Districts during outmigration of juvenile anadromous fish in March, April and May.

Phase

Phase 1.

Purpose

Improve streamflow for spring outmigration of spring Chinook, sockeye and coho. Reduce diversions by private irrigators that can inadvertently entrap fish in the power plant canals.

Description

Water is diverted at two locations on the Middle and Lower Yakima River to produce power for the Roza Irrigation District and Bonneville Power Administration's (BPA's) power grid. These two projects involve reducing diversions during spring months in order to leave water in the Yakima River to help smolt outmigration from the Yakima basin to the Pacific Ocean. Diversions would be curtailed when flows in the Yakima River drop below certain levels. This would expand an operational practice that has already been used.

Note: the Roza Roller Gate project is not included because it is currently being implemented. This project may also help reduce a portion of the smolt outmigration flow need that would be met through subordination.

Benefits (Preliminary Estimate)

For conditions similar to the drought year 2005, estimates of flow improvements are:

- Improve spring flows in a 14.6-mile reach below Roza Dam by 50 to 300 cfs;
- Improve spring flows in an 11.3-mile reach below Prosser Dam by 0 to 300 cfs.

Cost (Preliminary Estimate)

This project does not have capital costs; however, revenue from power production would be reduced, and/or costs would be incurred for power purchases to replace power currently generated at these locations.

Issues/Uncertainties

- Existing arrangements for power production help offset power needs and costs for Roza and Kennewick Irrigation Districts. Loss of power production will need to be made up through new power production elsewhere or during a different season, or cost impacts will need to be addressed.

- BPA has indicated that current power production at these facilities is economically marginal, and reduced power production could potentially compromise the value of these power facilities.

Kittitas Reclamation District
Main Canal and South Branch Modifications

Summary

Replace open laterals on the Main Canal and South Branch Canal with pressured pipe systems to allow water discharge directly to tributary creeks or to supply water users currently diverting from tributary creeks.

Phase

Phase 1.

Purpose

Increase instream flow in Big, Little, Taneum, and Manastash Creeks by improving laterals within the KRD system.

Description

Four tributaries within the KRD have instream flow problems that could be addressed through changes in KRD infrastructure and operations – Taneum and Manastash Creeks crossing the South Branch Canal, and Big and Little Creeks crossing the Main Canal. KRD currently augments flows in those streams with operational spills and occasionally conveys and discharges water to provide instream flows at Reclamation's request.

Five laterals on the Main Canal (M4.9, M6.1, M7.7, M13.6, and M16.9) and five laterals on the South Branch Canal (SB9.9, SB13.8, SB14.3, SB16.7 and SB17.6) are candidates for replacement with pipe. The laterals would be converted to pressurized systems, reducing seepage and spill at the tail end of the lateral. Increasing capacities of the KRD Main Canal and South Branch Canal laterals would enhance tributary flows by allowing additional discharge to the creeks and/or supplying water users currently diverting from the creeks.

Benefits (Preliminary Estimate)

The volume of water that could be supplied from this project is not precisely known, but is estimated to be 5,400 acre-feet (14.9 cfs on average) throughout the irrigation season). An estimate of benefits to each stream is:

Big Creek:	4 cfs
Little Creek:	3 cfs
Taneum Creek:	4 cfs
Manastash Creek:	4 cfs

Cost (Preliminary Estimate)

The estimated cost for KRD Main Canal and South Branch Canal modifications is $8 to 12 million.

Issues/Uncertainties

This project has not been studied in detail at this time. One issue requiring analysis will be determination of instream flow benefits to tributaries.

Raise Pool Level at Cle Elum Dam

Summary

Raise pool level at Cle Elum Dam 3 feet by modifying the spillway gates and use the additional stored water to enhance streamflows.

Phase

Phase 1.

Purpose

Provide an additional 14,600 acre-feet of storage to enhance streamflows in the Yakima basin.

Description

The reservoir pool level behind Cle Elum Dam would be raised 3 feet by constructing stiffened flatboards (3 feet high by 37 feet long) on the five radial gates of the spillway on the existing dam. Riprap would be placed along the shoreline to provide erosion control from the higher water levels. Section 1206 of the YRBWEP Act authorizes the additional water to be used exclusively for instream flows for fish and wildlife.

Raising the reservoir level would inundate additional land around the reservoir. Reclamation conducted preliminary real estate evaluations in 2002 and estimated the cost of acquiring inundated properties.

Benefits (Preliminary Estimate)

Use of the additional water is restricted to instream flows for fish and wildlife; therefore, there would be no improvements to TWSA.

The greatest flow benefits occur in average years when the additional storage can be refilled and released for instream flow benefit. The entire 14,600 acre-feet would be released on a schedule recommended by fish agencies or by the System Operations Advisory Committee (SOAC). During multiple drought years, the additional storage is not refilled and instream benefits would not occur. As a comparison to other elements, the estimated flow benefits for the third year of a drought (1994) are shown below:

April – September flows at Parker:	small increase
April – September flows at Yakima mouth:	small increase
July – October flow at Umtanum:	no increase

Cost (Preliminary Estimate)

Costs are estimated to be $20 to 40 million.

Issues/Uncertainties

Issues and uncertainties associated with raising the level of Cle Elum Reservoir include:

- Need to coordinate raising the reservoir level with installation of fish passage facilities which are currently undergoing environmental review.

Keechelus-to-Kachess Pipeline

Summary

Transfer water from Keechelus Reservoir to Kachess Reservoir through approximately 5 miles of pipeline.

Phase

Phase 1.

Purpose

Increase water supply and improve streamflows in the Upper Basin.

Description

The watershed contributing flows to Keechelus Reservoir produces substantially more water in proportion to reservoir storage volume than the watershed contributing to Kachess Reservoir. If water could be piped from Keechelus to Kachess, the storage volume available at Kachess could be used to capture water that must now be spilled from Keechelus. In addition, this project offers an opportunity to reduce high summer-time flows in the Keechelus River that can impair fish habitat.

This project offers particular value if combined with the Reservoir Inactive Storage project at Kachess.

Benefits (Preliminary Estimate)

Water supply benefits of this project have been included in the estimates provided for the Reservoir Inactive Storage at Kachess Reservoir (see previous project).

This project offers significant additional streamflow benefits in the 11 miles of the Keechelus River downstream of Keechelus Reservoir to the confluence with the Yakima River mainstem compared with the Reservoir Inactive Storage project without the pipeline. In this reach, high flows could be reduced by diverting water out of Keechelus Reservoir and into Kachess Reservoir.

Cost (Preliminary Estimate)

A preliminary cost estimate is $55 to 65 million. Substantial work is needed to improve this estimate.

Issues/Uncertainties

This is a relatively straightforward project in comparison with the others addressed in this report. Further analysis would be required to determine the optimal size of the pipeline, including consideration of hydrologic characteristics of the two reservoir watersheds.

Section B3 Surface Storage

Wymer Reservoir

Summary

Construct a 162,500 acre-foot off-channel reservoir on Lmuma Creek filled by a pump station located at the dam and/or on the Yakima River near Thorp with a canal/pipeline around Kittitas Valley, including power generation. (Also could include variation of direct pump from Columbia River to Wymer, and connection to other potential off-channel reservoir locations south of Wymer, such as Selah or Burbank Creek or directly into Roza Canal).

Phase

Phase 1 (with potential variations that could be added in Phase 2).

Purpose

Improve water supply to proratables during drought years; improve flows in portions of the Yakima River, Cle Elum River, and Kittitas Valley tributaries (Reecer, Wilson, Naneum, Cherry, and Coleman Creeks); and generate power.

Description

Construct a 450-foot-high dam on Lmuma Creek with a storage capacity of 162,500 acre-feet. Water would be pumped into the reservoir from the Yakima River during winter and spring. Reclamation evaluated a Wymer Reservoir option in its Storage Study with the reservoir filled by direct pumping from the Yakima River at the dam and/or near Thorp. The pumping costs for that option were considered too high.

An option for filling the reservoir using a pump station constructed on the Yakima River near Thorp is included. Water would be pumped to an expanded Kittitas Reclamation District (KRD) North Branch Canal or a separate pipeline generally following the route of the North Branch Canal. A tunnel would carry water from the Badger Pocket area through Manastash Ridge to a point above Wymer Reservoir. A hydroelectric plant would be constructed at the outlet of Wymer Dam. The energy generated at the plant would approximately offset the energy required by the pumping plant at Thorp.

The KRD North Branch Canal would need to be enlarged to provide capacity to fill the reservoir and other improvements would be needed to KRD facilities to accommodate the additional flow. The North Branch Canal would also be used to convey water in the summer. This would reduce the current high flows in the Yakima River between Thorp and Wymer. Additional flow benefits would include reduced high flows in the Cle Elum River in summer. Improvements to the North Branch Canal would also allow water diversions in tributary streams to be reduced, improving tributary streamflow conditions.

Benefits (Preliminary Estimate)

This project would provide 80,000 acre-feet for proratable irrigation water supply in drought years and 82,500 acre-feet for fish enhancement purposes.

Examples of yields for a 3-year drought (1992 to 1994 conditions) are:

Increase in TWSA in Year 1:	none
Increase in TWSA in Year 2:	none
Increase in TWSA in Year 3:	80,000 acre-feet

The estimated flow benefits for the third year of a drought (1994) are shown below:

April – September flows at Parker:	large increase
April – September flows at Yakima mouth:	large increase
July – October flow at Umtanum:	large decrease

These examples are intended solely to illustrate the expected scale of benefits and are based on specific operational assumptions. Benefits could be adjusted across years or between purposes, depending on operational rules adopted for the reservoir.

Cost (Preliminary Estimate)

A preliminary estimate of cost is $1.2 to 1.6 billion, with mitigation estimated at an additional $10 million. Substantial work is needed to improve this estimate.

Issues/Uncertainties

Plans to fill the reservoir using the canal/pipeline option from near Thorp have not been evaluated in detail. This will require investigation and design of a conveyance system from Thorp.

Consideration is also needed regarding additional variations with Columbia River pump and connection with other potential off-channel reservoirs.

Bumping Reservoir Enlargement

Summary

Expand existing Bumping Reservoir to a 160,000 or 190,000 acre-foot reservoir, depending on location.

Phase

Phase 1.

Purpose

Improve water supply to proratable users during drought years and increase flows in the Bumping and Naches Rivers and in the mainstem Yakima River below Parker gage.

Description

Bumping Reservoir is one of the five major storage reservoirs in the Yakima Project. It was completed in 1910 with a storage capacity of 33,700 acre-feet. Enlargement of Bumping Reservoir has been evaluated in numerous studies for over 50 years. Expanding the reservoir to 458,000 acre-feet has been proposed by Reclamation. Ecology's FEIS on the Integrated Water Resource Management Alternative considered a proposal for a smaller expansion, to 200,000 acre-feet.

To minimize impacts on prime bull trout spawning areas, this proposal is for an expansion to 160,000 or 190,000 acre-feet. The difference in reservoir size depends on the location of the dam. If the dam is located downstream of the existing dam, the reservoir would be 190,000 acre-feet; if the existing dam is modified, the reservoir would be 160,000 acre-feet. It is assumed that the reservoir would be expanded to an elevation of 3,490 feet regardless of the location of the dam.

Benefits (Preliminary Estimate)

RiverWare modeling was previously conducted for an expansion to 458,000 acre-feet but has not been conducted for the expansion to 160,000 or 190,000 acre-feet. However, a spreadsheet model using historic hydrologic data was used to evaluate an expansion to 200,000 acre-feet.

Examples of yields for a 3-year drought (1992 to 1994 conditions) are:

Increase in TWSA in Year 1:	40,000 acre-feet
Increase in TWSA in Year 2:	0 acre-feet
Increase in TWSA in Year 3:	66,000 acre-feet

The estimated flow benefits for the third year of a drought (1994) are shown below:

April – September flows at Parker:	increase
April – September flows at Yakima mouth:	increase

July – October flow at Umtanum: small increase

These examples are intended solely to illustrate the expected scale of benefits and are based on specific operational assumptions. Benefits could be adjusted across years or between purposes, depending on operational rules adopted for the reservoir.

Cost (Preliminary Estimate)

A preliminary cost estimate is $600 million to 1 billion, with mitigation estimated at an additional $20 million. Substantial work is needed to improve this estimate.

Issues/Uncertainties

This specific project has not been studied in detail at this time. Some of the issues requiring analysis will include:

- Feasibility of locating the dam for the expanded reservoir at the location of the existing dam.
- Modeling of TWSA and flow benefits using specific reservoir size and operational assumptions.
- Environmental impacts and potential mitigation of expanding the reservoir.

Expanding the reservoir would inundate habitat surrounding the existing reservoir, including northern spotted owl habitat (670 or 982 acres, depending on the location of the dam), late successional forest habitat (693 or 719 acres, depending on the location of the dam), and bull trout spawning habitat (approximately 3,400 linear feet of Deep Creek). The expanded reservoir would also inundate existing recreation facilities including an access road, campgrounds, and private cabins.

Reservoir Inactive Storage

Summary

Extract water from inactive storage in existing reservoirs (most likely Kachess) during drought years.

Phases

Phase 1: Facilities to extract 100 thousand acre feet (kaf).
Phase 2: Facilities to extract 100 kaf more (200 kaf total).

Purpose

Improve water supply to proratable users and increase flows in the mainstem Yakima River during drought years.

Description

Kachess Reservoir in the Upper Yakima River Basin was constructed at the site of a natural lake. As water is released from the existing reservoir, the storage pool can be drawn down almost to the elevation of the original lake surface. However, water below the "minimum-pool" elevation currently cannot be extracted.

This project involves modifying the existing reservoir so that water can be taken at depths below the current minimum pool elevation. From the standpoint of system operations, this is equivalent to enlarging the reservoir. However it has the advantage of not requiring additional land to be inundated, allows the current reservoir to remain operational during much of the construction process, and is less costly than enlarging the existing reservoir. However, additional energy costs may be incurred in drought years.

Tapping inactive storage could be done by pumping water from greater depths within the reservoir through a new pipeline or by constructing a tunnel beneath the bed of the reservoir to allow drainage by gravity flow. The pumping option would likely involve lower upfront construction costs, but would have higher operational costs due to the energy required to lift large volumes of water.

If inactive storage is tapped from Kachess Reservoir, construction of the Keechelus-to-Kachess Pipeline (described separately) would increase project benefits.

Benefits (Preliminary Estimate)

In Phase 1, this project would yield an additional 100,000 acre-feet of water available to either support proratable water users, improve streamflow during low-flow periods, or both. In Phase 2, this project would double this amount, for a total of 200,000 acre-feet. (If the tunnel option is used, it may be advantageous to construct the full capacity in one phase).

Operational rules could be established so that this increased quantity could be managed either for maximum benefits in the first year of a drought, or to extended benefits over longer periods of multiyear droughts.

For the 100,000 acre-foot quantity (Phase 1), examples of yields for TWSA and instream flow for the first year of a drought or in a 1-year drought (2005 conditions) are:

Increase in TWSA:	66,600 af
Increase in water available for Flow:	33,400 af

Examples of yields managed for a 3-year drought (1992-1994 conditions) are:

Increase in TWSA in Year 1:	33,300 af
Increase in TWSA in Year 2:	0 af
Increase in TWSA in Year 3:	33,300 af
Increase in water for Flow in Year 1:	16,700 af
Increase in water for Flow in Year 2:	0 (no releases for flow)
Increase in water for Flow in Year 3:	16,700 af

Benefits would essentially be doubled at the 200,000 acre-foot quantity (Phase 2).

These examples are intended solely to illustrate the expected scale of benefits, and are based on specific operational assumptions. Benefits could be adjusted across years or between purposes, depending on operational rules adopted for this supply.

Cost (Preliminary Estimate)

A preliminary cost estimate is $25 to 50 million. This assumes construction of a pump station, rather than a tunnel. Substantial work is needed to improve this estimate.

Issues/Uncertainties

This project has not been studied in detail at this time. Some of the issues requiring analysis will include:

- Modeling of basin hydrology with the additional water use in drought years.
- Environmental impacts of increasing reservoir drawdown.
- Economic considerations of gravity and pumping options.
- Impacts or benefits of routing water through a pipeline or tunnel to the Kachess River downstream from the existing dam.

Columbia River Pump/Storage

Summary

Pump water from the Columbia Basin contingent on demonstrated need from climate change or other factors. This project includes options with and without storage.

Phase

Phase 2

Purpose

Increase water supplies for proratable users and improve streamflow in the middle and/or lower Yakima basin.

Description

The Yakima River is a tributary of the Columbia River. Two major reservoirs are located behind Priest Rapids Dam on the Columbia River east of the Yakima Project – Wanapum and Priest Rapids Reservoirs, approximately 1-12 miles east of the Yakima basin drainage divide. This project would involve installation of a pump station and pipeline to pump Columbia River water to the Yakima River Basin for water supply and instream flow purposes. All of the water pumped would be delivered to water users. On a preliminary basis, the project is assumed to involve a total quantity of 50 kaf to 350 kaf.

Water could be delivered directly into irrigation canals within the Yakima basin ("direct pump" option) or could be stored in a new reservoir(s) located in one of the dry canyons east of the Yakima River such as Lmuma Canyon (same site as Wymer Reservoir project); or Selah Creek Canyon.

Benefits (Preliminary Estimate)

Water supply: 50 to 350 kaf

Cost (Preliminary Estimate)

To be determined.

Issues/Uncertainties

- There are many claimants to waters of the Columbia River in both Washington and Oregon. Initiating a project to divert water of the Columbia River for use in the Yakima basin is controversial.
- The project would have to meet stringent limitations in order to protect fish and wildlife habitat in the Columbia River basin.
- The project involves a substantial pumping plant to pump water to the Yakima River watershed from the Columbia River. Even with power-recovery elements built into the

project, this would involve substantial energy usage and associated annual pumping costs.

Section B4 Groundwater Storage

Municipal Aquifer Storage and Recovery

Summary

Inject treated Naches River water into wells around the City of Yakima to replace current surface-water diversions. Explore using this method for other municipal water systems in the Yakima basin where feasible.

Phase

Phase 1.

Purpose

Extend municipal supplies to serve growing populations.

Description

Aquifer Storage and Recovery (ASR) involves diverting surface waters during high-flow periods and storing the water in underground aquifers for use during low-flow periods. The City of Yakima has studied this approach and is proposing to implement it to extend its available supplies. Water would be diverted from the Naches River and treated at the City's existing water treatment plant. It would then be injected through wells and later pumped out for use by the City's residents and businesses.

ASR may also be viable for other cities in the Yakima basin. These opportunities will be explored further.

Benefits (Preliminary Estimate)

The City of Yakima project benefits are estimated to be approximately 5-10 kaf.

Cost (Preliminary Estimate)

A preliminary cost estimate is $4 to 6 million.

Issues/Uncertainties

- ASR is a relatively new approach to water management in Washington State and regulatory oversight is still evolving. State agencies with regulatory roles include the Departments of Ecology and Health.
- Performance may vary considerably due to characteristics of local aquifers.

Groundwater Infiltration Prior to Storage Control

Summary

Use stored water in the winter and early spring (prior to "storage control") to recharge groundwater aquifers. Water would be conveyed to recharge locations using existing canals. This technique may offer opportunities to increase streamflow and augment water supply. This concept requires further development and pilot studies.

Phase

Phases 1 and 2.

Purpose

Enhance water storage in the basin by using surface water to recharge aquifers and taking advantage of the natural storage capacity of geologic formations to store water for later recovery or gradual discharge to enhance streamflows.

Description

Aquifers would be recharged with surface water diverted from the Yakima River or tributaries during high-flow periods and prior to storage control. Water right permits would be required to divert, store, and use for recharge. New or existing infrastructure would be used to convey water to recharge sites. The infiltration sites would be located to meet desired timing objectives for passive recharge to enhance streamflows for downstream benefits (flow and supply). Wells and pump stations on drains may also be used to extract water to meet supply needs.

Benefits (Preliminary Estimate)

Enhance spring and early summer flows and water supply. If successfully implemented could result in 150 kaf improvement (or more) in TWSA in a given year.

Cost (Preliminary Estimate)

A preliminary cost estimate is $40 to 100 million. Substantial work is needed to define this approach and improve the cost estimate.

Issues/Uncertainties

- Needs further evaluation to identify more detailed conceptual approaches including conveyance systems, recharge locations, willing landowners, recharge facilities, monitoring, costs, and other considerations.
- Need pilot studies to determine recharge rates and timing back to surface waters.

Water right permits will be required from Ecology. Washington groundwater recharge rules are early in development for this type of recharge, because it is a relatively new approach to water management in Washington State. Therefore, regulatory uncertainty exists as State requirements

are emerging. This concept is being pilot-tested in a few locations in Washington (e.g., Walla Walla basin). Ecology is the lead permitting agency.

Section B5 Fish Habitat Enhancements

Mainstem Floodplain Restoration Program

Summary

Implement program to protect and restore floodplain habitats on mainstem Naches and Yakima Rivers.

Phase

Phases 1 and 2.

Purpose

Protect and restore floodplain habitats on the mainstem Naches and Yakima:

1) Protection of functional floodplain habitats
2) Restoration of floodplain function in major floodplain reaches

Description

The Workgroup has identified the following programmatic elements, funding levels, and timeframes for the floodplain restoration program:

Program Element	Recommended Funding Level*	Geographic Areas	Timing
Mainstem Floodplain Restoration			
Tier I – Existing projects with estimated budgets	$25M	Union Gap, Ellensburg Floodplain (Schaake), Lower Naches	Phase I (Years 1 – 7)
Tier II – Existing planning efforts underway	$50M ($2M/yr for 5 years; $4M/yr for 5 – 15 years)	Upper Ellensburg/Kittitas, Wapato, Naches/Nile, Selah/Taylor Ditch, Easton	Years 1 – 15
Tier III	$30M ($1M/yr for 30 years)	Benton City/West Richland, Yakima Delta, & all other areas	Years 1 - 30
Program Management (management and oversight, preliminary design)	$7.5M (or $0.25M/yr)	Basinwide	Years 1 – 30
Total	**$112.5M**		

*2009 dollars

Benefits (Preliminary Estimate)

This program will make significant progress toward meeting delisting goals for ESA-listed steelhead and bull trout and should significantly increase Chinook production. It will significantly improve prospects for recovering fish populations to levels that can sustain harvest and are resilient to catastrophic events and the potential impacts of climate change by

accelerating ongoing efforts to protect existing high-value habitats, improve fish passage, enhance flows, improve habitat complexity, and reconnect side channels and off-channel habitat to stream channels.

It will help create improved spawning/incubation, rearing, and migration conditions for all salmonid species in the Yakima basin, implement key strategies described in the Yakima Subbasin Plan, and complete most of the actions described in the Yakima Steelhead Recovery Plan, in combination with tributary habitat enhancement program.

Cost (Preliminary Estimate)

See table above. With contingency, costs could range from $115 to $150 million.

Issues/Uncertainties

- Need to conduct key tributary and mainstem floodplain restoration reach-level conceptual planning and budget estimate validation/updates as part of 2010 Yakima River Basin Study, in partnership with local agencies. Also, consider whether programmatic National Environmental Policy Act (NEPA) review documentation could be developed as part of this effort.
- Consider how floodplain restoration program could be integrated with county flood hazard reduction planning efforts.

Tributaries Habitat Enhancement Program

Summary

Implement habitat enhancement program to protect and enhance tributary habitats. Fund headwaters restoration and emergent opportunities.

Phase

Phases 1 and 2.

Purpose

Protect and enhance tributary habitats:

1) Improve riparian conditions and instream complexity
2) Maintain and restore connections with floodplains and headwaters
3) Ensure appropriate tributary flow regimes for fish needs
4) Improve upstream and downstream fish passage

Description/Cost Summary

The Workgroup has identified the following programmatic elements, funding levels, and timeframes for the habitat enhancement program:

Program Element	Recommended Funding Level*	Geographic Areas	Timing
Tributaries Program			
Passage/Screening Projects	$13.85M	Upper and Middle Yakima	Years 1 – 15
Habitat Restoration (Below Reservoirs)	$16.3M	Upper and Middle Yakima	Years 1 – 15
Wilson/Naneum	$12.25M	Wilson/Naneum	Years 1 – 10
Headwaters Restoration	$8.25M ($0.5M/yr)	Headwaters above reservoirs and on USFS lands	Years 1 – 30
YN Reservation Screening/Passage/Restoration	$25M	Satus and Toppenish Creeks	Years 1 –10
Emergent Needs Fund: Acquisition/Conservation Easement Opportunities	$15M ($5M upfront plus $0.5M/ yr)	Basinwide – tributaries	Years 1 – 20
Total	**$91 M**		

*2009 dollars

Benefits (Preliminary Estimate)

This program will make significant progress toward meeting delisting goals for ESA-listed steelhead and bull trout. It should significantly increase Chinook production. It will significantly improve prospects for recovering fish populations to levels that can sustain harvest and are resilient to catastrophic events and the potential impacts of climate change by

accelerating ongoing efforts to protect existing high-value habitats, improve fish passage, enhance flows, improve habitat complexity, and reconnect side channels and off-channel habitat to stream channels.

It will help create improved spawning/incubation, rearing, and migration conditions for all salmonid species in the Yakima basin, implement key strategies described in the Yakima Subbasin Plan, and complete most of the actions described in the Yakima Steelhead Recovery Plan, in combination with floodplain restoration program.

Cost (Preliminary Estimate)

Provided above. With contingency, costs could range from $95 to 130 million.

Issues/Uncertainties

- Need to conduct key tributary conceptual planning and budget estimate validation/updates as part of 2010 Yakima River Basin Study in partnership with local agencies.
- Need to coordinate with U.S. Forest Service on headwater tributary enhancements.

Section B6 Enhanced Water Conservation

Agricultural Water Conservation

Summary

Continue and expand a water conservation program to reduce water demands for irrigators and improve streamflows in targeted reaches.

Phase

Phase 1 would include YRBWEP conservation projects plus some Enhanced Water Conservation Element projects (see discussion below). Phase 2 would include additional Enhanced Water Conservation projects.

Purpose

Reduce the amount of water required to be diverted or used for irrigation by increasing efficiency in the transport, delivery, and application of irrigation water.

Description

Agricultural water conservation includes an aggressive program of irrigation district infrastructure improvements, and on-farm conservation and irrigation efficiency improvements. This program includes measures that are currently being evaluated for Yakima River Basin Water Enhancement Project (YRBWEP) funding and additional projects that go beyond the current funding ceiling for YRBWEP. The additional projects were described as the "Enhanced Water Conservation Element" in Ecology's June 2009 Final Environmental Impact Statement (FEIS).

Specific agricultural water conservation measures include lining or piping existing canals, automating canals, constructing reregulating reservoirs on irrigation canals, improving water measurement and accounting systems, installing onfarm water conservation improvements and other measures.

Water conservation programs implemented under the current YRBWEP allocate two-thirds of the conserved water resulting from a conservation measure to instream flows with one-third of the conserved water retained by the implementing entity for irrigation use. It is assumed that the two-thirds portion remains in the river from the implementing entity's point of diversion to the last point of operational discharge from its water delivery system. The distribution of the water conserved by projects under the Enhanced Water Conservation Element has yet to be determined. In Ecology's FEIS it was assumed that all savings from agricultural conservation projects implemented under the Enhanced Water Conservation Element would become part of the Total Water Supply Available (TWSA) to be managed by Reclamation for all water users.

Benefits (Preliminary Estimate)

Agricultural water conservation would increase TWSA during drought years and increase instream flow in various reaches of the Yakima and Naches Rivers. For a 1-year drought (2005 conditions), examples of estimated benefits are:

Increase in TWSA:	98,000 acre feet (af)
Increase in water flow at Parker:	65,000 af

For a 3-year drought (1992-1994 conditions), examples of estimated benefits are:

Increase in TWSA in Year 1:	95,000 af
Increase in TWSA in Year 2:	42,000 af
Increase in TWSA in Year 3:	8,000 af
Increase in water flow at Parker in Year 3:	68,000 af

Actual benefits will be dependent on projects implemented.

Cost (Preliminary Estimate)

The estimated cost for water conservation measures being evaluated under YRBWEP is $143 million. The estimated cost of the Enhanced Water Conservation Element is $425 million. This totals approximately $570 million. Phase 1 would include full implementation of YRBWEP plus some of the Enhanced projects for a total Phase 1 cost of $300 million. Phase 2 would include further enhanced projects funded at an additional $270 million. Actual costs will depend on the projects implemented.

Issues/Uncertainties

Individual projects within the agricultural water conservation program are at various levels of the evaluation process. Many projects require additional analysis and evaluation to determine feasibility and benefits at a greater level. Some issues requiring analysis include:

- Determination of entity interest in implementing projects.
- Determination of distribution of water conserved by project implementation.

Municipal/Domestic Conservation

Summary

Reduce water used by municipal water systems and rural households, through projects and programs that promote water-use efficiency.

Phase

Phases 1 and 2.

Purpose

Extend available municipal water supplies to serve ongoing population growth. Provide streamflow benefits where applicable.

Description

A variety of water conservation techniques can be applied to manage water demands in the municipal and industrial sector, as well as by individual homeowners using domestic wells. This program will expand and accelerate the adoption of water conservation practices and installation of water-efficient equipment for these users. In addition, this program will explore how efficiencies can be realized as farmland is converted for urban and residential uses.

This preliminary IWRMP action has not been developed at this time, and will require further attention as an element of the 2010 Plan of Study.

Benefits (Preliminary Estimate)

As part of the 2009 Workgroup process, an "order-of-magnitude" estimate was developed of how much municipal and domestic water production could be reduced through application of a comprehensive suite of common water conservation measures, coupled with reduction in leakage of municipal water distribution systems. The total reduction in water produced was estimated as follows, for varying levels of participation by residents and businesses throughout the Yakima basin:

Variable Participation (5-50%):	7,100 acre feet (af)
25% Participation:	7,500 af
50% Participation:	11,500 af
75% Participation:	15,400 af

These quantities represent total reductions in water pumped or diverted without adjusting for return flow effects from septic systems and municipal wastewater systems. Since much of the water produced currently is returned to surface or groundwaters of the Yakima basin, benefits to streamflow would be substantially lower than these water reduction estimates.

Cost (Preliminary Estimate)

A preliminary estimate is $1 to 3 million. Substantial work is needed to improve this estimate.

Issues/Uncertainties

- More detailed analysis would be needed to refine the preliminary work done to date.
- Implementation of water conservation on a consistent basis across the Yakima basin would require involvement by many local jurisdictions.
- Programs targeting municipal water system customers are likely to be more successful than programs targeting rural domestic well owners.
- The issue of water-use efficiency for lands converted from agricultural to urban uses has not been addressed at this time.

Section B7 Market-Based Reallocation of Water Resources/Transfers

Summary

Continue existing programs and policies that support transfers of water within the Yakima basin and take additional steps to reduce impediments to transfers.

Phase

Phases 1 and 2.

Purpose

Improve the flexibility of water supply and improve the economic value of goods and services produced using the basin's water resources.

Description

Ecology's 2009 FEIS on the Integrated Water Resource Management Alternative explored several options regarding water transfers and water banking. The FEIS recommends a combination of short-term options that would improve on existing programs and policies together with long-term options that would require substantial changes in existing laws and administrative structures.

Short-term options include:

- Seeking expanded jurisdiction for the Yakima Superior Court to expedite temporary transfers
- Seeking new authority for the Court to process permanent transfers
- Seeking new authority for the Court to process groundwater transfers
- Amending the "Hillis Rule" to support expedited processing of water bank transactions
- Exploring approval of temporary/seasonal transfers while a permanent transfer is being processed

Long-term options would go further to open the water market to a larger group of participants and change the administration of water rights. The long-term options are focused on irrigation districts as a central intermediary to facilitate transfers.

These short- and long-term approaches will be further developed with the objective of reducing impediments to water transfers and banking while continuing to protect the rights of third parties not involved in these transactions, maintaining a robust agricultural economy in the basin, and ensuring that transfers do not disrupt Reclamation's operational obligations.

Benefits (Preliminary Estimate)

In contrast with other elements of the preliminary IWRMP, this element would redistribute water supplies rather than expanding water supplies. Redistribution would promote flexibility among uses and increase economic outputs. Quantities are estimated as follows:

Phase I: potential reallocation of 20-40 kaf from sellers to buyers.
Phase II: increase potential reallocation to 40-80 kaf from sellers to buyers.

These estimates are provisional and depend on the nature of the changes accomplished as well as the level of participation by buyers and sellers in future years.

Cost (Preliminary Estimate)

Costs of institutional improvements to facilitate market-based transfers have not been estimated at this time. Costs would likely consist of long-term annual operating costs for the Yakima Superior Court and/or other administrative frameworks developed to support transactions. These costs are expected to be relatively low compared with other actions in the preliminary IWRMP.

Issues/Uncertainties

- This element requires a number of changes in procedures and/or legal authorities across institutional boundaries. Involved parties may include the State Legislature, Yakima Superior Court, Department of Ecology, Bureau of Reclamation, and/or participating irrigation districts. The number of parties involved creates uncertainties in implementing this action.
- Once institutional frameworks have been modified to support transfers and banking, irrigation districts and/or individuals with entitlements to surface and/or groundwater will need to participate in order to actually achieve the objectives. The level of participation cannot be predicted with high certainty.