CHAPTER 4: WATER SUPPLY INVENTORY

4.1 Introduction

This Chapter presents the results of the inventory requirements of ESSHB 2860. It includes a combination of information specifically required under ESSHB and some related inventory information not presented in Chapter 3. The inventory was compiled using existing documents and primary data from multiple sources. Table 4-1 summarizes the sources of information used for the inventory. In some cases, documents were identified but unavailable due to the short timeframe required for completion of this first legislative report.

4.1.1 Overview and Components of the Inventory

The options for allocating water rights from the Columbia River system under ESSHB 2860 focus on ways to allocate conservation savings (attributable to consumptive portion of the total savings) and new and existing storage (surface and ground water storage). Section 5 of ESSHB 2860 defines the required elements of the water supply inventory as:

- A list of conservation projects that have been implemented under this Chapter and the amount of water conservation achieved; and
- A list of potential water supply and storage projects in the Columbia Basin, including:
  - Cost per acre-foot;
  - Benefit to fish and other instream uses;
  - Benefit to out-of-steam uses; and
  - Environmental and cultural impacts.

Section 6 of ESSHB 2860 describes information requirements for a Columbia River mainstem water information system that includes:

- Total aggregate quantity of water rights issued under state permits and certificates, and filed under state claims on the Columbia River mainstem and for ground water within one mile of the mainstem; and
- Total volume of current water use under these rights as metered and reported by water users.

The water supply inventory described in this section of the report combines the information requirements under Sections 5 and 6 of ESSHB 2860. The information associated with these sections of the Bill will be updated annually.

To date, no conservation projects have been implemented under this chapter of the Bill. Therefore, this report provides an inventory of potential conservation projects and potential storage projects. Similarly, the short time-frame in which this report was prepared limited the ability to conduct a survey of water rights and water use. Existing data on water rights and water use from agency databases has been compiled and presented here with minimal confirmation and no field verification. Conclusions based on this information should be carefully considered. Chapter 5 provides further discussion of the use of these data for forecasting and analysis.

4.1.2 Organization of this Chapter

This Chapter contains sections, which are organized in pairs to present relevant

background information, followed by the results of the respective inventories:

- Section 4.2 contains an overview of water conservation generally, including relevant information compiled from the sources described in Table 4-1.
- Section 4.3 contains the results of the Conservation Inventory, in conformance with Section 5 of ESSHB 2860.
- Section 4.4 contains an overview of water storage generally, including relevant information compiled from the sources described in Table 4-1.
- Section 4.5 contains the water storage inventory, in conformance with Section 5 of ESSHB 2860.
- Section 4.6 contains an overview of water rights generally, including a discussion of some important aspects that are relevant to the Columbia River Water Management Program.
- Section 4.7 contains the water rights inventory, in conformance with Section 6 of ESSHB 2860
- Section 4.8 contains and overview of water use generally.
- Section 4.9 contains the water use inventory, in conformance with Section 6 of ESSHB 2860.

4.2 Water Conservation Overview

There are many water conservation strategies that are, or can be, applied to the different water use types in the Columbia Basin system. Conservation is not achieved quickly, and is generally considered a long-term management approach to reducing the total water demand over time. Successful implementation of conservation strategies can result in eventual savings that are realized in the Columbia River. These realized savings could improve streamflows in the Columbia River or they could be allocated for additional out-of-stream beneficial use. Not all conservation projects will result in an immediate savings in the Columbia River. The savings that "accrue" to the river will depend on a number of factors, including:

- the distance between the point of savings and the river, which creates a time lag;
- the dynamics of natural recharge and other return flows to the river, which complicates the analysis of conservation savings; and
- the ability to quantify and monitor consumptive versus non-consumptive water savings.

Conservation measures are applied to agricultural practices (both on-farm and to conveyance facilities), to municipal and domestic water use, and to industry. So while conservation has spatial and temporal complexities that require consideration when evaluating benefits to the Columbia River, compared to the long-term storage options considered under the Management Program, conservation is expected to yield more rapid benefits to instream flows and the potential for permits for out-of-stream demand.

4.2.1 Agricultural Production

Growers in arid parts of Eastern Washington, northeastern Oregon, and southern Idaho rely on Columbia Basin water to produce wheat, corn, potatoes, peas, alfalfa, apples, grapes, and a large variety of other grains, fruits, and vegetables. Diversions for agriculture typically occur between April and October while municipal and domestic demands occur year-

round. Water withdrawals typically peak during the summer months when flows are lowest. An inventory and econometric forecast for agricultural production is summarized in Chapter 5.

Approximately one-half of the Columbia Basin Project (CBP)-authorized lands are not yet irrigated, and any water diverted for these new lands in the project area would also be senior to the mainstem instream flow rights. The Bureau of Reclamation is authorized to deliver up to 3,158,000 acre-feet of water per year at full build out of the CBP.

4.2.2 Agricultural Water Conservation

Water conservation activities in irrigated agriculture have been ongoing in Washington State in response to droughts and water supply shortages as well as to modernize irrigation facilities, reduce energy use, improve water quality and provide better management of water both in irrigation system facilities and on-farm.

Relatively small changes in agricultural demand can yield large quantities of water. The types of agricultural water conservation activities typically used in the Columbia Basin are summarized below. This list of activities was used in surveys of irrigation districts and conservation districts to determine where potential future water savings may occur with additional funding.

- Lining/Piping: The conversion of open-ditch water conveyance delivery systems to a more efficient delivery pipe or the placement of an impermeable liner within a ditch.
- On-Farm Efficiency: The installation of a more efficient irrigation application system. Examples would include a conversion from flood or rill/furrow irrigation to center pivot technology. Also, the replacement of hand-lines or less efficient sprinkler systems to drip irrigation.
- Management: The application of a system of managing water applications that creates water savings through scheduling changes or other management practices. Irrigation Water Management (IWM) is an example of a management tool that may create water savings. Canal automation is another example.
- Fallowing Corners: Occurs when a center pivot with a round irrigation pattern is installed on a square(ish) field and the landowner decides to fallow the corners in lieu of irrigating them by some other method.
- Acquisition: The selling of whole or partial water right to state or federal agencies or to private conservation organizations. A landowner decides to permanently fallow a previously irrigated field or portion thereof.
- Tail Water Reuse: The capturing and reuse of tail water from a field or conveyance system rather than returning it back to the stream.
- Re-regulating/Storage Reservoirs: The installation of a reservoir to store fluctuations in canal flow for release at a later time, reducing the amount of water spilled at the end of a system. Also includes the installation of a reservoir to store water during high streamflow periods for use later in the season during low streamflow periods.
- Permanent Crop Change: A permanent change in a crop grown on a field to one with a smaller irrigation requirement. A change from tree fruit or alfalfa to grapes would be an example.
- Split-Season Acquisition: When a farmer voluntarily forgoes mid to late season

irrigation. An example is when a hay farmer decides to harvest only the first cutting of hay and forgo the rest of the season through a lease or contractual agreement.

- Land Conservation Program: A riparian or upland conservation program that removes irrigated land from production for some state or federal conservation program purposes. Conservation Reserve Enhancement Program (CREP) and Conservation Reserve Program (CRP) are potential examples where irrigated agriculture may have been fallowed or put to use for some other conservation practice that does not require irrigation.
- Power Buyback: Where formerly irrigated lands have been voluntarily fallowed in a contractual agreement with an electrical power provider. This occurred in the 2001 drought.
- Surface to Ground Water Conversion: When a well is drilled to be used as a primary source for a water right that was previously served from a surface water source. Water savings may accrue from a reduction in canal seepage. This technique may be used in some areas to mitigate for low instream flows.

Gravity surface water diversions are usually the least efficient means of distributing water to irrigators because of the long lengths of canal between the diversions and the leaky nature of canals. Canal efficiencies in Washington State have a wide range; from very efficient (around 90%) to very inefficient (about 20% of the water diverted is delivered to irrigators). Water that is saved as a result of improvements to irrigation facilities (lining, piping, improved management, regulation reservoirs) results in a reduced diversion and increased streamflow at the point of diversion. However much of the water that leaks or spills from canals usually returns to the river system from which it was diverted through direct discharges of spills and ground water return flow. That return flow enters the river system downstream of the original point of diversion. The reduced diversion provides a benefit as flow in the river increases from the original point of diversion to where the return flow reenters the river system. The timing of ground water return flow to the river is not immediate and may be delayed for a short period (days to months) depending on the location of the canal relative to the river and the geology of the aquifer. Leaks from canal systems also often feed ground water aquifers from which other irrigators or water users pump.

Improvements to on-farm irrigation practices have also been demonstrated to save a large quantity of water. Crop irrigation requirements typically range from 2.5 to 4 acre-feet/acre in the Columbia River Basin and irrigation efficiencies range from around 50% for some furrow irrigated lands to over 95% for some of the newest micro irrigation practices (Ecology, 2005). A reduction in on-farm use by improving irrigation efficiencies will have the same impacts as discussed for canal system improvements: a reduction in seepage, which reduces diversions and increases streamflow except when the seepage returns to the river from which it was diverted.

4.2.3 Return Flow from Water Conservation Projects

The timing of return flow resulting from canal or on-farm seepage is important when reviewing the effect of water conservation projects and determining the project benefits. An example

where return flow is an important component of water supply for others is in the Yakima Project. The Bureau of Reclamation has studied return flow characteristics of water lost through seepage from canals and farms and spills from canals as part of the Yakima Project. They determined that about one-half of the water diverted for irrigation returns to the Yakima River through seepage and return flow. Of that water one-half returned within one month. The lag time for the remainder was two months (EES, 2000).

In reviewing the effect of water conservation measures in the Columbia River Basin, the timing of return flow is also important. The timing of the return flows will be variable and will need to be reviewed on a case-by-case basis. If it takes a long time for seepage water to return to the Columbia River, then water conservation measures may result in an improvement in flows during the irrigation season through reduced diversion but may cause a reduction in flows in the late fall. The reduction in the fall is because seepage water that would otherwise return at that time has been conserved. Credit for the reduced diversions during July and August should consider this time lag.

4.2.4 Change in Consumptive Use from Water Conservation Projects

Water is used consumptively in irrigation distribution systems through evaporation from open canals and drains and evapotranspiration (ET) from vegetation growing along canal banks. It is difficult to separate seepage losses from evaporation and ET losses in canal systems but generally the evaporation and ET losses are much less than seepage losses. Evaporation losses are usually calculated using pan evaporation data for the area and multiplying by the surface area of the water in the canal. ET losses are usually calculated by measuring the area of vegetation and multiplying by a crop irrigation requirement for the vegetation found growing along the canals. The evaporation and ET losses from open canals are usually less than 5% of the total amount of water diverted.

Water is used consumptively in irrigating crops through evapotranspiration and can be consumed through evaporation of water sprayed into the air (spray evaporative loss), evaporation off the plant canopy (canopy loss) and it can blow off the irrigated property (wind drift) (Ecology, 2005). Ecology has published guidance on determining irrigation efficiency and crop consumptive use (Ecology, 2005) which is the source of the information contained in this section.

Evapotranspiration can be calculated using many different methods or derived from services that provide real-time crop consumptive use estimates (such as AgriMet and PAWS). Spray evaporative losses depend on the type and configuration of sprinkler system, climatic and wind conditions. Smaller losses (0-2%) occur when using sprinklers lower to the ground during low wind conditions while losses from high overhead sprinklers during high wind periods can exceed 10% (Ecology, 2005). Canopy loss varies based upon crop type, crop leaf area, crop growth stage, and method of irrigation. The net increase in evaporative loss

is estimated to be in the range of 3-5% for typical conditions.

Wind drift causes water to drift out of the area it is being applied to. If water drifts out of the property, it is considered to be consumed. If it falls into another part of the field, then it may slightly increase canopy loss. The net consumptive magnitude of wind drift under most conditions is a few percent (Ecology, 2005).

The Ecology guidance presents estimates of the percentage of total evaporative losses and return flow for various irrigation methods. Table 4-2 summarizes that information. It also presents examples of how to use the table to determine the consumptive use benefits of a water conservation project.

4.2.5 Municipal Water Conservation

4.2.5.1 Municipal Water Law

The Municipal Water Supply - Efficiency Requirements Act Chapter 5, Laws of 2003 provides greater certainty and flexibility for water rights held by public utilities, and more closely ties water system planning and engineering approvals by the Washington Department of Health (DOH) to water rights administered by the state Department of Ecology (Ecology). Commonly called the "Municipal Water Law," the act requires the DOH to change many of the processes and procedures it uses to approve water system plans. These changes affect the DOH's water system planning process and provide some unique benefits (including greater water right flexibility and certainty) to many water utilities. There are several areas where the Municipal Water Bill is relevant to the Columbia River Water Management Program. Table 4-3 summarizes some of the conservation-related components of the new law (http://www5.doh.wa.gov/ehp/dw/municipal_water/municipal_water_law.htm).

- Chapter 90.03.015(3) and (4) RCW - Municipal water supplier definition. Provides the definition of a municipal water supplier and establishes municipal water supply purposes.
- Chapter RCW 90.03.260(4) and (5) RCW - Water right connection/population limitations. Clarifies the state's Water Code by stating that the number of water service connections and population are not limiting attributes of water rights for water systems that have a DOH approved water system plan (WSP) or other approval that specifies the number of connections.
- Chapter 90.03.386(1) RCW - Plan Review Coordination between DOH and Ecology. Amends the state's Water Code directing DOH and Ecology to coordinate WSP approval procedures with water right determination procedures for both WSP and small water system management programs (SWSMP).
- Chapter 90.03.386(2) RCW - Service Area Consistency. Allows a municipal water supplier to expand the place of use on its water right to all areas included within the service area described in its approved WSP or SWSMP. This benefit is provided if the water right holder is in compliance with the terms of its WSP and the service area is consistent with applicable approved comprehensive plans, land use plans, development regulations, coordinated water system plans and watershed plans. A utility's place of use is not reduced if the service area identified in an approved WSP or SWSMP is smaller than the place of use identified in the water right.

- Chapter 90.03.386(3) RCW - Conservation requirements for systems with 1,000 or more connections. Provides direction on conservation to water systems with 1,000 or more connections. This includes reporting the conservation measures the utility has put into practice in the past and how those measures have increased its water use efficiency. It also directs water systems that are using inchoate portions of a water right certificate to describe how they could delay the use of the inchoate water rights through additional cost-effective conservation measures. "Inchoate" water rights are the portion of a water right permit that has not been "perfected" (put to beneficial use).
- Chapter 70.119A.180 RCW - Current conservation programs and the conservation rule. Directs DOH to develop water conservation rules by the end of 2005 and to involve key stakeholders in the process. It also directs municipal water suppliers to continue to meet current conservation planning requirements and continue implementing their current programs.
- Chapter 43.20.260 RCW - Local government consistency and duty to serve. Requires new services within a water system's service area to be consistent with applicable approved local land use plans, comprehensive plans, and development regulations. Water utilities must delineate retail service areas in their WSP. Water systems with DOH approved WSPs now have a duty to provide service to new connections within their retail service area.
- Chapter 90.46.120(3) RCW - Reclaimed Water. Requires systems serving 1,000 connections or more to evaluate reclaimed water opportunities.

Depending on the type of conservation and efficiency practices in a given municipality, water savings may yield either consumptive savings or reduce return flows. For example, efficiency practices that reduce pipe leakage would reduce return flow, whereas practices such as lot size or lawn watering restrictions could serve to reduce both consumptive use and return flow.

4.2.6 Reclaimed Water

"Reclaimed water" is defined as effluent derived in any part from sewage from a wastewater treatment system that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use or a controlled use that would not otherwise occur and is no longer considered wastewater (Ecology, 1998). Reclaimed water is an important water resource that can support multiple seasonal and year-round uses including streamflow augmentation, irrigation, wetlands creation or enhancement, industrial water supply, ground water infiltration and other applications.

The Washington Reclaimed Water Act (90.46 RCW) was approved in 1992 to encourage the development of water reclamation facilities so that reclaimed water could be made available to help meet the growing water needs of the state. The Washington State Water Reclamation and Reuse Standards (Reuse Standards) provide guidelines for water reuse applications (Ecology, 1997). These standards were jointly developed by stakeholders including the DOH, Ecology, the Water Reuse Advisory Committee, interested stakeholders, and a consultant team of nationally recognized water reuse experts.

The Reuse Standards describe allowable, direct, beneficial uses of reclaimed wastewater, and the required level of treatment appropriate for each

use. Achieving reuse standards typically requires treatment and disinfection beyond what most conventional wastewater treatment facilities provide. What differentiates a water reclamation facility from a wastewater treatment facility are the additional treatment and reliability and redundancy features, such as automated alarms, redundant treatment units, and emergency storage. These features ensure that the water is being treated to a level that is suitable for a direct beneficial use.

There are four classes of reclaimed water, A through D, described in the Reuse Standards. Class A requires the "highest" level of treatment. The classes are differentiated by the degree (or absence) of additional treatment provided after secondary treatment. Examples of allowable uses for each reclaimed water class are provided in Table 4-4. Some reclaimed water uses, including ground water infiltration, indirect potable reuse, wetland discharge, and streamflow augmentation, require additional treatment beyond that described for a specific reclaimed water class.

Whether a reclaimed water project would yield consumptive water savings or create additional impacts to waters of the State depends on the historic disposal method of the wastewater. For sprayfield and land application disposal, a new reclaimed water facility could result in "new" water to the system. For historic NPDES wastewater discharges to a river, treating that water to a higher standard would not increase water availability. Every reclaimed water project must consider whether the exclusive right to reclaimed water afforded in Chapter 90.46 RCW impairs existing water rights.

4.3 Water Conservation Inventory Results

An inventory of potential agricultural and municipal conservation projects is presented below to fulfill Ecology's obligations as described in Section 5 of the ESSHB 2860. Potential agricultural conservation projects were identified by conservation districts and irrigation districts within the Columbia Basin. About half of the conservation districts participated and together, identified over 5,000 potential conservation projects. Potential municipal conservation projects were identified by reviewing water system plans of the largest municipalities within the Management Zone. It is expected that future inventory reports to the Legislature will include more comprehensive estimates of water conservation savings.

4.3.1 Conservation District Survey

In July of 2006, Ecology contracted with the Washington State Conservation Commission (the Commission) to assist in identifying conservation projects for the Columbia River Water Supply Inventory (RCW 90.90.040). The Commission implemented this contract by creating the Columbia River Project Inventory Grant Program (Program).

Technical assistance funds under the Program were offered to the conservation districts of central and Eastern Washington whose boundaries included the Columbia River or one of its tributaries. About half of the districts inside the target area requested funds to help

populate an inventory spreadsheet provided to them. Several other districts chose to assist with the inventory using funding from other sources. Together, the participating conservation districts identified over 5,000 water conservation projects despite the short lead time to assess feasibility and apply for funds (about 2 weeks) and the short timeframe (about 1 month) available to collect the desired data.

While the initial screening for this first legislative report generated numerous potential conservation projects that could improve flows and serve as a source of additional supply for the Columbia River, it is expected that future reports will include greater participation by districts.

The inventory spreadsheet distributed to the conservation districts, prepared by Ecology, the Commission and the consultant team is presented in Appendix C. The primary information requested included the type of project, location, estimated water savings, estimated cost, priority of the project by the entity who would implement it, and a description of the project. A summary of the projects is shown in Table 4-5 by County and Table 4-6 presents a summary by project type. Figure 4-1 shows the results of the conservation survey on a map. The entire data inventory is provided in Appendix C.

A total of 5,315 projects were obtained from the conservation districts, and most (5,214) were on-farm conservation projects, 33 are lining/piping projects and the other projects include tailwater reuse, storage, irrigation water management, surface to ground water conversion, water right purchase projects. An explanation of these types of conservation projects is presented in Section 4.2. The total estimated water savings (consumptive and non-consumptive) are approximately 530,000 acre-feet with a total estimated cost of $663,000,000. The average cost per acre-foot for the projects is approximately $1,250.

The costs and water savings presented should be viewed as preliminary and used only to screen or compare projects within the inventory. A more detailed analysis of each set of projects is necessary before assessing the benefits of individual projects to the Columbia River.

4.3.2 Irrigation District Conservation Inventory

The conservation projects inventory request was also distributed to irrigation districts that are members of the Washington State Water Resources Association (WSWRA) and to other districts by individual contact (Appendix C has a list of the irrigation district and companies). A number of water conservation plans completed by irrigation districts were also obtained and reviewed. From this information, additional projects were identified and added to the water conservation inventory. A summary of the irrigation district projects is shown in Table 4-7 (the entire spreadsheet is provided in Appendix C).

A total of 82 projects or groups of projects within irrigation districts were obtained from the inventory. Most (52) were lining/piping projects, followed by 7 storage/re-regulation reservoir projects, 16 water management

projects and 5 on-farm water conservation projects. Many of the districts inventoried grouped a program of replacing canals or laterals into one project. The total estimated water savings are approximately 425,000 acre-feet with a total estimated cost of $450,000,000. The average cost per acre-foot for the projects is approximately $1,100. However, many of the projects had cost estimates prepared 5-10 years ago which means the costs are probably underestimated. They were not updated for this study as more detailed engineering analyses would be needed to accurately estimate costs for the projects. These total estimated costs and water savings should be viewed as being very preliminary and should be used only to screen or compare projects within the inventory. More detailed evaluation of the costs and water savings will be needed before determining the benefits of individual projects.

4.3.3 Municipal/County Conservation Inventory

Water system plans for the seven largest municipalities in the Columbia Basin were reviewed for current and future water use, demand, and conservation information, including water reuse. Few of these plans provided quantitative information regarding current conservation and reuse. However, water system plans for the City of Chelan and the City of East Wenatchee did provide some information, which is summarized in Table 4-8. An estimated 13 AFY is conserved by the City of Chelan, which is approximately 1% of their total annual water use. The City of East Wenatchee currently conserves approximately 3 AFY, or 0.1% of their total annual water use. The City of Kennewick estimates that 0.10 AFY is conserved through customer conservation measures such as lower pressure shower heads and low flush toilets. The City of Wenatchee hopes to achieve 4% conservation by the year 2008. The entire data inventory is in Appendix C.

It is expected that future inventory reports to the Legislature as required under ESSHB 2860 will include more ambitious and comprehensive estimates of municipal water conservation savings in response to the requirements of the Municipal Water Bill. Municipal water suppliers will be required to set water use efficiency goals through a public process and report annually on their performance to customers and to DOH, and also make it available to the public. Depending on a water system's size, it would be required to evaluate or implement a prescribed number of water efficiency measures. Water systems with 1,000 or more connections would be required to evaluate reuse options.

A summary of reclaimed water projects that have been implemented in Washington is presented in Table 4-8. It includes a description of the project, the class of reclaimed water produced, and the estimated cost per mgd of reclaimed water.

4.4 Water Storage Overview

4.4.1 Reservoir Storage

Spring runoff is partially stored in large reservoirs to provide flood control benefits,

hydroelectric power generation, navigation, and water for irrigation and other uses. Water stored in the reservoirs is also used to meet federally mandated flow targets for fish. Fifty-five major dams have been constructed by federal agencies, PUD's, and British Columbia agencies on the Columbia River and its tributaries. Hundreds of smaller impoundments have also been developed. Hydropower projects on the Columbia River mainstem and other storage developments in its tributaries within the entire basin have a total active storage capacity in excess of 46 million acre-feet; one-third of the mean annual flow of the Columbia River at The Dalles, Oregon (Ecology and WDFW, 2004).

Tables 4-9 and 4-10 summarize the total volume of existing federal and non-federal dam storage respectively in the Columbia Basin, as reported in the Washington Department of Ecology Dam Inventory database. Most of these projects have multiple purposes of use and are classified based on the first (primary) field in the database. Figures 4-2 and 4-3 show the distribution of existing storage on a map. Appendix C contains a table of all federal and non-federal dams in the Columbia River Basin (Washington only) including their locations, purpose of use, type, and ownership information. The majority of the storage capacity in the Columbia River Basin is located along the mainstem.

4.4.1.1 Reservoir Operations

The Columbia River system is operated in a coordinated manner to meet a combination of flood control, fish migration, and power production needs. Three seasons of system operation exist:

- September-December: Reservoirs are operated according to rule curves as volume runoff forecasts are not yet available. The goal is to make sure the reservoirs are at specific elevations by the end of December.
- January-April: Reservoirs are operated according to volume runoff forecasts. Water is released from storage (the reservoirs are drafted) during this season.
- April-September: Reservoirs are operated to meet flow objectives at Lower Granite Dam on the Snake River and McNary Dam on the Columbia River. Flow objectives are established to enhance the survival of endangered species.

The Biological Opinion (BiOp) for FCRPS operations contained the flow objectives that are an important component of the operations of federal dams. Another constraint to Columbia River system operations besides flow objectives are reservoir operating rules. Each reservoir has specific operating rules that account for flood control volumes, resident fish protection, erosion prevention, recreation, and other uses.

4.4.1.2 Columbia Basin Project

The Columbia Basin Project (CBP) is an important project for this report because it involves a significant diversion of water that is not used for hydropower and therefore does not stay in the Columbia River. Figure 4-4 shows the location of the project and its primary features. The CBP is a congressionally authorized multipurpose development located in the central part of Washington State. The key structure, Grand Coulee Dam, is on the

mainstem of the Columbia River about 90 miles west of Spokane, Washington. The extensive irrigation works extend southward on the Columbia Plateau 125 miles to the vicinity of Pasco, Washington, where the Snake and Columbia Rivers join.

Principal project features include Grand Coulee Dam, Franklin D. Roosevelt Lake, Grand Coulee Powerplant Complex, switchyards, and a pump-generating plant. Primary irrigation facilities are the Feeder Canal, Banks Lake, the Main, West, and East Low Canals, O'Sullivan Dam, Potholes Reservoir and Potholes Canal. There are over 300 miles of main canals, about 2,000 miles of laterals, and 3,500 miles of drains and wasteways on the project (Bureau of Reclamation, 2006a). The project is authorized to deliver a full water supply to 1,029,000 acres of land previously used only for dry farming or grazing. About 671,000 acres are currently irrigated and further development is on hold.

Irrigation water is pumped from Franklin D. Roosevelt Lake by the Grand Coulee Pump-Generating Plant, adjacent to the reservoir at the left abutment of the dam. The Bureau of Reclamation holds water rights that authorize the storage and use of 6.4 million acre-feet for development of the CBP. The current average annual diversion for the CBP is 2.6 million acre-feet.

All basic irrigation facilities applicable to the three Columbia Basin Irrigation Districts (Quincy-Columbia Basin Irrigation District, East Columbia Basin Irrigation District, and South Columbia Basin Irrigation District) are operated by the irrigation districts. Irrigation facilities operated as reserved works by the Bureau of Reclamation include Dry Falls Dam, Main Canal through the bifurcation works including Pinto Dam and Billy Clapp Lake, and O'Sullivan Dam, Potholes Reservoir, and Potholes Canal headworks. Grand Coulee Dam, Powerplant, and Pumping Plant, and Banks Lake also are operated by the Bureau of Reclamation as reserved works.

4.5 Water Storage Inventory Results

The water storage inventory was compiled to fulfill part of Section 5 of ESSHB 2860 using storage assessments prepared under watershed planning, the Bureau of Reclamation studies, and the BPA's (2005) loads and resources study. Storage options were split into categories consistent with the Draft Programmatic EIS for the Management Program: new large storage facilities (> 1 million acre-feet), new small storage facilities (< 1 million acre-feet), modification of existing storage facilities, and aquifer storage and recovery (ASR) (Ecology, 2006b). The entire data inventory is provided in Appendix C.

4.5.1 Large Storage Opportunities

A variety of new large storage facilities with a capacity of 1 million acre-feet or more are being considered in the Columbia Basin (Table 4-11). A Pre-Appraisal Report on off-stream storage facilities, prepared for Ecology and the Bureau of Reclamation identified eight potential projects larger than 1 million acre-feet. Four of those sites—Hawk Creek, Foster Creek, Sand Hollow, and Crab Creek—will undergo an appraisal level

evaluation by the Bureau of Reclamation (Ecology and Reclamation, 2005). Appraisal level reports typically include a more detailed environmental assessment that may include benefits to fish and other instream uses, benefits to out-of-stream uses, environmental and cultural impacts, and the potential power and transmission implications of lifting large quantities of water to fill off-stream storage sites. The Bureau of Reclamation is in the process of completing the appraisal level evaluation of Black Rock Reservoir, a 1.3 million acre-foot off-stream reservoir in the Yakima Basin as part of the separate Yakima Basin storage project. The Bureau of has also studied the feasibility of the Wymer Dam and is currently evaluating an additional component that involves pumping water from the Columbia River at the confluence with the Yakima River up to two large irrigation diversions (Sunnyside and Roza canals). The proposed pumpback option is at a pre-appraisal level (Golder, 2006), but would allow more flow from upstream reservoirs and the proposed Wymer Reservoir to be used to meet other flow objectives, including the ability to supply interruptible "junior" water right holders on the Yakima during dry years.

4.5.2 Small Storage Opportunities

The Pre-Appraisal Report identified three off-site storage projects smaller than 1 million acre-feet, but none of those sites was recommended for further study (Ecology and Reclamation, 2005). Several WRIA plans in the Columbia Basin area have identified numerous small on- and off-stream storage facilities that could be developed (Table 4-12). The largest is Wymer Dam in the Yakima Basin (174,000 acre-feet).

A number of smaller storage options have been identified by WRIA planning units. Most of the storage facilities identified by WRIA plans have a capacity of less than 1,000 acre-feet and do not have an estimated cost. A more detailed environmental review of the benefits to fish and other instream uses, benefits to out-of-stream uses, and environmental and cultural impacts of a proposed option varies widely between storage assessments. The projects range from conventional dams, to ASR projects, to wetland/floodplain restoration projects that would "hold" water in tributaries for a longer period of time. The cost, benefits, and timeline for these projects are typically not described in the WRIA planning documents, and further evaluation of the projects is necessary to determine whether they are feasible or not.

4.5.3 Modification of Existing Storage Facilities

Modification of existing storage facilities includes raising the height of existing impoundments (on-channel or off-channel) and operating existing facilities to provide water for additional beneficial uses. Examples of this type of project include the supplemental feed route for Potholes Reservoir and the additional drawdown of Lake Roosevelt (Ecology, 2006b). Both of these activities are modifications of the operation of existing facilities and discussed in the Draft Programmatic EIS.

4.5.4 Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) projects are not well represented in the storage inventories conducted. The Cities of Walla Walla, Yakima, and Pullman identified ASR in their watershed plans as storage options. Walla Walla is targeting 657 AF of storage. Additional information is needed to determine what Pullman's target could be. Outside of the watershed planning process, the Cities of Kennewick and Yakima have conducted pre-feasibility studies (Aspect Consulting, 2005; Golder, 2001) and other municipalities are likely considering ASR, but have not included it in a watershed plan. It is anticipated that other ASR projects will be identified in future inventory reports.

4.6 Water Rights Overview

4.6.1 Water Rights

Prior to enactment of the Surface Water Code in 1917 and the Ground Water Code in 1945, water rights could be acquired by simply putting water to beneficial use, or by posting a notice near the point of diversion, and perhaps filing a copy with the County auditor, and then putting the water to use. The key to preserving pre-code water rights, besides continuing to beneficially use the water through the years, was to file a water right claim under the Claims Registration Act (RCW 90.14.041). The claims registration was first opened in 1974 and again most recently in 1997-1998 (RCW 90.14.068). If a person holding a pre-code water right failed to file a claim to that water, the right was lost. A water right claim is not in and of itself a water right. The claim preserves whatever right may exist but the final validity of the claim may only be determined in an adjudication by the court (Ecology, 2006b).

Since adoption of the Water Code, in order to receive a new water right, a person must first file an application with Ecology to appropriate waters of the state. Ecology shall issue a permit if it makes the following four findings: (1) the proposed use of water is for a beneficial purpose; (2) there is water available for appropriation; (3) the proposed use would not impair existing water rights; and (4) the proposed use would be in the public interest (RCW 90.03.290) (Ecology, 2006b).

Beneficial uses include such things as stock watering; industrial, commercial, agricultural and domestic use; irrigation; and fish and wildlife maintenance (RCW 90.54.020(1)). Water availability has both a technical and a legal meaning. Technically, there must be water physically available from the source to meet the uses or needs proposed for the requested quantity of water. Legally, there is water available only if it can be appropriated without impairing existing water rights, either by reducing the quantity available to satisfy those rights, or by reducing the quality of the water available. Once the facilities have been constructed and the water has been put to beneficial use, the water right is said to have been perfected. Ecology then issues a water right certificate for the purpose of use, place of use, point of diversion or withdrawal, period of use, and quantity of water that has been put to

beneficial use (Ecology, 2006b). Water rights can be lost or relinquished if not used.

Water rights are tracked through Ecology's Water Right Tracking System (WRTS) database. The information captured in this database includes the type of water right (surface or ground), the name of the business or person applying for a right or a change to an existing right, the priority date or date of application, the instantaneous quantity (Q_i) or maximum withdrawal rate requested, the annual quantity (Q_a) or volume requested (reported in acre-feet per year), the purpose of use, the water source and the geographic location (township, range and section) for the point of diversion (place of withdrawal) and/or place(s) of use.

Some of the water rights available for review in the WRTS database are incomplete, and duplicate rights listed in the database may overestimate allocated water. The WRTS database may not capture federal or Tribal water rights. The Bureau of Reclamation holds a large quantity of water rights for the Columbia Basin Reclamation Project. Water rights held by the Bureau of Reclamation are state-based water rights.

4.6.2 Inchoate Water Rights

Inchoate water right is a term used to describe the portion of a water right that is unused (or unperfected). In relation to the Columbia River, inchoate rights represent a portion of existing water rights that may be "in the river" now, but may not be in the future.

Some water right holders have permits with inchoate water right under development. Still others may have inchoate water rights associated with "pumps-and-pipes" certificates based on Ecology's past practice of issuing rights for domestic and municipal uses before complete beneficial use occurred. In 2003, the state Legislature enacted the Municipal Water Supply-Efficiency Requirements Act (Municipal Water Law), which made changes to water resources statutes and DOH statutes pertaining to municipal water rights and public water systems. The legislation clarified that such rights were in good standing and could be used for growth by the water right holder, subject to certain limitations (e.g. a future adjudication, change decision by Ecology, etc.). The legislation also established that unperfected surface water rights (inchoate rights) for municipal water supply purposes may be changed or transferred subject to conditions including compliance with the supplier's water system plan (RCW 90.03.570).

4.6.3 Trust Water Rights

Trust water is a water right or a portion of a right acquired by the state for management in the Trust Water Right Program (Trust Program) (RCW 90.42.020(3)). The state may acquire all or portions of water rights by purchase, lease, or donation, and may acquire trust water rights on a permanent or a temporary basis. Although trust water rights are most commonly acquired for purposes of instream flow, trust water rights may in fact also be authorized for other beneficial uses including "irrigation, municipal, or other beneficial uses consistent with

applicable regional plans for pilot planning areas, or to resolve critical water supply problems" (RCW 90.42.040(1)). A trust water right retains the same priority date as the original water right and importantly, is not subject to relinquishment while in the Trust Program. For a water right transferred to trust on a temporary basis, "the full quantity of water diverted or withdrawn to exercise the right before the donation or acquisition" reverts to the donor when the temporary trust period ends.

In relation to the Columbia River, trust water represents a portion of existing water rights that are "in the river" now, but may not be in the future. Under the ESSHB 2860, Section 2(4), net water savings from conservation actions will be placed into the Trust Program in proportion to the amount of funding provided by the state.

4.7 Water Rights Inventory

An inventory of Washington and Oregon water rights is presented below to fulfill Ecology's obligations as described in Section 6 of the ESSHB 2860. Water rights include claims, permits, and certificates that have been recorded in each state's database. See Chapter 3 for an overview of Washington water rights. See Appendix C for an explanation of the inventory process and an overview of Oregon water rights. See Chapter 5 for a discussion of existing water right applications.

4.7.1 Washington Water Rights

There are fourteen counties in Washington with water rights within one mile of the Columbia River, designated the Management Zone. Ecology provided records of water rights (claims, permits, and certificates) and water right applications within the Management Zone (Ecology, pers. comm., 2006a). Water right applications are discussed in Chapter 5.

Water rights were organized by use codes into five General Use Designations (GUD) including Agriculture, Commercial and Industrial, Domestic, Environment and Wildlife and Undefined. With one exception, an assumption was made that the primary use of a water right would be listed first in the record. Many of the water rights list several use codes, which may encompass more than one GUD. Table 4-13 provides a list of use codes and the corresponding GUDs.

Water rights coded as power (PO) were assumed to mean hydropower and were not tabulated in this water right analysis because the stored water may be used downstream for other purposes. Water rights identified as reservoir water (RW) were not included in this inventory for the same reason.

Table 4-14 summarizes the total non-hydroelectric water rights within the Columbia River Management Zone. Figure 4-5 shows the existing water rights on a map. There are 7,087 water rights on file in the WRTS database (not including Oregon), totaling just over 8 million acre-feet per year. The WRTS database contains a significant number of records with no associated Q_a, the annual quantity, and may include duplicative records. In cases where no Q_a is reported in the database, the quantity is calculated based on continuous use of Q_i, the

instantaneous quantity. This likely overpredicts the maximum allowable annual water use associated with these water rights. A description of the WRTS data used and the steps taken to organize the data and to calculate Q_a (as applicable) are provided in Appendix C. Appendix C also contains tables showing various breakdowns of water rights by purposes of use and type (ground water and surface water). A short summary of existing water rights by purpose of use is provided below.

- The Agriculture GUD includes the dairy, frost protection, irrigation, and stock watering use codes. There are 2,365 water rights in the Agriculture GUD with a total Q_a of 6,508,773 AFY.[1]
- The Commercial and Industrial GUD includes the cooling for industrial purposes, commercial and industrial manufacturing, highway, mining, power, and railway use codes. There are 152 water rights in the Commercial and Industrial GUD with a total Q_a of 623,119 AFY.[1]
- The Domestic GUD includes the domestic general, domestic multiple, domestic single, heat exchange, domestic municipal and recreation use codes. There are 4,378 water rights in the Commercial and Industrial GUD with a total Q_a of 572,143 AFY.
- The Environment and Wildlife GUD includes the environmental quality, fire protection, fish propagation, and wildlife propagation use codes. There are 61 water rights in the Environment and Wildlife GUD with a total Q_a of 481,994 AFY.
- The Undefined GUD includes rights where the primary use was not provided or was an unrecognized (non-standard) use code. There are 131 water rights in the Undefined GUD with a total Q_a of 8,557 AFY.

Agriculture uses account for over 79% of the water right quantity in the Management Zone in Washington State. The largest number of water rights is associated with domestic uses, but the quantity of these rights accounts for approximately 7% of the total quantity of water rights issued in the Management Zone in Washington State. In the Management Zone, Grant County has the highest quantity associated with its water rights. The majority of this use is for agricultural water rights that account for over 3 million acre-feet of water. Chelan and Benton Counties also have over 1 million acre-feet of water rights, the majority of which are for agricultural uses. Yakima County has the least number and quantity (less than 1,400 acre-feet) of water rights in the Management Zone. The extent to which these water right records reflect actual water use is described in Chapter 5.

4.7.2 Oregon Water Rights

There are seven counties in Oregon with points of diversions for water rights within one mile of the Columbia River Management Zone. The Oregon Water Resources Department (OWRD) provided records of water rights and water right applications within the Management Zone (OWRD, pers. comm., 2006).

[1] One Bureau of Reclamation water right for 2,910,000 AFY is coded for multiple uses with the first (and assumed primary) use coded as commercial (CI) in the WRTS database and would be included in the Commercial and Industrial GUD based on assumptions used in this report. It is understood, however, that this water right is being put to use for agricultural purposes and therefore it has been added to the Agriculture GUD and removed from the Commercial and Industrial GUD total.

The data provided by OWRD were organized by Oregon General Use Designations (GUD) and was sorted into comparable GUDs as used for Washington water rights (Agriculture, Commercial and Industrial, Domestic, and Environment and Wildlife). See Appendix C for a list of codes and the corresponding GUD's.

Table 4-15 summarizes the total water rights in the Management Zone for Oregon. There are a total of 551 records in the Management Zone for Oregon with a total annual quantity (Q_a) of 936,190 acre feet per year (AFY). This value does not include 116,776 AFY of supplemental irrigation and 5,927,321 AFY of instream non-consumptive uses. When records provided an instantaneous quantity (Q_i), Q_a was calculated based on the assumption that the Q_i provided would be used twenty-four hours per day, every day of the year, using a formula that generated the maximum possible annual quantity, unless otherwise noted.

- The Agriculture GUD incorporates the agriculture, cranberry, dairy, frost protection, green house, irrigation, livestock, and nursery use codes. There are 334 water records in the Agriculture GUD, with a total Q_a of 678,179 AFY. Of this amount, 116,726 AFY are supplemental rights that are not used at the same time as primary rights. Livestock accounts for 3,978 AFY. Irrigation includes 557,475 AFY, using an average duty of 4.5 acre-feet per acre, to account for season of use.
- The Commercial and Industrial GUD incorporates the commercial, manufacturing, laboratory, mint still, log deck sprinkling, sawmill, mining shop, and road construction use codes. There are 36 water records in the Commercial and Industrial GUD with a total Q_a of 46,798 AFY.
- The Domestic GUD incorporates aesthetic, recreation, domestic, human consumption, and municipal use codes. There are 132 water records in the Domestic GUD with a total Q_a of 327,939 AFY.
- The Environment and Wildlife GUD incorporates the instream, fire protection, forest management, groundwater recharge, pollution abatement fisheries and wildlife use codes. There are 49 water rights in the Environment and Wildlife GUD with a total Q_a of 5,927,321 AFY of non-consumptive use.

Additional work is necessary to confirm the water right analysis. The data were provided by OWRD in a series of database queries by a unique "Snapshot" identification number that can be used to query individual water right records available online. The data also included whether the record referred to surface, ground water, reservoir, or other source characteristic. Water rights (claims, permits, and certificates) could not be differentiated from water right applications. The unusually large value associated with Environment and Wildlife GUD also needs to be investigated further by additional analysis of the information provided from the Oregon water rights database.

4.7.3 Interruptible Water Rights

Some of the water rights in the inventory are subject to interruption when streamflow falls below the flow levels established by the 1980 instream flow rule (WAC 173-563). Based on information in the WRTS database, Ecology has issued over 350 interruptible water rights (claims, permits and certificates) totaling 487,104 AFY within the Management Zone (Ecology, pers. comm., 2006c). Table 4-16

summarizes the interruptible water rights that have been issued by Ecology. These data suggest that less than 5% water rights issued by Ecology in the Management Zone are interruptible.

4.7.4 Washington Permit-Exempt Water Rights

Four types of ground water uses are exempt from the state's water right permitting system. These uses include: 1) Providing water for livestock (no gallon per day limit or acre restriction); 2) Watering a non-commercial lawn or garden one-half acre in size or less (no gallon per day limit); 3) Providing water for a single home or groups of homes (limited to 5,000 gallons per day); and 4) Providing water for industrial purposes, including irrigation (limited to 5,000 gallons per day but no acre limit). The well associated with these exempt uses of ground water is commonly called a permit-exempt well.

Ecology has been tracking the number of permit-exempt wells in the Washington State Notice of Intent Database since 1993. The database does not contain entries before 1993 and may contain duplicate entries in the case where wells have been deepened or reconditioned. Furthermore, well drillers were not required to file well logs before 1971; therefore, the existing data sources are incomplete. A future recommendation for Ecology is to improve its existing databases or use County building permit records to identify permit-exempt wells. The information in Table 4-17 and Figure 4-6 is based on the records in the Notice of Intent database and represents Ecology's best understanding of permit-exempt well demands within the Management Zone (Ecology, pers. comm., 2006b).

There are an estimated 1,807 permit-exempt wells in the Management Zone. The majority of the permit-exempt wells in the Management Zone are located in Stevens, Benton, Lincoln, and Franklin Counties. These counties account for almost 60% of the permit-exempt wells in the Management Zone. The legal water use limit for a permit-exempt well is 5,000 gpd, indicating a permitted volume of at least 10,127 AFY. However, this assumption is likely greater than actual use.

4.8 Water Use Overview

The inventory of actual water use is based on various compilations of data at different scales and geographic units. An important aspect of water use analysis is the distinction between aggregate volumes of water used and rates of water use. Water volumes are expressed in terms of acre-feet and are often reported on an annualized basis (AFY). Flow rates are expressed in terms of cubic feet per second (cfs) or gallons per minute (gpm). Translating between a volume (AF) and a flow rate (cfs) requires a mathematical calculation that accounts for the period of time involved.

When reported on an annualized basis, total water volumes do not provide information on the seasonality of use. Seasonality is very important in both agriculture and municipal water use analysis because consumptive use is greatest during the summer. Seasonality can be estimated from annual usage through a "shaping factor" that translates the annual amount to a

series of monthly amounts or rates. For agricultural estimations, the shaping factor typically mimics the crop irrigation requirement (CIR). CIR for many crops in many different areas are published by Washington State University (WSU) (Ecology, 2005) and provide a means for distributing annual water volume estimates according to the typical water use requirements for individual crops. The sum and acreage of each individual crop could be aggregated over a given area to produce an "aggregate" CIR, which could then be used to translate annual water volumes into monthly amounts. This level of detail is not feasible for this initial forecasting effort, so a surrogate distribution of CIR was developed to translate annual water volumes to monthly water volumes. The surrogate monthly CIR is based on alfalfa, as shown on Figure 4-7. This shows that, in August, about 22% of the annual volume of water is applied, while in May only about 10% is applied. The shaping factor is 0% during the winter months when there is no irrigation. The sum of all monthly percentages equals 100% of the annual water volume. This monthly shaping factor is used to estimate monthly water use from annual water volumes reported in the inventory. Monthly domestic water use can be estimated using a similar shaping curve, except that water is used year-round. The domestic shaping curve is also shown on Figure 4-7.

Monthly average flow rates can be calculated from an annual volume (in AF) by multiplying the annual average by the shaping factor for that month and converting to a rate (either AF per day or cfs). The time constant for the volume-to-rate conversion is 30 days.

4.9 Water Use Inventory Results

Water use is estimated by many entities for research and planning purposes. Water use estimates are developed by the U.S. Geological Survey (USGS) every five years, by municipalities every 6 years and are available in some watershed plans. This report relies on the USGS water use estimates to draw comparisons, because they are the most comprehensive and consistent estimates available. However, data from watershed planning documents and water system plans were also inventoried and estimates of permit-exempt well use based on population from Office of Financial Management (OFM) forecasts were performed.

Future updates should be able to address data gaps and accuracy issues by utilizing additional sources, resulting in more robust estimates of water use, especially if metering data are available.

4.9.1 USGS Water Use Estimates

The most current basin-wide estimates of water use were published in 2004 by the USGS (Lane, 2004; USGS, 2004) and are based on data from the year 2000. See Appendix C for the Lane (2004) report. The USGS reports water use for each County by use type and source. Use types include domestic, industrial, irrigation and golf course irrigation (commercial use was reported in 1985, 1990, and 1995 data but not 2000). The report also includes estimates of thermoelectric power; however, water use for thermoelectric purposes is not included in this inventory. Within each use type, use is further separated by source type. Source types include surface or

ground water and publicly supplied or self-supplied. This additional level of detail allows water use to be compared to water rights in more discrete groups (e.g., self-supplied domestic use estimates are assumed to be equivalent to use from permit-exempt wells). Table 4-18 presents total water use estimates for the counties within the Columbia Basin study area. Figure 4-8 shows estimated water use by County on a map.

The USGS estimates are based on data supplied by state and federal entities. The USGS uses available data and surveys which are supplemented by indirect estimation methods. The USGS has no control over the quality and accuracy of the data it receives. At present, the accuracy and confidence limits of the estimates are not quantified. The estimates are aggregated at a County level, and it is not possible to estimate water use within the Management Zone from the USGS reports. As the availability of geospatial information associated with the USGS data improves, it may be possible to calculate water use within the Management Zone for future updates of this report.

The USGS water use estimates indicate that the largest water use in the Columbia Basin is irrigation and that irrigation use is concentrated in counties within the Management Zone. However, it is not possible to determine how much of the water in each of those counties is used within the Management Zone. Information to answer this question should be gathered in future updates to this supply inventory.

4.9.2 Watershed Plan Water Use Estimates

Water use data in watershed planning documents are typically found in the Phase II technical assessment or the Phase III watershed management plan. Only seventeen of the thirty-five WRIAs in the Columbia Basin study area have plans containing estimates of current and/or future water use (Table 4-19). All seventeen have information on current water use and ten have information on future water use (future water use estimates are discussed in Chapter 5). However, there is no standardized reporting of water use. Some WRIAs do not report water use for all the categories used in the USGS report, while some combine categories. This lack of complete information makes it difficult to compare discrete categories with the USGS estimates or to compare between WRIAs. Appendix C contains the entire data inventory.

Watershed planning documents are not recommended for use in a basin scale analysis at this time because estimates are not available for every WRIA in the basin (not all of the WRIAs have begun or completed the process), and the estimates that do exist are not consistent in how they present the data or group the use categories.

4.9.3 County Comprehensive Plan Estimates

Comprehensive plans for counties within the Management Zone were also reviewed to characterize existing land use, expected land use trends, and how land use changes may impact water resources. Summaries from these plans are provided in Table 4-20. Comprehensive

plans for many of the counties were not available in the short turn around time. However, some counties have reported expected land use trends that may impact water resources. Benton County is expecting an increase in agricultural land use and population. These changes could increase the demand for water for irrigation and domestic purposes. Chelan County reported a change in the size of farms (small farms are consolidating into larger farms), Grant County expects that the majority of its population growth would be concentrated in urban growth areas, and Yakima County is concerned about the security of its water supply because of conflicting water needs. Except for generalized statements regarding water use, comprehensive plans are not useful for the inventory. Appendix C contains the entire data inventory.

4.9.4 DOH Water Use Estimates

The Washington State Department of Health (DOH) provided its 2006 water system database for Group A and Group B public water systems for the entire Columbia River Basin (DOH, pers. comm. 2006). Appendix C contains the entire data inventory. Group A water systems include those that regularly serve 15 or more connections or serve 25 or more people per day for 60 days or more (WAC 246-290). The rest of the water systems are classified as Group B systems. The number of Group A and B water system connections, population served by these systems and total estimated water use by Group A and B water systems are summarized by County in Table 4-21. There are currently 408,158 Group A connections and 12,424 Group B connections within the counties comprising the Columbia Basin. Total public water system use is estimated at 594 AF per day or approximately 200,000 AF annually. Average per person usage is estimated to be 170 gallons per day per person, with a range of 92 to 300 gallons per day per person.

Figure 4-9 illustrates the total number of connections per County within the Columbia River Basin. A significant portion of public water supply use in the basin occurs in Benton, Franklin, Grant, Kittitas, Spokane, and Yakima Counties. Spokane and Yakima Counties appear to have the largest number of Group A connections. Population served by water systems as reported in Table 4-21 only include those served by Group A or B water systems and does not constitute the entire population in the County, as permit-exempt wells also service residences in each County. The database contains geographic information for each water system. Table 4-22 provides connection information for public water systems within the Management Zone (within one mile of the Columbia River) by County, while Figure 4-10 illustrates the amount of water associated with public water systems. Total public water system use within the Management Zone is estimated at 34,000 AF annually (based on sum of Group A and Group B systems). Average per person usage is estimated to be 140 gallons per day per person.

Over eighty percent of Douglas, Franklin, and Benton County's public water use occurs within the Management Zone. Over one half of Chelan County's public water use occurs in the

Management Zone. Together, Benton and Franklin County's public water use in the Management Zone comprises over 50% of the total public water use in the Columbia River Management Zone and represents the growing use by the cities of Kennewick, Pasco, Richland, W. Richland, and Prosser.

4.9.5 Municipal Water System Plans

Approximately 17% of the Group A water system connections in the Management Zone belong to the seven major municipalities along the Columbia River, including Kennewick, Pasco, Richland, West Richland, Chelan, Wenatchee and East Wenatchee. These municipalities account for approximately 80% of the total connections within the Management Zone. Per capita water use for the primary municipal water purveyors in the Management Zone varies between 130 and 400 gpd and averages approximately 250 gpd. Appendix C contains the entire data inventory.

Over half of the seven largest municipalities have less than 10% unaccounted for water, which is the target set in Ecology's proposed water use efficiency rule. However, West Richland, Chelan, and Wenatchee have close to 15% unaccounted for water, or a total of 4,355 AFY. These cities could conserve a total of about 220 AFY by reducing their percentage of unaccounted for water to 10%. The majority of these municipalities take water directly or indirectly from the Columbia River. The cities of Kennewick, Pasco, and Richland meet a portion of their water demands through direct diversion of Columbia River water. These cities also use wells to supplement their supply. West Richland relies solely on deep ground water wells for its municipal water demands. Wenatchee and East Wenatchee meet their water demand by pumping from a series of shallow wells that are connected to the Columbia River through ground water flow. All the major municipalities that provided future projections in their water system plans expect significant increases in their service area populations over the next 20 years, with increases of 150% to near doubling of population.

4.9.6 Permit-Exempt Well Water Use Estimates

County Level Estimates

Water use estimates for permit-exempt wells were calculated for each County by combining the 2006 OFM and DOH population estimates (Table 4-23). Population that is not served by a public water system as indicated in the DOH database is assumed to be serviced by permit-exempt wells. The estimated water use, at a County scale, associated with permit-exempt wells is about 170 AF per day or 62,000 AF annually, equal to the population difference (OFM – DOH) multiplied by 170 gpd per person (which is the average per capita water use in Table 4-23). This value is comparable to the USGS estimate of self-supplied domestic water use in the Counties within the Columbia Basin (Table 4-18).

Management Zone Estimates

Ecology has estimated that there are 1,807 permit-exempt wells in the Management Zone (see Section 4.7). Water use for permit-exempt

wells in the Management Zone is equivalent to about 10,127 AFY based on a 5,000 gpd per well water use factor (Table 4-17). This is the maximum amount of water authorized for use under the permit-exempt well statute and is likely greater than actual use.

TABLES

Table 4-1. Documents and Databases Reviewed to Develop the Baseline Assessment and Inventory

Type	Reference
Existing Baseline Studies	
Federal Agency	Lane, R.C. 2004. Estimated Domestic, Irrigation, and Industrial Water Use in Washington, 2000. U.S. Geological Survey Science Investigations Report 2004-5015, 16 p. Available online at http://pubs.usgs.gov/sir/2004/5015/.
Federal Agency	U.S. Geological Survey (USGS). 2004. Estimated Use of Water in the United States in 2000. USGS Circular 1268. By Susan S. Hutson, Nancy L. Barber, Joan F. Kenny, Kristin S. Linsey, Deborah S. Lumia, and Molly A. Maupin. Available online at http://water.usgs.gov/watuse/data/2000/index.html.
Federal Agency	U.S. Geological Survey. 1999. 1991 Washington Land Cover Data Set. U.S. Geological Survey. Sioux Falls, South Dakota.
Academic	University of Washington. 2004. Economics of Columbia River Initiative Final Report to the Washington Department of Ecology and CRI Economics Advisory Committee. January 12, 2004.
Academic	National Research Council of the National Academies (National Research Council). 2004. Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival. Washington, DC: The National Academies Press.
State and Local Planning Documents	
Watershed Planning	Aspect Consulting. 2004. Level I Watershed Assessment WRIA 31 (Rock-Glade Watershed). November 12, 2004.
Watershed Planning	Economic and Engineering Services. 2003. Watershed Management Plan Yakima River Basin. January 2003.
Watershed Planning	HDR/EES, Inc. 2005. Walla Walla Watershed Plan. May 2005.
Watershed Planning	HDR Inc. 2006. Middle Snake Watershed Plan Draft. April 2006.
Watershed Planning	GeoEngineers. 2004. Level I Technical Assessment Water Resource Inventory Area 60, Kettle River Watershed. March 16, 2004.
Watershed Planning	GeoEngineers. 2004. WRIA 59 Colville River Watershed Plan. Presented to: Stevens County Board of County Commissioners. On Behalf of: Colville River Watershed Planning Team. November 15, 2004.
Watershed Planning	Golder Associates Inc. (Golder). 2004. Phase II - Level 1 Technical Assessment for the Palouse Basin (WRIA 34). December 8, 2004.
Watershed Planning	Golder Associates Inc. (Golder). 2005. Pend Oreille (WRIA 62) Watershed Management Plan. Prepared for the Pend Oreille Planning Unit. March 2005.
Watershed Planning	Hangman (Latah) Creek Watershed Planning Unit. 2005. The Hangman (Latah) Creek Water Resources Management Plan. May 19, 2005.
Watershed Planning	Kennedy/Jenks Consultants. 2005. Watershed Assessment Report WRIA 43. November 2005.

See notes at end of table.

Type	Reference
Watershed Planning	Kennedy/Jenks Consultants, GeoEngineers, Inc., and Water & Natural Resources Group (Kennedy/Jenks). 2005. Watershed Assessment Report Water Resource Inventory Area 43 Upper Crab Creek-Wilson Creek Watershed. Prepared for Lincoln County. Prepared by Kennedy/Jenks Consultants in association with GeoEngineers, Inc. and Water & Natural Resources Group. November 2005.
Watershed Planning	Methow Basin Planning Unit. 2005. Methow Basin (WRIA 48) Watershed Plan. Approved June 20, 2005.
Watershed Planning	Pacific Groundwater Group. 2003. WRIA 44/50 Final Phase II Basin Assessment. April 2003.
Watershed Planning	Watershed Professional Network. 2005. Klickitat Basin (WRIA 30) Watershed Management Plan. May 3, 2005.
Watershed Planning	WRIA 45 Planning Unit. 2006. Final Wenatchee Watershed Management Plan. April 26, 2006.
Watershed Planning	WRIA 46 Planning Unit. 2004. Management Plan. October 2004.
Watershed Planning	Little Spokane River and Middle Spokane River Planning Unit. 2006. WRIA 55 and 57 Watershed Management Plan. January 31, 2006.
Watershed Planning	Golder Associates Inc. (Golder). 2004. Draft Pend Oreille (WRIA 62) Watershed Planning Phase II, Level 2 Technical Assessment. Submitted to the Pend Oreille Watershed Planning Unit and Pend Oreille Conservation District. March 2004.
Storage Assessment	Aspect Consulting. 2003. Multipurpose Water Storage Screening Assessment Report WRIA 30. June 20, 2003.
Storage Assessment	Aspect Consulting. 2003. Addendum to WRIA 30 Multipurpose Water Storage Screening Assessment Report. November 25, 2003.
Storage Assessment	Kennedy/Jenks Consultants. 2003. Candidate SASR Sites Hydrogeology, Walla Walla Basin Aquifer Recharge. Prepared for Economic and Engineering Services, Portland, Oregon.
Storage Assessment	*Kennedy/Jenks Consultants. 2004. Proposed SAR monitoring and test plan, Hall-Wentland site, Umatilla County, Oregon. Prepared for EES-HDR, Pasco, Washington.
Storage Assessment	Golder Associates Inc. (Golder). 2002. Naches Basin (WRIA 38) Storage Assessment, Application of Aquifer Storage and Recovery Report.
Storage Assessment	Golder Associates Inc. (Golder). 2004. Multi-Purpose Storage Assessment for Hangman (Latah) Creek Watershed: Project completion report to WRIA 56 Planning Unit.
Storage Assessment	Montgomery Water Group (MWG). 2006. Chelan County Natural Resource Program Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed. March 8, 2006 Draft.
Storage Assessment	Golder Associates Inc. (Golder). 2006. Report to WRIA 46 (Entiat) Storage Sub-Committee, Step A Water Storage Assessment. Submitted to Chelan County Conservation District and WRIA 46 Planning Unit.
Storage Assessment	Pacific Groundwater Group and Montgomery Water Group (MWG). 2004. WRIA 44/50 Storage Assessment and Feasibility Study Final. Prepared for Foster Creek Conservation District. August 2004.
Storage Assessment	Golder Associates Inc. (Golder). 2004. Final Storage Assessment Little and Middle Spokane Watersheds. December 2004.

See notes at end of table.

Type	Reference
Storage Assessment	*Brown & Caldwell & GeoEngineers, June 2003. WRIA 59 Assessment of Multi-Purpose Water Storage Opportunities.
Irrigation District Conservation Plan	CH2M Hill. 1996. Kiona Irrigation District Comprehensive Water Conservation Plan. February 1996.
Irrigation District Conservation Plan	CH2M Hill. 1999. Kittitas Reclamation District Water Conservation Plan. February 1999.
Irrigation District Conservation Plan	CH2M Hill. 1995. Outlook Irrigation District Comprehensive Water Conservation Plan. November 1995.
Irrigation District Conservation Plan	CH2M Hill. 1994. South Naches Irrigation District Comprehensive Water Conservation Plan. February 1994.
Irrigation District Conservation Plan	Davis Engineering. 2000. Benton Irrigation District Water Conservation Plan. March 2000.
Irrigation District Conservation Plan	J-U-B Engineers. 1996. Columbia Irrigation District Comprehensive Water Conservation Plan. October 1996.
Irrigation District Conservation Plan	Montgomery Water Group (MWG). 2002. Brewster Flat Irrigation District Water Conservation Plan. June 2002.
Irrigation District Conservation Plan	Montgomery Water Group (MWG). 2000. Greater Wenatchee Irrigation District Water Conservation Plan. June 2000.
Irrigation District Conservation Plan	Montgomery Water Group (MWG). 2002. Okanogan Irrigation District Water Conservation Plan. May 2002.
Irrigation District Conservation Plan	Montgomery Water Group (MWG). 2002. Quincy-Columbia Basin Irrigation District Water Conservation Plan. March 2002.
Irrigation District Conservation Plan	Montgomery Water Group (MWG). 2002. South Columbia Basin Irrigation District Water Conservation Plan. February 2002.
Irrigation District Conservation Plan	Montgomery Water Group (MWG). 2000. Yakima-Tieton Irrigation Project Water Conservation Plan. June 2000.
Irrigation District Conservation Plan	Natural Resources Consulting Engineers. 1999. Irrigation Water Conservation and Management Plan for the Wapato Irrigation District. May 4, 1999.
Irrigation District Conservation Plan	UMA Consultants. 2000. Roza-Sunnyside Board of Joint Control Water Conservation Program Tier One Feasibility Study. March 2000.
County Comprehensive Plan	Benton County. 2005. Benton County Comprehensive Land Use Plan. Revised by Resolution 2005.
County Comprehensive Plan	Chelan County. 2005. Chelan County Comprehensive Plan 2000. Last Amended 2-14-05.
County Comprehensive Plan	Grant County. 1999. Grant County Comprehensive Plan. Prepared by Proulx Cearns, Inc. September 1999.
County Comprehensive Plan	Kittitas County. 2005. Kittitas County Comprehensive Plan. December 2001. Revised 9-28-2005.
County Comprehensive Plan	Okanogan County. 2005. Okanogan County Comprehensive Plan Update. June 15, 2005.
County Comprehensive Plan	Advanced Planning Solutions, Inc. 2006. Report of Findings for Skamania County Comprehensive Plan Update Visioning Exercise with Emphasis in the Swift Area. June 2006.

See notes at end of table.

Type	Reference
County Comprehensive Plan	Stevens County Land Services. 2006. Stevens County Comprehensive Land Use Plan. Resolution #59-2006. Effective July 13, 2006.
County Comprehensive Plan	Yakima County Planning Department. 1998. Plan 2015: A Blueprint for Yakima County Progress. Adopted May 20, 1997. Amended December 28, 1998.
Municipal Water System Plan	Coleman, Thomas, P.E. Consulting Services, 2004. City of Yakima Water System Plan, March 2004.
Municipal Water System Plan	RH2 Engineering, 2004. City of Wenatchee 2003 Comprehensive Water System Plan, Volume 1. City Service Area and Facilities. March, 2004. RH2 Engineering, 2003. City of Wenatchee 2003 Comprehensive Water System Plan, Volume 2 - Regional Service Area and Facilities. March 2004.
Municipal Water System Plan	RH2 Engineers Inc. 2005. City of East Wenatchee Water System Plan (summarized from City of Wenatchee 2005 Comprehensive Water System Plan).
Municipal Water System Plan	Gray and Osborne, Inc. 2002. City of Chelan Water System Plan, January 2002.
Municipal Water System Plan	HDR and EES. 2005. Quad Cities Water Right 2005 Regional Water Forecast and Conservation Plan. August 2005.
Washington Department of Health	Washington Department of Health (DOH) Office of Drinking Water. 2006. Personal Communication with Megan Nicodemus. Columbia River Data Group A Systems and Columbia River Data Group B Systems. Obtained 8/16/2006.
Federal Planning Documents	
Storage Assessment	United States Bureau of Reclamation. 2004. Summary Report Appraisal Assessment of the Black Rock Alternative. December 2004.
Storage Assessment	United States Bureau of Reclamation. 2006. Yakima River Basin Storage Alternatives Appraisal Assessment. May 2006.
Storage Assessment	Washington State Department of Ecology and U.S. Bureau of Reclamation (Ecology and Reclamation). 2005. Columbia River Mainstem Storage Options, Washington: Off-Channel Storage Assessment Pre-Appraisal Report. Prepared by Montgomery Watson Harza (MWH). December 2005.
Corps	U.S. Army Corps of Engineers (Corps). 2006a. 2006 Water Management Plan. Final May 17, 2006.
Corps	U.S. Army Corps of Engineers (Corps). 2006b. Fish Passage Plan Corps of Engineers Projects. March 2006.
BPA	Bonneville Power Administration (BPA). 2005. 2004 Pacific Northwest Loads and Resources Study (2004 White Book) Operating Years 2006 Through 2015. Updated November 15, 2005.
NMFS	National Marine Fisheries Service (NMFS). 2004. Endangered Species Act – Section 7 Consultation Biological Opinion, Consultation on Remand for Operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin (Revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE (D. Oregon)). November 30, 2004.

See notes at end of table.

Type	Reference
Water Rights	
Washington	Washington State Water Rights Tracking System (WRTS). Excerpt of water rights and applications within the 1 mile management zone. Provided by Ecology August 2, 2006.
Washington	Washington State Notice of Intent Database. Excerpt of exempt wells within the 1 mile management zone. Provided by Ecology August 7, 2006.
Washington	Washington State Department of Ecology (Ecology), personal communication, August 9, 2006. Email from Ron Dixon, Preliminary data on interruptible water rights within 1 mile of the Columbia River.
Oregon	Oregon Water Rights Database. Excerpt of water rights and applications within 1 mile of the Columbia River. Provided by Oregon Water Resources Department. September 14, 2006.
Tribal	Yakama Nation. Yakama Nation Water Code Title 60.
Tribal	Confederated Tribes of the Umatilla Indian Reservation. Water Code. Amended through resolution No. 05-027, March 7, 2005.
Tribal	Confederated Tribes of the Warm Springs. Warm Springs Tribal Code. Chapter 431. Warms Springs Water and Sewer System Act.
Tribal	Confederated Tribes of the Colville Reservation. Chapter 4-10 Water Resource Use and Permitting. June 2006.
Tribal	Nez Perce Tribe. Tribal Code. Section 4 Waters Infraction; Title 8 Water and Sewer Utility Authority.
Other	SCM Consultants. 2001. Facsimile; Subject: Yakima River Basin Watershed Plan. August 15, 2001.

NOTES
*Did not have a copy to review.
**See Table 3-5 for a list of key Washington and federal regulations pertaining to the Columbia River.

Table 4-2. Summary of Irrigation Application Efficiency Ranges, Consumptive Use, and Return Flows[1]

Method		Application Efficiency, EA (%)[2] Range	Application Efficiency, EA (%)[2] Average, Ea_{avg}	%Total Evaporated % Evap	% Total Use Consumed %CU, Average[3]	Return Flow %RF, Average[4]
Surface:	Graded Furrow	50 - 80	65	5	70	30
	w/tailwater reuse	60 - 90	75	5	80	20
	Level Furrow	65 - 95	80	5	85	15
	Graded Border	50 - 80	65	5	70	30
	Level Basins	80 - 95	85	5	90	10
	Flood	35 - 60	50	5	55	45
Sprinkler:	Periodic Move (Handline)	60 - 85	75	10	85	15
	Side Roll (Wheelline)	60 - 85	75	10	85	15
	Moving Big Gun	55 - 75	65	10	75	25
	Solid Set - Overtree	55 - 80	70	15	85	15
	Solid Set - Undertree	60 - 85	75	10	85	15
	Pop-Up Impact	60 - 85	75	10	85	15
Center Pivot:	Impact heads w/end gun	75 - 90	80	15	95	5
	Spray heads w/o end gun	75 - 95	90	10	100	0
	LEPA w/o end gun	80 - 98	92	5	97	3
Lateral-Move:	Spray heads w/hose feed	75 - 95	90	10	100	0
	Spray heads w/canal feed	70 - 95	85	10	95	5
Microirrigation:	Trickle/Drip	70 - 95	88	5	93	7
	Subsurface Drip	75 - 95	90	0	90	10
	Microspray	70 - 95	85	10	95	5

See notes on next page.

NOTES

[1] Calculate the actual water use from water meter data, power meter, or run-time data. In the absence of such data, the TIR (total irrigation requirement) - CIR / EA, where CIR is the crop irrigation requirement from the WIG (Appendix B) and Ea is the case-specific application efficiency above. Reference: Washington State Department of Ecology (Ecology). 2005. Determining Irrigation Efficiency and Consumptive Use. Water Resources Program Guidance. Guide 1210. Available online at http://www.ecy.wa.gov/programs/wr/rules/images/pdf/guid1210.pdf.

[2] % Evap is the portion of the total crop irrigation requirement that is evaporated due to factors other than crop ET.

[3] Select appropriate %CU based on type of irrigation system. If calculated Ea is greater or less than Ea_{avg}, then %CU = Ea + %Evap. CU = TIR x %CU.

[4] Select appropriate %RF based on type of irrigation system. If calculated Ea is greater or less than Ea_{avg}, then %RF = 100- %CU. RF =TIR x %RF.

Table 4-3. Municipal Conservation Summary

Element of Proposed Water Use Efficiency Rule	Description
Planning Requirements - #331-303	• To develop a water efficiency program that monitors on a regular basis and reports on water production and consumption to determine the best means of conservation. • To report water demand projections based on population projections and changes in land use and zoning. • To identify and evaluate a prescribed number of water use efficiency measures depending on the water system size. Water systems with 1,000 or more connections are required to evaluate reuse options.
Distribution Leakage Standard - #331-304	• To reduce unaccounted for water, or leaked water, to 10% or less • To have source and service meters within 10 years of rule adoption • To report leakage information in planning reports and annual performance reports
Goal-Setting and Performance Reporting Requirements - #331-305	• To set water use efficiency goals by July 2007 and update goals every 6 years • To include goals with measurable outcome, an implementation schedule, and supple and demand characteristics
Metering Requirements - #331-306	• To install source meters on all existing and new water sources • To meter existing and new water connections
Implementation Schedule - #331-340	• Rule adoption by September 15, 2006 • Begin recording data to include in planning documents by December 31, 2006

Table 4-4. Allowable Reclaimed Water Class Types for Various Reclaimed Water Uses[1]

Use	Type of Reclaimed Water Allowed			
	Class A	Class B	Class C	Class D
Irrigation of Nonfood Crops				
Trees and Fodder, Fiber, and Seed Crops	Yes	Yes	Yes	Yes
Sod, Ornamental Plants for Commercial Use, and Pasture to Which Milking Cows or Goats Have Access	Yes	Yes	Yes	No
Irrigation of Food Crops				
Spray Irrigation				
All Food Crops	Yes	No	No	No
Food Crops Which Undergo Physical or Chemical Processing Sufficient to Destroy All Pathogenic Agents	Yes	Yes	Yes	Yes
Surface Irrigation				
Food Crops Where There is No Reclaimed Water Contact With:				
Edible Portion of Crop	Yes	Yes	No	No
Root Crops	Yes	No	No	No
Orchards and Vineyards	Yes	Yes	Yes	Yes
Food Crops Which Undergo Physical or Chemical Processing Sufficient to Destroy All Pathogenic Agents	Yes	Yes	Yes	Yes
Landscape Irrigation				
Restricted Access Areas (e.g., Cemeteries and Freeway Landscapes)	Yes	Yes	Yes	No
Open Access Areas (e.g., Golf Courses, Parks, Playgrounds, School Yards and Residential Landscapes)	Yes	No	No	No
Impoundments				
Landscape Impoundments	Yes	Yes	Yes	No
Restricted Recreational Impoundments	Yes	Yes	No	No
Nonrestricted Recreational Impoundments	Yes	No	No	No
Fish Hatchery Basins	Yes	Yes	No	No
Decorative Fountains	Yes	No	No	No
Flushing of Sanitary Sewers	Yes	Yes	Yes	Yes
Street Cleaning				
Street Sweeping, Brush Dampening	Yes	Yes	Yes	No
Street Washing, Spray	Yes	No	No	No
Washing of Corporation Yards, Lots, and Sidewalks	Yes	Yes	No	No
Dust Control (Dampening Unpaved Roads and Other Surfaces)	Yes	Yes	Yes	No
Dampening of Soil for Compaction (at Construction Sites, Landfills, etc.)	Yes	Yes	Yes	No

See next page for notes.

Use	Type of Reclaimed Water Allowed			
	Class A	Class B	Class C	Class D
Water Jetting for Consolidation of Backfill Around Pipelines				
Pipelines for Reclaimed Water, Sewage, Storm Drainage, and Gas, and Conduits for Electricity	Yes	Yes	Yes	No
Fire Fighting and Protection				
Dumping from Aircraft	Yes	Yes	Yes	No
Hydrants or Sprinkler Systems in Buildings	Yes	No	No	No
Toilet and Urinal Flushing	Yes	No	No	No
Ship Ballast	Yes	Yes	Yes	No
Washing Aggregate and Making Concrete	Yes	Yes	Yes	No
Industrial Boiler Feed	Yes	Yes	Yes	No
Industrial Cooling				
Aerosols or Other Mist Not Created	Yes	Yes	Yes	No
Aerosols or Other Mist Created (e.g., Use in Cooling Towers, Forced Air Evaporation, or Spraying)	Yes	No	No	No
Industrial Process				
Without Exposure of Workers	Yes	Yes	Yes	No
With Exposure of Workers	Yes	No	No	No
Wetlands (additional requirements may apply)				
All Wetlands	Yes	Yes	Yes	Yes
Noncontact Recreational or Educational Use With Restricted Access	Yes	Yes	Yes	No
Fisheries Use, or Noncontact Recreational or Educational Use with Open (Unrestricted) Access	Yes	Yes	No	No
Potential Human Contact Recreational or Educational Use	Yes	No	No	No
Ground Water Recharge (additional requirements may apply)	Yes	No	No	No
Indirect Potable Reuse (additional requirements may apply)	Yes	No	No	No
Streamflow Augmentation (additional requirements may apply)	Yes	No	No	No

NOTES

[1] While these are the only uses described in the Reuse Standards, other uses can be considered through consultation with Ecology.

Sources:

Washington State Department of Ecology (Ecology). 1998. Criteria for Sewage Works Design, Water Quality Program. December 1998.

Washington State Department of Ecology. 2005. Case Studies in Reclaimed Water Use – Creating new supplies across Washington State. Publication No. 05-10-0513. June 2005.

Table 4-5. Potential Conservation District Projects by County

County	Conservation District Submitting Information	Type of Project	Number of Projects			Estimated Water Savings (ac-ft/yr)	Estimated Cost ($)	Estimated Cost/Acre Foot ($/ac-ft)
			Listed	with Est. Water Savings	with Estimated Cost			
Asotin	Asotin County CD	On-farm Conservation	10	7	7	>75	>171,400	2,285
Benton	BCD	Lining/Piping; On-farm Conservation	10	6	10	13,170	80,870,000	6,140
Douglas	Foster Creek	On-farm Conservation	34	34	34	5,869	24,266,000	4,135
Franklin	Franklin CD & Grant CD; Franklin CD	On-farm Conservation; On-farm Conservation Programs	1,056	1,056	1,056	156,091^	156,338,140*^	1,002
Grant	Grant CD; Franklin CD & Grant CD	On-farm Conservation; On-farm Conservation Programs	4,083	4,083	4,083	294,474^	327,031,720	1,111
Kittitas	Kittitas Co CD	Lining/Piping; On-farm Conservation; Tailwater Reuse; Other	20	19	19	41,676	58,916,200	1,414
Lincoln	Lincoln County CD	Automation/Irrigation Water Mgmt; On-farm Conservation; Other	38	0	3	Unknown	>30,000	Unknown
Okanogan	WSCC on behalf of Okanogan CD	On-farm Conservation	1	1	1	911	240,000	263
Skamania	Underwood CD	Automation/Irrigation Water Mgmt	1	0	0	Unknown	Unknown	Unknown
Walla Walla	Walla Walla CD	Automation/Irrigation Water Mgmt; Lining/Piping; On-farm Conservation; Surface to Groundwater Conversion; Water Right Purchase	36	36	36	20,898	15,212,000	728
Whitman	Palouse County CD	General water conservation	15	0	3	Unknown	>92,000	Unknown
Yakima	North Yakima CD	Lining/Piping; Storage/Re-reg Reservoirs	11	6	10	>12,100	118,700,000	Unknown
Total			**5,315**	**5,248**	**5,262**	**545,265**	**>781,867,460**	**1,434**

See next page for notes.

NOTES

Abbreviations: CD: Conservation District; Est.: Estimated; Mgmt: Management; WSCC: Washington State Conservation Commission

* This cost is based upon the amount of money required upfront to capitalize the expenditure assuming an annual interest rate of 5%.

^ Combined programs; split into counties assuming Grant County portion is 60% and Franklin County portion is 40%.

Table 4-6. Summary of Water Conservation Projects Obtained from Conservation Districts

Type of Project	Number of Projects Listed	Number with Estimated Water Savings/Estimated Costs	Estimated Water Savings (ac-ft/yr)	Estimated Cost	Estimated Cost/Acre Foot
Automation-Irrigation Water Mgmt	18	14/17	>5,807	>$3,500,000	$603/ac-ft
General Water Conservation	15	0/3	Unknown	>$92,000	Unknown
Lining/Piping	33	27/32	>23,458	>$158,763,000	$6,767/ac-ft
On-Farm Conservation Programs (Grant & Franklin CD)	8	8/8	346,101	$319,369,760*	$923/ac-ft
On-Farm Conservation Improvements	5,214	5,193/5,195	>160,279	>$258,792,700	$1,615/ac-ft
Other	20	1/1	>1,000	>$130,000	$130/ac-ft
Storage/Re-reg Reservoirs	2	0/1	Unknown	>$40,000,000	Unknown
Surface to Groundwater Conversion	1	1/1	360	$200,000	$556/ac-ft
Tailwater Reuse	2	2/2	2,900	$520,000	$179/ac-ft
Water Right Purchase	2	2/2	5,360	$500,000	$93/ac-ft
Total	**5,315**	**5,248/5,262**	**>545,265**	**>$781,867,460**	**$1,434/ac-ft**

NOTES
Abbreviations: CD: Conservation District
*This cost is based upon the amount of money required upfront to capitalize the expenditure assuming an annual interest rate of 5%.

Table 4-7. Potential Irrigation District Water Conservation Projects

County[1]	Number of Projects Listed	Number with Estimated Water Savings/ Estimated Costs	Estimated Water Savings (AFY)	Estimated Cost[2]	Estimated Cost/Acre-Foot
Adams	2	2/2	32,500	$9,300,000	$286/ac-ft
Benton	4	4/4	47,468	$32,927,620	$694/ac-ft
Columbia	1	1/1	706	$994,000	$1,408/ac-ft
Douglas	4	0/4	Unknown	>$802,000	NA
Franklin	3	1/3	>11,300	$6,081,000	$538/ac-ft
Grant	3	2/3	>47,360	>$52,810,000	$1,115/ac-ft
Kittitas	2	2/2	62,230	$52,234,000	$839/ac-ft
Okanogan	9	6/9	>10,594	$11,563,000	$1,091/ac-ft
Walla Walla	1	0/1	Unknown	>$13,176,000	NA
Yakima	53	48/52	>212,668	>$270,776,950	$1,273/ac-ft
Total	**82**	**66/81**	**>424,800**	**>$450,664,600**	**$1,061/ac-ft**

Type of Project	Number of Projects Listed	Number with Estimated Water Savings/ Estimated Costs	Estimated Water Savings (AFY)	Estimated Cost[2]	Estimated Cost/Acre-Foot
Automation-Irrigation Water Management	16	6/16	>15,500	$66,000,000	$4,258/ac-ft
Lining/Piping	52	48/51	>324,000	>$324,311,400	$1,001/ac-ft
On-Farm Conservation	5	4/5	>33,610	$21,237,000	$632/ac-ft
Other	2	2/2	10,914	$6,936,300	$636/ac-ft
Storage/Re-reg Reservoirs	7	6/7	>40,760	$32,420,700	$795/ac-ft
Total	**82**	**66/81**	**>424,800**	**>$450,905,400**	**$1,061/ac-ft**

NOTES

Abbreviations: ac-ft: acre-foot; AFY: acre-feet per year; NA: Not applicable

[1] County is based on the location of the project. In some cases, the county where the water was diverted is different from the location of the project.

[2] The total estimated cost by county and project type do not match due to averaging of one of the automation irrigation projects.

Table 4-8. Municipal Conservation and Reuse

County	Municipal Water Supplier	Conservation		Reuse		
		Current Conservation	Future Conservation	Level of Treatment	Description of Use	Facility Design Capacity
Benton	City of Kennewick	0.10 AFY based on customer conservation measures	NA	NA	NA	NA
Chelan	City of Wenatchee	NA	4 % conservation by 2008	NA	NA	NA
Chelan	City of East Wenatchee	3 AFY (0.1% total water use)	NA	NA	NA	NA
Chelan	City of Chelan	13 AFY (1% total water use)	Public education, rate surcharges, goal billing	NA	NA	NA
Grant	City of Ephrata	NA	NA	Class A	Groundwater recharge; washing of on-site equipment; on-site irrigation; water hydrant system for dust control and construction	1.22 MGD
Grant	City of Royal City	NA	NA	Class A	Aquifer recharge through surface percolation basins; treatment plant washdown; process water; on-site irrigation; hydrant system for construction	0.25 MGD
Grant	City of Quincy	NA	NA	Class A	Aquifer recharge through infiltration basins	1.54 MGD
Yakima	City of Yakima	New source meters, conservation program, leak repair, conservation pricing	Possible water reuse, aquifer storage and recovery (ASR)	NA	NA	NA
Walla Walla	City of Walla Walla	NA	NA	Unknown	Agricultural use; discharge to Mill Creek to satisfy senior water rights	9.6 MGD

See notes on next page.

County	Municipal Water Supplier	Conservation		Reuse		
		Current Conservation	Future Conservation	Level of Treatment	Description of Use	Facility Design Capacity
Walla Walla	City of College Place	NA	NA	Class C	Flow augmentation in Garrison Creek watershed	1.65 MGD
Spokane	City of Medical Lake	NA	NA	Class A	Maintain water levels in West Medical Lake; irrigation of treatment plant facility grounds	1.85 MGD
Spokane	City of Cheney	NA	NA	Class D	Wetlands habitat; facility wash down; on-site irrigation	Avg Annual: 1.5 MGD; Monthly Avg: 2.7 MGD

NOTES
Abbreviations: AFY: acre-feet per year; Avg.: Average; MGD: Million gallons per day; NA: Not available or Not applicable

Table 4-9. Federal Dam Storage by County and Purpose of Use (acre-feet)[1,2]

County	Irrigation[3]	Water Supply[4]	Hydropower[5]	Other[6]	Total
Adams	340	NA	NA	45	385
Asotin	NA	NA	NA	NA	NA
Benton	450	NA	1,350,000	NA	1,350,450
Chelan	NA	NA	NA	1,250	1,250
Columbia	NA	NA	565,200	NA	565,200
Douglas	NA	NA	593,000	NA	593,000
Ferry	18,950	NA	NA	NA	18,950
Franklin	38,993	NA	438,080	NA	477,073
Garfield	NA	NA	NA	NA	NA
Grant	12,794,950[7]	NA	730	570	12,796,250
Kittitas	1,131,100	NA	NA	NA	1,131,100
Klickitat	NA	NA	2,860,000	NA	2,860,000
Lincoln	NA	NA	NA	NA	NA
Okanogan	54,550	NA	NA	NA	54,550
Pend Oreille	NA	NA	NA	NA	NA
Skamania	180	NA	537,000	12	537,192
Spokane	NA	NA	NA	598	598
Stevens	NA	NA	NA	NA	NA
Walla Walla	NA	NA	376,000	NA	376,000
Whitman	NA	NA	485,000	NA	485,000
Yakima	244,830	NA	NA	NA	244,830
Total	14,284,343	NA	7,205,010	2,475	21,491,828

NOTES

Abbreviations: NA: Not applicable

[1] Source: Washington State Department of Ecology Dams of Washington State database, January 2006.

[2] Values are total maximum storage including the Columbia River mainstem.

[3] Total maximum storage for Columbia Basin dams with irrigation as primary use.

[4] Total maximum storage for Columbia Basin dams with water supply as primary use.

[5] Total maximum storage for Columbia Basin dams with hydropower as primary use.

[6] Total maximum storage for Columbia Basin dams with fish and wildlife as primary use or use unspecified.

[7] Includes 9,562,000 AF of storage on the Columbia River mainstem behind Grand Coulee Dam.

Table 4-10. Non-Federal Dam Storage by County and Purpose of Use (acre-feet)[1,2]

County	Irrigation[3]	Water Supply[4]	Hydropower[5]	Other[6]	Total
Adams	16,075	182	NA	3,366	19,623
Asotin	NA	NA	NA	23	23
Benton	418	NA	NA	654	1,072
Chelan	18,987	NA	1,580,350[7]	414	1,599,751
Columbia	NA	NA	NA	92	92
Douglas	1,769	NA	500,000	326	502,095
Ferry	NA	NA	NA	3,480	3,480
Franklin	2,793	NA	50	327	3,170
Garfield	50	NA	NA	NA	50
Grant	50,145	NA	1,018,775[8]	474	1,069,394
Kittitas	22	NA	NA	156	178
Klickitat	276	130	2,050	82	2,538
Lincoln	190	NA	262,180	4,544	266,914
Okanogan	80,426	NA	2,400	2,709	85,535
Pend Oreille	2,330	25	270,450	576	273,381
Skamania	34	10	756,000	16	756,060
Spokane	110	NA	9,143	263	9,516
Stevens	570	525	75	1,774	2,944
Walla Walla	90	46	NA	220	356
Whitman	NA	NA	NA	10	10
Yakima	5,798	NA	NA	127	5,925
Total	180,083	918	4,401,473	19,633	4,602,107

NOTES
Abbreviations: NA: Not applicable
[1] Source: Washington State Department of Ecology Dams of Washington State database, January 2006.
[2] Values are total maximum storage including the Columbia River mainstem.
[3] Total maximum storage for Columbia Basin dams with irrigation as primary use.
[4] Total maximum storage for Columbia Basin dams with water supply as primary use.
[5] Total maximum storage for Columbia Basin dams with hydropower as primary use.
[6] Total maximum storage for Columbia Basin dams with fish and wildlife as primary use or use unspecified.
[7] 521,000 AF is storage only on the Columbia River mainstem.
[8] 1,018,600 AF is storage only on the Columbia River mainstem.

Table 4-11. Potential Large Storage Opportunities

Name	County	Volume (AF)	Cost Estimate[4] ($ millions)	Cost per AF
Hawk Creek Dam[1]	Lincoln	1,550,000	$1,444 - $1,624	$932 – $1,048
Foster Creek Dam[1]	Douglas	1,340,000	$2,967 - $3,348	$2,214 – $2,499
Sand Hollow[1]	Grant	1,230,000	$971 - $1,092	$790 - $890
Crab Creek[1]	Grant	2,650,000	$1,703 - $1,915	$640 - $720
Wymer Dam plus Columbia River pump back[2]	Yakima/Benton	1,102,000	$2,582 - $2,850	$2,343 - $2,586
Black Rock Dam[3]	Yakima/Grant	800,000 - 1,300,000	$3,500 - $4,000	$2,692 - $5,000

NOTES

[1] Washington State Department of Ecology and Bureau of Reclamation (Ecology and Reclamation). 2005. Columbia River Mainstem Storage Options, Washington. Prepared by Montgomery Watson Harza. December 2005.

[2] Golder Associates Inc. (Golder). 2006. Preliminary Draft Report to U.S. Bureau of Reclamation on Appraisal Assessment of Yakima River Pump Back Alternative Delivery System for Roza and Sunnyside Irrigation Districts.

[3] Bureau of Reclamation. 2004. Summary Report Appraisal Assessment of the Black Rock Alternative. Technical Series No. TS-YSS-7. December 2004.

[4] Based on 20-35% of Direct Construction Costs, except for the pumpback costs which represent the costs associated with two plans for delivery. The cost estimates represent a total cost estimate that includes field construction costs plus additional costs estimated at 20-35% of the estimated field construction costs. Field construction costs represent costs associated with the cost of construction contracts. Additional costs include noncontract costs such as preparation of final engineering designs and specifications, regulatory compliance and permitting activities, environmental mitigation and monitoring, and construction contract administration and management.

Table 4-12. Potential Small Storage Opportunities[1]

Name	County	Volume (AF)
Beaver Restoration Pilot, Wetland Storage	Asotin/Garfield/Columbia/Whitman	NA
Wymer Dam and Reservoir[2]	Kittitas/Yakima	174,000
Reservoirs (multiple)	Chelan	5,590
Channel Migration Zone Projects (multiple)	Chelan	70
Alpine Lakes Optimization	Chelan	5,750
Uphill Reservoir	Okanogan	2,298
Elbow Coulee and Dead Horse Reservoir	Okanogan	5,253
Beaver Creek Alternative	Spokane/Pend Oreille/Stevens	1,850
Buck Creek Alternative	Spokane/Pend Oreille/Stevens	4,750
Saltese Flats Restoration	Spokane/Pend Oreille/Stevens	11,400
Wetland Restoration Complexes A & B	Spokane	1,225
Catchment/Balancing Basins	Spokane	600
Courtney Canyon Dam	Spokane	992
Spangle Creek Dam	Spokane	496
Smith Creek Dam	Spokane	534

NOTES

Abbreviations: NA: Not Applicable

[1] Based on information in WRIA 32 Watershed Plan, WRIA 35 Watershed Plan, WRIA 37/38/39 Watershed Plan, WRIA 45 Watershed Plan, WRIA 48 Watershed Plan, WRIA 55/57 Watershed Plan, WRIA 56 Watershed Plan, and Bureau of Reclamation. 2006. Yakima River Basin Storage Alternatives Appraisal Assessment. Technical Series No. TS-YSS-8. May 2006.

[2] Wymer Dam and reservoir option has an estimated cost of $340 - $380 million.

Table 4-13. Washington Water Right General Use Designations

General Use Designation	Use Code	General Purpose of Use
Agriculture	DY	Dairy
	FP	Frost Protection
	IR	Irrigation
	ST	Stock Watering
Commercial and Industrial	CI	Commercial and Industrial Manufacturing
	CO	Cooling for industrial purposes
	HW	Highway
	MI	Mining
	RW	Railway
Domestic	DG	Domestic General
	DM	Domestic Multiple
	DS	Domestic Single
	HE	Heat Exchange
	MU	Domestic Municipal
	RE	Recreation
Environment and Wildlife	EN	Environmental Quality
	FR	Fire Protection
	FS	Fish Propagation
	WL	Wildlife Propagation

NOTES
Reference: Department of Ecology.
http://www.ecy.wa.gov/programs/wr/rights/Images/pdf/wtrrts_purposecodes.pdf

Table 4-14. Total Existing Washington Water Rights within the Management Zone[1]

County	Total Water Rights	Q_a[2] (AFY)
Benton	1,199	1,081,696
Chelan	547	1,171,862
Douglas	1,125	747,382
Ferry	332	18,005
Franklin	950	581,314
Grant	199	3,297,220
Kittitas	74	14,022
Klickitat	470	87,392
Lincoln	276	508,124
Okanogan	398	91,765
Skamania	385	154,763
Stevens	805	38,834
Walla Walla	319	400,829
Yakima	8	1,378
Total	**7,087**	**8,194,586**

NOTES

Abbreviations: AFY: acre-feet per year

[1] Washington State Water Rights Tracking System (WRTS). Excerpt of water rights and applications within the 1 mile management zone. Provided by Ecology August 2, 2006.

[2] Q_a for water records are calculated from Q_i IF no Q_a is provided. (1 GPM = 1.61 AFY OR 1 CFS = 724.46 AFY).

Table 4-15. Oregon Management Zone Water Records[1]

Use Designation	No. of Records[6]	Q_a[7] (AFY)
Agriculture[2]	334	561,453
Commercial & Industrial[3]	36	46,798
Domestic[4]	132	327,939
Environment & Wildlife[5]	49	5,927,321
Total	**551**	**6,863,511**
Total excluding Environment and Wildlife (instream non-consumptive uses)	**502**	**936,190**

NOTES

Abbreviations: AFY: acre-feet per year; cfs: cubic feet per second; Q_a: annual quantity

[1] Oregon State Water Rights Information System (WRIS). Excerpt of water rights and applications with points of diversion within the 1 mile management zone. Provided by OWRD September 14, 2006. Records appearing to be duplicative were deleted.

[2] Q_a does not include 116,726 AFY of supplemental rights that are not used at the same time as primary rights. Q_a was calculated using an average duty rate of 4.5 acre-feet per acre to account for season of use. Agriculture incorporates the following use codes: AG, CH, CI, CR, DB, FR, GH, I*, IC, ID, IL, IR, IS, LV, LW, NU, and OI.

[3] Commercial and Industrial incorporates the following use codes: AH, CM, GT, IM, LA, LD, MI, MS, RW, SH, and SM.

[4] Domestic incorporates the following use codes: AS, CS, DI, DN, DO, DS, GD, HC, MP, MU, QM, R3, RA, RC, RR, SC, and SW.

[5] Environment and Wildlife uses were identified by OWRD as non-consumptive uses. Environment and Wildlife incorporates the following use codes: AQ, CF, F1, F2, F3, F4, F5, F6, F7, F8, FE, FI, FM, FP, FW, GR, PA, PF, PM, R1, R2, RF, and WI. Note that most of this amount of associated with 4 records.

[6] Water records may include records of surface, reservoir or groundwater, permit, claim or application.

[7] Q_a for water record is calculated from Q_i IF no Q_a is provided. (1 GPM = 1.61 AFY OR 1 CFS = 724.46 AFY).

Table 4-16. Interruptible Water Rights within the Management Zone

County	Total Number of Water Rights[1]	Total Acres Irrigated	Total Q_i (CFS)[2]	Total Q_a (AFY)[3]
Benton	71	17,761	396	66,210
Chelan	36	1,984	45	9,280
Douglas	86	4,563	189	19,695
Ferry	3	27	<1	52
Franklin	31	14,491	297	60,431
Grant	7	50,246	1,151	215,208
Kittitas	8	1,162	103	7,596
Klickitat	8	461	9	1,776
Lincoln	7	620	13	1,993
Okanogan	63	10,230	167	29,780
Skamania	0	NA	NA	NA
Stevens	10	91	1	295
Walla Walla	29	15,603	328	74,788
Yakima	0	NA	NA	NA
Totals	**359**	**117,239**	**2,699**	**487,104**

NOTES

Abbreviations: Q_i: instantaneous quantity; Q_a: annual quantity; NA: Not applicable

[1] Includes surface and ground water rights on the mainsem Columbia and Snake Rivers. Does not include interruptible rights associated with power (PO).

2 Q_i for ground water records converted from GPM to CFS using a 1 GPM = 0.002228 CFS conversion factor.

[3] Q_a for water records are calculated from Q_i IF no Q_a is provided. (1 GPM = 1.61 AFY OR 1 CFS = 724.46 AFY).

Table 4-17. Estimate of Permit-Exempt Wells within the Management Zone[1]

County	Number of Exempt Wells	Estimated Water Use (AFY)
Benton	266	1,491
Chelan	122	684
Douglas	141	790
Ferry	87	488
Franklin	206	1,155
Grant	113	633
Kittitas	2	11
Klickitat	83	465
Lincoln	217	1,216
Okanogan	59	331
Skamania	34	191
Stevens	385	2,158
Walla Walla	90	504
Yakima	2	11
Total within the Management Zone	1,807	10,127

NOTES

Abbreviations: AFY: acre-feet per year

[1] Based on data provided by Ecology on August 7, 2006 (Ecology, personal communication, 2006). Ecology provided the query results from the Notice of Intent database of the exempt wells that are within the one mile corridor of the Columbia River (Management Zone). Eight wells in Spokane County were included in the data provided by Ecology but not included in this table. However, the information in this database is limited for the following reasons. Well drillers were not required to file logs before 1971; therefore, there are more wells in the one-mile corridor than is recorded in this table. Additionally, Ecology built the database in 1993 and did not populate it with data before that time. Furthermore, the database may contain redundant entries because of deepening and reconditionings. The legal water use limit for a permit exempt well is 5,000 gpd. However, actual use varies according to purpose of use.

Table 4-18. USGS Water Use Classifications and Year 2000 Results by County[1]

County	Domestic (public supplied) (AFY)	Domestic (self-supplied) (AFY)	Crop Irrigation (AFY)	Golf Course Irrigation (AFY)	Industrial (AFY)	County Total (AFY)
Adams	2,780	1,468	209,610	123	2,500	216,481
Asotin	4,125	235	224	123	0	4,707
Benton	14,684	3,721	265,656	1,311	84,180	369,552
Chelan	6,580	2,242	56,382	818	16,253	82,275
Columbia	583	247	4,831	56	90	5,807
Douglas	3,497	594	27,462	347	3,744	35,644
Ferry	404	740	5,033	45	325	6,547
Franklin	9,079	2,477	489,838	191	1,962	503,547
Garfield	314	168	572	45	11	1,110
Grant	11,075	5,941	1,042,446	2,287	3,598	1,065,347
Kittitas	7,342	1,558	223,061	516	1,580	234,057
Klickitat	2,320	1,054	29,704	146	3,116	36,340
Lincoln	1,334	706	40,241	202	11	42,494
Okanogan	4,551	4,192	81,378	370	4,237	94,728
Pend Oreille	594	785	829	0	1,031	3,239
Skamania	628	460	280	235	12,666	14,269
Spokane	88,552	13,115	10,268	1,580	48,423	161,938
Stevens	2,858	2,074	10,682	146	135	15,895
Walla Walla	6,053	1,188	138,993	258	18,271	164,763
Whitman	3,632	1,009	3,139	90	0	7,870
Yakima	28,807	14,236	637,798	1,424	7,297	689,562
Oregon[2]	52,806	NA	768,204		26,084	847,094
Use Type Totals	252,598	58,210	4,056,944		235,514	4,603,266

NOTES

Abbreviations: AFY: acre-feet per year

[1] Data from Lane (2004) for Washington counties and USGS (2004) for Oregon were originally reported in million gallons per day (mgd) and converted to acre-feet per yr (AFY) (1 mgd = 1,120.91 AFY).

[2] Oregon includes water use from seven counties: Multnomah, Hood River, Wasco, Sherman, Gillam, Morrow and Umatilla. Data from USGS (2004).

Table 4-19. Current and Future Water Use as Reported in Watershed Planning Documents[1]

WRIA No. & Name	Current Water Use (AFY)					Future Water Use (AFY)				
	Crop Irrigation	Industrial (public-supplied)	Domestic (public-supplied)	Domestic (self-supplied)	Industrial (self-supplied)	Crop Irrigation	Industrial (public-supplied)	Domestic (public-supplied)	Domestic (self-supplied)	Industrial (self-supplied)
28 Salmon-Washougal[2]	6,844	44,242		7,752	44,686	NA	NA	NA	NA	NA
30 Klickitat[3]	29,459	471	1,376	871	NA	NA	NA	NA	NA	NA
31 Rock-Glade[4]	622,571	4,009	7,635	515	5,556	NA	NA	NA	NA	NA
32 Walla Walla[5]	92,500	7,891		3,800	56	NA	21,252		4,652	56
34 Palouse[6]	184,286	NA	7,112	2,968	NA	NA	9,630		4,868	
35 Middle Snake[7]	26,429	NA	500	1,286	NA	NA	NA	NA	NA	NA
37, 38 & 39 Lower Yakima, Naches & Upper Yakima[8]	3,020,382	74,008		41,764	NA	NA	107,686		55,630	NA
43 Upper Crab-Wilson[9]	26,429	4,103		1,987	NA	NA	5,714		3,103	NA
44 & 50 Moses Coulee & Foster Creek[10]	56,151	NA	NA	418	NA	NA	NA	15,691		NA
45 Wenatchee[11]	NA	5,405			NA	NA	7,950			NA
46 Entiat[12]	7,686	NA	50		NA	9,859	NA	NA	724	
48 Methow[13]	55,467	NA	210	956	NA	NA	NA	3,026		NA
55 & 57 Little Spokane & Middle Spokane[14]	7,676	NA	128,515	16,600	NA	NA	NA	186,504	NA	NA
56 Hangman[15]	7,860	1,862	6,868	1,130	6,100	NA	NA	NA	NA	NA
59 Colville[16]	21,600	NA	4,670	1,870	NA	29,894	NA	NA	NA	NA
60 Kettle[17]	NA	NA	5,311		NA	NA	NA	NA	NA	NA
62 Pend Oreille[18]	1,468	35	1,327	690	NA	1,800	NA	3,202		NA

See notes on next page.

NOTES

Abbreviations: AFY: acre-feet per year; NA: Not Available.

[1] No information was available for WRIAs 33, 36, 40, 41, 42, 47, 51, 52, 53, 58 and 61 because they have not begun the watershed planning process as of August 2006. In addition, watershed planning documents for WRIAs 29, 49, and 54 do not contain any specific information regarding water use.

[2] Current water use for 2000. Reference: GeoEngineers. 2001. Level I Technical Assessment Water Resource Inventory Areas 27 and 28. June 29, 2001.

[3] Current water use for 2003. Reference: Watershed Professional Network. 2005. Klickitat Basin (WRIA 30) Watershed Management Plan. May 3, 2005.

[4] Current water use for 2000. Reference: Aspect Consulting. 2004. Level I Watershed Assessment WRIA 31 (Rock-Glade Watershed). November 12, 2004.

[5] Current water use for 1997 (crop irrigation), 2000 (domestic self-supplied) and 2005 (industrial and domestic public supplied; industrial self-supplied). Future water use for 2020. Reference: HDR/EES, Inc. Walla Walla Watershed Plan. May 2005.

[6] Current water use for 2000. Future water use for 2025. Reference: Golder Associates Inc. Phase II - Level 1 Technical Assessment for the Palouse Basin (WRIA 34). December 8, 2004.

[7] Current water use for 2005. Future water use for 2025. Information on current and future water use for some of the implementation areas was not included in the table when it did not sum to total water use in the WRIA. Reference: HDR Inc. Middle Snake Watershed Plan Draft. April 2006.

[8] Current water use for 2000. Future water use for 2020. Reference: Economic and Engineering Services. 2003. Watershed Management Plan Yakima River Basin. January 2003.

[9] Current water use for 2003. Future water use for 2028. Reference: Kennedy/Jenks Consultants. 2005. Watershed Assessment Report WRIA 43. November 2005.

[10] Current water use year not reported. Future water use for 2025. Reference: Pacific Groundwater Group. 2003. WRIA 44/50 Final Phase II Basin Assessment. April 2003.

[11] Current water use for 2002. Future water use for 2025. Reference: WRIA 45 Planning Unit. 2006. Final Wenatchee Watershed Management Plan. April 26, 2006.

[12] Current water use for 2004. Future water use for 2025. Future domestic public and self-supplied was reported as 65 AF/yr. Reference: WRIA 46 Planning Unit. 2004. Management Plan. October 2004.

[13] Current water use year not reported. Future water use for 2015. Reference: Methow Basin Planning Unit. 2005. Methow Basin (WRIA 48) Watershed Plan. Approved June 20, 2005.

[14] Current water use year not reported. Future water use for 2020. Current industrial public and self-supplied was reported as 38,183 AF/yr. Reference: Little Spokane River and Middle Spokane River Planning Unit. 2005. Watershed Management Plan - WRIA 55 & WRIA 57. January 31, 2006.

[15] Current water use for 2000. Current water use does not include 5,817 AF/yr for commercial uses. Reference: Hangman (Latah) Creek Watershed Planning Unit. 2005. The Hangman (Latah) Creek Water Resources Management Plan. May 19, 2005.

[16] Current water use for 2001. Future water use for 2025. Current industrial public and self-supplied was reported as 239 AF/yr. Reference: GeoEngineers. 2005. WRIA 59 Colville River Watershed Plan. November 15, 2005.

[17] Current water use for 2000. Reference: GeoEngineers. 2004. Level I Technical Assessment Water Resource Inventory Area 60, Kettle River Watershed. March 16, 2004.

[18] Current water use for 2000. Future crop irrigation water use for 2008 and future domestic public and self-supplied water use for 2020. Reference: Golder Associates. 2004. Draft Pend Oreille (WRIA 62) Watershed Planning Phase II, Level 2 Technical Assessment. Submitted to The Pend Oreille Watershed Planning Unit and Pend Oreille Conservation District. March 2004.

Table 4-20. Comprehensive Plan Summary for Counties along the Mainstem of the Columbia River[1]

County	Existing Land Use (acres)				Trends
	Agriculture[2]	Range land & undeveloped	Urban[3]	Other	
Benton[4]	526,037	208,223	65,339	296,311	**Land Use** • Expansion of agricultural acreage through conversion of undeveloped or rangeland to dryland/ irrigated crop production. • Growth of commercial retail centers and the rural population. • Construction of residential/golf course communities. **Water** • Regionally, declining ground water levels in lower aquifers, and declining water quality in upper aquifers. • Nitrate contaminations occur principally in upper aquifer wells drilled in the lower lying areas of the county. • As federal and state-sponsored conservation projects reduce or eliminate diluting seepage from irrigation district canals, nitrate concentrations in the upper aquifer may actually rise.
Chelan[5]	123,731	NA	NA	NA	**Land Use** • Based on a trend from 1987 to 1997, there is an apparent shift to larger farming operations and a significant decrease in the number of farms, in all but the largest farm operations.
Grant[6]	690,291	768,163	32,625	296,135	**Land Use** • Most of the new housing in Grant County will locate in the UGAs during the next twenty years.
Kittitas[7]	--	445,943	29,730	1,010,804	NA
Okanogan[8]	1,240,000	NA	NA	2,171,203	NA
Yakima[9]	NA	NA	NA	NA	**Water** • Securing certainty in our water supply will be a major issue over the next twenty years. • Irrigated agriculture is the biggest user of water, but recently the needs of other surface water uses (e.g., protection and restoration of anadromous fish runs) have been fiercely fought for.

See notes on next page.

NOTES

Abbreviations: UGA: Urban Growth Area; NA: Not Available

[1] Comprehensive Plans were not available online for Douglas, Ferry, Lincoln, Franklin, Klickitat, Skamania and Walla Walla Counties. Stevens County's comprehensive plan did not contain information that could be used in this table.

[2] For Benton County, this includes irrigated and dryland agriculture.

[3] For Benton County, this includes five cities and their Urban Growth Areas.

[4] Benton County (2005) reported the 2005 land use.

[5] Chelan County (2005) reported 1997 agricultural land use.

[6] The land uses for Grant County were grouped as follows: Agriculture included irrigated agriculture (340,878 acres), dryland agriculture (314,836 acres) and orchard (34,577 acres); range land and undeveloped included rangeland (183,425 acres) and unimproved/vacant (584,738 acres), urban included residential (19,872 acres) and commercial/industrial (12,753 acres), and other included not classified (296,135 acres) (Grant County, 1999).

[7] Other includes coniferous forest and unspecified uses (Kittitas County, 2005).

[8] Other land use includes 14,318 acres of mining and 46,307 acres of privately-owned forest land (Okanogan County, 2005).

[9] Volume II of the plan was not available online (Yakima County Planning Department, 1998).

Table 4-21. Columbia Basin Public Water System Water Use Summary by County[1]

County	Number of Connections			Population Served[2]	Per Capita Water Use[3] (gal/d)	Estimated Water Use[4]	
	Group A	Group B	Total			(mgd)	(AFY)
Adams	4,763	251	5,014	12,629	221	2.8	3,000
Asotin	6,905	83	6,988	20,457	192	3.9	4,000
Benton	45,178	1,484	46,662	133,511	115	15.4	20,000
Chelan	24,351	1,151	25,502	47,051	118	5.6	6,000
Columbia	1,798	15	1,813	2,869	190	0.5	600
Douglas	13,826	355	14,181	31,157	108	3.4	4,000
Ferry	1,433	131	1,564	2,594	125	0.3	400
Franklin	13,747	596	14,343	51,710	208	10.8	10,000
Garfield	752	73	825	1,482	190	0.3	300
Grant	25,069	1,057	26,126	56,806	199	11.3	13,000
Kittitas	10,209	804	11,013	26,456	302	8.0	9,000
Klickitat	6,294	232	6,526	7,352	177	1.3	1,000
Lincoln	4,074	155	4,229	6,558	188	1.2	1,000
Okanogan	11,031	1,347	12,378	21,973	192	4.2	5,000
Pend Oreille	2,319	47	2,366	679	98	0.1	100
Skamania[5]	NA	NA	NA	NA	NA	0.0	0
Spokane	138,157	1,114	139,271	377,688	214	80.8	90,000
Stevens	10,302	443	10,745	23,170	109	2.5	3,000
Walla Walla	16,790	430	17,220	50,409	116	5.8	7,000
Whitman	11,930	200	12,130	37,573	92	3.5	4,000
Yakima	59,230	2,456	61,686	164,843	193	31.8	40,000
Total	408,158	12,424	420,582	1,076,967	170[6]	193.5	200,000

NOTES

Abbreviations: AFY: acre-feet per year; gal/d: gallons per day; NA: Not applicable; mgd: million gallons per day

[1] Information based on data provided by the Washington Department of Health (2006). Database cannot discern ground water vs. surface water sources. Connection information only available for water systems with approved planning documents. Includes both residential and non-residential connections. Does not include exempt well use.

[2] Population provided by Washington State Department of Health (2006).

[3] Per capita water use was calculated using population and domestic public-supplied water use data reported in Lane (2004) for each county.

[4] Estimated water use was calculated by multiplying the per capita water use by the population served. Estimated water use was converted into acre-feet per year (AFY) using 1 AF = 325,851 gal conversion factor.

[5] DOH did not provide data for Skamania County.

[6] This value is the average per capita water use rounded up from 167, not the total.

Table 4-22. Summary of Public Water System Connections in the Management Zone[1]

County	Number of Connections						Percent of County Connections in Mgmt Zone			Estimated Water Use in Mgmt Zone[3] (AFY)	
	Group A		Group B		Group A & B						
	Mgmt Zone[2]	County	Mgmt Zone[2]	County	Mgmt Zone[2]	County	Group A	Group B	Group A & B	Group A	Group B
Adams	NA	4,763	NA	251	NA	5,014	NA	NA	NA	NA	NA
Asotin	NA	6,905	NA	83	NA	6,988	NA	NA	NA	NA	NA
Benton	36,652	45,178	327	1,484	36,979	46,662	81%	22%	79%	13,518	121
Chelan	13,278	24,351	96	1,151	13,374	25,502	55%	8%	52%	3,240	23
Columbia	NA	1,798	NA	15	NA	1,813	NA	NA	NA	NA	NA
Douglas	12,054	13,826	253	355	12,307	14,181	87%	71%	87%	3,206	67
Ferry	345	1,433	27	131	372	1,564	24%	21%	24%	80	6
Franklin	11,948	13,747	121	596	12,069	14,343	87%	20%	84%	10,043	102
Garfield	NA	752	NA	73	NA	825	NA	NA	NA	NA	NA
Grant	2,981	25,069	53	1,057	3,034	26,126	12%	5%	12%	1,446	26
Kittitas	220	10,209	NA	804	220	11,013	2%	NA	2%	179	NA
Klickitat	2,877	6,294	62	232	2,939	6,526	46%	27%	45%	643	14
Lincoln	831	4,074	82	155	913	4,229	20%	53%	22%	272	27
Okanogan	1,779	11,031	78	1,347	1,857	12,378	16%	6%	15%	680	30
Pend Oreille	NA	2,319	NA	47	NA	2,366	NA	NA	NA	NA	NA
Skamania[4]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spokane	NA	138,157	NA	1,114	NA	139,271	NA	NA	NA	NA	NA
Stevens	1,092	10,302	33	443	1,125	10,745	11%	7%	10%	288	9
Walla Walla	1,147	16,790	75	430	1,222	17,220	7%	17%	7%	437	29
Whitman	NA	11,930	NA	200	NA	12,130	NA	NA	NA	NA	NA
Yakima	113	59,230	1	2,456	114	61,686	NA%	NA%	NA%	65	1
Total	**85,317**	**408,158**	**1,208**	**12,424**	**86,525**	**420,582**	**21%**	**10%**	**21%**	**34,097**	**455**

NOTES

Abbreviations: AFY: acre-feet per year; NA: Not applicable; Mgmt Zone: Management Zone

[1] Information based on data provided by the Washington Department of Health in 2006; geographic locator for management zone based on 2003 data. Database cannot discern ground water vs. surface water sources. Connection information only available for water systems with approved planning documents. Includes both residential and non-residential connections.

[2] Management Zone has been defined as within one mile of Columbia River. Values represent water system sources within township, range, and section that are in the Management Zone. TRS was available for 99.8% of Group A water system connections and 87% of Group B water system connections. Water system and the number of connections are within the Management Zone if at least one source is in the Management Zone.

[3] Estimated water use was calculated using the population and connection information in Table 4-21. The population per connection for each county was calculated by dividing the population served in the county by the total number of connections in the county. The population per connection was assumed to be the same for Group A and B systems. The population per connection was multiplied by the number of connections to determine the population served by Group A and Group B systems within the management zone. The per capita water use from Table 4-21 was then multiplied by the estimated population served by each system and converted to AFY.

[4] DOH did not provide data for Skamania County.

Table 4-23. Columbia Basin Residential Water Use by County[1]

County	Population			Per Capita Water Use		Estimated Water Use[7]			
						Group A and B Systems		Permit-Exempt Wells	
	OFM Total by County[2]	Served by Group A & B Systems[3]	Estimated Served by Permit-Exempt Wells[4]	Group A and B Systems[5] (gal/d)	Permit-Exempt Wells[6] (gal/d)	(gal/d)	(AFY)	(gal/d)	(AFY)
Adams	17,300	12,629	4,671	221	250	2,791,009	3,128	1,167,750	1,309
Asotin	21,100	20,457	643	192	160	3,927,744	4,403	102,880	115
Benton	160,600	133,511	27,089	115	116	15,353,765	17,210	3,142,324	3,522
Chelan	70,100	47,051	23,049	118	119	5,552,018	6,223	2,742,831	3,074
Columbia	4,100	2,869	1,231	190	165	545,110	611	203,115	228
Douglas	35,700	31,157	4,543	108	141	3,364,956	3,772	640,563	718
Ferry	7,500	2,594	4,906	125	379	324,250	363	1,859,374	2,084
Franklin	64,200	51,710	12,490	208	210	10,755,680	12,056	2,622,900	2,940
Garfield	2,400	1,482	918	190	161	281,580	316	147,798	166
Grant	80,600	56,806	23,794	199	211	11,304,394	12,671	5,020,534	5,628
Kittitas	37,400	26,456	10,944	302	119	7,989,712	8,956	1,302,336	1,460
Klickitat	19,800	7,352	12,448	177	127	1,301,304	1,459	1,580,896	1,772
Lincoln	10,200	6,558	3,642	188	163	1,232,904	1,382	593,646	665
Okanogan	39,800	21,973	17,827	192	202	4,218,816	4,729	3,601,054	4,036
Pend Oreille	12,300	679	11,621	98	110	66,542	75	1,278,310	1,433
Skamania[1]	NA	NA	NA	NA	NA	NA	NA	NA	NA
Spokane	443,800	377,688	66,112	214	237	80,825,232	90,598	15,668,544	17,563
Stevens	42,100	23,170	18,930	109	111	2,525,530	2,831	2,101,230	2,355
Walla Walla	57,900	50,409	7,491	116	122	5,847,444	6,554	913,902	1,024
Whitman	42,800	37,573	5,227	92	163	3,456,716	3,875	852,001	955
Yakima	231,800	164,843	66,957	193	142	31,814,699	35,661	9,507,894	10,658
Total	1,401,500	1,076,967	324,533	NA	NA	193,479,405	216,873	55,049,882	61,706

NOTES

Abbreviations: AFY: acre-feet per year; gal/d: gallons per day; NA: Not applicable

[1] Information based on data provided by the Washington Department of Health (2006). DOH did not provide data for Skamania County. Database cannot discern ground water vs. surface water sources. Connection information only available for water systems with approved planning documents. Includes both residential and non-residential connections. Does not include permit-exempt well use.

[2] Population provided by the Washington State Office of Financial Management, 2006 estimate.
[3] Population provided by Washington State Department of Health (2006).
[4] Population served by permit-exempt wells estimated by subtracting the population served by Group A and B systems from the total County (OFM) population.
[5] Group A and B Systems per capita water use was calculated using population and domestic public-supplied water use data reported in Lane (2004) for each county.
[6] Permit-exempt well per capita water use was calculated using population and domestic self-supplied water use data reported in Lane (2004) for each county.
[7] Estimated water use was calculated by multiplying the per capita water use by the population served. Estimated water use was converted into AFY using 1 AF = 325,851 gal conversion factor.

FIGURES