**REVIEW DRAFT**

# Shoreline Analysis Report for Shorelines in Benton County: *Yakima and Columbia Rivers*

30 NOVEMBER 2012

**REVIEW DRAFT**

**BENTON COUNTY**
**GRANT NO. G1200022**

# SHORELINE ANALYSIS REPORT

## FOR SHORELINES IN BENTON COUNTY: YAKIMA AND COLUMBIA RIVERS

Prepared for:

Benton County Planning Department
1002 Dudley Avenue
Prosser, WA 99350

Prepared by:

THE WATERSHED COMPANY
750 Sixth Street South
Kirkland . WA 98033
p 425.822.5242
f 425.827.8136
watershedco.com

BERK
STRATEGY | ANALYSIS | COMMUNICATIONS
2025 First Avenue, Suite 800
Seattle WA 98121

**November 30, 2012**

This report was funded in part through a grant from the Washington Department of Ecology.

**The Watershed Company Reference Number:**
120209

Printed on 30% recycled paper.

Cite this document as:

The Watershed Company and BERK. November 2012. REVIEW DRAFT Shoreline Analysis Report for Shorelines in Benton County: Yakima and Columbia Rivers. Prepared for the Benton County Planning Department, Prosser, WA

**The Watershed Company Contact Persons:**
Amy Summe/Sarah Sandstrom

**BERK Contact Person:**
Lisa Grueter

.

# TABLE OF CONTENTS

Page #


1 Introduction ..... 1

1.1 Background and Purpose ..... 1
1.2 Shoreline Jurisdiction ..... 1
1.3 Study Area ..... 3

2 Summary of Current Regulatory Framework ..... 4

2.1 Shoreline Management Act ..... 4
2.2 Benton County ..... 4
2.3 State Agencies and Regulations ..... 5
2.4 Federal Regulations ..... 8

3 Summary of Ecosystem Conditions ..... 11

3.1 Columbia River ..... 11

3.1.1 Geographic and Ecosystem Context ..... 11
3.1.2 Topography, Geology, and Drainage Patterns ..... 12
3.1.3 Major Land Use Changes ..... 14
3.1.4 Fish and Wildlife ..... 16

3.2 Yakima River ..... 20

3.2.1 Geographic and Ecosystem Context ..... 20
3.2.2 Topography, Geology, and Drainage Patterns ..... 20
3.2.3 Major Land Use Changes ..... 22
3.2.4 Fish and Wildlife ..... 24

4 Shoreline Inventory ..... 27

4.1 Inventory Sources ..... 27
4.2 Data Sources, Assumptions, and Data Gaps ..... 32

4.2.1 Ecological Characterization ..... 32
4.2.2 Land Use Characterization ..... 35

4.3 Summary of Shoreline Inventory Results ..... 40

5 Analysis of Ecological Functions ..... 52

5.1 Approach, Rationale and Limitations of Functional Analysis ..... 52

5.1.1 Reach Delineation ..... 52
5.1.2 Functions and Impairments ..... 53
5.1.3 Limitations ..... 60

5.2 Results of Functional Analysis ..... 61

5.2.1 Columbia River ..... 61
5.2.2 Yakima River ..... 80

5.3 Existing Setbacks and Vegetated Buffer Widths ..... 97

5.3.1 Approach ..... 97
5.3.2 Limitations ..... 99
5.3.3 Results ..... 99

6 Land Use Analysis ..... 101

6.1 Columbia River ..... 101

6.1.1 Current Land Use ..... 101
6.1.2 Future Land Use ..... 103
6.1.3 Shoreline Permit History ..... 107
6.1.4 Existing and Potential Public Access ..... 108
6.1.5 Historic and Archeological Sites ..... 111

6.2 Yakima River ..... 112

6.2.1 Current Land Use ..... 112
6.2.2 Future Land Use ..... 114
6.2.3 Shoreline Permit History ..... 116
6.2.4 Existing and Potential Public Access ..... 116
6.2.5 Historic and Archeological Sites ..... 119

7 Shoreline Management Recommendations ..... 119

7.1 Environment Designations ..... 119
7.2 General Policies and Regulations ..... 120

7.2.1 Archaeological and Historic Resources ..... 120
7.2.2 Critical Areas ..... 120
7.2.3 Flood Hazard Reduction ..... 121
7.2.4 Public Access ..... 122
7.2.5 Shoreline Vegetation Conservation ..... 122
7.2.6 Water Quality, Stormwater, and Nonpoint Pollution ..... 122

7.3 Shoreline Modification Provisions ..... 123

7.3.1 Shoreline Stabilization ..... 123
7.3.2 Piers and Docks ..... 123
7.3.3 Fill ..... 123
7.3.4 Breakwaters, Jetties, Groins and Weirs ..... 124
7.3.5 Dredging and Dredge Material Disposal ..... 124
7.3.6 Shoreline Habitat and Natural Systems Enhancement Projects ..... 124

7.4 Shoreline Uses ..... 124

7.4.1 Agriculture ..... 124
7.4.2 Aquaculture ..... 124
7.4.3 Boating Facilities ..... 124
7.4.4 Commercial Development ..... 125
7.4.5 Forest Practices ..... 125
7.4.6 Industry ..... 125
7.4.7 In-stream Structural Uses ..... 125
7.4.8 Mining ..... 125
7.4.9 Recreational Development ..... 125
7.4.10 Residential Development ..... 126
7.4.11 Transportation and Parking ..... 126
7.4.12 Utilities ..... 126

7.5 Restoration Plan ..... 126

8 References ..... 128
9 List of Acronyms and Abbreviations ..... 134

APPENDIX A Benton County Assessment of Shoreline Jurisdiction
APPENDIX B Shoreline Inventory Map Folio (online at www.BENTONCOUNTYSMPUPDATE.com)
APPENDIX C Map of Shoreline Reaches
APPENDIX D Channel Migration Zone Memo

# LIST OF FIGURES

Page #

Figure 3-1. Map of Water Resource Inventory Areas in Benton County ..... 12
Figure 5-1. Interpretation of relationship between functional scoring and proportion of altered function ..... 60

Figure 5-2. Assessment of reach protection, restoration, and development opportunities based on functions and extent of reach scale alterations to functions. Note that existing land use context and planning may result in different recommendations than those identified in this figure. .....77
Figure 5-3. Assessment of reach protection, restoration, and development opportunities based on functions and extent of reach scale alterations to functions. Note that existing land use context and planning may result in different recommendations than those identified in this figure. .....94
Figure 6-1. Current Land Use Acres – Columbia River Shoreline Parcels .....101
Figure 6-2. Columbia River zoned acres by Reach. .....104
Figure 6-3. Columbia River zoning district percentage by Reach. .....105
Figure 6-4. Hanford Site Comprehensive Land Use Plan Map .....107
Figure 6-5. Shoreline Permit History – Columbia and Yakima Rivers 1972-2012 ...108
Figure 6-6. Current land use acres – Yakima River shoreline parcels. .....113
Figure 6-7. Yakima River zoned acres by Reach.....114
Figure 6-8. Yakima River zoning percentage by Reach.....115
Figure 6-9. Red Mountain American Viticultural Area Master Site Plan .....118

# LIST OF TABLES

Page #

Table 3-1. State and federal priority fish species present in Benton County (WDFW 2012).....16
Table 3-2. Wildlife species found in the Mainstem Subbasin designated by state or federal agencies as endangered or threatened. F = federal, O = Oregon, W = Washington, E = endangered, and T = threatened. Numerous other species are considered sensitive or species of concern. (Table from Ward et al. 2001, updated per WDFW 2012).....17
Table 3-3. Partial list of butterfly species found in Benton County (R. Coler, M.D., personal communication, 7 November 2012). .....19
Table 3-4. Species distribution in the Yakima River. Shaded cells indicate species is rare (relatively few captures reported). Columns show distance from Columbia River mouth, and 0-44 represents area within Benton County. (Table from Yakima Subbasin Planning Board 2004) .....26
Table 4-1. Shoreline Inventory Elements and Information Sources. .....28
Table 4-2. Water-Oriented Uses Definitions and Examples.....38
Table 4-3. Comprehensive Plan Land Use Designations and Associated Zoning....40
Table 4-4. Summary of Shoreline Inventory by Reach. .....41
Table 4-5. Category 2 Waterbodies (Waters of Concern) by River and WRIA.....51
Table 4-6. Category 4 Waterbodies by River and WRIA.....51
Table 4-7. Category 5 Waterbodies (Impaired) by River and WRIA.....51
Table 5-1. Ecological processes and functions used to evaluate reaches .....53

Table 5-2. Description of shoreline functions and common sources of human disturbance. ....55
Table 5-3. Functional score ranking for Columbia and Yakima Rivers by indicator metric. ....57
Table 5-4. Reach ranking order from highest to lowest function for the Columbia River based on mean reach scores. ....61
Table 5-5. Reach ranking order from highest to lowest function for the Yakima River based on mean reach scores. ....80
Table 5-6. Habitat restoration actions specific to Benton County on the Yakima River. ....96
Table 5-7. Setback and vegetated width summary by Reach ....100
Table 6-1. Parks and open space acres by Reach – Columbia River ....109
Table 6-2. Parks and open space acres by Reach – Yakima River. ....117

# SHORELINE ANALYSIS REPORT

BENTON COUNTY: COLUMBIA AND YAKIMA RIVER SHORELINES

# 1 INTRODUCTION

## 1.1 Background and Purpose

Benton County (County) obtained a grant from the Washington Department of Ecology (Ecology) in 2012 to complete a comprehensive update of its Shoreline Master Program (SMP). One of the first steps of the update process is to inventory and characterize the County's shorelines as defined by the State's Shoreline Management Act (SMA) (RCW 90.58). This Shoreline Analysis Report was conducted in accordance with the Shoreline Master Program Guidelines (Guidelines, Chapter 173-26 WAC) and project Scope of Work promulgated by Ecology, and the analysis addresses all unincorporated areas within the County. Under these Guidelines, the County must identify and assemble the "most current, accurate, and complete scientific and technical information available that is applicable to the issues of concern" regarding natural and built environment characteristics in shoreline jurisdiction.

This Shoreline Analysis Report inventories and describes existing conditions and characterizes ecological functions in the shoreline jurisdiction. This assessment of current conditions will serve as the baseline against which the impacts of future development actions in shoreline jurisdiction will be measured. The Guidelines require that the County demonstrate that its updated SMP yields "no net loss" in shoreline ecological functions relative to the baseline (current condition) due to its implementation. By describing and inventorying existing conditions, this Shoreline Analysis Report will be used to help inform the development of appropriate SMP policies, regulations, and environment designations to help meet the "no net loss" goal.

## 1.2 Shoreline Jurisdiction

As defined by the Shoreline Management Act of 1971, shorelines include certain waters of the state plus their associated "shorelands." At a minimum, the waterbodies designated as shorelines of the state are streams whose mean annual flow is 20 cubic feet per second (cfs) or greater, lakes whose area is greater than 20 acres, and all marine waters. Shorelands are defined as:

> "those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter…Any county or city may determine that portion of a one-hundred-year-floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom… Any city or county may also include in its master program land necessary for buffers for critical areas (RCW 90.58.030)"

The ordinary high water mark (OHWM) is:

> "that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, That in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water" (RCW 90.58.030(2)(b)).

Ecology has identified the upstream limits of shoreline streams and rivers based on projected mean annual flow of 20 cubic feet per second (cfs) (Higgins 2003), and those lakes that are 20 acres or greater in size. All streams and rivers which have mean annual flow of 200 cfs or greater or portions of waterbodies downstream from the first 300 square miles of drainage area are considered Shorelines of Statewide Significance in Eastern Washington. This special status applies to the Columbia River and the Yakima River, and all of the associated shoreline jurisdictional area in the County. For Shorelines of Statewide Significance, the SMA sets specific preferences for uses and calls for a higher level of effort in implementing its objectives. A detailed discussion of the entire jurisdiction assessment and determination process can be reviewed in full in Appendix A of this report.

Due to its basin size, Glade Creek is noted in the County's current Shoreline Management Master Plan as a Shoreline of Statewide Significance, and is also listed in WAC 173-18-070 as a Shoreline of Statewide Significance. However, Glade Creek is not

identified in Ecology's suggested shoreline data set, and Glade Creek was excluded from shoreline jurisdiction based on its stream flow (Appendix A).

According to Ecology's shoreline data, there are nine suggested "waterbodies (lakes, wetlands, etc)" present in the County that are 20 acres or greater. GIS verification of these waterbodies found that several lakes are part of the Columbia River, several lakes do not meet the size threshold for shoreline waterbodies, one lake is within a city, and two lakes are actually wetlands. Based on these findings, the proposed Benton County shoreline jurisdiction does not include any lakes (Appendix A).

## 1.3 Study Area

Benton County encompasses 1,760 square miles and is located in the southeast part of Washington. Benton County is bounded on three sides (north, east, and south) by the Columbia River. The County is bordered to the west by Klickitat and Yakima Counties. The County includes portions of three Water Resource Inventory Areas (WRIAs), including the eastern portion of the Lower Yakima Watershed (WRIA 37), the Rock-Glade Watershed (WRIA 31), and the Alkali-Squilchuck Watershed (WRIA 40).

The County is predominantly rural and agricultural in nature, with unincorporated areas making up most of the county territory. There are unincorporated communities with housing and industry such as Plymouth, Paterson, and Finley. Incorporated cities include Benton City, Kennewick, Prosser, Richland, and West Richland. Each City has an assigned Urban Growth Area (UGA) in which the County retains governance until the area is annexed. The County coordinates planning in the UGAs with each City.

The study area for this report includes all land currently within proposed shoreline jurisdiction for unincorporated Benton County. The study area includes relevant discussion of the contributing watersheds. The study area includes unincorporated UGAs, but does not include incorporated cities because they are in the process of developing independent SMP updates.

In total, this shoreline inventory has mapped 330 miles of river shoreline that meet shoreline jurisdiction criteria. The total acreage of upland shorelands is 14.93 square miles, which includes floodways, and associated floodplains and wetlands. Federal lands make up approximately 35 percent of that acreage, or 3,369 acres total. The three federal entities that own the majority of the federal land are the U.S. Department of Energy (DOE), the U.S. Bureau of Land Management (BLM), and the U.S. Army Corps of Engineers (Corps).

# 2 SUMMARY OF CURRENT REGULATORY FRAMEWORK

## 2.1 Shoreline Management Act

The Shoreline Management Act of 1971 promoted planning along shorelines and coordination among governments. The legislative findings and policy intent of the SMA states:

> "There is, therefore, a clear and urgent demand for a planned, rational, and concerted effort, jointly performed by federal, state, and local governments, to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines (RCW 90.58.020)."

While protecting shoreline resources by regulating development, the SMA is also intended to provide balance by encouraging water-dependent or water-oriented uses while also conserving or enhancing shoreline ecological functions and values. SMPs will be based on state guidelines, but should be tailored to the specific conditions and needs of the local community.

## 2.2 Benton County

Benton County adopted its present Shoreline Management Master Plan in 1974, and it has not been updated since that time. Shoreline uses, developments, and activities are also subject to the County's Comprehensive Plan, County Code, and various other provisions of County, state and federal laws.

The current Shoreline Master Program designations for Benton County are briefly described below.

- Urban: The Urban environment is an area of high density land-use including residential, commercial, recreational and industrial development. It is particularly suitable to those areas presently subjected to extremely intensive use pressure, as well as areas planned to accommodate urban expansion.
- Rural: The Rural environment is intended for those areas characterized by intensive agriculture and outdoor recreational uses and those areas having a high capability to support active agricultural practices and intensive outdoor recreational development.

- Conservancy: Preferred uses in the Conservancy environment are those which are non-consumptive of the physical and biological resources of the area
- Natural: The Natural environment is characterized by the presence of some unique natural or cultural features considered valuable in their natural or original condition which are relatively intolerant of intensive human use.

Each incorporated City in the County is in the process of its own individual SMP update with the exception of the City of Kennewick, which has already completed its SMP update. The County will coordinate with each of the Cities to ensure future consistency in shoreline regulation within the County's unincorporated urban growth areas (UGAs).

The County Comprehensive Plan, last updated in 2012, is a statement of policies and goals that guides growth and development throughout the County. Each of the basic elements required by the Growth Management Act (GMA) are addressed in the County Comprehensive Plan, including land use, rural, housing, transportation, utilities, capital facilities, economics, and parks and recreation.

County regulations applicable to critical areas - called Critical Areas and Resources regulations - were adopted in 1994, and subsequently revised in 1997. In those regulations, the County specifies buffers of 50 feet for creeks and 100 feet for rivers (BCC 15.20). The regulations require wetland buffers between 25 and 200 feet based on wetland classification (BCC 15.15.060). For agricultural ditches, ponds, and channels (classified as Category V wetlands), the County requires a buffer sufficient to maintain water quality. Many shoreline and wetland areas within the County contain functioning buffers of the required widths. Smaller buffers are found where developments existed prior to the critical areas regulations or where buffers of different widths were previously established in approved site plans or protected critical area easements. The County's Critical Areas and Resources regulations also apply to geologic hazards, frequently flooded areas, critical aquifer recharge areas, and mineral resource areas. The next update to the County's Comprehensive Plan and development regulations is scheduled for 2017.

## 2.3 State Agencies and Regulations

Aside from the Shoreline Management Act, State regulations most pertinent to development in the County's shorelines include the State Hydraulic Code, Growth Management Act, State Environmental Policy Act, Watershed Planning Act, Water Resources Act, Salmon Recovery Act, and case law. A variety of agencies (e.g., Washington Department of Ecology, Washington Department of Fish and Wildlife,

Washington Department of Natural Resources) are involved in implementing these regulations or otherwise manage public shoreline areas. The Department of Ecology reviews all shoreline projects that require a shoreline permit, but has specific regulatory authority over shoreline conditional use permits and shoreline variances. Other agency reviews of shoreline developments are typically triggered by in- or over-water work, discharges of fill or pollutants into the water, or substantial land clearing.

Depending on the nature of the proposed development, state regulations can play an important role in the design and implementation of a shoreline project, ensuring that impacts to shoreline functions and values are avoided, minimized, and/or mitigated. During the comprehensive SMP update, the County will consider other state regulations to ensure consistency as appropriate and feasible with the goal of streamlining the shoreline permitting process. A summary of some of the key state regulations and/or state agency responsibilities follows.

**Hydraulic Code:** Chapter 77.55 RCW (the Hydraulic Code) gives the Washington Department of Fish and Wildlife (WDFW) the authority to review, condition, and approve or deny "any construction activity that will use, divert, obstruct, or change the bed or flow of State waters." These activities may include stream alteration, culvert installation or replacement, pier and bulkhead repair or construction, among others. In a permit called a Hydraulic Project Approval (HPA), WDFW can condition projects to avoid, minimize, restore, and compensate adverse impacts.

**Section 401 Water Quality Certification:** Section 401 of the federal Clean Water Act allows states to review, condition, and approve or deny certain federal permitted actions that result in discharges from fills or excavations to State waters, including wetlands and streams. In Washington, the Department of Ecology is the State agency that has been delegated responsibility for conducting that review, with their primary review criteria of ensuring that State water quality standards are met. Actions within streams or wetlands within the shoreline zone that require a Section 404 permit (see below), Coast Guard Permit, or a Federal Energy Regulatory Commission (FERC) license require a Section 401 water quality certification.

**Shoreline Management Permits on Hanford Reservation – MOU between Benton County and Washington Department of Ecology:** In 1994, a Memorandum of Understanding (MOU) was signed by Benton County Commissioners and Department of Ecology representatives. It addresses County responsibilities for providing oversight for the administration of the SMP regarding activities on the Hanford reservation. The MOU also describes the cooperative roles and responsibilities that Ecology's Shorelands

Program and Nuclear and Mixed Waste Management Program play in accordance with various state laws. Generally the County administers regulations, enforces requirements, and issues approvals and inspects projects regarding permit actions, while Ecology retains overall and final review and approval authority over Hanford projects requiring shoreline management permit actions.

**Washington Department of Natural Resources:** Washington Department of Natural Resources (WDNR) is charged with protecting and managing use of state-owned aquatic lands. WDNR manages more than 5.6 million acres of state-owned forest, range, commercial, agricultural, conservation, and aquatic lands. DNR manages these lands for revenue, outdoor recreation, and habitat for native fish and wildlife. Water-dependent uses waterward of the ordinary high water mark require review by WDNR to establish whether the project is on state-owned aquatic lands. WDNR recommends that all proponents of a project waterward of the ordinary high water mark make contact with WDNR to determine jurisdiction and requirements.

**Watershed Planning Act**: The Watershed Planning Act of 1998 (Chapter 90.82 RCW) was passed to encourage local planning of local water resources, recognizing that there are citizens and entities in each watershed that "have the greatest knowledge of both the resources and the aspirations of those who live and work in the watershed; and who have the greatest stake in the proper, long-term management of the resources." Benton County is within three watershed basins. The Yakima Basin Plan was the first in the State to be approved by a planning unit and forwarded for consideration and adoption by the counties. In 2005, Benton and Yakima Counties approved the Yakima Basin Watershed Management Plan for the Lower Yakima watershed. The Rock-Glade Watershed Planning Group approved the Watershed Management Plan for WRIA 31 in 2007; however, the plan is still awaiting approval from Yakima, Benton, and Klickitat Counties. The Alkali-Squilchuck watershed is not presently working under the Watershed Planning Act.

**Water Pollution Control Act:** Chapter 90.48 RCW establishes the State's policy "to maintain the highest possible standards to insure the purity of all waters of the State consistent with public health and public enjoyment thereof, the propagation and protection of wild life, birds, game, fish and other aquatic life, and the industrial development of the State, and to that end require the use of all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the State of Washington." The Department of Ecology is the agency charged

with crafting and implementing rules and regulations in accordance with this legislation.

## 2.4 Federal Regulations

Federal regulations most pertinent to development in the County's shorelines include the Endangered Species Act, the Clean Water Act, and the Rivers and Harbors Appropriation Act. Other relevant federal laws include the National Environmental Policy Act, Anadromous Fish Conservation Act, Clean Air Act, and the Migratory Bird Treaty Act. A variety of agencies (e.g., Corps, National Marine Fisheries Service, U.S. Fish and Wildlife Service) are involved in implementing these regulations, but review by these agencies of shoreline development in most cases would be triggered by in- or over-water work, or discharges of fill or pollutants into the water. Depending on the nature of the proposed development, federal regulations can play an important role in the design and implementation of a shoreline project, ensuring that impacts to shoreline functions and values are avoided, minimized, and/or mitigated. During the SMP update, the County will consider other federal regulations to ensure consistency as appropriate and feasible with the goal of streamlining the shoreline permitting process. A summary of some of the key federal regulations and/or federal agency responsibilities follows.

**Clean Water Act**: The federal Clean Water Act has a number of programs and regulatory components, but of particular relevance to Benton County is the National Pollutant Discharge Elimination System (NPDES) program. In Washington State, the Department of Ecology has been delegated the responsibility by the U.S. Environmental Protection Agency for managing implementation of this program. The County is engaged in compliance with the NPDES Phase II Municipal Stormwater General Permit requirements that address stormwater system discharges to surface waters.

**Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):** Commonly known as Superfund, CERCLA establishes requirements for closed and abandoned hazardous waste sites; liability for releases of hazardous waste at these sites; and a fund to provide for cleanup when no responsible party can be identified. The Hanford site is subject to long-term CERCLA provisions.

**Endangered Species Act (ESA):** Section 9 of the ESA prohibits "take" of listed species. Take has been defined in Section 3 as: "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The take prohibitions of the ESA apply to everyone, so any action that results in a take of listed

fish or wildlife would be a violation of the ESA and is strictly prohibited. Per Section 7 of the ESA, activities with potential to affect federally listed or proposed species and that either require federal approval, receive federal funding, or occur on federal land must be reviewed by the National Marine Fisheries Service (NOAA Fisheries) and/or U.S. Fish and Wildlife Service (USFWS) via a process called "consultation." Activities requiring a Section 10 or Section 404 permit also require such consultation if these activities occur in waterbodies with listed species. Since the listing of Chinook salmon, coho salmon, chum salmon, sockeye salmon, steelhead trout, and bull trout as Threatened under the ESA, the Corps, NOAA Fisheries and USFWS have jointly developed a number of Regional General Permits (RGPs) or programmatic consultations to streamline permitting of projects in waterbodies containing listed fish, including RGP 5 (now expired), which authorized the maintenance, modification and construction of residential overwater structures in the mid-Columbia and lower Okanogan Rivers in Washington State. Section 4(f) of the ESA directs the Services to develop or appoint teams to develop and implement recovery plans for threatened and endangered species. Benton County is a member of the Yakima Basin Fish and Wildlife Recovery Board, hereafter referred to as the Yakima Basin Recovery Board, and County staff contributed to the development of the 2009 Yakima Steelhead Recovery Plan.

**Magnuson-Stevens Fishery Conservation and Management Act:** The Magnuson-Stevens Fishery Conservation and Management Act of 1996 is administered by the National Marine Fisheries Service to foster and protect commercial and recreational fisheries of designated species that "contribute to the food supply, economy, and health of the Nation and provide recreational opportunities" (18 U.S.C. §1801-a). In Benton County, Chinook and coho salmon are the two designated species. The primary avenue for on-the-ground management of those species is designation and protection of "essential fish habitat" (EFH), which is "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The National Marine Fisheries Service incorporates consideration of EFH into the same process under which projects are reviewed per the Endangered Species Act.

**McNary Shoreline Management Plan:** The majority of the Lake Wallula shoreline, located above McNary Dam, is owned and managed by the Corps. In 2012, the Corps updated a 1983 plan for management and permitting of private use on Lake Wallula and Corps-managed lands with frontage on Lake Wallula (http://www.nww.usace.army.mil/Portals/28/docs/programsandprojects/msmp/MSMP-Final_121211.pdf). Most of Benton County's unincorporated shoreline area governed by the McNary Shoreline Management Plan is designated as "Protected Lakeshore," with a

couple locations designated either "Prohibited Access," "Public Recreation," or "Limited Development." The latter two designations are found in the Finley area. The updated plan provides criteria for design and construction of existing private docks (including "special status" docks, or "grandfathered" docks), new community and private docks, and vegetation modification. The plan does not apply to public docks. The plan allows for a total of 100 private docks on Lake Wallula, including existing docks, assigning priority to new community docks that jointly serve multiple users. As of January 2012, only 27 new, private docks can be permitted in areas designated under the McNary Shoreline Management Plan for "Limited Development."

**Pacific Northwest Electric Power Planning and Conservation Act:** Congress established the Northwest Power Act in 1980, which established the Northwest Power and Conservation Council with the goals of preparing and adopting (1) a regional conservation and electric power plan and (2) a program to protect, mitigate, and enhance fish and wildlife. As a member of the Yakima Subbasin Fish and Wildlife Planning Board (Yakima Subbasin Planning Board), Benton County contributed to the preparation of the Yakima Subbasin Plan in 2004, prepared for the Northwest Power and Conservation Council. The Subbasin Plan describes to the Council the most effective ways that the Council and the Bonneville Power Administration (BPA) can meet their obligations in the Yakima Subbasin to mitigate the impacts on fish and wildlife resources from the construction and operation of the Federal Columbia River Power System (FCRPS).

**Section 10:** Section 10 of the federal Rivers and Harbors Appropriation Act of 1899 provides the U.S. Army Corps of Engineers (Corps) with authority to regulate activities that may affect navigation of "navigable" waters. Accordingly, proposals to construct new or modify existing over-water structures (including bridges), to excavate or fill, or to "…alter or modify the course, location, condition, or capacity of…" navigable waters must be reviewed and approved by the Corps. Designated "navigable" waters in Benton County include the Columbia River and the Yakima River.

**Section 404:** Section 404 of the federal Clean Water Act (see above) provides the Corps, under the oversight of the U.S. Environmental Protection Agency, with authority to regulate "discharge of dredged or fill material into waters of the United States, including wetlands" (http://www.epa.gov/owow/wetlands/pdf/reg_authority_pr.pdf). The extent of the Corps' authority and the definition of fill have been the subject of considerable legal activity. As applicable to the County's shoreline jurisdiction, however, it generally means that the Corps must review and approve most

activities in streams and wetlands. These activities may include wetland fills, stream and wetland restoration, and culvert installation or replacement, among others. Similar to NEPA requirements, the Corps is interested in avoidance, minimization, restoration, and compensation of impacts to waters of the United States.

**Yakama Nation Treaty Reserved Rights**: In 1855, a treaty with the federal government established a confederation of 14 tribes as the Yakama Nation and provided for a 1.2-million-acre reservation along the Yakima River. In addition to occupation and use of the reservation, the Yakama Nation retained rights to fish and construct temporary fish-curing buildings at all "usual and accustomed places" outside of the reservation (the "ceded area" totaling more than 12 million acres), as well as to hunt, gather roots and berries, and pasture horses and cattle upon "open and unclaimed land" (Treaty with the Yakama, 1855). While the boundaries of the reservation do not extend into Benton County, the ceded area includes a large portion of Benton County, including most of the Yakima and Columbia Rivers (http://www.yakamanation-nsn.gov/docs/CededMap0001.pdf).

# 3 SUMMARY OF ECOSYSTEM CONDITIONS

Portions of three major watersheds are located within Benton County; these include: the Lower Yakima Watershed, the Rock-Glade Watershed, and the Alkali-Squilchuck Watershed. These watersheds are identified by the state as Water Resource Inventory Areas (WRIAs). A map of the WRIAs within Benton County is provided in Figure 3-1.

## 3.1 Columbia River

### 3.1.1 Geographic and Ecosystem Context

The Columbia River is the largest river in the Pacific Northwest, and the fourth largest river in the United States by volume. The Columbia River watershed originates in Canada, and the drainage area of over 258,000 square miles includes areas of Washington, Oregon, Montana, and Idaho, Wyoming, and Nevada.

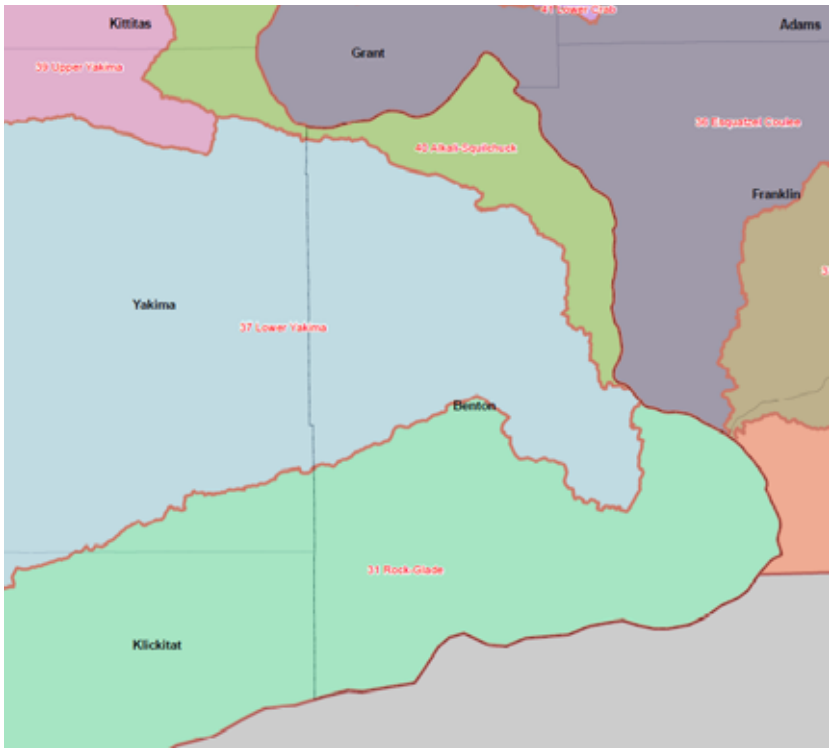



Figure 3-1. Map of Water Resource Inventory Areas in Benton County

Within Benton County, the Columbia River flows through the Alkali-Squilchuck WRIA and the Rock-Glade WRIA. The Alkali-Squilchuck WRIA extends from the mouth of Squilchuck Creek in Chelan County to the mouth of the Yakima River in Benton County. The Rock-Glade WRIA extends downstream from the Yakima River mouth to the John Day dam in Klickitat County. Other than the Yakima River, tributaries to the Columbia River within Benton County are small, ephemeral streams that flow through steep, confined canyons. The Snake River is the largest tributary to the Columbia River, and its confluence is located on the border of Walla Walla and Franklin Counties, a few miles southeast of the City of Kennewick. Discharge from the Snake River is generally less than 50% that of the Columbia River above the confluence. Other major tributaries in the Columbia River Plateau ecological province include the Yakima, Walla Walla, Umatilla, John Day, and Deschutes Rivers.

### 3.1.2 Topography, Geology, and Drainage Patterns

The Columbia River was formed by the forces of glaciation, volcanism, hydrology, and erosion and accretion of sediments. The Cascade mountain range was formed -50 to -35 million years ago, at which time uplift of the Rocky Mountains combined with subduction of the oceanic plates of the Pacific Ocean, creating the flow path for the River. Subsequent glaciation restructured and expanded the extent of the Columbia River basin. Near the end of the last glacial period, the Missoula Floods shaped the

physical landscape, transporting and depositing silt, sand, and gravel that now form much of the landscape in the Columbia River basin (Simenstad et al. 2011).

The geology of WRIA 31 is dominated by extensive basalt flows having a total thickness of up to 5000 feet (Lautz 2000). The erosion-resistant nature of these flows has resulted in the creation of deep (500 to 800 feet), steep-walled canyons and has severely constrained floodplain development along substantial portions of the streams and the Columbia River within this WRIA (Lautz 2000). The Wallula Gap on the Columbia River, recognized as a National Natural Landmark for its geological history, is an example of a location where glacial meltwater from the Missoula Floods carved steep walls and a confined channel through the basalt flows.

The hydrology of the Columbia River Basin reflects the interaction of topography geology, and climate. Within Benton County, rainfall is limited, and generally less than 10 inches per year. Most of the drainage of the Columbia River falls as snow in the Rocky Mountains and in the Cascade Range. Annual peak discharges occur in the spring (April to June) and generally results from snowmelt in the interior subbasin. Historically, flood flows peaked at 1.2 million cfs (Simenstad et al. 2011). Today, as a result of dam regulation, the highest flows occur from April to June, with discharge at the mouth of the river ranging from 100,000 to 500,000 cfs (Neal 1972, Marriott et al. 2002).

Within Benton County, McNary Dam is operated by the U.S. Army Corps of Engineers for navigation, hydroelectric power generation, recreation, and incidental irrigation. Although the Dam is a run-of the-river dam, meaning that it has limited storage capacity, water impounded by the dam forms Lake Wallula, which extends upstream to the Hanford site and to Ice Harbor Dam on the Snake River. Below McNary Dam, Lake Umatilla is formed by the John Day Dam, approximately 110 miles downstream. The geology and topography of the Columbia River in Benton County, combined with dam regulation and shoreline stabilization measures, substantially limit any channel migration (see also Appendix D).

The Hanford Reach contains many riverine processes that no longer exist in Columbia River impoundments. As the last free-flowing reach on the Columbia River, it is extremely valuable for aquatic resources. Several mid-channel islands were flooded as a result of dam operations. Today, riparian areas in the Hanford Reach include cobble shorelines, islands, floodplain lakes, and wetlands. Upland habitats adjacent to the Hanford Reach include large tracts of relatively undisturbed shrub-steppe vegetation.

### 3.1.3 Major Land Use Changes

Human influences have resulted in substantial changes to the shoreline of the Columbia River. The most significant changes to the River's shoreline have resulted from European settlement following the Lewis and Clark expedition in the early 1800s.

The 21 dams built on the Columbia and Snake Rivers since 1933 have substantially altered the Columbia River hydrograph. Dam operations have reduced the frequency of spring freshets, which historically helped maintain floodplain habitat connectivity and aided the migration of juvenile salmon. Today, over-bank flows and associated large woody debris (LWD) recruitment and sediment transport processes have been substantially reduced. In WRIA 31, extensive flatlands which existed along the Columbia River prior to inundation have formed shallow wetlands and embayments along the shore of Lake Umatilla; these serve as holding or resting areas for migrating adults and juveniles (Lautz 2000).

These backwater areas have been further altered by development, including the construction of railroad causeways that separate the shoreline habitats from the mainstem river, except where culverts allow water exchange and fish passage (P. La Riviere, WDFW, personal communication, 11 October 2012). Agricultural water return flows also affect the ecology of these backwaters. Irrigation drains from the Kennewick Irrigation District and the Columbia Irrigation District (Yakima River sources) intercept natural streams and springs that drain into the Columbia River, supplementing their natural flow. The source of these drains (Yakima River, springs, or groundwater) may trigger a stray response in spawning salmon, and for years, adult coho salmon have been observed in these backwater areas of the Columbia River (P. La Riviere, WDFW, personal communication, 11 October 2012).

Today, the Columbia basin supports significant water-dependent commercial and industrial uses, ports, transportation, and urban population centers. In these developed areas, riprap and docks have replaced riparian vegetation, and rip rap revetments now comprise a significant portion of the reservoir shorelines. Historic and ongoing dredging operations are responsible for maintaining a viable navigation channel to support five deep-water ports, which transport 30 million tons of goods annually. Development on the Columbia River in Benton County is primarily centered on the Tri-Cities area of Kennewick, Richland, and Pasco.

The 560-square-mile Hanford Nuclear Site borders 51 miles of the Columbia River, occupying the majority of the WRIA 40 shoreline in Benton County. Groundwater at the site has become contaminated from leaking storage tanks of nuclear wastes. As

contaminated groundwater moves toward the Columbia River, it poses risks to water quality in downstream reaches. As a result, the Hanford Site is the focus of the nation's largest environmental cleanup. During the period of active operations of the Hanford Nuclear site, surface water quality in the Columbia River near the site contained elevated beta radioactivity and water temperatures, and lower dissolved oxygen and sulfate (Becker and Gray 1992). The last production reactor was shut down in 1987, and by the late 1980s beta radioactivity and water temperatures decreased, but nitrates had increased significantly (Ward et al. 2001). Recent water quality monitoring in the Columbia River within the Hanford Site detected radioactive materials downriver from the Hanford Site, but in concentrations that are below federal and state limits (Patton 2009).

Today, Hanford includes a commercial nuclear power plant and numerous centers for scientific research and development, such as the Pacific Northwest National Laboratory and the LIGO Hanford Observatory. Only about 6% of the land within the reservation was used for nuclear materials production, waste storage, or waste disposal (Ward et al. 2001). The remaining area was left undeveloped, serving as a security buffer for nuclear facilities. As noted above, because of its protected status, shoreline habitats in the Hanford Reach offer some of the most intact vegetation, habitat, and hydrologic features in the middle Columbia River. In June 2000, 257 square miles of the Hanford Site were declared a National Monument, including: Saddle Mountain National Wildlife Refuge, Wahluke Wildlife Recreation Area, and the Fitzner-Eberhardt Arid Lands Ecology (ALE) Reserve.

Access to most of the land in the Hanford site is extremely limited. The Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (DOE 1999) identifies the majority of lands within the Hanford Site for Conservancy (mining) and Preservation land uses. A small portion of the Columbia River shoreline is designated for Low Intensity and High Intensity Recreational Uses.

Within Lake Wallula, water quality is strongly influenced by the Snake and Yakima rivers. Flow from the Snake, Yakima, and Columbia Rivers are not fully mixed until they reach McNary Dam (Ward et al. 2001). The Snake River-influenced portion on the southeast side of the river experiences high turbidity and a high nutrient load, and the Yakima River-influenced portion experiences lower turbidity (Ward et al. 2001). In Lake Wallula and Lake Umatilla, high total dissolved gas levels that occur below McNary and the John Day Dam during high flows and high water temperatures in late summer are the primary water quality problems (See Tables 4-5 through 4-7).

### 3.1.4 Fish and Wildlife

Hundreds of fish and wildlife species reside in or migrate through the Columbia River. At least 51 species of fish, including thirty native species, have been reported from the mainstem Columbia River between Wanapum and The Dalles Dams (Ward et al. 2001) (see Table 3-1). Thirty-three species were found just in backwaters between McNary and Bonneville dams (USFWS 1980 in Ward et al. 2001). Catches from April-June in the Hanford Reach are dominated by subyearling fall Chinook salmon (U.S. Geological Survey, USGS, unpublished data in Ward 2001). Fall Chinook salmon are the dominant salmonid during spring in nearshore areas. Fall Chinook salmon also use the upper portions of McNary and John Day reservoirs for rearing, but do not prefer riprap habitats that constitute a large portion of reservoir shorelines (USGS, unpublished data in Ward 2001).

Other numerically significant species during the spring period are redside shiners, carp, largescale suckers, northern pikeminnow, and peamouth (Ward et al. 2001). Mountain whitefish are common in the Hanford Reach and support a recreational fishery.

Threatened and endangered fish species that use the mid-Columbia River are identified below in Table 3-1. In 2005, wild populations of salmon in the Columbia River basin represented only 12% of their historic numbers (Bottom et al. 2005). All 13 ESA-listed evolutionary significant units (ESUs) of salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) in the Columbia basin use the mainstem Columbia River for migration to and from freshwater natal areas to the Pacific Ocean (NMFS 2009). Most of the ESA-listed species spawn and incubate in tributaries, but some populations of fall Chinook and chum salmon spawn in the mainstem itself.

Table 3-1. State and federal priority fish species present in Benton County (WDFW 2012).

| Species | State Status | Federal Status |
|---|---|---|
| Pacific Lamprey | | Species of Concern |
| River Lamprey | Candidate | Species of Concern |
| White Sturgeon | | |
| Leopard Dace | Candidate | |
| Umatilla Dace | Candidate | |
| Mountain Sucker | Candidate | |
| Bull Trout | Candidate | Threatened |
| Chinook Salmon | Candidate | Threatened (Upper Columbia Spring run is Endangered) |
| Chum Salmon | Candidate | Threatened |
| Coho | | Threatened – Lower Columbia |
| Pink Salmon | | |

| Species | State Status | Federal Status |
|---|---|---|
| Steelhead/ Inland Redband Trout | Candidate | Threatened |
| Sockeye Salmon | Candidate | Endangered – Snake River |

The Hanford Reach is presently designated as critical habitat for the Upper Columbia River steelhead ESU; however, little is known about the quality and quantity of steelhead spawning, rearing, and adult holding habitat in the Hanford Reach (Ward et al. 2001).

At least 258 species of birds, 44 species of mammals, and 21 species of reptiles and amphibians have been reported from habitats along or near the mainstem Columbia River between Wanapum and The Dalles Dams (Ward et al. 2001). State or federally listed threatened and endangered wildlife species are listed in Table 3-2. Many other species are listed as sensitive or species of concern, or are a candidate for state or federal listing. The middle Columbia River mainstem supports one of the largest Northwest concentrations of wintering waterfowl, particularly Canada geese and mallards (Ward et al. 2001). All reservoirs and the Hanford Reach in the subbasin support colonies of colonial nesting birds, most of which forage primarily on fish. Riparian forest and cliffs in this subbasin provide nesting opportunities for several species of raptors. Many species of passerine birds also occur along the Columbia River, typically foraging on insects associated with riverine and wetland habitats.

Table 3-2. Wildlife species found in the Mainstem Subbasin designated by state or federal agencies as endangered or threatened. F = federal, O = Oregon, W = Washington, E = endangered, and T = threatened. Numerous other species are considered sensitive or species of concern. (Table from Ward et al. 2001, updated per WDFW 2012)

| Common name | Scientific name | Status |
|---|---|---|
| **Birds** | | |
| American white pelican | *Pelecanus erythrorhynchos* | WE |
| Ferruginous hawk | *Buteo regalis* | WT |
| Sage grouse | *Centrocerus urophasianus* | WT |
| Sandhill crane | *Grus canadensis* | WE |
| Snowy plover | *Charadrius alexandrines* | FT, WE |
| Upland sandpiper | *Bartramia longicauda* | WE |
| **Mammals** | | |
| Western gray squirrel | *Sciurus griseus* | WT |
| Pygmy rabbit | *Brachylagus idahoensis* | FE, WE |
| **Reptiles and Amphibians** | | |
| Western pond turtle | *Clemmys marmorata* | WE |
| Northern leopard frog | *Rana pipiens* | WE |

Four species of reptiles and three species of amphibians are commonly found in association with riparian and marsh habitats of impoundments downstream from McNary Dam (USACE 2000 in Ward et al. 2001). The Hanford area provides important habitat for amphibian and reptile populations. Sixteen species occur at Hanford, and the site is particularly important for sensitive species that are rare or have limited distributions in Washington (Ward et al. 2001).

The middle Columbia River shorelands support significant populations of small mammals, which are highly responsive to changes in vegetation cover and play important roles in ecosystem functions, including water infiltration, habitat formation, and prey source for predators.

The Hanford Site is also particularly rich in invertebrate diversity. To date, 1,536 species in 16 orders have been identified, of which 43 were previously undescribed, and 142 represent new records for Washington (Ward et al. 2001). The Hanford area supports invertebrate species that have elsewhere suffered from the impacts of habitat conversion, fragmentation, and degradation, as well as the use of pesticides. At least 50 butterfly species have been documented on the Hanford site (Pacific Northwest Laboratory *no date*). High diversity has been recorded in the Lepidoptera family (butterflies and moths), although it was measured specifically in the moth branch (Ward et al. 2001). Butterflies are of importance in the Hanford area and in general as indicators of environmental health, and may be the most sensitive gauge of ecosystem function at the Hanford site and other areas in shoreline jurisdiction. They respond to pesticide use, particularly malathion (Eliazar and Emmel 1991), and could be useful in decision-making regarding potential mosquito abatement methods. Butterflies are a significant prey source for some bird species, including Brewer's sparrow, which is not presently listed as a state or federal sensitive species, but is considered a focal species in the Yakima Subbasin Plan (Yakima Subbasin Planning Board 2004) because of recent widespread declines. Butterflies also play a role as pollinators, and occur across a range of habitat types, including the shrub-steppe, riparian areas, and wetlands of Benton County. Due to their role in these ecological processes and functions, they are considered as possible indicators of priority habitats.

Because butterflies often require more than one vegetation type to meet food and cover needs throughout their lifecycle stages of egg, larvae, pupa, and adult, impacts over a range of habitat types can potentially effect butterfly populations. Likewise, foraging strategies in butterflies vary over the life cycle, from the host plant leaves that feed larva

to nectar-producing flowers that support adults, and these food sources can be of widely diverse species, occurring across the habitat types identified in shoreline jurisdiction. In addition to food sources, butterflies require the cover of crevices or hollows for hibernacula in winter. Tree bark, wood piles, rocks, and man-made structures can serve this purpose. Removal or alteration of these features may negatively impact butterfly populations.

The Draft Mainstem Columbia River Subbasin Plan (Ward et al. 2001) includes actions, generally related to limiting factors in the subbasin, that are necessary to effectively protect and manage species or taxa. For invertebrates, general needs are protection, maintenance, and restoration of habitat. For butterflies in particular, the plan identifies a need for inventory, survey, and monitoring of populations, as well as further study of the ecology and life history requirements.

Important sites of butterfly occurrence or likely occurrence along the Columbia and Yakima Rivers are depicted in Appendix C (R. Coler, M.D., personal communication, 7 November 2012). Species collected, observed, or otherwise known to occur on these sites or elsewhere in shoreline jurisdiction are listed in Table 3-3. The sites comprise shrub-steppe, riparian, and wetland areas, sometimes bordered by agricultural area. As described above, butterflies regularly occur across habitat types during their life cycle, and each of these common habitat types in these identified butterfly areas may be crucial to the species that occur there.

Table 3-3. Partial list of butterfly species found in Benton County (R. Coler, M.D., personal communication, 7 November 2012).

| Common name | Scientific name |
|---|---|
| Acmon blue | *Icaricia acmon* |
| Anise swallowtail | *Papillo zelicaon* |
| Alfalfa butterfly | *Colias eurytheme* |
| Cabbage butterfly | *Pieris rapae* |
| Gray hairstreak | *Strymon molinus* |
| Juba skipper[1] | *Hesperia juba* |
| Lorquin's admiral | *Basilarchia lorquini* |
| Monarch | *Danaus plexippus* |
| Milbert's tortoiseshell | *Aglais milberti* |
| Morning cloak | *Nymphalis antiopa* |
| Orange-bordered blur | *Lycaeides melissa* |
| Purplish copper[1] | *Epidemia helloides* |
| Large wood nymph | *Cercyonis pegala* |
| Ringlet | *Coenonympha tullia* |
| Satyr anglewing | *Polygonia satyrus* |
| Viceroy | *Basilarchia archippus* |
| Mylitta crescebt | *Phyciodes mylitta* |
| West coast lady | *Venessa annabella* |

| Common name | Scientific name |
|---|---|
| Western tiger swallowtail | *Papilio rutulus* |
| Red admiral | *Vanessa atalanta* |

[1]State Monitor species

## 3.2 Yakima River

### 3.2.1 Geographic and Ecosystem Context

The Yakima River basin is characterized by a diverse landscape of rivers, ridges, and mountains totaling just over 6,100 square miles, making it the largest basin with its boundaries entirely within Washington State. The river flows west to east from the Cascade Mountains to the Columbia River within the Columbia Plateau ecological province. The Yakima River is divided into three WRIAs, the Upper Yakima (WRIA 39), the Naches (WRIA 38), and the Lower Yakima (WRIA 37). Benton County occupies the eastern half of WRIA 37.

### 3.2.2 Topography, Geology, and Drainage Patterns

The Yakima Basin begins in the Cascade Mountains near Snoqualmie Pass at over 2,500 feet in elevation, and continues southeast through the Columbia Plateau to its confluence with the Columbia River in the City of Richland. The major geologic processes affecting the formation of the Yakima basin have been volcanoes and lava flows, glaciation, and uplifting (Haring 2001). The geology of the Yakima watershed is described by the Yakima Subbasin Planning Board (2004), as follows:

> "The Yakima River Subbasin consists of two very different physiographic and geologic regions; the Cascade Mountains occupy roughly the western third of the subbasin, while the Columbia Plateau extends from the Cascade foothills to the eastern border of the subbasin. The mountains consist of continental formations of Eocene-age sandstone, shale and some coal layers, and pre-Miocene volcanic, intrusive, and metamorphic formations. Tertiary and quaternary age andesite and dacitic lavas, tuff, and mudflows form a broad north-south arch along the western edge of the subbasin. The upper mainstem Yakima and Naches Rivers and several tributaries occupy valleys excavated by glaciers. Lowlands typical of landforms associated with the Columbia Plateau are found along the lower half of the Yakima River.
>
> The principal rock of the Columbia Plateau is a series of basalt flows of Tertiary age that cover older rock and reach the western edge of the Cascade Mountains. The

> majority of these basalt flows, interspersed with sedimentary layers are called the Columbia River Basalt Group. The thickness of the Columbia River Basalt Group within the lower and middle Yakima River basin ranges from 9,000 to 12,000 feet, increasing in thickness along a west to east gradient. The basalt plateau of the eastern basin was subsequently folded and faulted into a series of west-east trending anticlinal ridges and synclinal valleys, called the Yakima Fold Belt, that extend from the Cascades to the broad plains of the Columbia River. The antecedent Yakima River incised canyons and water gaps through the ridges and deposited gravels, eroded from uplifting mountains and ridges in the valleys.
>
> Outflow from glaciers along the Cascade crest into the Yakima and Naches valleys delivered large volumes of glacial outwash to the alluvial basins, resulting in partial filling of Cle Elum, Kittitas, and upper and lower Yakima valleys with sand, gravel, and silt. Glaciation created many lakes. Backwaters from the Ice-age Lake Missoula flood left thick silt deposits in the lower valley from Union Gap to Richland. Extensive portions of the eastern and southeastern subbasin are mantled by loess, a wind-deposited silt derived from outwash deposits."

Precipitation is highly variable across the basin, ranging from approximately 7 inches per year in the eastern portion to over 140 inches per year near the crest of the Cascades (Yakima Subbasin Planning Board 2004). Virtually all of the streams originate at higher elevations where annual precipitation is 30 inches or more (Yakima Subbasin Planning Board 2004).

Six major reservoirs, managed by the Bureau of Reclamation, are located in the upper Yakima watershed and Naches watershed. As a result of the construction and operation of the reservoirs, flows are generally lower in the fall, winter, and spring, and higher in the summer and early fall, than they were historically.

The Columbia River basalts of the Columbia Plateau provide a locally important aquifer system. As noted in the Yakima Subbasin Plan, "The overlying alluvial aquifers are highly permeable and are heterogeneous and anisotropic, due to their deposition within the fluvial environment where the processes of cut and fill alluviation by the Yakima River and tributaries occurred" (Yakima Subbasin Planning Board 2004). The Yakima River cuts through four large groundwater subbasins (Rosyln, Kittitas, upper Yakima, and lower Yakima). The Yakima Subbasin Plan conceptualized the interchange of surface and subsurface water as losing surface water to the hyporheic and groundwater systems at the upstream end, and gaining surface water from the groundwater and hyporheic systems at the downstream end.

Channel migration on the lower Yakima River in Benton County is limited by the low gradient and geologic and structural controls in the eastern portion of Benton County (see Appendix D). Backwater effects from McNary Dam on the Columbia River and structural controls further limit channel migration in the lower reaches of the Yakima River near the City of Richland (see Appendix D).

### 3.2.3 Major Land Use Changes

Approximately one third of the Yakima watershed is in private ownership. Approximately 38 percent of the land area is owned by the federal government. Federal ownership is divided among the Wenatchee National Forest, the U.S. Army Yakima Training Center, a portion of the Department of Defense Hanford Nuclear Reservation, and the Bureau of Land Management. The Yakama Reservation occupies about 23 percent of the basin.

Primary land uses in the Yakima watershed include grazing, timber harvest, irrigated agriculture, and urbanization (50 square miles).

Irrigated agriculture occupies approximately 1,000 square miles of the Yakima Subbasin. Important crops include apples, hops, grapes, cherries, mint, and forage crops. In recent years, vineyard agriculture has become increasingly significant in terms of land cover and economic importance in the Yakima Valley.

Development of irrigated agriculture began in the 1860s and expanded once the railroad connected Yakima to the Puget Sound region. The federal government authorized the Yakima Irrigation Project in 1905, which resulted in the construction of five storage reservoirs. Today, there are six major diversion dams (Easton, Roza, Tieton, Wapato, Sunnyside, and Prosser) on the Yakima and its tributaries. These dams provide irrigation water to farms from Cle Elum to the Tri-Cities through 420 miles of canals, 1,697 miles of laterals, and 30 pumping plants (Yakima Basin Recovery Board 2009).

Today, the reduction in flood frequency and floodplain connectivity resulting from reservoir management and diversion of irrigation water has altered the timing and character of streamflow and groundwater recharge through the Yakima watershed. Streamflows are higher during summer months in the upper watershed as a result of dam releases. On the other hand, irrigation diversions at Sunnyside and Wapato typically divert one half of the entire river flow during the irrigation season, from May to October, while the Chandler Dam in Prosser diverts 1,413 cfs throughout most of the year for irrigation and power production (Yakima Subbasin Planning Board 2004). As a result of the diversion and use of irrigation water, the recharge of cold, spring-melt

water into the aquifer systems has been replaced by recharge of warmer irrigation water later in the spring and summer. The Yakima River is impaired by high water temperatures. Recent studies have found groundwater seeps in backwater habitats and irrigation wastewater outflows still provide a source of cooler groundwater compared to elevated river temperatures (Appel et al. 2011).

The USBR's Interim Comprehensive Basin Operating Plan (IOP) summarized the effects of land use changes and river management on current floodplain and instream conditions as follows:

> "Floodplain isolation and channel simplification, combined with inversion and truncation of the natural hydrograph, have dramatically reduced river floodplain interactions and degraded the aquatic environment. The floodplain is isolated from the river by diking, channelization, wetland draining, gravel mining, and highway and railroad building. Many of these same activities have eliminated or isolated vast areas of side channels and sloughs. River operations for irrigation and flood control alter the natural hydrograph by impounding spring freshets, substantially increasing summer flow, and decreasing winter flow. A common effect of these developments is a sharp reduction in the frequency with which spring floods recharge the alluvial floodplain aquifer system. Water temperatures in the lower river are therefore higher in summer, and the number and extent of thermal refugia are reduced" (USBR 2002).

The extensive agricultural development in the Yakima River watershed has affected water quality, and the lower Yakima River is impaired by several pesticides, as well as temperature, pH, and dissolved oxygen (see Table 4-7). In 1997, Ecology published a total maximum daily load (TMDL) for the lower Yakima River - *Lower Yakima River Suspended Sediment TMDL*. Since the completion of the TMDL, entities and organizations throughout the watershed have worked to improve irrigation practices and limit the transport of fine sediment into streams and irrigation return drains. These efforts have been successful in reducing pesticide concentrations and turbidity in the Yakima River. A study in 2006 found reduced contaminant levels in the tissues of Yakima River fish. Despite improvements, however, the TMDL was developed and approved to address chronic aquatic life criteria for legacy impacts from past DDT use (DDT usage was banned beginning in 1972), and not the more stringent standards for human health. Therefore, despite the existence of a TMDL to reduce the concentration of DDT in the watershed, DDT remains on the 303(d) list (Category 5) for threats to human health.

In addition to the influence of irrigation, the watershed character has been altered with the increased urbanization in riparian and floodplain areas. Although urbanized areas only cover approximately one percent of the watershed area, associated development "…has an impact on fish and wildlife habitats that is significant and disproportionate to its relative size" (Yakima Subbasin Planning Board 2004). In many areas, river channels have been leveed, armored, realigned, and shortened, restricting or eliminating natural river-floodplain interactions.

Historically, the riparian zone of the lower Yakima River was predominantly composed of willows and cottonwoods. Even historically, the effect of this vegetation on shade and temperature regulation of the river was likely limited given the width and orientation of river (Appel et al. 2011). Rather, as noted above, groundwater seeps and cooler water from tributaries provide natural thermal refugia for fish. Similarly, while riparian vegetation within Benton County may have contributed some wood to the river, the most significant large woody debris inputs would have come from higher in the watershed (Appel et al. 2011). As surveyors noted in 1863:

> *Yearly, the Yakama River disgorges from its mountain sources [an] abundance of driftwood, composed of the finest quality of timber, whole trees from 20 to 70 in diam. And from 100 to 250 feet in length of fir and cedar lumber are often seen winding their way down its current, into the broad waters of the Columbia.*

As upstream sources of large woody debris (LWD) have decreased, LWD and the associated diversity of channel form in the lower Yakima channel has also dwindled. Islands capture LWD during high flows, and they are significant features for the formation of diverse habitats in the lower Yakima River (Appel et al. 2011).

Shrub-steppe is the predominant upland native habitat type from approximately Ellensburg to Pasco. However, conversion of shrub-steppe habitats to cropland and grazing has left only about 5 percent of the historical habitat in relatively undisturbed condition. A larger proportion of the native habitat is moderately disturbed by grazing, off-road vehicle use, and other land uses, but still provides cover, food, and nesting habitat for many species of wildlife, particularly during winter months when cultivated fields provide no vegetative cover.

### 3.2.4 Fish and Wildlife

The Yakima Subbasin Plan (Yakima Subbasin Planning Board 2004) identifies the importance of the Yakima watershed for waterfowl and wildlife:

> "The Yakima Subbasin supports a significant population of waterfowl during the spring and summer nesting season as well as during the winter period. The Basin produces a significant portion of all wood ducks hatched in the state, as well as mallards, Canada geese, and other duck species. While wintering populations of waterfowl in the Basin have decreased over the past 30 years, the Basin still plays host to many thousands of duck and geese each winter, including mallards, Canada geese, green-wing teal, northern pintail, and other species. Wintering waterfowl are concentrated in the Lower Yakima Basin on the Toppenish creek and the Yakima River floodplain below the city of Granger. From these concentration areas, waterfowl feed in many agricultural areas throughout the Lower Yakima Valley.
>
> Ninety-eight large and small mammals are found in the subbasin. Loss of habitat has drastically reduced numbers of one small mammal, the western gray squirrel, and this species is now a Washington State threatened species. Several species of big game inhabit the Yakima Basin, including black bear, black-tailed deer, mule deer, Rocky Mountain elk, bighorn sheep, mountain goats, and cougar. Bighorn sheep were reintroduced over 40 years ago and inhabit the canyons and ridges between Selah/Naches and Ellensburg. A small number of mountain goats are found at high elevations along the western fringe of the subbasin. In recent years, wolverine sightings have been reported in the upper portions of the subbasin, as have unconfirmed sightings of gray wolves[1] and grizzly bears (NPPC 2001)."

Anadromous fish in the Yakima watershed include federally threatened fall Chinook salmon, steelhead, and bull trout. Native coho, sockeye and summer Chinook salmon were extirpated from the Yakima watershed. Coho, sockeye, and summer Chinook salmon have recently been reintroduced to the watershed by the Yakama Tribe. These species primarily use the lower Yakima watershed in Benton County as a migratory corridor; however, approximately one third of adult steelhead migrating into the Yakima watershed hold between McNary Pool and Prosser for several months before finishing their upstream migrations to spawning areas (Yakima Basin Fish and Wildlife Recovery Board [hereafter called Yakima Basin Recovery Board] 2009). Pacific lamprey and westslope cutthroat are present in the watershed and designated as species of concern by USFWS. The Yakama Tribe is presently conducting a study to assess the abundance, distribution, and status of lamprey in watersheds within Yakama Nation Ceded Lands.

---

[1] A wolf pack was confirmed in the Teanaway River valley in 2011. See http://wdfw.wa.gov/news/release.php?id=jul0511a

Several non-native fish species are also present in the Yakima River that may compete with native fish. These species include brook trout, brown trout, and lake trout, as well as smallmouth bass in the lower reaches of the River, among others. A table showing fish distribution in the Yakima River is provided below from the Yakima Subbasin Plan (Yakima Subbasin Planning Board 2004) (Table 3-4). A complete list of wildlife in the Yakima Subbasin can be found in Appendix E of the Yakima Subbasin Plan.

Table 3-4. Species distribution in the Yakima River. Shaded cells indicate species is rare (relatively few captures reported). Columns show distance from Columbia River mouth, and 0-44 represents area within Benton County. (Table from Yakima Subbasin Planning Board 2004)

| Species | 0 to 44 | 45 to 68 | 69 to 161 | 162 to 180 | 181 to 305 |
|---|---|---|---|---|---|
| W. brook lamprey | | | X | X | X |
| Unidentified lamprey | | | X | | X |
| Pacific lamprey | X | X | X | X | |
| Coho salmon | X | X | X | X | X |
| Spring chinook salmon | X | X | X | X | X |
| Fall chinook salmon | X | X | X | X | |
| Sockeye salmon | X | X | X | X | X |
| Summer steelhead | X | X | X | X | X |
| Bull trout | | X | | X | X |
| Lake trout | | | X | X | X |
| Brook trout | | | | X | X |
| Rainbow trout | X | X | X | X | X |
| Cutthroat trout | | | | X | X |
| Brown trout | X | X | X | X | X |
| Mountain whitefish | X | X | X | X | X |
| Pygmy whitefish | | | | | X |
| Chiselmouth | X | X | X | X | X |
| Common carp | X | X | X | X | X |
| Goldfish | X | X | | | |
| Peamouth | X | X | X | | |
| Northern pikeminnow | X | X | X | X | X |
| Longnose dace | X | X | X | X | X |
| Speckled dace | X | X | X | X | X |
| Leopard dace | X | X | X | | |
| Umatilla dace (subspecies) | X | X | X | | |
| Unidentified dace | X | X | X | X | X |

| Species | 0 to 44 | 45 to 68 | 69 to 161 | 162 to 180 | 181 to 305 |
|---|---|---|---|---|---|
| Redside shiner | X | X | X | X | X |
| Bridgelip sucker | X | X | X | X | X |
| Largescale sucker | X | X | X | X | X |
| Mountain sucker | | | X | X | X |
| Unidentified sucker | X | X | X | X | X |
| Brown bullhead | X | X | X | X | |
| Channel catfish | X | X | X | | |
| Three-spine stickleback | X | X | X | X | X |
| Pumpkinseed | X | X | X | X | X |
| Bluegill | X | X | | | X |
| Smallmouth bass | X | X | X | X | X |
| Largemouth bass | X | X | X | X | X |
| Black crappie | X | X | | | |
| White crappie | X | | | | |
| Yellow perch | X | X | X | X | X |
| Walleye | X | X | X | | |
| Mottled sculpin | | | X | X | X |
| Torrent sculpin | | | X | X | X |
| Piute sculpin | | | X | X | X |
| Shorthead sculpin | | | X | | X |
| Prickly sculpin | X | | | | |
| Unidentified sculpin | X | X | X | X | X |
| Burbot | | X | | | X |
| White sturgeon | X | X | | | |
| Mosquitofish | X | | | | |
| Sandroller | X | | X | | |

Mouth (Tri-cities) = River m 0; Kiona (Benton City) = RM 27; Prosser = RM 42; Yakima = RM 100;Roza Dam = RM 111; Keechelus Dam = RM 189. Source: WDFW Ecological Interactions Team 1998

# 4 SHORELINE INVENTORY

## 4.1 Inventory Sources

Development of a shoreline inventory is intended to record the existing or baseline conditions upon which the development of SMP provisions will be examined to ensure the adopted regulations provide no net loss of shoreline ecological functions. At a minimum, local jurisdictions shall gather the inventory elements listed in the Guidelines, to the extent information is relevant and readily available. Collected information principally included Watershed Resource Inventory Area (WRIA) and other basin documents, Benton County studies, scientific literature, aerial photographs, and Geographic Information Systems (GIS) data from a variety of data providers. Table 4-1 lists those relevant inventory elements for which data is available for the County's shorelines. The table also describes the information collected for each of the required inventory elements. Map figures are provided in the Map Folio (Appendix B), and they depict the various inventory pieces listed in the table, as well as additional analysis. Data gaps and limitations are discussed further in Section 4.2. The Guidelines do not require generation of new information or mapping to fill identified data gaps.

Table 4-1. Shoreline Inventory Elements and Information Sources.

| Inventory Element | Information Gathered | Data Source | Use/Assumptions/Limitations |
|---|---|---|---|
| Land Use Patterns | • Current land use<br>• Land ownership | Benton County, Assessor data 2012 | • Identifies publicly owned land by agency (e.g., USFS, Department of Energy, State, County)<br>• Useful in assessing existing intensity and type of development at broad-scale planning level<br>• Gross scale characterization (e.g., urban, forest, rural/agriculture)<br>• Data may not be up-to-date<br>• Assessor Data regarding current use at Hanford Reach is limited |
| | • Comprehensive Plan designations (future land use)<br>• Zoning | Benton County, Assessor data 2012, and Planning Department | • Comparison to current use indicates likely changes in intensity and type of development<br>• Useful in planning to accommodate future land use changes at broad-scale planning level<br>• Based on area-wide categorization- includes roads, easements, and utilities |
| Public Access Areas | • Parks<br>• Trails<br>• Utility Corridors<br>• Boat Launches (handheld and motorized)<br>• Public Lands | • Benton County<br>• Washington Department of Fish and Wildlife<br>• U.S. Fish and Wildlife Service<br>• Washington Department of Ecology<br>• Washington Department of Natural Resources<br>• Tapteal Greenway Association<br>• Ridges to Rivers | • Includes established parks and recreation sites |
| Surface water | Streams | U.S. Geological Survey, National Hydrologic Dataset | • Small, intermittent or ephemeral streams may not be identified in data<br>• Data for Hanford Reach is limited |
| Surficial Geology | Extent and label of geologic units | WA Department of Natural Resources, Division of Geology and Earth Resources, Surface Geology, June 2010 | • Based on broad scale geologic classifications<br>• Useful for broad scale assessment of geologic conditions (1:100,000-scale)<br>• Not to be used in place of site-specific studies |

| Inventory Element | Information Gathered | Data Source | Use/Assumptions/Limitations |
|---|---|---|---|
| Soils | Soil types | USDA NRCS (SSURGO), 2009 | • Based on broad scale soil mapping<br>• Useful for broad scale assessment of soil conditions (1:24,000-scale; small soil units, not visible at this scale are not mapped)<br>• Not to be used in place of site-specific studies<br>• Data for Hanford Reach is lacking |
| Vegetation/Land Cover | Terrestrial vegetation type and land cover | Multi-Resolution Land Characteristics (MRLC) Consortium, National Land Cover Database, 2011 | • Based on interpretation of multispectral imagery at 30 x 30 m cell resolution<br>• Useful for broad scale assessment of vegetation coverage and extent of existing development<br>• Not useful for accurate characterization of fine scale data (e.g., City or parcel level, species composition)<br>• May overestimate or underestimate impervious surface coverage<br>• Data may not be up-to-date (Released every 5-10 years; data reflects 2005-2007 conditions) |
| Geologically hazardous areas | • Landslide hazard areas<br>• Seismic hazard areas | Washington Department of Natural Resources, Geology and Earth Sciences Division, 2010 | • Data are primarily seismic hazard areas<br>• Limited landslide hazard areas are mapped, but many more are likely<br>• Requires site-specific review to verify presence/absence of geologic hazards |
| Floodplains | • Floodplains<br>• Floodways | FEMA, Q3, 1998 | • Floodplain and floodways based on federal models established in 1998, and may contain some inaccuracies<br>• Data for Hanford Reach is lacking |
| Channel Migration Zone | Channel Migration Zones | • USBR 2000<br>• Benton County 2010<br>• See Appendix D | • CMZ was mapped and delineated for lower Yakima River, but not Columbia River<br>• Channel migration zone delineation based on LiDAR, aerial photography and historic and current mapping<br>• Based on graphical overlay of pertinent data, and not based on field survey of conditions<br>• Requires site-specific review to verify presence/absence of CMZ |

| Inventory Element | Information Gathered | Data Source | Use/Assumptions/Limitations |
|---|---|---|---|
| Wetlands | Potential wetlands | • U.S. Fish and Wildlife Service National Wetland Inventory, 2012 | • Useful for broad scale assessment of soil conditions and potential wetlands (1:24,000-scale)<br>• NWI mapping based on interpretation of multi-spectral imagery<br>• Many wetlands are not identified by NWI mapping; mapped wetlands may not meet wetland criteria<br>• Not to be used in place of site-specific studies |
| Aquifer Recharge Areas | N/A | N/A | • No data was available for critical aquifer recharge areas, and this represents a data gap |
| WDFW Priority Habitats & Species | • Priority fish, priority wildlife, priority habitats | • WA Department of Fish and Wildlife, 2011 | • WDFW maps do not capture every priority species location or habitat, particularly for rare species or species that use shoreline habitats seasonally or intermittently<br>• Absence of mapping information does not indicate absence of a particular species<br>• The number of documented species may reflect the relative amount of past survey efforts<br>• New data will need to be obtained at the time of project application<br>• Additional information is publicly available through interactive species maps online at http://wdfw.wa.gov/conservation/phs/ and http://wdfw.wa.gov/mapping/salmonscape/index.html |
| Butterflies | • Locations of likely butterfly sites in shoreline jurisdiction | • Rod Coler, M.D. | • Absence of mapping information does not indicate absence of butterflies<br>• Information provided by local butterfly enthusiast |
| Shoreline Modifications | • Dams<br>• Docks and other overwater structures<br>• Levees | • WA Department of Natural Resources, 2007<br>• Benton County, 2012<br>• WA Department of Ecology, 2010 | • Overwater structures may include docks, bridges, floats, structural support fill, and other structures such as floating homes<br>• Shoreline armoring data was not available |

| Inventory Element | Information Gathered | Data Source | Use/Assumptions/Limitations |
|---|---|---|---|
| Water quality impairment | 303(d) waters and regulated sites | WA Department of Ecology, Water Quality Assessment 305(b) Report, 2008 | • Water quality impairments are based on monitoring at specific locations<br>• Impairments may extend beyond the mapped area |
| Restoration opportunities | Site-specific and general projects | Various, including Yakima Steelhead Recovery Plan (Yakima Basin Recovery Board 2009) | • Data not mapped in shoreline inventory report<br>• Preliminary restoration opportunities discussed in Sections 5.2.1 and 5.2.2 of this Report. Greater detail and mapping will be provided in the future Shoreline Restoration Plan (see Section 7.5 of this Report). |
| Historical Sites | Historical places available as point data, but not mapped in inventory | WA Department of Archaeology and Historic Preservation, Washington State Heritage Register, 2009 | • Data not mapped in shoreline inventory report<br>• Data represent only known sites; additional, presently unknown sites may exist<br>• Yakama Nation is currently reviewing records; information at a planning level may be available for final analysis report |

## 4.2 Data Sources, Assumptions, and Data Gaps

### 4.2.1 Ecological Characterization

The following discussion identifies assumptions and limitations for each of the inventory elements, and may provide a brief Countywide or watershed-wide narrative where qualitative descriptions provide more information than quantitative measures. Despite data gaps and limitations, a substantial quantity of information is available for the shorelines of Benton County to aid in the development of the inventory and analysis report, as well as the shoreline master program.

***Vegetation Coverage***

The data was generated using multi-spectral satellite imagery with 30x30-meter cell resolution. Spectral data was classified using Multi-Resolution Land Characteristics (MRLC) Consortium, National Land Cover (NLC) Database. Because each cell represents 900 square meters, the classification may over or under represent coverage when the type of coverage within cells is mixed. The spatial resolution of the NLC data provides a good foundation for broad scale assessment of vegetation coverage. Its utility is higher in rural areas where vegetative cover is more uniform over broad areas compared to more developed UGAs.

Because the data is based on interpretation of multi-spectral imagery, classification of some data may be inaccurate. Most notably, shrub steppe vegetation on steeper slopes is frequently miscategorized as "cultivated crops" using the NLC model. So long as the inherent inaccuracies of the data or recognized, the NLC data provides a good broad-scale assessment of vegetation coverage.

Finally, because the ordinary high water mark changes over time, water is occasionally included within the total shoreline area used for the calculation of vegetation coverage. For this reason, any area identified as "Water" was excluded from the calculation of percent coverage.

***Impervious Surfaces***

Similar to the vegetation coverage data, impervious surface data was generated using MRLC Consortium NLC data (2006) of multispectral satellite imagery with 30x30-meter cell resolution. National Land Cover categories that apply to areas of higher impervious surface coverage include Developed- Low, Medium, and High Intensity categories. The same limitation as the vegetation coverage data apply to impervious surfaces. With these limitations in mind, a comparison of impervious surface coverage among reaches provides useful information on broad scale spatial trends in development.

***Wetlands***

Wetland mapping was assembled from the National Wetlands Inventory (NWI). Benton County has not completed a County-wide inventory of potential wetlands and therefore the NWI dataset was used as the most relevant and useful information. The NWI dataset is based on many factors, including soil inventories and aerial interpretations. Although it is very comprehensive and is fairly accurate in approximating wetland locations, it is acknowledged that many wetlands, especially small wetlands, are not identified by NWI. Likewise, some areas identified as NWI wetlands may not meet wetland criteria. Whether or not they are captured by this mapping effort, actual wetland conditions that may or may not be found on a site will determine shoreline jurisdiction (as a potential shoreline-associated wetland) on a site-specific basis.

***Soils***

Soil data are derived from the Natural Resource Conservation Service (NRCS) national soil survey. This data represents soils over broad areas; therefore, site-specific soil characteristics may differ from what is mapped.

***Surficial Geology***

Data on surficial geology are based on information from Washington DNR. Information on alluvial soil presence and distribution was used to assess hyporheic functions.

***Fish and Wildlife Habitat Conservation Areas***

WDFW Priority Habitat and Species maps are presented as three separate units: Habitat Regions (species or habitat ranges by area), Habitat Species (precise species locations); and Fish (fish species presence).

These maps do not capture every priority species location or habitat in shoreline jurisdiction, particularly rare species or species that use the water for foraging and drinking, but that nest or den farther from the shoreline. Absence of mapping information does not indicate that a particular species does not or could not utilize the shoreline or adjacent lands. Furthermore, the number of documented species may reflect the relative amount of past survey efforts rather than the presence or absence of suitable habitat.

***Frequently Flooded Areas***

For all practical purposes, "frequently flooded areas" are those areas within the 100-year floodplain. Floodplain and floodway maps were developed using FEMA's Q3 map for Benton County. Flood mapping is not available within the Hanford reach.

### *Channel Migration Zone*

Existing Channel Migration Zone (CMZ) data was not available for shorelines within Benton County. Therefore, the CMZ of the Yakima River was delineated using recommended criteria including LiDAR topography (USBR 2000), aerial photography (Benton County 2010), and both historic and current mapping in the area. The Columbia River CMZ was not delineated because river flows are regulated by hydropower dams and shoreline areas upstream of Richland are in federal ownership (WDOE 2012).

The CMZ map represents a graphical overlay of the different elements and does not include field surveys or onsite data collection. Approvals for projects and permits relying on these boundaries should include detailed assessments with stream surveys, particularly in active channel areas downstream of Benton City.

### *Geologically Hazardous Areas*

Maps of geologically hazardous areas were developed by Washington Department of Natural Resources. The data primarily focus on seismic hazards, and landslide hazard data seems limited. Data on the distribution and location of steep slopes within the proposed shoreline jurisdiction was not available, and this represents a data gap. Steep slopes should be evaluated for landslide hazard potential on a site and project specific basis.

The presence of geologically hazardous areas in shorelines can be a factor in determining suitability of the area for certain activities, including restoration and development. Human safety is an important concern for development in geologically hazardous areas. In addition, geologically hazardous areas can be important sources of large woody debris and sediment to the aquatic system, the latter to the benefit or detriment of aquatic life.

### *Water Quality*

As a requirement of Section 303(d) of the federal Clean Water Act that all waterbodies be "fishable and swimmable," Ecology classifies waterbodies into five categories:

- Category 1: Meets tested standards,
- Category 2: Waters of concern,
- Category 3: No data,
- Category 4: polluted waters that either have or do not require a TMDL, and

- Category 5: polluted waters requiring a TMDL.

Individual waterbodies are assigned to particular "beneficial uses" (public water supply; protection for fish, shellfish, and wildlife; recreational, agricultural, industrial, navigational and aesthetic purposes). Waterbodies must meet certain numeric and narrative water quality criteria established to protect each of those established beneficial uses. Waterbodies may provide more than one beneficial use, and may have different levels of compliance with different criteria for those beneficial uses in different segments of the stream or lake. As a result, many waterbodies may be on the 303(d) list for more than one parameter in multiple locations.

As presented in the Water Quality map of Appendix B, only Category 4 and 5 waters are depicted. For more information on specific waterbodies and their water quality classifications, Ecology provides an interactive on-line viewer at the following website: http://apps.ecy.wa.gov/wqawa2008/viewer.htm.

### *Shoreline Modifications*

Shoreline modifications are human-caused alterations to the natural water's edge. The most common types of shoreline modifications include overwater structures and shoreline armoring.

The Washington Department of Natural Resources has digitized piers and other in-water structures such as boatlifts, boathouses, and moorage covers. However, this dataset does not differentiate between each of these various types of overwater structures. Thus, reporting of overwater cover is usually an overstatement when assessing just piers, docks, and floats. Although not technically overwater structures, boat ramps are also reported in the inventory.

Levees were mapped based on data from the Department of Ecology. Countywide data were not available for shoreline stabilization, including rip rap armoring and dikes. A visual assessment of shoreline stabilization using aerial photography was incorporated into the analysis of ecological functions. This visual assessment is likely to underestimate the extent of armoring and diked areas.

### *Critical Aquifer Recharge Areas*

Critical aquifer recharge areas are "areas that have an effect on, or are associated with, aquifers used for potable water in community water systems" (BCC 15.25.020(5)). They are regulated and protected by BCC Chapter 15.25, Critical Aquifer

Recharge/Interchange Areas. GIS data on critical aquifer recharge areas were not available, and this represents a data gap.

### 4.2.2 Land Use Characterization

This shoreline inventory reviews current and planned land use within shoreline jurisdiction to provide a basis to establish a compatible use pattern over the 20-year planning period of the SMP and to identify current or planned preferred uses in shoreline jurisdiction that should be protected or promoted to meet SMA goals for water-oriented uses, shoreline access, and ecological protection.

The SMA promotes the following use preferences (RCW 90.58.020) for shorelines of statewide significance (identified in Section 1.2) in the stated order:

1. Recognize and protect the statewide interest over local interest;
2. Preserve the natural character of the shoreline;
3. Result in long term over short term benefit;
4. Protect the resources and ecology of the shoreline;
5. Increase public access to publicly owned areas of the shorelines;
6. Increase recreational opportunities for the public in the shoreline;
7. Provide for any other element as defined in RCW 90.58.100 deemed appropriate or necessary.

In addition, the following use preferences apply within shoreline jurisdiction in the following order [from WAC 173-26-201(2)(d)]:

1. Reserve appropriate areas for protecting and restoring ecological functions to control pollution and prevent damage to the natural environment and public health. In reserving areas, local governments should consider areas that are ecologically intact from the uplands through the aquatic zone of the area, aquatic areas that adjoin permanently protected uplands, and tidelands in public ownership. Local governments should ensure that these areas are reserved consistent with constitutional limits.
2. Reserve shoreline areas for water-dependent and associated water-related uses. Harbor areas, established pursuant to Article XV of the state Constitution, and other

areas that have reasonable commercial navigational accessibility and necessary support facilities, such as transportation and utilities, should be reserved for water-dependent and water-related uses that are associated with commercial navigation unless the local governments can demonstrate that adequate shoreline is reserved for future water-dependent and water-related uses and unless protection of the existing natural resource values of such areas preclude such uses. Local governments may prepare master program provisions to allow mixed-use developments that include and support water-dependent uses and address specific conditions that affect water-dependent uses.

3. Reserve shoreline areas for other water-related and water-enjoyment uses that are compatible with ecological protection and restoration objectives.

4. Locate single-family residential uses where they are appropriate and can be developed without significant impact to ecological functions or displacement of water-dependent uses.

5. Limit nonwater-oriented uses to those locations where the above described uses are inappropriate or where nonwater-oriented uses demonstrably contribute to the objectives of the Shoreline Management Act.

***Current Land Use***

Existing land use provides a baseline for types of land use and land cover found within shoreline jurisdiction. Existing land use data was obtained from the Benton County Assessor, and then overlaid on Folio maps for current land use, land ownership patterns, and aerial images. Mapped assessor use types were sorted into land use categories established in WAC 458-53-030. Land use data from the County Assessor's office may not be updated as frequently as other property information; however, it represents the best readily available information on current land use at a countywide level. The predominant shoreline land use pattern across all shoreline jurisdiction in Benton County is pasture/rangeland, agriculture, public, and low-density residential. Current land use is not specified within the Hanford Site, and that represents a data gap.

***Water Oriented Use***

According to Ecology's SMP Guidelines (WAC173-26-020), "water-oriented use means a use that is water-dependent, water-related, or water-enjoyment, or a combination of such uses." The Shoreline Management Act promotes uses that are "unique to or dependent upon use of the state's shoreline," as well as "ports, shoreline recreational uses including but not limited to parks, marinas, piers, and other improvements

facilitating public access to shorelines of the state, industrial and commercial developments which are particularly dependent on their location on or use of the shorelines of the state and other development that will provide an opportunity for substantial numbers of the people to enjoy the shorelines of the state." (RCW 90.58.020)

Definitions and examples of water-oriented uses are included in Table 4-2 below.

Table 4-2. Water-Oriented Uses Definitions and Examples.

| Water-Oriented Use Definitions | Examples |
|---|---|
| "Water-dependent use" means a use or portion of a use which cannot exist in a location that is not adjacent to the water and which is dependent on the water by reason of the intrinsic nature of its operations. (WAC 173-26-020(39)) | Examples of water-dependent uses may include ship cargo terminal loading areas, ferry and passenger terminals, barge loading facilities, ship building and dry docking, marinas, aquaculture, irrigation diversions, float plane facilities and sewer outfalls. |
| "Water-related use" means a use or portion of a use which is not intrinsically dependent on a waterfront location but whose economic viability is dependent upon a waterfront location because:<br>(a) The use has a functional requirement for a waterfront location such as the arrival or shipment of materials by water or the need for large quantities of water; or<br>(b) The use provides a necessary service supportive of the water-dependent uses and the proximity of the use to its customers makes its services less expensive and/or more convenient. (WAC 173-26-020(43)) | Examples of water-related uses may include warehousing of goods transported by water, seafood processing plants, hydroelectric generating plants, gravel storage when transported by barge, oil refineries where transport is by tanker, log storage, and potentially agriculture and agriculturally related water transportation systems. |
| "Water-enjoyment use" means a recreational use or other use that facilitates public access to the shoreline as a primary characteristic of the use; or a use that provides for recreational use or aesthetic enjoyment of the shoreline for a substantial number of people as a general characteristic of the use and which through location, design, and operation ensures the public's ability to enjoy the physical and aesthetic qualities of the shoreline. In order to qualify as a water-enjoyment use, the use must be open to the general public and the shoreline-oriented space within the project must be devoted to the specific aspects of the use that fosters shoreline enjoyment. (WAC 173-26-020(40)) | Primary water-enjoyment uses may include, but are not limited to, parks, piers and other improvements facilitating public access to the shorelines of the state; and general water-enjoyment uses may include, but are not limited to, restaurants (where views or other features allowing significant public access are provided), museums, aquariums, scientific/ecological reserves, and resorts/hotels (as part of mixed-use development or with significant public access or restoration components), and commercial/office as part of a mixed-use development. |

Based on a review of County Assessor records and the current land use pattern, the current use categories that were considered most likely to meet the definition of water-oriented uses were selected as follows:

- Transportation, Communication and Utilities (water-dependent when a port or marina)
- Cultural, Entertainment, and Recreational (when a water-enjoyment use)
- Manufacturing (water-related when a use is dependent upon shipping)

In the rural portions of the County, much of the potential water-oriented uses are parks; open space; and cultural, entertainment, and recreational activities. More urban examples of water-oriented uses, including eating/drinking places and hotel/lodging uses, are found in the Cities and UGA portions of the County.

More discussion of water-oriented uses is found in Chapter 6, broken down by Columbia River and Yakima River reaches.

***Transportation and Utility Infrastructure***

There are several County, state and federal highway road sections and railroad corridors in Benton County that either parallel, cross or are otherwise located in existing or future shoreline jurisdiction. Road densities are highest in the eastern portion of the county near population centers. Railroads include two Class I lines (largest lines in terms of revenue), including the BNSF Railway, which is most prevalent along both rivers, and Union Pacific which serves the Finley area. There are two short line Class III railroads including the Central Washington Railroad along the Yakima River and the Tri-City Railroad extending from Richland to Hanford. Utility infrastructure such as water, wastewater, electrical, communication, and other facilities are found throughout the County with a higher prevalence in populated areas of the County as well. More information about transportation and utility infrastructure by waterbody is found in Chapter 6.

***Existing and Potential Public Access***

The Columbia River and Yakima River are accessed in Benton County at federal, state, and County parks and trails, though there are gaps in the network, which are the subject of parks and recreation plans. Information about Benton County shoreline public access facilities and potential opportunities was obtained from the County's GIS data, the Benton County Comprehensive Parks Plan (2008), the Comprehensive Plan Parks and Recreation Element (2008), Tapteal Greenway Association website, Ridges to Rivers plans, and other sources.

***Historical or Archaeological Sites***

The Columbia and Yakima Rivers have been used for centuries for fishing, hunting, and travel, and more recently for agriculture, power, and other uses. Towns were

established along their banks (e.g. Prosser, Benton City, Richland, West Richland, and Kennewick) and still contain civic, residential, commercial and transportation facilities considered historic. The Hanford B reactor is the first large-scale nuclear reactor ever built and is listed as a National Historic Landmark. Due to the wealth of cultural resources, the State of Washington Department of Archaeology and Historic Preservation requires cultural resources assessments when development or activities are proposed that may affect archaeological or historic resources.

***Future Land Use***

The following table of land use districts describes Benton County Comprehensive Plan Land Use Designations and their associated zoning. There is a close alignment between the Comprehensive Plan and Zoning designations.

Table 4-3. Comprehensive Plan Land Use Designations and Associated Zoning

| Comprehensive Plan Designation | Implementing Zoning Designation |
|---|---|
| Rural Lands Designation (RL-20) (RL-5) & (RL-1 to 3) | Community Center Residential CCR<br>Rural Lands One Acre RL-1<br>Rural Lands Five Acre RL-5<br>Rural Lands Twenty Acre RL-20 |
| Light Industrial Designation (LI) | Light Industrial LI |
| Heavy Industrial Designation (HI) | Heavy Industrial HI |
| Public Lands Designation (PR) | Park P |
| Community Commercial | Community Commercial CC |
| General Commercial | General Commercial GC |
| Interchange Commercial | Interchange Commercial IC |
| Hanford Reach and Hanford | Unclassified U |
| GMA Agricultural Lands | GMA Agricultural GMAAD |
| Open Space-Conservation | Rural Lands Five Acre RL-5 |
| Urban Growth Areas (UGAs) | Urban Growth Area Residential UGAR |

Source: Benton County Comprehensive Plan and County Code
Note: The Comprehensive Plan Land Use Element text discusses some particular designations for Hanford including Research and Development, Visitor Serving Commercial, but these do not appear to be mapped on Land Use Map 4.0. Mineral lands are also described in the Comprehensive Plan but not mapped in that document.

## 4.3 Summary of Shoreline Inventory Results

Table 4-4 expands upon the relevant required inventory elements, providing specific detail and data for each reach (see Section 5.1.1 below for description of reach delineation). Unless otherwise noted, Table 4-4 considers only information available within the boundaries of shoreline jurisdiction of each reach. Additionally, water quality listings are identified by Ecology's 303(d) listing categories in Tables 4-5 through 4-7 (see Section 4.2.2 above for details).

Table 4-4. Summary of Shoreline Inventory by Reach.

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| **C1- Crow Butte Park** | 110.8 | 27,628 | Comprehensive Plan:<br>Public<br><br>Zoning:<br>Park District<br><br>Current Land Use %:<br>Parks - 93.5<br>No data: 6.5 | Other public: 89.8<br>Federal – USACE: 3.7<br>No data: 6.5 | Shrub/Scrub: 53.5<br>Developed, Low Intensity: 17.1<br>Developed, Open Space: 13.7<br>Herbaceous: 8.2<br>Cultivated Crops: 5.0<br>Emergent Herbaceous Wetlands: 1.8 | 6 OWS<br><br>0% levees | Floodplain: 32.7<br><br>Floodway: 0 | Crow Butte Park | Wetlands: 12.4%<br><br>Priority Habitat Regions:<br>Sand Dunes - 13.0%<br>Waterfowl Concentrations - 21.2% |
| **C2- Lake Umatilla** | 185.7 | 36,955 | Comprehensive Plan:<br>Public<br>GMA Agricultural<br><br>Zoning:<br>Park District<br>GMA Agricultural<br><br>Current Land Use %:<br>Pasture/Rangeland - 53.8<br>Other or Unclassified - 10.8<br>Transportation, Communication, and Utilities - 0.4<br>No data: 35.0 | Federal – USACE: 35.1<br>Federal – BLM: 18.7<br>Unclassified: 10.8<br>Private: 0.4<br>No data: 35.0 | Shrub/Scrub: 38.5<br>Deciduous Forest: 22.6<br>Developed, Low Intensity: 21.5<br>Developed, Open Space: 12.3<br>Emergent Herbaceous Wetlands: 15.6<br>Cultivated Crops: 7.6<br>Woody Wetlands: 2.2 | 4 OWS<br><br>0% levees | Floodplain: 57.5<br><br>Floodway: 0 | Umatilla National Wildlife Refuge (UNWR) | Wetlands: 36.7%<br><br>Priority Habitat Regions:<br>American White Pelican - 0.2%<br>Waterfowl Concentrations - 65.1% |
| **C3- UNWR** | 1,523.7 | 375,006 | Comprehensive Plan:<br>Public<br>GMA Agricultural<br><br>Zoning:<br>Park District<br>GMA Agricultural<br><br>Current Land Use %:<br>Pasture/Rangeland - 60.7<br>Agriculture - 14.0<br>Other or Unclassified - 3.8<br>Parks - 2.0<br>Transportation, Communication, and Utilities - 0.9<br>No data: 18.6 | Federal – BLM: 46.0<br>Federal – USACE: 26.7<br>Other public: 4.4<br>Unclassified: 3.8<br>Private: 0.5<br>No data: 18.6 | Shrub/Scrub: 55.4<br>Emergent Herbaceous Wetlands: 20.8<br>Cultivated Crops: 11.1<br>Woody Wetlands: 5.6<br>Developed, Low Intensity: 3.2<br>Deciduous Forest: 1.6<br>Developed, Open Space: 1.1 | 1 OWS<br><br>0% levees | Floodplain: 62.5<br><br>Floodway: 0 | UNWR | Wetlands: 48.9%<br><br>Priority Habitat Regions:<br>American White Pelican - 9.7%<br>Islands - 5.1%<br>Sand Dunes - 1.0%<br>Waterfowl Concentrations - 81.4%<br><br>Water Quality Listings:<br>Cat. 4A Chemical(s) |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| **C4-Plymouth Ag** | 147.3 | 32,010 | Comprehensive Plan:<br>Light Industrial<br>GMA Agricultural<br>Heavy Industrial<br>Rural Lands 1-3<br><br>Zoning:<br>Light Industrial<br>GMA Agricultural<br>Heavy Industrial<br>Community Center Residential (CCR)<br>Current Land Use %:<br>Pasture/Rangeland -43.9<br>Mining -15.3<br>Cultural, Entertainment, and Recreational - 11.7<br>Transportation, Communication, and Utilities - 8.5<br>Residential - 0.1<br>No data: 20.5 | Federal – USACE: 56.5<br>Port: 11.7<br>Private: 11.3<br>No data: 20.5 | Shrub/Scrub: 50.2<br>Emergent Herbaceous Wetlands: 30.3<br>Developed, Open Space: 12.1<br>Woody Wetlands: 4.0<br>Developed, Low Intensity: 3.3 | 3 OWS<br><br>0% levees | Floodplain: 71.5<br><br>Floodway: 0 | None | Wetlands: 9.1% |
| **C5-Plymouth** | 130.6 | 30,219 | Comprehensive Plan:<br>Public<br>Rural Lands 1-3<br><br>Zoning:<br>Park District<br>Community Center Residential (CCR)<br>Current Land Use %:<br>Parks - 40.9<br>Cultural, Entertainment, and Recreational - 36.3<br>Pasture/Rangeland - 13.6<br>Other or Unclassified - 0.9<br>Residential - 0.1<br>No data: 8.1 | Federal – USACE: 54.5<br>Port: 36.3<br>Other public: 0.8<br>Other State: 0.0<br>No data: 8.1 | Shrub/Scrub: 67.0<br>Emergent Herbaceous Wetlands: 18.2<br>Woody Wetlands: 4.4<br>Developed, Open Space: 4.1<br>Developed, Low Intensity: 3.4<br>Deciduous Forest: 1.4<br>Evergreen Forest: 1.2 | 8 OWS<br><br>0% levees | Floodplain: 85.7<br><br>Floodway: 0 | Plymouth Park | Wetlands: 20.4%<br><br>Priority Habitat Regions:<br>Islands - 71.0%<br>Shrub-steppe - 2.0%<br>Waterfowl Concentrations - 0.5%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 2 - pH<br>Cat. 5 - Temperature |
| **C6-McNary** | 59.6 | 21,687 | GMA Agricultural<br><br>Zoning:<br>GMA Agricultural<br>Current Land Use %:<br>Pasture/Rangeland - 45.5<br>Parks - 17.8<br>Commercial/Services - 5.7<br>No data: 31.0% | Federal – USACE: 63.3<br>Federal – BLM: 5.7<br>No data: 31.0 | Shrub/Scrub: 82.8<br>Developed, Low Intensity: 13.7<br>Developed, Medium Intensity: 2.0 | 3 OWS<br><br>0% levees | Floodplain: 40.9<br><br>Floodway: 0 | None | Wetlands: 0.3%<br><br>Priority Habitat Regions:<br>Cliffs/bluffs - 4.2%<br>Waterfowl Concentrations - 1.6%<br><br>Water Quality Listings:<br>Cat. 4A - Total Dissolved Gas<br>Cat. 5 - Temperature |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| **C7-Columbia Ag** | 653.5 | 170,769 | Comprehensive Plan:<br>GMA Agricultural<br>Public<br><br>Zoning:<br>GMA Agricultural<br>Park District<br>Current Land Use %:<br>Pasture/Rangeland - 25.0<br>Other or Unclassified - 1.8<br>Agriculture - 1.1<br>Transportation, Communication, and Utilities - 0.2<br>Vacant Land - Residential - 0.1<br>Parks - 0.1<br>No data: 71.8 | Federal – USACE: 10.5<br>Private: 9.5<br>Benton County: 2.6<br>Unclassified: 1.8<br>Other public: 1.5<br>Other Federal: 1.3<br>Federal – BLM: 0.9<br>Public Utility District: 0.2<br>No data: 71.8 | Shrub/Scrub: 98.0 | 7 OWS<br><br>0% levees | Floodplain: 35.4<br><br>Floodway: 0 | None | Wetlands: 7.6%<br><br>Priority Habitat Regions:<br>Cliffs/bluffs - 3.2%<br>Mule Deer - 12.5%<br>Shrub-steppe - 12.5%<br>Waterfowl Concentrations - 4.5%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 2 - Temperature<br>Cat. 4A - Chemical(s)<br>Cat. 5 - Temperature |
| **C8- Hover** | 376.0 | 38,251 | Comprehensive Plan:<br>Rural Lands 5<br>Public<br>Heavy Industrial<br><br>Zoning:<br>Rural Lands 5<br>Park District<br>Heavy Industrial<br>Current Land Use %:<br>Pasture/Rangeland - 47.2<br>Vacant Land - Industrial - 1.5<br>No data: 51.3 | Federal – USACE: 19.6<br>Other public: 16.2<br>Private: 7.6<br>State – WDNR: 3.0<br>Port: 1.5<br>Federal – BLM: 0.8<br>No data: 51.3 | Cultivated Crops: 28.6<br>Shrub/Scrub: 26.5<br>Woody Wetlands: 26.5<br>Developed, Open Space: 9.2<br>Emergent Herbaceous Wetlands: 5.0<br>Developed, Low Intensity: 4.2 | 6 OWS<br><br>0% levees | Floodplain: 56.3<br><br>Floodway: 0 | Hover Park | Wetlands: 81.1%<br><br>Priority Habitat Regions:<br>Waterfowl Concentrations - 3.6% |
| **C9-Finley Industrial** | 115.9 | 29,795 | Comprehensive Plan:<br>Heavy Industrial<br>Rural Lands 5<br><br>Zoning:<br>Heavy Industrial<br>Rural Lands 5<br>Current Land Use %:<br>Vacant Land – Industrial - 30.7<br>Manufacturing - 19.3<br>Transportation, Communication, and Utilities - 3.2<br>Agriculture - 0.5<br>Residential - 0.3<br>Other or Unclassified - 0.2<br>No data: 45.7 | Port: 29.1<br>Private: 22.7<br>Federal – USACE: 2.3<br>No data: 45.9 | Developed, Low Intensity: 33.3<br>Shrub/Scrub: 36.1<br>Developed, Medium Intensity: 14.3<br>Cultivated Crops: 8.9<br>Developed, Open Space: 2.2<br>Mixed Forest: 3.0 | 12 OWS<br><br>0% levees | Floodplain: 40.0<br><br>Floodway: 0 | None | Wetlands: 22.0%<br><br>Priority Habitat Regions:<br>American White Pelican - 0.7%<br>Waterfowl Concentrations - 69.0% |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| **C10- Two Rivers** | 71.9 | 24,065 | Comprehensive Plan:<br>Public<br>Rural Lands 5<br><br>Zoning:<br>Park District<br>Rural Lands 5<br>Current Land Use %:<br>Parks - 72.1<br>Residential - 9.9<br>Other or Unclassified - 5.6<br>Vacant Land - Residential - 0.6<br>No data: 11.7 | Federal – USACE: 72.1<br>Private: 10.5<br>Unclassified: 5.6<br>No data: 11.7 | Developed, Low Intensity: 28.4<br>Shrub/Scrub: 24.2<br>Cultivated Crops: 17.4<br>Emergent Herbaceous Wetlands: 9.2<br>Woody Wetlands: 9.1<br>Developed, Medium Intensity: 4.9<br>Deciduous Forest: 2.1<br>Mixed Forest: 2.0<br>Developed, Open Space: 1.4<br>Evergreen Forest: 1.3 | 11 OWS<br><br>Levees along 9% of reach | Floodplain: 65.4<br><br>Floodway: 0 | Two Rivers Park | Wetlands: 27.2%<br><br>Priority Habitat Regions:<br>Waterfowl Concentrations - 0.1% |
| **C11- North Finley** | 46.1 | 10,020 | Comprehensive Plan:<br>Rural Lands 5<br><br>Zoning:<br>Rural Lands 5<br>Current Land Use %:<br>Other or Unclassified - 45.2<br>Vacant Land - Residential - 14.7<br>Residential - 10.4<br>Agriculture - 0.1<br>No data: 29.6 | Unclassified: 25.0<br>Federal – BLM: 20.2<br>Other public: 14.7<br>Private: 10.5<br>No data: 29.6 | Developed, Low Intensity: 60.3<br>Developed, Open Space: 19.7<br>Cultivated Crops: 12.7<br>Shrub/Scrub: 7.6 | 0 OWS<br><br>Levees along 100% of reach | Floodplain: 9.0<br><br>Floodway: 0 | None | Wetlands: 0.9%<br><br>Water Quality Listings:<br>Cat. 4A - Chemical(s) |
| **C12- Kennewick UGA** | 9.3 | 2,174 | Comprehensive Plan:<br>Urban Growth Area<br><br>Zoning:<br>Light Industrial<br>Current Land Use %:<br>Residential - 34.7<br>No data: 65.3 | Port: 34.7<br>No data: 65.3 | Developed, Open Space: 38.7<br>Developed, Low Intensity: 27.4<br>Shrub/Scrub: 21.4<br>Cultivated Crops: 10.7<br>Hay/Pasture: 1.9 | 0 OWS<br><br>Levees along 100% of reach | Floodplain: 20.3<br><br>Floodway: 0 | None | Wetlands: 1.1%<br><br>Water Quality Listings:<br>Cat. 2 - pH |
| **C13- North Richland UGA** | 55.6 | 12,152 | Comprehensive Plan:<br>Urban Growth Area<br><br>Zoning:<br>Urban Growth Area Residential<br>Park District<br>Light Industrial<br>Unclassified<br>Current Land Use %:<br>Commercial/Services - 59.9<br>Pasture/Rangeland - 33.6<br>No data: 6.5 | Federal – BLM: 77.4<br>Federal – USACE: 16.1<br>No data: 6.5 | Shrub/Scrub: 66.2<br>Developed, Low Intensity: 17.9<br>Developed, Medium Intensity: 15.4 | 0 OWS<br><br>0% levees | No data | McNary NWR | Wetlands: 18.9%<br><br>Priority Habitat Regions:<br>Long-billed Curlew - 56.7% |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| **C14-Hanford** | 1,983.9 | 448,741 | Comprehensive Plan:<br>Hanford Reach<br>Hanford<br><br>Zoning:<br>Unclassified<br><br>Current Land Use %:<br>Federal – 99.4<br>Pasture/Rangeland - 0.6 | Federal – BLM: 0.6<br>Federal—Hanford: 80.7 | Shrub/Scrub: 92.1<br>Hay/Pasture: 3.0<br>Deciduous Forest: 1.1<br>Emergent Herbaceous Wetlands: 1.1 | 8 OWS<br><br>0% levees | No data | Hanford Reach, McNary NWR | Wetlands: 30.5%<br><br>Priority Habitat Regions:<br>American White Pelican - 1.5%<br>Bald Eagle - 11.9%<br>Canada Goose - 6.4%<br>Chinook Salmon - 5.3%<br>Ferruginous Hawk - 4.5%<br>Great Blue Heron - 0.0%<br>Instream Habitat - 17.6%<br>Islands - 6.3%<br>Long-billed Curlew - 10.2%<br>Mule Deer - 46.8%<br>Sand Dunes - 6.8%<br>Sandhill Crane - 11.1%<br>Waterfowl Concentrations - 14.9%<br>Woodhouse's Toad - 1.7%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 2 - pH<br>Cat. 4A - Chemical(s)<br>Cat. 4A - Total Dissolved Gas<br>Cat. 5 - Chemical(s)<br>Cat. 5 - Temperature |
| **C15- Priest Rapids** | 89.8 | 20,015 | Comprehensive Plan:<br>GMA Agricultural<br><br>Zoning:<br>GMA Agricultural<br>Unclassified<br><br>Current Land Use %:<br>Pasture/Rangeland - 38.2<br>Agriculture - 11.4<br>No data: 50.4 | Private: 49.6<br>No data: 50.4 | Shrub/Scrub: 75.3<br>Emergent Herbaceous Wetlands: 16.4<br>Deciduous Forest: 7.3<br>Hay/Pasture: 1.0 | 0 OWS<br><br>0% levees | Floodplain: 65.2<br><br>Floodway: 0 | None | Wetlands: 7.8%<br><br>Priority Habitat Regions:<br>Chinook Salmon - 8.4%<br>Chukar - 0.1%<br>Cliffs/bluffs - 0.1%<br>Instream Habitat - 14.6%<br><br>Water Quality Listings:<br>Cat. 2 - pH |
| **Y1-Richland UGA** | 5.1 | | Comprehensive Plan:<br>Rural Lands 1<br><br>Zoning:<br>Rural Lands 1 | Private: 99.0<br>No data: 1.0 | Developed, Low Intensity: 63.7<br>Developed, Open Space: 34.0<br>Shrub/Scrub: 2.3 | 0 OWS<br><br>0% levees | Floodplain: 16.2<br><br>Floodway: 16.2 | None | Wetlands: 1.4% |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| | | | Current Land Use %:<br>Residential - 84.9<br>Vacant Land - Residential, Limited Use - 8.9<br>Vacant Land - Residential - 5.2<br>No data: 1.0 | | | | | | |
| **Y2- Riverside** | 59.7 | 13,152 | Comprehensive Plan:<br>Rural Lands 1<br><br>Zoning:<br>Rural Lands 1<br><br>Current Land Use %:<br>Residential - 56.6<br>Vacant Land - Residential - 7.0<br>Residential - Outbuildings - 2.5<br>Vacant Land - Residential, Limited Use - 1.5<br>No data: 32.4 | Private: 67.0<br>Benton County: 0.6<br>No data: 32.4 | Developed, Low Intensity: 62.8<br>Cultivated Crops: 22.2<br>Developed, Open Space: 8.9<br>Shrub/Scrub: 6.1 | 1 OWS<br><br>Levees along 47% of reach | Floodplain: 24.0<br><br>Floodway: 24.0 | None | Wetlands: 36.0%<br><br>Priority Habitat Regions:<br>Waterfowl Concentrations - 7.7%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 2 - pH<br>Cat. 4A - Total Dissolved Gas<br>Cat. 5 - Chemical(s)<br>Cat. 5 - Dissolved Oxygen<br>Cat. 5 - pH<br>Cat. 5 - Temperature |
| **Y3- Barker** | 1,726.0 | 60,765 | Comprehensive Plan:<br>Open Space Conservation<br>Rural Lands 5<br><br>Zoning:<br>Rural Lands 5<br><br>Current Land Use %:<br>Pasture/Rangeland - 80.1<br>Agriculture - 16.1<br>Residential - 1.5<br>Vacant Land - Residential - 0.2<br>Residential - Outbuildings - 0.1<br>Other or Unclassified - 0.1<br>No data: 2.0 | Private: 98.0<br>Unclassified: 0.1<br>No data: 2.0 | Cultivated Crops: 93.6<br>Woody Wetlands: 3.1<br>Developed, Open Space: 1.0 | 1 OWS<br><br>0% levees | Floodplain: 98.6<br><br>Floodway: 72.9 | None | Wetlands: 35.1%<br><br>Priority Habitat Regions:<br>Wetlands - 0.1% |
| **Y4- Harrington** | 350.4 | 39,563 | Comprehensive Plan:<br>Rural Lands 5<br>Open Space Conservation<br><br>Zoning:<br>Rural Lands 5 | Private: 87.3<br>Unclassified: 1.1<br>Federal – BLM: 0.1<br>No data: 11.5 | Cultivated Crops: 65.8<br>Developed, Low Intensity: 11.7<br>Shrub/Scrub: 8.5<br>Woody Wetlands: 6.8<br>Developed, Open Space: 5.5 | 2 OWS<br><br>0% levees | Floodplain: 82.0<br><br>Floodway: 51.4 | None | Wetlands: 28.4% |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| | | | Current Land Use %:<br>Residential - 51.9<br>Agriculture - 14.2<br>Pasture/Rangeland - 11.9<br>Vacant Land - Residential, Limited Use - 5.1<br>Vacant Land - Residential - 2.6<br>Residential - Outbuildings - 1.4<br>Other or Unclassified - 1.1<br>Commercial/Services - 0.2<br>No data: 11.5 | | Emergent Herbaceous Wetlands: 1.7 | | | | |
| **Y5- Horn Rapids** | 249.2 | 59,228 | Comprehensive Plan:<br>Public<br>Rural Lands 5<br>Hanford<br><br>Zoning:<br>Park District<br>Rural Lands 5<br>Unclassified<br><br>Current Land Use %:<br>Parks - 45.8<br>Pasture/Rangeland - 20.6<br>Residential - 5.0<br>Agriculture - 2.8<br>Other or Unclassified - 0.8<br>Vacant Land - Residential - 0.4<br>No data: 24.5 | Benton County: 45.8<br>Private: 23.0<br>State – DFW: 2.2<br>Federal – BLM: 1.6<br>Irrigation District: 1.6<br>Unclassified: 0.8<br>Other State: 0.4<br>No data: 24.5 | Shrub/Scrub: 61.1<br>Developed, Open Space: 14.4<br>Woody Wetlands: 7.5<br>Developed, Low Intensity: 6.3<br>Cultivated Crops: 6.0<br>Emergent Herbaceous Wetlands: 2.7<br>Hay/Pasture: 1.3 | 2 OWS<br><br>0% levees | Floodplain: 29.0<br><br>Floodway: 1.0 | Horn Rapids County Park | Wetlands: 24.1%<br><br>Priority Habitat Regions:<br>Shrub-steppe - 18.8%<br>Wetlands - 1.4%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 5 - Chemical(s) |
| **Y6- River Road** | 512.8 | 64,917 | Comprehensive Plan:<br>Rural Lands 5<br><br>Zoning:<br>Rural Lands 5<br><br>Current Land Use %:<br>Residential - 40.2<br>Pasture/Rangeland - 21.2<br>Agriculture - 13.3<br>Vacant Land - Residential - 12.6<br>Residential - Outbuildings - 3.7<br>Vacant Land - Residential, Limited Use - 1.0<br>Transportation, Communication, and Utilities - 1.0<br>Other or Unclassified - 0.8<br>Winery - 0.2<br>No data: 6.0 | Private: 90.9<br>Irrigation District: 1.2<br>Unclassified: 0.8<br>State – DFW: 0.6<br>Federal – BLM: 0.3<br>Benton County: 0.2<br>No data: 6.0 | Cultivated Crops: 58.0<br>Shrub/Scrub: 15.0<br>Developed, Open Space: 13.7<br>Woody Wetlands: 4.5<br>Developed, Low Intensity: 4.0<br>Emergent Herbaceous Wetlands: 3.4 | 2 OWS<br><br>0% levees | Floodplain: 87.5<br><br>Floodway: 64.3 | None | Wetlands: 13.7%<br><br>Priority Habitat Regions:<br>Wetlands - 0.5% |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| **Y7- Benton City UGA** | 30.7 | 6,151 | Comprehensive Plan:<br>Urban Growth Area<br><br>Zoning:<br>Urban Growth Area Residential<br>Current Land Use %:<br>Residential - 47.9<br>Residential - Outbuildings - 23.3<br>Vacant Land - Residential, Limited Use - 14.0<br>Vacant Land - Residential - 12.1<br>No data: 2.7 | Private: 97.3<br>No data: 2.7 | Cultivated Crops: 52.5<br>Developed, Open Space: 28.1<br>Shrub/Scrub: 16.0<br>Developed, Low Intensity: 3.1 | 0 OWS<br><br>0% levees | Floodplain: 95.2<br><br>Floodway: 27.5 | None | Wetlands: 16.5%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 5 - Chemical(s) |
| **Y8- OIE** | 792.0 | 167,118 | Comprehensive Plan:<br>Rural Lands 5<br>Light Industrial<br><br>Zoning:<br>Rural Lands 5<br>Light Industrial<br>Current Land Use:<br>Pasture/Rangeland - 19.4<br>Residential - 17.9<br>Agriculture - 13.6<br>Vacant Land - Residential - 9.0<br>Other or Unclassified - 6.2<br>Vacant Land - Residential, Limited Use - 2.7<br>Vacant Land - Industrial - 2.0<br>Manufacturing - 1.1<br>Residential - Outbuildings - 1.0<br>Transportation, Communication, and Utilities - 0.4<br>Commercial/Services - 0.3<br>No data: 26.4 | Private: 63.1<br>Unclassified: 6.2<br>State – DFW: 2.5<br>Federal – BLM: 0.8<br>Irrigation District: 0.7<br>Federal – USBR: 0.2<br>Benton County: 0.1<br>No data: 26.4 | Shrub/Scrub:46.4<br>Cultivated Crops: 24.6<br>Developed, Open Space: 14.9<br>Emergent Herbaceous Wetlands: 7.6<br>Woody Wetlands: 2.6<br>Developed, Low Intensity: 1.9 | 3 OWS<br><br>0% levees | Floodplain: 55.9<br><br>Floodway: 15.6 | None | Wetlands: 13.9%<br><br>Priority Habitat Regions:<br>Prairies And Steppe - 0.6%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 2 - Dissolved Oxygen<br>Cat. 2 - Fecal Coliform<br>Cat. 2 - pH<br>Cat. 4A - Turbidity<br>Cat. 5 - Chemical(s)<br>Cat. 5 - Dissolved Oxygen<br>Cat. 5 - Fecal Coliform<br>Cat. 5 - pH<br>Cat. 5 - Temperature |
| **Y9- Prosser UGA East** | 11.7 | 2,519 | Comprehensive Plan:<br>Urban Growth Area<br><br>Zoning:<br>Light Industrial<br>Current Land Use %:<br>Other or Unclassified - 57.5<br>No data: 42.5 | Private: 57.5<br>No data: 42.5 | Shrub/Scrub: 88.0<br>Emergent Herbaceous Wetlands: 12.0 | 0 OWS<br><br>0% levees | Floodplain: 8.0<br><br>Floodway: 0 | None | Wetlands: 0.1% |
| **Y10- Prosser UGA Chandler** | 22.7 | 3,811 | Comprehensive Plan:<br>Urban Growth Area<br><br>Zoning:<br>Park District<br>Light Industrial | Private: 47.2<br>Other public: 29.7<br>Federal – BLM: 13.6<br>Unclassified:9.3<br>No data: 0.2 | Developed, Open Space: 25.2<br>Herbaceous: 24.1<br>Developed, Low Intensity: 14.1<br>Emergent Herbaceous | 0 OWS<br><br>0% levees | Floodplain: 81.2<br><br>Floodway: 43.4 | None | Wetlands: 40.0%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 2 - Fecal Coliform |

| Reach | Unit Area (Acres) | Unit Length (Feet) | Dominant Land Use Patterns | Ownership (% of reach) | Land Cover (% of reach) | Shoreline Modification (# of overwater structures/% levees) | Floodplain and Floodway Area (% of reach) | Parks | Critical Areas/ Water Quality |
|---|---|---|---|---|---|---|---|---|---|
| | | | Current Land Use %:<br>Fishing - 29.7<br>Pasture/Rangeland - 23.8<br>Residential - 23.5<br>Vacant Land - Residential - 13.6<br>Other or Unclassified - 9.3<br>No data: 0.2 | | Wetlands: 13.1<br>Shrub/Scrub: 12.7<br>Developed, Medium Intensity: 10.1 | | | | Cat. 2 - Temperature<br>Cat. 4C - Instream Flow |
| **Y11- Prosser UGA West** | 51.1 | 10,987 | Comprehensive Plan:<br>Urban Growth Area<br><br>Zoning:<br>Urban Growth Area Residential<br><br>Current Land Use %:<br>Residential - 42.9<br>Vacant Land - Residential - 23.6<br>Other or Unclassified - 12.4<br>Agriculture - 7.7<br>Cultural, Entertainment, and Recreational - 2.6<br>Vacant Land - Industrial - 0.7<br>No data: 10.0 | Private: 71.5<br>Federal – BLM: 9.6<br>Unclassified: 3.3<br>Irrigation District: 3.2<br>Benton County: 2.3<br>No data: 10.0 | Developed, Open Space: 34.2<br>Cultivated Crops: 27.2<br>Developed, Low Intensity: 17.6<br>Emergent Herbaceous Wetlands: 12.7<br>Developed, Medium Intensity: 4.7<br>Shrub/Scrub: 3.5 | 9 OWS<br><br>0% levees | Floodplain: 49.1<br><br>Floodway: 35.6 | None | Wetlands: 5.2%<br><br>Water Quality Listings:<br>Cat. 2 - Chemical(s)<br>Cat. 2 - Dissolved Oxygen<br>Cat. 2 - pH<br>Cat. 2 - Temperature<br>Cat. 4A - Turbidity<br>Cat. 5 - Chemical(s)<br>Cat. 5 - Dissolved Oxygen<br>Cat. 5 - Fecal Coliform<br>Cat. 5 - pH |
| **Y12- Byron Road** | 182.8 | 36,832 | Comprehensive Plan:<br>Rural Lands 5<br><br>Zoning:<br>Rural Lands 5<br><br>Current Land Use %:<br>Residential - 38.0<br>Agriculture - 35.1<br>Vacant Land - Residential - 10.6<br>Other or Unclassified - 2.2<br>Vacant Land - Residential, Limited Use - 2.1<br>Residential - Outbuildings - 1.3<br>Pasture/Rangeland - 0.8<br>Commercial/Services - 0.5<br>Transportation, Communication, and Utilities - 0.5<br>No data: 8.8 | Private: 89.0<br>Unclassified: 2.2<br>No data: 8.8 | Cultivated Crops: 40.9<br>Developed, Open Space: 36.6<br>Shrub/Scrub: 10.4<br>Developed, Low Intensity: 7.8<br>Emergent Herbaceous Wetlands: 2.4<br>Woody Wetlands: 1.8 | 5 OWS<br><br>0% levees | Floodplain: 50.3<br><br>Floodway: 29.2 | None | Wetlands: 2.6%<br><br>Water Quality Listings:<br>Cat. 2 - Dissolved Oxygen<br>Cat. 2 - Fecal Coliform<br>Cat. 2 - Temperature<br>Cat. 5 - pH |

THIS PAGE INTENTIONALLY LEFT BLANK

Table 4-5. Category 2 Waterbodies (Waters of Concern) by River and WRIA

| River | WRIA | Temperature | Mercury | pH | Polychlorinated Biphenyls (PCBs) | Other chemical compounds, including pesticides | Dissolved Oxygen | Ammonia | Fecal Coliform | Arsenic |
|---|---|---|---|---|---|---|---|---|---|---|
| Columbia | Rock-Glade 31 | X | X | X | X | X | | | | |
| | Alkali-Squilchuck 40 | | X | X | | X | | | | |
| Yakima | Lower Yakima 37 | X | | X | X | X | X | X | X | X |

Table 4-6. Category 4 Waterbodies by River and WRIA

| River | WRIA | Turbidity | Total Dissolved Gas | Dioxin | Instream Flow |
|---|---|---|---|---|---|
| Columbia | Rock-Glade 31 | | X | X | |
| | Alkali-Squilchuck 40 | | | X | |
| Yakima | Lower Yakima 37 | X | | | X |

Table 4-7. Category 5 Waterbodies (Impaired) by River and WRIA

| River | WRIA | PCB | DDT/DDE | Other Chemicals, including pesticides | Dissolved Oxygen | pH | Temperature | Dioxin |
|---|---|---|---|---|---|---|---|---|
| Columbia | Rock-Glade 31 | | | | | | X | |
| | Alkali-Squilchuck 40 | | | | | | | |
| Yakima | Lower Yakima 37 | X | X | X | X | X | X | X |

# 5 ANALYSIS OF ECOLOGICAL FUNCTIONS

## 5.1 Approach, Rationale and Limitations of Functional Analysis

A GIS-based semi-quantitative method was developed to characterize the relative performance of relevant ecological processes and functions by shoreline reach, as outlined in WAC 173-26-201(3)(d)(i). The assessment used the available information gathered as part of the shoreline inventory and applied a standardized ranking criterion for each independent shoreline reach to provide a consistent methodological treatment among reaches. Because watershed processes and the underlying geomorphic context are distinct between the Columbia River and the Yakima River, separate scoring criteria were developed for each river. These semi-quantitative results will ensure consistent and well-documented treatment of all reaches when assessing existing ecological conditions, yet allow for a qualitative evaluation of functions for data that are not easily summarized by GIS data alone. The results are intended to complement the inventory information in Chapter 4 and provide a comparison of watershed functions relative to other reaches in the County. Analysis scores and descriptions are accompanied by aerial oblique photographs from Ecology's Coastal Atlas (2012) and bird's eye view images from Bing.com (2012).

### 5.1.1 Reach Delineation

In order to assess shoreline functions at a local scale, each river was broken into discrete reaches based on a review of maps and aerial photography. Land use (e.g., land use patterns, zoning, vegetation coverage, and shoreline modifications) was weighted heavily in determining reach break locations because the intensity and type of land use has affected and will affect shoreline ecological conditions. Furthermore, functional analysis outcomes will be more relevant for future determination of appropriate shoreline environment designations if the reach breaks occur at likely transition points in environment designations. In addition to land use, physical drivers of shoreline processes were used to establish an overall framework for determining reach break locations. The following criteria in the following general order were used for determining reach break locations:

- Changes in land use
- Changes in vegetation (coverage and type)
- Shoreline modifications (levees, dikes, dams)
- Significant wetland areas

Reach breaks are always placed at parcel boundaries.

### 5.1.2 Functions and Impairments

The analysis of reach functions was based on the four major function categories identified in the Department of Ecology's guidelines: hydrologic, hyporheic, shoreline vegetation, and habitat. The four primary functional categories were further broken down into relevant functions which were used to evaluate reach performance (Table 5-1):

Table 5-1. Ecological processes and functions used to evaluate reaches

| Ecological Process and Functions |
|---|
| **1. Hydrologic Functions**<br>• Moderating erosion processes and the transport of water and sediment<br>• Development and maintenance of instream habitat features (e.g., riffles, pools, and off-channel habitat)<br>• Attenuating flow energy |
| **2. Vegetative Functions**<br>• Provision of large woody debris (LWD) and organic matter<br>• Filtering of upland inputs, including excess nutrients, fine sediment, and toxic substances<br>• Slowing riverbank erosion; bank stabilization |
| **3. Habitat Functions**<br>• Wetland and riparian habitat<br>• Physical space (upland and aquatic, including migration corridors) and conditions for life history |
| **4. Hyporheic Functions**<br>• Water and sediment storage, cool water refugia, and maintenance of base flows<br>• Support of vegetation |

The available information gathered County-wide in the Shoreline Inventory Map Folio (Appendix B) was used to determine the performance of these functions (High, Moderate, or Low). Metrics were developed based on best professional judgment related to known impacts of different parameters and the data available (Table 5-3). Rankings were developed for each function based on the distribution of conditions within the County for each river, so that each ranking provides a relative measure of functions compared to other reaches.

In addition to the functional scoring, each function was evaluated by reach to determine if the functional score is a result of shoreline alterations or a product of natural geomorphic processes. For example, wetland habitat functions may be inherently low in a confined channel reach, and this low score may not be related to anthropogenic alterations. On the other hand, wetland habitat functions may also be scored as "low" in

a reach where wetlands once abounded, but where wetlands no longer exist because they were ditched, drained, and filled at some point in the past. By considering whether existing functions are a product of natural conditions or localized disturbance, this analysis can help identify and prioritize opportunities for restoration of altered functions and protection of intact functions.

Table 5-2 provides a description of the significance of each function, and how each function may be affected by human alterations. It should be noted that alterations to watershed-wide processes (e.g., flow regulation) affect functions throughout all reaches of each river. Since the purpose of this analysis is to differentiate between levels of function and anthropogenic alterations, the effects of these watershed-wide impairments are addressed in Table 5-3, and not incorporated into the scoring of each reach.

Table 5-4 describes the metrics and scoring methodology for each function in the Columbia River and Yakima River. Scoring of some functions is different between the Yakima and Columbia Rivers so that the range of scores for each river represents the range of relative functions of each reach compared to other reaches in the same river. For example, floodway area is much greater overall in the Yakima River, and virtually non-existent on the Columbia River; therefore, the scoring criteria for flow attenuation incorporates floodway data for the Yakima River and uses floodplain data for the Columbia River. On a similar note, a recent study in the lower Yakima River provides specific spatial information on the siting of groundwater seeps, and comparable information is not available for the Columbia River. Therefore, data on seeps are incorporated into the scoring of hyporheic functions for the Yakima River and not for the Columbia River.

Table 5-2. Description of shoreline functions and common sources of human disturbance.

| Hydrology | Vegetative | Habitat | Hyporheic |
|---|---|---|---|
| **Functions** | | | |
| Sediment Production Sediment transport is an integral process to building and maintaining instream habitat features. In a high functioning system, gravel beds and sand bars help form diverse geomorphic conditions. Metered sediment delivery typically occurs through bank erosion, landslides, and bedload transport. Excessive fine sediment delivered to channels can suffocate salmonid eggs, inhibit emergence of fry from gravels, decrease feeding success, increase physiological stress, and through adsorption, may facilitate the transport and persistence of chemical contaminants. Alternatively, if banks are too stable, the erosive power of high flows may scour the bed of the river, causing channel incision and disconnecting the river from its floodplain.<br><br>Development of Instream Habitat Features In both the Columbia and Yakima Rivers, diverse channel habitat features are primarily formed by islands and backwaters. Large woody debris (LWD) that is transported downstream from mature tree cover influences stream channel morphology and habitat complexity.<br><br>Wave and Flow Attenuation Floodway areas and riverine wetlands provide a transition between upland and riverine habitats. Vegetated floodways help slow and disperse flood flows. The extent to which local conditions affect flow is related to the position of a reach within a watershed and the size of the floodplain or wetland area relative to watershed size. | Shade Riparian vegetation helps maintain cool water temperatures through provision of shade and creation of a cool and humid microclimate over the stream. Given the width of the Columbia and Yakima Rivers and the type of riparian vegetation that grows along the banks, shading from vegetation has a limited potential to provide temperature refuge in any shoreline reaches in the County. Instead, thermal refugia in these rivers are primarily derived by groundwater seeps and small tributaries (which can significantly benefit from riparian shading).<br><br>Large Woody Debris/Organic Inputs Riparian vegetation provides a source of large woody debris recruitment, and provides organic matter which is important to the ecosystem in the form of leaves, branches, and terrestrial insects.<br><br>Removing Excess Nutrients Dense riparian vegetation encourages infiltration of surface water. Nutrients and contaminants in subsurface water are filtered out of the soil and taken up by the roots of plants.<br><br>Shoreline Stabilization The root structure of woody vegetation stabilizes shoreline soils and prevents excessive erosion. | Wetland/Riparian Habitats Continuous riparian vegetation along the length of a waterbody provides a dispersal corridor for animals using riparian habitats. Larger and wider riparian and wetland areas tend to have more complex vegetation communities and more habitat types. Wetlands adjacent to streams provide an important habitat niche for a variety of species, particularly amphibians.<br><br>Physical Space for Life History Some areas support important or rare species assemblages or habitat features that require an elevated level of protection to ensure that these natural features are conserved.<br>Many aquatic species, including some species of salmon, rely heavily on off–channel areas, for rearing. Riparian forested habitats are particularly important for breeding, foraging, and rearing of many terrestrial species. | Water storage, cool water refugia, and filtration Storage of peak flows is provided by floodplains, off channel areas and large wetland complexes; these features serve to reduce peak flows and contribute to summer low flows.<br><br>Groundwater from shallow aquifers is often a substantial component of base flows, and groundwater seeps provide an important source of cool water refugia. Storage of peak flows is provided by local topography.<br><br>Within shallow alluvial soils adjacent to steam nutrients and toxic compounds may be filtered or removed by uptake, especially in floodplain areas.<br><br>Support of Vegetation Hyporheic flow helps support broad forested riparian floodways and floodplains. |
| **Watershed-wide Alterations** | | | |
| Dam regulation affects the timing, duration, and frequency of flood events. As discussed in Section 4, dam regulation has substantially altered they hydrograph in both the lower Yakima and mid-Columbia Rivers. By limiting the frequency and intensity of flood events, flow regulation reduces floodplain connectivity and habitat forming processes.<br><br>Irrigated agriculture has transformed the Yakima River watershed. Irrigation water is drawn from the summer surface flow, and irrigation returns have substantially replaced natural groundwater recharge.<br><br>Dredging of the Columbia River has also greatly simplified the channel form and limited geomorphic diversity. | Dam regulation limits floodplain connectivity, which helps support the establishment of riparian vegetation. Over time, as flood events are reduced in magnitude and frequency, the area of riparian vegetation is reduced.<br><br>As described in Section 4, LWD recruitment from within Benton County was likely always limited given the climate and type of riparian and upland vegetation naturally occurring in the County. Instead, LWD was transported from upstream reaches. Clearing and development in the upper watersheds has limited recruitment of LWD to Benton County shoreline reaches. | Hydrologic alteration from dams interrupts natural habitat forming processes, which create diversity in channel form and suitable instream habitat function.<br><br>Periodic dredging of depositional areas in the Columbia River limits the development of instream habitat features. | Dam regulation limits the frequency and intensity of flooding events, which limits the recharge capacity of the aquifer.<br><br>Agricultural return flows now combine with historically cool groundwater sources to provide cool water seeps and tributary outlets. |

| Hydrology | Vegetative | Habitat | Hyporheic |
|---|---|---|---|
| **Localized Alterations** | | | |
| Armored shorelines prevent natural erosion and sediment delivery processes. Shoreline armoring can accelerate erosion of adjacent properties and eliminate shoreline complexity.<br><br>Steep areas with highly erodible soils are particularly sensitive to destabilization and excessive erosion when vegetation is removed. Excess erosion of fine sediments fills pools and eliminates suitable spawning substrate.<br><br>Loss of mature native forests and wetlands affects the timing, rate, magnitude, and duration of stream flows. An increase in impervious surfaces results in increased frequency and intensity of flooding. Changes in flow volume or frequency can alter channel morphology and the sediment balance of the stream. | Clearing and grading for development often results in the removal of significant vegetation. Impervious surfaces related to roadways, driveways and parking areas tend to produce hydrocarbon pollutants and heavy metals. Depending on management activities, even pervious surfaces such as lawns and pastures can substantially increase nutrients from fertilizers and pollutants and toxins through herbicides and pesticides.<br><br>Armored shorelines can isolate the river from potential sources of organic matter and eliminate filtration potential. | Historic draining, ditching, and fill of wetlands for agriculture and development have reduced the availability of suitable habitat for aquatic and terrestrial species.<br><br>In water structures interrupt the longitudinal flow of sediment and alter habitat associations. | Impervious surfaces reduce infiltration, increasing surface flows. The net result is a reduction in shallow groundwater and hyporheic flows capable of maintaining summer low flows in streams and rivers.<br><br>Levees that limit channel migration and floodplain area also restrict hyporheic activity. |

Table 5-3. Functional score ranking for Columbia and Yakima Rivers by indicator metric.

| Process/Function | | High | Moderate | Low |
|---|---|---|---|---|
| Hydrologic | Moderation of sediment transport | • No armoring or dams present within the reach<br>AND<br>• Creek mouths present with natural deltas | • Steep slopes present, but not developed or well-vegetated<br>AND<br>• Limited armoring present | • Steep slopes present with development<br>OR<br>• Majority of the reach is armored |
| | Development/ maintenance of in-stream habitat features | Backwater areas, islands, and wetlands occupy >30% of the reach | • Backwater areas, islands, and wetlands occasionally present<br>OR<br>• Off-channel habitats are isolated from the mainstem channel by armoring or causeways | • No backwater areas, islands, or wetlands<br>OR<br>• Off-channel habitats are significantly altered (i.e. dredged or armored) |
| | Attenuation of flow energy | • Majority of the reach is not armored or protected by levees<br>AND<br>• Large wetlands or backwaters are present<br>AND<br>• Floodway >50% of area (Yakima River only) | • Wetlands are occasionally present<br>AND<br>• Majority of the reach is not armored or protected by levees<br>AND<br>• Floodplain >20% of area (Columbia River Only)<br>OR<br>• Floodway 20-50% of area (Yakima River only) | • Levees present<br>OR<br>• Majority of the reach is armored<br>OR<br>• Floodplain area <20% of total area (Columbia River only)<br>OR<br>• Floodway <20% of total area (Yakima River only) |
| Vegetative | LWD and organic matter recruitment | • Forest, shrub, or wetland vegetation >75% of area within immediate proximity of shoreline<br>AND<br>• No armoring or structures separate vegetation from the water's edge. | • Forest, shrub, or wetland vegetation 50-75% of area within immediate proximity of shoreline<br>OR<br>• A portion of the vegetation isolated from the water's edge by armoring or other structures | • Forest, shrub, or wetland vegetation <50% of area within immediate proximity of shoreline<br>OR<br>• Vegetation is separated from the shoreline by armoring and other structures |
| | Filtration of upland inputs | A broad band of dense vegetation separates uplands from the river | A narrow band of dense vegetation or a broad band of sparse vegetation separates uplands from the river | • No vegetation along the shoreline<br>OR<br>• A narrow band of sparse vegetation separates uplands from the river |
| | Bank stabilization | Riparian trees and shrubs stabilize the banks in the majority of the reach | • Riparian trees and shrubs are sparsely present along the shoreline<br>OR<br>• A portion of the shoreline is armored | • The majority of the reach is armored |

| Process/Function | | High | Moderate | Low |
|---|---|---|---|---|
| Habitat | Wetland/ riparian habitat | • Wetland area >30% of total area<br>OR<br>• A broad band of dense riparian vegetation is present | • Wetland area 15-30% of total area<br>OR<br>• Limited areas of dense riparian vegetation are present | • Wetland area <15% of total area<br>AND<br>• Dense riparian vegetation is absent |
| | Space and conditions supporting wildlife, including PHS species | • PHS region> 50% of area<br>OR<br>• Significant wetland, riparian, or unique habitat features are present and corridors between habitats are free from roads and other development | Significant wetland, riparian, or unique habitat features are present within the reach, but the corridors between habitats are impaired by development | Significant wetland, riparian, or unique habitat features are absent of significantly degraded |
| Hyporheic | Water storage and filtration | • Riverine wetlands are present<br>AND<br>• Armoring does not isolate the wetland from the mainstem channel<br>AND<br>• Seeps have been found to reduce river temperatures (Yakima River only) | • Banks of the river are moderately sloped<br>AND<br>• The majority of the banks are not armored<br>AND<br>• Seeps have been found to have a minor influence on river temperatures (Yakima River only) | • Banks slope steeply up from the River<br>OR<br>• The majority of the banks are armored<br>OR<br>• No cool water sources have been documented in the reach (Yakima River only) |
| | Support of vegetation | • Large, riverine wetlands occur within the reach<br>• OR<br>• Alluvial soils comprise over 75% of the reach (Yakima River only) | • River banks support moderate density of scrub or forested vegetation<br>AND<br>• Alluvial soils comprise 10-75% of the reach(Yakima River only) | • Banks of the river support little, if any, vegetation<br>AND<br>• Alluvial soils comprise over 10% of the reach (Yakima River only) |

For purposes of ranking the relative function of each reach within the County and assisting with later development of the Restoration Plan, the descriptive ratings were assigned a value of 1 through 3, with 1 representing low function and 3 representing high function. Reaches were ranked within each river system, and the average functional score and percent of functions identified as "altered" are presented in order of highest to lowest function.

The reach scale assessment of functions and reach-scale alterations to existing functions were plotted against each other to create a graphic of ecological function and disturbance that may be used to support watershed-level planning and land use policies and decisions. The approach used is similar to Ecology's water flow assessment approach (Stanley et al. 2005). The comparison of functions and alterations is meant to inform broad scale land use management, and is not intended to provide site-specific guidance. The approach relies on the assumptions inherent in the evaluation of functions and is limited by the fact that the measure of alterations does not evaluate the extent of alterations, rather the evaluation of alterations measures the proportion of functions that have been altered. Also, because the functional analysis does not consider the watershed-wide impacts of hydrologic regulation, the most significant impact on water-flow processes is not weighed in the assessment of function. Finally, the assessment is based on an ecological evaluation of existing functions, and does not consider factors such as existing land use demands or planned changes in land use related to proximity to population centers and site access. It is expected that these practical land use factors will play a primary role in determining future land use development, and the hope is that a simple graphic of existing shoreline ecological functions and alterations to those functions may provide a useful reference for development regulations.

Overall, impacts to shoreline functions may be limited by focusing future development in reaches with extensive alterations and low functions. In contrast, reaches with low functions but a more limited level of alterations have greater potential to realize significant benefits to shoreline function with only minor modifications to the existing condition. These latter reaches would be well-suited for future restoration. Finally, in currently high-functioning reaches, land use regulations and planning should focus on ensuring that existing functions are maintained. A graphical summary of how the relationship between functions and alterations might be interpreted to inform land use planning and the development of regulations is provided below (Figure 5-1).

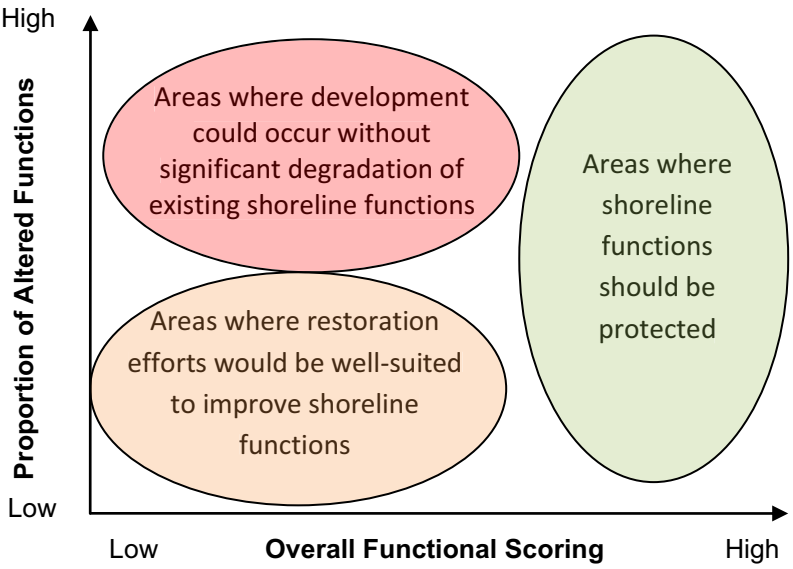



Figure 5-1. Interpretation of relationship between functional scoring and proportion of altered function.

### 5.1.3 Limitations

This evaluation was limited by the quality and availability of inventory data. Therefore, limitations presented in Sections 4.2.1 also apply to this evaluation.

In evaluating shoreline functions, the area of shoreline impacts and conditions assessed was generally limited to the area of shoreline jurisdiction. In many cases, shoreline impacts may occur at a site due to ecological and geomorphological processes that are disturbed at a remote site upstream, further inland, or up-current. This evaluation approach may not identify all of the functional responses occurring as a result of impacts to nearby or remote areas.

The approach was limited to an evaluation of shoreline ecological potential, and it did not integrate this potential with the opportunity to perform a given function based on site-specific conditions. For example, the analysis assessed the ability of a shoreline to store water, but it did not consider the frequency of flooding downstream and the corresponding significance of such a function.

## 5.2 Results of Functional Analysis

### 5.2.1 Columbia River

***Reach-Based Existing Ecological Functions***

Table 5-4, below, provides a summary of functional ranking of reaches in the Columbia River.

Table 5-4. Reach ranking order from highest to lowest function for the Columbia River based on mean reach scores.

| Reach Number/ Name | | Rank | Hydrologic | | | Vegetative | | | Habitat | | Hyporheic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Moderation of sediment transport | In-stream habitat features | Attenuating flow energy | LWD and organic matter recruitment | Filtration of upland inputs | Bank stabilization | Wetland/riparian habitat | Space and conditions supporting wildlife | Water storage and filtration | Support of vegetation |
| C3 | UNWR | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| C10 | Two Rivers (Park) | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| C14 | Hanford | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| C8 | Hover | 4 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| C5 | Plymouth | 5 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| C2 | Lake Umatilla | 6 | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 3 | 3 |
| C15 | Priest Rapids | 7 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| C1 | Crow Butte Park | 8 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| C4 | Plymouth Ag | 9 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 |
| C13 | North Richland UGA | 9 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| C9 | Finley Industrial | 11 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 |
| C6 | McNary | 12 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| C7 | Columbia Ag | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| C10 | Two Rivers (Residential) | 13 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| C11 | North Finley | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| C12 | Kennewick UGA | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

# Reach C1 – Crow Butte Park

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - natural** | Shoreline armoring in the northeast portion of the reach minimizes the potential for instream habitat complexity and reflects wave energy. Shoreline complexity is limited. Boat launch, pier, and bridge alter instream hydrology. |
| | Development and maintenance of in-stream habitat features | **Low - altered** | |
| | Attenuating flow energy | **Moderate - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - natural** | Riparian forest and shrub vegetation is limited to a thin strip adjacent to the bank in places. Upland shrub-steppe vegetation provides filtration. |
| | Filtration of upland inputs | **Moderate - natural** | |
| | Bank stabilization | **Moderate - altered** | |
| **Habitat** | Wetland/riparian habitat | **Low - natural** | Wetland and riparian vegetation is limited. Natural area and open space provide habitat for waterfowl. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate - natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - natural** | Steep, armored banks prevent development of floodplain vegetation |
| | Support of vegetation | **Low - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**

The boat launch provides an artificial off-channel area lacking in riparian or shallow-water habitat. The hook southwest of the boat launch provides some off-channel habitat and shallow-water refugia for small fish, including juvenile salmonids.

Crow Butte Park looking north

Road, railroad, and shoreline armoring looking north

# Reach C2 – Lake Umatilla

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - natural** | Riverine wetlands provide wave energy attenuation and instream habitat complexity, but shoreline armoring throughout most of the reach minimizes the potential for instream habitat complexity and reflects wave energy. |
| | Development and maintenance of in-stream habitat features | **Moderate - altered** | |
| | Attenuating flow energy | **Moderate - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - altered** | Riparian forest and shrub vegetation is concentrated at creek mouths. Vegetation at creek deltas provides organic recruitment and nutrient filtration. Vegetation on small creeks helps maintain cool water sources. Armored shorelines limit vegetative functions. |
| | Filtration of upland inputs | **Low - altered** | |
| | Bank stabilization | **Low - altered** | |
| **Habitat** | Wetland/riparian habitat | **High - natural** | Wetlands at creek mouths provide significant habitat for waterfowl and off-channel shallow water habitat for small fish and salmonids. Habitat connectivity is limited by roads. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate- altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **High - altered** | Limited areas of forested vegetation are supported along the water's edge. Glade Creek is supported by groundwater seeps, and summer flows are higher due to irrigation runoff (Davis 1992). |
| | Support of vegetation | **High- altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**

Creek mouth deltas provide habitat diversity among the relatively uniform shores of the Columbia River. The confluence with Glade Creek provides a source of cool water refuge.

Glade Creek mouth looking north

Road, railroad, and shoreline armoring with wetland vegetation looking north

# Reach C3 – UNWR

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - altered** | Islands and backwaters allow for sediment deposition and off-channel habitat. Extensive wetlands and off-channel habitats help attenuate flow energy and provide habitat diversity. A relic railroad causeway remaining in channel affects natural hydrologic connectivity. |
| | Development and maintenance of in-stream habitat features | **High - altered** | |
| | Attenuating flow energy | **High - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **High - natural** | Broad, vegetated shorelines and wetlands provide significant functions. |
| | Filtration of upland inputs | **High - natural** | |
| | Bank stabilization | **High - natural** | |
| **Habitat** | Wetland/riparian habitat | **High - natural** | Riverine wetlands and riparian forested and scrub-shrub vegetation provide high habitat values throughout this reach, including significant waterfowl and salmonid rearing habitat. |
| | Space and conditions supporting wildlife, including PHS species | **High - natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **High - natural** | Wetlands throughout this reach maintain water and support significant shoreline vegetation. |
| | Support of vegetation | **High - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Extensive wetland habitats provide high hydrologic, habitat, and vegetative functions. Inundation caused by the John Day Dam created several off-channel ponds in the reach, which are used by juvenile fish (P. La Riviere, WDFW, personal communication, 11 October 2012). This reach is an important wintering and staging area for waterfowl. The former railroad causeway runs through portions of the reach. The backwaters behind the causeway provide off-channel rearing habitats, but access to these off-channel areas is limited by the relic causeway.

Riparian vegetation and off-channel ponds

Backwater areas looking southwest

# Reach C4 – Plymouth Ag

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Low - altered** | Armoring of the western half of the shoreline alters hydrology, accelerating flow energy and sediment transport and limiting development of habitat features. |
| | Development and maintenance of in-stream habitat features | **Low - altered** | |
| | Attenuating flow energy | **Moderate - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - altered** | Vegetation in the eastern half of the reach provides organic recruitment, filtration, and bank stabilization. The road prism runs along an armored shoreline in the western half of the reach, limiting vegetative functions |
| | Filtration of upland inputs | **Moderate - altered** | |
| | Bank stabilization | **Moderate - altered** | |
| **Habitat** | Wetland/riparian habitat | **Low - altered** | The road prism and armoring limits floodplain connectivity in the western half of the reach. |
| | Space and conditions supporting wildlife, including PHS species | **Low - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - altered** | Hyporheic connectivity is limited; however, hyporheic flow helps support scrub-shrub vegetation in the eastern half of the reach. |
| | Support of vegetation | **Moderate - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Bank armoring for the road prism in the western portion of the reach limits hydrologic, vegetative, and habitat functions. Functions are higher as a result of scrub shrub vegetation in the eastern portion of the reach.

Road and shoreline armoring in western portion of reach

Riparian vegetation in eastern portion of reach

# Reach C5 – Plymouth

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **High - altered** | Low shoreline armoring. Slower water refuge is provided in channel on the north side of Plymouth Island. Causeways between Plymouth and Plymouth Island limit the hydrologic connectivity within the reach. |
| | Development and maintenance of in-stream habitat features | **High - altered** | |
| | Attenuating flow energy | **High - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - natural** | Filtration potential is most limited in area adjacent to Plymouth, which is likely to have the greatest source of inputs in the reach. Riparian vegetation is present in most of the reach, although limited to a narrow band in places. |
| | Filtration of upland inputs | **Moderate - natural** | |
| | Bank stabilization | **Moderate - altered** | |
| **Habitat** | Wetland/riparian habitat | **Moderate - natural** | Plymouth Island provides habitat complexity, including diverse instream habitat, as well as intact riparian vegetation and wetlands. |
| | Space and conditions supporting wildlife, including PHS species | **High - natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate - altered** | Hyporheic functions in the reach are most intact on Plymouth Island. |
| | Support of vegetation | **Moderate - altered** | |

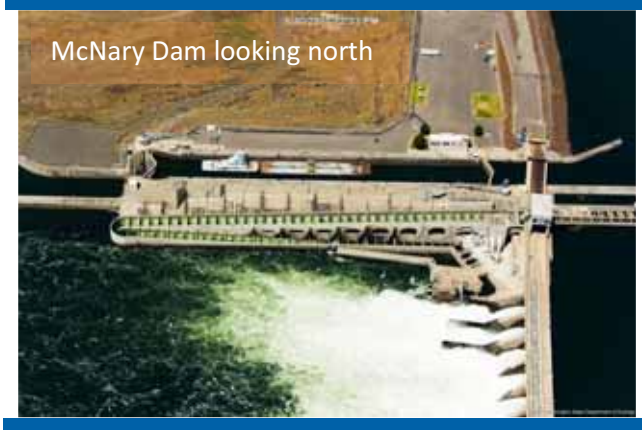
**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Plymouth Island creates diverse instream habitat. Causeways, boat launch, and pier alter natural hydrologic processes.

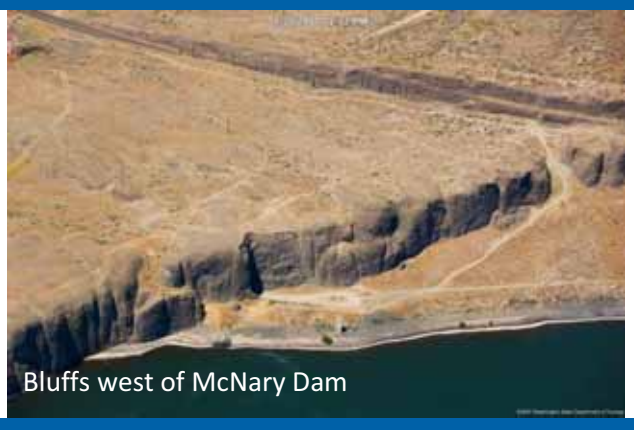
Plymouth and Plymouth Island looking southwest

# Reach C6 – McNary

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Low - altered** | Dam operations retain sediment upstream and significantly alter river velocities and habitats downstream. |
| | Development and maintenance of in-stream habitat features | **Low - altered** | |
| | Attenuating flow energy | **Low - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Low - altered** | Cliffs and steep slopes limit vegetation immediately adjacent to the shoreline and limit the potential for filtration. |
| | Filtration of upland inputs | **Moderate - altered** | |
| | Bank stabilization | **Low - natural** | |
| **Habitat** | Wetland/riparian habitat | **Low - natural** | The area's topography limits significant wetland or riparian vegetation. Dam operations alter instream habitat. |
| | Space and conditions supporting wildlife, including PHS species | **Low - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - natural** | Hyporheic functions are naturally limited in this reach. |
| | Support of vegetation | **Low - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Dam operations retain sediment and large woody debris and result in seasonal and daily fluctuations in water levels. Natural cliffs limit vegetative and hyporheic functions in the reach. The cliffs provide nesting and foraging habitat for raptors.


McNary Dam looking north


Bluffs west of McNary Dam

# Reach C7 – Columbia Ag

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Low - altered** | Armoring along the majority of the shoreline limits flow attenuation and instream habitat diversity. |
| | Development and maintenance of in-stream habitat features | **Low - altered** | |
| | Attenuating flow energy | **Low - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Low - altered** | The railroad and associated armoring runs along the shoreline for most of the reach. Vegetation is located upland of the railroad prism, limiting its potential shoreline functions. |
| | Filtration of upland inputs | **Low - altered** | |
| | Bank stabilization | **Low - altered** | |
| **Habitat** | Wetland/riparian habitat | **Low - altered** | Although riparian vegetation is limited, shrub steppe vegetation and bluffs provide upland habitat value. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - altered** | Hyporheic functions are limited by armoring throughout most of the shoreline. |
| | Support of vegetation | **Low - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The railroad prism and associated armoring runs along the river channel, and causeways extend over open water areas in much of the reach, limiting shoreline functions. Cliffs and bluffs of Wallula Gap and shrub-steppe vegetation provide significant upland habitats.

Cliffs and bluffs with railroad and causeway along the shoreline (looking north)

Looking southwest with railroad and causeway along the shoreline

# Reach C8 – Hover

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - altered** | Extensive wetlands in the reach provide valuable off-channel habitat. Railroad causeways limit the hydrologic connectivity between these off-channel areas and the mainstem channel. |
| | Development and maintenance of in-stream habitat features | **High - altered** | |
| | Attenuating flow energy | **Moderate - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **High - natural** | Significant forested and scrub-shrub vegetation is associated with wetlands in the reach. |
| | Filtration of upland inputs | **High - natural** | |
| | Bank stabilization | **Moderate - altered** | |
| **Habitat** | Wetland/riparian habitat | **High - altered** | Significant wetland areas in this reach provide habitat for fish, birds, and amphibians. Despite high habitat functions in wetlands and off-channel habitats, connectivity is limited by the railroad causeway. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **High - altered** | Wetland areas provide significant water storage and vegetative support. Small streams feed backwater areas. |
| | Support of vegetation | **Moderate - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Wetland areas are abundant in this reach. Off-channel habitat is valuable for juvenile Chinook salmon, and adult coho salmon return to off-channel habitats (P. La Riviere, WDFW, personal communication, 11 October 2012). Small streams have been supplemented by agricultural return flows. Hydrologic and habitat connectivity is limited by railroad causeways; culverts allow fish passage, but passage could be improved to allow greater connectivity for fish, aquatic mammals, waterfowl, and other wildlife.

Wetland, railroad causeway in southern portion of reach

Wetland and railroad causeway

# Reach C9 – Finley Industrial

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Low - altered** | Hydrologic processes are altered by armoring and overwater structures. An inlet provides shallow water off-channel habitat. |
| | Development and maintenance of in-stream habitat features | **Moderate - altered** | |
| | Attenuating flow energy | **Low - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Low - altered** | Much of the shoreline area is developed with impervious surfaces, and vegetation is lacking along most of the shoreline length. Shrub vegetation around the inlet provides significant filtration value. |
| | Filtration of upland inputs | **Moderate - altered** | |
| | Bank stabilization | **Low - altered** | |
| **Habitat** | Wetland/riparian habitat | **Moderate - altered** | Wetland and riparian habitat is present in the inlet. Despite its developed nature, the reach is identified as significant use by concentrations of waterfowl. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - altered** | Armored shorelines leave little potential for significant hyporheic functions in this reach. |
| | Support of vegetation | **Low - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Bank armoring and overwater structures limit ecological functions in this reach. Vegetation and functional shoreline habitat are limited to the inlet area.

Industrial development, overwater structures, and inlet looking south

# Reach C10 – Two Rivers

| Process/Function | | Function-Cause | | Notes |
|---|---|---|---|---|
| | | Park | Residential | |
| Hydrologic | Moderation of sediment transport | High – altered | Low-altered | Riverine wetlands in Two Rivers Park provide diverse shallow-water habitat and wave attenuation. In the residential area, several overwater structures are present and the banks are steep without significant vegetation. |
| | Development and maintenance of in-stream habitat features | High - altered | Low-altered | |
| | Attenuating flow energy | High - altered | Low-altered | |
| Vegetation | LWD and organic matter recruitment | Moderate - altered | Low-altered | Vegetative functions are high in the Park wetlands, and moderate in the active park areas. Vegetation is patchy along the shoreline in the residential portion of the reach. |
| | Filtration of upland inputs | Moderate - altered | Moderate-altered | |
| | Bank stabilization | High-altered | Low-altered | |
| Habitat | Wetland/riparian habitat | High-altered | Low-altered | Wetlands in Two Rivers Park provide excellent habitat opportunities for birds, fish, and amphibians. Roads and development limit habitat in the residential area. |
| | Space and conditions supporting wildlife, including PHS species | High - altered | Low-altered | |
| Hyporheic | Water storage, cool water refugia, and filtration | High - altered | Low-altered | Wetlands provide significant water storage, filtration capacity, and support of shoreline vegetation. Hyporheic functions are limited on the armored residential shoreline. |
| | Support of vegetation | High - altered | Low-altered | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The sheltered basin was created during dredging operations related to levee construction. The wetland complex provides shoreline hydrologic, vegetative, habitat, and hyporheic functions. Steep banks with patchy vegetation and numerous overwater structures occur in the residential area. The active use portion of Two Rivers Park is vegetated with patchy trees and has a moderate level of functions.

Wetlands in Two Rivers Park looking south

Residential development with private overwater structures

# Reach C11 – North Finley

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Low - altered** | Levees cover 100% of the reach. |
| | Development and maintenance of in-stream habitat features | **Low - altered** | |
| | Attenuating flow energy | **Low - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Low - altered** | Sparsely vegetated levees cover 100% of the reach. |
| | Filtration of upland inputs | **Low - altered** | |
| | Bank stabilization | **Low - altered** | |
| **Habitat** | Wetland/riparian habitat | **Low - altered** | Habitat diversity is lacking in this reach. |
| | Space and conditions supporting wildlife, including PHS species | **Low - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - altered** | Levees that cover the entire reach limit hyporheic functions. |
| | Support of vegetation | **Low - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The primary alteration in this reach is a levee that runs the entire length. Roads run along the top of the levee, and a ditch collects stormwater from land uses landward of the levee.

North Finley reach looking south

# Reach C12 – Kennewick UGA

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Low - altered** | Levees cover 100% of the reach. |
| | Development and maintenance of in-stream habitat features | **Low - altered** | |
| | Attenuating flow energy | **Low - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Low - altered** | Sparsely vegetated levees cover 100% of the reach. |
| | Filtration of upland inputs | **Low - altered** | |
| | Bank stabilization | **Low - altered** | |
| **Habitat** | Wetland/riparian habitat | **Low - altered** | Habitat diversity is lacking in this reach. |
| | Space and conditions supporting wildlife, including PHS species | **Low - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - altered** | Levees that cover the entire reach limit hyporheic functions. |
| | Support of vegetation | **Low - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The primary alteration in this reach is a levee that runs the entire length. Roads run along the top of the levee, and a ditch collects stormwater from land uses landward of the levee.

Kennewick UGA reach looking south

# Reach C13 – North Richland UGA

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - natural** | The shoreline is straight, but generally unarmored in this reach. |
| | Development and maintenance of in-stream habitat features | **Low - natural** | |
| | Attenuating flow energy | **Low - natural** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - natural** | A narrow band of scrub-shrub riparian vegetation is present along the shoreline. |
| | Filtration of upland inputs | **Low - altered** | |
| | Bank stabilization | **Moderate - natural** | |
| **Habitat** | Wetland/riparian habitat | **Low - natural** | Riparian habitat is limited in this reach. Undeveloped open spaces in this reach provide habitat opportunities for small mammals and birds. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - natural** | Hyporheic functions support a narrow band of riparian vegetation. |
| | Support of vegetation | **Moderate - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Development is generally set back from the shoreline in this reach, which allows for natural shoreline functions. The reach lacks hydrologic or geomorphic complexity.

North Richland UGA reach looking west

# Reach C14 – Hanford

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **High - natural** | Islands and backwaters provide significant hydrologic and geomorphic complexity compared to other reaches on the Columbia River. |
| | Development and maintenance of in-stream habitat features | **High - natural** | |
| | Attenuating flow energy | **High - natural** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - natural** | Riparian vegetation is generally unaltered through the reach. Riparian vegetation is limited in steeper areas of the reach. |
| | Filtration of upland inputs | **High - natural** | |
| | Bank stabilization | **Moderate - natural** | |
| **Habitat** | Wetland/riparian habitat | **High - natural** | Wetlands occur through the reach in backwater areas. Islands provide nesting areas for waterfowl. Together, wetlands and shrub-steppe vegetation in upland areas provide significant habitat areas. |
| | Space and conditions supporting wildlife, including PHS species | **High - natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate - natural** | Areas of significant hyporheic functions occur in wetland areas in the reach. |
| | Support of vegetation | **Moderate - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The Hanford reach provides some of the least altered shoreline habitats on the Columbia River. Islands in this reach are part of the McNary National Wildlife Refuge. Despite the limited area of shoreline impact, water quality issues remain a concern in the reach.

Mid-channel islands and shrub-steppe vegetation

Limited areas of industrial development and in-water structures

# Reach C15 – Priest Rapids

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - natural** | Steep slopes of the Hanford Reach National Monument provide sediment to the river. Given the position of the reach below Priest Rapids Dam, sediment delivery in this reach provides a sediment source for Lake Wallula. |
| | Development and maintenance of in-stream habitat features | **Moderate - natural** | |
| | Attenuating flow energy | **Moderate - natural** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - natural** | A narrow band of patchy shrub vegetation is relatively undisturbed along the shoreline. |
| | Filtration of upland inputs | **Moderate - natural** | |
| | Bank stabilization | **Moderate - natural** | |
| **Habitat** | Wetland/riparian habitat | **Low - natural** | Wetland habitat is limited in this reach. The cliffs and bluffs associated with the reach provide unique shoreline habitats. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate - natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - natural** | Hyporheic activity supports a relatively narrow band of vegetation along the shoreline. |
| | Support of vegetation | **Low - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The shoreline is undeveloped with the exception of a road that runs along the base of the bluffs. The reach is not armored.

Agricultural uses at base of steep slopes

Bluffs with a road along the shoreline

***Restoration Opportunities***

A comparison of reach scale functions and alterations identifies reaches for protection and restoration, and those that may be more suitable for development (Figure 5-2). Based on this comparison, the UWNR and Hanford reaches should be prioritized for protection of shoreline functions. Reaches that may benefit most from restoration include Crow Butte Park and the North Richland UGA.

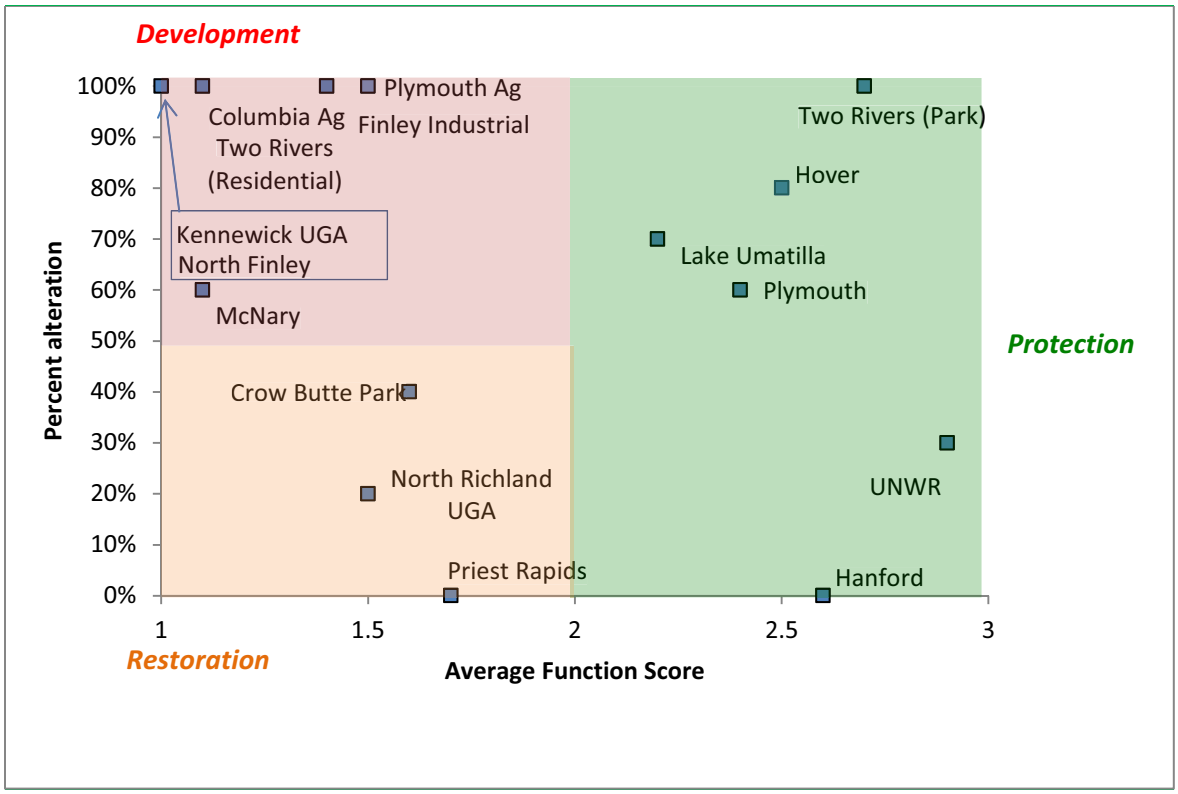



Figure 5-2. Assessment of reach protection, restoration, and development opportunities based on functions and extent of reach scale alterations to functions. Note that existing land use context and planning may result in different recommendations than those identified in this figure.

**Dam operations**

Current hydropower programs and operations are engaged in activities to minimize impacts of flow regulation on the ecological processes of the Columbia River. These actions are generally the result of obligations under the Endangered Species Act (Section 7 consultations, Section 10 Habitat Conservation Plans (HCPs)) or FERC relicensing.

The following actions are identified by NMFS (2009) as significant actions to minimize impacts of mainstem dams on the hydrology, habitat, and water quality of the Columbia River:

- Modify Columbia and Snake River dams to maximize juvenile and adult fish survival.
- Implement spill and juvenile transportation improvements at Columbia and Snake River dams.
- Operate and maintain facilities at Corps mainstem projects to maintain biological performance.
- Implement piscivorous predation control measures to increase survival of juvenile salmonids in the lower Snake and Columbia rivers.
- Implement avian predation control measures to increase survival of juvenile salmonids in the lower Snake and Columbia Rivers.
- Implement marine mammal control measures to increase survival of adult salmonids at Bonneville Dam.
- Provide information needed to support planning and adaptive management and demonstrate accountability related to the implementation of FCRPS [Federal Columbia River Power System] ESA hydropower actions for all ESUs (i.e., implement research, monitoring, and evaluation programs for hydropower actions and predator control actions).

**Hanford Site**

Groundwater quality is a primary concern in WRIA 40, where the Hanford Reach Superfund (CERCLA) Site is located. CERCLA requires five-year reviews on remedial actions when hazardous substances, pollutants, or contaminants will remain on site above levels that allow for "unlimited use and unrestricted exposure." Clean up measures and monitoring of the site continues today.

In addition to Hanford clean-up measures, substantial conservation effort has been directed to guiding management of the Hanford Reach National Monument. The National Monument, managed by USFWS and DOE, was established in 2000 by President Clinton, who noted the many unique natural features worthy of conservation, including:

- A shrub-steppe ecosystem.
- 46.5 miles of the Columbia River, fall Chinook salmon spawning areas, and sturgeon.
- Important archaeological and historic artifacts from more than 10,000 years of human occupation.

- A diversity of native plant and animal species, including rare and sensitive plant species.
- Microbiotic crusts.
- Significant geological and paleontological objects, such as the White Bluffs and Hanford Dune Field, and mammalian fossils of rhinoceros, camel, mastodon and others.

Conservation goals for the Monument identified in the Hanford Reach Comprehensive Conservation Plan (2008) include the following:

- Conserve and restore the plants, animals and shrub-steppe and other upland habitats native to the Columbia Basin.
- Conserve and restore the communities of fish and other aquatic and riparian-dependent plant and animal species native to the Monument.
- Enhance Monument resources by establishing and maintaining connectivity with neighboring habitats.
- Protect the distinctive geological and paleontological resources of the Monument.
- Protect and acknowledge the Native American, settler, atomic and Cold War histories of the Monument, incorporating a balance of views, to ensure present and future generations recognize the significance of the area's past.
- Compatible with resource protection, provide a rich variety of educational and interpretive opportunities for visitors to gain an appreciation, knowledge and understanding of the Monument.
- Compatible with resource protection, provide access and opportunities for high-quality recreation.
- Protect the natural visual character and promote the opportunity to experience solitude in the Monument.
- Facilitate research compatible with resource protection, emphasizing research that contributes to management goals of the Monument.
- Establish and maintain a cooperative fire management program that protects facilities, resources and neighbors and fulfills natural resource management objectives.

Through the Comprehensive Conservation Plan, the USFWS established objectives and strategies to address each of the above listed goals.

**Umatilla National Wildlife Refuge**

The Umatilla National Wildlife Refuge is intensively managed to provide habitat for migratory birds and resident wildlife. Management practices include restoration of

wetlands, manipulation of seasonal wetlands to encourage native food supplies, farming, prescribed burning, native planting in riparian areas, removal of exotic weed species, and planting native grasses in upland areas. Approximately 1,400 acres of refuge lands are irrigated croplands which provide food and cover for wildlife. Local farmers grow corn, wheat, alfalfa, and other crops under a cooperative agreement whereby the refuge's share of the crop is left in the field for wildlife.

**McNary National Wildlife Refuge**

Established in 1956, the McNary NWR was created to replace wildlife habitat lost to construction of the McNary Dam downstream. The 15,000 acres of sloughs, ponds, streams and islands includes islands north of the City of Richland in Benton County.

The McNary NWR is primarily focused on conservation of functioning shorelines, and active shoreline management is underway to maximize natural shoreline functions. Seasonal wetlands are managed to promote diverse wetland plant growth. Upland areas are managed with prescribed burning, removal of exotic weed species, and planting of native grasses. Native willows and cottonwoods are planted in riparian areas. Approximately 700 acres of refuge lands are managed in agriculture specifically to provide waterfowl with winter forage opportunities.

### 5.2.2 Yakima River

***Reach-Based Existing Ecological Functions***

Table 5-6, below, provides a summary of functional ranking of reaches in the Yakima River.

Table 5-5. Reach ranking order from highest to lowest function for the Yakima River based on mean reach scores.

| Reach Number/ Name | | Rank | Hydrologic | | | Vegetative | | | Habitat | | Hyporheic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Moderation of sediment transport | In-stream habitat features | Attenuating flow energy | LWD and organic matter recruitment | Filtration of upland inputs | Bank stabilization | Wetland/riparian habitat | Space and conditions supporting wildlife | Water storage and filtration | Support of vegetation |
| Y3 | Barker | 1 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Y10 | Prosser UGA Chandler | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| Y11 | Prosser UGA West | 3 | 1 | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 3 |
| Y7 | Benton City UGA | | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |

| Reach Number/ Name | | Rank | Hydrologic | | | Vegetative | | | Habitat | | Hyporheic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Moderation of sediment transport | In-stream habitat features | Attenuating flow energy | LWD and organic matter recruitment | Filtration of upland inputs | Bank stabilization | Wetland/riparian habitat | Space and conditions supporting wildlife | Water storage and filtration | Support of vegetation |
| Y4 | Harrington | 5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| Y8 | OIE | 6 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 3 |
| Y1 | Richland UGA | | 2 | | | 2 | 2 | 2 | 2 | 2 | | |
| Y9 | Prosser UGA East | | 2 | 3 | 1 | 2 | 2 | 2 | 1 | 3 | 2 | 2 |
| Y6 | River Road | 9 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 3 |
| Y5 | Horn Rapids | | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 1 | 2 |
| Y2 | Riverside | 11 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| Y12 | Byron Road | | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 2 |

# Reach Y1 – Richland UGA

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate- altered** | Residential structures are situated above a steep, well vegetated slope. This reach includes the area landward from the base of the slope, and excludes the flat vegetated area extending out to the OHWM, which is located in the City of Richland. |
| | Development and maintenance of in-stream habitat features | **NA** | |
| | Attenuating flow energy | **NA** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate- altered** | Vegetation at the top of the slope is primarily maintained lawn; however, the densely vegetated slope provides a source of organic material, filtration, and slope stabilization. |
| | Filtration of upland inputs | **Moderate- altered** | |
| | Bank stabilization | **Moderate- altered** | |
| **Habitat** | Wetland/riparian habitat | **Moderate- altered** | Vegetation on the slope provides habitat for small mammals and birds. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate- altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **NA** | The reach excludes the primary area of hyporheic functions |
| | Support of vegetation | **NA** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Residential lawns and impervious surfaces at the top of the slope increase stormwater runoff, and may contribute nutrients or household contaminants to the River. Note: This reach includes the area landward from the base of the slope, and excludes the flat vegetated area extending out to the OHWM, which is located in the City of Richland.

Reach Y1 facing east

# Reach Y2 – Riverside

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate- altered** | A levee parallels the northern portion of this reach. Several residences have shoreline armoring, but armoring is typically at or above the OHWM. Riverine wetlands and small islands are present in the reach. |
| | Development and maintenance of in-stream habitat features | **Moderate- altered** | |
| | Attenuating flow energy | **Low- altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate- altered** | The road and levee limit vegetative functions in the northern portion of the reach. Elsewhere in the reach, a band of dense vegetation separates roads and residential development from the shoreline. |
| | Filtration of upland inputs | **Moderate- altered** | |
| | Bank stabilization | **Low- altered** | |
| **Habitat** | Wetland/riparian habitat | **Moderate- altered** | Riverine wetlands and riparian vegetation provide habitat for birds, fish, and small wildlife. Habitat corridors are impaired by roads, levees, and development. |
| | Space and conditions supporting wildlife, including PHS species | **Low- altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low- altered** | Hyporheic functions are impaired by leveed portions of the reach. |
| | Support of vegetation | **Low- altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The levee and road prism that parallel the shoreline in the northern portion of the reach limit hydrologic, vegetative, habitat, and hyporheic functions there.

Riverside Road and residential development in southern portion of reach

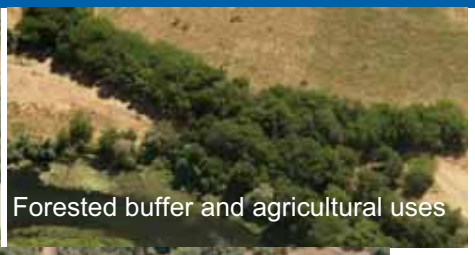
Riverside Road and levee near north end of reach

# Reach Y3 – Barker

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **High - altered** | The majority of the shoreline area is within the active floodway. Wetlands occur in the reach, but agricultural development has limited connectivity of these wetlands and side-channels over time. |
| | Development and maintenance of in-stream habitat features | **Moderate - altered** | |
| | Attenuating flow energy | **High - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **High - altered** | The reach area includes several areas of forested and scrub-shrub wetlands. Riparian forested and scrub-shrub vegetation provides filtration and stabilization functions. |
| | Filtration of upland inputs | **High - natural** | |
| | Bank stabilization | **High - natural** | |
| **Habitat** | Wetland/riparian habitat | **High - natural** | Wetlands in this reach provide significant habitat opportunities for amphibians and birds. Open fields also provide winter stopover areas for migratory birds. |
| | Space and conditions supporting wildlife, including PHS species | **High - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **High - natural** | Alluvial soils cover the majority of the reach, and hyporheic flow supports the wetland complex. Several seeps were identified by Appel et al. 2011 that are likely related to groundwater returns from Barker Ranch. |
| | Support of vegetation | **High - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Agricultural uses are the primary modification in this reach. Wetlands have been filled and drained over time to allow for agricultural production, but wetlands were restored on Barker Ranch to provide habitat for waterfowl.

Wetland and agricultural uses


Forested buffer and agricultural uses

Scrub shrub riparian vegetation and wetlands

# Reach Y4 – Harrington

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - altered** | Armoring is present, but limited to a few parcels. Extensive floodway area is developed with residential uses. Mid-channel islands provide instream habitat diversity. In the northern portion of the reach, the Columbia Canal irrigation ditch runs parallel to the River within shoreline jurisdiction. |
| | Development and maintenance of in-stream habitat features | **Moderate - altered** | |
| | Attenuating flow energy | **Moderate - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - altered** | Patches of trees and shrubs occur along the shoreline, amidst residential development and limited shoreline armoring. In the northern portion of the reach, stables and hobby farms provide a potential source of nutrients along the river. |
| | Filtration of upland inputs | **Moderate - altered** | |
| | Bank stabilization | **Moderate - altered** | |
| **Habitat** | Wetland/riparian habitat | **Moderate - altered** | Riverine wetlands throughout the reach provide habitat for fish, amphibians, and birds. Some of these wetlands have been altered by development. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate - natural** | The majority of the reach is located on alluvial soils that store water and support vegetation within the shoreline area. Cool water seeps in this area are attributed to hyporheic activity in Reach 3. |
| | Support of vegetation | **High - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Residential uses are the dominant alteration throughout most of the reach. Riparian vegetation is present along the shoreline, but altered by development. The Columbia Canal irrigation ditch closely parallels the River at the north end of the reach, potentially limiting hyporheic storage capacity.

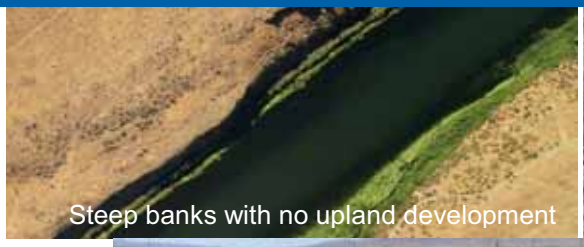
Residential with patchy riparian vegetation

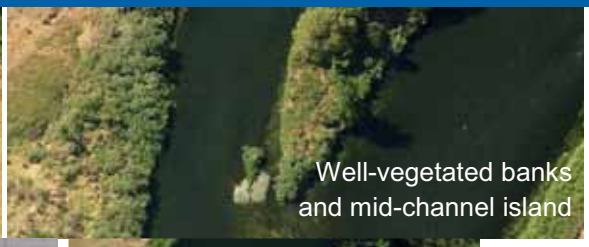
Residential uses with patchy riparian vegetation

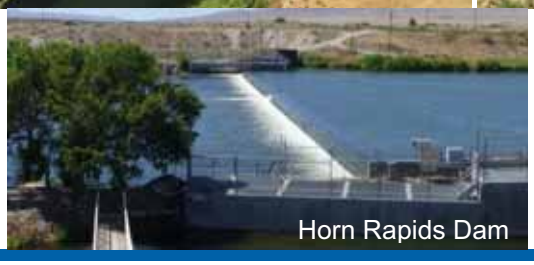
# Reach Y5 – Horn Rapids

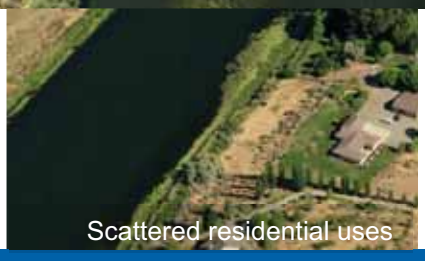
| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - altered** | Horn Rapids dam alters the reach hydrology and sediment transport and diverts streamflow into irrigation canals. Several islands and riverine wetlands provide instream habitat diversity. Armored shorelines are rare within the reach. |
| | Development and maintenance of in-stream habitat features | **Moderate - altered** | |
| | Attenuating flow energy | **Low - altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - natural** | The reach includes areas of broad, forest and shrub vegetation, as well as areas where vegetation is naturally limited to a narrow band at the base of a steep slope. Armoring is limited in the reach, and vegetation helps stabilize banks. |
| | Filtration of upland inputs | **Moderate - natural** | |
| | Bank stabilization | **Moderate - natural** | |
| **Habitat** | Wetland/riparian habitat | **Moderate - natural** | Small riparian wetlands are present throughout the reach. The reach includes areas of native shrub-steppe habitat with limited development. |
| | Space and conditions supporting wildlife, including PHS species | **High - natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Low - natural** | Significant seeps were not identified in this reach by Appel et al 2011, but alluvial soils support plant growth along low elevation shorelines. |
| | Support of vegetation | **Moderate - altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Horn Rapids Dam is the primary modification affecting the reach hydrology. Much of the reach is in open space, but limited agricultural and residential uses are also present, and vegetative functions are more altered in these areas.


Steep banks with no upland development


Well-vegetated banks and mid-channel island


Horn Rapids Dam

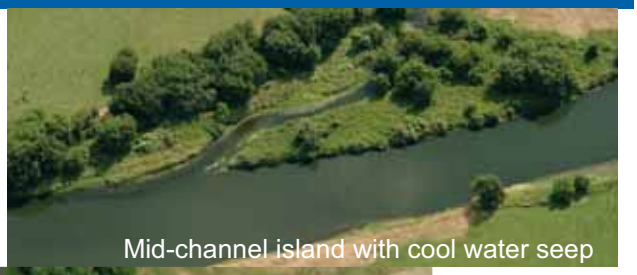

Scattered residential uses

# Reach Y6 – River Road

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate - altered** | Undeveloped mid-channel islands provide low-velocity backwaters and side channels. Limited armoring is present in the reach. |
| | Development and maintenance of in-stream habitat features | **Moderate - altered** | |
| | Attenuating flow energy | **Moderate - natural** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate - altered** | Residential and agricultural development has resulted in a patchy coverage of riparian shrubs and trees. |
| | Filtration of upland inputs | **Moderate - altered** | |
| | Bank stabilization | **Moderate - altered** | |
| **Habitat** | Wetland/riparian habitat | **Low - altered** | Wetlands occur infrequently, primarily on mid-channel islands. Off-channel areas formed by these islands provide some instream habitat diversity. Corridors between habitats are altered. |
| | Space and conditions supporting wildlife, including PHS species | **Low - altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate - natural** | Alluvial soils store water and support vegetation along the shoreline. A cool water seep was identified just downstream of the large island pictured in the upper right below (Appel et al. 2011). |
| | Support of vegetation | **High - natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Riparian vegetation has been altered in places by agricultural and residential development.

Agricultural uses


Mid-channel island with cool water seep

Residential uses (left) and undisturbed riparian vegetation (right)

# Reach Y7 – Benton City UGA

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| Hydrologic | Moderation of sediment transport | Moderate - natural | This reach is unarmored. Natural instream habitat diversity is limited, but large riparian trees along the shoreline provide a rare source of potential large woody debris recruitment in the lower Yakima River. |
| | Development and maintenance of in-stream habitat features | Moderate - natural | |
| | Attenuating flow energy | Moderate - natural | |
| Vegetation | LWD and organic matter recruitment | Moderate - altered | As noted above, large riparian trees at the south end of the reach provide shade and potential recruitment of large woody debris. Elsewhere in the reach, shrubby riparian vegetation occurs along the banks. |
| | Filtration of upland inputs | Moderate - altered | |
| | Bank stabilization | High - natural | |
| Habitat | Wetland/riparian habitat | Moderate - altered | A potential wetland occurs at the south end of the reach, providing habitat for amphibians, birds, and small mammals. |
| | Space and conditions supporting wildlife, including PHS species | Moderate - altered | |
| Hyporheic | Water storage, cool water refugia, and filtration | Moderate - natural | Alluvial soils store water and support vegetation along the shoreline. A cool water seep was identified in the northern segment of this reach (Appel et al. 2011). |
| | Support of vegetation | High - natural | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Rural residential development is the most significant land use factor affecting functions in this reach.

Southern portion of reach with riparian trees and potential wetland

Central portion of reach

Northern portion of reach

# Reach Y8 – OIE

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate- altered** | Roads and railroads run adjacent to this reach. Banks tend to be steep. The Chandler Spillway discharges in this reach. |
| | Development and maintenance of in-stream habitat features | **Moderate- natural** | |
| | Attenuating flow energy | **Low- natural** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate- altered** | A narrow band of riparian vegetation occurs along most of this reach, with areas of impairment, and a few mid-channel islands that provide the greatest vegetative functions. |
| | Filtration of upland inputs | **Moderate- altered** | |
| | Bank stabilization | **Moderate- natural** | |
| **Habitat** | Wetland/riparian habitat | **Low- natural** | A road or railroad runs parallel to the shoreline along most of this reach, which limits wildlife dispersal opportunities. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate- altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **High- natural** | Alluvial soils store water and support vegetation along the shoreline. Appel et al. 2011 found several seeps, as well as creek mouths that function as wasteway discharges for irrigation return flows (Knox Creek and Corral Creek), which provide cool water refuge in this reach. |
| | Support of vegetation | **High- natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Roads running parallel to the both shorelines have altered shoreline topography and vegetation. Cool water seeps and inflows have the greatest influence on River temperatures within the County in this reach.

Railroad along River and mid-channel island

Chandler spillway

# Reach Y9 – Prosser UGA East

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate- natural** | A small rapid occurs at the upstream end of this reach. The banks reach are moderate to steep, and they do not allow for significant attenuation of high flows. |
| | Development and maintenance of in-stream habitat features | **Moderate- natural** | |
| | Attenuating flow energy | **Low- natural** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate- natural** | Steep slopes in this area promote sheet flow runoff and limit the ability of vegetation to provide significant filtration. A band of shrubs and trees provides organic matter and potential LWD recruitment to the channel. |
| | Filtration of upland inputs | **Moderate- natural** | |
| | Bank stabilization | **Moderate- natural** | |
| **Habitat** | Wetland/riparian habitat | **Low- natural** | There is little potential wetland habitat within this reach; however, riparian vegetation is limited to a narrow strip along the shoreline. Despite little riparian vegetation, this undeveloped reach provides potential habitat for small mammals. |
| | Space and conditions supporting wildlife, including PHS species | **High- natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate- natural** | Although this reach is predominantly composed of alluvial soils, the steep banks limit the extent of hyporheic functions. |
| | Support of vegetation | **Moderate- natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
This reach is relatively unaltered, but the steeper slopes moderate the potential shoreline functions.

Reach Y9 looking south

# Reach Y10 – Prosser UGA Chandler

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **High- natural** | Small islands and one relatively large wetland is present within this reach. |
| | Development and maintenance of in-stream habitat features | **Moderate- natural** | |
| | Attenuating flow energy | **Moderate- natural** | |
| **Vegetation** | LWD and organic matter recruitment | **High- natural** | Riparian vegetation is generally undisturbed in this reach, and existing upland development is limited. |
| | Filtration of upland inputs | **High- natural** | |
| | Bank stabilization | **High- natural** | |
| **Habitat** | Wetland/riparian habitat | **High- natural** | A large wetland in the eastern portion of the reach provides habitat for fish, amphibians, and birds. |
| | Space and conditions supporting wildlife, including PHS species | **Moderate- natural** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate- natural** | Alluvial soils store water and support vegetation along the shoreline. |
| | Support of vegetation | **High- natural** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
A fish hatchery is located just outside of shoreline jurisdiction, and channels connect from the River to acclimation facilities. Rural residential parcels are undeveloped with little shoreline disturbance.

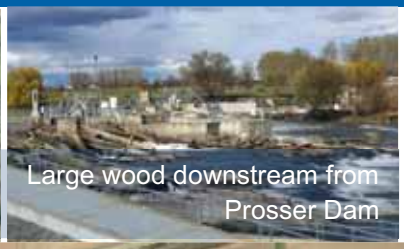
Reach Y10 looking north

# Reach Y11 – Prosser UGA West

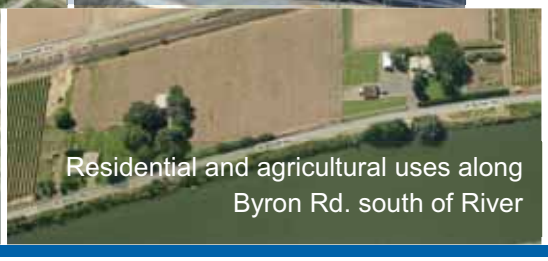
| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Low- altered** | Sediment transport processes are altered by the Chandler diversion and Prosser dam. LWD accumulates upstream of the Prosser Dam and is transferred downstream. The large wetland below the dam attenuates high flows. |
| | Development and maintenance of in-stream habitat features | **High- altered** | |
| | Attenuating flow energy | **High- altered** | |
| **Vegetation** | LWD and organic matter recruitment | **Moderate- altered** | The wetland complex below the dam provides a source of organic matter. West Byron Road closely parallels the shoreline in the eastern segment of the reach, limiting vegetative functions. |
| | Filtration of upland inputs | **Moderate- altered** | |
| | Bank stabilization | **Moderate- altered** | |
| **Habitat** | Wetland/riparian habitat | **High- altered** | Wetland habitat below the Prosser Dam provides significant habitat. Developed residential and agricultural shorelines elsewhere in the reach have impaired corridors. |
| | Space and conditions supporting wildlife, including PHS species | **Low- altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate- altered** | Alluvial soils store water and support vegetation. |
| | Support of vegetation | **High- altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
The Chandler diversion and Prosser Dam have the most significant impact on shoreline functions in the reach. When large woody debris is captured by the dam, it is removed and transported just downstream of the dam. However, given the altered hydrograph, without significant high flows in the winter, the large woody debris tends to remain just downstream of the dam, limiting its influence on habitat features. Residential and agricultural land use and roads limit habitat and vegetative functions.

Prosser Dam looking north


Large wood downstream from Prosser Dam

Residential and agricultural uses north of River


Residential and agricultural uses along Byron Rd. south of River

# Reach Y12 – Byron Road

| Process/Function | | Function-Cause | Notes |
|---|---|---|---|
| **Hydrologic** | Moderation of sediment transport | **Moderate- altered** | The reach is lacking instream geomorphic diversity. A narrow band of floodway along the length of the reach provides the opportunity to attenuate high flows. |
| | Development and maintenance of in-stream habitat features | **Low- altered** | |
| | Attenuating flow energy | **Moderate- natural** | |
| **Vegetation** | LWD and organic matter recruitment | **Low- altered** | Vegetation is limited to a narrow band of shrubs in most places. This band of vegetation is generally effective at maintaining bank stability in the reach, but the width of vegetation does not provide significant filtration. |
| | Filtration of upland inputs | **Low- altered** | |
| | Bank stabilization | **Moderate- alerted** | |
| **Habitat** | Wetland/riparian habitat | **Low- altered** | Areas of wetland and significant riparian vegetation are generally lacking in this reach. |
| | Space and conditions supporting wildlife, including PHS species | **Low- altered** | |
| **Hyporheic** | Water storage, cool water refugia, and filtration | **Moderate- altered** | Although most of the reach is composed of alluvial soils, West Byron Road running parallel to the reach limits hyporheic functions. |
| | Support of vegetation | **Moderate- altered** | |

**Key Environmental or Land Use Factors Affecting Processes/Functions:**
Roads running parallel to the River limit floodplain connectivity and vegetative, habitat, and hyporheic functions. Residential and agricultural land uses also limit vegetative and habitat functions in the reach.

Residential and agricultural uses looking east (Byron Road on right side of photo)

Residential and agricultural uses looking east (Byron Road on right side of photo)

***Restoration Opportunities***

A comparison of reach scale functions and alterations identifies reaches for protection and restoration (Figure 5-3). Based on this comparison, the Barker and Prosser UGA Chandler reaches should be prioritized for protection of shoreline functions. Reaches that may benefit most from restoration include the Horn Rapids and OIE reaches.

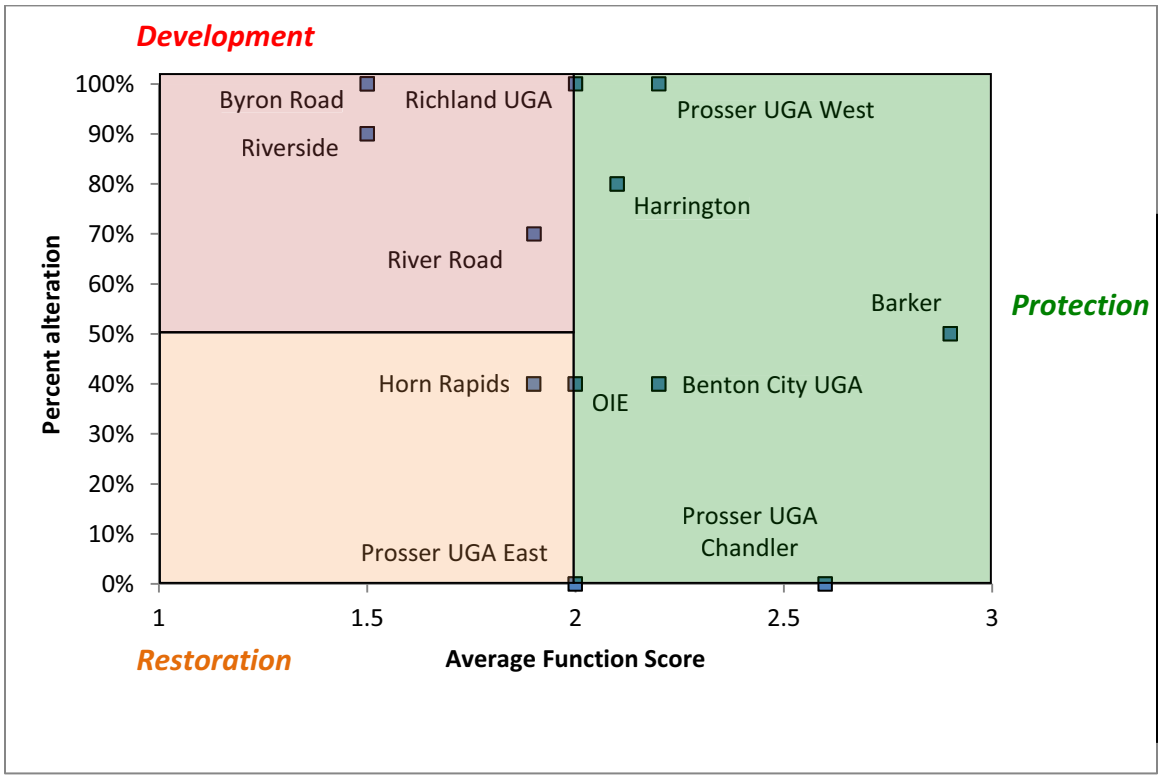



Figure 5-3. Assessment of reach protection, restoration, and development opportunities based on functions and extent of reach scale alterations to functions. Note that existing land use context and planning may result in different recommendations than those identified in this figure.

The primary threats and limiting factors for the lower Yakima River are identified in the Yakima Steelhead Recovery Plan (Yakima Basin Recovery Board 2009) as the following:

*Altered Streamflows:* Low flows, high air temperatures, limited riparian vegetation, and reduced floodplain function combine to result in high water temperatures with limited refuge opportunities. High temperatures in the early fall may limit the timing of salmon migrations and the diversity of life history strategies expressed in the River. High temperatures also favor non-native predatory fish, and may make native salmonids more susceptible to disease.

*Floodplain Alteration:* Highway, railroads, and dike system development have cut off significant portions of the floodplain. In lower reaches of the Yakima, residential development along the river and associated alterations to natural riparian vegetation are becoming increasingly common.

*Creation of False Attraction Flows:* Hydropower wasteways, irrigation drains, and spillways discharge flow that can entrain or confuse adult steelhead during the upstream migration period. This can result in stranding of fish in unsuitable habitat and/or delays in upstream migration.

*Reduced Water Quality:* Degraded water quality (especially pH, dissolved oxygen [DO], and temperature conditions) significantly reduces habitat quality in the lower Yakima River. Intensive agricultural production, including drainage improvements, and the use of fertilizers and pesticides have left a legacy of contamination, and residual concentrations of nutrients.

In 1997, the Roza Sunnyside Board of Joint Control initiated a water quality improvement program for drains and wasteways in the lower Yakima River, making significant strides to improve water quality in the lower river. The recent growth of water star-grass in the lower Yakima River has led to concerns about its effect on water quality (especially dissolved oxygen), habitat, and migration conditions for salmonids. Growth of this native plant may have increased as a result of a combination of a reduction in suspended sediments, which increased light penetration into the water column, and by long periods without bed-scouring high flows.

*Predation by Introduced Species:* Non-native fish species can prey on juvenile salmonids. Smallmouth bass and channel catfish are of particular concern as potential predators to juvenile salmon.

*Impaired Fish Passage:* Despite significant work to ensure fish passage at irrigation diversions in the mainstem Yakima River, certain seasonal operations and flow conditions at some diversions can still hinder migrations.

Since many of the limiting factors in the Lower Yakima watershed are influenced by the watershed's altered hydrologic regime, restoration actions that occur throughout the entire Yakima watershed will significantly improve shoreline ecological functions in Benton County. The implementation framework for the Yakima River Basin Integrated Water Resource Management Plan (IWRMP) was completed in October of 2012 (HDR et al. 2012). This document sets the stage to move forward to improve the management of

the Yakima River flow regime to benefit natural hydrologic processes and salmonid habitat functions.

The complete list of restoration recommendations in the Yakima Steelhead Recovery Plan can be found in Chapter 5.5 of that report (Yakima Basin Recovery Board 2009). Habitat restoration actions directly applicable to Benton County's Yakima River shoreline are listed in Table 5-6, below.

Table 5-6. Habitat restoration actions specific to Benton County on the Yakima River.

| Restoration Action | Time to Implement | Benefit | Source |
|---|---|---|---|
| Increase flows in Chandler bypass reach to improve juvenile out-migration conditions | O-3 years | Outmigration survival of juvenile salmon | Yakima Basin Recovery Board 2009 |
| Improve flows below Parker through irrigation system improvements | >10 years | Improved instream flows by moving diversion points downstream | Yakima Basin Recovery Board 2009 |
| Improve hydrograph through artificial storage and/or Columbia River water transfer | >10 years | Maintain more natural flow regime in the Lower Yakima River | Yakima Basin Recovery Board 2009, HDR et al. 2012 |
| Protect and restore mainstem floodplain habitats below Sunnyside dam | 0-3 years | Habitat enhancements; opportunities in Benton County include Barker Ranch and River adjacent to West Richland | Yakima Basin Recovery Board 2009 |
| Improve quality of irrigation return flows | 0-3 years | Improve water quality; improve understanding of ecological interactions with water stargrass | Yakima Basin Recovery Board 2009 |
| Investigate whether removal of the Bateman Island Causeway would affect River temperatures at the Yakima River delta | >10 years | Reduce temperatures and increase diversity of upstream salmonid migration timing | Appel et al. 2011 |
| Fish screening and irrigation water conservation | 0-3 years | Limit injury to fish from irrigation withdrawals; maximize irrigation efficiencies | Appel et al. 2011 |
| Work with private landowners to restore riparian vegetation and manage streamside grazing | 0-3 years | Limit sedimentation and promote riparian vegetation | Appel et al. 2011 |
| Restore and protect side channels from Prosser to Richland through removal of water stargrass or scouring with large woody debris | 5-10 years | Improve side channel habitat, particularly in areas of thermal refugia or historic spawning grounds | Appel et al. 2011 |
| Restore access to off-channel habitats from Benton City to Richland through alterations to dam operations (preferred) or local alterations to off-channel areas | 5-10 years | Improve off-channel habitat opportunities | Appel et al. 2011 |

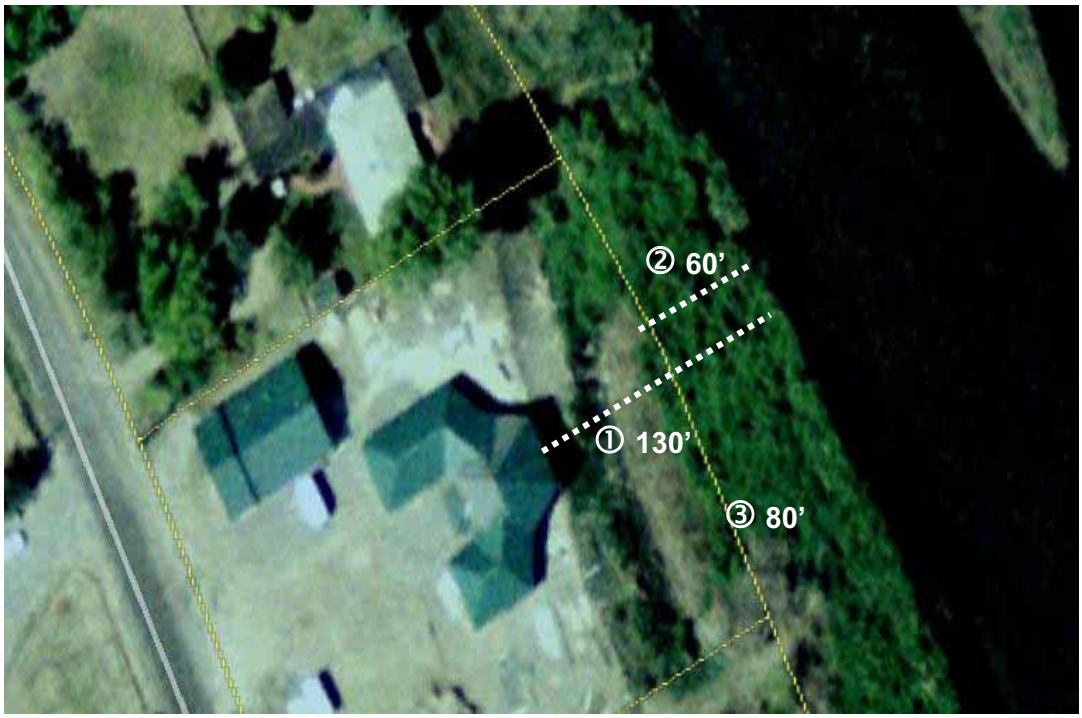
| Restoration Action | Time to Implement | Benefit | Source |
|---|---|---|---|
| Protect islands and floodplains between Prosser and West Richland | >10 years | Maintain off-channel habitat opportunities | Appel et al. 2011 |
| Protect, enhance, and analyze thermal refugia | 0-3 years | Identify and prioritize restoration and protection of cool water sources | Appel et al. 2011 |
| Water stargrass management | 0-3 years | Maintain instream habitat for salmon | Appel et al. 2011 |
| Manage capture and distribution of large woody debris at Prosser Dam | 5-10 years | Enhance diversity of instream habitats | Appel et al. 2011 |
| Modify levees and manage floodplain areas to minimize nutrient enrichment of the river during floods | 5-10 years | Enhance habitat and water quality conditions | Appel et al. 2011 |

## 5.3 Existing Setbacks and Vegetated Buffer Widths

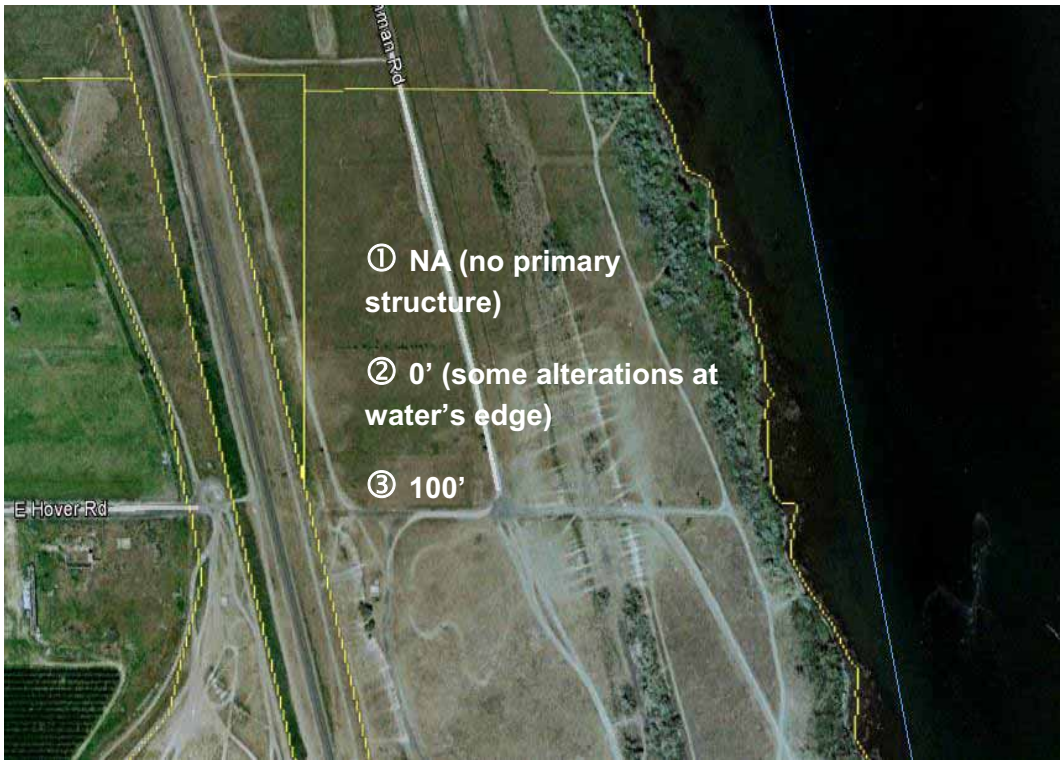
### 5.3.1 Approach

The distance between the water's edge and development and/or shoreline alterations is often a quick indicator of the extent of shoreline disturbance. From a regulatory perspective, shoreline setbacks and buffers are often used as a simple, cost-effective approach to maintaining shoreline functions. An analysis of the width of existing structural setbacks and functioning shoreline vegetation was conducted in an effort to describe local baseline conditions. Information was gathered for a subset of 20% of parcels within each reach, and no fewer than 10 parcels if present (in some reaches, fewer than 10 parcels occurred within shoreline jurisdiction). Parcels were selected randomly using a random number generator.

The approximate distance from the OHWM to the nearest primary structure ① and from the OHWM to the nearest alteration ② was measured for each parcel based on aerial photography. The average width of relatively undisturbed vegetation ③ was also estimated for each parcel (this area excludes mowed lawns, plowed fields, and orchards). Figures below show a Yakima River and a Columbia River example of how the three metrics were captured.




Example in Reach Y2 – Riverside on the Yakima River.




Example in Reach C8 – Hover on the Columbia River

The parcel data were summarized for each reach to provide an overall measure of existing development patterns in shoreline jurisdiction. The summary is expected to

help inform SMP management policies regarding appropriate setbacks and/or buffer strategies tailored to existing conditions. Additional analysis will be conducted during SMP development, particularly after assignment of Environment Designations.

### 5.3.2 Limitations

The summary calculations were weighted by the number of parcels and not by the parcel size or length along the shoreline; therefore, summary metrics do not necessarily represent the average shoreline condition. For example, large parcels with broad shoreline frontage have a disproportionate effect on shoreline condition compared to smaller parcels, or parcels with more limited shoreline frontage. These proportional effects on shoreline frontage are not considered in the summary measures.

Setbacks were measured to the nearest alteration or primary structure on a parcel basis, so for large parcels with one minor alteration adjacent to the water, despite significant open space throughout the majority of the parcel, the overall setback width may appear low. An example of this effect is apparent in the Hover Reach (C8), where a boat ramp resulted in a low setback width despite significant undisturbed areas. In this case, the average width of functional vegetation provides a more complete picture of development intensity in the shoreline area.

Finally, measures of functional vegetation and non-primary structure alterations were limited in accuracy by the subjective interpretation of disturbance based on aerial photography. Where the width of functional vegetation is widely varied within a parcel, the average width may not represent the full range of actual conditions.

### 5.3.3 Results

Summary measures in Table 5-7 provide a broad-scale quantitative summary of development patterns within shoreline jurisdiction. Relatively broad primary structure setbacks are present through most of the unincorporated County shorelines; however, non-primary structure alterations generally occur within much closer proximity to the shoreline. The average width of functional vegetation is highly varied by reach, and this metric may be particularly helpful to inform appropriate vegetation conservation policies in the SMP.

Table 5-7. Setback and vegetated width summary by Reach

| Reach | Distance between OHWM and Closest Non-primary Structure/Alteration | | Distance between OHWM and Closest Point of Primary Structure | | Approximate Average Distance between OHWM and Upland Edge of Functional Vegetation | |
|---|---|---|---|---|---|---|
| | Average | Median | Average | Median | Average | Median |
| **Columbia River** | | | | | | |
| **C1- Crow Butte Park** | 80* | 80* | -- | -- | 153 | 200 |
| **C2- Lake Umatilla** | 19 | 27 | 88* | 88* | 116 | 60 |
| **C3- UNWR** | 99 | 70 | -- | -- | 343 | 175 |
| **C4- Plymouth Ag** | 26 | 20 | 18* | 18* | 329 | 200 |
| **C5-Plymouth** | 47 | 42 | -- | -- | 250 | 200 |
| **C6- McNary** | 23 | 20 | 42* | 42* | 64 | 48 |
| **C7- Columbia Ag** | 97 | 125 | -- | -- | 284 | 150 |
| **C8- Hover** | 11 | 5 | -- | -- | 147 | 125 |
| **C9-Finley Industrial** | 19 | 5 | 124* | 124* | 35 | 15 |
| **C10- Two Rivers (Park)** | 56 | 56 | -- | -- | 433 | 500 |
| **C10- Two Rivers (Residential)** | 23 | 22 | 104 | 100 | 30 | 27 |
| **C11- North Finley** | 0 | 0 | 299 | 275 | 0 | 0 |
| **C12- Kennewick UGA** | 0* | 0* | 429* | 429* | 0* | 0* |
| **C13- North Richland UGA** | 21 | 20 | 182* | 182* | 97 | 100 |
| **C14- Hanford** | 91* | 91* | -- | -- | 200* | 200* |
| **C15- Priest Rapids** | 98 | 53 | -- | -- | 225 | 175 |
| **Yakima River** | | | | | | |
| **Y1- Richland UGA** | 84 | 82 | 115 | 119 | 92 | 102 |
| **Y2- Riverside** | 47 | 47 | 112 | 117 | 61 | 63 |
| **Y3- Barker** | 32 | 29 | 244* | 244* | 140 | 88 |
| **Y4- Harrington** | 74 | 22 | 228 | 108 | 110 | 78 |
| **Y5- Horn Rapids** | 33 | 23 | 406* | 406* | 131 | 58 |
| **Y6- River Road** | 47 | 37 | 540 | 510 | 81 | 50 |
| **Y7- Benton City UGA** | 50 | 40 | 494* | 494* | 77 | 50 |
| **Y8- OIE** | 82 | 59 | 167 | 113 | 144 | 92 |
| **Y9- Prosser UGA East** | 82* | 82* | -- | -- | 136* | 136* |

| Reach | Distance between OHWM and Closest Non-primary Structure/Alteration | | Distance between OHWM and Closest Point of Primary Structure | | Approximate Average Distance between OHWM and Upland Edge of Functional Vegetation | |
|---|---|---|---|---|---|---|
| | Average | Median | Average | Median | Average | Median |
| **Y10- Prosser UGA Chandler** | 32 | 48 | -- | -- | 81 | 88 |
| **Y11- Prosser UGA West** | 24 | 18 | 287 | 183 | 39 | 22 |
| **Y12- Byron Road** | 71 | 55 | -- | -- | 82 | 57 |

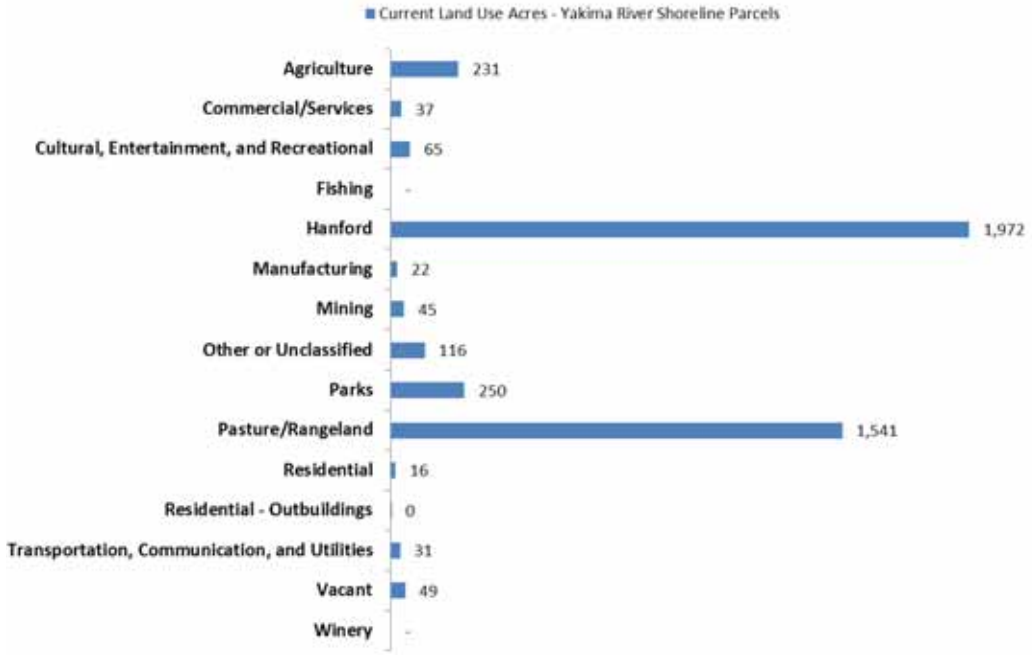
All measurements reported in feet.
* Indicates fewer than 3 parcels available to generate summary metric.

# 6 LAND USE ANALYSIS

## 6.1 Columbia River

### 6.1.1 Current Land Use

Based on Benton County Assessor information for parcels within or touching shoreline jurisdiction, the majority of land along the Columbia River is used for Hanford federal purposes, or as pasture/rangeland, agriculture and parks (Figure 6-1).




Source: Benton County Assessor, The Watershed Company, and BERK 2012

Figure 6-1. Current Land Use Acres – Columbia River Shoreline Parcels

***Water-Oriented Uses***

Along the Columbia River, water-dependent uses include the McNary Dam, docks and barges supporting agricultural and industrial transport, and recreational boat launches. Wastewater outfalls are located in populated areas (e.g. cities) or in association with industry, including Hanford.

Water-related uses include hydroelectric production, irrigation pumping stations, and canals and ditches supporting agricultural operations and domestic water supplies. Future water-related uses may include water withdrawal, such as for the Yakima Basin Integrated Water Resource Management Plan, which contemplates significant future water withdrawal from the Columbia River to be pumped into the Yakima basin. Potential withdrawal sites include the Vernita reach (C15 – Priest Rapids) of the Columbia River.

Water-enjoyment uses are varied and include parks and open space, trails, and camping facilities. See Section 6.1.4, Existing and Potential Public Access, below.

***Transportation and Utilities***

Transportation facilities in unincorporated Benton County include a network of state and County roads and railroads. Goods and materials are also shipped along the Columbia River. Road and railroad bridges connect Benton County to Franklin County and Umatilla, Oregon. There is about 1.9 miles of trails, which is only about 1% of the length of the Columbia River shoreline in unincorporated Benton County.

Interstate freeways include highways 82 and 182. State routes include State Routes (SR) 14, 22, 24, 221, 224, 225, 240, 395 and 397. Bridges cross the Columbia River on SR 24 (Vernita), I-82, I-182 and SR 395 (Pioneer Memorial Bridge), and SR 397 (Benton-Franklin Intercounty Bridge). Major collectors and minor arterials connect to federal and state highways and to local roads. County roads also provide access to agricultural, industrial, commercial, and residential areas along the Columbia River. I-82 and SR 14 are designated as State Scenic and Recreational Highways (Benton Franklin Council of Governments 2011).

Railroad service includes the BNSF Railway, which runs along the Yakima River in part, and turns at the Columbia River serving Finley, Plymouth, Paterson and other south county lands. The Tri-City short haul railroad serves Hanford from Richland. The Central Washington short-haul railroad serves western Benton County and handles

various agricultural and chemical products on former BNSF and Union Pacific lines, interchanging with BNSF at Yakima, Toppenish, and Gibbon (Benton Franklin Council of Governments 2011).

The Columbia River serves as an inland commercial waterway, and the navigation channel is maintained for bulk commodity transportation. In addition to the Port of Benton facilities at Richland, barges can be loaded and unloaded at facilities in Kennewick and Finley. Agricultural products are also shipped from privately owned docking facilities located at grain storage and industrial sites (Benton County 2008).

Other transportation services include transit operated by Ben Franklin Transit, bicycle routes, and trails. Non-motorized transportation is discussed under Existing and Potential Public Access below. Public airports are located in the Cities of Richland, Kennewick, and Prosser outside of shoreline jurisdiction.

Utility systems along the Columbia River include (Benton County 2008; MRSC 2012):

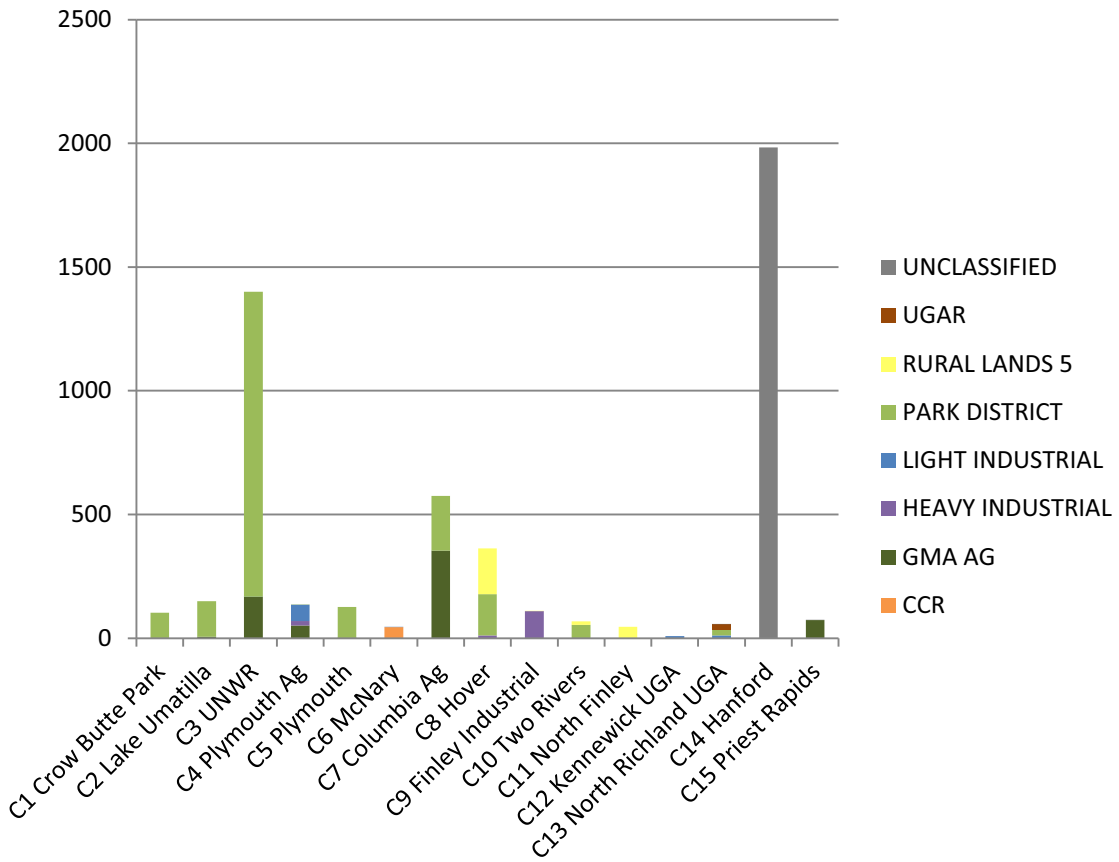
- Water systems (e.g. Plymouth Water District);
- Electrical power including transmission lines crossing the Columbia River at the North Finley and Crow Butte Park reaches;
- Natural gas lines such as in the UGAs and Finley area;
- Communication towers, particularly along the river in south Benton County in reaches C1 to C7; and
- Irrigation facilities such as those associated with the Columbia Irrigation District and Kennewick Irrigation District.

### 6.1.2 Future Land Use

***Columbia River as a Whole***

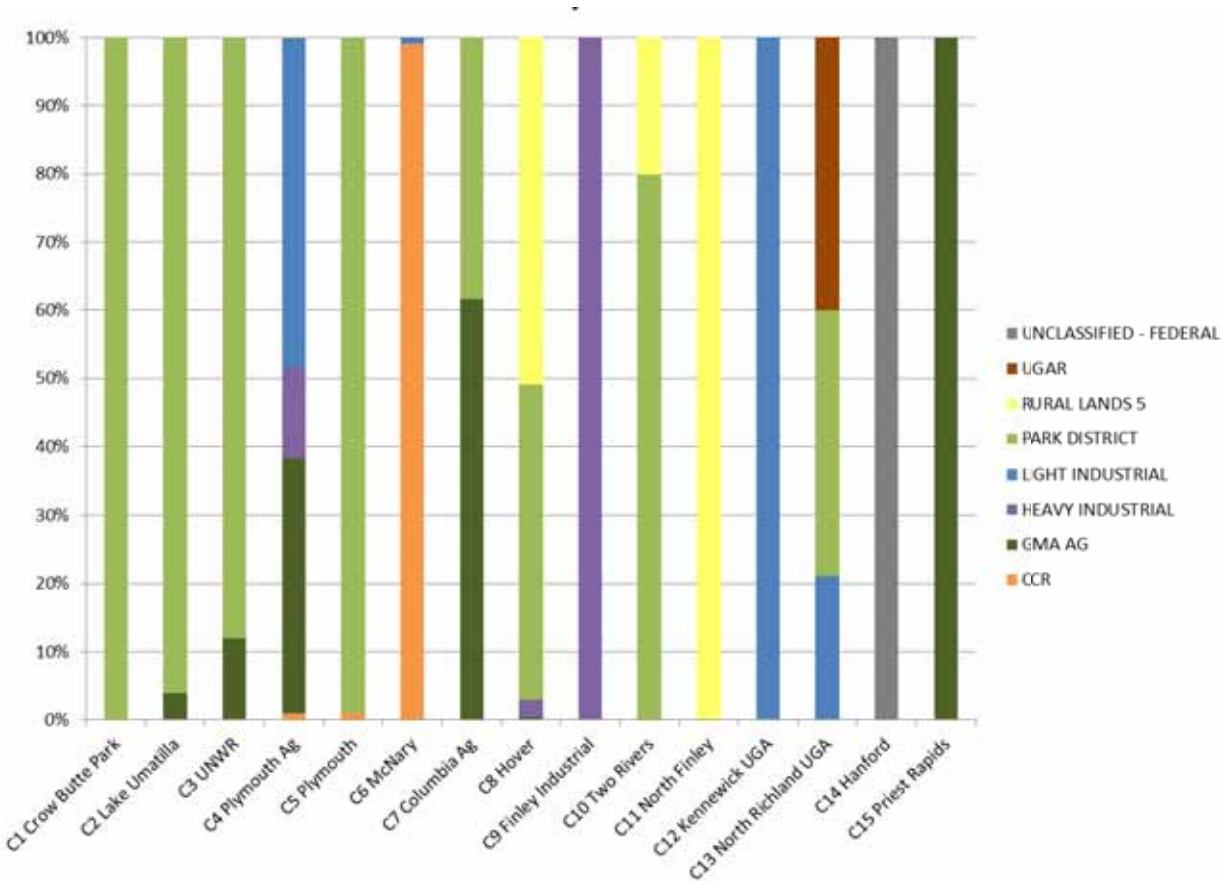
A majority of the Columbia River shoreline is designated as GMA Agricultural (Growth Management Act Agriculture) and Public in the Comprehensive Plan, with other areas designated as Rural Lands 5, Light Industrial, Heavy Industrial, and Urban Growth Areas immediately adjacent to cities. Implementing zoning largely matches this pattern, with more varied zones in the UGAR/mixed zone in the Urban Growth Areas.

Figure 6-2 shows zoned acres by shoreline reach, and Figure 6-3 shows the percentage of reaches in different zoning districts. The largest number of acres is zoned as Unclassified and applies to the Hanford Reach. Outside of this area, shoreline acres tend to be Park District or GMA Agricultural.




Note: CCR = Community Center Residential, UGAR = Urban Growth Area Residential, GMA AG = Growth Management Act Agriculture
Source: Benton County, The Watershed Company, and BERK 2012

Figure 6-2. Columbia River zoned acres by Reach.




Note: CCR = Community Center Residential, UGAR = Urban Growth Area Residential, GMA AG = Growth Management Act Agriculture
Source: Benton County, The Watershed Company, and BERK 2012

Figure 6-3. Columbia River zoning district percentage by Reach.

Relatively less land along the Columbia River is vacant or able to be further subdivided compared to developed property or land with a particular use or activity. However, some growth is possible. To forecast growth, a land capacity analysis prepared for this Shoreline Analysis Report inventoried vacant property and assumed a 30% discount for roads, public purposes (e.g. stormwater), and critical areas, and application of zoned densities in residential areas and an industrial floor area ratio of 40%. This Report also considers whether land that is two times larger than the minimum lot size of the zone could be subdivided.

There are about 21 vacant parcels equaling 178 acres, though only 47 acres is in shoreline jurisdiction. About 10 parcels are zoned for industrial use in reaches C8 (Hover) and C9 (Finley Industrial), and 11 parcels are zoned for residential use (CCR, Rural Lands 5, or GMA Agricultural where residential is allowed as a secondary use) in reaches C5 (Plymouth), C10 (Two Rivers), and C11 (North Finley). A land capacity analysis of the

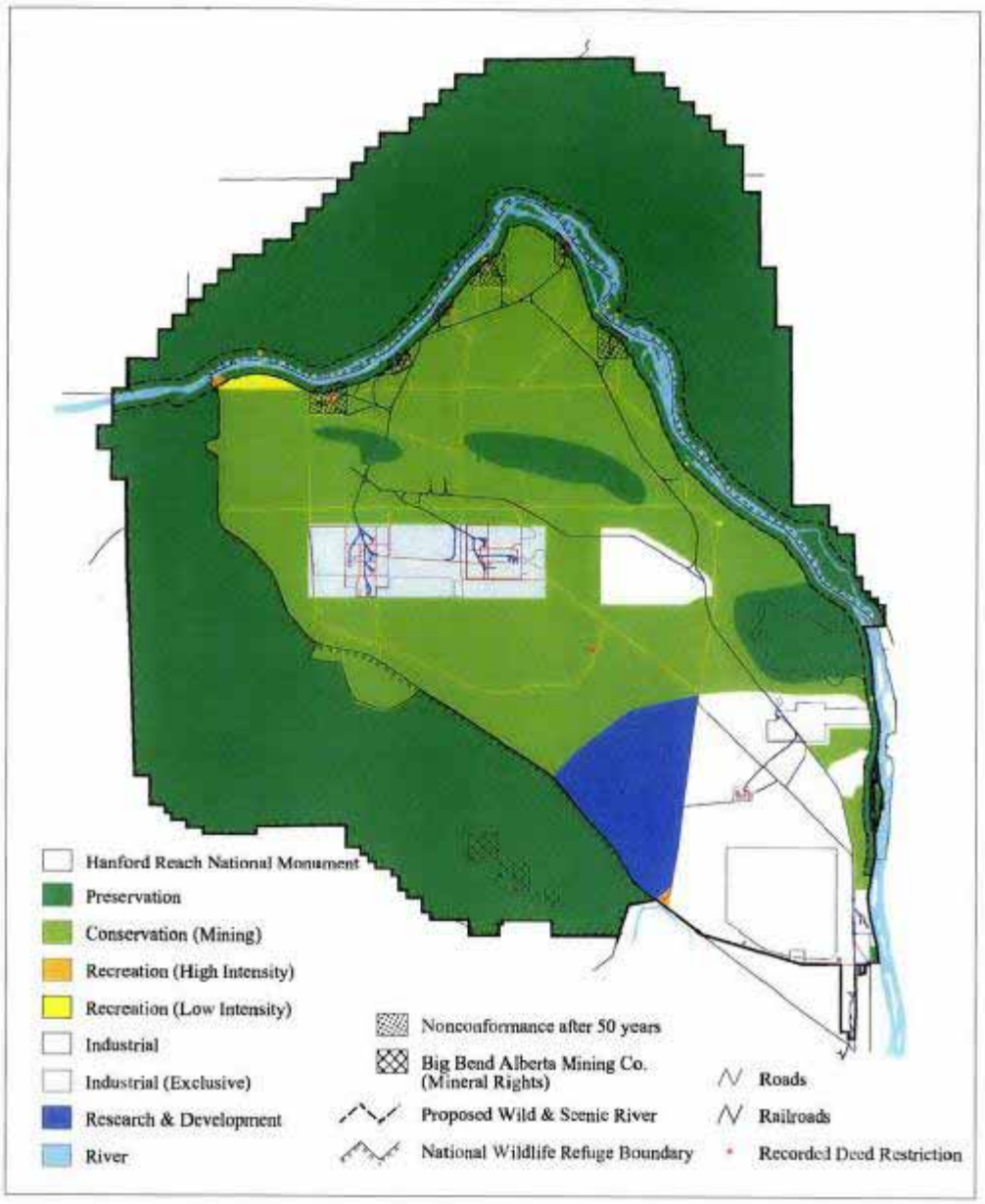
vacant parcels shows a potential for between one and five homes and 500,000 to 1.5 million square feet of light and heavy industrial space. The lower numbers represent capacity just within shoreline jurisdiction and the larger numbers represent development on whole parcels (land within and immediately outside jurisdiction). The available vacant land is more likely found in industrially zoned areas such as in Reaches C8 (Hover) and C9 (Finley Industrial). Some percentage of property owners would not be interested in developing during the planning period (this is considered a market factor), and, if so, even less development could be possible on vacant lands.

There is also a potential for some residentially zoned land to be further subdivided, potentially allowing about 20 to 455 single-family dwellings, with the smaller number potentially occurring in shoreline jurisdiction and the larger number representing dwellings both within and immediately adjacent to shoreline jurisdiction. Most land that could be further subdivided is in Reaches C3 (UNWR), C7 (Columbia Ag) and C8 (Hover). Again, due to market factors, it is possible that less land would be subdivided.

In total, with housing on vacant and subdividable lots and a household size of 2.67 consistent with the U.S. Census estimates (2006-2010), it is possible that there could be up to 1,228 additional persons on lots within or touching shoreline jurisdiction, and only about 56 persons in shoreline jurisdiction.

***Hanford Reach***

A Comprehensive Land Use Plan has been developed for the Hanford site by the U.S. Department of Energy. It was evaluated in an Environmental Impact Statement (EIS) in 1999 and a revised record of decision was issued in 2008. The land use plan as presented in the 2008 documentation is shown in Figure 6-4. The future land use pattern promotes preservation and conservation, research and development, and industrial. Some focused areas of recreation are also anticipated, such as along the Columbia River at the Vernita Terrace. About 125 acres are planned for high intensity recreation (some concepts explored in the EIS included a museum, golf course, and RV park) and 334 acres are planned for low-intensity recreation (examples studied in the EIS included sport fishing and day-use activities).




Source: U.S. Department of Energy, 2008

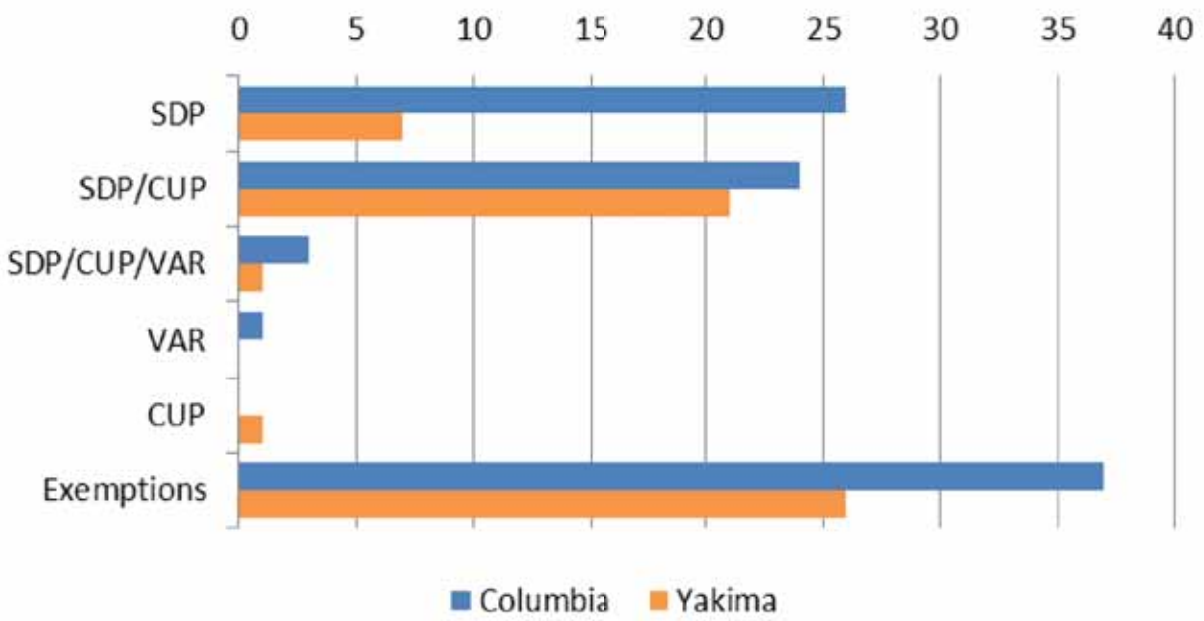
Figure 6-4. Hanford Site Comprehensive Land Use Plan Map

### 6.1.3 Shoreline Permit History

Figure 6-5 illustrates the results of a 40-year shoreline permit review. The analysis shows the following permits and exemptions were allowed under the current County Shoreline Management Master Plan along the Columbia River:

- 37 Shoreline Exemptions for activities such as maintenance and repair of docks, bridges, parks, as well as installation of irrigation systems, and fish habitat enhancement
- 26 Shoreline Substantial Development Permits (SDPs) for a variety of activities including pumping plants, dredging, docks, a parks administration complex, and utility installation
- 24 combined SDP/Conditional Use Permits for communication towers, an industrial park, recreation facility, boat ramp, pipelines, in-water work such as dam turbine, dolphins and more
- 3 combined SDP/Conditional Use/Variance Permits for an interstate bridge installed by WSDOT, an ethyl alcohol plant, and communication tower
- 1 variance for an interstate bridge installed by WSDOT

Over the 40-year review period, there have been relatively few permits each year, and usually no more than four in any year.




Note: SDP = Shoreline Substantial Development Permit, CUP = Shoreline Conditional Use Permit, VAR = Shoreline Variance
Source: Benton County, BERK 2012

Figure 6-5. Shoreline Permit History – Columbia and Yakima Rivers 1972-2012

### 6.1.4 Existing and Potential Public Access

Existing public access along the Columbia River in unincorporated Benton County includes over 5,400 acres of parks and open space of which about 4,100 are in shoreline

jurisdiction, more than 10,000 linear feet (1.9 miles) of trails, and campgrounds at Crow Butte Park and Plymouth Park.

***Parks and Open Space***

Parks and open space along the Columbia River includes the Hanford Reach, Two Rivers Park (County 159 acres), Hover Park (County 175 acres), Wallulla Gap Preserve (County 110 acres), Plymouth Park (Corps), the Umatilla National Wildlife Refuge (UNWR), McNary National Wildlife Refuge (McNary NWR), and Crow Butte Park. Outside of the Hanford Reach, the largest acreage is for the Umatilla National Wildlife Refuge.

Table 6-1 lists the current parks and recreation acres by ownership and reach.

Table 6-1. Parks and open space acres by Reach – Columbia River

| Reach Number | Reach Name | Park and Open Space Acres Ownership | Park and Open Space Acres in Jurisdiction |
|---|---|---|---|
| C1 | Crow Butte Park | Federal | 65.2 |
| C1 | Crow Butte Park | Other | 91.8 |
| C2 | Lake Umatilla | Federal | 29.8 |
| C2 | Lake Umatilla | Other | 13.8 |
| C3 | UNWR | Federal | 1,475.2 |
| C3 | UNWR | Other | 0.3 |
| C3 | UNWR | Private | 0.7 |
| C4 | Plymouth Ag | Federal | 0.1 |
| C5 | Plymouth | Federal | 84.6 |
| C5 | Plymouth | Other | 53.4 |
| C6 | McNary | Federal | 43.3 |
| C6 | McNary | Other | 10.6 |
| C7 | Columbia Ag | Federal | 258.4 |
| C8 | Hover | County | 84.2 |
| C8 | Hover | Federal | 154.8 |
| C10 | Two Rivers | County | 20.0 |
| C10 | Two Rivers | Federal | 51.2 |
| C11 | North Finley | County | 0.1 |
| C13 | North Richland UGA | Federal | 55.2 |
| C14 | Hanford | Federal | 1,983.6 |
| C15 | Priest Rapids | Federal | 37.8 |

Source: The Watershed Company 2012

***Recreation: Boat Launches and Trails***

The boat launches are found in the following reaches and parks:

- C1 Crow Butte Park
- C2 Lake Umatilla (primitive launch at Paterson)
- C5 Plymouth (at Plymouth Park)
- C6 McNary
- C10 Two Rivers (Two Rivers Park)

Trails are found in four reaches:

- C8 Hover, South of Kennewick Trails
- C10 Two Rivers, South of Kennewick Trails
- C11 North Finley, South of Kennewick Trails
- C12 Kennewick UGA, South of Kennewick Trails

Trails are not continuous on the Columbia River, likely due to land use, security, location of railroads, and presence of environmentally sensitive features.

***Future Public Access***

The County Parks Comprehensive Plan identifies several future improvements at existing shoreline parks, including:

- Hover Park: Control access. Develop a park master plan that considers, water access, primitive camping options, Columbia water trail stop-over, bathroom facilities, small boat access, parking and trail head, and interpretive signage.
- Two Rivers Park: This park is described as having opportunities for formal and passive recreation. The improved areas provide large expanses of grass for informal team sports, swimming, picnic areas, and boat launching. Unimproved areas provide for bird watching and relaxation and natural shoreline opportunities.
- Wallula Gap Preserve: The Benton County Comprehensive Parks Plan describes the preserve as difficult to access. The site serves as an aesthetic and view property from the Columbia River and the river corridor. Means to improve access are recommended such as through easements or other options.

Other desirable improvements include working with the City of Kennewick to develop a trail that connects Columbia Park to Two Rivers Park and on to Hover Park (Policy 2.10).

The 20-year capital improvement program in the Comprehensive Parks Plan identifies several proposed projects including:

- Years 2012-16: Hover Park Master Plan and Improvements
- Years 2012-16: Hover Park Controlled Access
- Years 2012-16: Two-Rivers Park and Trail design
- Years 2016-28: Columbia River Trail (Kennewick, Two-Rivers Park, Hover Park)

Another policy includes that the County should "assist in the development of a Yakima and Columbia River water trail system with pullouts and stopping points within riverfront parks" (Policy 1.6). Hover Park is identified as a potential stop on the water trail.

After completing a planning grant, WDFW received a Boating Facilities Grant from the Washington State Recreation and Conservation Office (RCO) to improve the Paterson Boat Launch. According to an RCO web map, this project is in progress and "will allow WDFW to fully develop this site by installing a new boat ramp, concrete abutment and loading float. A new road approach, concrete vault toilet, ADA paved parking pad, pathways and an ADA loading platform will also be installed. The primary recreation opportunity provided by the project will be recreational boating."

Potential Population and Future Tourism DemandFuture population growth would be limited along the Columbia River shoreline in unincorporated Benton County as described above.

Tourism is currently limited on the Columbia River within the unincorporated shoreline jurisdiction by the limited recreation opportunities. However, in addition to County parks plans described above, long-range planning for the Hanford Reserve includes accommodation for limited tourism and recreational access to the Columbia. The degree of tourism will depend on the types of services and amenities made available. The 1999 Final Hanford Comprehensive Land-Use Plan EIS estimated a net increase in recreational spending of $1.4 million per year (assumes a golf course, RV park, and museum among other uses); however, the portion of spending that would be represented by tourism versus local use was not described. Current estimates of recreation spending and tourism projections are not available.

### 6.1.5 Historic and Archeological Sites

The Columbia River has been used for centuries for fish, hunting, and transport by native tribes. As European settlers arrived resource-based agriculture and mining became more prevalent and there was greater interest to transport products by River. Between 1930 and 1970, sections of the Columbia River were dammed to promote navigation, irrigation, and power. The McNary Dam was constructed in 1957. In 1943,

the Hanford Nuclear Reservation of approximately 600 square miles in size was established by the U.S. Government for the purposes of developing a nuclear bomb.

A number of historic and archaeological sites are along the Columbia River. The Hanford B reactor has been designated on the National and State register. There are also several archaeological sites such as the Hanford Island Archeological Site, the Hanford North Archeological District, and a number of other archaeological districts along the River.

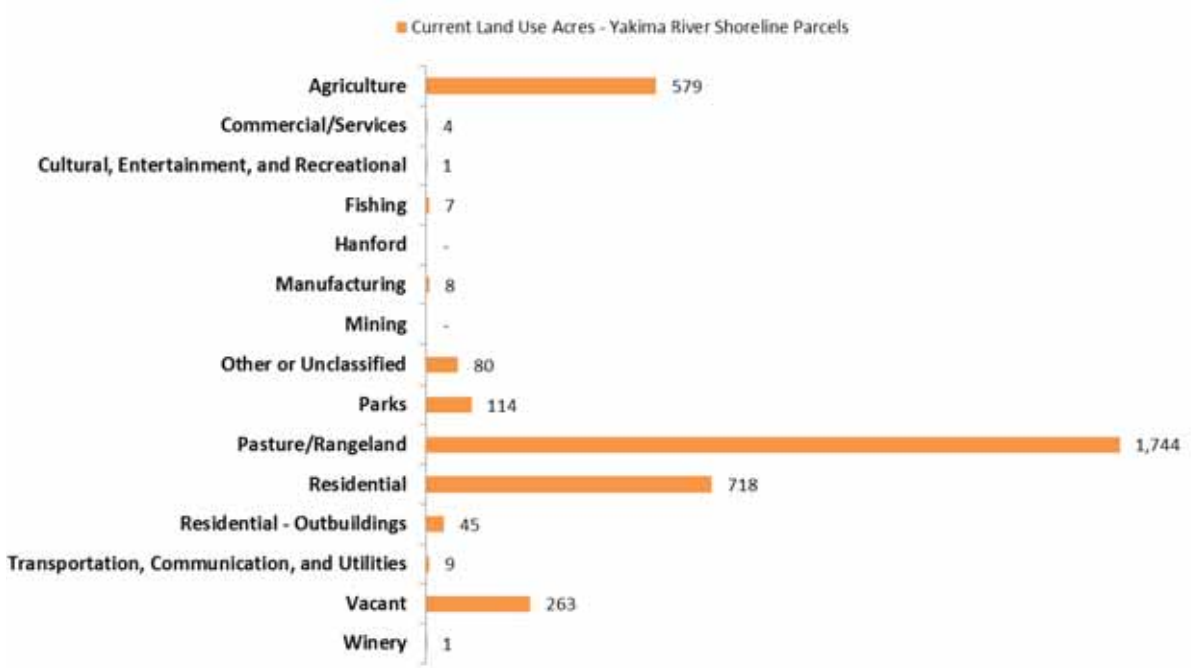
Other sites inventoried in or near shoreline jurisdiction include, but are not limited to:

- The Wallula/Hover Ferry Site now under water in the vicinity of Hover
- Kennewick Railroad Bridge spanning the Columbia River
- BN Railroad Depot in Plymouth
- Crossing Towers, Pasco-Kennewick Transmission Line Columbia River

## 6.2 Yakima River

### 6.2.1 Current Land Use

Yakima River shoreline parcels, within and touching shoreline jurisdiction, tend to be pasture/rangeland and agriculture similar to the Columbia River, but there is more residential and vacant land along the Yakima River and less park land than along the Columbia River (Figure 6-6).




Source: Benton County Assessor, The Watershed Company, and BERK 2012

Figure 6-6. Current land use acres – Yakima River shoreline parcels.

### *Water-Oriented Uses*

Along the Yakima River, water-dependent uses include a recreational boat launch at Horn Rapids County Park (note: the portion on State-owned aquatic lands is not under DNR agreement), dams at Horn Rapids and Prosser, wastewater outfalls, and fish screens on diversion pumps (Benton County 2012).

Water-related uses include irrigation pumping stations and a discharge channel and settling pond installed by the Yakama Indian Nation Fisheries Program (Benton County 2012).

Water enjoyment uses include parks and open space, a boat launch, and trails. See Existing and Potential Public Access below.

### *Transportation and Utilities*

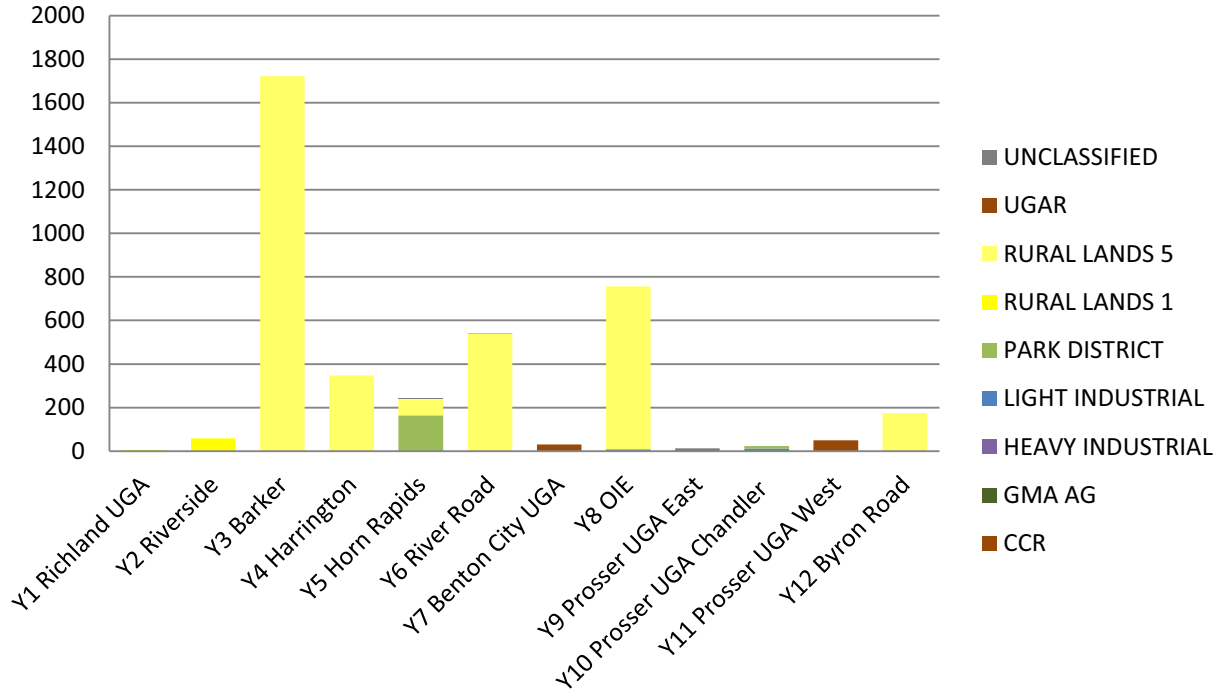
Major interstate and state routes crossing the Yakima River or along the river include SR 22, I-82, SR 224, SR 225, and SR 240. County roads crossing the Yakima River or within shoreline jurisdiction include, but are not limited to, OIE (Old Inland Empire) Highway, Twin Bridges Road, Harrington Road, Riverside Drive, Byron Road, North River Road, Demoss Road, and Benton City Road.

Utilities within shoreline jurisdiction would include water systems, electrical power systems such as the Ashe-Slatt Transmission Line crossing west of Benton City, natural gas lines such as in the Prosser vicinity, fiber optic cables along the Yakima River near Prosser, and several irrigation district facilities (e.g. Roza Irrigation District).

### 6.2.2 Future Land Use

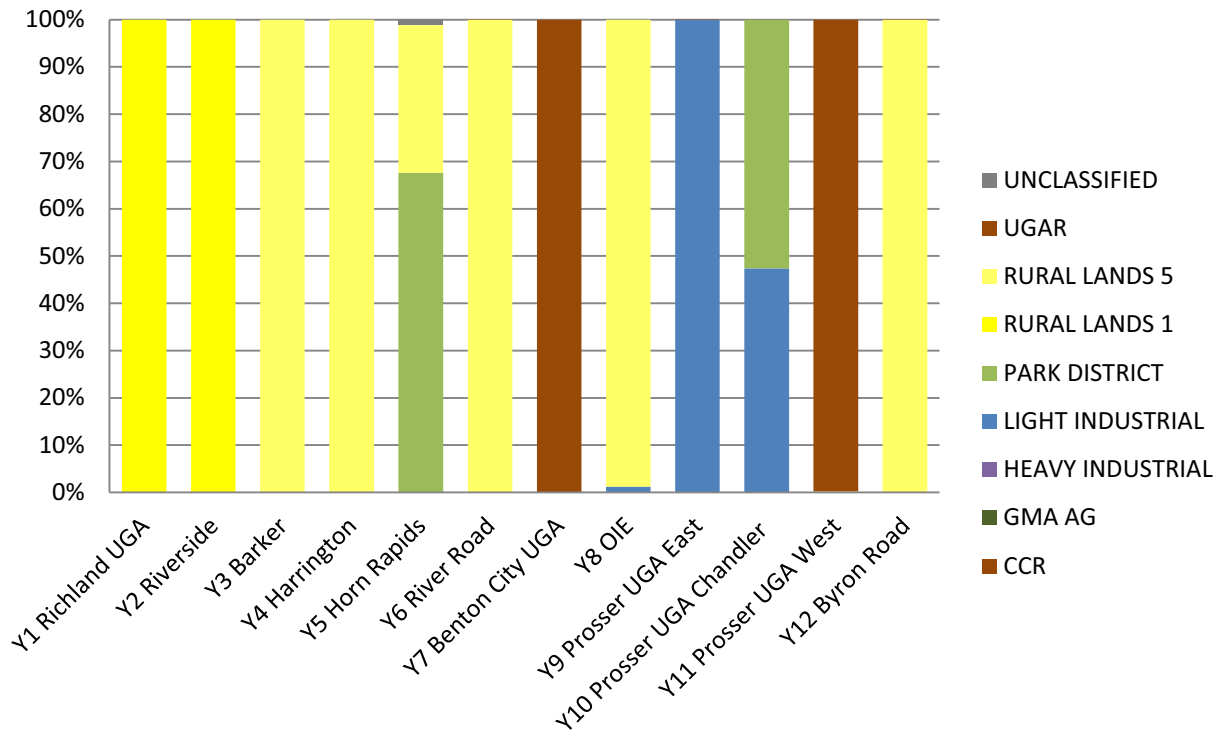
A majority of the Yakima River shoreline is designated as Rural Lands 5 in the Comprehensive Plan, with other areas designated as Open Space Conservation, Rural Lands 1, GMA Agricultural, and Urban Growth Area immediately adjacent to cities. Implementing zoning largely matches this pattern, with more detailed zones in the Urban Growth Areas and with Rural Lands 5 implementing Open Space Conservation.

Figure 6-7 shows zoned acres by shoreline reach and Figure 6-8 shows the percentage of reaches in different zoning districts. Prevalent categories are Rural Lands 5 and Rural Lands 1, but the reaches have different characteristics with some focused on Parks, Light Industrial, or Urban Growth Area Residential.




Note: CCR = Community Center Residential, UGAR = Urban Growth Area Residential, GMA AG = Growth Management Act Agriculture
Source: Benton County, The Watershed Company, and BERK 2012

Figure 6-7. Yakima River zoned acres by Reach.




Note: CCR = Community Center Residential, UGAR = Urban Growth Area Residential, GMA AG = Growth Management Act Agriculture
Source: Benton County, The Watershed Company, and BERK 2012

Figure 6-8. Yakima River zoning percentage by Reach.

There are approximately 620 vacant acres (150 acres in shoreline jurisdiction), as well as land that could be further subdivided along the Yakima River. This shows a higher potential for new growth than the Columbia River, which had far less land available for new development or redevelopment.

Using similar assumptions as noted in the Columbia River analysis, a land capacity analysis of 150 vacant parcels shows a potential for between 118 and 260 single-family dwellings. The lower number represents capacity just within shoreline jurisdiction and the larger number represents development on whole parcels (land within and immediately outside jurisdiction). The available vacant land is more likely found in Reaches Y4 (Harrington), Y6 (River Road), Y8 (OIE), and Y12 (Byron Road). It is likely that some property owners would not wish to develop their vacant parcels over the planning period, in which case, the development capacity would be reduced.

There is also a potential for some land used for residential purposes to be further subdivided, particularly in Reaches Y3 (Barker), Y4 (Harrington) and Y8 (OIE). If

subdivision occurred consistent with zoning densities, there would be between 134 and 2,573 single-family dwellings, with the smaller number occurring in shoreline jurisdiction and the larger number representing dwellings both within and immediately adjacent to shoreline jurisdiction. It should be noted that land that can be further subdivided was discounted by 100% in Reach Y3 (Barker) within shoreline jurisdiction, and 50% outside of shoreline jurisdiction, due to the larger wetlands, floodway, and floodplain areas. Barker Ranch properties that have conservation easements were not included. Again, market factors may reduce the overall level of subdivision activity.

Based on the housing estimates above and using a 2.67 household size from the 2010 U.S. Census, the added population would equal about 3,168 persons total, with about 673 in shoreline jurisdiction.

### 6.2.3 Shoreline Permit History

Similar to the Columbia River, shoreline permits along the Yakima River over the past 40 years have addressed a variety of activities with only a few permits in any one year (see Figure 6-5 above):

- 26 Shoreline Exemptions for a variety of activities such as cable and bridge replacements, fish screens on diversion pumps, pump stations, maintenance dredging, and fish habitat enhancement
- 7 SDPs for roads, pumping stations, utility crossing, and a residential short plat
- 21 combined SDPs/Conditional Use Permits for parks, road widening, bridges, and utility installations
- 1 combined SDP/Conditional Use/Variance Permit for an interstate bridge installed by WSDOT
- 1 Conditional Use Permit for a buried cable across the river

### 6.2.4 Existing and Potential Public Access

Existing public access includes parks and open space totaling approximately 1,600 acres with 123 acres located in shoreline jurisdiction, a boat launch at Horn Rapids County Park, and trails, existing and planned along the Tapteal Greenway.

#### *Parks and Open Space*

Existing parks and open space along the Yakima River include Horn Rapids Park and Rattlesnake Mountain Shooting Facility. There is other state and federal ownership along the river as well (Table 6-2).

Table 6-2. Parks and open space acres by Reach – Yakima River.

| Reach Number | Reach Name | Ownership | Acres in Jurisdiction |
|---|---|---|---|
| Y1 | Richland UGA | Federal | 4.0 |
| Y2 | Riverside | Federal | 0.1 |
| Y5 | Horn Rapids | County | 92.9 |
| Y5 | Horn Rapids | Federal | 7.4 |
| Y5 | Horn Rapids | Other | 115.2 |
| Y5 | Horn Rapids | State | 5.9 |
| Y6 | River Road | Federal | 4.6 |
| Y8 | OIE | State | 21.7 |

Source: The Watershed Company, 2012

***Recreation: Boat Launches, Fishing Access, and Trails***

There is one boat launch at Horn Rapids County Park. In addition, there are several WDFW water access points in unincorporated areas or in abutting cities, such as at Prosser, Benton City, Snively Road (at border with West Richland), Hyde Road (City of Richland), and Duportail Road (City of Richland).

Currently, there is trail access along the Yakima River at Horn Rapids County Park. There is a plan that would result in 4.4 miles of trails in shoreline jurisdiction following the Tapteal Greenway Trail. The Tapteal Greenway would provide a recreational and natural/wildlife corridor across the County, linking major public lands such as Horn Rapids Park to Columbia Point. Benton County's Comprehensive Plan Parks and Recreation Element considers the Tapteal Greenway Plan. In addition, Benton County's Parks Comprehensive Plan includes Policy 1.11, "Continue to support the efforts of the Tapteal Greenway Association to complete the Tapteal Greenway Trail, five miles of which go through the Horn Rapids Park." As with the Columbia River, the County wishes to have a water trail along the Yakima River with pullouts at riverfront parks (Policy 1.6). The County's 20-Year Capital Improvements Program does not identify particular trails along the Yakima River, but does include a Horn Rapids Master Plan Update and Improvements.

The Red Mountain American Viticultural Area Master Site Plan was prepared for Benton County and shows potential trail concepts along the Yakima River between Benton City and West Richland (Benton County 2006). This plan has not been implemented, but rather shows potential recommendations for agri-tourism uses and associated recreational support. See Figure 6-9 for a conceptual map.

The U.S. Congress authorized the Ice Age Floods National Geologic Trail in 2009, which would provide interpretive facilities regarding the Glacial Lake Missoula Floods that impacted the Northwest more than 12,000 years ago. The trail would extend from

Yakima County through Benton County along the Yakima River and continue through Franklin County (Ridges to Rivers Open Space Network Steering Committee 2011).

Based on informal use patterns, there is demand for formal river access in Reach Y3 (Barker). News reports in Summer 2012 note persons wanting to float the river ignoring "private property" and "no parking" signs and accessing near Twin Bridges and the Van Giesen bridges (Tri-City Herald, July 22, 2012).

It is expected that additional locations of public access opportunities will be identified through the SMP visioning process in the first part of 2013.

Source: Benton County 2006

Figure 6-9. Red Mountain American Viticultural Area Master Site Plan

### *Potential Population and Tourism Demand*

In addition to the increased demand generated by additional housing within current land use capacity, there may be additional public access demand associated with tourist activity. The Red Mountain American Viticultural Area conceptual plan projects a 2% annual increase in visitation resulting in approximately $1.5 million annual visitors by

2025. The amount and rate of tourism growth will depend on many factors, as each different development scenario has different impacts on tourism.

#### 6.2.5 Historic and Archeological Sites

The Yakima River is named for the native Yakama people. Historic structures have been designated or inventoried largely in the settled communities of Prosser and Benton City, though there are also some scatted barns and other facilities away from the river. It is likely that archaeological sites are located along the river, though it has been altered for agricultural and other purposes. Additional planning level cultural resources information is being requested through the Yakama Nation.

# 7 SHORELINE MANAGEMENT RECOMMENDATIONS

The following are recommended actions for translating inventory and characterization findings into the draft SMP policies, regulations, environment designations, and restoration strategies for areas within shoreline jurisdiction. In addition to the following analysis-specific recommendations, the updated SMP will incorporate all other requirements of the Shoreline Management Act (RCW 90.58) and the Shoreline Master Program Guidelines (WAC 173-26).

## 7.1 Environment Designations

As outlined in WAC 173-26-191(1)(d), "Shoreline management must address a wide range of physical conditions and development settings along shoreline areas. Effective shoreline management requires that the shoreline master program prescribe different sets of environmental protection measures, allowable use provisions, and development standards for each of these shoreline segments." In WAC 173-26-211(2)(a), the Guidelines further direct development and assignment of environment designations based on "existing use pattern, the biological and physical character of the shoreline, and the goals and aspirations of the community as expressed through comprehensive plans…"

The County's current Shoreline Management Master Plan (http://www.co.benton.wa.us/docview.aspx?docid=10253) utilizes a system of four environment designations: Natural, Conservancy, Rural, and Urban. The shoreline environment designation map has not been modified since it was originally developed in 1974, and thus the environment designation assignments no longer provide the best

fit with the existing biological and land use character or the community's vision as expressed in the latest Comprehensive Plan. Further, the Hanford area was not assigned an environment designation due to State-wide misunderstanding of the applicability of the SMA to federal lands.

The Guidelines recommend use of six unique environments: Aquatic, Natural, Urban Conservancy, Rural Conservancy, Shoreline Residential, and High Intensity. Urban Conservancy, Shoreline Residential, and High Intensity are each intended by the Guidelines to be applied only in incorporated areas, UGAs, and intensely developed rural areas. However, each jurisdiction may use "alternative" environment designations, as appropriate, as long as they provide equal or better protection than the standard.

The findings of this Analysis Report would support development of several alternative designations to supplement the Guidelines system as follows:

- Consider development of an "Agriculture" designation to accommodate unique agricultural industrial activities (e.g. diversions), as well as recognize the community's economic and cultural connection to this important land use.
- Consider application of "Shoreline Residential" environment to residential lands in the County both inside and outside of UGAs. This would facilitate development of environment designation-specific residential standards and increase clarity and usability for residents of the County.
- Consider development of a "Hanford" designation.
- Consider development of a "Shoreline Parks" designation that might facilitate implementation of parks and recreation management plans.

## 7.2 General Policies and Regulations

### 7.2.1 Archaeological and Historic Resources

The findings of this Shoreline Analysis Report do not suggest a need for additional regulations beyond those mandated by the SMP Guidelines.

### 7.2.2 Critical Areas

The County should consider whether the County's critical areas regulations (Title 15 Critical Areas and Resources), should be incorporated into the SMP by reference or through direct inclusion. The latter method is generally recommended, particularly when the critical areas regulations have not been updated recently and thus may require considerable revision to meet the most current scientific standards as mandated by

WAC 173-26-201(2)(a). Either method of incorporation will require modification of the County's critical areas regulations as it applies in shoreline jurisdiction to meet SMA criteria. For example:

- Any exceptions, such as reasonable use, will need to be removed as the appropriate SMA process for such action is through the Shoreline Variance.
- The critical areas regulations establish buffers for the Columbia and Yakima Rivers of 100 feet or "to the top of the bank where there is one that is 50' or more in height, as measured along its incline from the toe, with a slope of 5:1 or greater, and covered predominantly with native vegetation." These regulations will need to be revisited to assess if changes are needed to recognize existing shoreline conditions and to accommodate water-oriented and other preferred uses consistent with no net loss of ecological functions (as required by WAC 173-26-221(2)(a)(ii)). In particular, the County's existing stream buffers are not environment designation- or waterbody-based, which indicates that they may need to be further customized to accomplish these objectives.
- The wetlands regulations will need to be updated as well to specify use of the currently approved federal manual and supplements, the latest Ecology wetland rating system for Eastern Washington, and the latest science-based wetland buffers and mitigation ratios.
- Sand dunes cover approximately 12 square miles of the Hanford Reservation. This habitat is extremely sensitive to disturbance. The area is presently well-protected by federal regulations associated with the Hanford Site, but the area should be protected if access is ever provided to the Site.

### 7.2.3 Flood Hazard Reduction

- Levee systems are present in the Kennewick UGA, North Finley, Two Rivers, and Riverside reaches. These levees provide flood protection for existing infrastructure and development. Consistent with the WAC provisions in the Guidelines, the SMP should provide maximum flexibility for maintaining flood hazard reduction measures as needed to continue protection of existing uses.
- In areas throughout the Columbia and Yakima Rivers, roads and railroads form *de facto* dikes. Per WAC guidance, Benton County is encouraged to craft regulations that facilitate through incentives the removal of artificial restrictions to natural channel migration (on the Yakima River) and floodplain functions where feasible and appropriate. In determining feasibility, the action's relative public costs and public benefits should be considered in terms of both short- and long-term time frames.

### 7.2.4 Public Access

- Provide policies and regulations that recognize and facilitate implementation of existing County parks, recreation, and open space plans.
- Consider integration of regional plans by Tapteal Greenway and Ridges to Rivers, as well as the Ice Age Floods National Geologic Trails.
- Through visioning and other SMP outreach processes, identify other opportunities to improve public access, such as on land in federal ownership, which could add public access over the 20-year planning period (e.g. Hanford Reach).

### 7.2.5 Shoreline Vegetation Conservation

- Build on the existing protections provided in the County's critical areas regulations and current SMP, paying special attention to measures that will promote retention of shoreline vegetation, replacement of invasive vegetation with native vegetation, and development of a well-functioning shoreline which provides both physical and habitat processes.
- Ensure that vegetation provisions allow for appropriate modifications to accommodate preferred uses, particularly water-oriented uses and public access.
- Consider development of environment designation-specific and possibly waterbody-specific buffer and/or setback strategies that meet requirements for environmental protection and recognition of local conditions. Reach-based sampling of parcels' current primary structure setback, functioning vegetation width, and alteration location are presented in Table 5-7 in Section 5.3 above, and can be used to develop and evaluate different options.

### 7.2.6 Water Quality, Stormwater, and Nonpoint Pollution

- Consider incorporating regulations to facilitate maximum implementation of TMDL plans for DDT and turbidity in the lower Yakima River, and controlling introduction of 303(d)-listed pollutants for which TMDLs have not yet been prepared.
- Ensure that regulations allow for placement of water quality-related structures or facilities in shoreline jurisdiction.
- Consider adding clarifying statements noting that the policies of the SMP are also policies of the County's comprehensive plan and that the policies also apply to activities outside shoreline jurisdiction that affect water quality within shoreline jurisdiction. However, the regulations apply only within shoreline jurisdiction.

## 7.3 Shoreline Modification Provisions

### 7.3.1 Shoreline Stabilization

- Ensure "replacement" and "repair" definitions and standards are consistent with WAC 173-26-231(3)(a). Consider defining a replacement threshold so that applicants and staff will know when "repair" has been exceeded and additional "replacement" requirements need to be met.
- Otherwise, fully implement the intent and principles of the WAC Guidelines. Reference appropriate exemptions found in the WAC related to "normal maintenance and repair" and "construction of the normal bulkhead common to single-family residences." These are not exemptions from the regulations, however; they are exemptions from a Shoreline Substantial Development Permit.
- Give preference to those types of shoreline modifications that have a lesser impact on ecological functions. Policies and regulations should promote "soft" over "hard" shoreline modification measures. Consider requiring a Conditional Use Permit for any new hard shoreline stabilization, at least in certain environment designations.
- Incentives should be included in the SMP that would encourage modification of existing armoring, where feasible, to improve habitat while still maintaining any necessary site use and protection.

### 7.3.2 Piers and Docks

- Develop detailed dimensional and material standards for new piers and replacement/modified piers, customized for the Columbia River environment.
- Be consistent, to the extent practicable based on local conditions and requirements for no net loss, with Washington Department of Fish and Wildlife and U.S. Army Corps of Engineers design standards, WAC 332-30-144 regarding private recreational docks, and the McNary Shoreline Management Plan; recognize special local issues or circumstances.
- Recognize that there a variety of pier and dock types in the Columbia River system, with highly variable design requirements – from single-family residential dock to a barge-loading facility.

### 7.3.3 Fill

- Restoration fills can benefit shoreline functions and should be encouraged, including improvements to shoreline habitats, material to anchor LWD placements, and as needed to implement shoreline restoration.

- Fills waterward of the OHWM to create developable land should be prohibited, and should only be allowed landward of OHWM if not inconsistent with the requirement to protect shoreline ecological functions and ecosystem-wide processes.

#### 7.3.4 Breakwaters, Jetties, Groins and Weirs

- Consider prohibiting new breakwaters, jetties, groins, or weirs except where they are essential to restoration or maintenance of existing water-dependent uses.

#### 7.3.5 Dredging and Dredge Material Disposal

- Except for purposes of shoreline restoration, flood hazard reduction, and maintenance of existing legal moorage and navigation, consider prohibiting these modifications.
- Dredging for commercial sale of materials would be considered mining, addressed in Section 7.4.8, below.

#### 7.3.6 Shoreline Habitat and Natural Systems Enhancement Projects

- Consider incentives to encourage restoration projects, particularly in areas identified as having lower function. For example, allow modification of impervious surface coverage, density, height, or setback requirements when paired with significant restoration. Emphasize that certain fills, such as streambed or nearshore gravels or material to anchor logs, can be an important component of some restoration projects.

## 7.4 Shoreline Uses

#### 7.4.1 Agriculture

- Maintenance of existing agriculture is commercially and culturally important to Benton County. This should be recognized in shoreline policies.
- Consider a shoreline environment designation and associated regulations that addresses unique agricultural industrial activities (e.g. diversions).

#### 7.4.2 Aquaculture

- Ensure that any salmon recovery-related aquaculture activities are facilitated in the aquatic and appropriate upland environments.

#### 7.4.3 Boating Facilities

- Benton County includes a variety of commercial, public and private boating facilities, including port uses and community and park boat moorage and launching facilities. Regulations for the over- and in-water components should be developed to provide applicants with as much predictability as possible, while still allowing for an

appropriate amount of flexibility based on site-specific conditions and use-specific needs.

### 7.4.4 Commercial Development

- Recognize commercial uses and consider incentives to attract water-oriented uses in appropriate locations along the shoreline. There is minimal commercial use in unincorporated Benton County along the shorelines. Identify criteria for where future such uses may be appropriate.
- Support the Cities' efforts to provide for commercial development in their centers along the rivers.

### 7.4.5 Forest Practices

- This use is not found in Benton County. Recommend prohibiting it in Benton County.

### 7.4.6 Industry

- Recognize current industrial uses and consider incentives to attract water-oriented uses in appropriate locations along the shoreline.

### 7.4.7 In-stream Structural Uses

- Small and large-scale in-stream structures intended to produce energy and/or moderate flooding are found in Benton County. There are also a number of irrigation diversion and discharge structures in the Columbia and Yakima Rivers. Regulations need to accommodate anticipated new diversion structures, and repair/maintenance and possible expansion of existing projects. In particular, if studies of inter-basin water transfer indicate that in-stream structures would contribute to improved water quality and shoreline functions, such structures should be accommodated.

### 7.4.8 Mining

- Provide general policies and regulations for mining according to the SMP Guidelines. Clearly differentiate between upland and aquatic mining, and address recreational mining.

### 7.4.9 Recreational Development

- Include provisions for existing and potential recreational uses, including boating, swimming, and fishing.
- Work with local, state and federal parks and refuge officials to ensure consistency between shoreline policies and regulations and long-term parks management plans.

- Policies and regulations related to parks management should provide clear preferences for shoreline restoration consistent with public access needs and uses. Existing "natural" parks should be protected and enhanced.

#### 7.4.10 Residential Development

- Residential uses are particularly prevalent and planned along the Yakima River and would be a relatively less prevalent use on the Columbia River. Recognize current and planned shoreline residential uses with adequate provision of services and utilities as appropriate to allow for shoreline recreation and ecological protection.

#### 7.4.11 Transportation and Parking

- Allow for maintenance and improvements to existing roads and parking areas and for necessary new roads and parking areas where other locations outside of shoreline jurisdiction are not feasible.
- Address railroads.
- Promote additional trail connections consistent with local and regional plans.

#### 7.4.12 Utilities

- Allow for new, expanded, and maintained utilities with criteria for location and vegetation restoration as appropriate.

## 7.5 Restoration Plan

A Restoration Plan document will be prepared at a later phase of the Shoreline Master Program update process, consistent with WAC 173-26-201(2)(f). The Shoreline Restoration Plan will address the following six subjects (WAC 173-26-201(2)(f)(i-vi)) and incorporate findings from this Shoreline Analysis Report:

*(i) Identify degraded areas, impaired ecological functions, and sites with potential for ecological restoration;*

*(ii) Establish overall goals and priorities for restoration of degraded areas and impaired ecological functions;*

*(iii) Identify existing and ongoing projects and programs that are currently being implemented, or are reasonably assured of being implemented (based on an evaluation of funding likely in the foreseeable future), which are designed to contribute to local restoration goals;*

*(iv) Identify additional projects and programs needed to achieve local restoration goals, and implementation strategies including identifying prospective funding sources for those projects and programs;*

*(v) Identify timelines and benchmarks for implementing restoration projects and programs and achieving local restoration goals; and*

*(vi) Provide for mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans and to appropriately review the effectiveness of the projects and programs in meeting the overall restoration goals.*

The Restoration Plan will "include goals, policies and actions for restoration of impaired shoreline ecological functions. These master program provisions should be designed to achieve overall improvements in shoreline ecological functions over time, when compared to the status upon adoption of the master program." The Restoration Plan will mesh potential projects identified in this report with additional projects, regional or local efforts, and programs of each jurisdiction, watershed groups, and environmental organizations that contribute or could potentially contribute to improved ecological functions of the shoreline.

# 8 REFERENCES

Appel, M., R. Little, H. Wendt, M. Nielson. 2011. Assessment of the Lower Yakima River in Benton County, Washington. Produced in cooperation with the Yakima Basin Fish and Wildlife Recovery Board.

Benton County. 2012. Shoreline Permits 1971-2012. Benton County Planning Department. Prosser, WA.

Benton County. 2008. Benton County Comprehensive Plan. Available: http://www.co.benton.wa.us/pView.aspx?id=1450&catid=45. Accessed: October 26, 2012.

Benton County. 2006. Red Mountain AVA Conceptual Plan. Prepared by JT Atkins & Company. Available: http://www.co.benton.wa.us/pView.aspx?id=805&catid=45. Accessed: October 30, 2012.

Benton County. Geospatial data: Dams, Parks, City Limits, Comprehensive Plan, Contours, Hanford Site, Parcels and Assessor Data, Ponds, Port Districts, Roads, Soils, UGAs, Zoning [computer files]. Benton County Geographic Information Systems Department, Prosser, WA. Available at: http://www.co.benton.wa.us/pView.aspx?id=1807&catid=45 [Accessed May 2012].

Benton Franklin Council of Governments. 2011. 2011-2032 Regional/Metropolitan Transportation Plan. Available: http://www.bfcog.us/RTP.html. Accessed: October 30, 2012.

Bottom, D. L., C. A. Simenstad, J. Burke, A. M. Baptista, D. A. Jay, K. K. Jones, E. Casillas, and M. H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, National Oceanic Atmospheric Administration, National Marine Fisheries Service.

C-CAP zone 1 2006-Era Land Cover [computer file]. 2008. Charleston, SC: NOAA's Ocean Service, Coastal Services Center (CSC). Available at http://www.csc.noaa.gov/crs/lca [Accessed November 2010].

DOE/EIS-0222-F. 1999. Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement. U.S. Department of Energy, Richland, Washington. DOE/EIS-0222-F.

Davis, D. 1992. Nitrate-nitrite level in Glade Creek. Internal Department of Ecology memo to Bob Barwin. 12 October 1992. https://fortress.wa.gov/ecy/publications/publications/92e16.pdf

Eliazar, P.J., and T.C. Emmel. 1991. Adverse impacts to non-target insects. Mosquito control pesticides: ecological importance and management alternatives. Scientific Publishers, Inc., Gainesville, Florida (1991): 17-19.

Haring, D. 2001. Habitat Limiting Factors Yakima River Watershed, Water Resources Inventory Areas 37-39, Final Report. Prepared by the Washington State Conservation Commission. 364 pp.

HDR Engineering, Anchor QEA, ECONorthwest, Natural Resource Economics, and ESA. 2012. Yakima River Basin Integrated Water Resource Management Plan: Framework for Implementation Report. Prepared for U.S. Department of the Interior, Bureau of Reclamation , Pacific Northwest Region, Columbia-Cascades Area Office and Washington Department of Ecology, Office of Columbia River.

Lautz, K. 2000. Salmon and Steelhead Limiting Factors Water Resource Area 31. Washington State Conservation Commission. 50 pp.

Marriott, D., and 27 contributors. 2002. Lower Columbia River and Columbia River Estuary Subbasin Summary. Report Prepared for the Northwest Power Planning Council, dated May 17, 2002. (Available at: http://www.cbfwa.org/)

Municipal Research and Services Center. 2012. Washington Water and Sewer Districts Listed by County. Available: http://www.mrsc.org/subjects/governance/spd/spd-watsew.aspx. Accessed October 30, 2012.

National Wetlands Inventory [computer file]. 2010. Washington, D.C.: U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation. Available at: http://www.fws.gov/wetlands/ [Accessed August 2010].

National Marine Fisheries Service (NMFS). 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. National Marine Fisheries Service Northwest Region.

Neal, V. 1972, Physical aspects of the Columbia River and its Estuary. In The Columbia River Estuary and Adjacent Ocean Waters: Bioenvironmental Studies, edited by A. T. Pruter and D. L. Alverson (Seattle: University of Washington Press), pp. 19-70.

Northwest Power Planning Council (NPPC). 2001. Yakima Subbasin Summary. Laura Berg, editor. Portland, OR. 376 pp.

Pacific Northwest Laboratory, Ecology Group, Earth and Environmental Sciences Center . *No date.* Field Guide to Species of Concern on the Hanford Site. Prepared under U.S. Department of Energy contract DE-AC06-76RLO 1830.

Pacific States Marine Fisheries Commission (PSMFC). StreamNet geospatial data for Yakima region. Gladstone, OR. Available at: http://www.streamnet.org/mapping_apps.cfm [Accessed July 2012].

Patton, G.W. 2009. Surface-Water and Sediment Monitoring *in* Hanford Site Environmental Report. Pacific Northwest National Laboratory. Prepared of the U.S. Department of Energy.

Ridges to Rivers Open Space Network Steering Committee. 2011. Vision Plan for Open Space Conservation and Trail Connectivity in the Mid-Columbia Region. January.

Simenstad, C., J. Burke, E. O'Conner, C. Cannon, D. Heatwole, M. Ramirez, I. Waite, T. Counihan, and K. Jones. 2011. Columbia River Estuary Ecosystem Classification-Concept and Application. U.S. Geological Survey. Open File Report 2011-1228.

Stanley, S., J. Brown, and S. Grigsby. 2005. Protecting Aquatic Ecosystems: A guide for Puget Sound planners to understand watershed processes. Ecology Publication #05-06-027.

U.S. Army Corps of Engineers (Corps). 2012. McNary Shoreline Management Plan. January, 2012. http://www.nww.usace.army.mil/Portals/28/docs/programsandprojects/msmp/MSMP-Final_121211.pdf [Accessed October 2012].

U.S. Bureau of Reclamation (USBR). 2002. Interim Comprehensive Basin Operating Plan (IOP) for the Yakima Project, Washington. 434 pp.

U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS) and National Geospatial Management Center. Cropland Data Layer coverage of Washington State [computer file]. Fort Worth, TX: U.S. Available at: http://www.nass.usda.gov/ [Accessed July 2012].

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). 2009. Soil Survey Geographic (SSURGO) database for Benton County Area, Washington [computer file]. Fort Worth, TX. Available at: http://soildatamart.nrcs.usda.gov/ [Accessed June 2012].

U.S. Department of Energy. 2008. Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement. June.

_____. 1999. Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement. September.

U.S. Department of the Interior. 2003. LIDAR contours of Benton County, WA [computer file]. Bureau of Reclamation, Upper Columbia Area Office, Yakima, WA.

U.S. Fish and Wildlife Service. 2012. United States Fish & Wildlife Service Cadastral Geodatabase – Approved Acquisitions [computer file]. Division of Realty, Arlington, VA. Available at: http://www.fws.gov/GIS/data/CadastralDB/FwsCadastral.zip [Accessed July 2012].

_____. 2008. Hanford Reach National Monument Comprehensive Conservation Plan. Available at: http://www.fws.gov/hanfordreach/documents/final-plan/hanford-ccp-low.pdf [Accessed November 2012].

_____. 2006. National Wetlands Inventory [computer file]. Division of Habitat and Resource Conservation, Washington, D.C. Available at: http://www.fws.gov/wetlands/ [Accessed June 2012].

U.S. Geological Survey (USGS). National Hydrography Dataset (NHD) [computer file]. Reston, VA: Available at: http://nhd.usgs.gov/data.html [Accessed July 2012].

_____. 2011. National Land Cover Database coverage of Washington State [computer file]. Sioux Falls, SD. Available at: http://seamless.usgs.gov/ [Accessed July 2012].

_____. 2011. Protected Areas Database of the United States 1.2 [computer file]. U.S. Geological Survey Gap Analysis Program and National Geospatial Management Center, Fort Worth, TX.

Ward, D. and 19 contributors. 2001. Draft Mainstem Columbia River Subbasin Plan. Prepared for Northwest Power and Conservation Council. 169 pp.

Washington State Department of Ecology (Ecology). 2012. https://fortress.wa.gov/ecy/coastalatlas/tools/ShorePhotos.aspx

_____. 2010. Levees of Washington State [computer file]. Olympia, WA: Available at: http://www.ecy.wa.gov/services/gis/data/data.htm [Accessed July 2012].

_____. 2009. 2008 Water Quality Assessment (WQA) 305(b) Report for Benton County, WA [computer file]. Olympia, WA: Available at: http://www.ecy.wa.gov/services/gis/data/data.htm [Accessed July 2012].

_____. 2000. Water Resource Inventory Areas (WRIA) for Washington State [computer file]. Olympia, WA. Available at: http://www.ecy.wa.gov/services/gis/data/data.htm [Accessed August 2010].

_____. 1994. Washington base map [computer file]. Olympia, WA. Available at: http://www.ecy.wa.gov/services/gis/data/data.htm [Accessed February 2011].

Washington Department of Ecology and Benton County. 1994. Memorandum of Understanding between the Washington Department of Ecology and Benton County related to the

Respective Roles and Responsibilities of the Two Agencies Related to the Review and Approval of Shoreline Management Permits on the Hanford Reservation. Transmitted by Letter, February 2, 1994.

Washington State Department of Fish and Wildlife (WDFW). Assorted Years. Priority Habitats and Species geospatial data [computer files]. Olympia, WA.

Washington State Department of Natural Resources (DNR). DNR Managed Land Parcels [computer file]. Olympia, WA: Available at: http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html [Accessed June 2012].

_____. 2011. Fault locations with known or suspected Quaternary activity of Washington State [computer file]. Division of Geology and Earth Resources (DGER), Olympia, WA. Available at: http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/gis_data.aspx [Accessed July 2012].

_____. 2010. Fold locations with known or suspected Quaternary activity of Washington State [computer file]. Division of Geology and Earth Resources (DGER), Olympia, WA. Available at: http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/gis_data.aspx [Accessed July 2012].

_____. 2010. Geology of Washington State [computer file]. Division of Geology and Earth Resources (DGER), Olympia, WA. Available at: http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/gis_data.aspx [Accessed July 2012].

_____. 2010. Location and depth of earthquakes of magnitude 3.0 and greater in the state of Washington from 1872 to 2/14/2011 [computer file]. Division of Geology and Earth Resources (DGER), Olympia, WA. Available at: http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/gis_data.aspx [Accessed July 2012].

_____. 2010. Mapped landslides of Washington State [computer file]. Division of Geology and Earth Resources (DGER), Olympia, WA. Available at: http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/gis_data.aspx [Accessed July 2012].

_____. 2010. NDMPL (Washington State Non-DNR Major Public Lands) data [computer file]. Olympia, WA. Available at: http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html [Accessed July 2012].

_____. 2007. Overwater Structures in Navigable Rivers in Washington State [computer file]. Aquatic Resources Program, Olympia, WA. Available at: http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html [Accessed July 2012].

Washington State Department of Transportation. 2012. Railroads in Washington State [computer file]. Olympia, WA: Available at: http://www.wsdot.wa.gov/mapsdata/geodatacatalog/default.htm#main [Accessed June 2012].

Yakima Basin Fish and Wildlife Recovery Board (Yakima Basin Recovery Board). 2009. 2009 Yakima Steelhead Recovery Plan- Extracted from the 2005 Yakima Subbasin Recovery Plan with Updates.

Yakima Subbasin Fish and Wildlife Planning Board (Yakima Subbasin Planning Board). 2004. Yakima Subbasin Plan. Prepared for Northwest Power and Conservation Council. 1038 pp.

# 9 LIST OF ACRONYMS AND ABBREVIATIONS

BLM.....United States Bureau of Land Management
CERCLA .....Comprehensive Environmental Response, Compensation, and Liability Act
cfs.....Cubic Feet per Second
Corps.....U.S. Army Corps of Engineers
Ecology .....Washington Department of Ecology
EIS.....Environmental Impact Statement
ESA.....Endangered Species Act
FEMA.....Federal Emergency Management Agency
GIS.....Geographic information systems
GMA.....Growth Management Act
HPA.....Hydraulic Project Approval
IWRMP .....Yakima River Basin Integrated Water Resource Management Plan
LWD.....Large Woody Debris
MOU .....Memorandum of Understanding
NLC.....National Land Cover
NOAA.....National Oceanographic and Atmospheric Administration
NPDES.....National Pollutant Discharge Elimination System
NRCS.....Natural Resources Conservation Service
NWI.....National Wetlands Inventory
OHWM .....Ordinary High Water Mark
PAH.....Polycyclic aromatic hydrocarbon
PCB.....Polychlorinated biphenyl
PEIS.....Final Programmatic Environmental Impact Statement
PHS.....Priority Habitats and Species
RCW.....Revised Code of Washington
SEPA .....State Environmental Policy Act
SMA .....Shoreline Management Act
SMP .....Shoreline Master Program
SSURGO .....Soil Survey Geographic Database
TMDL.....Total Maximum Daily Load
UGA .....Urban Growth Area
USDA .....U.S. Department of Agriculture
USFWS.....U.S. Fish and Wildlife Service

USGS .....U.S. Geological Service
WAC.....Washington Administrative Code
WDFW .....Washington Department of Fish and Wildlife
WDNR .....Washington Department of Natural Resources
WRIA .....Water Resource Inventory Area

APPENDIX A

# Benton County Assessment of Shoreline Jurisdiction

21 June 2012

Susan Walker
Senior Planner
Benton County Long Range Planning
1002 Dudley Avenue
Prosser, WA 99350

Re: Proposed Benton County Shoreline Jurisdiction

Dear Susan:

The Watershed Company has developed the attached proposed maps of shoreline jurisdiction, illustrating the minimum jurisdiction option and the additional full floodplain and wetland buffers options. This information is provided to assist the County in selecting its preferred shoreline jurisdiction option.

**EXISTING SHORELINE JURISDICTION PER CURRENT SMP**

Under the County's current Shoreline Master Program (SMP), the Yakima River, Columbia River, and Glade Creek are regulated shorelines. Existing shoreline jurisdiction includes the shorelands extending 200 feet from the ordinary high water mark and identified associated wetlands, and includes the floodway and 200 feet of floodway-adjacent floodplain where present. The County's adopted map of shoreline jurisdiction (1974) does not assign an environment designation to the U.S. Department of Energy's Hanford Site. The County's adopted map also does not recognize the expansion of the cities since 1974, or depict the extent of the shorelands.

**PROPOSED SHORELINE JURISDICTION**

The first step in updating the map of shoreline jurisdiction is to collect data relevant to the jurisdiction assessment, namely:

1. Waterbodies: National Hydrography Dataset (download from Ecology website) for Columbia River, and County's OHWM polygon layer for Yakima River dated 2004. An overlay of the data with the aerial generally revealed a close match with existing conditions. The data was only slightly modified in areas to better match existing conditions.

2. Shoreline Management Act Suggested Points, Arcs and Polygons: Ecology has identified the upstream limits of shoreline streams and rivers based on projected mean annual flow of 20 cubic feet per second (cfs) (Higgins 2003), and those lakes that are 20 acres or greater in size. Verification of the lake size was conducted using County's pond inventory dated 2004 in GIS and 2011 aerial photo for those lakes that looked like they might meet the shoreline size threshold.

3. Floodways and Floodplains: The FEMA Q3 data (download from Ecology website) was compared to a dataset from the County. The County data appeared to be equivalent to the Q3, except that the County's projection matched the existing condition more accurately. Accordingly, the County's data for floodway and floodplains was used to create the shoreline jurisdiction maps.

4. Wetlands: The U.S. Fish and Wildlife Service National Wetlands Inventory data set was used to identify wetlands that are potentially associated with the shoreline. For mapping purposes, all wetlands are shown as potentially being an element of shoreline jurisdiction if they are in or partially in the area 200 feet upland of the OHWM or are in or partially in the floodway or floodplain. Other wetlands outside those parameters may also be shoreline-associated wetlands, but that assessment would need to be made at the site-specific scale at the time of a development application.

**MINIMUM JURISDICTION**

The proposed illustration of the minimum shoreline jurisdiction is provided on the *Minimum Shoreline Jurisdiction* exhibit. The basic steps are to illustrate 200 feet upland of OHWM, add floodways and floodplains, and then clip jurisdiction to extend the greater of 200 feet from the OHWM or 200 feet of floodplain upland from the floodway (where present). Shoreline-associated wetlands remain a separate feature on the shoreline jurisdiction map because they have lower accuracy and are more subject to variation based on future site-specific delineation and analysis. The minimum shoreline jurisdiction area, including the potentially associated wetlands, is approximately 9,559 acres.

**<u>Rivers/Streams</u>**

Consistent with the current SMP, Washington Department of Ecology's data set shows that the Yakima and Columbia Rivers in Benton County are Shorelines (20 cfs or greater), and further are Shorelines of Statewide Significance (200 cfs or greater).

Glade Creek is noted in the County's current SMP as a Shoreline of Statewide Significance, and is also listed in WAC 173-18-070 as a Shoreline of Statewide Significance. However, Glade Creek is not identified in Ecology's suggested shoreline data set as either a Shoreline or a Shoreline of Statewide Significance. USGS published a report in 2003 that updated its earlier 1971 work identifying the upstream limit of 20 cfs mean annual flow. The 2003 report predicted the boundary point for streams in southeastern Washington by applying a multiple-linear-regression equation that relates mean annual discharge to drainage area and mean annual precipitation (Higgins 2003). An equation was developed for the lower Yakima hydrologic region, which includes Benton County. The USGS report noted that "[u]pstream boundary points were not determined for any of the streams in Benton and Adams Counties because none of the streams in those counties have mean annual discharges that exceed 20 $ft^3/s$" (Higgins 2003).

Scattered references to stream flows in Glade Creek were found online. One source notes that Glade Creek is an intermittent stream, largely supplied by irrigation run-off (Anderson 1982). Another source noted that "most of the water" in Glade Creek is supplied by groundwater seeps, and that summer flows are higher due to irrigation runoff (Davis 1992). In a follow-up study by Department of Ecology (Garrigues 1996), flow measurements at the mouth of Glade Creek were reported at 15.6 and 13.2 cfs in May and September 1995, respectively. The author further acknowledged that prior investigators observed little to no water in the summer months in many reaches of the creek, and speculates that the higher flows noted at two points in 1995 are related to irrigation. In combination with the USGS projections, these reports support a determination that Glade Creek is highly unlikely to meet the Shoreline definition for a shoreline stream, and therefore would not be eligible for further consideration as a Shoreline of Statewide Significance.

Accordingly, the Columbia and Yakima Rivers remain in shoreline jurisdiction, but Glade Creek is proposed to be excluded from shoreline jurisdiction based on its stream flow.

**Lakes**

According to Ecology's shoreline data, there are nine suggested "waterbodies (lakes, wetlands, etc)" present in the County that are 20 acres or greater.

- Three of the waterbodies were included in the proposed shoreline jurisdiction maps as part of the Columbia River.
- Three of the ponded features are well under 20 acres as determined by review of aerial photographs and measurement of area using GIS.

- One of the features is located in the boundaries of a City.
- The remaining two waterbodies are wetlands, and not lakes. Both features are mapped as potential shoreline-associated wetlands in the Yakima River floodplain near Richland.

In conclusion, the proposed shoreline jurisdiction does not include any lakes in Benton County.

## OTHER JURISDICTION OPTIONS

The information above describes assembly of the minimum shoreline jurisdiction. The County may further elect to expand jurisdiction to include 1) all or part of the 100-year floodplain, and/or 2) buffers of associated wetlands[1] that would otherwise encompass areas outside of shoreline jurisdiction. Under either of these options, the area of shoreline jurisdiction increases and additional properties or areas of properties would be subject to the SMP and its additional layer of permitting requirements.

### Floodplain

The 100-year floodplain option was assembled by combining the minimum shoreline jurisdiction with the remaining floodplain that is beyond the 200 feet of floodplain adjacent to floodways. The resulting optional jurisdiction is illustrated on the *Minimum Jurisdiction and 100 Year Floodplain* exhibit. This option increases the total area of jurisdiction by 1,731 acres (an 18% increase), most of which is found on the Columbia River in an agricultural area just west of Hanford and in the Umatilla National Wildlife Refuge, and in areas on the Yakima located between Richland and West Richland and between West Richland and Benton City.

Use of this option would allow for maximum integration and consistency of the SMP with Chapter 3.26: Flood Damage Prevention and Chapter 15.30: Frequently Flooded Areas of the County's Code.

### Wetland Buffers

The wetland buffers option was assembled by combining the minimum shoreline jurisdiction with buffers assigned to the potentially associated wetlands. The available GIS information does not include wetland classifications using Ecology's wetland rating

[1] The RCW actually allows for expansion of jurisdiction to include *critical area* buffers, not just wetland buffers. However, this generally is limited to wetland buffers in practice. The nature of non-shoreline streams as a mostly perpendicular element to a shoreline waterbody already brings their full buffer into shoreline jurisdiction. Geologically hazardous areas are generally assigned a setback, not a buffer. Critical aquifer recharge areas (CARAs) are not addressed in the SMA or SMP Guidelines, and CARAs further are not assigned a setback or a buffer.

system as required by the County's critical areas regulations. Accordingly, a buffer of 100 feet, corresponding to a Category II wetland, was assigned to all potentially associated wetlands solely for illustration purposes (see *Minimum Jurisdiction and Wetland Buffers* exhibit).

Expanding the minimum jurisdiction to encompass associated wetland buffers would add 833 acres to the total shoreline jurisdiction area, an increase of 8.7 percent from the minimum jurisdiction. Most of the wetland buffer acreage expansion is located on the associated wetland complex on the Yakima River between Richland and West Richland and on wetlands mapped on the Columbia River islands or in the Umatilla National Wildlife Refuge.

RCW 36.70A.480(6) says "If a local jurisdiction's master program does not include land necessary for buffers for critical areas that occur within shorelines of the state, as authorized by RCW 90.58.030(2)(f), then the local jurisdiction shall continue to regulate those critical areas and their required buffers pursuant to RCW 36.70A.060(2)." Ecology's SMP Handbook chapter on Shoreline Jurisdiction explains the implications of this RCW as follows:

> If the local government chooses not to extend its shoreline jurisdiction under *RCW 90.58.030(2)(f)(ii),* the CAO will protect the entire critical area and its buffers (see *RCW 36.70A.480(6)).* The CAO will continue to apply to the entire critical area and its buffers, even after SMP approval. However, the SMP will <u>also</u> apply to the portion(s) of the critical area and its buffers that lie within shoreline jurisdiction. This means the subject critical area and some or all of its buffers will have "dual coverage" with regulation by both the SMP and the CAO.

Please call if you have any questions.

Sincerely,

Amy Summe
Environmental Planner

Enclosures

References:

Anderson, T. 1982. Ecologically sensitive areas of Benton County. Lower Columbia Basin Audubon Society, Kennewick, WA. 48 p. http://www.co.benton.wa.us/docview.aspx?docid=10279

Davis, D. 1992. Nitrate-nitrite level in Glade Creek. Internal Department of Ecology memo to Bob Barwin. 12 October 1992. https://fortress.wa.gov/ecy/publications/publications/92e16.pdf

Garrigues, R.S. 1996. Ground-water quality characterization and nitrate investigation of the Glade Creek watershed. Washington Department of Ecology, Olympia, WA. Publication No. 96-348. https://fortress.wa.gov/ecy/publications/publications/96348.pdf

Higgins, J.L. 2003. Determination of upstream boundary points on southeastern Washington streams and rivers under the requirements of the Shoreline Management Act of 1971: U.S. Geological Survey Water-Resources Investigations Report 03-4042. 26 p. http://pubs.usgs.gov/wri/wri034042/pdf/wri034042.pdf

# APPENDIX B

## Shoreline Inventory Map Folio (online at www.BENTONCOUNTYSMPUPDATE.com)

## APPENDIX C

# Map of Shoreline Reaches

# REACHES

Map Sheet Index

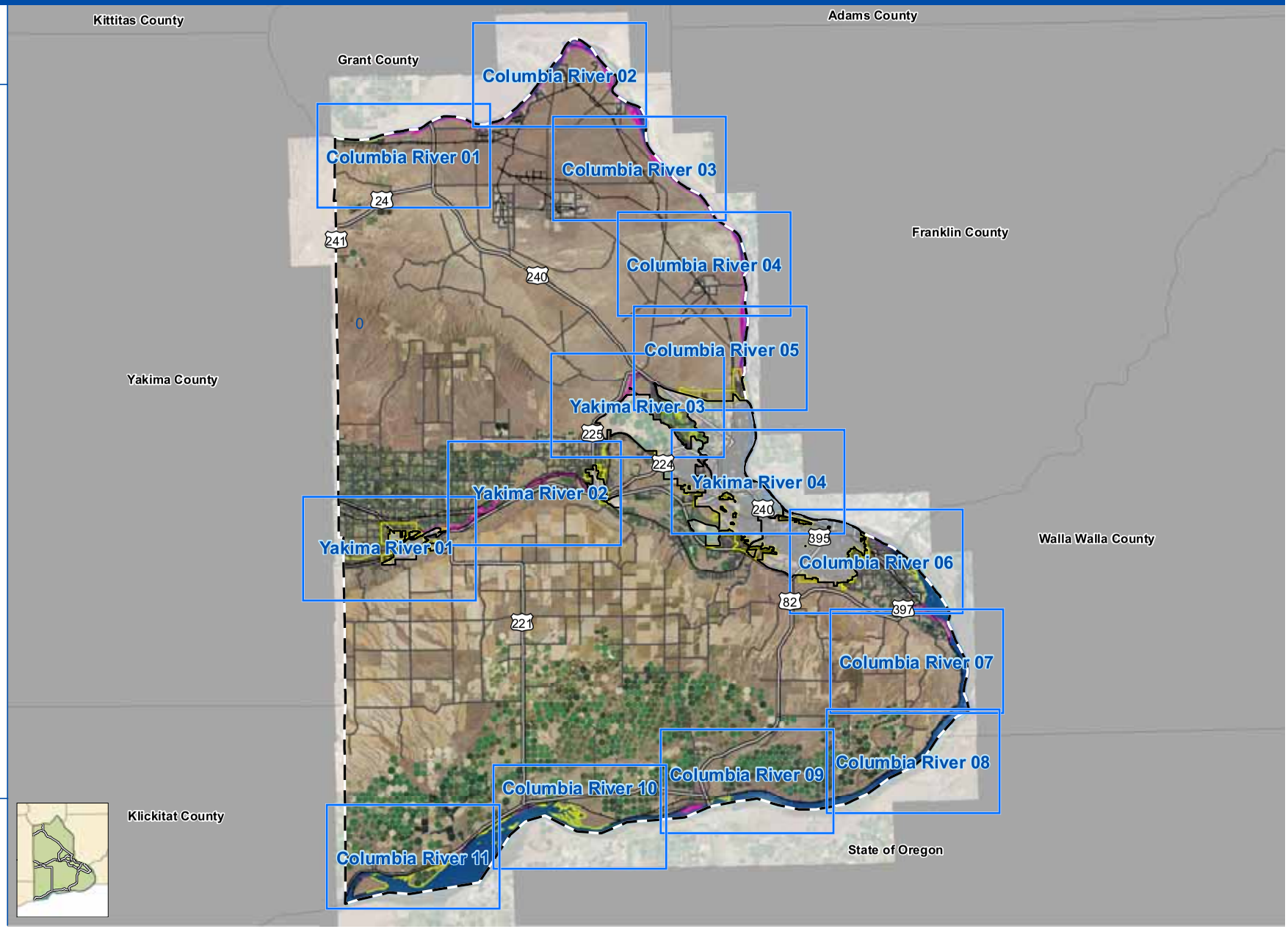
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 4 8
Miles

*10.2.2012*

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*



# REACHES

Columbia River 01

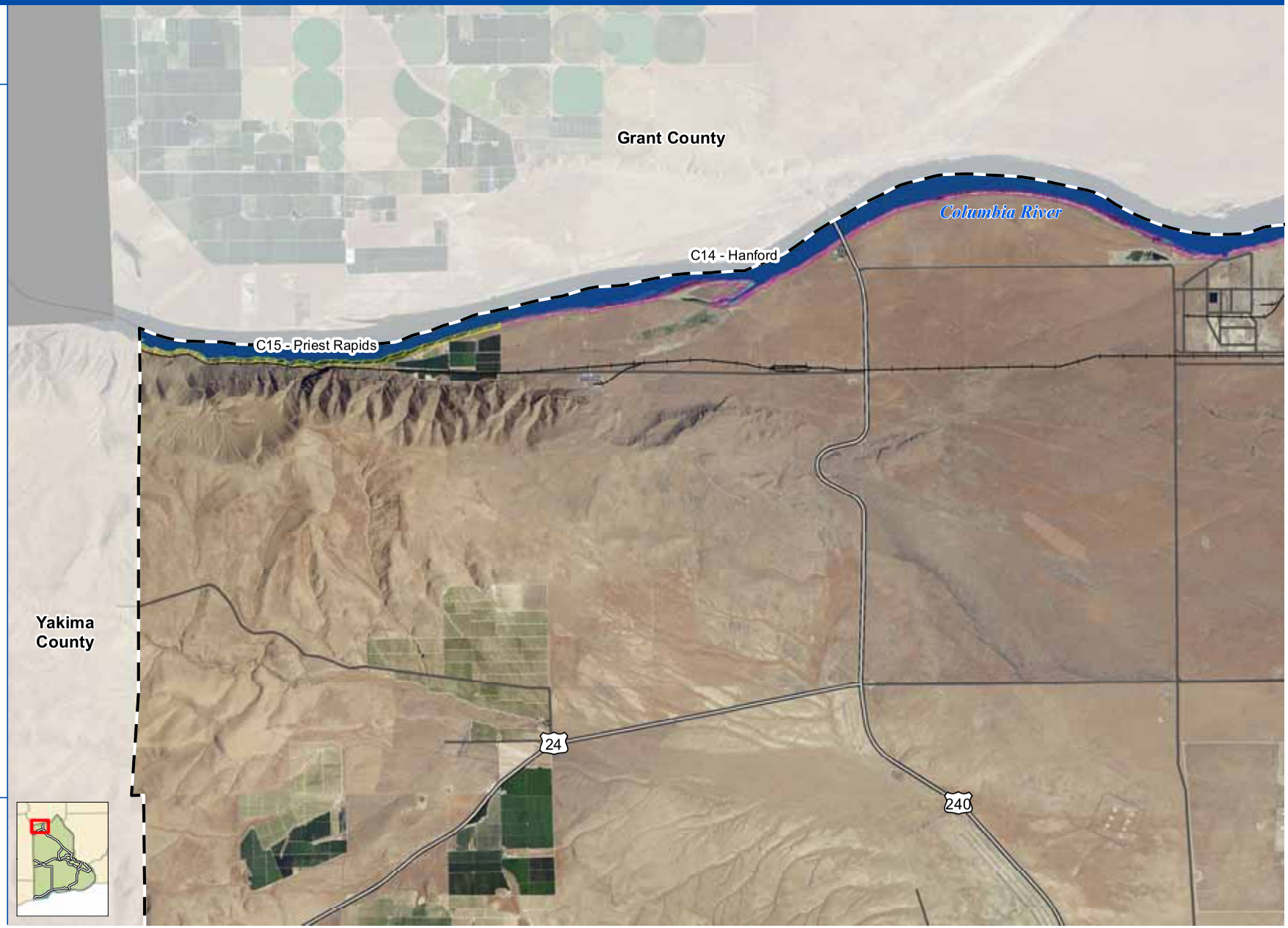
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

***10.2.2012***

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*



# REACHES

Columbia River 02

Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

***10.2.2012***

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

Columbia River 03

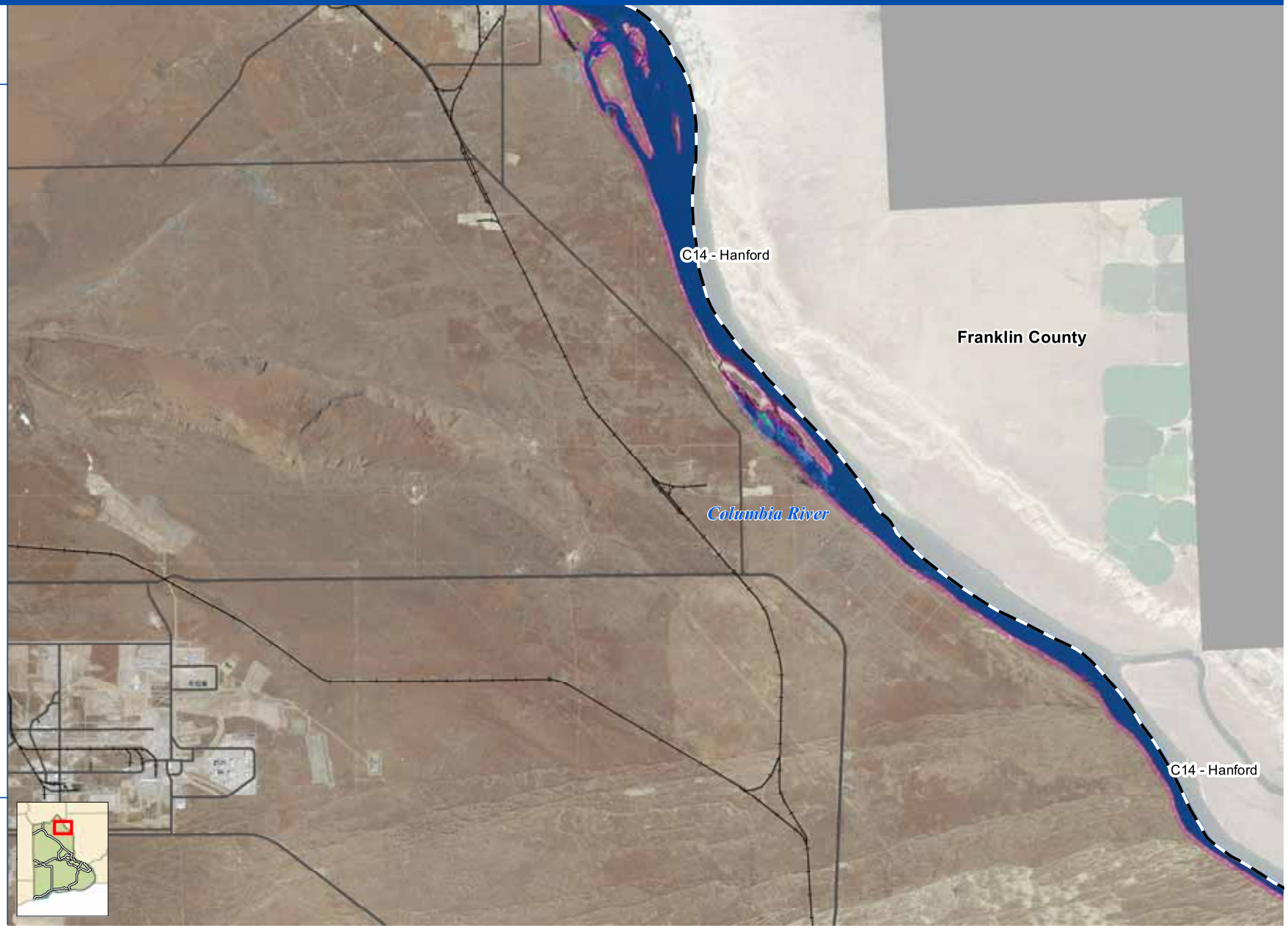
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road

Potentially Associated Wetlands [2]
SMP Waterbodies [3,4]
County Boundary [5]
City Boundaries [3]
Urban Growth Areas [3]
Parcels [3]
Highways [6]
Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

***10.2.2012***




*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

## Columbia River 04

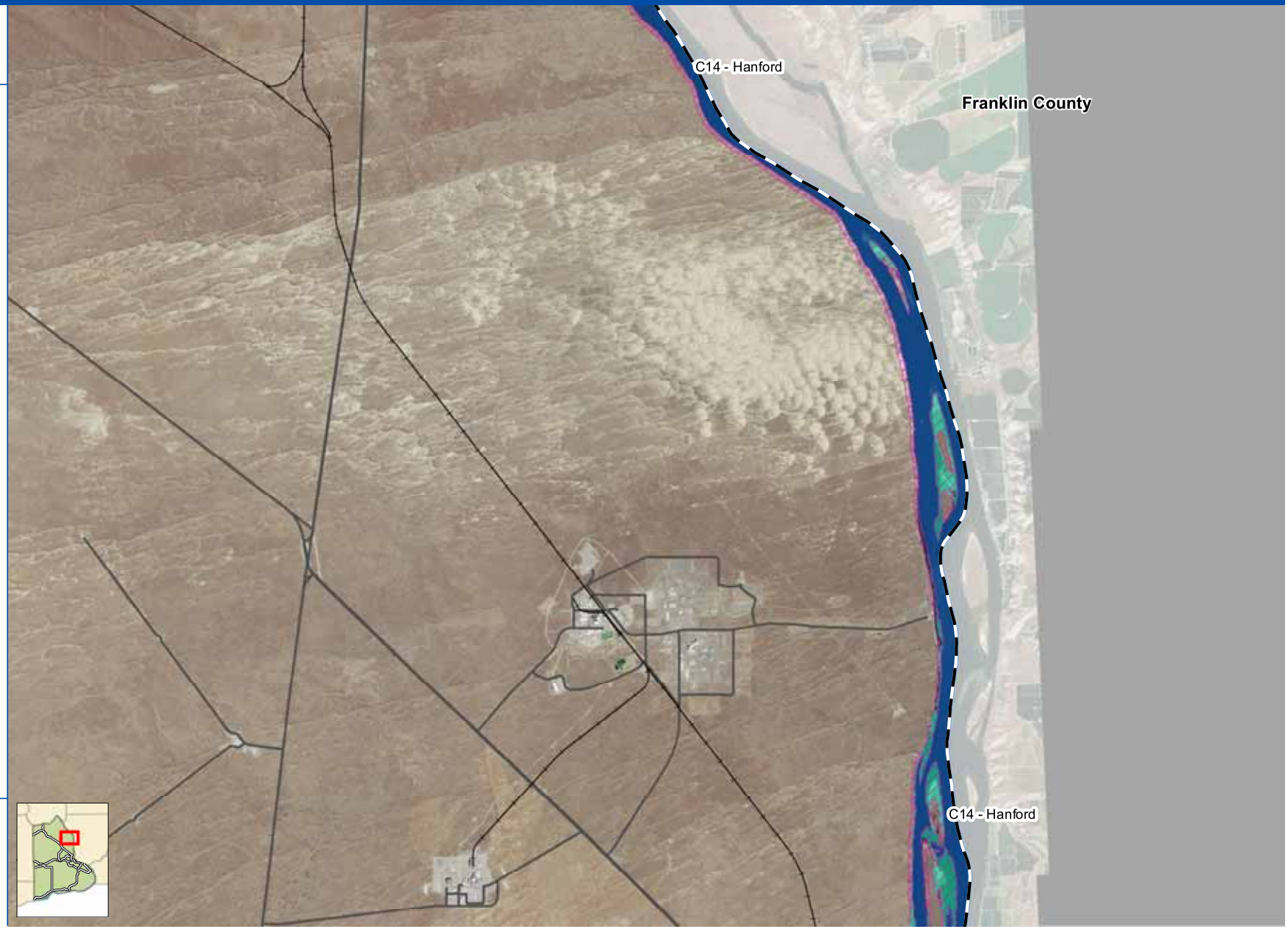
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

***10.2.2012***

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*



# REACHES

Columbia River 05

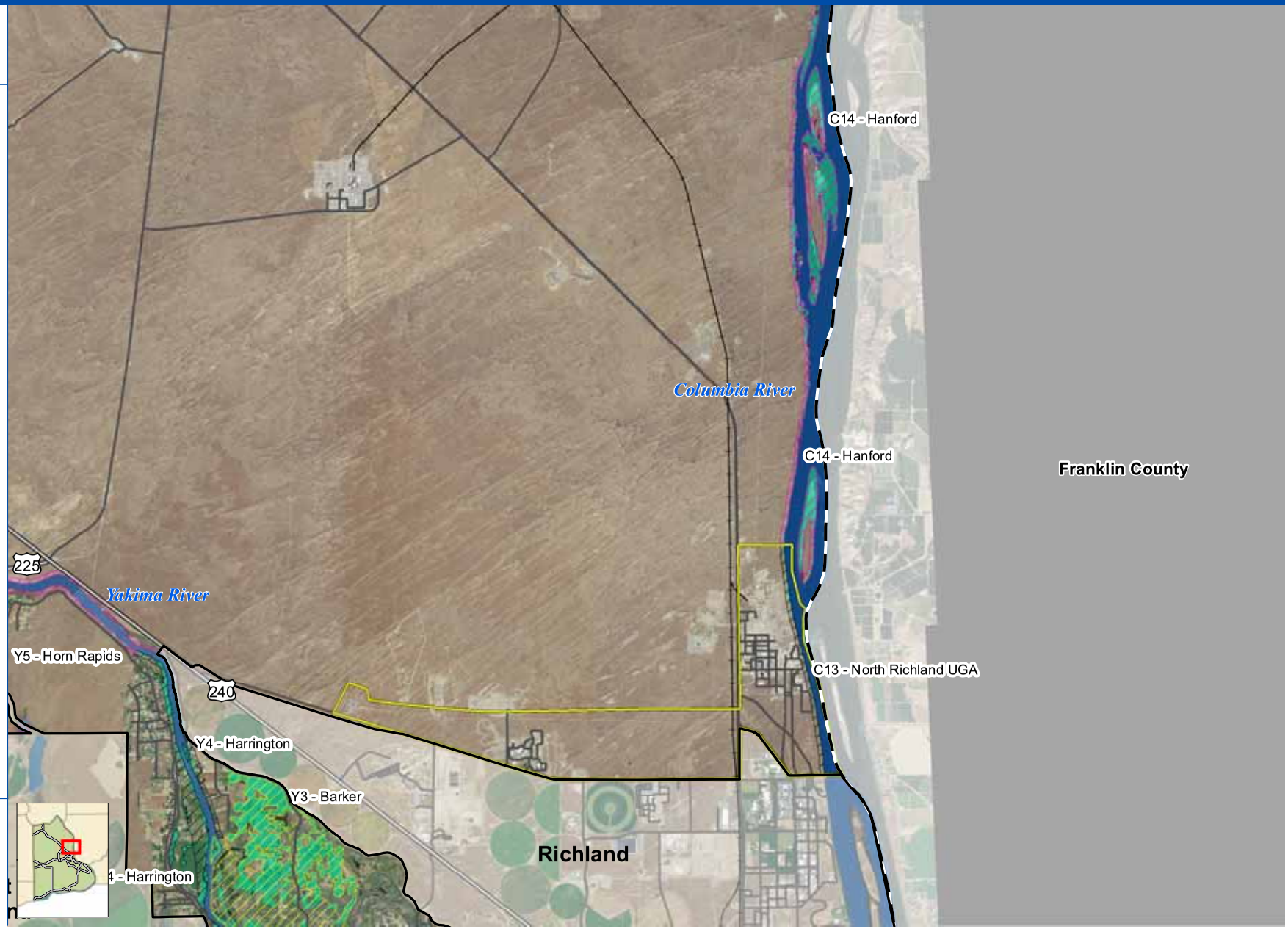
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*



# REACHES

Columbia River 06

Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

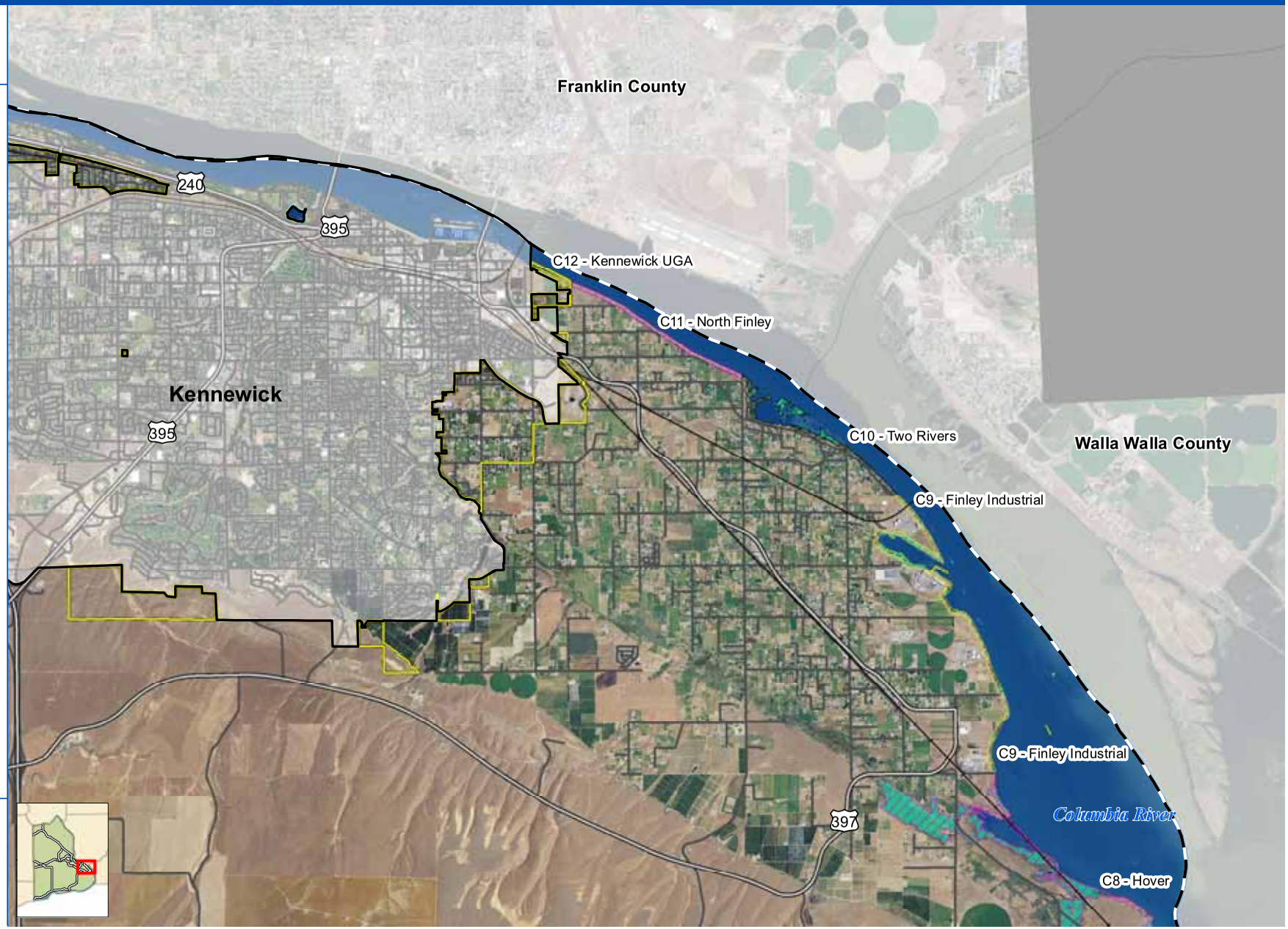
*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*

THE WATERSHED COMPANY

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*



# REACHES

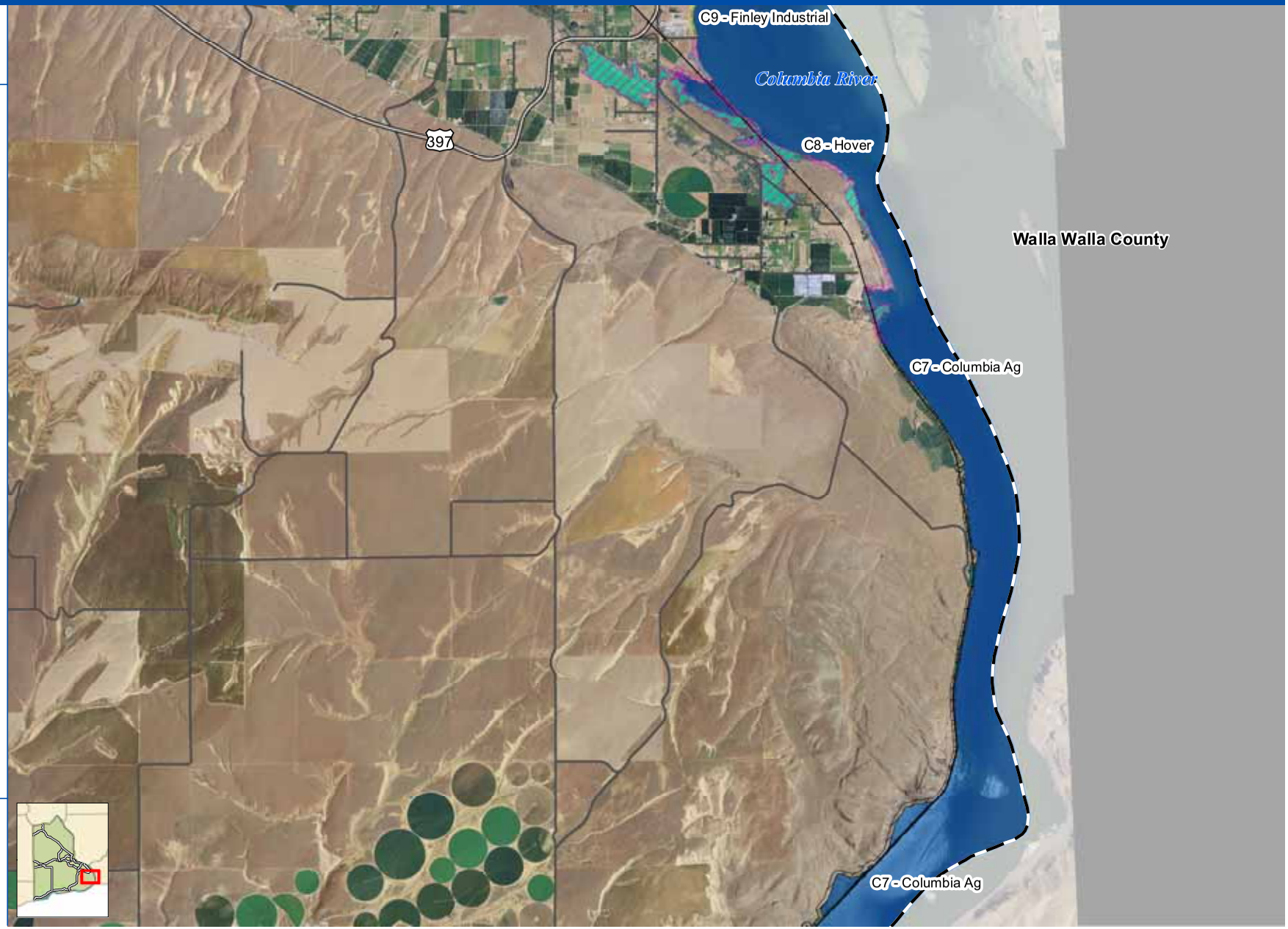
Columbia River 07

Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*




*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

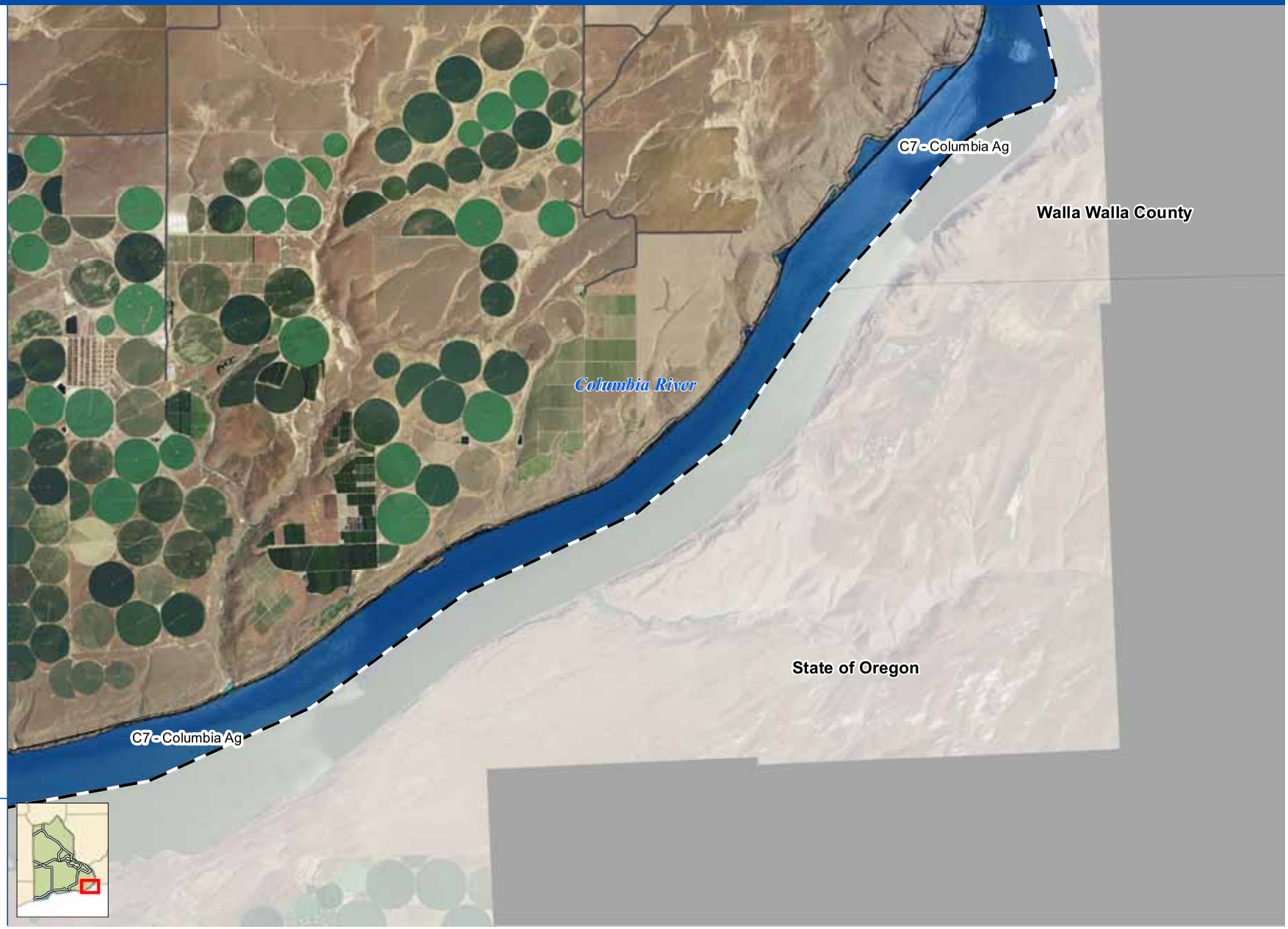
Columbia River 08

Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*




*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

Columbia River 09

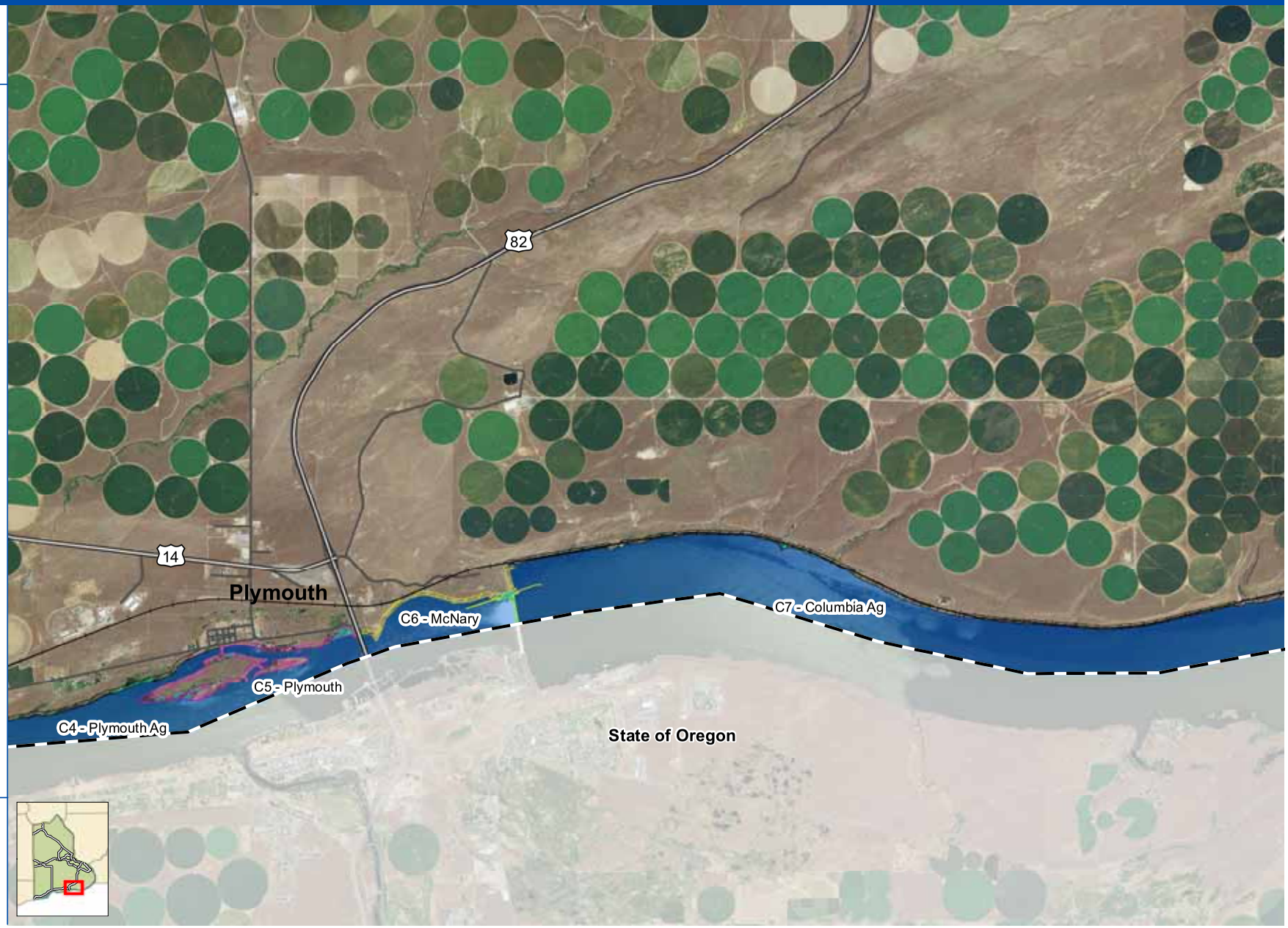
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*



# REACHES

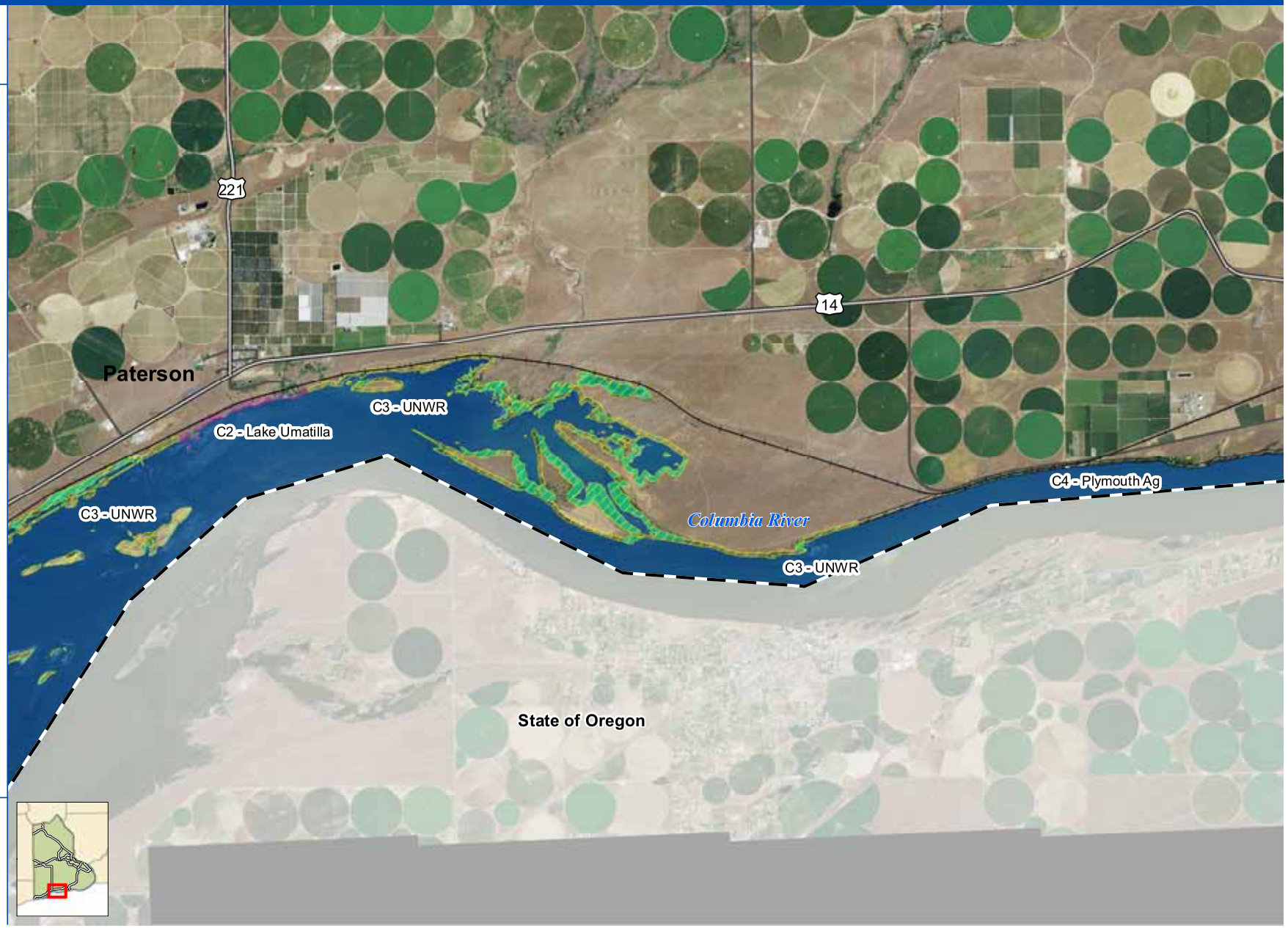
Columbia River 10

Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*




*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

Columbia River 11

Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

Yakima River 01

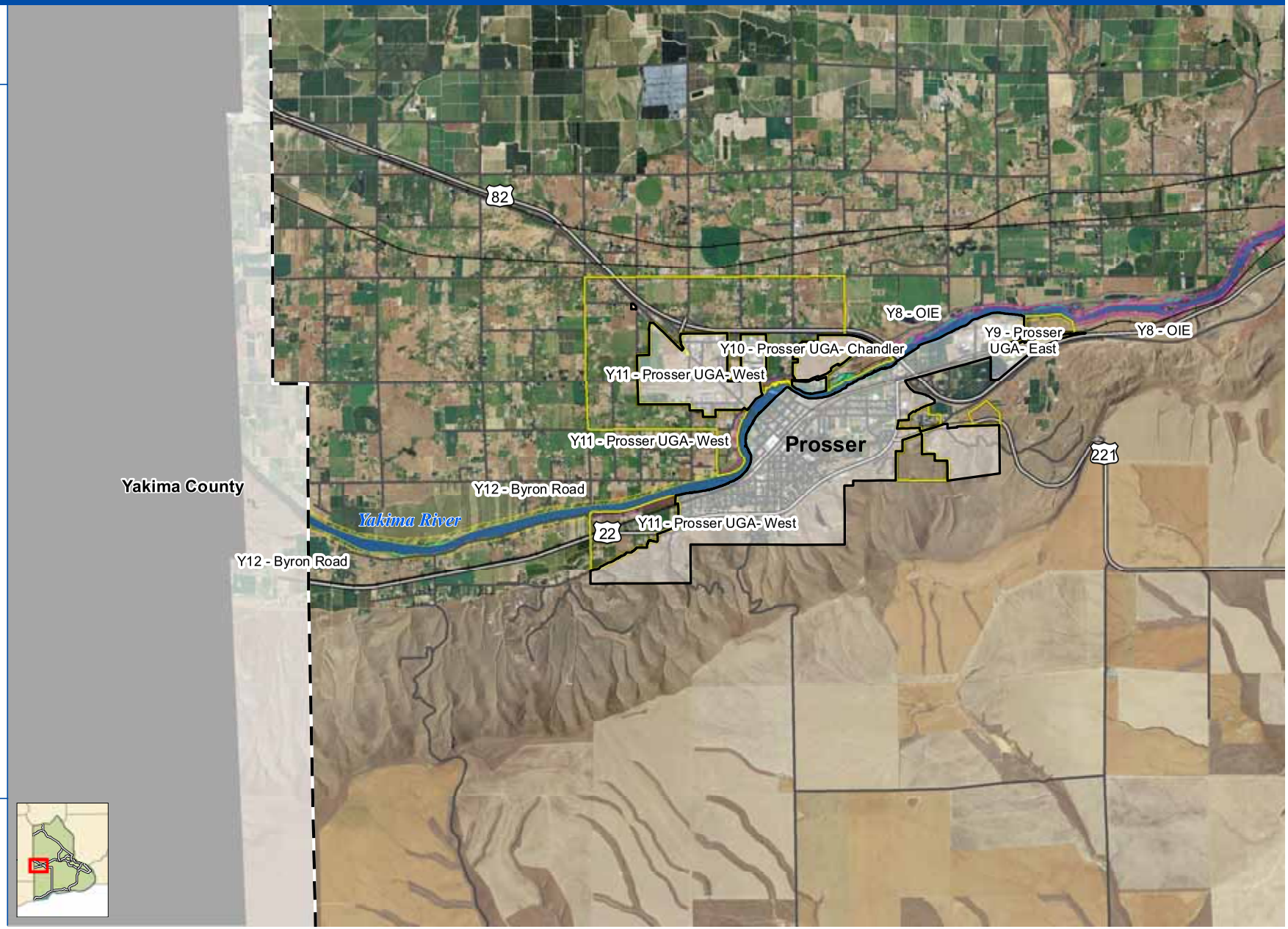
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road

Potentially Associated Wetlands [2]
SMP Waterbodies [3,4]
County Boundary [5]
City Boundaries [3]
Urban Growth Areas [3]
Parcels [3]
Highways [6]
Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*




*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

Yakima River 02

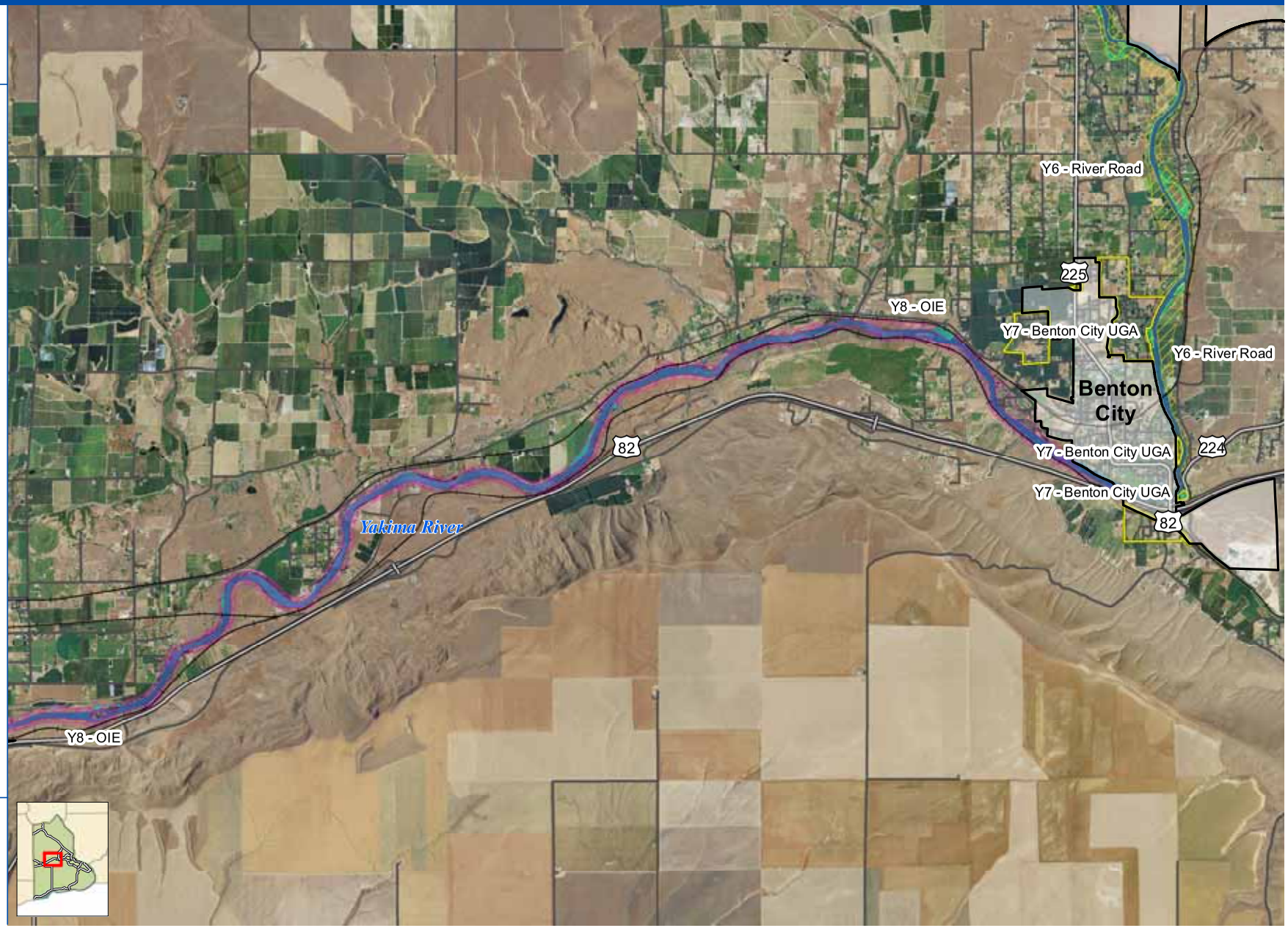
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road

Potentially Associated Wetlands [2]
SMP Waterbodies [3,4]
County Boundary [5]
City Boundaries [3]
Urban Growth Areas [3]
Parcels [3]
Highways [6]
Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County [4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

***10.2.2012***




*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

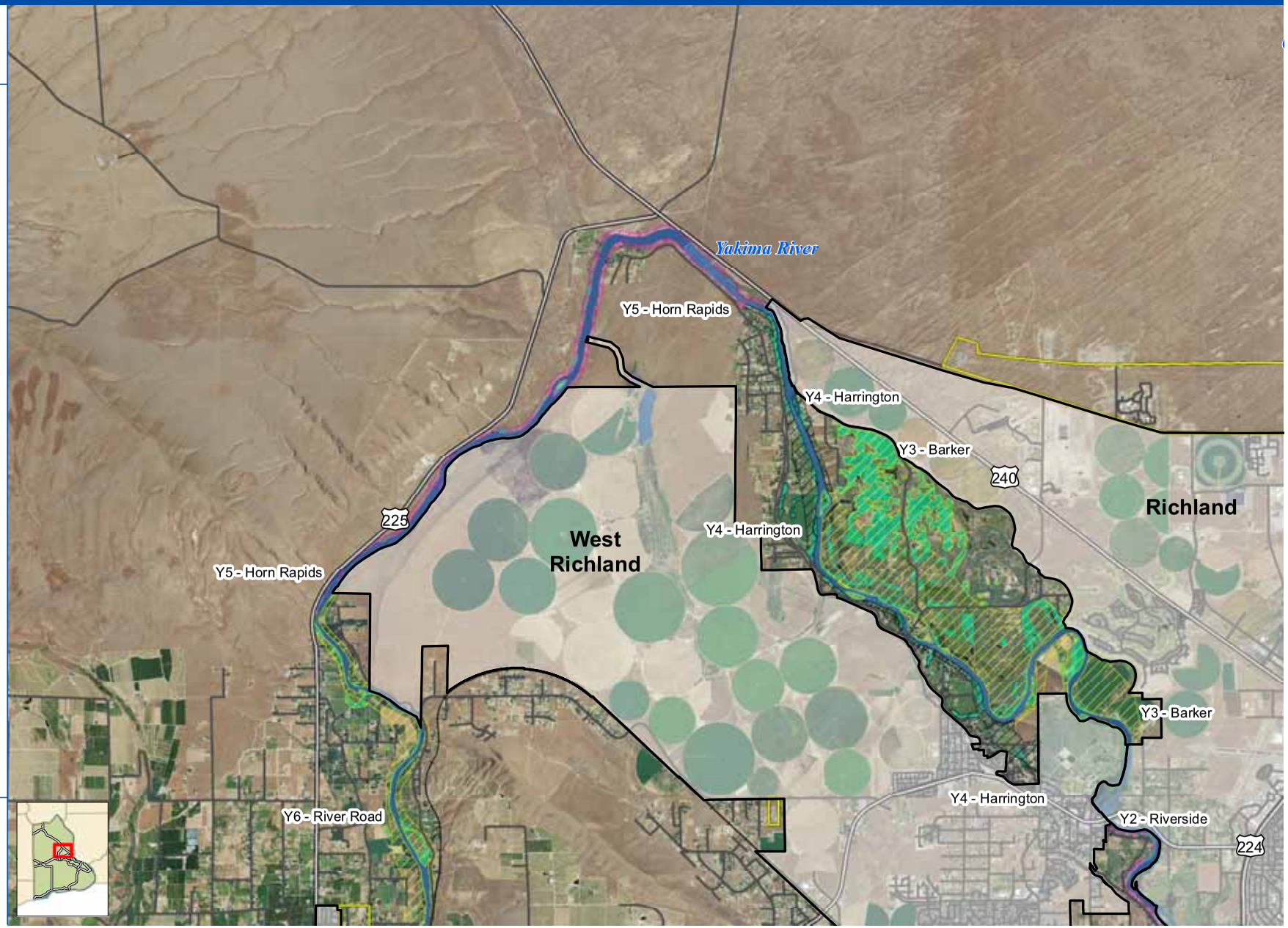
Yakima River 03

Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

***10.2.2012***




*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*

# REACHES

Yakima River 04

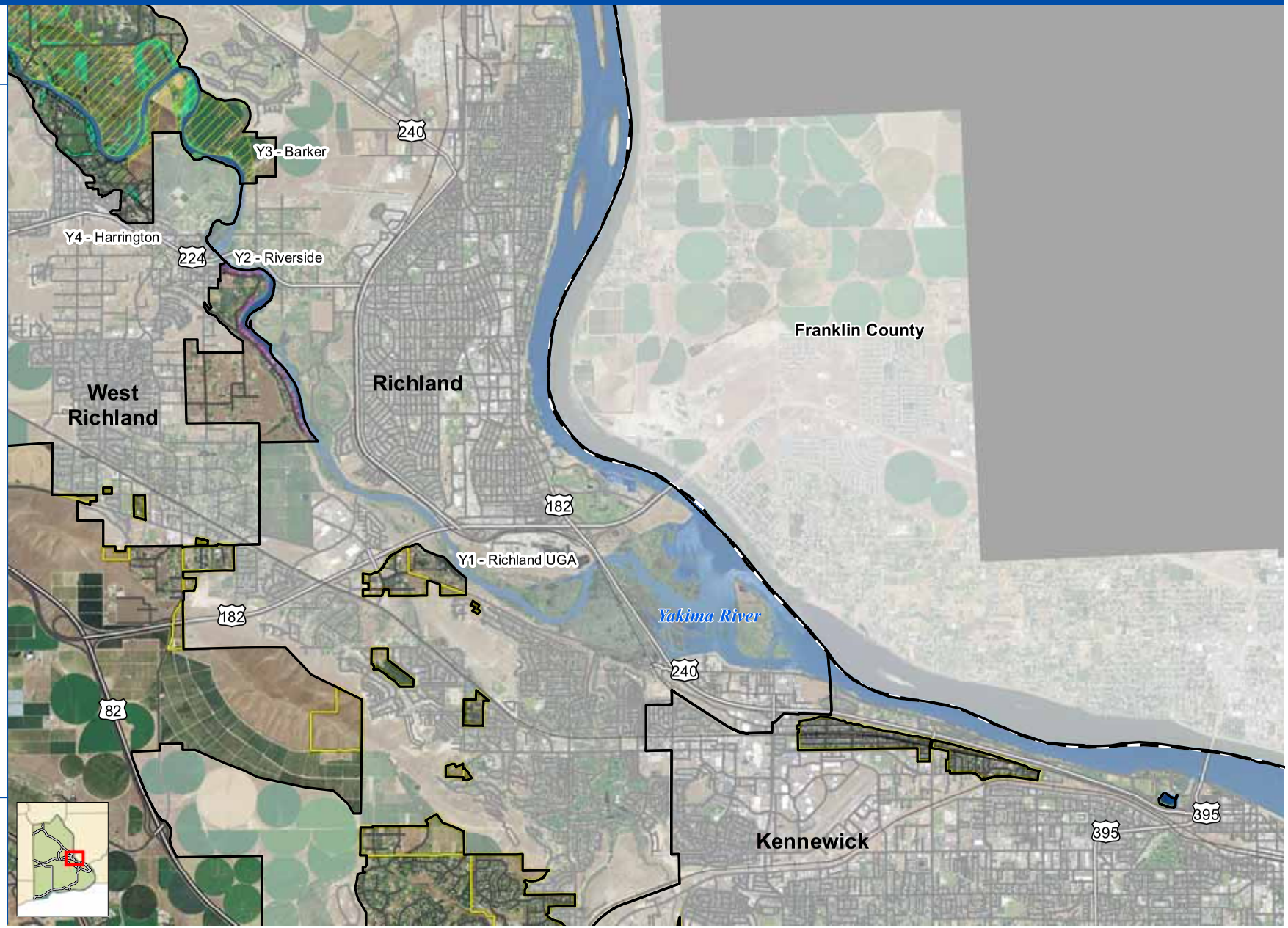
Reaches [1]
- C1 - Crow Butte Park
- C2 - Lake Umatilla
- C3 - UNWR
- C4 - Plymouth Ag
- C5 - Plymouth
- C6 - McNary
- C7 - Columbia Ag
- C8 - Hover
- C9 - Finley Industrial
- C10 - Two Rivers
- C11 - North Finley
- C12 - Kennewick UGA
- C13 - North Richland UGA
- C14 - Hanford
- C15 - Priest Rapids
- Y1 - Richland UGA
- Y2 - Riverside
- Y3 - Barker
- Y4 - Harrington
- Y5 - Horn Rapids
- Y6 - River Road
- Y7 - Benton City UGA
- Y8 - OIE
- Y9 - Prosser UGA- East
- Y10 - Prosser UGA- Chandler
- Y11 - Prosser UGA- West
- Y12 - Byron Road
- Potentially Associated Wetlands [2]
- SMP Waterbodies [3,4]
- County Boundary [5]
- City Boundaries [3]
- Urban Growth Areas [3]
- Parcels [3]
- Highways [6]
- Railroads [6]

*Data sources:*
*[1] The Watershed Company; [2] US Fish and Wildlife Service; [3] Benton County*
*[4] US Geological Survey; [5] WA Dept of Ecology; [6] WA Dept of Transportation*

0 1
Miles

*10.2.2012*

*Shoreline jurisdiction boundaries depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.*



## APPENDIX D

# Channel Migration Zone Memo

# TECHNICAL MEMORANDUM

THE WATERSHED COMPANY

Date: 01 November 2012
To: Amy Summe
From: Al Wald, LG, LHG, Hydrogeologist
Project Number: 120209
Project Name: Benton County SMP Update

**Introduction**. The purpose of this study is to assess and delineate a Channel Migration Zone (CMZ) for the Lower Yakima River in Benton County, Washington. The essential elements of the CMZ are the Active Channel Corridor (ACC), Avulsion Hazard Area (AHA), Erosion Hazard Area (EHA), and Disconnected Migration Areas (DMA) as defined for shoreline planning purposes (WDOE 2011). These elements are delineated using recommended criteria including LiDAR topography (USBR 2000), aerial photography (Benton County 2010), and both historic and current mapping in the area. The CMZ represents a graphical overlay of the different elements and does not include field surveys or onsite data collection. Approvals for projects and permits relying on these boundaries should include detailed assessments with stream surveys, particularly in active channel areas with sedimentary deposits downstream of Benton City.

CMZ maps for the Lower Yakima River will be included in the 2012 Benton County Shoreline Master Program (SMP) update. The Columbia River CMZ is not included in the update because river flows are regulated by hydropower dams and shoreline areas upstream of Richland are in federal ownership (WDOE 2012).

**Study Area**. The Lower Yakima River Basin downstream of the Benton County line (Section 7, Township 8N, Range 24E) drains an area of 686 square miles to the Yakima River confluence at the Columbia River (Section 19, Township 9N, Range 29E). The mainstem is 52.2 river miles (RM) in length and flows from elevation of 651 feet mean sea level (msl) to elevation 341 feet msl at the confluence (Google Earth 2012). Overall gradient of the river is 6 feet/mile or 0.1%. The study includes unincorporated areas within the basin, but does not include areas within the city limits of Richland, West Richland, Benton City, and Prosser.

The geologic material of the Lower Yakima River Basin is composed of four major rock types: Columbia River Basalt (basalt), Columbia River flood and glaciolacustrine deposits, upland nonmarine deposits (principally loess), and river alluvium. The lower river flows in a southeasterly direction through the Yakima Fold Belt, a subprovince of the Columbia Basin Physiographic Province, in a relatively narrow synclinal valley between the southern extent of Rattlesnake Hills and the northern extent of Horse Heaven Hills (WDNR 1990). The river bends abruptly at a fold in the Horse Heaven Hills, between Goose Hill and Benton City, and flows northly between Red Mountain

750 Sixth Street South | Kirkland, WA 98033
p 425.822.5242 | f 425.827.8136 | watershedco.com

and the southeastern extent of Rattlesnake Hills. Much of the river valley upstream of Horn Rapids is confined within a narrow canyon eroded into the basalt (Kinnison and Sceva 1963) and numerous bedrock outcrops restrict the width and depth of the channel. The area from Prosser Dam (RM 47) to Chandler Powerhouse (RM 35) is a narrow canyon of bedrock (Wise et al. 2009) and the channel is confined with minimal meanders and braiding (Appel et al. 2011). Geologic controls on valley form near Benton City (Kiona) are shown in Figure 1 (from Kinnison and Sceva 1963).

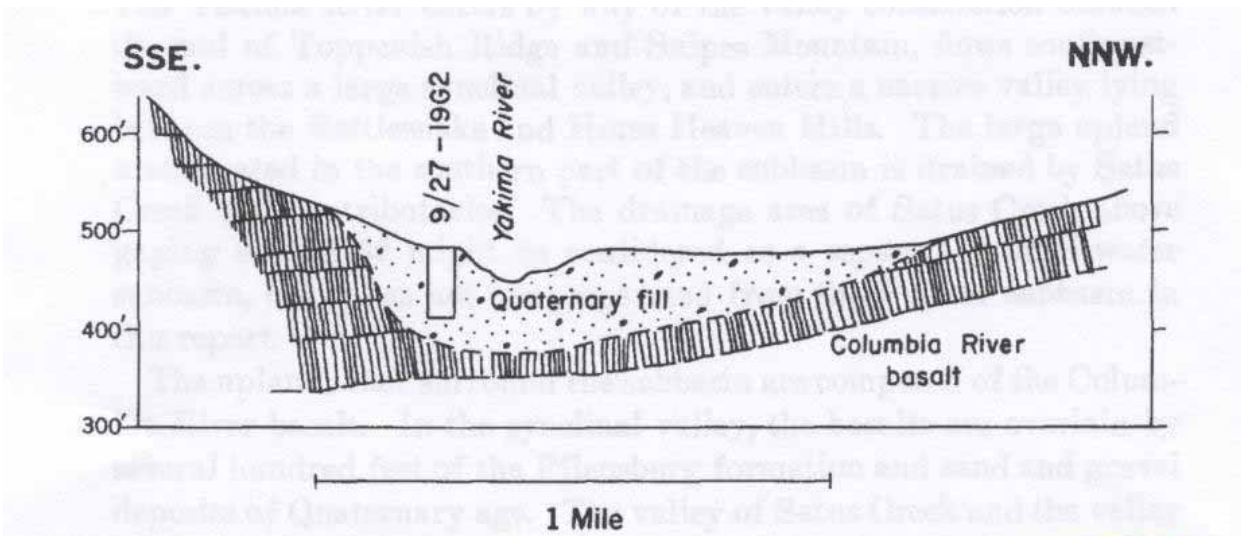



Figure 1. Geologic controls on valley form near Benton City (Kiona)

The river bends at Horn Rapids and flows southeasterly through Columbia River flood deposits in the area of West Richland and Richland (Schuster 2002 and Freudenthal 2012). The river valley is dominated by alluvial deposits with numerous side channels and islands in the river (Appel et al. 2011) although the channel is constrained by artificial structural controls that restrict river meandering and braiding.

Active channel width is generally confined by bedrock outcrops, railroad and highway embankments, improved (paved) township roads, irrigation diversions and canals, flood control levees, numerous bridges, and three dams. The lower river habitat type is dominated by runs with few riffles and one short pool (Wise et al. 2009). Impoundments backwater variable lengths of the channel behind Prosser Dam, Horn Rapids Dam, and McNary Dam on the Columbia River.

The hydrologic regime of the lower river has been altered by irrigation storage and diversion projects upstream although the general effect of these changes has been to reduce high flow magnitudes and extend their durations. Figure 2 shows the reduced range in high flows of record for the USGS gage at Kiona, WA (below).

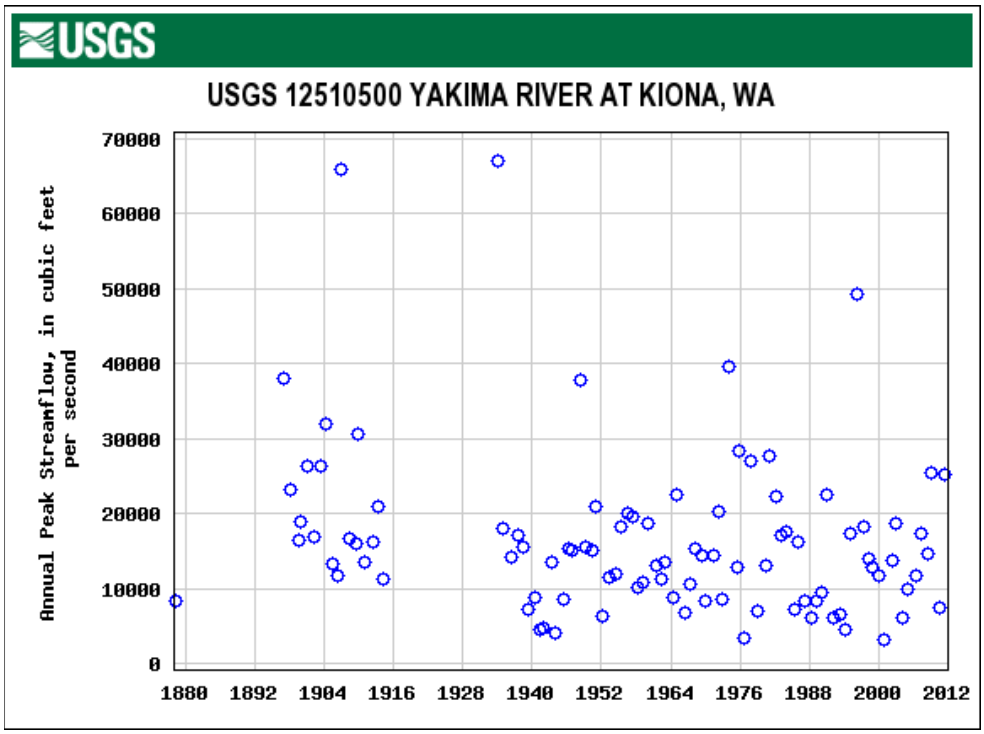



Figure 2. High flows of record at Kiona, WA

Table 1 shows calculated peak flows for the lower Yakima River (below). They range from a 2-year discharge of 16,200 cfs upstream to a 100-year discharge of 57,900 cfs at the confluence (USGS Streamstats 2012).

Table 1. Peak flows for the lower Yakima River

| | Drainage area (sq mi) | Q2 cfs | Q10 cfs | Q100 cfs |
|---|---|---|---|---|
| Yakima River at Benton County Line | 5,397 | 16,200 | 30,500 | 52,800 |
| Yakima River at Columbia River | 6,083 | 17,800 | 33,500 | 57,900 |

Note: these discharges are presented for comparative purposes only as drainage area is outside the range of study parameters.

**Study Reaches**. For purposes of this study, the Lower Yakima River includes three reaches: the Prosser Reach (RM 52.2 to RM 29.9), the Horn Rapids Reach (RM 29.9 to RM 17.5), and the Richland Reach (RM 17.5 to RM 0.0).

The Prosser Reach extends 22.3 river miles from the Benton County line to the USGS gage (#12510500) at Kiona. The stream gradient ranges from 0.15% near Prosser to 0.12% at Chandler (USBR 2003). Average gradient is 0.16% and valley width is generally

defined by bedrock control. The active channel is stable. Channel width ranges from less than 100 feet in the bedrock canyon below Prosser to great than 150 feet upstream where impounded behind Prosser Dam (RM 46.9). Figure 3 (below) shows a cross-section at RM 45 in this reach (USBR 2003).

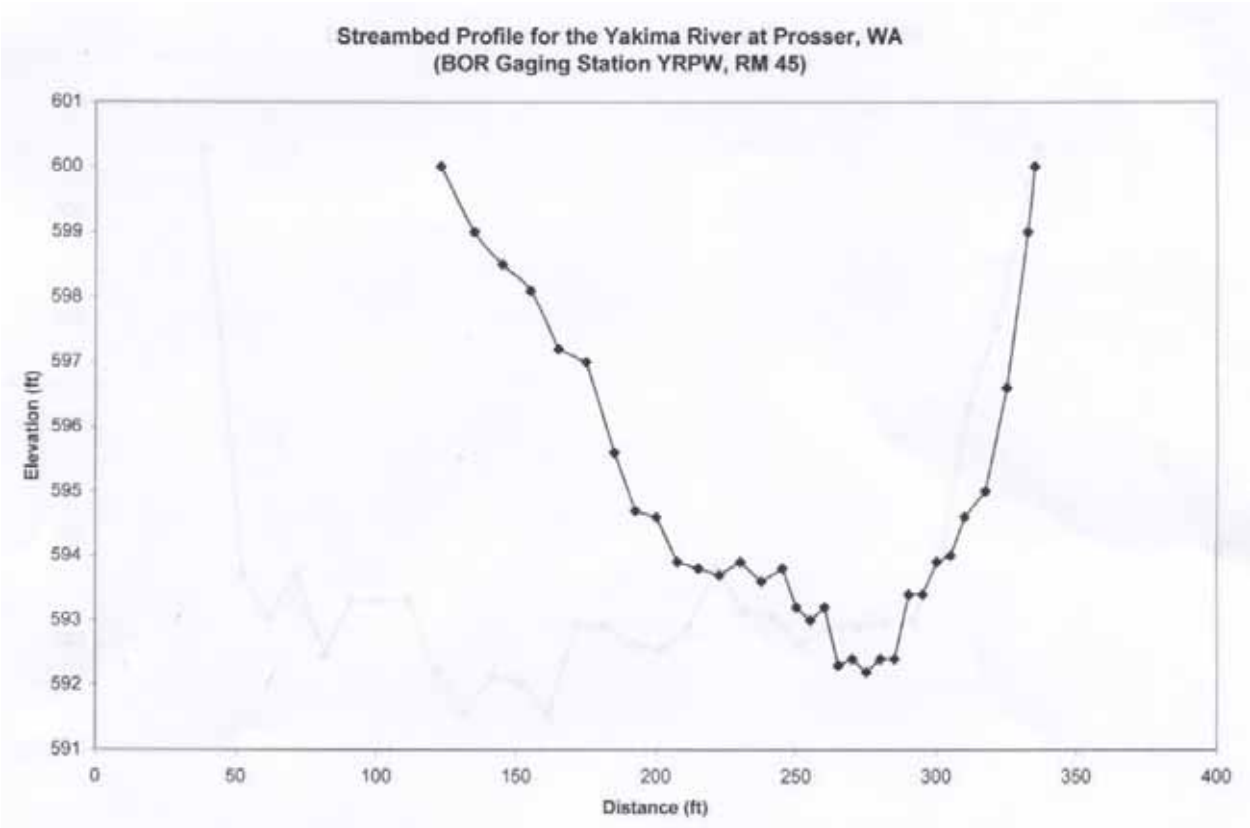



**Figure 3. Channel cross section at river mile (RM) 45.**

The Horn Rapids Reach extends 12.4 river miles from the USGS gage at Kiona to Horn Rapids Dam. Valley width through most of the reach is constrained by bedrock and consolidated sediments downstream of Benton City. Active channel width is less than 100 feet in some locations. Figure 4 (below) shows a cross-section at RM 29.9 in this reach (USBR 2003). Total channel width is 250 feet, including 150 feet of overbank, at this location.

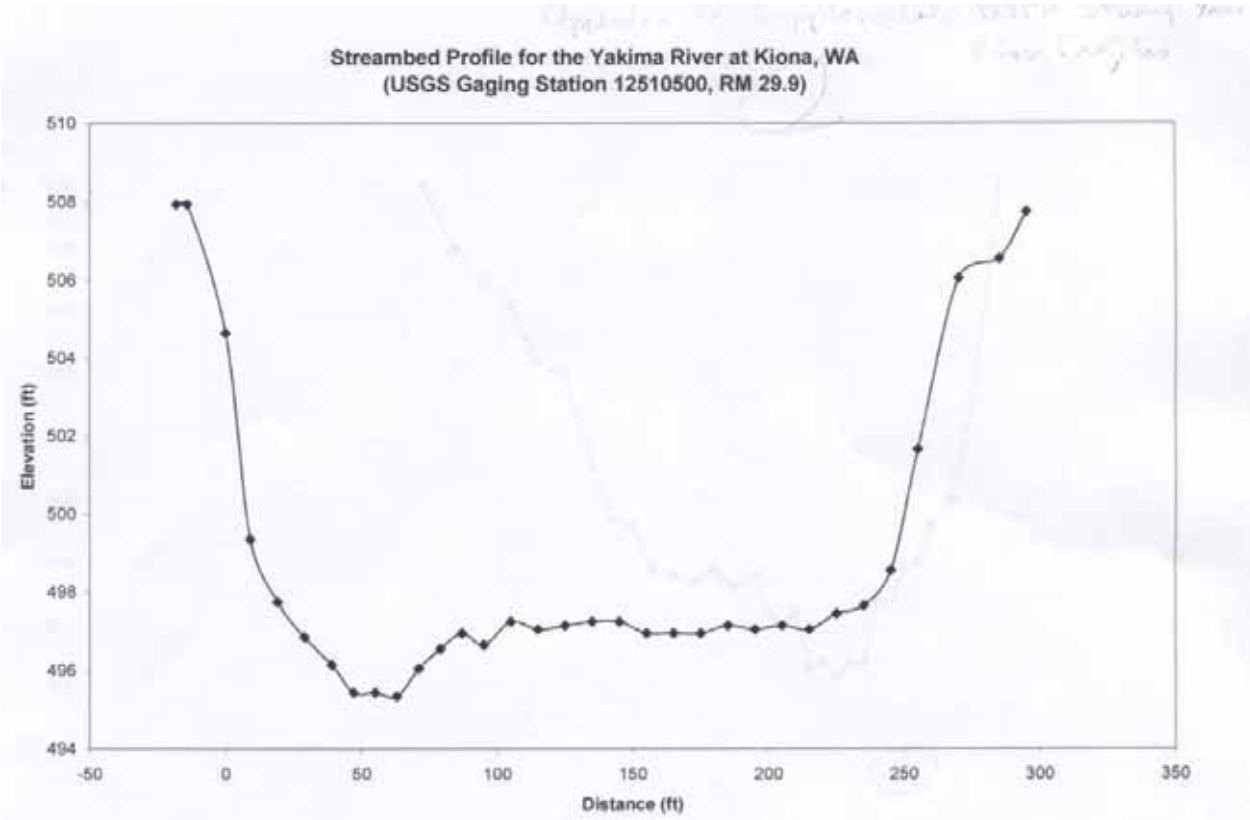



**Figure 4. Channel cross section elevation at river mile (RM) 29.9.**

The Richland Reach extends 14 river miles from Horn Rapids Dam to RM 3.5 at the city limits of Richland. Valley fill is composed of Columbia River floodplain and alluvial deposits. The reach gradient near Horn Rapids is 0.1% in a meandering planform with a sinuosity of 1.8 (WSDOT 2007).

Table 2 (below) presents a summary of reach characteristics:

Table 2. Channel reach characteristics.

| | Length (miles) | Geology | Gradient (%) | Avg valley width (VW) (ft) | Avg channel width (CW) (ft) | VW/CW |
|---|---|---|---|---|---|---|
| Prosser Reach | 22.2 | bedrock | 0.16 | 2,415 | 125 | 19.3 |
| Horn Rapids Reach | 12.4 | bedrock | 0.06 | 2,844 | 90 | 31.6 |
| Richland Reach | 17.5 | sediments | 0.10 | 3,468 | 85 | 40.8 |

**Active Channel Corridor (Historic Migration Zone)**. An overlay of the 1864 General Land Office (GLO) maps on 2009 aerial photography showed no measureable change in

the HMA through most of the study area (Appel et al. 2011). Changes in channel alignment noted downstream of West Richland were outside of the study area. Figure 5 (below) is the Horn Rapids Section of the GLO overlay (Benton County 2010).

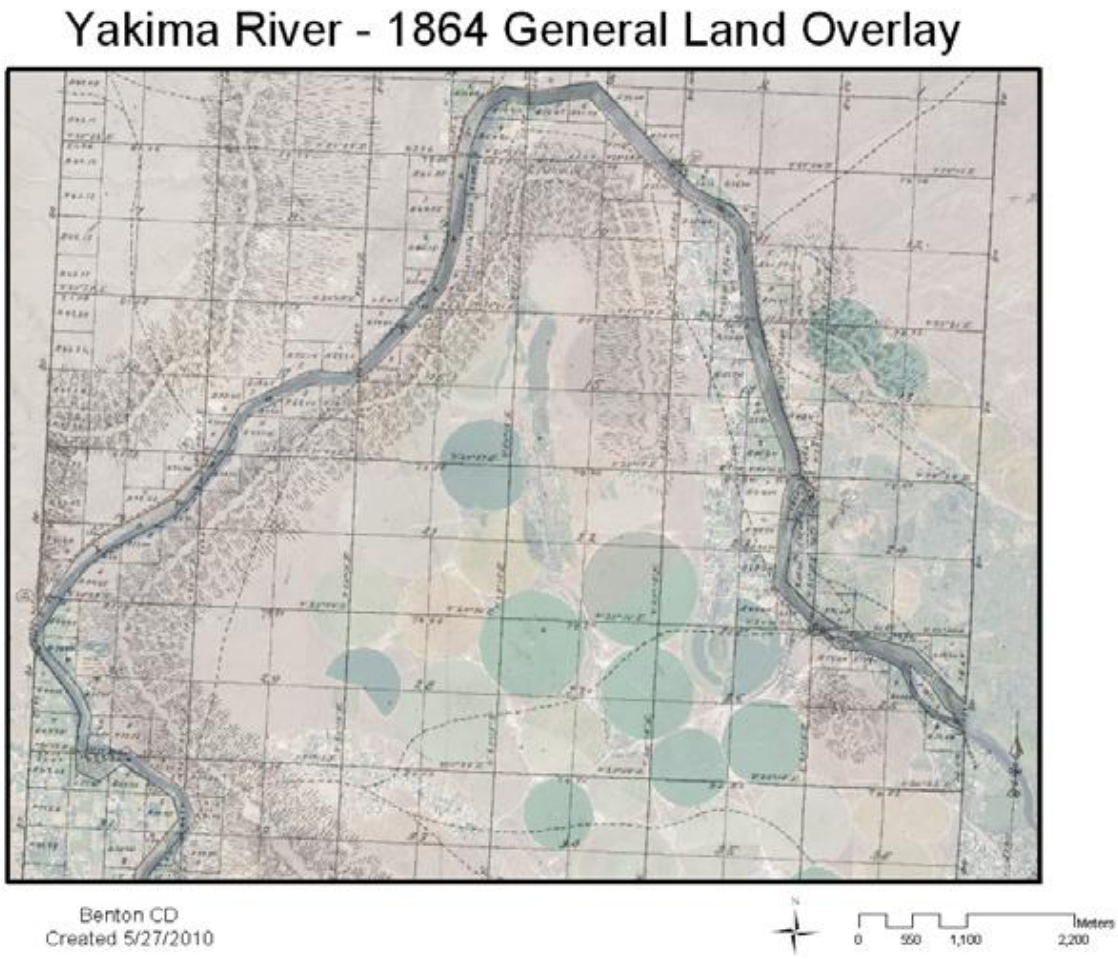



Figure 5. Horn Rapids section of the 1864 General Land Office (GLO) map.

Active Channel Area (ACA) delineation in the study reaches reflects long-term channel stability due to geologic (bedrock) constraints; reduced high flows due to storage and diversion; and extensive buildout of railroads, township roads and highways, bridges, irrigation works, dams, and other forms of infrastructure. ACA boundaries were further evaluated with cross-sections plotted from the 2000 LiDAR coverage. Figure 6 (below) is a cross-section showing valley confinement and channel position in the Prosser Reach.

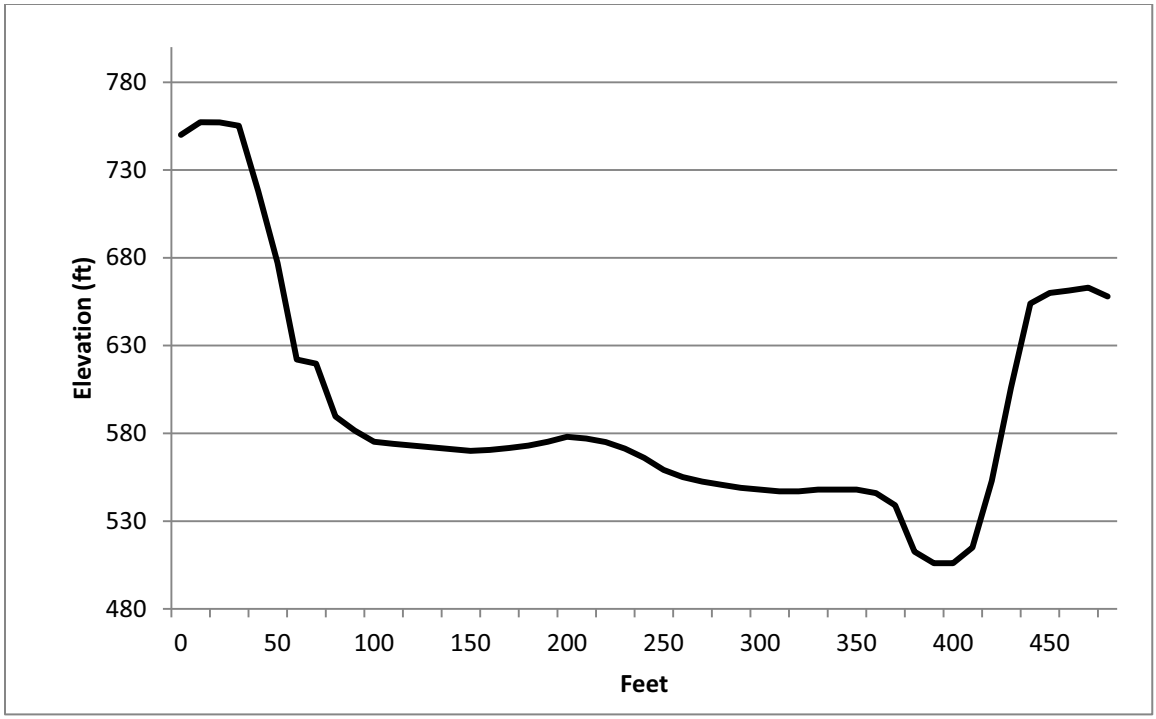



Figure 6. Channel cross-section showing valley confinement and channel position in the Prosser Reach.

**Avulsion Hazard Area (AHA).** A relatively low gradient and geologic and structural controls on active channel width greatly reduce the risk of avulsion in the Prosser and Horn Rapids Reaches of the Lower Yakima River. Avulsion potential in alluvial sections of the Richland Reach is further reduced by backwater effects from McNary Dam on the Columbia River and structural controls due to developments and infrastructure. For this study, the AHA includes the upland extent of historic or relic side channels and geomorphic features without bedrock or mapped structural controls. Other features considered stable were flagged for geologic considerations. Relic point bars and other channel features were evaluated for relative risk of avulsion using LiDAR bare-earth elevation plots. Figure 7 (below) is a LiDAR plot of bare-earth elevations from RM 37.5 to RM 39+ showing a relic point bar currently inactive, but flagged subject to scour during high flows.

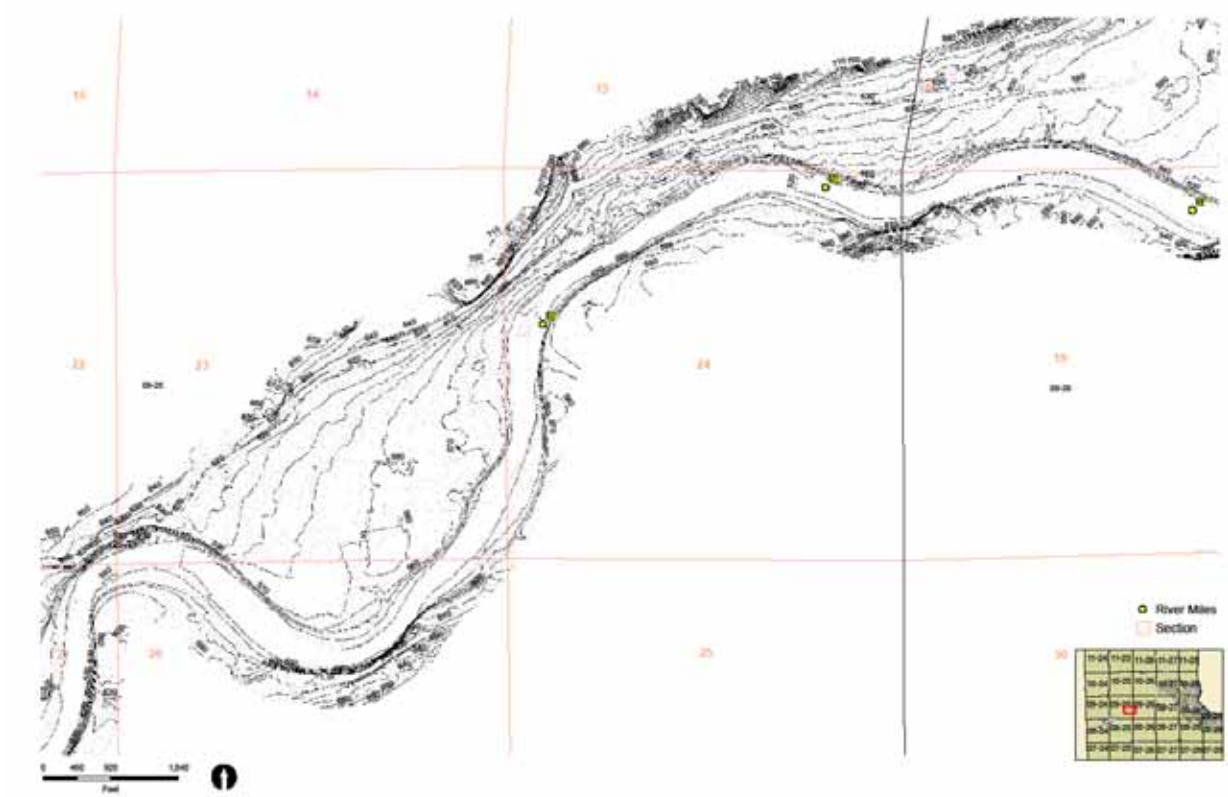



Figure 7. LiDAR plot of bare-earth elevations from RM 37.5 to RM 39+ showing a currently inactive relic point bar, but flagged as subject to scour during high flows.

**Erosion Risk Areas (ERA).** The risk of bank erosion occurs where riverbanks and terraces composed of alluvium or other unconsolidated sediments are undermined by high flows. Riverbank erosion has been documented for relatively short sections downstream of Benton City (Benton CD 2009) and along highway SR 240 (WSDOT 2007). In these cases, erosion was treated with standard bioengineering methods. A geologic flag was included for channel features that appear inactive, but may be subject to bank erosion during high flows.

**Disconnected Migration Areas (DMA).** For this study, the DMA includes many but not all of the legally existing artificial structures that may limit the extent of the CMZ. Table 3 (below) lists structures evaluated for the study reaches:

Table 3. Structures evaluated in each study reach.

| | Prosser Reach | Horn Rapids Reach | Richland Reach |
|---|---|---|---|
| Federal and State Highways and Bridges | SR 12 | SR 225 | SR 240 |
| Improved Roads (paved) | Old Inland Empire, Byron Road | Demoss Road, Lower River Road | Snively Road, Yakima River Road |

| | Prosser Reach | Horn Rapids Reach | Richland Reach |
|---|---|---|---|
| Dams, Diversion Structures, Canals | Prosser Dam, Chandler Powerhouse, Chandler Canal, Kennewick Canal, Kiona Canal | Horn Rapids Dam, Kiona Canal, Columbia Canal | McNary Dam (Columbia R.), Columbia Canal, Richland Canal, Horn Rapids Ditch |
| Railroad embankments and Bridges | Burlington Northern RR | Union Pacific RR | |
| Flood Control Levees and Revetments | unknown | unknown | Corps of Engineers levee RM 16- RM 17.1 |
| Shoreline Modification, Groins, Barbs, RipRap | unknown | unknown | unknown |
| Municipal Structures, Sewage Treatment Plant (STP) | Prosser STP | Benton City STP | |

**SMP Channel Migration Zone (CMZ).** The SMP regulatory CMZ is based on the equation CMZ = ACA + AHA + ERA - DMA (Ecology 2011). The following maps show the elements of the equation for subsections of each reach. The Shoreline Inventory Map Folio in Appendix B contains the final maps showing the GIS-digitized regulatory CMZ. The Appendix B maps include internal review and corrections by The Watershed Company using high resolution comparison of initial boundary delineations. These maps were reviewed by the Department of Ecology using an ArcGIS water surface elevation model for comparison to LiDAR elevation-based delineations (Olson 2012). Based on this review, only minor changes or adjustments in CMZ boundaries were made in the Prosser Reach, RM 52 to 30. Changes in delineations in the Horn Rapids and Richland reaches generally reflect minor adjustments for water surface conditions and infrastructure. A change in boundary delineation was made on the right bank in the vicinity of RM 28 (Horn Rapids Reach) to reflect erodible deposits and unsurfaced roads subject to scour during high flows. A change in boundary delineation was made on the left bank in the vicinity of RM 10.8 to 11.2 to include an abandoned oxbow and oxbow lake feature subject to potential avulsion during high flows. Although there is no photo documentation of past avulsion at this site, the photo record is incomplete and the site has no obvious barrier to future avulsion that would exclude it from delineation.

**References**.

Appel, M. et al. Assessment of the Lower Yakima River in Benton County, Washington. In cooperation with the Yakima Basin Fish and Wildlife Recovery Board. Salmon Recovery Funding Board Grant 07-1566. February, 2011.

Benton County. Yakima River Streambed Profiles. Black Rock Reservoir Study. Appendix B. Prosser, WA 2009

Google Earth. U.S. Dept of State Geographer. Map Link/TeleAtlas. 2012

Joel Freudental, Yakima County Public Works. personal communication. 2012

Kinnison, H.B. and Sceva, J.E. Effects of Hydraulic and Geologic Factors on Streamflow of the Yakima River Basin, Washington. US Geological Survey, Water Supply Paper 1595. US Government Printing Office. Washington D.C. 1963

Olson, Patricia. Shorelands and Environmental Assistance Program. WA Dept of Ecology. personal communication. 2012

U.S. Geological Survey. Streamstats Program. url: http://water.usgs.gov/osw/streamstats/

Vaccarro, J. River Aquifer Exchanges in the Yakima River Basin, Washington. US Geological Survey Scientific Investigations Report 2011-5026. Tacoma, WA. 2011

Washington Department of Ecology. Draft Planning Level Channel Migration Zone Assessment and Delineation Methodology. Cardno/Entrix, Inc. and Geoengineers, Inc. Chapter 4. Olympia, WA. 2011

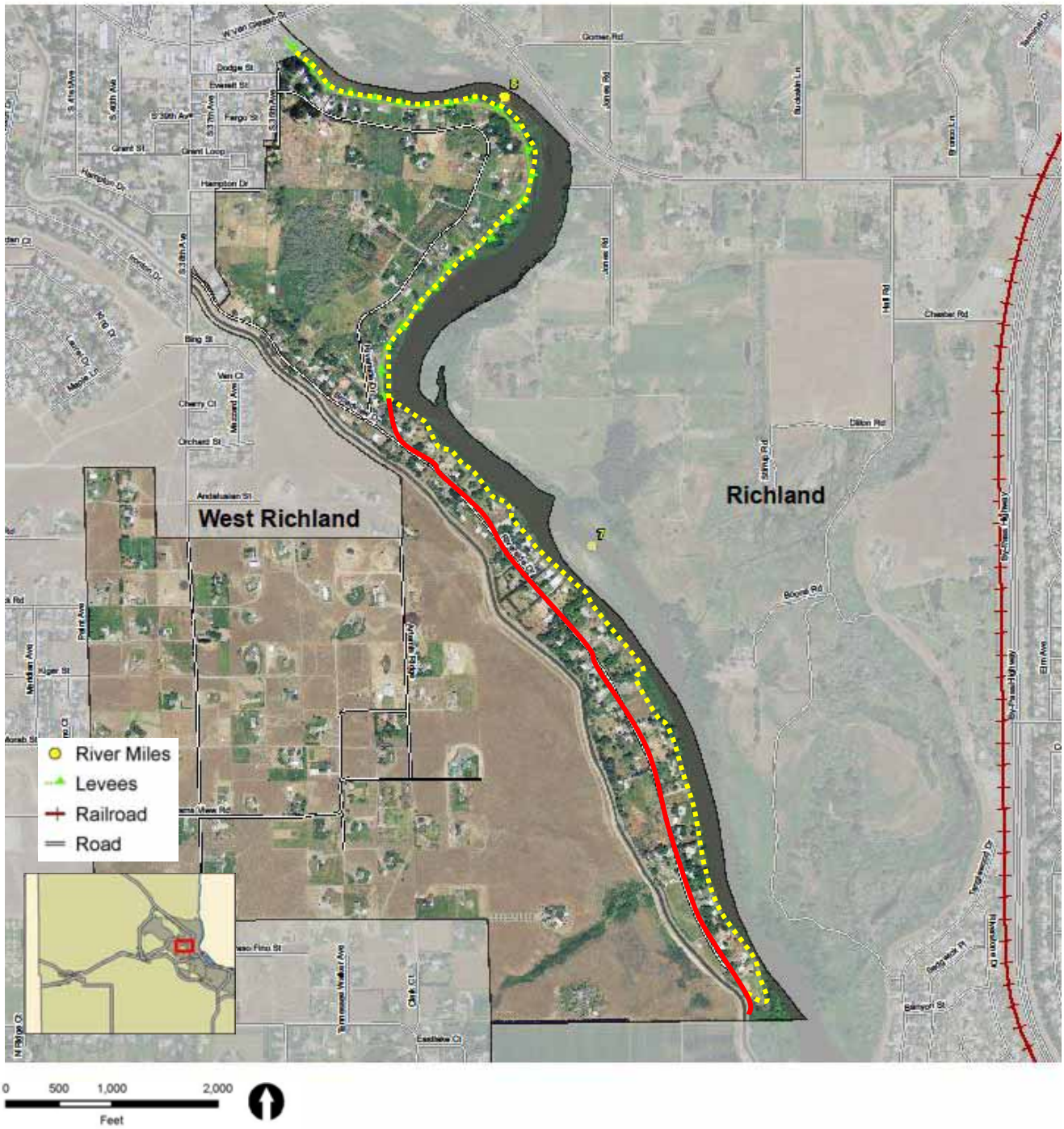
Washington Department of Ecology. A Framework for Delineating Channel Migration Zones. Rapp, C.F. and Abbe, T.B. Washington Department of Ecology, Washington Department of Transportation. Olympia, WA. 2003

Washington Department of Ecology. Dr. Patricia Olson. personal communication. 2012

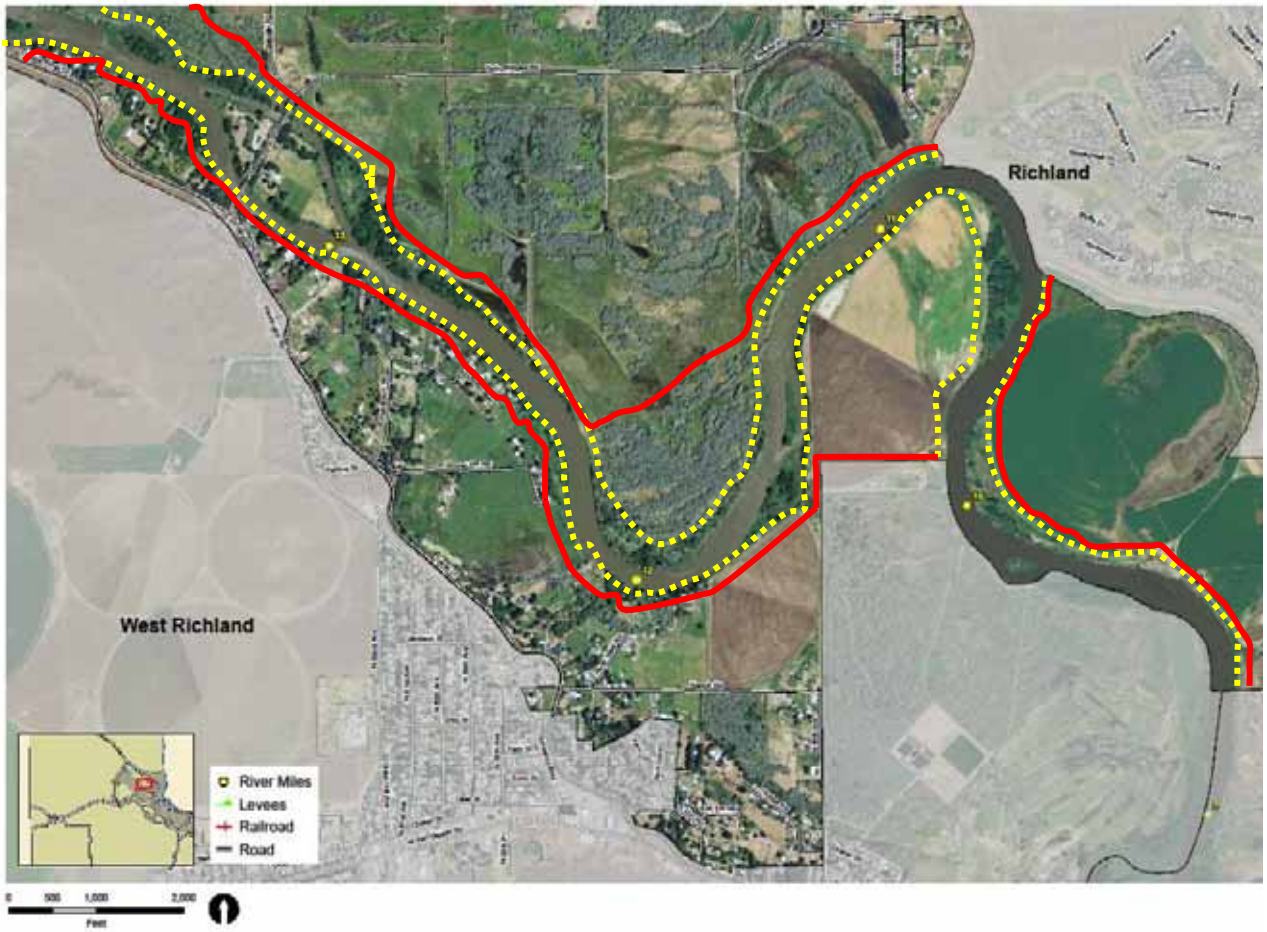
Washington Department of Natural Resources. Schuster, E.J. Geologic Map of Washington and Geology of Washington State. Adapted by Lynn Moses from an article by Raymond Lasmanis. Washington Division of Geology and Earth Resources. Olympia, WA. 1990

Washington Department of Transportation. Molash E. and Park, J. Site and Reach Assessment. Yakima River at SR 224 (Van Giesen Road). Work Order MT0100. WSDOT. Olympia, WA. 2007

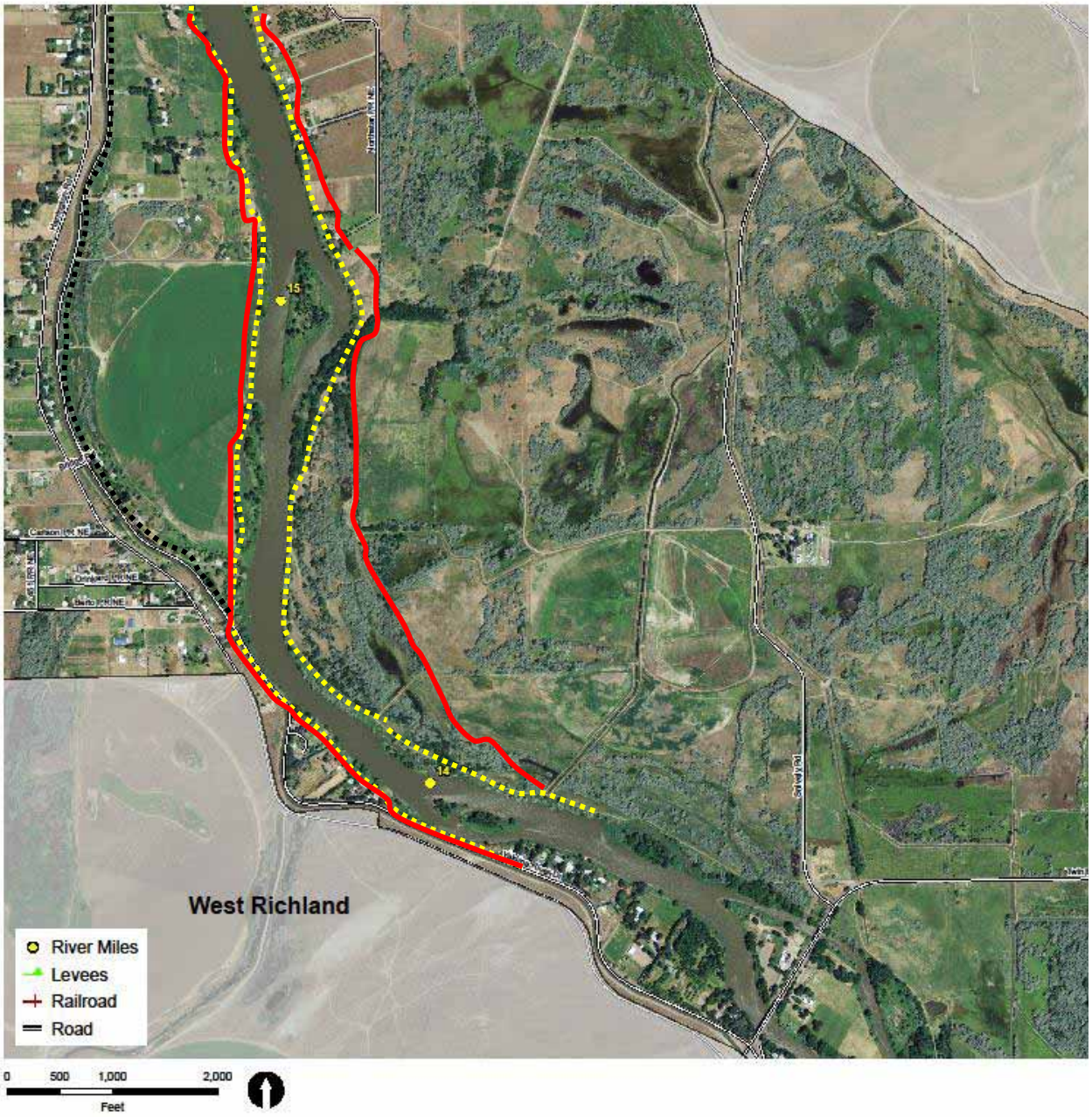
Wise, D. et al. Assessment of Eutrophication in the Lower Yakima River, Washington. USGS Scientific Investigations Report 2009-5078. Tacoma, Washington. 2009




Notes: RM 6.9 to 8.4
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, green (waterward of flood control levee)
Erosion Risk Area, generally within ACA. Geological setback, none
Disconnected Migration Area, outside of flood control levee, Riverside Drive, Columbia Canal
CMZ (red) including waterward of Riverside Drive




Notes: RM 9.4 to 13.7
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Areas, scroll bar at RM12.3 and potential meander cutoff at RM11.5
Erosion Risk Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, outside of Yakima River Drive, Twin Bridges, irrigation circles
CMZ, red




Notes: RM 13.7 to 15.5

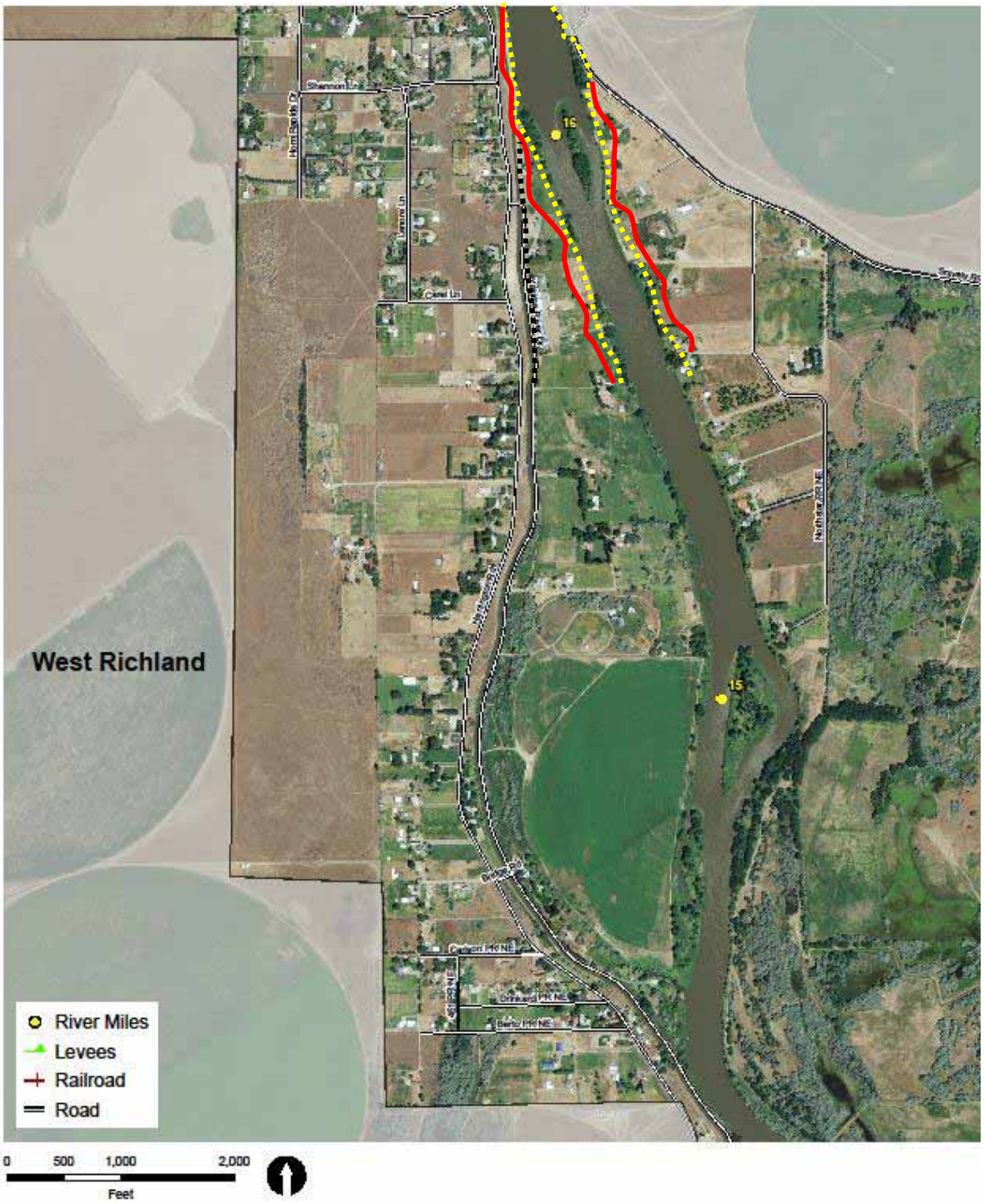
Active Channel Area, yellow (riparian area)

Avulsion Hazard Area, point bar at RM 15.6 to RM 14.5

Erosion Risk Area, generally within ACA. Geologic flag, black (right bank RM 14.5 to RM15.6) relic point bar, subject to erosion during high flows

Disconnected Migration Area, outside of Yakima River Drive, Northstar PR NE, irrigation circle

CMZ, red



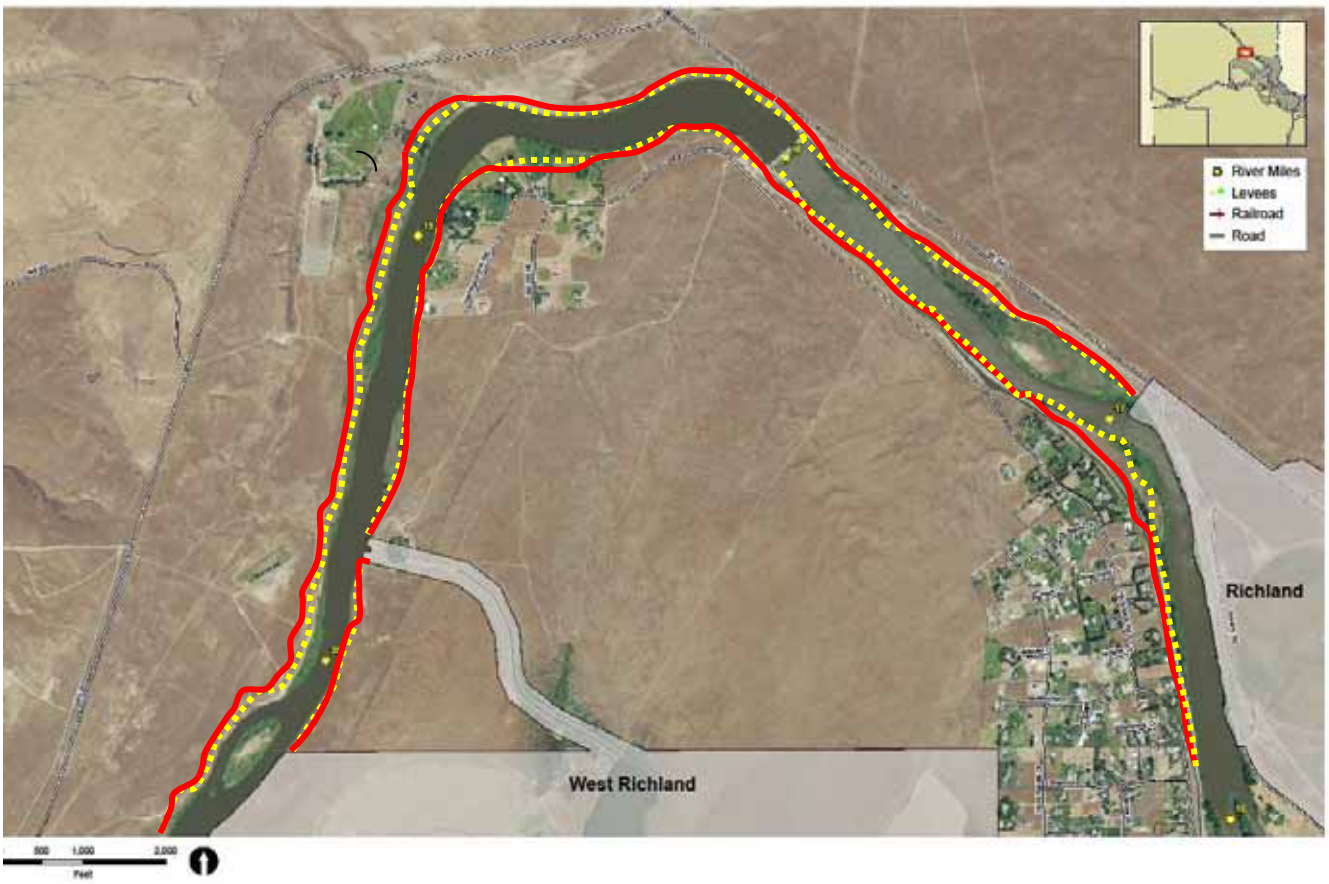

Notes: RM 15.5 to 16.2

Active Channel Area, yellow (riparian zone)

Avulsion Hazard Area, moderate to low risk at mid-channel island, RM 16

Erosion Risk Area, generally within ACA. Geologic flag, black (right bank RM 15.6 to RM 16), relic point bar, subject to scour during high flows

Disconnected Migration Area, outside of Columbia Canal, Yakima River Drive, Snively Rd




Notes: RM 16.2 to RM 20.4

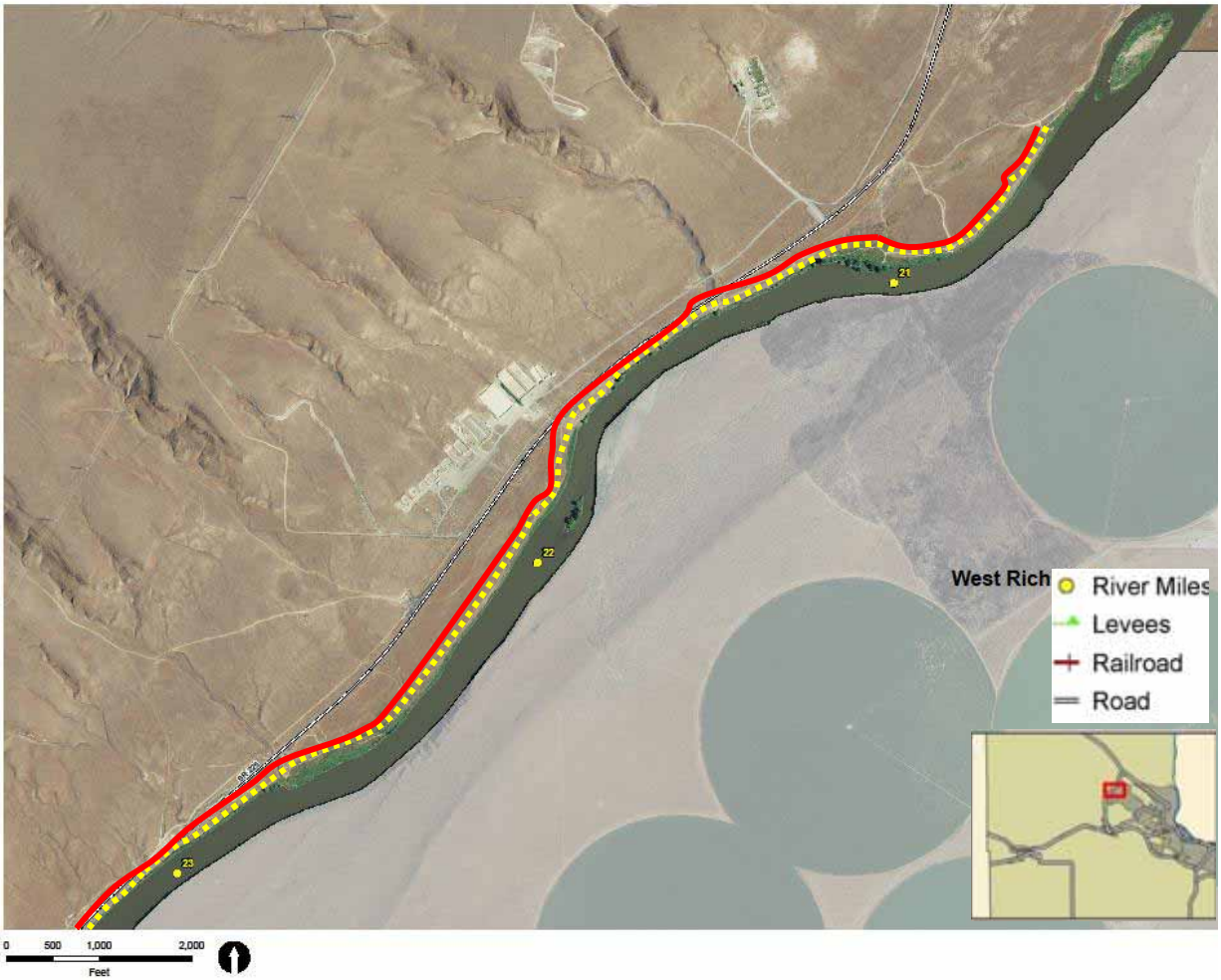
Active Channel Area, yellow (riparian zone)

Avulsion Hazard Area, relic point bar at RM 19

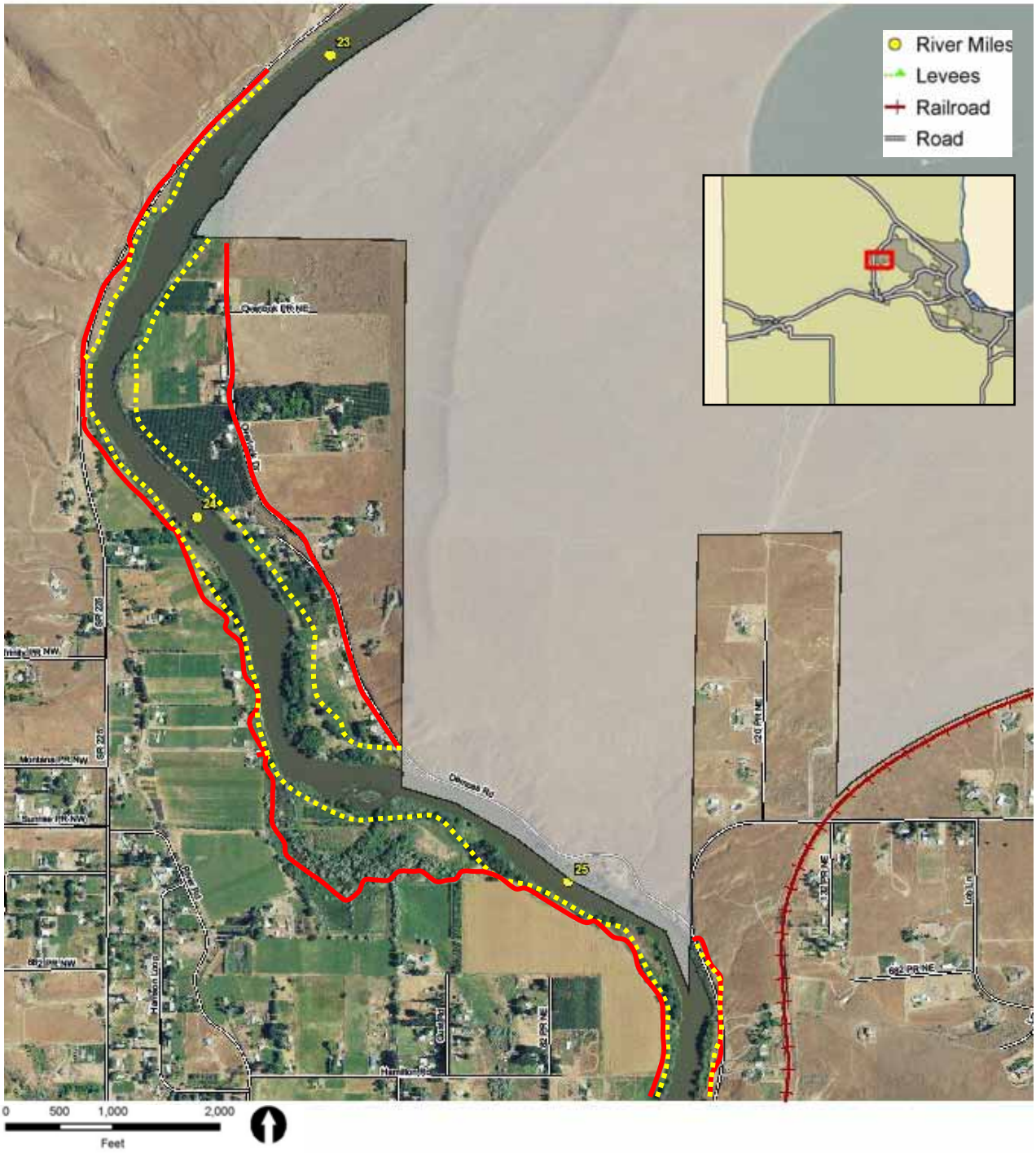
Erosion Risk Area, generally within ACA. Geologic setback, none

Disconnected Migration Area, outside of highway SR240, Horn Rapids Dam (RM 18), and Harrington PR NE

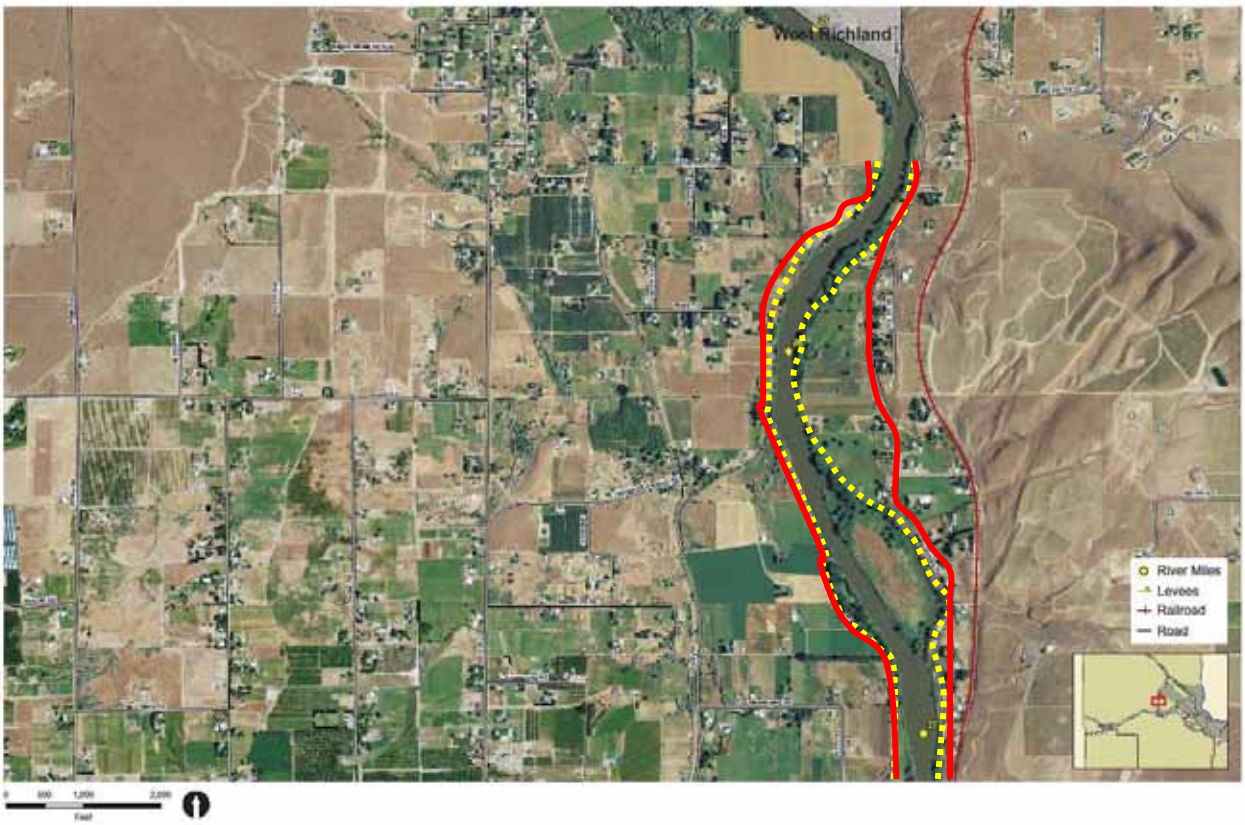
CMZ, red



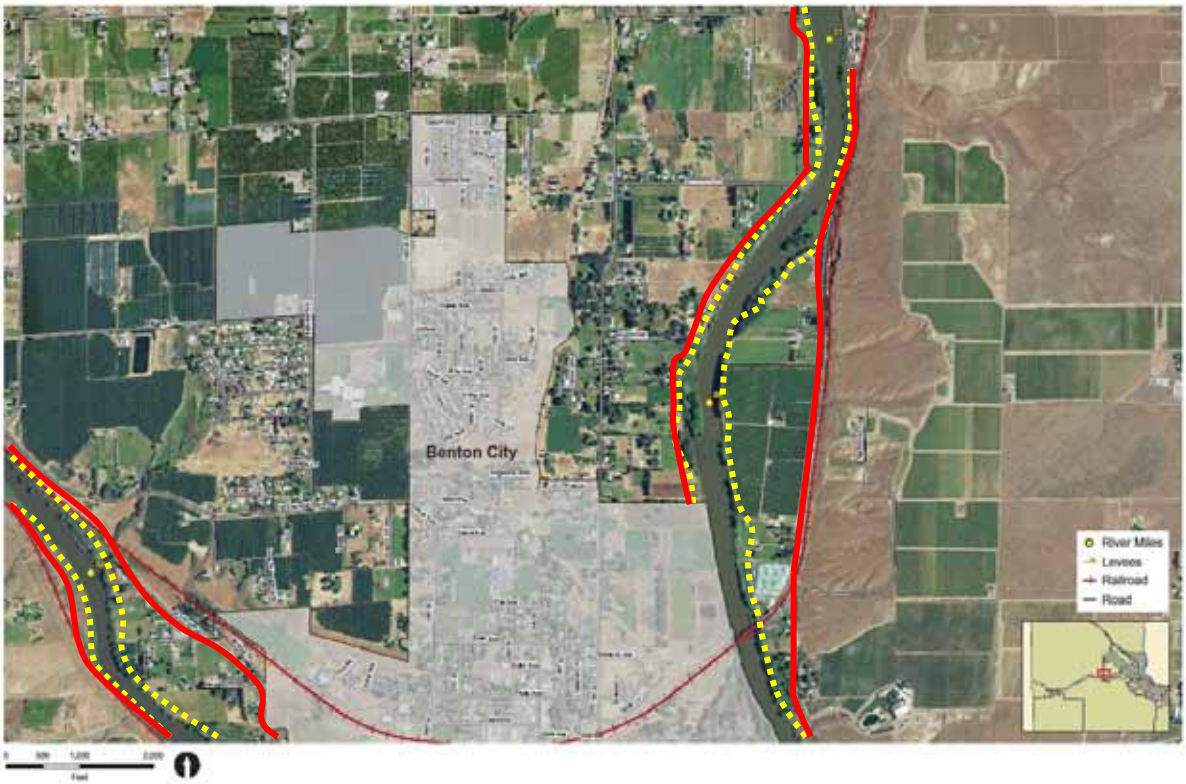

Notes: RM 20.4 to RM 23.1
Active Channel Area, yellow (riparian area)
Avulsion Hazard Area, none
Erosion Risk Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, outside of highway SR225
CMZ, red



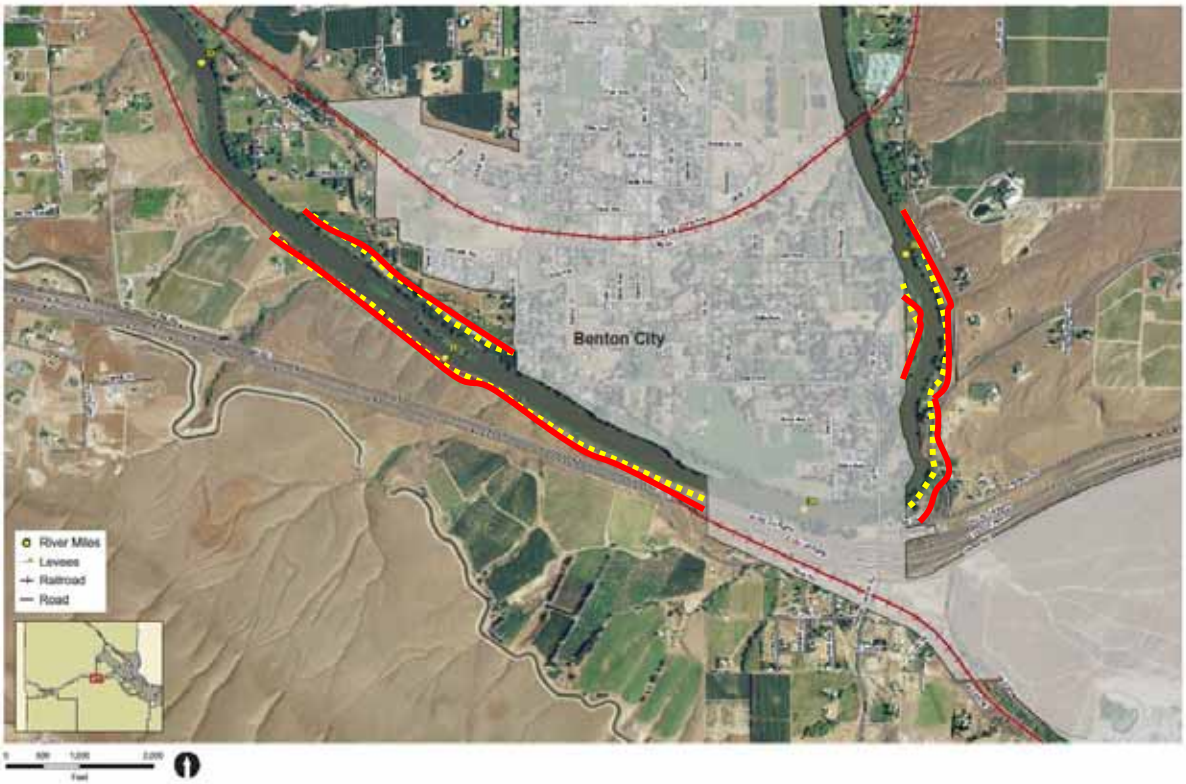

Notes: RM 23.2 to RM 25.5
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, relic channel at RM 24.6, inactive point bar RM 23.5 to RM 24.5
Erosion Risk Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, outside of DeMoss Rd, Overlook Dr.



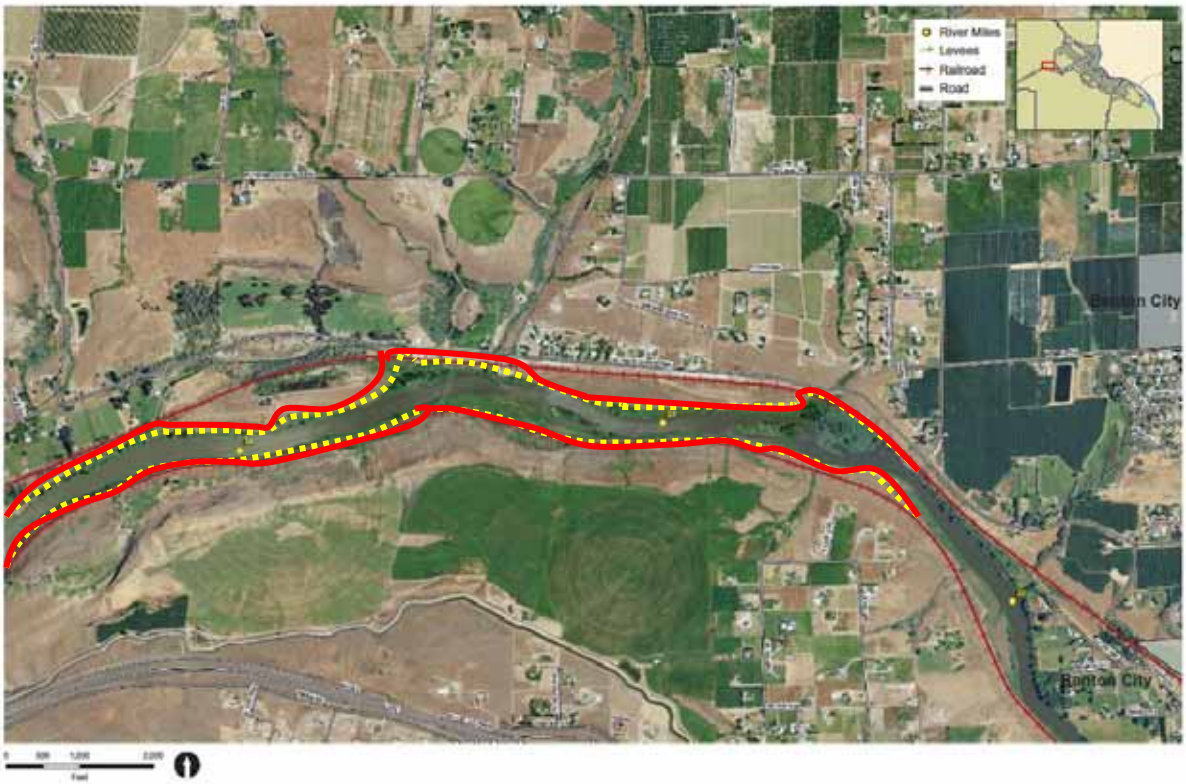

Notes: RM 25.5 - RM 27.2
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, relic point bar upstream of island, RM 26
Erosion Risk Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, outside of Ruppert Rd, Demoss Rd, Union Pacific RR
CMZ, red



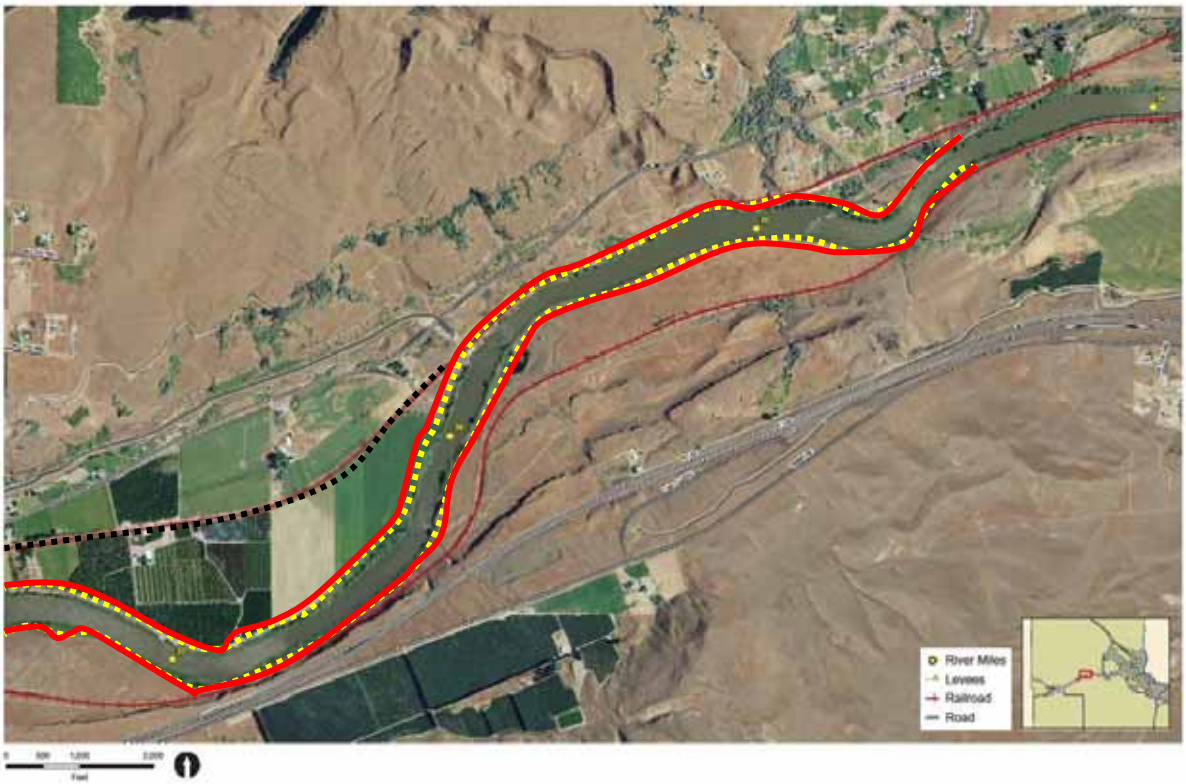

Notes: RM 27.2 to RM 32.4 (interrupted at Benton City)
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, relic point bar at RM 27.6 and at RM 31.7
Erosion Risk Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, outside of Union Pacific Railroad Bridge at RM 28.6, Demoss Rd, Burlington Northern Railroad
CMZ, red




Notes: RM 28.8 to RM 31.5, Benton City
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, none
Erosion Risk Area, gnerally within ACA. Geologic setback, none
Disconnected Migration Area, outside of Demoss Rd, Burlington Northern RR
CMZ, red




Notes: RM 32.4 to RM 34.5
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, none
Erosion Risk Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, outside of Burlington Northern RR (RM 33.3)
CMZ, red




Notes: RM 34.5 to 37.5

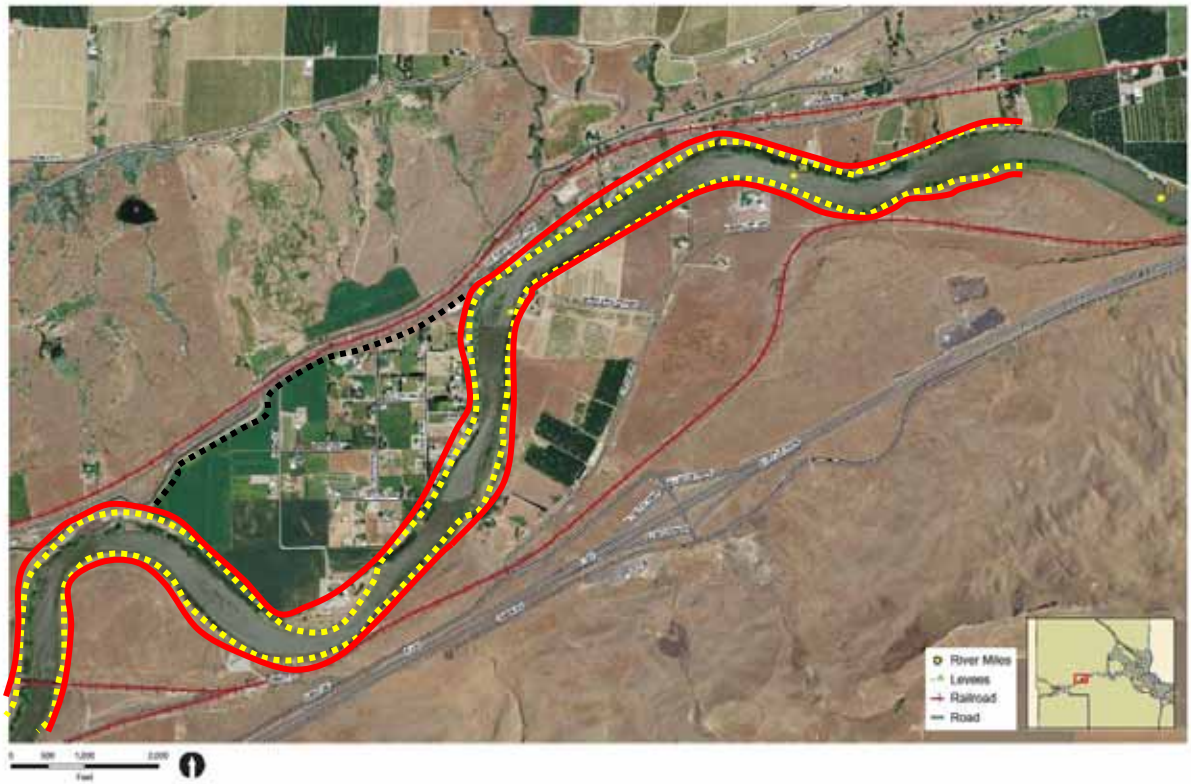
Active Channel Area, yellow (riparian zone)

Avulsion Hazard Area, little to none

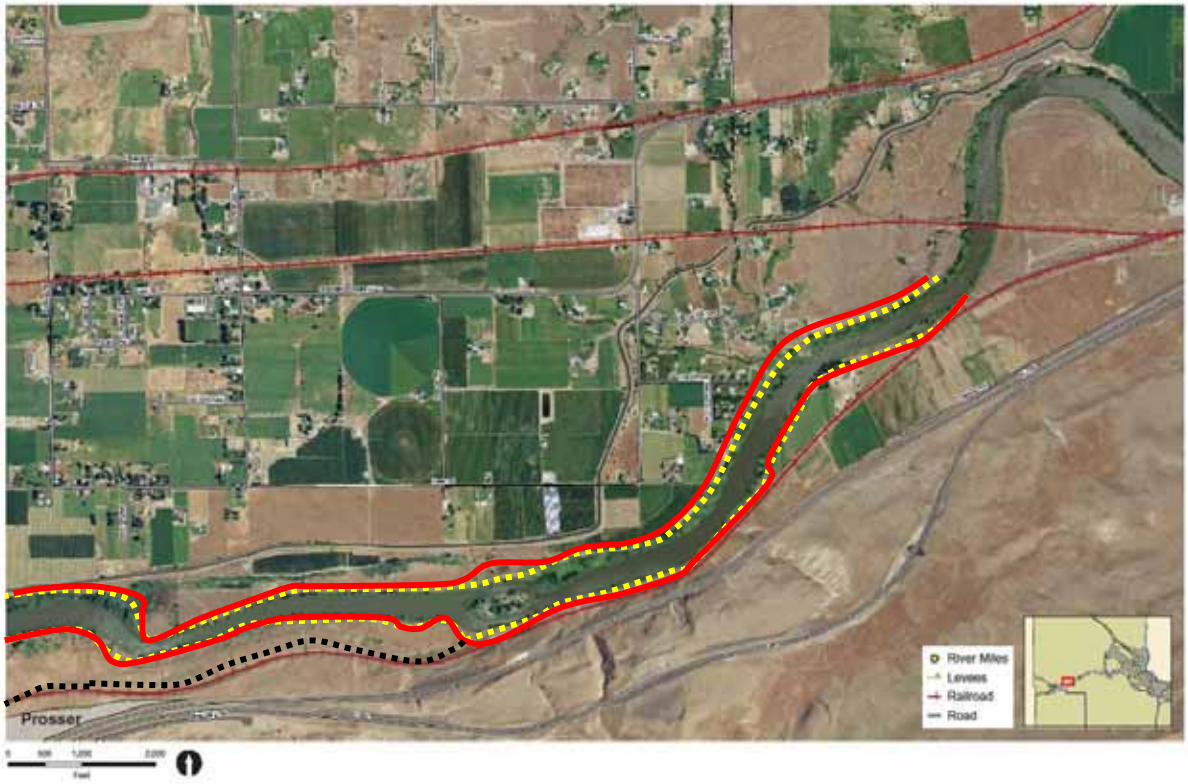
Erosion Risk Area, generally within ACA. Geologic flag, black (left bank RM 36 to RM 37.5), relic point bar waterward of Union Pacific RR, subject to scour during peak flows

Disconnected Migration Area, slight to none outside of Burlington Northern RR

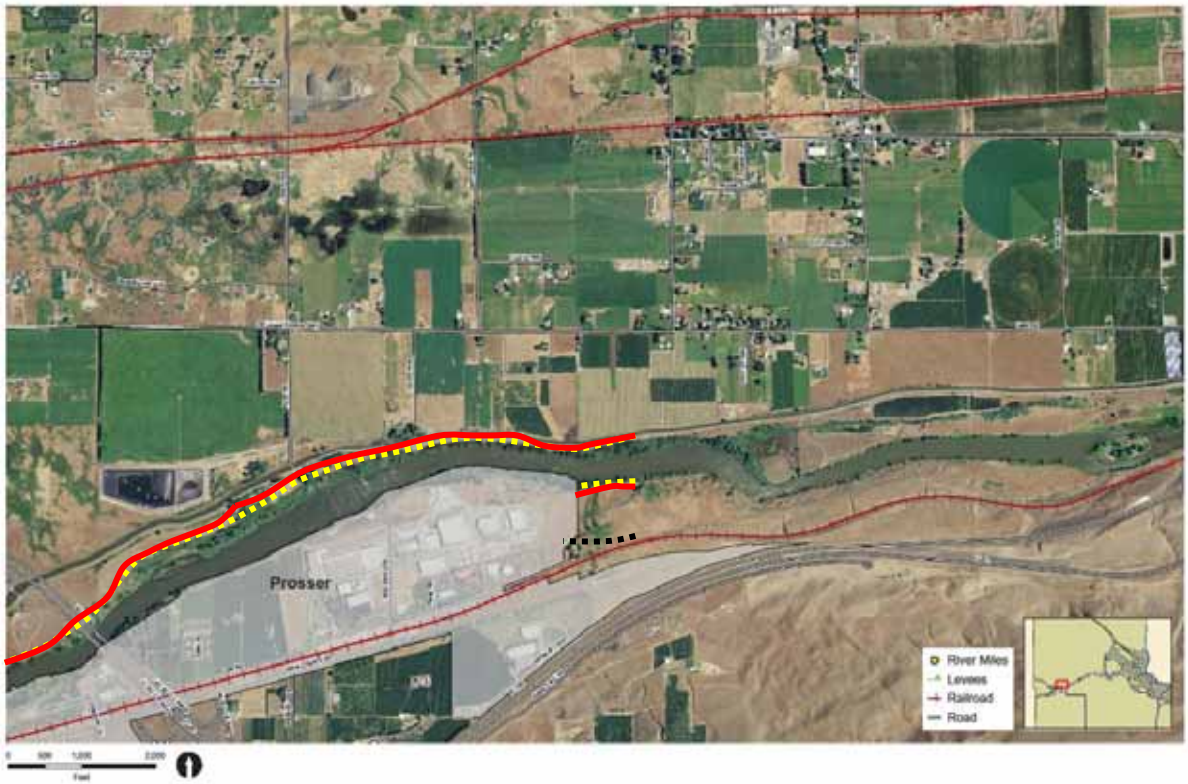
CMZ, red



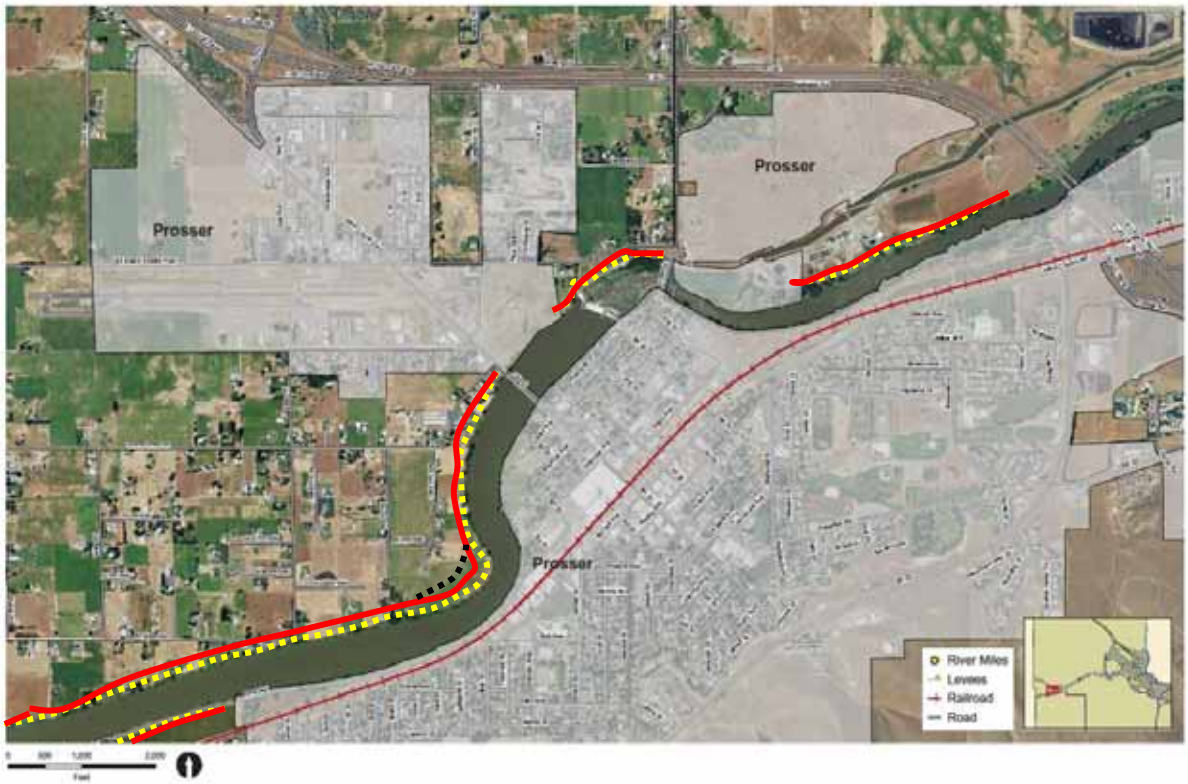

Notes: RM 37.5 to RM 39+
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, small area at tip of relic point bar, left bank RM 39+
Erosion Risk Area, generally within ACA. Geologic flag, black (left bank RM 39+) relic point bar waterward of Chandler Canal and Union Pacific RR, subject to scour during peak flows
Disconnected Migration Area, area of point bar downstream of Hosko and Rattery Road
CMZ, red



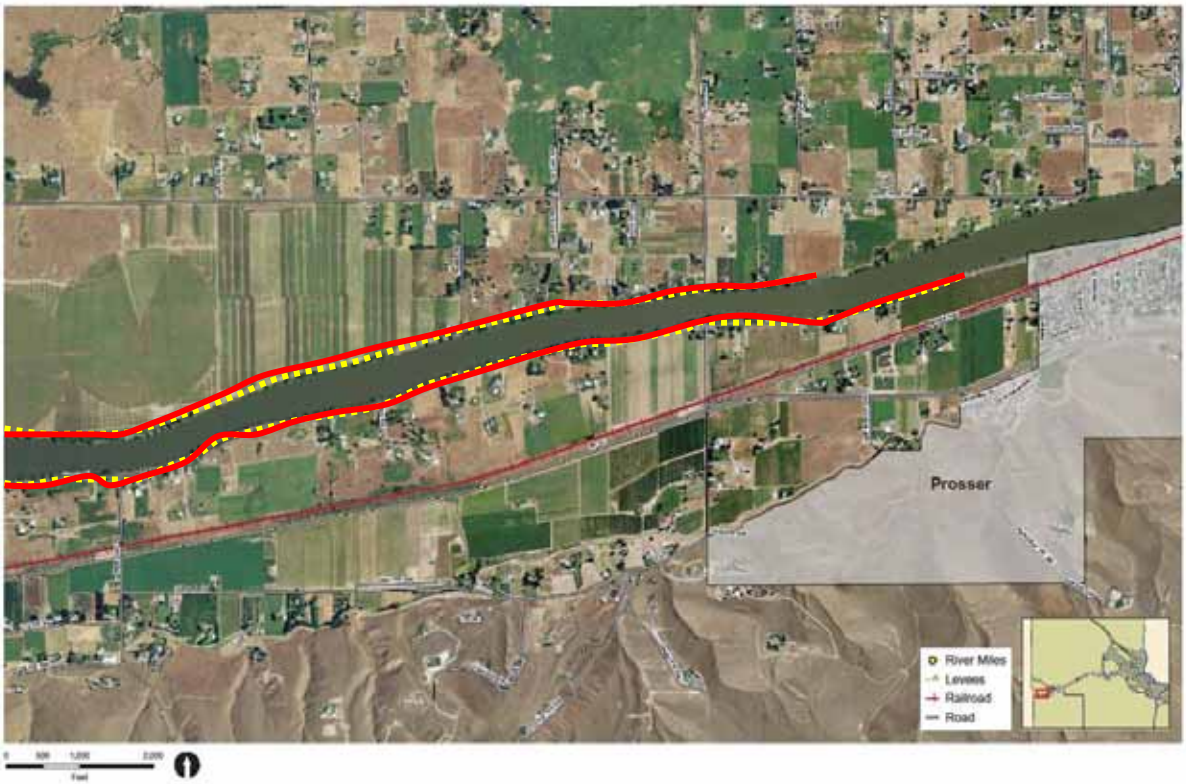

Notes: RM 39+ to Prosser, WA
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, little to none
Erosion Risk Area, generally within ACA. Geologic flag (black) for old landslide and terrace deposits generally unstable or subject to erosion during high flows
Disconnected Migration Area, little to none
CMZ, red



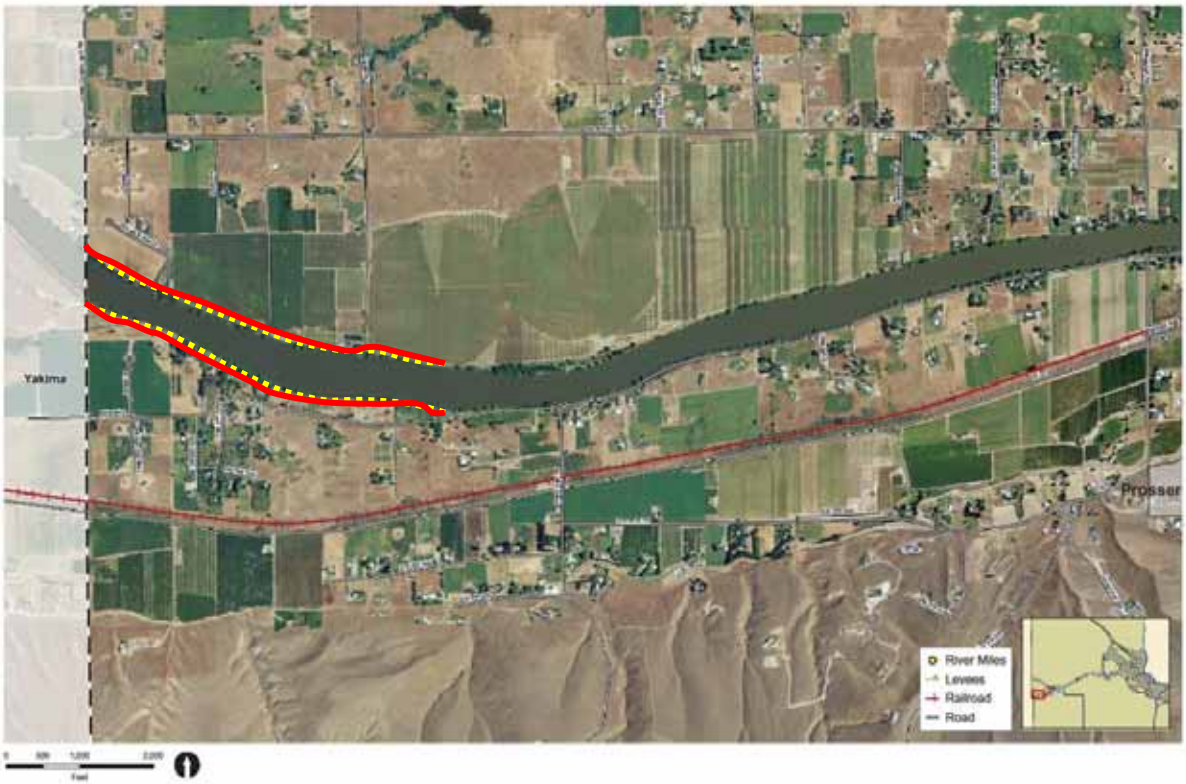

Notes: Lower Yakima River at Prosser, WA
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, little to none
Erosion Risk Area, generally within ACA. Geologic flag (black) for old landslide and terrace deposits generally unstable or subject to erosion during high flows
Disconnected Migration Area, little to none
CMZ, red




Notes: Lower Yakima River at Prosser, WA (continued)
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, little to none
Erosion Risk Area, generally within ACA. Geologic flag (black) at small, relic point bar upstream of 6th St. Bridge, backwater to Prosser Dam
Disconnected Migration Area, little to none
CMZ, red




Notes: Lower Yakima River, upstream of Prosser, WA
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, little to none
Erosion Risk Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, little to none, outside of Byron Road
CMZ, red




Notes: Lower Yakima River at Benton County line
Active Channel Area, yellow (riparian zone)
Avulsion Hazard Area, little to none
Erosion Hazard Area, generally within ACA. Geologic setback, none
Disconnected Migration Area, little to none
CMZ, red