CHAPTER 2.
STUDY AREA CHARACTERISTICS

YAKIMA RIVER BASIN

The CFHMP study area lies in the Yakima River Basin (Figure 2-1), a major drainage basin of the Columbia River. The Yakima River Basin drains 6,062 square miles and is bounded on the west by the Cascade Mountains, on the north by the Wenatchee River Basin, on the east by Horse Heaven Hills, and on the southeast by a narrow divide separating it from the mainstem of the Columbia River. The western portion of the basin is mountainous, with elevations ranging from 6,000 to 8,000 feet; the eastern portion consists of arid lowlands and rolling foothills dropping in elevation to approximately 450 feet.

The Yakima River originates in northwest Kittitas County east of the Stampede and Snoqualmie Passes. Below its confluence with the Cle Elum River, the Yakima River flows southeasterly to the City of Ellensburg and Yakima Canyon. Yakima Canyon extends for over 20 miles before the river valley widens upstream of the town of Selah. The river valley becomes constricted through Selah Gap, and then the river is joined by its largest tributary, the Naches River. The Yakima River then flows past the City of Yakima, is joined by Ahtanum Creek, and cuts through Ahtanum Ridge at Union Gap. Below Union Gap, the Yakima River enters the lower Yakima Valley. The Lower Yakima River continues for over 100 miles before discharging to the Columbia River near the City of Richland.

Annual precipitation ranges from 100 inches in the Cascades to less than 10 inches in the eastern portion of the basin. Most of the precipitation occurs as snowfall in the Cascades from October through January; less than five percent of the precipitation falls during July and August. Approximately 25 percent of the average annual precipitation is discharged by the Yakima River at the basin outlet. The Yakima River average annual discharge is approximately 3,700 cubic feet per second (2,700,000 acre-ft per year) near the basin outlet at Kiona, and 2,500 cubic feet per second (1,800,000 acre-ft per year) near the City of Yakima (USGS 1993).

During the early 1900s, the Bureau of Reclamation began extensive development of an irrigation water supply system in the Yakima Basin (Figure 2-2). Six storage reservoirs, 14 diversion dams, approximately 2,000 miles of irrigation canals, numerous pump stations, and three hydroelectric plants have been constructed to service approximately 500,000 acres in the basin. About 60 percent of total water use in the basin is attributed to agriculture. Return flows from agricultural land account for as much as 80 percent of the Yakima mainstem flow in the Lower Valley during irrigation season (USGS 1993).

Upper basin reservoirs provide over 1 million acre-feet of storage (Table 2-1) and are informally operated for flood control. Approximately 580 square miles drain to the storage reservoirs, 10 percent of the total Yakima River drainage area or 17 percent of the drainage area above the study area. Five major diversion dams are located on the Yakima River: Easton, Roza, Wapato, Sunnyside, and Prosser. Canals divert approximately 2.4 million acre-feet of water annually from surface streams for irrigation (Higgens and Copp 1974) and hydroelectric plants. A schematic of the Yakima River with primary tributary streams and irrigation diversions is presented in Figure 2-3.

TABLE 2-1.
RESERVOIRS IN THE YAKIMA RIVER BASIN

Reservoir Name	River	Year of Completion	Drainage Area (sq. mi.)	Active Storage (acre-feet)
Bumping Lake	Bumping River	1910	69.3	33,700
Cle Elum Lake	Cle Elum River	1933	203.0	436,900
Clear Lake	North Fork Tieton River	1914	Not available	5,300
Kachess Lake	Kachess River	1912	63.6	239,000
Keechelus Lake	Yakima River	1917	54.7	157,800
Rimrock Lake	Tieton River	1925	187.0	198,000

SOURCE: FEMA 1994.

Much of the Yakima River Basin is undeveloped, with large portions owned and controlled by federal, state, and tribal governments. Proper management of these lands is essential to ensure that flood problems in the study area are not exacerbated. Large federal land holdings include the Wenatchee National Forest, Snoqualmie National Forest, and the Department of Defense's Yakima Training Center. The State's DNR and WDFW administer a significant portion of the basin, and one of the largest land holdings is trust lands of the Yakama Indian Nation. Population centers and urban development are primarily along the Yakima River in the cities of Ellensburg, Yakima, and Richland.

STUDY AREA LIMITS

The CFHMP study area lies entirely within the Yakima River Basin and Yakima County. The County is Washington's second largest in area, encompassing 4,400 square miles, and is drained primarily by the Yakima River; the study area is in the center of the County, and includes the floodplain of the Yakima River from the northern County line to Union Gap, and the floodplain of the Naches River from its mouth upstream approximately 3.4 river miles to Twin Bridges on State Route (SR) 12. This study area was selected because it is the County's primary urban area. The CFHMP addresses flooding within the Yakima and Naches River floodplains. Flooding associated with tributary streams will be briefly discussed but the focus will be on the Yakima mainstem.

Because the varying characteristics of the Yakima River can alter the flooding patterns and flood problems vary along the river, the study area can be considered as three reaches: Yakima Canyon to Selah Gap, Selah Gap to the SR 24 bridge, and the SR 24 bridge to Union Gap. The physical characteristics of each reach are described below and summarized in Table 2-2.

Upper Reach—Yakima Canyon to Selah Gap

The study area's upper reach begins in the Yakima River Canyon at the County line. From that point, the river meanders slightly through a narrow channel, with the floodplain confined by the railroad grade to the east and natural terrain features to the west. At Wenas Creek, the Yakima floodplain begins to open up into the Selah Valley.

Figure 2-3.

TABLE 2-2.
PHYSICAL CHARACTERISTICS OF YAKIMA RIVER REACHES IN CFHMP STUDY AREA

Description	Upper Reach Yakima Canyon to Selah Gap	Middle Reach Selah Gap to SR 24 Bridge	Lower Reach SR 24 Bridge to Union Gap
River Channel			
Extent (river miles)	124.0 - 117.2	117.2 - 111.6	111.6 - 107.0
Length (miles)	6.8	5.6	4.6
Average Gradient (feet/mile)	11.0	15.4	11.1
Floodway			
Average Width (feet)	1,160	1,165	1,860
Average Velocity (fps)[a]	5.8	7.0	5.0
100-year Floodplain			
Area (acres)[b]	3,764	1,344	2,858
Average Width (feet)	4,570	1,980	5,125

a. Average velocity for base flood flow (56,300 cfs at Parker).
b. Floodplain area is based on the County's GIS system, which is being updated to reflect recent revisions to the 100-year floodplain.

SOURCE: FEMA 1994

Below Wenas Creek, the Yakima River widens as it enters the Selah Valley below Harrison Road. The river meanders through the Selah Valley and is again constricted as it cuts through Yakima Ridge at Selah Gap, four miles downstream of Harrison Road.

The 100-year floodplain along this 6.8-mile reach covers approximately 3,764 acres and averages 4,570 feet in width. The average gradient is 11 feet per mile as the river flattens coming out of Yakima Canyon. Land use in the reach is mostly agricultural. Development pressure is primarily in East Selah and Pomona.

Middle Reach—Selah Gap to SR 24 Bridge

The study area's middle reach begins below Selah Gap, where the Yakima River is joined by its largest tributary, the Naches River, and is confined by a federal levee system constructed following the 1933 flood. The middle reach includes the Yakima River floodplain south of the Naches River downstream to SR 24, in addition to the Naches River floodplain from its mouth to Twin Bridges; both the Yakima and Naches Rivers are confined in this reach by the federal levee system and natural features. The levee system, built to protect urban development in the City of Yakima and unincorporated Yakima County, has cut off many overflow channels that historically conveyed or stored floodwaters.

The 5.6-mile reach displays a slight meandering pattern. Its 15.4-foot-per-mile gradient is steeper than those of the upper and lower reaches, and its floodplain is narrower, averaging 1,980 feet in width. The Yakima and Naches River floodplain encompasses 1,344 acres and is primarily undeveloped between existing levees.

Lower Reach—SR 24 Bridge to Union Gap

The lower reach of the study area extends from SR 24 to Union Gap. As the river flows past SR 24, its floodplain widens to an average of 5,125 feet and the gradient flattens to 11.1 feet per mile. This reach has many gravel bars, indicating a history of sediment deposition. The river is confined by levees that extend downstream of SR 24 and provide various levels of protection. A right bank levee extends for approximately 1 mile downstream of SR 24 bridge; a left bank levee extends for approximately 2 miles downstream. Private levees have also been installed along this reach. Agriculture and undeveloped land are the primary land uses. The City of Yakima has a sewage treatment plant along the right bank. The City of Union Gap is west of the river near the end of this 4.6-mile study reach, where the river is again confined as it cuts through Ahtanum Ridge.

PHYSICAL CHARACTERISTICS

Climate

The climate in the Yakima River Basin varies from desert conditions in the southern lowlands to moist alpine conditions in the mountains. The Rocky Mountains to the east and north shield Yakima County from winter cold-air masses moving southward from Canada, resulting in moderate winters. To the west, the Cascade Mountains form a barrier to the easterly movement of moist air from the Pacific Ocean. This produces warm and dry summer months. The climate in the study area is classified as semi-arid.

Climate data for the City of Yakima (Table 2-3) are recorded at a National Weather Service station at the Yakima Airport. The city's mean annual rainfall is approximately 8 inches, and its mean annual snowfall is approximately 24 inches. The wettest month on record was December 1964, when the city received 4.16 inches of precipitation. Temperatures range from an average low of 20° F in January to an average high of 87° F in July. Approximately 50 percent of the annual precipitation falls between October and January, and 75 percent between October and March (Figure 2-4). The greatest amounts of snowfall occur in December and January. Snow can be expected by the first of December and generally remains on the ground for periods from a few days to six weeks between mid-December and late February.

Hydrology

The Yakima River is the principal drainage feature in the study area, and several tributaries contribute sizable drainage areas. The largest tributary is the Naches River, which joins the Yakima near Selah. Smaller contributing streams include Wenas and Selah Creeks in the northern portion of the study area, and Ahtanum Creek in the southern portion near Union Gap.

The U.S. Geological Survey (USGS) and the U.S. Bureau of Reclamation collect river flow data on the Yakima and Naches Rivers. Three gauging stations near the study area are described in Table 2-4. The Yakima River at Umtanum station is north of the study area, 0.5 miles upstream from Umtanum Creek; the Yakima River at Parker station is south of the study area, 500 feet downstream of Sunnyside Dam; and the Naches River near North Yakima station is 0.6 miles upstream from the confluence of the Yakima and Naches Rivers. Table 2-5 summarizes daily average flows at these stations.

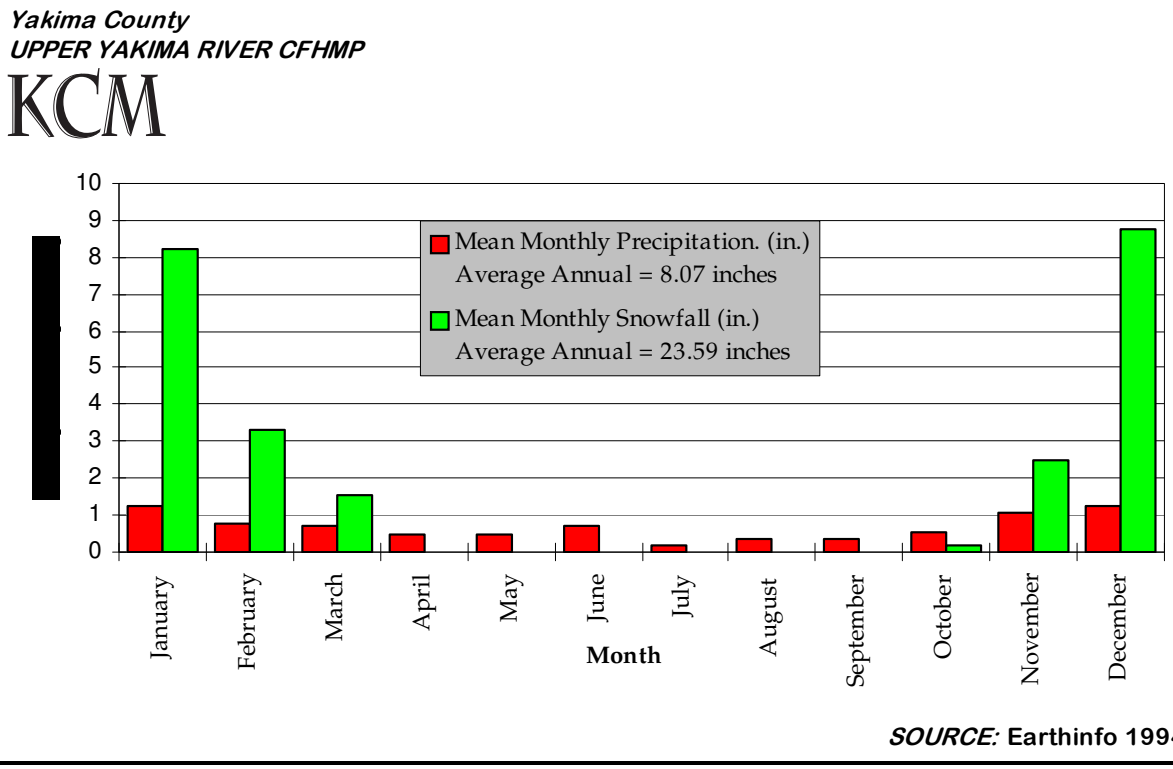

Figure 2-4.
MEAN MONTHLY PRECIPITATION IN YAKIMA

TABLE 2-4
FLOW GAUGING STATIONS NEAR THE STUDY AREA

Station	Yakima at Umtanum	Naches near North Yakima[b]	Yakima near Parker[a]
Station No.	12484500	12499000	12505000
Drainage Area (sq. mi.)	1,594	1,106	3,660
Location	10 miles south of Ellensburg 0.5 miles upstream of Umtanum Cr.	0.6 miles upstream from the confluence of the Naches and Yakima Rivers	1.3 miles east of Parker 500 feet downstream from Sunnyside Dam
Period of Record	1906 to present	1895 to 1915, 1987 to present	1908 to present
Maximum daily flow (cfs/date)	29,600/December 23, 1933	28,000/November 24, 1909	65,000/December 23, 1933
Minimum daily flow (cfs/date)	139/October 3, 1915	30/August 24, 1906	0.60/June 11, 1977

a. This station has been maintained by the Bureau of Reclamation since 1978.
b. This station has been maintained by the Bureau of Reclamation since 1990.
SOURCE: USGS 1993.

TABLE 2-5
SUMMARY OF DAILY AVERAGE FLOWS

	Yakima at Umtanum		Naches near North Yakima		Yakima near Parker	
Month	Daily Avg. Flow (cfs)	% of Avg. Annual Flow	Daily Avg. Flow (cfs)	% of Avg. Annual Flow	Daily Avg. Flow (cfs)	% of Avg. Annual Flow
January	1,601	6	1,007	5	3,045	10
February	1,697	5	847	4	2,987	9
March	2,158	8	1,563	8	3,330	11
April	3,375	11	2,825	14	3,759	12
May	4,313	15	4,016	21	5,000	17
June	3,940	13	3,467	17	4,335	14
July	2,984	11	1,481	8	1,098	4
August	2,857	10	442	2	365	1
September	1,911	7	511	3	363	1
October	1,089	4	589	3	920	3
November	1,214	4	1,606	8	2,144	7
December	1,717	6	1,343	7	3,237	11
Annual	2,468	100	1,659	100	2,542	100

SOURCE: EarthInfo 1994.

Yakima River flow comes from snowmelt and rainfall on the eastern slope of the Cascade Mountains. Average flows are highest during the months of April, May, and June (Figure 2-5) as a result of spring snowmelt runoff. However, peak flood flows typically occur during the winter. Winter flood flows are associated with warm temperatures and rainfall on melting snowpack, and typically follow precipitation periods that have saturated soils, producing greater rates of runoff.

Reservoirs in the upper basin have been operated for flood control when deemed appropriate by the operators, and this has reduced winter flood flows. The reservoirs store water at times of high flow and release it for irrigation during spring and summer. This reduces flood flows in the winter and increases otherwise low flows in the summer.

Geology

Dunne (1976) describes the geology in the study area as follows:

> During the Pliocene epoch (2-12 million years ago) an ancestral Yakima River flowed from the Cascade Mountains across flat-lying basalt lava which had originated from great fissures in the earth's surface during the Miocene epoch (12-26 million years ago). In the vicinity of Yakima, mountain-building forces began to fold the lava into a series of parallel ridges and downwarps. As the lava beds were pushed up the river cut down through the ridges in a series of

narrow gaps. Downcutting kept pace with uplift. Yakima Ridge appeared to have risen more quickly than its southern neighbor, Ahtanum Ridge.

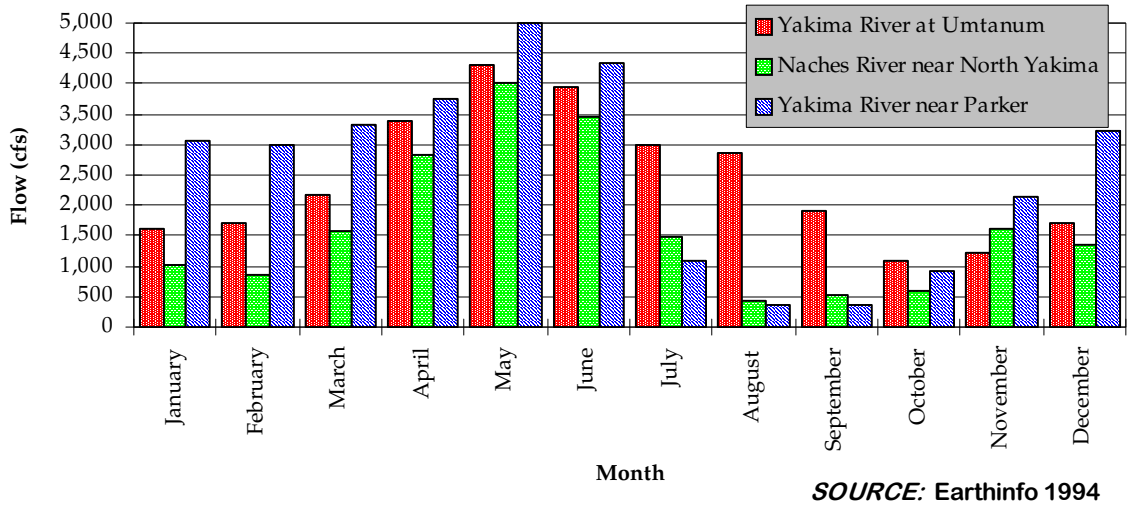

Figure 2-5.
SUMMARY OF DAILY AVERAGE FLOW

At the same time, large andesitic volcanoes in the mountains to the west were undergoing explosive eruptions and vast quantities of ash and volcanic agglomerates were fed into the Yakima Basin and carried downstream by the river. The sediments were deposited as thick layers in the downwarps between the rising basalt ridges. Erosion of the gaps also contributed coarse basaltic gravel to the accumulating deposits. These sediments are now called the Ellensburg formation and in the Moxee Valley are as much as 1,500 feet deep.

During the Pleistocene epoch (2 million to 10,000 years ago) the activity described above continued and glaciers advanced from the high Cascades down the Yakima Valley as far as Cle Elum. The Yakima River was swollen many times with glacial meltwater and large quantities of coarse gravelly sediment from the Naches and Upper Yakima basins. This Pleistocene sediment now covers the surface of the Moxee Valley in the vicinity of Yakima and consists of gravel derived from the basalt ridges together with a minor amount of granitic rocks from the Cascades.

Since the retreat of the Cascade glaciers, the river has cut down about 10 feet into its Pleistocene sediments leaving a terrace of sand and gravel covered by windblown silt along both sides of the valley. This terrace now defines a natural corridor within which the floodwaters are confined…. [The floodplain] is intricately laced with active and abandoned river channels which reflect the vigor with which the river has been migrating across its floodplain during the last few thousand years.

Figure 2-6 shows the identified geologically hazardous areas in the study area. Geologically hazardous areas are lands that, because of their susceptibility to erosion, sliding, earthquake, or other geological events, pose public health and safety concerns for the siting of commercial, residential, or industrial development (WAC 365-195). These areas require protection under the GMA (see Chapter 6).

Alluvial fan, landslide, and steep slope hazard areas are shown in Figure 2-6. Alluvial fans are zones of sediment deposit near the mouths of streams that can experience debris flows and catastrophic flooding. One is located adjacent to Ahtanum Ridge. Steep slope hazards, identified by the U.S. Soil Conservation Service (SCS) in soil surveys, lie near the base of Yakima Canyon, along Yakima and Ahtanum Ridges, and adjacent to Wenas and Ahtanum Creeks. Landslide hazard areas are potentially subject to landslides due to a combination of geologic, topographic, and hydrologic factors; they can be found along the steep walls of tributary creeks and near Yakima and Ahtanum Ridges. A small percentage (8 percent) of the parcels within the floodplain are located in geologically hazardous areas (Table 2-6).

TABLE 2-6.
PARCELS CONTAINING CRITICAL AREAS IN THE CFHMP STUDY AREA

Classification	Parcels	Percent	Acreage	Percent
Priority Species and Habitat Areas	638	55	7,063	87
Wetlands	448	39	5,755	72
Geologic Hazards	92	8	1,150	19
100-Year Floodplain	1,161	100	7,967	100

Note: Percentages add to more than 100 percent because most parcels fall into more than one category.

Soils

Most of the soils in or near the floodplain developed from transported materials. Water-transported soil deposits are present on the lower slopes of the ridges and on the benchlands, stream terraces, alluvial fans, lowlands, and stream bottoms. SCS soil maps delineate these areas as *map units* according to the predominant soil types. General map units typically include one or more major soil type and some minor soil types. Detailed map units represent areas dominated by one or more major soil of a specific classification. Along the floodplain, the primary soil types are Yakima loam, sandy loam, and gravelly sand loam. Yakima loam is characterized by stratified layers and beds of permeable gravel and sand at shallow depths. It contains minimal organic matter, and drainage through the soil is medium to very rapid. It is best suited for general farm crops. Detailed properties of soils are described in the SCS Soil Survey (SCS 1985).

Wetlands

Wetlands, as defined in RCW 36.070A.030, are those areas inundated or saturated by surface water or ground water at a frequency and duration to support vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and

similar areas. They may also include wetlands artificially created as mitigation for conversion of wetlands to other uses. Wetlands do not include artificial wetland areas that have been unintentionally created from irrigation, drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, or landscape amenities.

Wetlands are important to flood hazard management because they serve natural retention and detention functions. They store water above and below the ground surface, reducing the volume and velocity of floodwaters downstream and thus decreasing downstream erosion. Wetlands also improve water quality and provide habitat for a wide range of plants and animals. Maintaining wetlands, particularly those located in floodplains, is one of the most cost-effective ways to reduce the adverse effects of flooding and erosion and to support healthy ecosystems.

Results of a wetlands inventory completed in the Yakima Valley by the U.S. Fish and Wildlife Service as part of the National Wetland Inventory are shown in Figure 2-7. Wetlands are identified as *riverine, lacustrine*, and *palustrine*; these categories are the first level of a standard hierarchical classification system. Generally, a riverine system includes all wetlands and deep water habitats within a channel of continuously moving water. Lacustrine wetlands are larger than 20 acres, in a topographic depression or a dammed river channel, and lack trees, shrubs, persistent emergents, emergent mosses, and lichens. A palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all wetlands in tidal areas where salinity is below 0.5 percent. Riverine and palustrine systems are most prominent in the study area.

The wetland inventory identified 448 wetlands in the study area (see Table 2-6), ranging from 0.7 to 315 acres, with an average size of about five acres. Large wetlands are located primarily in the upper and lower study reaches along the river. The lower reach contains the largest percentage of parcels with wetlands, while the upper reach contains the largest total area of wetlands.

Fisheries and Wildlife

Historically the Yakima River and its tributaries have provided rearing habitat for large numbers of trout and salmon. The river currently supports populations of spring and fall Chinook and coho salmon as well as steelhead. The number of these fish has drastically declined due to low stream flows, impassable dams, loss of habitat, and poor water quality. Poor water quality includes higher water temperatures and concentrations of pesticides, nutrients, and heavy metals in the water than in 1880. Prior to 1880, estimated anadromous fish runs exceeded half a million. In 1995, spring Chinook runs were at an all-time low of less than 700 fish. Suspected reasons for this decline include the following (USGS 1991):

- Poor fish passage around irrigation diversions
- Low stream flows, which limit rearing habitat and fish passage
- Flow fluctuations downstream of storage reservoirs, which affect rearing and spawning habitat
- Fine sediment deposition on spawning beds from agricultural runoff
- Agricultural return flows producing false attraction flows
- Prolonged flow augmentation resulting in degraded rearing habitat

- Loss of off-channel rearing habitat due to floodplain encroachment
- Excessive stream temperatures
- Pesticide concentrations above chronic exposure levels for fish
- Degradation of riparian cover due to grazing and agricultural activities.

Other possible contributors to this decline include the Columbia River dams, ocean fishing, major floodplain development, and reservoir construction within the basin.

The Yakima Basin is rich with wildlife. Big game species include mule deer and blacktail deer, elk, black bear, mountain lion, and mountain goat. Ring-necked pheasant, Hungarian partridge, chukar, bobwhite, valley quail, and other upland species are scattered throughout the basin. Canada goose, mallard, teal, and many other waterfowl are found in the lowland valleys. Mule deer and blacktail deer inhabit the river bottom lands along with other mammals, upland game birds, and considerable duck populations. Identified endangered or threatened species in the study area include the peregrine falcon. The study area is within their feeding range, but the falcons do not nest there.

Fish and wildlife habitat areas in the study area are shown in Figure 2-8. Under the GMA (see Chapter 6), the following areas require protection (WAC 365-190):

- Areas with which endangered, threatened, and sensitive species have a primary association
- Habitats and species of local importance
- Commercial and recreational shellfish areas
- Kelp and eelgrass beds; herring and smelt spawning areas
- Naturally occurring ponds of less than 20 acres and their submerged aquatic beds that provide fish or wildlife habitat
- Waters of the state
- Lakes, ponds, streams, and rivers stocked with game fish by a government or tribal entity
- State natural area preserves and natural resource conservation areas.

Riparian areas along floodplains provide a variety of wildlife habitat. As seen in Figure 2-8, wildlife habitat areas are spread throughout the floodplain. Over 85 percent of the parcel acreage with in the 100-year floodplain lies within habitat areas (Table 2-6).

Vegetation

Differences in elevation, exposure to sun, and soil provide conditions for a variety of plant species across the Yakima River Basin. Southern and western exposure promote sparse native vegetation cover and drought-resistant species. These exposures experience the most severe wind and water erosion, so soils are generally shallow. Plant cover on northern and eastern slopes is more abundant. These exposures have greater soil depths and a greater concentration of organic matter.

Within the semi-arid climate of the study area, the dominant native vegetation pattern is shrub-steppe. Big sagebrush becomes abundant after the original cover of bunch grasses and

smaller native perennial grasses are thinned out or destroyed by overgrazing or agricultural clearing. Semi-arid shrubs, such as rabbitbrush and hopsage, grow on shallow soils along southern exposures. Cheetgrass is the most abundant grass on the semi-arid ranges. Moisture is sufficient to allow seeds to germinate in the fall and grow in the spring.

Vegetation of the bottom lands consist of cottonwood, willow, hawthorn, wild rose, chokecherry, serviceberry, and various deciduous plant species in moist soils along streams. Greasewood and saltgrass are the principal native vegetation on saline and alkaline soils. Giant wildrye is common on low-lying, slightly saline soils. The streams of lower canyons are bordered with cottonwoods, aspens, several species of willows, alders, dogwoods, hawthorns, and many shrub species.

Water Quality

Water quality continues to be a concern in the Yakima River Basin. Federal and state agencies are actively collecting data along the Yakima River and performing water quality assessments to address these concerns. Two water quality assessment programs are currently taking place: the USGS's National Water Quality Assessment (NAWQA) and Ecology's Total Maximum Daily Load (TMDL) study.

National Water Quality Assessment for the Yakima River Basin

As part of the NAWQA program, the USGS is conducting investigations to assess the quantity and quality of water resources. The Yakima River Basin is one of the assessment project areas. The goals of the program are as follows:

- To provide a nationally consistent description of current water quality conditions
- To define long-term trends in water quality
- To identify, describe, and explain the major factors that affect water quality conditions and trends.

The USGS has published several reports on water quality conditions in the Yakima River Basin. The following conditions that impair beneficial uses of the river have been identified (USGS 1991):

- Stream water quality is degraded because of poor agricultural and irrigation practices.
- Concentrations of the parameters measured to assess water quality increase downstream in the Yakima mainstem and are highest in tributaries that contain agricultural return flow.
- The Yakima River from its mouth to the Cle Elum River is designated as Class A by the State of Washington (WAC 173-201-045). Class A water quality standards for stream temperature, pH, fecal-coliform bacteria, and dissolved oxygen (Table 2-7) have not been achieved. Turbidity and phosphorus concentrations have been detected at levels that affect aquatic life.
- Water quality trends indicate increases in stream temperature, specific conductance, and nutrients.

- Increases in nutrients may be due to increased use of fertilizers and increased populations of livestock.
- Organic pesticides were found in water samples and fish that inhabit the lower reaches of the Yakima River.

TABLE 2-7.
WATER QUALITY CRITERIA FOR CLASS A WATERS

1.	Water quality shall meet or exceed the requirements for all or substantially all uses.
2.	Fecal coliform organisms shall not exceed a geometric mean value of 100 organisms/100 mL, with not more than 10 percent of samples exceeding 200 organisms/ 100 mL.
3.	Dissolved oxygen shall exceed 8 mg/L.
4.	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
5.	Temperature shall not exceed 21.0° C due to human activities. When natural conditions exceed 21.0° C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3° C; nor shall such temperature increases, at any time, exceed t = 34/(T+9). ("t" represents the change across the dilution zone, and "T" represents the highest existing temperature in the water classification outside of any dilution zone.)
6.	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
7.	Toxic, radioactive, or deleterious material concentrations shall be below those of public health significance, or those that may cause acute or chronic toxic conditions for the aquatic biota or that may adversely affect any water use.
8.	Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch or taste.

a. The temperature water quality criterion is a special condition for the Yakima River from its mouth to the Cle Elum River.

SOURCE: WAC 173-201-045(2)

Total Maximum Daily Load

Ecology implements water quality standards under Section 303 of the federal Clean Water Act. Section 303(d) requires states and the U.S. Environmental Protection Agency (EPA) to prioritize, and establish total maximum daily loads (TMDLs) for, all waters that fail to meet state water quality standards (i.e., "impaired water bodies"). TMDLs specify the amount of pollutants that can be discharged to a receiving stream without impairing beneficial uses. The lower Yakima River from the confluence with the Naches River to the Columbia River does not meet water quality standards (Table 2-8). Recent assessments of the Yakima River identified suspended sediment loads from irrigated agricultural areas as a serious impairment of water quality. Ecology is conducting a comprehensive study to address suspended sediment and associated pesticide and turbidity problems in the lower Yakima Basin.

The TMDL process is a systematic approach to identifying priority problems and setting specific water quality improvement goals. The study will recommend measures to reduce sediment loads, and thus DDT and turbidity associated with sediment and runoff from irrigated areas on the lower Yakima River. The study will identify irrigated subbasins that

contribute the greatest sediment loads, and identify and evaluate sedimentation control and water quality management measures to benefit fisheries. The TMDL evaluation will be conducted in two phases: Phase I will assess problem areas in the basin; Phase II will more closely examine one or two of the most seriously affected subbasins and derive a model for calculating load allocations for return flows. The final TMDL report will establish load allocations for total suspended solids for return flow in the Yakima River.

TABLE 2-8.
STREAMS IN CFHMP STUDY AREA NOT MEETING WATER QUALITY STANDARDS

Name	Parameter Exceeding Standards
Yakima River from Sunnyside Dam Bridge to Naches River	Fecal Coliform
Naches River from Mouth to Tieton River	Temperature, pH
Spring Creek	DDT
Wide Hollow Creek	DDT, Dieldrin, Alpha-endosulfan, Fecal Coliform
Moxee Drain	DDT, Dieldrin, Endosulfan, Malathion, Fecal Coliform
Cowiche Creek	Temperature

SOURCE: Ecology 1994

SOCIOECONOMIC CHARACTERISTICS

Jurisdictional Boundaries

The study area includes portions of unincorporated Yakima County as well as the cities of Yakima, Selah, and Union Gap, which are in the central, northern, and southern portions of the study area, respectively. The unincorporated areas, primarily east of the Yakima River, include the Terrace Heights, Birchfield, and Yakima Sportmans Park areas. Approximately 73 percent of the parcel acreage within the 100-year floodplain is unincorporated Yakima County, 7 percent is within the City of Yakima, 7 percent is within the City of Union Gap, and 13 percent is within the City of Selah.

Population

With the introduction of railroads and extensive irrigation projects in the late 1800s, the population of Yakima County began to grow as the arid desert of the Lower Yakima Valley was transformed into agricultural farmland and pasture. With the expansion of land area under irrigation, related industries such as food processing industries began to flourish. The rate of population growth peaked in the 1950s and began to decline during the 1960s as job opportunities became more available on the western side of the Cascades and agricultural opportunities decreased (Table 2-9). During the 1970s, population growth shifted to the suburban areas, followed by a decline in the migrant farm worker population in the 1980s. Since the mid-1980s population growth has shown a steady increase. Currently, 47 percent of Yakima County residents live in unincorporated areas; recent trends indicate a relatively higher increase in growth within unincorporated areas of the County.

TABLE 2-9.
YAKIMA COUNTY POPULATION HISTORY AND PROJECTIONS

Year	Population	% Change
1910	41,709	--
1920	63,710	52.8
1930	77,402	21.5
1940	99,019	27.9
1950	135,723	37.1
1960	145,112	6.9
1970	145,212	0.1
1980	172,508	18.8
1990[a]		
Unincorporated	88,214	--
Incorporated	100,609	--
Total	188,214	9.5
1994[a]		
Unincorporated	94,248	6.8
Incorporated	107,852	7.2
Total	202,100	7.4

a. Yakima County Population Estimates from 1990 to 1994 are from State of Washington Office of Financial Management.
SOURCE: Yakima County 1995.

Population densities in the study area are greatest west of the Yakima River and I-82, where the cities of Selah, Yakima, and Union Gap are located. The largest population density east of the Yakima River is in the Terrace Heights area.

Land Use

Current land uses in the Yakima River 100-year floodplain are predominantly rural. However, increasing population and ongoing development pressures may result in changing land uses. Existing land use information was obtained from the County in the form of GIS and parcel databases. The 100-year floodplain is approximated by existing GIS data and revised preliminary FEMA maps. This preliminary information was analyzed and compiled into maps and tables for this study.

The 100-year floodplain in the study area encompasses more than 7,900 acres. Land uses in the floodplain are diverse, and include residential development, agriculture, transportation, trade, and recreation (Figure 2-9). Ownership is primarily private, with minor government ownership in the upper and lower reaches.

Parcels in the floodplain have a total assessed value of $72.4 million, of which improved parcels with structures account for $60.8 million. The average assessed value per parcel is $62,435. Figure 2-10 shows the distribution of assessed parcel value in the floodplain. In general, parcels values are higher in the upper and lower reaches. Numerous floodplain parcels in the middle reach have no building improvements.

Of the more than 1,100 parcels in the floodplain, 35 percent are classified *residential*, 24 percent *resource production and extraction*, and 27 percent *undeveloped land*, representing 7.8 percent, 59.3 percent, and 19.1 percent of the parcel acreage within the floodplain, respectively (Table 2-10). Parcel acreage is primarily resource production and extraction in the upper reach, undeveloped land and resource production and extraction in the middle reach, and resource production and extraction in the lower reach.

TABLE 2-10.
LAND USE DISTRIBUTION IN FLOODPLAIN STUDY AREA

Land Use Category	Parcels	Percent	Acreage	Percent
Residential	407	35.1	621	7.8
Resource Production and Extraction	280	24.1	4,725	59.3
Undeveloped Land	314	27.1	1,519	19.1
Water	22	1.9	95	1.2
Manufacturing	8	0.7	173	2.2
Transportation, Communication and Utilities	55	4.7	397	4.9
Trade	29	2.5	40	0.5
Services	19	1.6	176	2.2
Cultural, Entertainment and Recreational	26	2.2	220	2.8
Total	1,161	100.0	7,967	100.0

Parcel Size in the Floodplain

Parcels in the 100-year floodplain range from over 375 acres to less than 1 acre (Table 2-11). Of over 1,100 parcels in the floodplain, nearly 54 percent are smaller than 2 acres and 83 percent are smaller than 10 acres. However, 76 percent of floodplain acreage is in parcels larger than 10 acres. Similarly, 70.2 percent of parcels along the Yakima River shoreline are smaller than 10 acres, but 83.4 percent of shoreline acreage is in parcels larger than 10 acres.

TABLE 2-11.
PARCEL SIZE DISTRIBUTION IN FLOODPLAIN STUDY AREA

Parcel Size	100-Year Floodplain		Shoreline		Open Space Designation	
(acres)	No./%	Acreage/%	No./%	Acreage/%	No./%	Acreage/%
0-2	631/54.4	359/4.5	108/35.3	86/2.2	9/9.7	10/0.4
2-5	218/18.8	695/8.7	57/18.6	191/5.0	19/20.4	72/3.1
5-10	116/9.9	857/10.8	50/16.3	364/9.4	18/19.4	129/5.6
10-50	173/14.9	3,627/45.5	81/26.5	1,753/45.5	35/37.6	787/34.3
50-100	16/1.4	981/12.3	6/2.0	412/10.7	8/8.6	523/22.8
100+	7/0.6	1,448/18.2	4/1.3	1,050/27.2	4/4.3	776/33.8
Total	1,161/100	7,967/100	306/100	3,856/100	93/100	2,297/100

Large parcels are generally located in agricultural areas and in the upper and lower study reaches. Parcel sizes are smaller closer to the City of Yakima.

Open Space in the Floodplain

Figure 2-11 shows designated open space parcels in the 100-year floodplain. These parcels are highly concentrated in the upper and lower study reaches, west of the Yakima River in the upper reach and east of the river in the lower reach. They make up over 28 percent of the land area in the 100-year floodplain (Table 2-12); 33 percent, 2.8 percent, and 35.6 percent of the area in the upper, middle, and lower reaches, respectively. Fewer open space parcels exist in the urbanized areas surrounding the City of Yakima. Open space acreage primarily consists of parcels larger than 10 acres.

TABLE 2-12.
OPEN SPACE CLASSIFIED PARCELS IN FLOODPLAIN STUDY AREA

Classification	Parcels	Percent	Acres	Percent
Open Space	93	8.0	2,297	28.8
Non-Open Space	1,068	92.0	5,670	71.2
Total	1,161	100.0	7,967	100.0

Current Zoning in the Floodplain

Current Yakima County zoning is shown in Figure 2-12. Zoning classifications are shown in Table 2-13. In the upper reach, agricultural and general rural zoning account for over 88 percent of the 100-year floodplain. In the lower reach, over 90 percent of the 100-year floodplain is zoned exclusive agricultural and general rural. In the middle reach, 47.8 percent of the area is within the City of Yakima; the city's zoning was not obtained for this study. For unincorporated Yakima County in the middle reach, current zoning is primarily suburban residential and general rural. Higher concentrations of residential and commercial zoning can be expected in this urbanized reach.

TABLE 2-13.
ZONING DISTRIBUTION IN THE FLOODPLAIN STUDY AREA

Zoning Classification [a]	No. of Parcels	Percent	Acreage	Percent
General Rural (GR)	709	61.1	3,861	48.5
General Agricultural (GA)	28	2.4	953	12.0
Exclusive Agricultural (EA)	25	2.2	735	9.2
Suburban Residential (SR)	225	19.4	523	6.6
Residential (R)	33	2.8	257	3.2
Rural Residential (RR)	11	0.9	69	0.9
County Zone M1 (M1)	5	0.4	9	0.1
Planned Development (PD)	1	0.1	8	0.1
One-Family Residential (R-1)	1	0.1	3	0.0
Highway Commercial (HC)	1	0.1	2	0.0
Non-County Zoning Jurisdiction (LIM)	122	10.5	1,547	19.4
Total	1,161	100.0	7,967	100.0

a. Zoning classification for parcels within the 100-year floodplain

The EA zone is intended to preserve and maintain areas for the continued practice of agriculture and to permit only those new uses that are compatible with agricultural activities. The minimum lot size for this zone is 40 acres. Permitted uses within the EA zone include agriculture, floriculture, horticulture, general farming, livestock raising, and other agricultural activities; plants for the processing and storage of agricultural products, such as fruit-packing plants and canneries; one single-family dwelling or mobile home per 40-acre parcel; accessory dwellings, such as agricultural stands and farm labor shelters; and other special uses as defined in Chapter 15.60 of the Zoning Ordinance.

The GR zone district is intended to protect and maintain the openness and rural character of outlying areas of the County where agricultural zoning is not appropriate or desirable. This district is characterized by a wide mixture of parcel sizes and land uses including semi-arid range lands, large- and small-scale commercial agriculture, part-time farms, and scattered small-scale low-density residential development. The minimum lot size for this zone is one-half acre. Permitted uses are consistent with those listed for the EA zone.

The PD zone district is intended to encourage flexibility in design and development of land that will result in a more efficient, aesthetic, and desirable use of the land; promote maximum use of sites characterized by special features of geography, topography, size, or shape through flexibility in design (e.g., building placement, use of required open spaces, and circulation); facilitate the provision of streets and utilities; and preserve the natural and scenic qualities of open spaces.

The SR zone is a newly created residential zone for lands within designated urban areas. The SR District is intended to be a transitional zone that allows a mixture of land uses ranging from agriculture to single-family residences. Uses permitted within this zone are subject to one of three levels of review. A Class 1 review is conducted by the Building Department. Permitted uses within this class include agricultural-related uses and industries, single-family residences, and home occupations. A Class 2 review is conducted by the Planning Department. Uses within this class include movie theaters, auditoriums, equipment storage areas, earth stockpiling areas, single- and two-family residences, and retirement homes. A Class 3 review is conducted through a hearing process. Class 3 covers more controversial uses, such as planned residential developments, multi-family residences, mining activities, public facilities, campgrounds, and golf courses.

Several zoning inconsistencies have been identified in the floodplain. Suburban Residential (SR) zoning exists west of I-82, near Hartford Road, east of the end of Valley Mall Boulevard, and along the eastern boundary of the City of Union Gap. One parcel near the Moxee Canal is zoned Single-family Residential (R1), and one parcel in East Selah is zoned Planned Development (PD). Several parcels along the Naches River near Cowiche Creek are zoned Residential (R).