CHAPTER 3

Affected Environment

3.1 Introduction

General Characteristics

Portland, the Innovative Wet Weather Program area, is situated at 20 feet above sea level, near the confluence of the Columbia and Willamette rivers, about 65 miles inland from the Pacific Ocean. It lies midway between the lower Coast Range to the west and the high Cascades Range to the east, each of which is about 30 miles distant. Portland's varied topography includes steep hills, isolated volcanic cones, low rolling hills, and extensive flat areas. The area is composed primarily of alluvial deposits and Columbia River basalts. Much of the city is located in the Willamette Valley Plains ecoregion, although steeper portions of the Tualatin Hills on the west side are characteristic of Willamette Valley Hills and Coastal Mountains ecoregions (Clarke et al., 1991).

Portland has a mid-latitude, West Coast marine climate that is heavily influenced by the mountain ranges east and west of the city. The Coast Range protects the Portland area from Pacific storms, while the Cascades prevent colder continental air masses from invading western Oregon. The Cascades also lift moisture-laden westerly winds from the Pacific, driving local rainfall patterns. Average annual rainfall in the Portland area is approximately 37 inches. Nearly 90 percent of the annual rainfall occurs from October through May. Only 9 percent of the annual rainfall occurs between June and September, with 3 percent in July and August. Precipitation falls predominantly as rain, with an average of only 5 days per year recording measurable snow.

Summers are comparatively dry and cool, and winters are mild, wet, and cloudy. In summer the average temperature is 65°F with an average daily maximum of 74 to 78°F (Rockey, 2002). In winter, the average temperature is 40°F and the average minimum temperature is 34°F.

The City of Portland's 2001 population was 523,000 (U.S. Census Bureau, 2002). Land uses in the Portland area include industrial, commercial, low- and high-density residential and open space.

3.2 Air Quality/Noise

The Oregon Department of Environmental Quality (DEQ) and EPA have jurisdiction over air quality and noise in the Portland area. Ambient air quality standards for air pollutants have been established by federal and state agencies to protect public health (primary standards) and welfare (secondary standards). Areas in which pollutant concentrations exceed allowable ambient air quality standards are designated as nonattainment areas for that pollutant. Portland is classified as a nonattainment area for carbon monoxide (CO) and ozone. Ozone is controlled by regulating nitrogen oxide (NO_x) and nonmethane

hydrocarbon (NMHC) or volatile organic compound (VOC) emissions in the area. Air pollutants of interest in evaluating the impacts of the projects include CO, VOC, NO_x, and particulates.

Air quality in the Portland area has improved in recent years. The number of days classified as "good" has steadily increased, and the number of days classified as "moderate" or "unhealthful" has decreased. The state implementation plan developed by DEQ and approved by EPA includes enforceable emission limitations, related control measures, and schedules or timetables for compliance with ambient air quality standards.

Major noise sources in the project area include highways (Highway 26, I-5, and I-405), busy roads, Portland International Airport, and railroad operations. Noise receptors are for the most part people who live in residential neighborhoods and work within or adjacent to the commercial, industrial, and institutional land uses. Wildlife, where present, could be sensitive to noise, particularly during nesting and breeding.

3.3 Water Resources

The Willamette River flows through Portland for 17 miles before joining the Columbia River. More than 11,500 square miles of land in the Willamette watershed, including most of Portland, drain into the Willamette River, making the river the tenth largest by volume in the continental United States (City of Portland, 2001). Typical Willamette mainstem flow rates through the city range from 5,000 cubic feet per second during the summer to approximately 80,000 cubic feet per second during high flow periods in the winter and spring. Peak flows after heavy rains can swell to between 200,000 and 400,000 cubic feet per second.

Watersheds

A number of tributaries to the Willamette River pass through the City of Portland, including Tryon Creek, Fanno Creek (via the Tualatin River), Johnson Creek, the Columbia Slough, and the Willamette River watershed, which includes a series of small tributaries draining the Tualatin Hills, Forest Park, and east Portland. The city's five primary watersheds are depicted in Figure 3.3-1. A general overview of existing water resource conditions within the five primary watersheds is provided in this section (City of Portland, July 1999; City of Portland, November 2002).

Over the past 150 years, an estimated 260 of the Portland's original 476 miles of streams have vanished—most of them paved over, piped, culverted, or filled while the city grew (see Figure 3.3-2). As the streams disappeared, patterns of runoff, streamflow, and water quality changed, especially in watersheds with the greatest proportion of stream loss.

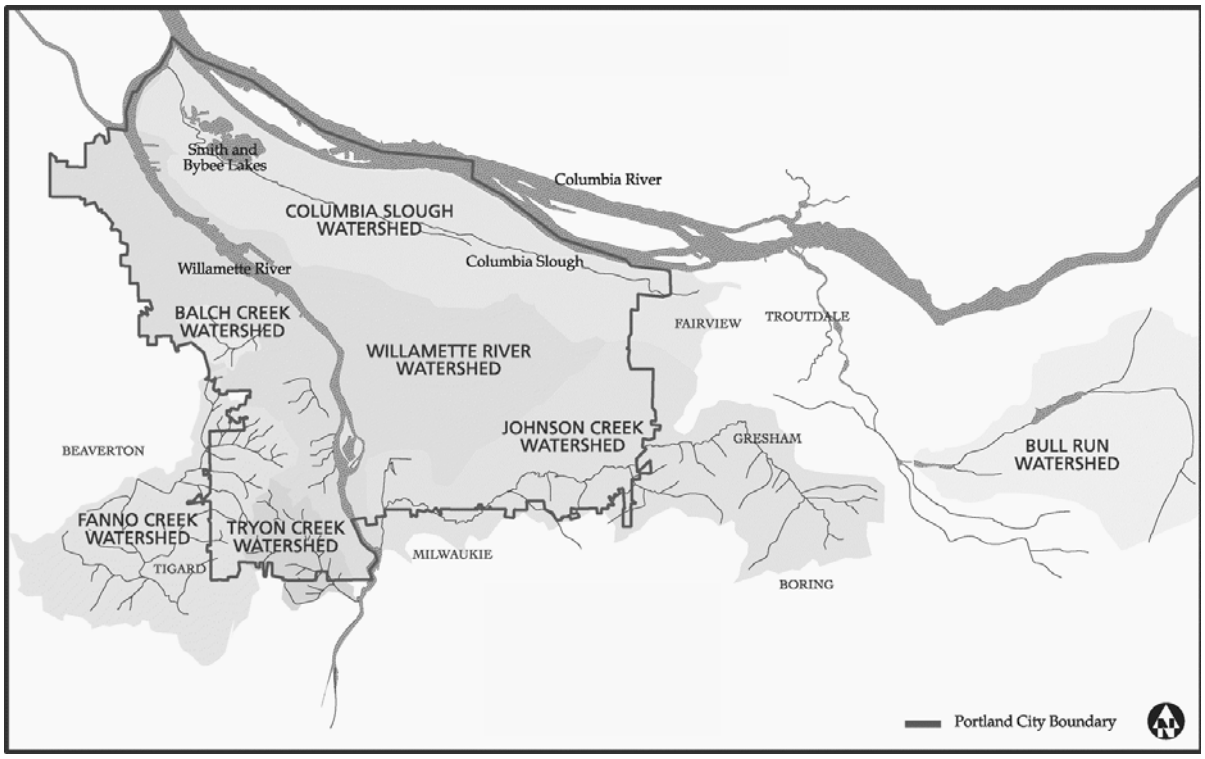

FIGURE 3.3-1. CITY OF PORTLAND WATERSHEDS

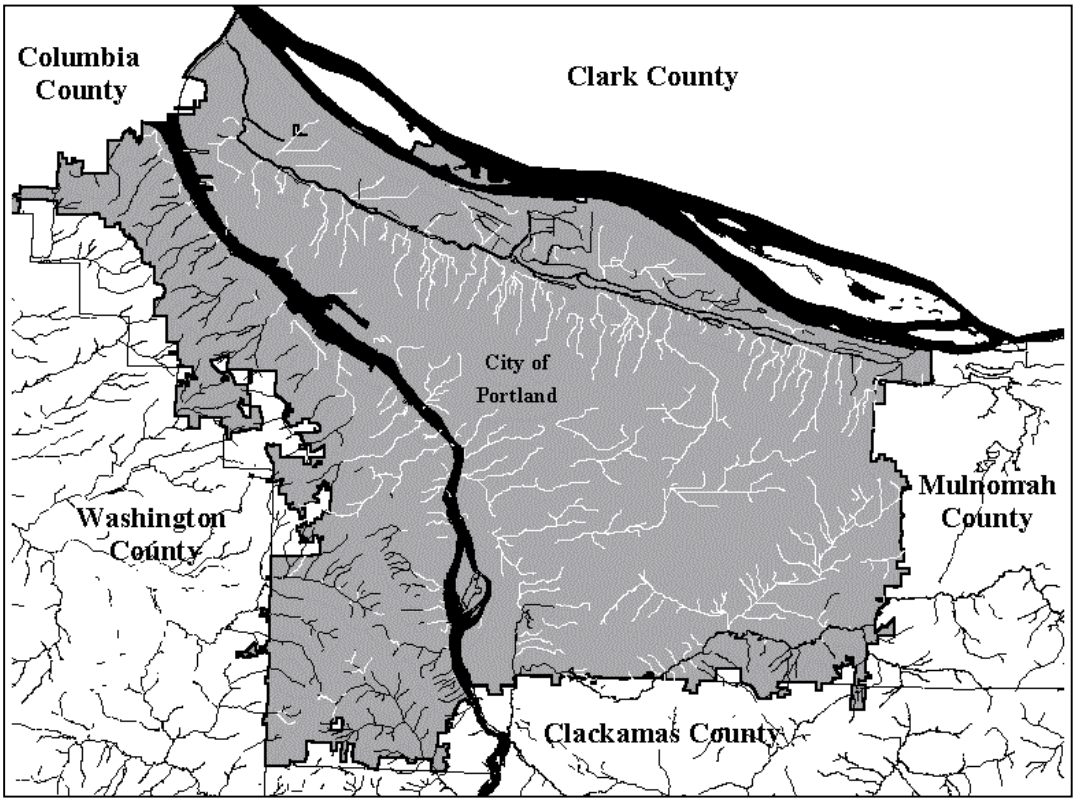

FIGURE 3.3-2. HISTORICAL STREAM LOSS IN THE CITY OF PORTLAND (CITY CLUB OF PORTLAND 1999). WHITE LINES INDICATE LOST STREAMS.

Wet Weather Management

The City of Portland estimates that there are approximately 35,000 acres of impervious surfaces in the city (City of Portland, November 2003). About one-third of those acres are roof top areas; the rest are primarily street surface, parking lots, sidewalks, and driveways. Impervious surfaces could expand to more than 50,000 acres in the future based on current comprehensive land use zoning (City of Portland, November 2003).

BES provides sewer and stormwater drainage services in an area that covers more than 94,000 acres (BES website, 2003). The agency owns and operates more than 2,250 miles of pipes and more than 90 pump stations that transport sewage to two treatment plants. More than 26,000 acres of the service area is served by 845 miles of combined sewer pipes that mix sanitary sewage and stormwater runoff. Each year, on average, about 9.9 billion gallons of stormwater flows into the combined sewer system. During wet weather, the capacity of the system is exceeded, and frequently the combined sewer system overflows. Stormwater inflows cause CSOs that discharge about 6 billion gallons to the Willamette River each year, during about 50 events (City of Portland, December 1994).

About 80 percent of a CSO is stormwater (City of Portland, December 1994). Average pollutant concentrations in CSOs are higher than in separated stormwater but much less than in domestic sewage (Table 3.3-1).

TABLE 3.3-1. AVERAGE POLLUTANT CONCENTRATIONS FOR SEWAGE, CSOs, AND STORMWATER

Pollutant	Domestic Sewage	CSO	Stormwater
TSS, mg/L	265	120	59
BOD_5, mg/L	260	28	10
TKN, mg/L	68	7.8	1.2
Copper, mg/L	0.068	0.020	0.014
Lead, mg/L	0.015	0.016	0.021
Zinc, mg/L	0.158	0.090	0.083
E. coli bacteria, CFU	1-10 million	10-100 thousand	1000

TSS = total suspended solids.
BOD_5 = 5-day biochemical oxygen demand.
TKN = total kjeldahl nitrogen.
CFU = Colony Forming Units.
Source: City of Portland, December 2003.

The separated stormwater system is designed and operated to collect and safely convey stormwater flow for discharge to local receiving waters. The stormwater system consists of 15 basins, each with its own independent network of conduits (pipelines and culverts), ponds, and stream channels (City of Portland, July 1999). Surface stormwater management facilities are designed and constructed according to Portland's *Stormwater Management Manual* (BES, 2002).

In 1999, the *Public Facilities Plan* (City of Portland, 1999) recommended numerous projects to improve combined sewers, sanitary sewers, and stormwater sewers in Portland (City of

Portland, 1999). The plan recommended wet weather improvements at numerous locations throughout the combined sewer area, representing a shift toward watershed-based approaches to stormwater management.

Willamette River Watershed

The Willamette River is a tributary to the Columbia River at approximately River Mile [RM] 102. It is the tenth largest river in the contiguous United States in terms of streamflow. The entire Willamette Basin is 11,460 square miles in size; it constitutes 12 percent of the land area of Oregon, and about 70 percent of Oregon's population lives there (Willamette Restoration Initiative, 1999). The Willamette Basin is divided into 12 subbasins. The lower reach of the Willamette—the subbasin that includes the City of Portland—extends from the mouth upstream to the falls at Oregon City (River Mile 26.5 of the Willamette River).

Historically, the Willamette River in the Portland area consisted of an extensive and interconnected system of active channels, open slack waters, emergent wetlands, riparian forest, and adjacent upland forests on hill slopes and Missoula Flood terraces. Today, the channel is diked and dredged throughout the Portland Harbor. The channelized characteristics of the Portland Harbor and surrounding area have adversely modified the habitat types and the localized flow regime. The urban setting minimizes the presence of riparian vegetation and the input of new large wood from riparian areas.

Water quality in the lower Willamette River is fair to poor. The Portland Harbor was recently placed on the National Priorities List ("Superfund") for elevated levels of DDT, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. The lower Willamette River is listed on the 303(d) list of impaired waterbodies for temperature, bacteria, biological criteria (fish skeletal deformities), and toxics (mercury, arsenic, and pentachlorophenol). DEQ also identified lead and copper as potential water quality concerns in a 1997 analysis (Oregon Department of Environmental Quality, 1997). These parameters are being investigated further to evaluate whether they should be included on the 303(d) list, using ultraclean sampling and analysis methods and improved detection limits.

Forest Park Streams (Balch Creek, Miller Creek, and Other Tributaries)

The Forest Park streams contain a number of small watersheds such as Balch and Miller creeks that flow to the Willamette. The Forest Park watersheds are probably among the least altered watersheds within Portland when compared with their historical hydrological conditions because many are protected by Forest Park. The hydrographs of these small watersheds are probably reasonably comparable to historical conditions because of the low overall percentages of imperviousness and small amounts of stormwater drainage to them.

Water quality is generally good, but excessive amounts of fine sediment may occur in sections of these streams near residential or industrial development. Summer temperatures may be unsuitable in certain areas where riparian areas are narrow and unvegetated. Toxic contamination may be an issue in reaches receiving CSO and stormwater discharges. One example is the Tanner Creek combined sewer system, which conveys wastewater, hillside stormwater, the historical Tanner Creek stream, and groundwater through underground pipes along Highway 26, then under the downtown area. The Tanner Creek Stream

Diversion Project was described previously in an environmental assessment prepared for EPA (City of Portland, May 1997).

Exceptions to the general conditions of Forest Park streams occur in the lower reaches where each stream must pass under Highway 30 and through the heavily industrialized port and industrial areas along the banks of the Willamette River. The streams typically pass through pipes for considerable lengths through this section and receive stormwater and combined sewer overflow discharges before discharging to the Willamette. Consequently, stream biota in these areas no longer reflect historical conditions.

Wet Weather Management in the Willamette River Watershed

The Willamette River Watershed in Portland west of the mainstem comprises about 12,801 acres and consists of seven combined sewer basins, two sanitary sewer basins, and three stormwater basins. The combined sewer basins in the western Willamette River Watershed tend to have significant basement flooding problems where the steep topography in the upper watershed transitions to moderate slopes in the lower watershed. Recommended improvements include sewer separation projects, increasing pipe diameters, increasing pumping capacity, and further incorporating stream separation projects to reduce the size and extent of flood control facilities. Stream separation entails diverting stream flow from the combined conveyance system to its natural stream path for discharge to the Willamette River.

The eastern Willamette River Watershed in Portland comprises about 15,546 acres and consists of 16 combined sewer basins, 1 sanitary sewer basin, and 2 stormwater basins. Most of the combined sewer basins in the eastern Willamette River Watershed have significant capacity problems, which result in basement flooding. Problems are caused by undersized conveyances, flat slopes, and very long connection networks. The *Public Facilities Plan* (City of Portland, 1999) recommended sewer replacement to obtain greater capacity (which may also address structural deficiencies), inflow reduction measures, inline storage, and partial sewer separation (meaning sewer separation in some portions of some basins) to address the remaining basement flooding problems.

For the separated stormwater system, steep slopes in the western watershed contribute to high stream velocities that cause erosion and loss of riparian vegetation. High erosion rates in the upper channels deliver debris, cobbles, and dirt to the lower ends of each steam where the materials settle out. At Balch Creek, for example, erosion leading to sedimentation harms fish spawning areas. The *Public Facilities Plan* (City of Portland, 1999) recommended replacing or improving undersized culverts, addressing sedimentation problems by improving channels and increasing maintenance activities, limiting soil exposure, and retrofitting the storm system with water quality protection features (such as trapped catch basins, water quality inlets, and oil/water separators). The piped system in the eastern Willamette River Watershed is adequate to convey stormwater flows, and there are minimal stormwater facilities.

Tryon Creek Watershed

Tryon Creek is a 7-mile free-flowing stream located in a 4,237-acre watershed. The stream flows in a southeasterly direction from the West Hills of Portland to the Willamette River near Lake Oswego. It is primarily a moderate gradient stream with steep sideslopes. The

upper watershed has been subject to common impacts associated with urban development, including increased stream velocities and stream bank erosion (City of Portland Bureau of Environmental Services, 1997). The increased amount of impervious surface in the upper watershed has resulted in higher volume peak flows.

The channel condition is typical of a moderate-gradient stream with steep sideslopes. Approximately 60 to 75 percent of the slopes within the watershed exceed a 30 percent grade (City of Portland Bureau of Environmental Services, 1997). This results in a high degree of mass wasting and erosion. In addition, soils in the watershed are from a silt loam series (Cascade) that are underlain by a fragipan that impedes water infiltration and root penetration. This results in a high incidence of wind throw, mass wasting, channel incision, and bank erosion. The most serious problems for salmonids resulting from this type of watershed are siltation of spawning gravels and a decrease in substrate and habitat complexity.

Historically, Tryon Creek provided important habitat for sea-run cutthroat, steelhead, coho and possibly chinook salmon. However, development activities, particularly culvert and road crossings, have resulted in degraded habitat and migration barriers. Habitat in Tryon Creek has been evaluated in Oregon Department of Fish and Wildlife (ODFW) stream surveys (Oregon Department of Fish and Wildlife, 2000) and a City of Portland corridor assessment (City of Portland Bureau of Environmental Services, 1997). Instream habitat ranged from marginal to optimal in a few areas, with most of the marginal habitat within the more heavily urbanized upper watershed. Highest quality habitats were located within Tryon Creek State Park, which had wide and relatively undisturbed riparian buffers.

Arnold Creek, one of the larger tributaries to Tryon, has good instream habitat but with suboptimal percentages of fines. Bank erosion and incision are the primary forms of degradation within the creek's lower reaches. Falling Creek, another major tributary to Tryon, has poor to marginal instream habitat, with a lack of instream cover, poor bank and riparian structure, and excessive fine sediments.

Water quality in Tryon Creek is good to fair. Tryon Creek is on DEQ's 303(d) list for summer temperature. The City of Portland is currently monitoring the concentrations of 13 water quality parameters. A preliminary examination of the data indicates that with the exception of temperature, water quality generally meets water quality standards.

Impairment of fish access to habitat by culverts is a significant issue throughout the Tryon Creek watershed. A large culvert is present at the mouth of Tryon Creek just above its confluence with the Willamette River (at RM 19.9). Although baffles are present within this culvert, it is likely that the culvert impairs salmonid movements into and out of the watershed. An impassable culvert is present at Boones Ferry Road. Above this, there are many additional impassable culverts on Tryon and Arnold creeks that limit movements of resident fish through the watershed. A series of waterfalls and rapids at Marshall Park (at RM 2.7) that are considered a natural barrier would have limited anadromous fish access prior to the presence of culverts.

Fanno Creek Watershed

Fanno Creek is a tributary to the Tualatin River Basin. The creek drains about 20,500 acres, but most of this is outside the city limits (City of Portland Bureau of Environmental

Services, 1997). Instream habitat quality in Fanno Creek and in two tributaries—Vermont and Woods Creeks—was rated as extremely impaired or threatened, primarily as a result of adverse effects from excessive amounts of fine sediment (City of Portland Bureau of Environmental Services, 1997). High channel erosion is present through much of the watershed within the city as a result of lack of bank vegetation, large wood, and rock. These factors result in limited habitat complexity and instream cover. Channel morphology is generally poor and dominated by pools or glides with very few riffle areas. Isolated areas with comparably higher habitat values are present in some reaches in relatively undeveloped areas or in headwater reaches.

Fanno Creek has TMDLs for temperature, phosphorous, dissolved oxygen, and bacteria. Urban and suburban development within the watershed has contributed to these water quality problems as a result of reduced riparian vegetation, increased nutrient loading and stream temperatures.

Wet Weather Management in the Tryon Creek/Fanno Creek Watersheds

The Tryon Creek/Fanno Creek watersheds in Portland comprise about 15,763 acres and consist of six combined sewer basins, six sanitary sewer basins, and six stormwater basins. Stream separation is one effective approach for addressing capacity problems and providing CSO control benefits in these watersheds (City of Portland, July 1999). Inline storage solutions are limited in this watershed because they require construction at steep slopes.

Stormwater basins in these watersheds are typically small urban streams, with culverts routing flows under roads and fills as the streams meander toward the receiving waters. In some cases, these basins are served by neighborhood water piping networks that discharge to the streams. Several reaches throughout the basins have undersized culverts and a history of streambank flooding. Numerous areas have excess velocities in the channels, erosion, degraded instream and riparian habitat, sediment deposits, and poor structural conditions. The *Public Facilities Plan* (City of Portland, 1999) recommended stabilizing streambanks, increasing culvert capacity, repairing culverts, and improving biofiltration capabilities of the riparian zone to meet water quality requirements and provide optimum flooding and water quality benefits.

Johnson Creek Watershed

Johnson Creek originates in the hills east of Portland and flows westward approximately 25 miles to its confluence with the Willamette River. The stream receives water from several major tributaries, including Crystal Springs Creek, Kelley Creek, Mitchell Creek, Butler Creek, Hogan Creek, Sunshine Creek, and Badger Creek. Land use in the entire 34,560-acre Johnson Creek watershed ranges from heavily developed urban areas (the cities of Portland, Milwaukie and Gresham) to rural farm and nursery lands (headwaters).

Johnson Creek has been substantially altered from its historical configuration. Diking, channelization, and other alterations of the natural floodplain have eliminated many of the areas that once absorbed and conveyed floods through the watershed. One of the most significant alterations occurred in the 1930s when the Works Progress Administration widened, deepened, rock-lined, and channelized 15 miles of the 25-mile stream in an attempt to control flooding. These alterations have had long-lasting and marked effects on the habitat and hydrology of the watershed.

Flow monitoring indicates that low-flow conditions in Johnson Creek may adversely affect aquatic life. The Oregon Department of Fish and Wildlife has set minimum flow targets to protect salmonids in Johnson Creek (Meross, 2000). Flows in the middle and upper watershed frequently do not meet those minimum flows, particularly in spring and summer months. Below Crystal Springs, which provides consistent and abundant groundwater flows, minimum instream flows are typically met.

There is also evidence of adverse impacts from excessive peak flows, primarily in the winter. Statistical evaluation of flow since 1940 indicates some increase in the flashiness of peak flows over the period of record (Clark, 1999). Significant impacts on peak flows in Johnson Creek also appear to be affected by alterations in the stream channel and floodplain that change the way floods flow through Johnson Creek.

Fish access to habitat is impaired by culverts throughout the watershed. Although there are no culverts on the mainstem until high in the watershed, they are present on nearly all the tributaries to Johnson Creek. Crystal Springs, a channel used by local and migratory Willamette salmonids, has a series of partially impassable culverts along its length. Some of the least developed tributaries along the southern side of the middle watershed also have culverts along their confluences with the mainstem.

Water quality in Johnson Creek is rated as fair to poor. Johnson Creek was placed on the 303(d) list by DEQ for bacteria, summer temperature, and toxics (DDT and dieldrin). The 303(d) listing includes the entire stream, from the mouth to headwaters. The numerous investigations of temperature in Johnson Creek over the years have consistently indicated that elevated temperatures are a problem throughout the watershed.

Wet Weather Management in the Johnson Creek Watershed

The Johnson Creek Watershed comprises about 14,070 acres in the City of Portland and consists of two combined sewer basins, one sanitary sewer basin, and one stormwater basin. The two combined sewer basins serve approximately 10 percent of the watershed however, no CSOs are directed to Johnson Creek. There are few hydraulic problems in the small Lents 1 basin in the southwest portion of the watershed; however, there are potential areas of basement flooding from peak storm flows. The larger Lents 2 basin northeast of Lents 1 has significant capacity problems that result in basement flooding. Problems are due to undersized conveyances, flat slopes, and very long collection networks. The focus of the city's relief and reconstruction program in this watershed is to address basement flooding problems and critical sewer pipes in poor structural condition. Recommended projects include sewer replacement for increased capacity (which may also address structural deficiencies), inflow reduction measures, inline storage, and partial sewer separation.

The single separated stormwater basin in the watershed encompasses approximately 90 percent of the watershed area within the Urban Services Boundary and includes the natural stream system, storm drain pipelines, culverts, and detention ponds. Johnson Creek has been severely altered by urbanization, including development and channel-straightening projects. Frequent flooding characterizes the Johnson Creek mainstem. The stream responds rapidly to precipitation during saturated conditions, primarily in the Lents and Powellhurst neighborhoods. Several culverts are undersized. The *Public Facilities Plan* (City of Portland, 1999) recommended one stormwater channel improvement project and improvements to

Johnson Creek that integrate flood management, water quality, and fish and habitat improvements.

Columbia Slough Watershed

The Columbia Slough extends 19 miles from Fairview Lake on the east to the Willamette River at Kelley Point Park on the west. It drains about 34,711 acres of varied land uses, including portions of Portland International Airport and Portland's "industrial sanctuary." The northern half is relatively flat, with shallow groundwater, and the southern part includes Alameda Bluff. The slough's channel configuration and flow regime have been altered significantly from historical conditions. It is now a highly managed water conveyance system with dikes and pumps that provide watershed drainage and flood control, maintaining a highly artificial hydrograph.

Water quality in the Columbia Slough watershed is highly degraded. DEQ has placed the Columbia Slough on the 2002 303(d) list for 3 parameters (iron, manganese, and temperature). DEQ has already established TMDLs for pH, DO, and phosphorus.

In addition to the main Columbia Slough, the watershed contains the relatively good habitat at Smith and Bybee, Wilkes Creek, Fairview Lake, Fairview Creek and tributaries, as well as numerous wetlands that receive area stormwater and groundwater flow.

Wet Weather Management in the Columbia Slough Watershed

The Columbia Slough Watershed consists of 11 combined sewer basins, 5 sanitary sewer basins, and 6 stormwater basins. Stormwater runoff in the watershed goes mainly to infiltration sumps, pipes to the Columbia Slough, and pipes to the POTW, which discharge to the Columbia River. In general, the four stormwater basins in the northwestern half (approximately) of the watershed are primarily industrial and consist mainly of open channels and culverts that convey flow to the Columbia Slough. The two stormwater basins in the southeastern part of the watershed are highly developed mixed residential and commercial uses and are served by piped systems or stormwater infiltration sumps.

The combined sewer system area has received significant stormwater and collection system improvements as part of the CSO Management Program. Since 1994, the city initiated several programs throughout the watershed to reduce stormwater inflow to the combined sewer system. Stormwater infiltration sumps have been installed, roof downspouts have been disconnected to surface infiltration, and new stormwater conduits have been constructed. The "Big Pipe" also was installed and a majority of stormwater either goes to the water treatment plant (and thence to the Columbia River) or is piped to Ramsey Lake wetland for stormwater treatment (and thence to the Columbia Slough).

The *Public Facilities Plan* (City of Portland, 1999) for stormwater recommended pollution reduction facilities, riparian restoration, and slough infrastructure improvements to improve conveyance. Projects recommended to address basement flooding problems include sewer replacement for increased capacity (which may also address structural deficiencies), inflow reduction measures, inline storage, stream separation, and regional detention.

3.4 Geology and Soils

Geology

The program area is located in the Portland Basin physiographic province, in which consolidated and unconsolidated sediments overlie basalt (Woodward-Clyde Consultants, March 1995; Parametrix, June 1994; Madin, 1990). From youngest (and shallowest) to oldest (and deepest), the geologic units consist of the following formations:

1. Late Pliocene to Holocene Age volcaniclastic conglomerates, loess, terrace deposits, catastrophic flood deposits, and alluvium (Swanson et al., 1993)
2. Late Pliocene and Pleistocene Age Boring Lavas that are locally intruded into the sedimentary rocks and younger deposits (Mabey et al., 1993)
3. Troutdale Formation, consisting of quartzite-bearing conglomerate and sandstone (Trimble, 1963)
4. Sandy River Mudstone, consisting of mudstone, siltstone, sand, and claystone
5. Miocene Age Columbia River Basalt

Portland lies in a moderately active seismic region and is south of the more active St. Helens seismic zone. The nearest mapped fault trends northwest–southeast and parallels the shoreline of the Willamette River between Mocks Bottom and Southeast Hawthorne Boulevard (Beeson et al., 1991). The Portland Hills Fault parallels the eastern foot of the Portland Hills and is inferred to extend beneath downtown Portland (Beeson et al., 1991).

Soils

The *Soil Survey of Multnomah County* (Soil Conservation Service, 1983) describes the soil resources occurring in Portland. In addition to the native soils, fill materials ranging from miscellaneous waste materials to clean, crushed rock may be encountered during construction because of the developed, industrialized nature of some areas of the city. None of the soil types are classified as prime or unique farmlands by the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (formerly the Soil Conservation Service).

Willamette River Watershed

Soils in the upper elevations of the western Willamette River Watershed are silt loam with moderate permeability. They are characterized by a slow infiltration rate and high runoff potential. Extreme slopes accelerate runoff. Soils in the lower elevations and on some of the hillsides are primarily gravelly loam. They are well drained, with a moderate rate of permeability.

The majority of the watershed east of the Willamette River is relatively flat; slopes are usually less than 3 percent, but Mt. Tabor, Kelly Butte, and Rocky Butte have slopes ranging from 8 to 60 percent. The bluffs along the Willamette River serve as a dividing point between two different soil types. The low-lying areas along the Willamette River range from excessively drained to very poorly drained silt loams, silty clay loams, and sands.

High groundwater in these areas makes them generally unsuitable for infiltration facilities. The higher areas to the east are characterized as moderately drained or well-drained loams and silt loams. Other areas east of the river are sand or silty loam and are generally very porous. The easternmost portion of the watershed readily absorbs rainfall; consequently, generation of stormwater is lower and the residential areas have a large number of infiltration sumps. Because the watershed is highly developed, about 50 percent of it is impervious surface area.

Tryon/Fanno Creeks Watersheds

Upland slopes in some parts of the watershed exceed 30 percent. Soils mostly range from moderately drained to poorly drained silt loams that are often saturated during the rainy season, resulting in surface runoff and erosion.

Johnson Creek Watershed

Slopes generally range from 1 to 10 percent, but steep hillsides also exist in this watershed, including Mt. Scott and Powell Butte. Slopes on Mt. Scott range from 10 to 30 percent, with a few approaching 50 percent.

Johnson Creek forms a divide between two distinct soil types. South of Johnson Creek, the soils primarily range from moderately well-drained to somewhat poorly drained silt loams. Soils north of Johnson Creek are generally well-drained loams and silt loams.

Columbia Slough Watershed

The Columbia Slough lies within the floodplain of the Columbia River, an area that is characterized by relatively level ground that generally slopes down to the slough. Existing undisturbed soils in the slough area consist of alluvial materials. These soils may be soft or loose and saturated. Because of their silt and clay content, these soils are sensitive to water and can be slippery, heavy, and difficult to handle when wet.

The low-lying areas, generally north of NE Columbia Boulevard, range from excessively drained to very poorly drained silt loams, silty clay loams, and sands; high groundwater is common. Soils to the south of NE Columbia Boulevard are generally moderately or well-drained loams and silt loams. The soils throughout this watershed have been disturbed over time by construction, cutting, and filling.

3.5 Floodplains and Wetlands

Floodplains

Floodplains are dry in some seasons, but inundated when heavy rain, snow melt, tide, increased rate of surface runoff, or other conditions cause streams or rivers to overflow their normal channels. A 100-year floodplain is submerged by a flood level occurring once every 100 years. Standards for development in 100-year floodplains, which are specified in the federal Flood Hazard Insurance Act, must be met for Portland to qualify for federal flood insurance assistance. The density of development in natural flood hazard areas is controlled consistent with the provisions of the city's Building Code, Chapter 70, the Floodplain Ordinance and the Subdivision Ordinance.

Willamette River Watershed

Historically, connectivity of floodplain habitat was high both longitudinally along the river and laterally from the vegetated riverbanks to the upland forests. Gradually, floodplain habitats along the Willamette River have been destroyed, degraded, or disconnected through construction of dams throughout the Willamette and Columbia rivers and from development along the riverbanks (City of Portland, November 2002). Large expanses of black cottonwood/Pacific willow forest and spirea/willow wetland have been filled and developed, leaving small strips of riparian forest, wetland, and associated upland forests. These remnants are few or entirely lacking in large reaches through the downtown and industrial segments of the river. Most of the historical off-channel habitats, such as side channels, oxbow lakes, and marshes, have long since been cut off from the channel and filled. Connectivity and maintenance of these habitats have been reduced or eliminated as a result of marked alteration of the seasonal hydrograph, particularly a dramatic reduction of peak flows. Connection of many tributary habitats to the mainstem is eliminated or reduced by culverts. Within the Portland downtown and harbor areas, the river's banks are typically steep and are primarily composed of bank stabilization and fill materials such as sheet pile, riprap, seawall, and concrete fill. Riparian vegetation is generally sparse to absent and frequently consists of nonnative plants and shrubs.

A few small areas of higher quality habitat remain within the highly urbanized reaches of the Willamette. Remnant habitats of high quality—or with the potential to provide important functions if reconnected or restored—include Powers Marine Park, Ross Island, lower Stephens Creek, Oaks Bottom, Willamette Park, Kelley Point Park, the Forest Park watersheds, and Smith and Bybee lakes.

Channel conditions of subbasins draining the Forest Park area range from mature forested stands with good bank stability in the middle and upper sections to underground pipes that carry the streamflow through industrial areas and then out to the Willamette River via a pipe outlet in the lower sections.

Tryon Creek Watershed

Highest quality habitats are located within Tryon Creek State Park, which has wide and relatively undisturbed riparian buffers. Even within this protected area, however, wood volume is low and channel incision is evident. Above the park, the stream becomes highly segmented by road crossings and their associated culverts, and it is affected by intensive urban development.

Arnold Creek has good instream habitat but is highly segmented by culverts from road and driveway crossings. In addition, invasions of nonnative plants are evident even within the higher quality areas of Arnold Creek and Tryon Creek State Park. Falling Creek has poor to marginal instream habitat, with a lack of instream cover, poor bank and riparian structure, and excessive fine sediments.

Fanno Creek Watershed

Drainages in this watershed are typically small urban streams, with culverts routing flows under roads and fills. In some cases, neighborhood water piping networks have replaced floodplains and wetlands. There are numerous areas along Fanno Creek and its tributaries

where excess velocities in the channels have caused erosion and degraded riparian habitat. Sediment deposits and poor structural conditions also are evident.

Johnson Creek Watershed

The historical floodplain of Johnson Creek is disconnected or minimally connected through much of the stream's length (City of Portland, November 2002). The lack of floodplain connection means that flood flows cannot spread out and attenuate on the floodplain. Instead they are directed and concentrated into the main channel, where they increase scour and degrade instream habitat.

ODFW conducted habitat surveys throughout Johnson Creek (Oregon Department of Fish and Wildlife, 2000). The department's findings indicate that Johnson Creek has extremely low wood volumes, a high percentage of hardened banks, lack of refugia through many reaches, channel incision, and high levels of fine sediment. Riparian vegetation is minimal or lacking throughout much of the watershed. Riparian vegetation is as lacking in the upper watershed as it is in the lower watershed.

Columbia Slough Watershed

The Columbia Slough is located on the southern 100-year floodplain of the Columbia River between Fairview Lake and the Willamette River. The U.S. Department of the Interior (USDI) Fish and Wildlife Service's National Wetland Inventory shows that the slough system is primarily riverine and palustrine wetlands. Currently a maintained channel, it is a remnant of former marshes, wetlands, lakes, and side channels that characterized the historical floodplain system.

Over the years, extensive development has resulted in a watershed that has lost a vast percentage of its upland, wetland, and aquatic habitat. Large amounts of open water areas and wetlands have been eliminated as a result of urban development, and the hydrologic connectivity of the entire system has been greatly reduced. The creation of the levee on which Marine Drive is located has blocked the direct connection between the Columbia Slough and the Columbia River system, severing the river from its floodplain. A levee and pump station at NE 18th Avenue blocks passage of fish into the middle and upper parts of the slough. Consequently, juvenile salmonids from the lower Willamette River that are seeking out rearing habitats have access only to the lower section of the slough.

Wetlands

Wetlands include streams, ponds, marshes, and swamps. The majority of the wetlands are in the regional riverine hydrogeomorphic (HGM) class (41%), while 23% are in HGM classes atypical to the region due to human manipulation (Kentula and Gwin 2002). Most wetlands are in fair or marginal condition with 14% rated good and 35% poor (Kentula and Gwin 2002).

About 26% of all wetland resources are small wetlands <2 ha, and over half (57%) of small wetlands are palustrine emergent/open water wetlands (PEM/POW). Small (<2 ha) PEM/POW wetlands are the wetland types most often disturbed or lost in the rapidly developing areas of Portland (Kentula and Gwin 2002). About 40% of the small wetlands

have been altered during the last two decades, mostly during the 1980s despite development pressure throughout the 1990s.

3.6 Vegetation and Habitats

Vegetation

The vegetation of Portland's watersheds is listed in the *Portland Plant List* (City of Portland, June 1998). Many listings are native—historically found in Portland—while others are introduced or nonnative to Portland. They include trees and arborescent shrubs, shrubs, and ground covers found among the wetland, riparian, forest, forested slopes, thicket, grass, and rocky habitats of the City of Portland. Native, naturalized, and exotic plant categories include "nuisance" plants. Nuisance plants either dominate plant communities (40 species) or are considered harmful to people (four species).

Five plant species are prohibited from use in all reviewed landscaping plans because they pose a serious threat to the health and vitality of native plant and animal communities. Prohibited plants include Scot's broom (*Cytisus scoparius*), English ivy (*Hedera helix*), purple loosestrife (*Lythrum salicaria*), reed canarygrass (*Phalaris arundinacea*), and Himalayan blackberry (*Rubus discolor*). Revegetation projects often aim to control these prohibited species.

Threatened and Endangered Plants

The USDI Fish and Wildlife Service has identified six federally listed plant species that may occur in Multnomah County (USFWS, 2002): golden paintbrush (*Castilleja levisecta*, threatened), Willamette daisy (*Erigeron decumbens* var. *decumbens*, endangered), howellia (*Howellia aquatilis*, threatened), Bradshaw's lomatium (*Lomatium bradshawii*, endangered), Kincaid's lupine (*Lupinus sulphureus* var. *kincaidii*, threatened), and Nelson's checkermallow (*Sidalcea nelsoniana*, threatened). Of these species, golden paintbrush, Willamette daisy, howellia, Kincaid's lupine, and Nelson's checkermallow are on the *Portland Plant List (*City of Portland, June 1998). A search of the Oregon Natural Heritage Information Center's records of rare, threatened and endangered plant records for Portland led to the following conclusions about species presence (ONHIC, 2003).

Golden paintbrush typically occupies fescue grasslands at elevations below 300 feet and is often rooted in glacial outwash or deposits. It is unlikely that golden paintbrush occurs in Portland because no known populations have been recorded and the species is commonly believed to be extirpated from Oregon.

The Willamette daisy occupies areas of native wetland prairie in low, flat regions of the Willamette Valley where flooding creates anaerobic and strongly reducing soil conditions. The species is not known to occur in Multnomah County and is unlikely to occur because native wetland prairie communities are not present.

Howellia is not known to exist in the program area. The nearest documented population is at the Ridgefield National Wildlife Refuge, approximately 15 miles north of Portland (personal communication, L. Todd, ONHP, June 29, 1995). The species prefers still water and shaded areas in the floodplains of the Columbia River and ash woods and vernal pools.

A high degree of water clarity, which is important to Howellia, is rarely present in the urban waters, where turbidity is often high (personal communication, J. Christy, ONHP, July 5, 1995).

Bradshaw's lomatium typically occurs in wet prairies of the Willamette. There are no known occurrences of Bradshaw's lomatium in Portland, and there are no native wet prairies. It is unlikely that this lomatium is present in the project vicinity.

Kincaid's lupine occurs in the native upland grassland habitats within the Willamette Valley, on heavier soils with mesic to slightly xeric soil moisture levels. There are no known occurrences in Portland, and there are no native grassland habitats in the city. It is unlikely that this lupine is present in the project vicinity.

Nelson's checkermallow most frequently occurs in ash swales and meadows with wet depressions, along streams, and in wetlands within remnant prairie grasslands, but it may also occur in roadside ditches and mowed hayfields. There are no known occurrences of Nelson's checkermallow in the city and no native prairies are present. It is unlikely that this plant occurs in the IWWP area.

Additionally, the USDI Fish and Wildlife Service has identified 13 species of concern that may occur in Multnomah County (USFWS, 2002): Howell's bentgrass (*Agrostis howellii*), white top aster (*Aster curtus*), tall bugbane (*Cimicifuga elata*), cold-water corydalis (*Corydalis aquae-gelidae*), pale larkspur (*Delphinium leucophaeum*), peacock larkspur *(Delphinium pavonaceum*), Howell's fleabane (*Erigeron howellii*), Oregon daisy (*Erigeron oreganus*), white meconella (*Meconella oregona*), Howell's montia (*Montia howellii*), Barrett's penstemon (*Penstemon barrettiae*), Columbia cress (*Rorippa columbiae*), and Oregon sullivantia (*Sullivantia oregana*).

There are no records of Howell's bentgrass, cold-water corydalis, peacock larkspur, Howell's fleabane, white meconella, or Barrett's penstemon occurring in Portland. Consequently, these species are unlikely to occur in the area.

White top aster is assumed to be extirpated in Portland.

Tall bugbane has been reported in Forest Park and on Powell Butte and Sentinel Hill. It is found in moist areas within open forest (for example, Douglas-fir woodland).

Pale larkspur is known to occur in Sandy, Lake Oswego, and Milwaukie, but not in Portland.

Howell's montia, which prefers moist lowland areas, has been reported on Sauvies Island. It has not been reported in the program area.

Columbia cress has been documented along the north shore of the Sandy River delta. It is not known to occur in the program area.

Oregon sullivantia is known to occur at Sauvies Island, Milwaukie, and Elk Rock, but not in Portland.

Habitats

Three broad classes of habitat that support fish and wildlife are present in the Portland area: aquatic, riparian, and upland (City of Portland, November 2002). The health of biological communities is directly affected by the types and condition of specific habitat features.

Aquatic Habitat

Mainstem Rivers

The mainstem Willamette River is a running-water habitat with slow-rising, extensive, and long-lasting floods that drive disturbances. Tree falls and bank erosion are common, and logjams are scattered along the shoreline near the high-water line, at the end of islands and bars, and submerged in the channel. Most of the solar input reaches the river, although penetration can be limited by river depth. The sunlight supports the production of phytoplankton, periphyton, and rooted vascular plants that are dominant in food webs. Floodplain inundation is critical to providing the organic inputs necessary to support productivity.

Tributaries

Tributaries to the mainstems are running-water systems with irregular flood patterns strongly influenced by local precipitation events. Direct contact between the stream and adjacent hillsides results in frequent landslides, debris flows, dam-break floods, and bank erosion. Channel form is more likely to be influenced by mass wasting and alluvial processes (Naiman et al., 1992).

Tributary streams generally have smaller channels and narrower floodplains with larger rocks and boulders and poorly sorted gravels (Gurnell, 1995). Pools, riffles and glides are common habitat features of properly functioning streams. Wood may be large enough to span the channel and is not easily dislodged in headwater streams. In larger, low-gradient streams such as Columbia Slough and Johnson Creek, sediments are sorted by size and generally include abundant fine particles of silt and clay. Channel roughness, shallow-water areas, and deep pools define aquatic habitats. In less disturbed tributary streams, relatively little sunlight reaches the stream; however, many Portland streams have little vegetation to shade the water, or they are piped.

Riparian Habitat

Riparian areas are the environments adjacent to rivers and streams, a zone of direct interaction between terrestrial and aquatic ecosystems. Although many historical riparian habitats have been eliminated by the urban landscape, where present, riparian vegetation influences adjacent aquatic systems by providing important components of the food web; it can also play a significant role in the structure of aquatic communities.

Where streams are connected to historical floodplains, annual flooding allows for the interchange of organic material and nutrients between the riparian and aquatic environments. Riparian vegetation can act as a barrier that reduces sediment and debris transport, slows surface flows, and encourages infiltration. Riparian areas also can filter sediments, pollutants, metals, and excess nutrients.

In intact riparian areas, water can be stored and transported into the atmosphere, vegetation, stream channels, the floodplain, soil, and shallow or deep groundwater aquifers.

The leaves, needles, and branches in the canopy and on the ground can absorb precipitation and prevent it from reaching the ground, or they slow its progress, thus reducing the amount of erosion and runoff. When present, riparian vegetation creates a microclimate that influences both the riparian area and stream environment by affecting soil moisture and temperature, air temperature, water temperature, wind speed, and relative humidity.

Changes to Portland's riparian vegetation have influenced associated benthic communities, birds and mammals, and herpetofauna. Historical changes include reductions of the following:

- Diversity of vegetation species and structure
- Unique vegetation assemblages
- Corridors and migration routes
- Habitat features for wildlife
- Ongoing restoration efforts are attempting to improve these conditions.

Upland Habitats

Upland habitat refers to all areas that are not riparian, wetland, or open water habitats. Johnson and O'Neil (2001) describe five upland habitat types present in the Portland area. These include Westside Lowlands Conifer-Hardwood Forest, Westside Oak and Dry Douglas-fir Forest and Woodlands, Westside Grasslands, Agriculture Pasture and Mixed Environs, and Urban and Mixed Environs. Eighty-nine percent of all terrestrial species in the Portland area are associated with upland habitats, with at least 28 percent depending on these habitats to meet their life history requirements.

Of the five habitat types, the Westside Lowlands Conifer-Hardwood Forest is most widespread and prevalent, and the Urban and Mixed Environs are widely distributed but patchy. Urbanized habitats are characterized by buildings and other structures, impervious surfaces, reduced wildlife diversity, nonnative species, reduced canopy cover and habitat features, elevated temperatures, and increased background lighting and wind velocities (Penland, 1984; Puchy and Marshall, 1993). Frequent human disturbance is normal in urban habitats, and species that are disturbance-sensitive tend to be absent or reduced in numbers (Marzluff et al., 1998). There are no species at risk dependent upon this habitat.

3.7 Fish and Wildlife

Aquatic Species

Generally, game fish found in Portland include salmonids, black crappie, white crappie, blue gill, yellow perch, brown bullhead, warmouth, large mouth bass, and white sturgeon. Nongame species common throughout the area include large-scale sucker, carp, goldfish, stickleback, pea mouth, cottids, sculpin, mosquitofish, and crayfish. The poor water quality, turbidity, lack of rooted vegetation, muddy substrate, and effects of tidal water movement within waters such as the Columbia Slough contribute to the dominance of nongame species (U.S. Army Corps of Engineers, July 1992).

Benthic abundance is not particularly high because of the silty nature and lack of detritus of the urban streams and sediments (U.S. Army Corps of Engineers, July 1992). Aquatic invertebrates include cladoceranes, rotifers, oligochaete worms, chironomid larvae, clams, and midge fly larvae. The populations and abundance of species vary seasonally. Also, microscopic algae are part of the aquatic ecosystems. The extent and abundance of aquatic species vary among Portland watersheds, influenced by habitat features and historical disturbances.

Willamette River Watershed

The aquatic biota of the lower Willamette River have changed significantly from historical conditions. Extirpations of sensitive species have occurred, and introductions of nonnative species have resulted in increased competition for food and habitat for native species. The existing fish community in the lower Willamette River consists of warm-water, cool-water, and cold-water fish. Several listed salmonid evolutionarily significant units (ESUs) use the lower Willamette River. At least 33 other native and introduced species of both warm-water and cool-water fish inhabit the river (Oregon Department of Fish and Wildlife, 1994).

The biota of the Forest Park streams probably are altered relative to historical conditions. The piping of streams and installation of culverts have blocked habitat access for anadromous fish; this has resulted in the extirpation of native anadromous fish species. Resident cutthroat trout are still present in many of these watersheds.

Tryon Creek Watershed

Historically, Tryon Creek provided important habitat for sea-run cutthroat, steelhead, coho, and possibly chinook salmon. However, development activities, particularly culvert and road crossings, have resulted in degraded habitat and migration barriers.

Fanno Creek Watershed

Most of Fanno Creek within the City of Portland is inaccessible to anadromous fish because of impassable culverts downstream of city limits. The City of Portland sampled fish populations in 1993 and found reticulate sculpin, redshide shiner, cutthroat trout, and peamouth present in the upper reaches.

Johnson Creek Watershed

The fish community in Johnson Creek is dominated by redside shiners, reticulate sculpin, and speckled dace (Johnson Creek Corridor Committee, 1995). Large-scale suckers are abundant in the lower reaches. Adult salmonids that have been observed in the stream include coho salmon, chinook salmon, cutthroat trout, and steelhead (ODFW unpublished data, as cited in Ellis, 1994).

Columbia Slough Watershed

The biological communities in the Columbia Slough are degraded as a result of the extensive degradation of flow, habitat, and water quality conditions. Salmonids are restricted to the lower slough. Fish communities are dominated by nonnative warm-water fish species such as common carp and bluegill. Benthic macroinvertebrate communities are extremely sparse.

Threatened and Endangered Fish Species

Information about threatened and endangered fish species was obtained from the USDI Fish and Wildlife Service (USFWS, 2002) and Beak Consultants (1998). The listed fish species that may occur in the city's waterways include chum salmon (Lower Columbia River) (*Onchorhynchus keta*, threatened), steelhead (Lower Columbia, Middle Columbia, Upper Willamette, and Snake River Basin) (*Onchorhynchus mykiss*, threatened), sockeye salmon (*Onchorhynchus nerka*, endangered), Chinook salmon (Lower Columbia, Upper Willamette, and Snake River) (*Onchorhynchus tshawytscha*, threatened), and bull trout (Columbia River) (*Salvelinus confluentus*, threatened). Coho salmon (Lower Columbia River) (*Onchorhynchus kisutch*) is a candidate species for listing. Coastal cutthroat trout (*Onchorhynchus clarki clarki*) was formerly proposed for listing as threatened, but the southwestern Washington/ Columbia River population became "Not Listed" in July 2002. Green sturgeon (*Acipenser medirostris*) became a candidate species for listing in January 2003. Pacific lamprey (*Lampetra tridentata*) are listed as species of concern.

Changes to stream flows and the loss of side channels and floodplains as a result of diking and filling have reduced the historical distribution of threatened and endangered fish species. Many areas of Portland are able to support only temporary rearing of individuals from populations of steelhead and chinook that are emigrating out of larger tributaries in the upper portion of the Willamette River watershed.

Many Portland watersheds are blocked near the mouth by culverts that allow anadromous fish access to, at best, only a thousand or so feet of stream. These areas offer opportunities for fish to temporarily move off the mainstem of the Willamette, and fish in these areas most likely are coming from more productive watersheds such as the Clackamas River. However, anadromous fish use some Portland stream reaches as described below.

Willamette River Watershed

Given the extensive culverting of streams emptying into the Willamette within Portland, there is very little stream habitat that is accessible to salmonids for spawning and rearing in the tributaries. All of the Forest Park streams that historically flowed into the Willamette River have been blocked by culverts. Balch Creek was isolated in 1921 when the lower part of the creek was diverted and incorporated into the City of Portland’s sewer system.

In the lower Willamette River, juveniles of winter steelhead and spring chinook use habitats available in the shallower margins of the river or off-channel sites where available for rearing as they out-migrate through the lower river (City of Portland, November 2002). Adult steelhead and spring chinook have been documented holding up in the lower mainstem for a period of time before moving upriver (City of Portland, 1999). Adult spring chinook come in as late as December and hold in the main river before crossing Willamette Falls. Adult steelhead have been documented entering the mouth of the Clackamas River with a darkened coloration, indicating that they have been in freshwater for some time (City of Portland, 1999).

Fall chinook juveniles exhibit similar near-shore and off-channel behaviors as spring chinook and steelhead juveniles with a series of migrating and rearing strategies as they move down the Willamette River in the vicinity of Portland.

There are several small streams where temporary off-channel rearing of out-migrating juvenile steelhead may be occurring where habitat exists between culverts and the river. For example, there is documentation of off-channel rearing of steelhead and/or rainbow trout in the lower portion of Miller Creek below St. Helens Road (City of Portland, 1992). When conditions are appropriate, the lower reach of Stephens Creek may offer temporary rearing opportunities to out-migrating juvenile steelhead spawned in tributaries upstream in the Willamette watershed.

Cutthroat trout have been documented in several streams that drain into the Willamette River. Cutthroat trout have been observed in Miller Creek (Gram and Ward, 2002), and a population of 2,000 to 4,000 resident cutthroat trout has been documented in Balch Creek (Johnson, 1993). Also, cutthroat trout are found in Stephens Creek, which has been cut off from the Willamette River by culverts. This evidence suggests that similar isolated populations of cutthroat may exist in Forest Park streams where appropriate flows and habitat exist.

Tryon Creek Watershed

Steelhead and/or rainbow trout have been documented in Tryon Creek (Gram and Ward, 2002; Pacific Habitat Services, 1997; Reed and Smith, 2000). The documented findings of spawning and rearing steelhead suggest that these are an independent population. Tryon Creek is one of two watersheds within the metropolitan area that is accessible to migrating steelhead. (A culvert under Highway 43 near the mouth of Tryon Creek has been determined to be passable by an Oregon Department of Fish and Wildlife inventory. However, there has been speculation that the culvert is impassable at certain times of the year, depending on water levels [personal communication, C. Prescott, City of Portland, 2002].) Also, when conditions are appropriate, the lower reach of Tryon Creek may offer temporary rearing opportunities to out-migrating juvenile steelhead spawned in tributaries upstream in the Willamette watershed.

Cutthroat trout are found in Tryon Creek, where access to habitat is unimpeded by culverts.

Fanno Creek Watershed

Steelhead and/or rainbow trout have been documented in the Tualatin Basin (Friesen and Ward, 1996), but not in Fanno Creek, which has been cut off from the Willamette River by culverts. However, cutthroat trout are found in Fanno Creek.

Johnson Creek Watershed

Adult chinook have been documented spawning in lower Johnson Creek over the years but in such small numbers as to prompt Ellis (1994) to speculate that these fish may be strays. Juvenile chinook have been documented in the lowest reaches of Johnson Creek and Crystal Springs Creek (Ellis, 1994; Reed and Smith, 2000). Given the limited information that is available regarding the number of adult chinook that have returned to spawn, the evidence suggests the possibility that juveniles that have spawned in other watersheds may be using these areas as temporary off-channel sites as they migrate through the area.

Johnson Creek Watershed is one of the two watersheds within the metropolitan area that is accessible to migrating steelhead. Steelhead and/or rainbow trout have been documented in the Crystal Springs Creek tributary to Johnson Creek, the lower 9.6 miles of Johnson

Creek (from roughly SE 145th to the confluence with the Willamette River) (Ellis, 1994), and the Kelley Creek tributary of Johnson Creek (Ellis, 1994; Reed and Smith, 2000). The documentation of steelhead juveniles in surveys between 1992 and 1999 in the Kelley Creek subwatershed to Johnson Creek and documentation of possible overwintering juveniles (Reed and Smith, 2000), combined with ongoing observations of spawning steelhead adults, suggest the continued presence of a small population and not just sightings of occasional strays. Also, when conditions are appropriate, the lower reaches of Johnson Creek may offer temporary rearing opportunities to out-migrating juvenile steelhead spawned in tributaries upstream in the Willamette watershed.

Cutthroat trout are found in Johnson Creek, where access to habitat is unimpeded by culverts.

Columbia Slough Watershed

Juvenile chinook have been documented in Smith and Bybee lakes (Fishman Environmental Services, 1987). It is probable that juveniles that spawn in other watersheds are using this area as a temporary off-channel site as they migrate through Portland.

Essential Fish Habitat

Under the Magnuson-Stevens Act, Essential Fish Habitat (EFH) for the Pacific coast salmon fishery (chinook and coho salmon) means those waters and substrate necessary for salmon production needed to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. To achieve that level of production, EFH must include all those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon. In the estuarine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the Exclusive Economic Zone offshore of Washington, Oregon, and California north of Point Conception. Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon, except areas upstream of certain impassable man-made barriers (as identified by the Pacific Fisheries Management Council), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). EFH for various life stages of chinook and coho salmon is found within the mainstem Columbia and Willamette Rivers and their tributaries in the IWWP area, although many of the historical EFH streams have "disappeared" from the urbanizing landscape of Portland.

EFH for Pacific coast groundfish is defined as the aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and for groundfish contributions to a healthy ecosystem. The groundfish EFH includes all waters from the mean higher high water line, and the upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon and California seaward to the boundary of the U.S. Exclusive Economic Zone. Estuarine groundfish EFH are found in the mainstem Columbia and Willamette Rivers within the IWWP area.

Wildlife

The Portland metropolitan area is fortunate to have retained some important natural areas such as Forest Park, the East Buttes, Cooper Mountain, and other habitat that is essential for

maintaining a diversity of wildlife species within the urban area (Houck and Cody, 2000). The following discussion is based on Metro's species list of Portland wildlife (Metro, 2002).

Amphibians

There are sixteen extant native amphibian species in the Portland metro area, including twelve salamanders and five frogs. An additional species, the bullfrog, is introduced and places considerable pressure on native species.

Amphibians and birds are the two groups in the area most dependent on aquatic and riparian habitats. In the Portland area, 69 percent of native amphibian species (salamanders, toads, and frogs) rely exclusively on stream- or wetland-related riparian habitat for foraging, cover, reproduction sites, and habitat for aquatic larvae. Another 25 percent use these habitats during their life cycle. Six Portland-area amphibian species are state-listed species at risk; four species are considered at risk at the federal level.

Reptiles

Thirteen native reptile species inhabit the Portland area, including two turtle, four lizard, and seven snake species. This is the least riparian-associated group; even so, 23 percent of native reptile species depend on water-related habitats and another 46 percent use water-related habitats during their lives. Although most lizards and snakes are associated with upland habitats, many species use riparian areas extensively for foraging because of the high density of prey species and vegetation. Both of the native turtle species—the western pond turtle and the painted turtle—are riparian/wetland obligates and rely on large wood in streams and lakes for basking (Kauffman et al., 2001). These two turtles are state and/or federal species at risk. Several nonnative turtle species have established breeding populations in Portland, and they compete with native turtle species.

Birds

According to the Metropolitan Service District, birds represent the majority of vertebrate diversity in this region, and 209 native bird species occur in the Portland area. An additional four nonnative species have established breeding populations in the area. The Portland Audubon Society lists 233 bird species observed in Portland, including 48 "accidentals" (Davis 1984)

In the Portland area, about half (49 percent) of native bird species depend on riparian habitats for their daily needs, and 94 percent of all native bird species use riparian habitats at various times during their lives. Twenty-two bird species are state or federal species at risk. Nineteen of these are riparian obligates or regularly use water-based habitats. An additional riparian obligate, the yellow-billed cuckoo, is extirpated in the Portland area.

Mammals

Mammals are another diverse group of species in the Portland area, with 54 native species. This is the terrestrial group with the highest number of nonnative species (eight species, or 15 percent of total species; most are rodents). Of native species, 28 percent are closely associated with water-based habitats, with another 64 percent using these habitats at various points during their lives. Six out of nine bat species and three native rodent species are state or federal species at risk.

Mammals can profoundly influence habitat conditions for other animals, including fish. Historically, beavers were nearly extirpated from the Willamette Valley as a result of trapping, but populations have rebounded (Oregon Department of Fish and Wildlife, 2001). The introduced nutria can damage streambanks and consume riparian vegetation. Large herbivores such as deer browse on herbs and shrubs, which can promote vigorous growth (Kauffman et al., 2001). Medium-sized carnivores keep rodent and small predator populations in check, with important implications for bird nest success. Bats help regulate insect populations and may contribute to nutrient cycling, particularly in riparian areas (LaRoe et al., 1995).

Threatened and Endangered Wildlife Species

There are three species of threatened or endangered wildlife that may occur in Multnomah County: Columbian white-tailed deer (*Odocoileus virginianus leucurus*, endangered), bald eagle (*Haliaeetus leucocephalus*, threatened), and northern spotted owl (*Strix occidentalis caurina*, threatened) (USFWS, 2002). Columbian white-tailed deer migrate along the Columbia River, including Burlington Bottoms, but are not found in the urban areas of the city. Bald eagles are occasional flyovers, and nests have been observed along the mainstems of the Willamette and Columbia rivers and the Smith and Bybee lakes area. Northern spotted owls are not known to occur in the city, and are unlikely to be found because they are associated with interior forest habitat.

The streaked horned lark (*Eremophila alpestris strigata*) is a candidate species for listing. They nest in areas of sparse to no vegetation such as agricultural lands, pastures, prairies, desert shrublands, and alpine areas. This lark may occur in the program area, although there are no recorded occurrences in the city.

Also, the USFWS identified 25 species of concern—five invertebrates, four amphibians, one reptile, seven birds, and eight mammals. The invertebrates are California floater (*Anodonta californiensis*), Mt. Hood primitive brachycentrid caddisfly (*Eobrachycentrus gelidae*), Great Columbia River spire snail (*Fluminicola columbianus*), Columbia Gorge neothremman caddisfly (*Neothremma andersoni*), and Wahkeena Falls flightless stonefly (*Zapada wahkeena*). None of these invertebrates has been recorded in Portland.

The amphibians and reptiles are the tailed frog (*Ascaphus turei*), northwestern pond turtle (*Clemmys marmorata marmorata*), Larch Mountain salamander (*Plethodon larselli*), northern red-legged frog (*Rana aurora aurora*), and Cascades frog (*Rana cascadae*). The northwestern pond turtle has been recorded at ponds and lakes in the Portland area, including Fanno Creek, but there are no records of its occurrence in Portland. The northern red-legged frog has been recorded at relatively undisturbed tree-covered streamsides in Forest Park and at Johnson Creek. None of the other amphibian and reptile species has been recorded in Portland, and they are unlikely to occur because they inhabit emergent wetlands, lakes, and slow-moving streams or sloughs.

The birds are the northern goshawk (*Accipiter gentilis*), tricolored blackbird (*Agelaius tricolor*), olive-sided flycatcher (*Contopus cooperi* (=*borealis*)), little willow flycatcher (*Empidonax traillii brewsteri*), harlequin duck (*Histrionicus histrionicus*), yellow-breasted chat (*Icteria virens*), and Oregon vesper sparrow (*Pooecetes gramineus affinis*). The tricolored blackbird has been recorded along Blind Slough in north Portland. No records of the other

species were found; however, it is possible that they may rarely occur in woodlands and marshes of the program area.

The mammals are the Pacific big-eared bat (*Corynorhinus* (=*Plecotus*) *townsendii townsendii*), silver-haired bat (*Lasionycteris noctivagans*), California wolverine (*Gulo gulo luteua*), long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), long-legged myotis (*Myotis volans*), Yuma myotis (*Myotis yumanensis*), and Camas pocket gopher (*Thomomys bulbivorus*). The Pacific big-eared bat was found in Portland decades ago, but not recently. Yuma myotis has been found in Burlington, but not Portland. None of the others has been recorded in Portland, and it is unlikely that they occur because suitable habitat is lacking.

3.8 Land Use

The City of Portland's Comprehensive Plan and Map, and Zoning Code have shaped the urban landscape since 1980 (City of Portland, January 1999). Land uses in the Portland area are diverse. Table 3.8-1 provides the 1994 land use distribution by watershed, based on zoning designations rather than actual land use (City of Portland, July 1999). Commercial and industrial land uses have the greatest percentages in the Columbia Slough and Willamette watersheds.

TABLE 3.8-1. LAND USE DISTRIBUTION AS A PERCENTAGE OF THE WATERSHED

	Land Use (%)					
Watershed	Multifamily Residential	Single-family Residential	Commercial	Industrial	Parks/ Open Space	Other
West Willamette	3	15	4	18	45	15
East Willamette	12	56	8	19	4	0
Tryon Creek/ Fanno Creek	6	71	6	0	11	6
Johnson Creek	16	56	5	4	13	0
Columbia Slough	7	33	5	37	12	5

Willamette Watershed

Land uses within the Willamette River watershed are urban/industrial, residential, and rural/agricultural (City of Portland, November 2002). Many of the state's heaviest industrial users are present in the lower Willamette Watershed, which has been heavily urbanized and industrialized for decades. Land use within subbasins draining Forest Park is largely open space, although there also are residential, industrial, and transportation uses.

Tryon Creek/Fanno Creek Watersheds

Most of the watershed is currently developed, except for small land parcels scattered throughout the watershed and the higher elevations of the West Hills. About 77 percent of the existing urban development is zoned residential, 6 percent is zoned commercial, and 11 percent is zoned for parks and open space. Highly impervious commercial, residential, and roadway areas predominate in the lower elevations. Single-family residential homes are surrounded by natural open space in the upper elevations. Impervious areas, which are

connected to a stormwater drainage system, make up 21 percent of the watershed, and 12 percent of the watershed consists of impervious areas that are not connected to the storm drain system.

Johnson Creek Watershed

About 72 percent of the Johnson Creek Watershed is currently zoned residential, 5 percent is zoned commercial, 4 percent is zoned industrial, and 13 percent is zoned for parks and open space. Land use is typically a mixture of single-family and multifamily developments, with commercial uses concentrated along major arterial streets. The watershed is not fully developed, and agricultural land uses occur upstream and east of Portland, so the existing land use is expected to change in the near future. A moderate amount of commercial development is expected to occur, and significant residential growth is anticipated in the undeveloped southern and eastern portions (which include the Pleasant Valley urban reserve area).

Columbia Slough Watershed

The Columbia Slough drains residential neighborhoods, vegetable farms, industrial areas, and transportation corridors (City of Portland November, 2002). Over the years, extensive urban, agricultural, and industrial development have profoundly altered the watershed. Land uses within the Columbia Slough watershed are primarily industrial and residential. Many of the region's heaviest industrial users are present in the Columbia Slough watershed.

3.9 Cultural Resources

The following summary of cultural resources within the IWWP area is based on information from the U.S. Army Corps of Engineers (July 1992) and the City of Portland (December 1994 and 1995). The State Historic Preservation Office was not contacted for this resource summary because the volume of recorded sites is known to be large and site-specific records probably would not be relevant given the programmatic nature of this environmental assessment.

Prehistoric and Early Historic Conditions

The prehistoric subsistence economy was organized around the topographic distribution and seasonal availability of productive natural habitats and food resources. Environmental characteristics of the Columbia floodplain provided adequate resources to sustain large populations, and long-term occupation resulted in recognizable patterns in the archaeological data.

In 1805, Lewis and Clark mentioned the abundance, availability, and intensive use of the area resources. In addition to the two villages noted in the Lewis and Clark journals, there were approximately 25 other ethnohistorically documented villages in the Portland Basin, but many of these sites remain undiscovered (Saleeby, 1984).

Recent Historic Conditions

Early settlers in the bottomlands cleared their land and sold logs; others raised cattle and sold supplies to Fort Vancouver. The historic records frequently mention the heavily timbered areas that were cleared by the early settlers. These efforts prepared the bottomlands for agricultural purposes and provided logs to sell. The Willamette River and Columbia Slough were used as commercial waterways in the 1800s for rafting logs to sawmills. Later, companies competed for business along the waterways. The Vancouver Road conveyed travelers and commerce between Portland and the ferry landing on the South Shore of the Columbia (Barber, 1977).

The Historic Resource Inventory (City of Portland, 1984) lists approximately 5,000 historic resources that are protected from demolition. This inventory includes districts, buildings, trees, and landmarks of historic value.

3.10 Recreation

Portland offers a wealth of outdoor recreational opportunities. Portland Parks & Recreation (PP&R) is responsible for 239 parks covering more than 10,000 acres, which represent about 9.9 percent of all city land (PDC, 2002; City of Portland, 2000a). Public park land in Portland includes traditional neighborhood parks with sports fields and picnic areas, urban plazas with benches and fountains, natural areas with valuable habitat, and acres of greenspace. PP&R's parks range from Forest Park, one of the nation's largest wooded city parks, to Mill Ends, which, at 24 inches in diameter, is one of the world's smallest parks. Between these two extremes fall 6 botanical gardens, 25 community gardens, 35 community parks, 4 golf courses, 47 habitat parks, 98 neighborhood parks, 12 regional parks, and 12 urban parks.

The city's preeminent geographic feature, the Willamette River, provides countless opportunities for recreation and habitat preservation. The river is a magnificent resource that is the center of Portland's parks. The recently completed South Waterfront Park, on the west side of the river, is a nationally recognized park project that provides an abundance of beauty and recreational opportunities. The Eastbank Riverfront Park on the opposite bank does the same. Renovation of Tom McCall Waterfront Park, now used primarily for festivals and major events, provides river recreation and public gathering places in the heart of the city. The Willamette River and other large waterbodies are used for boating, swimming, fishing, and other water-based recreation.

Included in PP&R's responsibilities are 7,500 acres of natural resource areas, miles of bike and pedestrian trails, and the urban forest. Natural areas and the urban forest contribute to the ecological health of the city, and provide residents with opportunities for bird watching, wildlife viewing, and connections to nature. Bike and pedestrian trails fall both within and outside park boundaries. The Springwater Corridor, for example, is a regional trailway and wildlife corridor of which nearly 20 miles are built. In many areas of the city, traffic volume, topography, streams, or unsafe pedestrian connections limit park access.

Table 3.10-1 summarizes the type and amount of park land and recreation spaces found among the city's watersheds. These lands vary according to the landscape character, geography, and history of land use (City of Portland, 2000a).

TABLE 3.10-1. TYPE AND AMOUNT OF PARK LAND AND RECREATION SPACES FOUND AMONG THE CITY'S WATERSHEDS

Sub-Area	Type	Amount
Central City/ Northwest	• Majority is in Forest Park, with few programmed areas or facilities for its size • Three botanical gardens	• 56 percent of Portland's park land • Has the most urban parks and plazas in the city • Fewest neighborhood and community parks
North	• Best balance of park types • Regional parks include West Delta Park, Heron Lakes Golf Course, and Portland International Raceway	• 1,215 acres of park land • Nearly 50 percent of the city's regional park acreage
Northeast	• Almost no habitat park land • East Delta Park is a regional park	• Smallest total acreage of all park types (508 acres) • Average amount of neighborhood and community parks (191 acres)
Outer East	• Second-largest habitat park in the system (Powell Butte) • Leach Botanical Garden • Springwater Corridor • No regional parks	• Second smallest amount of total park land (879 acres) • Smallest amount of community parks • Largest acreage of neighborhood parks (130 acres)
Southeast	• Few habitat parks • Limited regional park land • Contains part of the Springwater Corridor	• 898 acres of park land • Largest amount of community park land (221 acres)
Southwest	• Large natural areas, difficult to access because of hilly, wooded topography	• 838 acres of park land • Some regional park land • Modest amount of habitat park land • Average amount of community and neighborhood park land

3.11 Human Health and Safety

Human health and safety relates to the groups of individuals that will be affected by the proposed IWWP projects. These groups include the workers performing construction, the public that comes in contact with the projects during construction, the neighborhoods surrounding the projects, the recreational users, and the future visitors to the completed projects.

Potentially hazardous materials in soil or water may be encountered during construction of the projects because the urban area has a history of general industrial use. For example, the Tanner Creek basin may contain contaminated soil. However, the exact locations of all contaminated sites are unknown.

Surface water does not meet Oregon water quality criteria. Surface water, sediments, and fish in the city's waters contain a variety of metals and organic compounds (Dames and Moore, 1995; Parametrix, 1995). Primary chemicals of potential concern (COPC) for human and wildlife exposure risks (ingestion and dermal contact) that were identified in Portland's most polluted waters are PCBs and benzidine. The City of Portland posts signs warning the

public about swimming in waters contaminated with raw sewage discharged from combined sewer overflow pipes. For risks associated with consumption of crayfish and fish (fillet or whole body), the COPCs are PCBs, DDE/DDT, and arsenic. Dioxins are also found in fish. PCBs and pesticides bioaccumulating in fish tissue may pose threats to human health and wildlife through fish consumption and may cause developmental effects and cancer.

3.12 Traffic/Transportation

Portland's urban transportation system serves an area of approximately 147 square miles and a population of 523,000 people (City of Portland, December 2002; U.S. Census Bureau, 2002). Portland's street system includes arterials, collectors, local streets, and other important noncollector street connections.

According to the 1996 *Transportation System Plan Inventory* (PDOT, 1996), the number of lane miles in Portland's street system is 3,678, including 1,179 arterial and 2,499 local street lane miles. In addition, the Oregon Department of Transportation (ODOT) maintains 12 state highways within the city boundaries. The Portland street system increased by 43 percent between 1984 and 1994, primarily through annexation. Of all improved streets for which the Portland Department of Transportation (PDOT) is responsible, 93 percent are hardsurfaced asphalt or concrete and 7 percent are oil or gravel.

In addition to streets, the structures inventoried in 1996 include 158 bridges, 202 retaining walls, 15 miles of guardrails, 169 stairways, and the harbor wall along the Willamette River. Also inventoried were 128 miles of bikeways, 31,027 street segments, 2,102 miles of sidewalks, and nearly 3,000 miles of curbs (City of Portland, December 2002). There are thousands of ditches, culverts, and crossdrains that convey stormwater across the roadways.

Tri-Met is the transit provider for Portland. As of the 1996 inventory, Tri-Met operated 90 bus routes (six of which provide crosstown service) and Eastside MAX, a light rail line extending from downtown Portland to downtown Gresham. Since the inventory, Westside MAX and Airport MAX have been built, and the Interstate MAX line is currently under construction.

Other transportation systems include aviation, marine, and rail. The Port of Portland operates Portland International Airport and five marine terminals and owns industrial property adjacent to the Portland Harbor (PDC, 2002). Rail lines run primarily along the Willamette River and Interstate 84 corridors.

A large proportion of Portland's impervious surfaces are streets, sidewalks, and parking lots. Important amounts are associated with public facilities (schools, parks, etc.), commercial and industrial operations, and other institutions (such as churches). Most were constructed prior to current standards for surface water quality treatment and implementation of BES's *Stormwater Management Manual* (BES, 2002). Many convey potentially polluted stormwater directly to receiving waters. Newer Green Streets and water quality-friendly parking lots detain and filter stormwater runoff using surface infiltration systems such as swales and sheet flow to landscaped areas (see Section 3.3 of this EA).

3.13 Socioeconomics

In 2001, Portland had a household population of 523,000; 265,000 (51 percent) females and 258,000 (49 percent) males (U.S. Census Bureau, 2002). The median age was 34.9 years. Twenty-two percent of the population were under 18 years of age, and 11 percent were 65 years and older. About one-third of the population (36 percent) lives in the Willamette River watershed, and one-third (30 percent) lives in the Columbia Slough watershed, with the remaining one-third in the Johnson Creek watershed (18 percent) and Fanno/Tryon Creek watersheds (16 percent) (City of Portland, July 1999). Since 1990, Portland's population has been growing by about 2.3 percent annually (PDC, 2002). In 2001, Portland had a total of 240,000 housing units, including 151,200 single-family and mobile homes (U.S. Census Bureau, 2002).

At times the Portland metropolitan region has enjoyed a strong and growing economy. Growth in the manufacturing sector, especially high-technology manufacturing, over the past two decades dramatically shifted the regional economy away from one primarily dependent on the natural resources sector. Trade makes up a significant share of the regional economy, and much of the region's growth is due to its strategic location along primary traffic corridors (railway, highway, and waterway) and the availability of deep-water ports.

Portland's employment by industry sector in 2001 is given in Table 3.13-1 (State of Oregon, 2002). The 2001 median income of households in Portland was $39,928 (U.S. Census Bureau, 2002). Over the past eight years, total employment in Portland grew consistently at an average rate of 3.3 percent per year, with total employment in 2002 reaching 958,700 (PDC 2002; FHWA 2002). Manufacturing employment is divided among electronics (36 percent), machinery and transportation (18 percent), primary and fabricated metals (13 percent), printing and publishing (7 percent), food and kindred products (7 percent), lumber and wood products (6 percent), paper and allied products (5 percent), and other (8 percent) (State of Oregon, 2002).

TABLE 3.13-1. PORTLAND EMPLOYMENT BY INDUSTRY SECTOR (STATE OF OREGON 2002)

Industry Sector	Relative Employment (Percent)	Industry Sector	Relative Employment (Percent)
Agriculture, forestry, fishing and hunting, and mining	0	Finance, insurance, real estate, and rental and leasing	7
Construction	5	Professional and business services	14
Manufacturing	12	Education, health, and social services	20
Wholesale trade	4	Leisure and hospitality	10
Retail trade	11	Other services (except public administration)	5
Transportation, warehousing, and utilities	5	Public administration	3
Information	3		