

PART II: FACTORS OF DECLINE/CONDITIONS

**1. Watershed-wide
Conditions**

1.1. *Land Use*

1.2. *Water Quality*

1.1. Land Use: Shaping the Landscape of the Watershed

1.1. Land Use: Shaping the Landscape of the Watershed

EXECUTIVE SUMMARY

An understanding of the landscape as influenced by human activities is essential to providing a full picture of WRIA 9 (Green/Duwamish River Watershed). Land use activities from forestry to agriculture to urbanization have shaped the landscape of WRIA 9 for the past 150 years. This report discusses how human land use activities can influence watershed processes and salmon habitat, provides information about the historical and current land uses in the watershed, and notes the policies that have shaped and continue to shape the watershed's land use and land cover.

Over the past 20 years, a significant amount of research has been done in the Pacific Northwest and the Puget Sound area regarding the impacts on streams and wetlands by various land use practices. Human activities such as forestry, agriculture, urbanization, and mining can drastically disrupt aquatic ecosystems by altering watershed ecological processes either directly or indirectly. Disruptions can include degradation or destruction of in-stream habitat through clearing of riparian vegetation, channelization and bank armoring, barriers to salmonids by dams or other water diversions, increased peak runoff rates and volume of surface water runoff, and removal of wood and reduction of wood recruitment. All of these activities in turn impact hydrology, water quality, riparian functions, and other factors of decline.

WRIA 9 was one of the first areas of Puget Sound extensively settled by immigrants in the late 18th century. As the Native American populations declined, the settlers began to occupy the vacated lands. The settlers employed various methods and policies to gain economic benefit from the land. The 19th century and the early 20th century brought land clearing for agriculture, commercial forestry, channelization for navigational purposes, diversion of major Green/Duwamish tributaries to reduce flooding, and filling of tidelands for development. Various federal, state, and local policies allowed and even encouraged these activities to occur.

During the middle of the 20th century, economic development fostered leveeing and damming to reduce flooding, road building and transportation infrastructure construction, and industrial, commercial, and residential development. Again, federal, state, and local policies encouraged this type of development. During the last 30 years of the 20th century, government agencies and the public began to support environmental protection measures and growth management. The federal government passed environmental legislation to protect undeveloped land, wetlands, shorelines, and endangered species habitat. State and local government began to embrace policies to manage development growth, protect shorelines, protect undeveloped land, protect wetlands, and protect farmlands. The effectiveness of these policies varies due to a variety of constraints including overlapping and conflicting regulatory goals.

Today, 97 percent of the Green/Duwamish River estuary has been filled, 70 percent of the area of the former Green/Duwamish River Watershed has been diverted out of the drainage basin, and about 90 percent of the once-extensive floodplain of the Green/Duwamish River is no longer inundated on a regular basis (Fuerstenberg, 1999).

The land area of WRIA 9 is 568 square mile area. Thirty percent of the WRIA is within the Urban Growth Area (UGA). The land in the Upper Green River Sub-watershed is primarily managed forest. The Middle Green River Sub-watershed is primarily farmland and a mix of urban and rural residential. The Lower Green River Sub-watershed contains less farmland and is urban in nature. The Duwamish Estuary Sub-watershed is predominantly urban residential, commercial, and industrial. Nearly all the Nearshore Sub-watershed is also urban residential while the Vashon Sub-watershed is rural residential.

Population has increased dramatically since the beginning of the 19th century. In the early 20th century, the region experienced a dramatic increase in population predominantly in the urban areas such as Seattle and the other watershed cities. As the Puget Sound population centers continued to expand through the 1970s, 1980s, and 1990s, WRIA 9 has experienced increasing urbanization throughout its UGA. In 1999, population in WRIA 9 was estimated at 563,980 (adapted from PSRC data, 2000). About 89 percent live in the UGA and 11 percent live in the Rural Area or Resource Lands.

KEY FINDINGS

- Effects of land use on habitat range from elimination of habitat to degradation of habitat quality to mitigation for environmental damages under existing regulations.
- Historically, local, state, and federal policies have greatly influenced the amount and type of land use that has occurred in WRIA 9:
 - By the early part of the twentieth century, the region and state planned to develop the Duwamish River and Lower Green into the main industrial area in the county and Puget Sound region.
 - For the first 120 years of settlement, economic development was the predominant driver of growth and development.
 - For the last 30 years, development has occurred under an increasing number of environmental protection policies and growth management policies.
 - Specific actions were taken over many years to enable economic growth and develop natural resource industries.
 - Many policies have been established in the last 30 years that require sound planning and development at both the regional and local level.
 - Meeting multiple objectives for the Growth Management Act, the Endangered Species Act, and other complex regulations creates a challenging, overlapping framework for regulations and protections.
- The seven years from 1910 to 1916 saw the most dramatic hydrologic change. During this time period, 70 percent of the acreage of the Green/Duwamish Watershed was diverted

away from the original Green/Duwamish River and a dam was constructed that blocked fish access to 45 percent of the remainder.

- Growth management is having a significant influence on directing growth to the Urban Growth Area (UGA) and reducing sprawl. However, as population increases, there is a corresponding increase in the amount of developed land:
 - Growth indicators suggest that the UGA is large enough to accommodate projected growth through 2012.
 - Eighty nine percent of the population of WRIA 9 is concentrated in the UGA.
 - Thirty percent of WRIA 9's land area is within the UGA.
- Most of the urban land uses are located in the western third of the WRIA while the middle and upper portions of the WRIA are primarily rural and natural resource lands:
 - Forestry is the primary designated land use at 99 percent in the Upper Green River sub-watershed.
 - Residential development (50 percent), forestry (27 percent) and agriculture (12 percent) are the primary land uses in the Middle Green River sub-watershed.
 - Residential development (50 percent), industrial development (17 percent), and commercial development (10 percent) are the primary uses in the Lower Green River sub-watershed.
 - Industrial development (43 percent) and residential development (39 percent) are the primary designated land uses in the Green/Duwamish Estuary Sub-watershed.
 - Residential development (68 percent) and industrial development (10 percent) are the primary designated land use in the Nearshore Sub-watershed.
 - Residential development at 92 percent is the primary designated land use in the Vashon-Maury Island Sub-watershed.
- Population growth has been a driving factor for the rapid development rates in the watershed:
 - Before 1996, the majority of jurisdictions in WRIA 9 were experiencing a 1 percent per year or higher population growth rate.
 - Population growth has slowed since 1997 to less than 1 percent per year overall in King County.
 - Every 1 percent increase in population growth corresponds with a 2 percent or higher increase in developed land during the 1990s.

DATA GAPS

Land use information currently available presents certain challenges. The information is not currently organized by watershed boundaries. Although a great deal has been written regarding land use and its effect on salmonids, there has not yet been a close look at local regulations and the subsequent effects on salmonid habitat. Below are the identified land use data gaps:

- Prepare land development and demographic information for King County by boundaries of the Water Resource Inventory Areas, sub-watersheds, and basins.
- Inventory permitting and regulatory processes (SEPA and Shoreline review, permit review, sensitive area review, ordinance and regulatory review) throughout the WRIA. Assess the biological implications of various land use activities, regulations, and policies.
- Inventory impervious surface areas (location and amount), road densities, and forest cover retention at a sub-watershed or smaller scale.

EFFECTS OF LAND USE ACTIVITIES

Over the past 20 years, a significant amount of research has been done in the Pacific Northwest and the Puget Sound area regarding the impacts on streams and wetlands by various land use practices. Human activities such as forestry, agriculture, urbanization, and mining can drastically disrupt aquatic ecosystems by altering watershed ecological processes either directly or indirectly. Disruptions can include degradation or destruction of in-stream habitat through clearing of riparian vegetation, channelization and bank armoring, barriers to salmonids by dams or other water diversions, increased peak runoff rates and volume of surface water runoff, and removal of wood and reduction of wood recruitment. All of these activities in turn impact hydrology, water quality, riparian functions, and other factors of decline.

Below in table LU-1 is an overview and summary of possible impacts to the natural aquatic system due to human uses. Each of the individual factor of decline reports conducted for the WRIA 9 Reconnaissance Assessment discusses these impacts in more detail. For example, the hydrology chapter discusses impacts of dams, increased storm and surface water runoff, and water use on the natural flow regime; the hydromodifications chapter illustrates loss of salmon habitat due to human influenced changes to the river channel; and the sediment transport chapter highlights increased erosion and sedimentation as a result of forestry practices.

Table LU-1. Overview of Possible Impacts of Human Land Use to Natural Aquatic Systems (adapted from Tri-County Urban Issues Study, R2 Resource Consultants, 1999).	
Land Use and Human Activities	Potential Result and Impact of Salmon Habitat
Channelization and confinement of stream channels for urban and rural land uses	Reduced channel complexity; increased velocities; loss of pools for holding and rearing; loss of spawning gravel habitat; loss of side channels; loss of wood recruitment; loss of connectivity with flood plain and riparian zone (reduced quality and quantity of habitat)
Loss of riparian vegetation due to urbanization, mining, forestry, agriculture, etc.	Reduced overhanging vegetation and shade cover; increased solar radiation; elevated water temperatures; loss of LWD recruitment; reduced terrestrial insect influx; reduced leaf litter influx; alteration of energy cycle (reduced quality and quantity of habitat)
Loss of forested areas due to urbanization, mining, forestry, agriculture, etc.	Reduced effective watershed area; altered runoff cycle with altered timing and magnitude of flows; increased erosion; changed channel morphology (reduced quality and quantity of habitat)
Loss of wetlands due to urbanization, mining, forestry, agriculture, etc.	Altered runoff cycle with altered timing and magnitude of flows; reduced base flows; changed channel morphology and loss of connectivity with floodplain (reduced quality and quantity of habitat)
Creation of impervious surfaces	Altered runoff cycle with altered timing and magnitude of flows; changed channel morphology; degraded water quality increased stormwater runoff (reduced quality and quantity of habitat)
Water allocation	Altered flow regime; altered instream habitat availability (reduced quality and quantity of habitat)
Waste water treatment effluent	Degraded water quality related to sewage effluent; altered water temperatures; reduced dissolved oxygen concentrations; released contaminants (reduced quality and quantity of habitat)
Industrial effluent	Degraded water quality; released contaminants and toxins (reduced quality and quantity of habitat)
Culverts, pipes, ditches	Obstructed upstream passage; reduced downstream movement of wood and gravel; stranded fish in ditches (reduced quality and quantity of habitat)
Loss of estuarine and nearshore habitats; port development	Loss of important freshwater to saltwater transition habitats, including cover and food production for smolts; loss of staging and holding habitats for adult salmon; degraded water quality (reduced quality and quantity of habitat)
Bulkhead and dock construction	Increased habitat for predators (e.g., bass); altered nearshore currents and gravel movement; loss of eelgrass habitat (increased interaction with predators; reduced quality and quantity of habitat)
Erosion and sedimentation	Increased turbidity and inputs of fine sediment during construction and prior to revegetation (reduced quality and quantity of habitat)
Water related recreational activities	Increased potential direct contact with ESA-listed salmon; degraded water quality (e.g., fuel spills) (reduced quality and quantity of habitat)
Fertilizer and pesticide use*	Degraded water quality and increased toxicity; biological degradation (reduced quality and quantity of habitat)
Dams*	Loss of upstream habitat due to obstructed upstream passage; altered timing and magnitude of flows; reduced base flows; changed channel morphology; reduced downstream movement of wood and gravel; and loss of connectivity with floodplain. (reduced quality and quantity of habitat)

* Information taken from "An Ecosystem Approach to Salmonid Conservation" (Spence et. al., 1996)

With over 400 reports and studies looking at impacts of land use on habitat, a thorough review of all the literature covering human impacts on natural systems is beyond the scope of this chapter. Initial studies on effects of urbanization on the aquatic system in the Northwest focused on the impacts of urbanization on peak-flow increases. In 1975, Hollis synthesized separate studies to show how the dual factors of percent impervious surfaces and percent of a watershed in storm sewers increased the peak discharges of floods. Then in 1979, Klein published the first study correlating development and aquatic-system conditions in which he reported a rapid decline in biotic diversity where watershed imperviousness exceeded 10 percent (Booth, 2000).

Subsequent studies and models on the subject done throughout the 1980s and 1990s built upon this initial research. Results of research done to date have several overall implications: (1) “Imperviousness,” although an imperfect measure of human influence, is clearly associated with stream-system decline. A range of stream conditions, however, can be associated with any given level of imperviousness; (2) “Thresholds of effect,” identified in some of the earlier literature (e.g., Klein, 1979; Booth and Reinelt, 1993 referenced in R2, 2000) exist largely as a function of measurement precision, not necessarily as intrinsic characteristics of the system being measured. Crude evaluation tools require that large changes accrue before they can be detected, but lower levels of development may still have consequences that can be revealed by other, more sensitive methods. In particular, biological indicators demonstrate a continuum of effects resulting from human disturbance; and (3) Hydrology is not the sole determinant of stream conditions, but its effects are ubiquitous in urban systems (Booth, 2000).

One of the most comprehensive of the recent studies on impacts of urbanization on aquatic systems was conducted by Chris May et al. The resulting report, titled “Quality Indices for Urbanization Effects in Puget Sound Lowland Streams,” was published in 1997 for the Department of Ecology. The study collected and analyzed data from 22 Puget Sound lowland streams representing a range of development intensity from predominantly rural watersheds to watersheds that were 99 percent urban. The researchers measured stream habitat conditions, water quality, sediment composition, sediment contamination, fish populations, and benthic organisms at each study site and compared them to watershed conditions. The results demonstrated that the greatest impacts of urbanization to streams typically include:

- Changes in hydrology;
- Changes in riparian corridor;
- Changes in physical habitat; and
- Water quality (R2, 2000).

The frequency, volume, and quality of large woody debris also decreased significantly as basin development increased. In general, fine sediment in spawning gravels generally increased as urbanization increased while intragravel dissolved oxygen decreased. The study further found that as the level of basin development increased above 5 percent total impervious area, results indicated an initial decline in biological integrity as well as physical habitat conditions necessary to support natural biological diversity and complexity (May et al., 1997). One interesting finding of

the May et al. report was that the density of the road network could be used, similarly to total impervious area, as an indicator of impacts to stream conditions. This is primarily because of the drainage system associated with most roads (R2, 2000).

Less information is available regarding the impacts of urbanization on Puget Sound salmon habitat in nearshore environments, estuaries, large rivers, and lakes. In general, changes in hydrology, pollutants, and physical habitat structure in these environments may cause ecological impacts that are comparable to the findings from freshwater research (R2, 2000). Study results have indicated that in the Duwamish and Puyallup estuaries, contaminant exposure in juvenile chinook was likely from the consumption of benthic and epibenthic organisms, which inhabit the contaminated estuarine sediments in these basins (R2, 2000). Some studies have suggested that suppressed immune systems in young salmon could make the fish more susceptible to disease as they move further into the marine environment (R2, 2000).

Below is a list of resources with more information on the impacts of urbanization on aquatic systems.

- The ESA Urban Issues Document Library and Database contains over 400 documents including documents from federal, tribal, state, and local agencies, as well as scientific articles that were published in peer-reviewed journals.
- Forest Cover, Impervious Surface Area, and the Mitigation of Urbanization Impacts in King County. (Derek Booth, Center for Urban Water Resources Management, University of Washington, September 2000) discusses impacts from urbanization on hydrology of aquatic systems.
- Tri-County Urban Issues Study (R2 Consulting, February 2000) reviews and consolidates existing information related to impacts of urbanization on natural aquatic systems, summarizes current management activities to mitigate these impacts, and presents guidance in selecting salmon recovery options in urban and urbanizing areas.
- An Ecosystem Approach to Salmonid Conservation (Brian C. Spence et al., December 1996) provides a technical basis for implementation of an ecosystem approach to habitat conservation planning. Chapter 6 discusses effects of human activities on watershed processes, salmonids, and their habitats.
- Quality Indices for Urbanization Effects in Puget Sound Lowland Streams (Chris May et al., June 1997) reports on a study of instream habitat, riparian conditions, water quality, and biological attributes of 22 streams to determine the relationships between urbanization and stream quality.
- Factors Affecting Chinook Populations (Parametrix, June 2000) is a “snapshot” of what is currently known about how development in the City of Seattle has affected chinook salmon.

HISTORIC POLICY CONTEXT AND LAND USE EVENTS

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OVERVIEW AND CHRONOLOGY OF WATERSHED LAND USE CHANGES

The WRIA 9 land use history began several thousand years ago when indigenous people first moved into the WRIA 9 (Green/Duwamish Watershed). However, a great preponderance of the major land use changes has occurred in the last 150 years since settlers moved into the area. Table LU-2 shows a chronology of the land use events and policies affecting WRIA 9 beginning in 1790 and ending in 2000 (Fuerstenberg, 1999). The scope of this chronology does not include tribal history prior to 1790.

Date	Policies and Events	Notes
1790s	First settlers move into the Puget Sound area	
1840s	Native populations in the WRIA decreased to one tenth of 1790 population levels	Settlers move into unoccupied lands
1850	Oregon Donation Land Act	Granted land to settlers if they homestead for 5 years
1851	First settlers arrive in the Duwamish estuary area	Land clearing begins - three claims filed
1852	King County is established	Settlers' first major governance system in WRIA
1852	Livestock introduced into Lower Green River Valley	Grazing begins on land
1853	Washington Territory is established	
1853	Extension of Land Act through 1855	Seventeen claims filed along the river
1854	First road built in King County	Road built through the lower river valley
1855	Treaty of Point Elliott	Establishment of Muckleshoot and Duwamish Reservations
1855-58	State requests Congressional funding for river clearing	River boat/scow major mode of travel along the Green/Duwamish River - removal of debris from river done for navigation purposes
1855-56	Indian Wars	Settlers move to Seattle for protection - settlement slows
1856	Land clearing resumes	Duwamish area gardens planted, orchards established, wide scale timber cutting begins
1858	King County Drainage Laws	County passes laws permitting ditches for drainage, swampland drainage begins
1862	Homestead Act	Settlement of territory encouraged
1865	City of Seattle is established	
1866	Population of valley starts to grow in earnest	Development increases
1867	First RR bridge built across Black River	Local railroad construction begins in area
1870	277 settlers living in valley	
1870s	Major railroads build lines	Pace of logging increases in WRIA 9
1875	Channel Improvement Act	County road funds used for improvement of rivers
1878	Golden Age of Hops begins	Hops production popular, continues for 20 years
1880-1910	Majority of logging occurs in WRIA 9	
1888	Northern Pacific Railroad constructs east/west line through Green/Duwamish River Watershed	Logging camps such as Borup, Kennedy, Nagrom and Maywood, and town of Lester, are established
1889	Washington granted statehood	
1893	Great Northern Railroad develops lines in north/south direction in valley	
1895	Drainage District Act	County Drainage Districts formed
1895	Duwamish East Waterway construction begins	Duwamish East Waterway dredged and used for Harbor Island fill
1897	Federal Government creates forest reserve that later becomes Snoqualmie National Forest	Curtails further development in the Upper Green River Sub-watershed
1899	Federal Rivers and Harbors Act	Encouraged federal actions to protect navigation rights
1900	Extensive logging on Vashon Island	Little old growth forest remains on Vashon Island
1902	Green River Hatchery completed	State-operated Green River Hatchery opens on Soos Creek
1901-04	Hydraulic sluicing of Beacon Hill in Seattle	Fill placed in the intertidal area of the Duwamish River to raise land and decrease flooding potential
1906	Major flooding in rivers during fall and winter	Log jam on lower "White River" forces floodwater down the Stuck River into the Puyallup River
1902-27	Interurban Electric railway operates	Interurban eclipses Green/Duwamish River as a means of travel
1910	Tacoma Headworks dam authorized	Construction begins on Tacoma Headworks on Green River to provide water for the City of Tacoma
1911	White River Diversion	White River completely diverted to Puyallup River to reduce flooding problems
1913	Tacoma Headworks completed	Drinking water diverted from Green River for the City of Tacoma
1916	Black and Cedar Rivers diverted from Duwamish and Ship Canal cut to Lake Union draining Lake Washington to Puget Sound	This diversion reduced flooding in the Duwamish River lowlands, provided flushing for Lake Washington, and created access to fresh water for ships
1917	East/West Waterways finished	Dredging of channel completed, 2.2 sq. miles of Duwamish intertidal area filled - reduces potential flooding
1918	Coal production peaks and is one of the state's largest exports	Renton and Black Diamond coal mining peaks
1919	Private levee construction begins	Levees built to protect lowlands from flooding all along the Green/Duwamish River

Date	Policies and Events	Notes
1926	King County Planning Commission appointed and releases recommendations	Report includes preparation of county road plan, acquisition of parks, regulation of platting, and formation of a metropolitan sewer district
1935	Washington State Planning Enabling Act	Counties and jurisdictions allowed to regulate land use
1938	The first soil survey was initiated as a cooperative effort of the United States Department of Agriculture (USDA), the Washington Agricultural Experiment Station, and the Washington State Planning Council	Described and located numerous types of soil and documented the productive capacity of various soils for different types of agricultural crops
1949	Tacoma Water signs cooperative agreement with all major land owners in Upper Green	Agreement leading to a limit of activities that affect water quality, access, and fish habitat
1954	City of Seattle, King County, and Port of Seattle release the Development Plan for the Duwamish and Lower Green River	Recommends constructing Howard Hanson Dam, converting 2,500 acres of farmland to industrial area, expanded dredging of the river and filling of the estuary
1957	Duwamish Valley Study released by King County Planning Commission	Recommends construction of highway project that affect the Green/Duwamish basin (e.g., I-5, I-405, SR 18, SR 167, SR 516)
1963	Howard Hanson Dam completed	Reduces maximum flow of Green River to 12,500 cfs at Auburn to reduce flooding potential
1964	King County adopts its first comprehensive plan	Recognizes the need for an effective means of guiding and coordinating the physical development of the County; a means for coordinating programs and services; a source of reference to aid in developing coordinated official plans and regulations for the County and municipalities within it; and a means of promoting a desirable environment for housing, commerce, industry, agriculture, and recreation
1970	National Environmental Policy Act	Requires environmental review for all development with a federal nexus
1971	Washington State Shoreline Management Act	Requires local jurisdictions to create master plans that protect coastal resources while also allowing development activities
1972	Federal Coastal Zone Management Act	Unique federal/state partnership to encourage states to develop programs that preserve, protect, and restore coastal resources
1973	Washington State Land Use Act	Allowed lands that are undeveloped and left in the natural state to be taxed at a lower rate than developed land
1973	Federal Endangered Species Act	Federal agencies required to protect endangered species and their habitat from harmful human activities
1974	Boldt Decision	Washington State Supreme Court interpreted the Treaty of Point Elliott to mean that Native American tribes were entitled to half of the total allowable catch of fish in the tribe's usual and accustomed fishing grounds
1977	Clean Water Act (Amendment to the Federal Water Pollution Control Act of 1972)	Generally halted filling of wetlands or required mitigation for filling of freshwater or marine wetlands
1978	King County Growth Management Program	Directed future comprehensive plans to deal with growth while incorporating environmental protection, energy conservation, and farm land preservation
1979	King County voters pass Farmland Preservation Program	\$50 million bond issue to purchase development rights on agriculture lands in King County
1985	King County Comprehensive Plan--1985	Addressed expected population and employment growth; established urban areas, transitional areas, rural areas, open space, and natural resource lands
1990	Washington State Growth Management Act	Requires local governments to plan for growth; all urban counties and their cities are required to plan comprehensively and jointly for the future
1994	King County Comprehensive Plan--1994 Cities begin to adopt comprehensive plans County and city plans are guided by the Countywide Planning Policies	Urban Growth Area established in the western one-third of the County where most future growth and development will occur to reduce urban sprawl, enhance open space, protect rural areas including the establishment of the Agriculture Production District, and more efficiently use human services, transportation, and utilities
1998	Washington State Department of Ecology initiates an update of the Shoreline Master Program guidelines	
1999	Federal listing of chinook salmon and bull trout as threatened species	Protection and recovery of species in Puget Sound Region is required

PRE-1850: THE YEARS BEFORE THE SETTLERS

Before settlers arrived in the region, streams of the Puget Sound lowland were a network of sloughs, islands, beaver ponds, and estuaries (Fuerstenberg, 1999). Historians estimate about 300 Native American people lived in the Tukwila area in the 18th century and fewer than 4,000 Native American people lived throughout the Duwamish River area (Fuerstenberg, 1999). Primary activities of native people were fishing, hunting, and food gathering. Shellfish and salmon were the primary foods of Native Americans. Gardens and camas fields (maintained by burning) were the only evidence of forest clearing by Native Americans.

1850-1917: SETTLERS AND THE YEARS OF RESOURCE EXTRACTION

SETTLERS LAND USE POLICY—1850-1917

Human Settlement

Native peoples including the Muckleshoot Tribe have lived in the WRIA 9 watershed for thousands of years. However, the native peoples' land use and natural resource use patterns were less disruptive to the natural ecosystem than the settlers' subsequent land use patterns. The Treaty of Point Elliott signed in 1855 allowed the settlers to begin to dominate land use in the watershed. This treaty moved tribes to reservations that were a fraction of the land area that the tribes used to occupy. The federal policies of "manifest destiny," the Donation Land Act of 1850, the Homestead Act, and the laissez faire economic policies of the federal government influenced the settlers' development of the Green/Duwamish River Watershed. The results of these policies were the rapid settlement of the area and the exploitation of natural resources. (Benoit, 1979)

Navigation/Transportation

The Green/Duwamish River was a significant transportation corridor during early settlement, fostering development of communities along the edge of the river. As communities sprang up, the shorelines were cleared and adjacent wetlands were drained under drainage laws established by King County in 1858. Policies that encouraged these settlements and federal policies that encouraged use of the river for navigation, resulted in extensive development of land for agriculture. In turn, the agricultural development in the Duwamish area supported the growth of communities near Elliott Bay.

As the land was settled, federal policy encouraged the expansion of the railroad. Three distinct land use patterns developed as a direct result:

- Federal land grants to railroads resulted in the checkerboard pattern of land ownership in the Upper Green River Sub-watershed that influences patterns of forestry activity even today;
- The routes taken shaped the growth of local communities and industry; and

- Later patterns of highway development were influenced by early rail routes, thus further reinforcing the development of commercial and industrial land uses in the valley.

The Federal Rivers and Harbors Act of 1899 provided the policy basis for federal actions in and around the navigable waters of King County and gave responsibility for conducting water projects to the U.S. Army Corps of Engineers. In 1910, construction of the Hiram M. Chittenden Locks and the Lake Washington Ship Canal occurred under the auspices of the Rivers and Harbors Act. These major projects diverted the Cedar River and Lake Washington outflow via the Black River away from the Duwamish estuary and into Puget Sound via the ship canal and locks. The policy basis for improving the transportation corridor of the Lake Washington system reinforced other policy choices that gave greatest prominence to the use of the Duwamish estuary for industrial development.

Tidelands Development

The State Constitution established the policy basis for filling of the Duwamish estuary and the resultant industrial land uses that still prevail there today. The State Constitution (Article XV-XVII) established state ownership of tidelands and required that tidelands should be “reserved for lands, wharves, streets, and other conveniences of navigation...” In 1894, the State Legislature authorized any person or company to excavate waterways through the tide and shorelands in front of incorporated cities, giving individuals or companies a first lien upon any lands they filled in, for the cost of the work plus, fifteen percent added to the lien on the lands benefited. This provided a financial incentive to develop the Duwamish estuary for industrial and commercial uses. Because much of the land in the downtown area was on fairly steep slopes that were largely unsuitable for industrial and commercial uses, the filled shoreline areas were rapidly developed for such purposes.

Reinforcing State policies that viewed estuaries as ripe for industrial and commercial development, the State established the legal basis for special waterway districts. The East Waterway district of the Duwamish River was among the first of such districts established (Warren, 1997).

Adding to this development, at the time of statehood, ownership of all tidelands in Washington State was transferred from the federal government to the state under the equal footing doctrine of the U.S. Constitution (Good and Ridlington, 1992). The tidelands were supposed to be held in the “public trust” per the Public Trust Doctrine, which is a common law doctrine protecting shorelands in the public interest. Over time, 70 percent of Washington’s inland marine water tidelands were sold to private upland owners (Broadhurst, 1998). The Public Trust Doctrine and the “takings” clause of the Fifth Amendment of the U.S. Constitution protecting private property rights have been invoked many times in court battles over shoreline land use since the beginning of the 20th century.

Flood Control

The nation had long been engaged in issues of flood control, especially in the Mississippi River basin (MRC, 2000). Flood control measures in this region of the United States influenced the

policy foundation for flood control in WRIA 9, including the White River diversion in 1911 (Bagley, 1929) and Howard Hanson Dam construction in 1963. The purpose of flood control was to protect the economic well-being of the region by preventing floods, such as one in 1906, which disrupted agricultural land uses. The diversion of the White River was only one of several steps taken from the early 1900s to the present to control flooding within WRIA 9.

Commercial Forestry

Land dedicated to railroads was often transferred to subsidiary commercial forestry companies (e.g., Plum Creek Timber Company was originally part of Burlington Northern, which was the successor company to both the Great Northern and the Northern Pacific Railroads) or sold to other commercial forestry interests. In addition, the federal government, recognizing the value of forestlands, established a policy to create federal forest reserves in 1897. The creation of the Snoqualmie National Forest and a federal policy of allowing logging on public lands, ensured that land uses in the Upper Green River Sub-watershed would focus on timber production and mineral extraction. The National Forest Management Act later broadened the mandates of federal forestlands to include recreation, fish and wildlife habitat, and other designated forest uses.

SETTLERS LAND USE PATTERNS 1850-1917

After Euro-Americans arrived in the 1850s, the landscape changed dramatically. The Treaty of Point Elliott in 1855 moved native peoples to a small reservation in WRIA 9, allowing Euro-Americans to move further into areas previously occupied by native peoples. WRIA 9 was among the first areas west of the Cascade Mountains to be logged (Fuerstenberg, 1999). By 1895, the riparian zone had been logged from the mouth of the Duwamish River to Horseshoe Bend near Kent. From Horseshoe Bend to Big Soos Creek, the riparian area was a mix of intact trees and areas that had been burnt or cleared. Above the confluence of Soos Creek and the Green River, the riparian area was cut or cleared (Fuerstenberg, 1999).

In 1888, the Northern Pacific Railroad was the first transcontinental railroad to the Pacific Northwest and made almost all parts of the basin accessible to timber production (Fuerstenberg, 1999). The railroad companies acquired land from the federal government and transferred it to Plum Creek or sold the land to other timber companies. Subsequent logging operations supplemented by frequent forest fires greatly depleted the original forest (Fuerstenberg, 1999). In a survey from 1853 to 1861 of plant life west of the Cascades for the Northern Pacific Railroad, Cooper notes the excellent firewood characteristic of Douglas fir, “From its combustibility extensive tracts of this forest get burnt every year, taking fire from friction or any other slight cause.” Cooper described ascending the western slopes of the Cascade Range where “we passed for days through dead forests.” As the Northern Pacific Railroad had not yet constructed its line through the Green/Duwamish River watershed, Cooper probably observed and recorded evidence of natural fires in the Green/Duwamish River watershed or natural fires fostered by poor logging practices (Fuerstenberg, 1999).

Before 1900, settlers established orchards and farms along the Lower Green River. As land was cleared, tree stumps were usually discarded in the river. Levees and revetments were constructed along segments of the river to protect farms and homesteads from flooding and erosion. Around

the turn of the century, Vashon Island was extensively logged and, with the exception of a small stand of privately owned trees in the Christensen Creek area, few trees over 100 years old remained (Thomas, 1979). Commercial forestry had also begun along the tributaries and along the Green River mainstem leaving logging debris in the channels. In the 1850s, logs began to be removed from the river to allow riverboats, an early mode of transportation in the valley, to navigate. Flooding continued to be a problem for people in the valley. In 1906, major flooding occurred on the White and Green Rivers (Fuerstenberg, 1999).

As the land was cleared of vegetation for commercial forestry and agriculture operations, protection was needed from flooding and the excess water generated by lack of forest cover. (A 1919 Washington State Fish Commission report noted that "...as timber is cleared away, hatchery operations are more and more hampered by flood conditions. The water in streams rises more quickly now than was formerly the case when there was heavy timber growing...") Extensive levee and revetment construction began in about the same year. Flood-prone valley areas along the Green/Duwamish mainstem and the estuary were drained and filled, and major tributaries were rerouted or disconnected from the Green (Fuerstenberg, 1999).

Replumbing of the Green

The seven years from 1910 to 1916 saw the most dramatic hydrologic change. During this period, 70 percent of the land area of the Green/Duwamish Watershed was diverted away from the original Green/Duwamish River and a dam blocked fish access to another 10 percent of the land area of the original Green/Duwamish Watershed. These activities were a major disruption to salmon and other aquatic species migration and rearing.

In 1910, the Cedar, Black, White, and Green Rivers combined to form the Duwamish. After the large flood of 1906, plans to divert the White River permanently to the Puyallup River were made by the U.S. Corps of Engineers. In 1911, this diversion was completed (Fuerstenberg, 1997). One of the effects of this diversion was to reduce the volume of water flowing in the lower portion of the Green/Duwamish River (Fuerstenberg, 1999).

In 1913, the City of Tacoma completed its Headworks water diversion dam on the Green River near the town of Palmer. The Headworks further reduced the flow and shut off the Upper Green River Sub-watershed to anadromous fish passage. The State granted Tacoma Water (now known as Tacoma Public Utilities) the right to remove a maximum of 113 cfs of water from the River. Tacoma Water subsequently began purchasing land adjacent to the river in the Upper Green River Sub-watershed to protect water supply operations, although Tacoma still allows logging in certain portions of the riparian area (TPU, 1998).

By 1916, the Black and Cedar Rivers had been diverted from the Duwamish River as part of a project to connect Lake Washington and Puget Sound. This diversion reduced flooding in the Duwamish River lowlands, thereby allowing more development. This diversion provided flushing for Lake Washington and navigational access from Puget Sound to Lake Washington via the Hiram M. Chittenden Locks and the Lake Washington Ship Canal. As a result, the Cedar River now flows into Lake Washington while the Black River has been reduced to a fraction of its former volume and is disconnected from Lake Washington (Fuerstenberg, 1999).

In 1854, 1900 linear miles of stream and river were accessible to fish through the Duwamish River. By 1985, fish could access only 125 river miles through the Duwamish River. The entire lengths of the White and Cedar Rivers remain accessible to fish through the Puyallup River and Lake Washington Ship Canal, respectively (Fuerstenberg, 1999).

1917-1970: THE YEARS OF ECONOMIC DEVELOPMENT

ECONOMIC DEVELOPMENT POLICY—1917-1970

Flood Control

At the federal level, continued discussion of flooding on the Mississippi River provided the basis for approaches to further control flooding in the Green River valley (MRC, 2000). Private levees that had been permitted by State and County legislation were supplemented by publicly financed levee construction under the Flood Control Act of 1936 (33 USC Chapter 15). The U.S. Army Corps of Engineers took the lead in creating a system that would protect the agricultural, commercial, industrial, and residential land uses that were growing throughout the region. This policy was followed by the Watershed Protection and Flood Prevention Act of 1954, which reaffirmed previous policy (16 USC Chapter 18). The Act stated:

“Erosion, flood water, and sediment damages in the watersheds of the rivers and streams of the United States, causing loss of life and damage to property, constitute a menace to the national welfare; and it is the sense of Congress that the Federal Government should cooperate with States and their political subdivisions, soil or water conservation districts, flood prevention or control districts, and other local public agencies for the purpose of preventing such damages, of furthering the conservation, development, utilization, and disposal of water and protecting and improving the Nation’s land and water resources and the quality of the environment.”

The Howard Hanson Dam was constructed in 1963. Its primary purpose was flood control by holding back peak flows and attenuating their release over a long duration in the spring in order to protect developing cities like Auburn, Kent, and Tukwila from flood damage. With assurances that development would not be flooded, industrial, commercial, and residential land uses in the valley burgeoned while agricultural uses diminished. The population of the City of Auburn increased 121 percent between 1960 and 1980. During the same period, the City of Kent grew 157 percent while the City of Seattle saw a population decline of 11 percent. King County, as a whole experienced population growth of about 35 percent (Washington State Office of Financial Management, 2000).

Transportation

Federal highway construction policies emphasize increasing freight mobility across the continent. Federal funding for construction of Interstate 5 and Interstate 90 encouraged the development of industry in the Green/Duwamish River Watershed. In 1957, the King County Planning Commission released the “Duwamish Valley Study.” This study recommended the current locations for the major highway systems in WRIA 9 including Interstates 5 and 405, and State

Routes 18, 167 and 516. The study paved the way for increased development in the lower portion of WRIA 9 and nearshore tributary sub-basins (KCPC, 1957). Also, highway access to major industrial development encouraged residential development outside of the core cities.

Shorelands Development

During the 1917-1970 period, most of the development and bulkheading along the WRIA 9 shoreline occurred. This was driven by Washington State selling tidelands to private landowners and landowners protecting the land from erosion. Equally important to transportation, the Port of Seattle, the fifth largest port in the United States, requires dredging of the Duwamish River, promotes heavy shoreline development, and creates potential for exotic species introduction.

Economic Growth

In 1954, the City of Seattle, King County, and the Port of Seattle released the “Development Plan for the Duwamish and Lower Green River.” This plan recommended that a large amount of land be converted from farmland to industrial uses. The Development Plan found that “the basic requirements for industrial development either exist or can be developed” in the Duwamish Estuary and Lower Green River Sub-watersheds. At the time, this area seemed to be the logical area to place more than 70 percent of Seattle’s expected industrial growth due to the proximity of existing railroad lines and proposed highways. The Development Plan recommended construction of the Howard Hanson Dam to control flooding and expanded dredging and filling of the estuary. It further proposed increasing the industrial area by more than two and a half times from 1,500 acres to 4,000 acres (DGRJSB, 1954).

Recognizing the need for an effective means of guiding and coordinating the physical development of King County, the County Commissioners in June 1959, initiated a reorganization of the County Planning Agency and provided the necessary budget to develop a modern planning program. By 1964, a Comprehensive Plan was prepared under the requirements of the State Planning Enabling Act (RCW 36.70). This initial plan was designed to serve a projected 1985 population of about 1.6 million people within the entire County. The objective of the plan was to “assure the highest degree of public health, safety, and general welfare” while not “unduly jeopardizing the rights of the individual” (KCPD, 1964).

The policy construct of the 1964 King County Comprehensive Plan was to direct growth within the County to predominantly occur in the “Urban Area” outside the City of Seattle. The plan expected that the population of Seattle would increase slightly over its 1960 population of 557,100 persons while the County outside Seattle was expected to reach nearly a million people -- nearly triple its 1960 population. The rest of the County, or that area outside the Urban Area, was expected to grow from 28,700 in 1960 to 73,000 in 1985 (KCPD, 1964). As the population of the County increased, the density of population was expected to increase. Gross density (persons per total acres) for the whole County was expected to increase from 0.68 to 1.21 persons per acre; in Seattle, from 9.84 to 10.33 persons per acre; in the King County Urban Area outside Seattle from 1.17 to 5.34 persons per acre; and in King County outside the Urban Area from 0.3 to 0.7 persons per acre.

ECONOMIC DEVELOPMENT LAND USES & POPULATION CHANGE—1917-1970

From 1910 to 1930, timber production peaked in the Middle and Upper Green River Sub-watersheds. The Great Depression slowed this production beginning in 1930. Coal production peaked in 1918 following earlier coal finds in Renton and Black Diamond. This coal production later decreased as alternative energy sources were found, and sand and gravel production became more important as a result of the increased demand for industrial, residential, and road development (Fuerstenberg, 1999).

Between 1930 and 1960, the Puget Sound Region, consisting of King, Pierce, Snohomish, and Kitsap Counties, was one of the fastest growing areas of the State. The population of the region doubled during that time period, growing from 737,000 people to more than 1.5 million. Most of this growth occurred in the 1940s with the stepping up of defense production. Due to high birth rates and continued defense production, this growth continued throughout the 1950s but at a reduced rate. King County's growth during this period mirrored that of the region. Between 1930 and 1960, the population of King County increased from 464,000 to 935,000, most of which occurred between 1940 and 1950 (KCPD, 1964).

One area in particular experienced a dramatic increase in urbanization. The prime farmlands of the Lower Green River valley from Auburn to Tukwila was converted to warehouses, malls, and industry due to the proximity of roadway systems, reduced threat of flooding, and the flat, easily developable land. Between 1965 and 1989, agricultural land uses in the Lower Green Sub-watershed dropped by 70 percent (from 11,172 acres to 3,447 acres) while industrial and warehouse areas increased by more than 500 percent (from 1,226 acres to 6,559 acres) (Scarey, 1994). The areas of Big Soos Creek, Covington Creek, and the plateau west of the Green River valley also experienced rapid suburban residential development during this time period (USACE, 1997).

1970-2000: HEIGHTENED REGIONAL PLANNING & ENVIRONMENTAL AWAKENING

ENVIRONMENTAL PROTECTION POLICY—1970-2000

Environmental Concerns Establish a Regulatory Framework

The federal Environmental Protection Agency (EPA) was established in 1970 to respond to nationwide concerns about environmental damage. The National Environmental Protection Act (NEPA), the first official federal action of 1970, established a national policy to weigh human land use activities with environmental concerns. Environmental impact statements were required for new development, alternatives were evaluated, and mitigation required for environmental damages (Lewis, 1985).

The State Environmental Protection Act (SEPA) was adopted in 1971 (RCW 43.21c). It sought to strike a balance between development and environmental protection. SEPA aimed to avoid negative environmental impacts by requiring land use projects to consider impacts of various alternative project designs and mitigate for environmental damages. The passage of SEPA ushered in an era that saw a policy shift toward environmental considerations on both the state and local level that affected land use in WRIA 9.

Shorelands Protection

The federal Coastal Zone Management Act (CZMA) was enacted in 1972 to preserve, protect, and restore the nation's coastal zone resources. The CZMA established a unique state-federal partnership designed to encourage and assist states in developing and implementing management programs to achieve a variety of goals, including the achievement of "wise use of the land and water resources of the coastal zone" (Good et. al., 1998).

Washington State was the first state in the nation to establish a federally approved coastal zone management program (CZMA). The State Shoreline Management Act (SMA) (RCW 90.58.020) is the primary means by which the state meets its CZMA requirements. The SMA states that shorelines should be managed to:

- Foster all reasonable and appropriate uses, particularly "water dependent uses;"
- Provide the public the opportunity to enjoy the physical and aesthetic qualities of natural shorelines; and
- Ensure uses are designed and conducted in a manner to minimize damage to the ecology and environment of the shoreline area and any interference with the public's use of the water.

The SMA is implemented and enforced by local governments in the form of Shoreline Master Programs (SMPs) and the State Department of Ecology serves in a support and review capacity to assist and ensure that local governments comply with the act (Broadhurst, 1998).

Specific uses and activities within the shoreline zone are governed/regulated by local SMPs, including aquaculture, mining, commercial development, industrial development, recreation, marinas, and shoreline modifications such as dredging, landfills, piers, and bulkheads. However, because the SMA is explicitly designed to balance public shoreline uses with the rights of private property owners, a number of activities within the shorezone are exempt from the mitigation and other requirements set forth in the SMA and local SMPs. These include:

- Developments having a fair market value less than \$2,500;
- Maintenance of existing structures;
- Construction of single family bulkheads; and
- Construction of single family residences.

Approximately 90 percent of Puget Sound's shorelines are in private ownership. Single family residences are exempt from permitting requirements in the Shoreline Management Act and it is unclear if these shorelines are being afforded the necessary level of protection (Broadhurst, 1998). In November 2000 (too late to be reviewed for this document), the State finished reviewing and updating the Shoreline Master Program Guidelines to reflect best available science regarding the functions and values of shoreline resources.

Farmlands Preservation

Recognizing that an unintended consequence of earlier flood control policies in the Green/Duwamish River Watershed was the rapid conversion of agricultural land to other, more intensive land uses, the 1964 Comprehensive Plan included “Land Used for Agriculture” as an element in its definition of Open Space and identified policies to ensure that these areas were retained within the County (KCPD, 1964). The County continued to categorize its agricultural lands and emphasize the need to protect them and in 1977 adopted Ordinance No. 3064 that established seven Agricultural Districts and designated specific areas within them as “Agricultural Lands of County Significance.”

King County voters adopted the Farmlands Preservation Act in 1979, which created the Farmland Preservation Program. This ballot measure allowed the County to purchase \$50 million worth of development rights on agricultural lands at fair market value in return for a guarantee that those lands would remain in agricultural use. This policy has helped slow the conversion of agricultural lands to other uses, with approximately 2,900 acres of farmlands in the WRIA 9 preserved in the 1980s and 1990s. Nearly 10,000 acres in WRIA 9 are in the Agriculture Production District, which gives farmers tax breaks for farming. The Farmland Preservation Program does, however, limit some protection and restoration of fish and wildlife habitat on parcels under the Program, since the covenants placed on these properties prohibit decreasing their agricultural capability to support non-agricultural uses. In 1985, the County took further action to protect farmland when it established agricultural land use policies and zoning regulations.

Growth Management

The environmental awakening of the 1970s coincided with an economic downturn in the Puget Sound region. Despite the economic downturn, the growth and development predicted by the 1964 King County Comprehensive Plan proved to be real. This growth presented many unanticipated growth-related problems, including energy shortages, congested highways, air pollution, disappearing farmlands, and rising cost for housing and public services. In response, King County established a growth management program in 1978 to reexamine and revise the 1964 document. The King County population increased 9.5 percent between 1970 and 1980. Forecasts at that time predicted the population to increase 9.3 percent between 1980 and 1990, then increase 19.1 percent between 1990 and 2000. The 2000 forecast population was 1,638,920 people, or nearly 30 percent greater than the 1980 population of 1,269,749.

The 1985 King County Comprehensive Plan established a pattern of countywide growth development, which would encourage population growth in areas with the infrastructure and facilities to support growth, the “Urban Growth Area” (UGA), while discouraging growth in areas designated as the “Rural Area” and “Resource Lands and Industries.” In the Rural Area, low-density residential development was encouraged to maintain rural character and promote small-scale farming and forestry. The Rural Area was also to provide a buffer to Resource Lands from incompatible land uses and rural service levels were to be maintained. Resource Lands and Industries designations were intended to conserve farmlands, forestlands, and mineral resources, and to encourage and promote their productive management by resource industries (KCPD, 1985).

To address environmental quality issues presented by growth, the 1985 Comprehensive Plan established policies to protect the quality of the natural environment through land use plans, regulations, and incentive programs and to encourage the retention of open space. One policy called for the following areas of the County to remain undeveloped:

- Floodways of 100-year floodplains;
- Slopes with a grade of 40 percent or more;
- Severe landslide hazard areas;
- Wetlands rated as unique/outstanding or significant; and
- Coal mine hazard areas.

These natural features were designated as Open Space and described, classified, and mapped in the Sensitive Areas Map Folio and the Inventory of King County Wetlands. These reports, along with all other available data, were the basis for specific land use regulations for “environmentally sensitive areas” (KCPD, 1985).

Washington State responded to problems associated with statewide growth by adopting the State Growth Management Act (GMA) of 1990 (RCW 36.70A), which was the first critical step in the development of rational policies to sustain growth in Washington. For the first time in the State’s history, all urban counties and their cities were required to develop and adopt comprehensive plans and regulations to implement these plans. To ensure comparable planning efforts, the GMA required that comprehensive plans address specific issues including (but not limited to) land use, transportation, housing, facilities and services, utilities, natural environment, and economic development. To achieve coordinated planning efforts, the GMA further required that counties and cities develop a set of framework policies to guide development of each jurisdiction’s comprehensive plan. The King County Countywide Planning Policies define the countywide vision and establish the parameters for comprehensive plans of all the cities and the County. Implementing regulations were required that must be consistent with comprehensive plans (KCDDES, 1994). King County adopted a new Comprehensive Plan in 1994 to respond to the GMA. All of the cities followed suit between 1994 and the present.

The Countywide Planning Policies call for consistent approaches to protect critical areas (also known as environmentally sensitive areas) and directed the majority of future growth to within the Urban Growth Area of the western third of the County. In so doing, the intent was to limit urban sprawl, enhance open space, protect rural areas, and more efficiently use human services, transportation, and utilities. Within the Urban Growth Area, the Countywide Planning Policies designated “Urban Centers” within the boundaries of several cities. The 14 Urban Centers are areas in which concentrated employment and housing is to be achieved. The Urban Centers are to be directly serviced by high-capacity public transit. They contain a wide variety of land uses including retail, recreational, cultural and public facilities, parks, and open spaces. The policy construct is to establish well-designed, highly livable Urban Centers that will encourage people to work and live there. If successful, this will contribute to achieving the growth management goal of

concentrating infrastructure investments and preventing urban sprawl and environmental degradation. Six of the 14 designated Urban Centers are located in WRIA 9. They are the central business districts of Seattle, Renton, SeaTac, Kent, and Tukwila, and the First Hill/Capital Hill area of Seattle (KCDDDES, 1994).

One of the basic goals of the Growth Management Act is to encourage affordable housing. The GMA directs all the jurisdictions' comprehensive plans to make adequate provisions for existing and projected housing needs of all economic segments of the communities. The Countywide Planning Policies call for each jurisdiction to specify the range and amount of housing needed for various income groups. A key component of meeting this housing objective is by providing sufficient land for housing in communities throughout the County. In particular, land must be available for affordable housing types: higher density single-family housing; multifamily housing; manufactured housing; accessory apartments; and mixed-use developments. All of these housing types provide opportunities for development of affordable housing (KCDDDES, 1994). Efforts to provide sufficient land, infrastructure, and reduced development costs for affordable housing is difficult to balance with the need to establish and maintain an Urban Growth Area sized to reduce urban sprawl. This balance remains difficult as costs associated with new housing construction and the demand for housing in the Puget Sound region grow.

The Urban Growth Area created by the Countywide Planning Policies was established to provide sufficient land to accommodate the expected number of households through 2012 (20-year planning horizon). Ensuring that there was capacity to accommodate projected household growth was a key element of growth management planning efforts throughout the County in the early to mid 1990s (KCDDDES, 1994B and KCCPPBP, 2000).

Land use indicators of the Countywide Planning Policies Benchmark Program show that there is ample capacity within the existing Countywide Urban Growth Area to accommodate the estimated remaining number of targeted households and jobs by 2012 (170 to 198 percent capacity of remaining target). In WRIA 9, the capacity remaining in the Urban Growth Area ranges from 95 percent in Tukwila to over 200 percent in Renton, Kent, and Seattle. The Countywide Rural Area has over 500 percent capacity to accommodate household and job targets (2000 King County Benchmark Report).

These land use indicators suggest that there is no need to increase the size of the Urban Growth Area to accommodate projected growth and to achieve affordable housing goals. This information also suggests that the growth capacity in the Rural Area is not needed. Indeed, the amount of growth in the Rural area has decreased from 1994 to 1999 from 11 percent to five percent of the total amount of Countywide household growth; the amount of growth in the Urban Growth Area increased from 88 percent in 1994 to 95 percent in 1999. Another trend is growth in urban core areas versus the outer portions of the Urban Growth Area. Urban core areas steadily increased from 47 percent of the total amount of household growth to 62 percent from 1994 to 1999. During this same period of time, the amount of growth in the outer fringe areas of the UGA decreased from 42 percent to 33 percent of the total Countywide household growth (2000 King County Annual Growth Report).

Endangered Species Protection

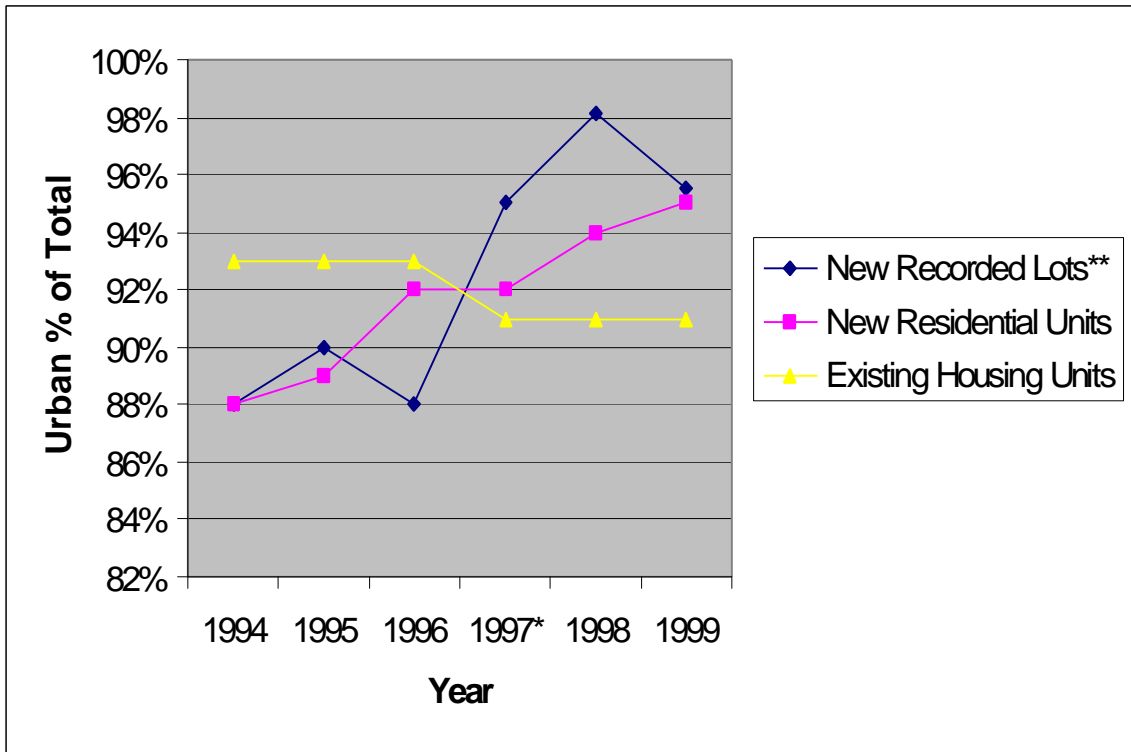
The latest policy to affect land uses in WRIA 9 is the Endangered Species Act (ESA) of 1973, triggered locally by the 1999 listing of chinook and bull trout as threatened species. The purpose of the Endangered Species Act is “to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, and to provide a program for the conservation of these species.” The ESA prohibits the “take” of any “endangered” or “threatened” species or the degradation of habitat critical to these species. The ESA involves a process of species listings (Section 4), definition of “take” (Section 4d), federal agency consultations to avoid “take” (Section 7), prohibition of “take” (Section 9) and a citizen suit provision (Section 11). The Act may affect land use activities if the land use is construed as a “take.” It is unclear how the ESA will be implemented in the area. However, land use activities are one of many human activities that may be restricted in order to protect salmon populations. The effect of ESA on GMA will play out over the next 10-20 years and may have new impacts on land use in WRIA 9 (West Group, 1998).

LAND USES AND ENVIRONMENTAL PROTECTION—1970-2000

As the Puget Sound population centers continued to expand from the 1970s through the 1990s, WRIA 9 became increasingly urbanized in the Nearshore, Green/Duwamish Estuary, Lower Green, and Middle Green River sub-watersheds. With the inception of the Washington State Growth Management Act in 1990, local governments have tried to slow growth in the rural area. Figure LU-1 and LU-2 show the King County development trends from 1994 to 1999. (Figures LU-1 and LU-2 were developed from Table LU-6 in the Appendix.) Figure LU-1 shows that from 1994 to 1999, or following implementation of the GMA, there has been a dramatic increase in the amount of residential development in the Urban Growth Area. Figure LU-2, shows that there has been a corresponding decrease in the amount of residential development in the Rural Area. Only eight percent of the permits issued by King County in 1997 were in the Rural Area, versus 20 percent for the Puget Sound region as a whole (PSCR, 1998).

Despite this trend, which is driven by the successful implementation of growth management plans by all jurisdictions of the County, the Puget Sound Regional Council (PSRC) found that a 19 percent increase in population between 1980 and 1990 was also accompanied by a 37 percent increase in developed land (PSRC, 1998).

Figure LU-1. King County Land Development Indicators -Urban (KCORPP,

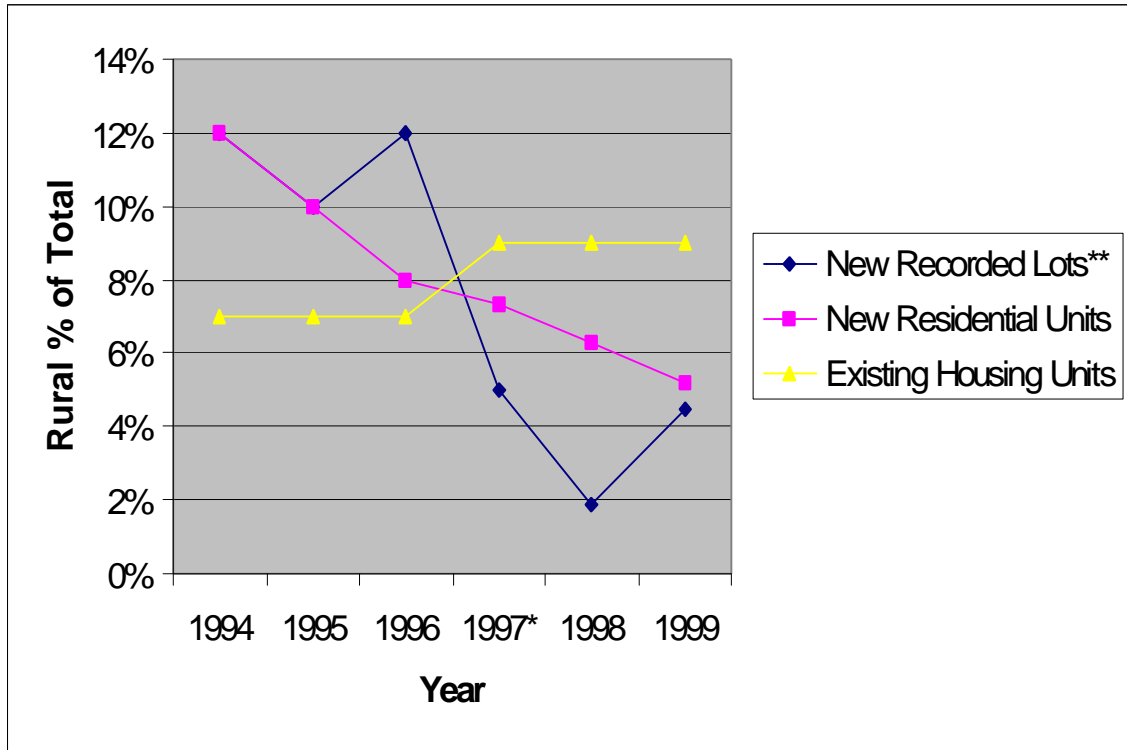


2000).

* Data not comparable in previous years due to a change in measuring existing housing units.

** Does not include short plats.

Figure LU-2. King County Land Development Indicators - Rural (KCORPP, 2000).



* Data not comparable in previous years due to a change in measuring existing housing units.

** Does not include short plats.

Estimates using PSRC data show that the population of WRIA 9 is currently approximately 563,980. About 89 percent live in the Urban Growth Area and 11 percent live in the Rural Area or Resource Lands (derived from 2000 PSRC data). Additional population information is presented later in this chapter.

PRESENT-DAY LAND COVER AND DESIGNATED LAND USE

The land area of WRIA 9 is 568-square-mile area. Thirty percent of the WRIA is within the Urban Growth Area (UGA). The land use/land cover statistics (found in the tables and maps of the text and Appendix) are categorized from 1995 King County land cover data. Designated land use statistics (found in the tables and maps of the text and Appendix) are categorized from recent Puget Sound Regional Council data that summarized current comprehensive plans. Figure LU-4 and figure LU-5 show land cover and designated land use mapped, respectively. The maps show the increasing urbanization within the UGA and how planning can drive these types of development.

Table LU-3 summarizes some of the information found in tables LU-7 through LU-18 in the Appendix. Each sub-watershed is listed below with the designated land use (from comprehensive plans) and percent land area found in the UGA. The land use designation is vastly different from

sub-watershed to sub-watershed. WRIA 9 has a variety of land uses from forestry to agriculture and from residential to industrial.

Table LU-3. Designated Land Uses in WRIA 9 (derived from 2000 PSRC data).

Land Use Designations	% of Upper Green River Subwatershed	% of Middle Green River Subwatershed	% of Lower Green River Subwatershed	% of Green/Duwamish Estuary Subwatershed	% of Nearshore Subwatershed	% of Vashon Is. Subwatershed
Agriculture		11	5			4
Commercial		1	10	1	6	
Commercial Forestry	100	26				
Industrial		1	17	44	10	
Mixed Use		1	5	2	4	
Residential		50	50	39	68	92
Mineral Resources		2				1
Other		3	7	10	4	
Parks & Open Space		5	6	4	8	3
% of Sub-watershed in UGA	0	22	100	100	100	0

UPPER GREEN RIVER SUB-WATERSHED

The Upper Green River Sub-watershed is nearly 100 percent utilized for commercial forestry. No permanent settlements currently exist in this sub-watershed but human development is characterized by large forestry operations, a flood control dam and reservoir, a water supply diversion dam providing water for the City of Tacoma, the Burlington Northern Santa Fe railroad, and a major electric utility transmission line (USACE, 1997). Public access is restricted in some areas. There are seven principal land owners in the sub-watershed including U.S. Forest Service, Plum Creek, Weyerhaeuser, Guistina Resources, Washington Department of Natural Resources, Tacoma Public Utilities, and Burlington Northern Santa Fe. None of the Upper Green River Sub-watershed is in the UGA. (See Tables LU9 & LU10 in Appendix)

MIDDLE GREEN RIVER SUB-WATERSHED

The Middle Green River Sub-watershed is roughly split between residential development (50 percent) and a mix of commercial forestry (27 percent) and agriculture (12 percent). Most of the upper portion is rural residential, forestry, and agriculture while cities and unincorporated urban areas dominate the lower portion of this sub-watershed. It includes all or portions of the cities of Auburn, Black Diamond, Covington, Enumclaw, Kent, and Maple Valley. Twenty-two percent of the Middle Green Sub-watershed is in the UGA. (See Tables LU11 & LU12 in Appendix).

LOWER GREEN RIVER SUB-WATERSHED

The Lower Green Sub-watershed consists of residential development (50 percent), industrial development (17 percent), and commercial development (10 percent). Most of the land area is incorporated in the cities of Algona, Auburn, Federal Way, Kent, Renton, SeaTac, and Tukwila (representing four of the 14 Urban Centers). In this sub-watershed, it is estimated that 80 percent of the Green River from river mile (RM) 17 to river mile (RM) 33 has been leveed or revetted on

at least one bank for flood protection (Perkins, 1993). Most of the floodplain has been filled, drained and developed. About 5 percent is in the County's Agricultural Production District. Nearly 100 percent of the Lower Green River Sub-watershed is in the UGA. (See Tables LU13 & LU14 in Appendix)

GREEN/DUWAMISH ESTUARY SUB-WATERSHED

The Green/Duwamish Estuary Sub-watershed is characterized by industrial development (43 percent) and residential development (39 percent). The cities of Seattle and Tukwila, operations of the Port of Seattle (the fifth largest port in the U.S.), and the region's largest industrial complexes are in this sub-watershed. In the lower portion of the estuary, the loss of estuarine and riparian habitat has been extensive. The estuary shoreline has been dramatically altered: 21,000 feet have been lost due to straitening of the channel and 53,000 feet have been filled and developed. Only 19,000 feet of vegetated riparian shoreline remains. The once extensive 3,850 acres of tidal mudflats, marshes, and swamps have been reduced to only 45 acres. Ninety-seven percent of the estuary has been filled (USACE, 1997). This entire sub-watershed is in the UGA. (See Tables LU15 & LU16 in Appendix)

NEARSHORE SUB-WATERSHED

The Nearshore Sub-watershed has been heavily altered and currently consists of residential (68 percent) and industrial (10 percent) land uses. This portion of the Puget Sound coastline has one of the largest coastal populations in the state including all or portions of the cities of Burien, Des Moines, Federal Way, Kent, Normandy Park, SeaTac, and Seattle. In the center of this sub-watershed is one of the region's largest public facilities, SeaTac International Airport. The Nearshore Sub-watershed has one of the highest degrees of shoreline modification in the state at nearly 80 percent. Most shoreline modification such as seawalls and bulkheads were placed to protect residential development from erosion (WSDNR, 1998). This entire sub-watershed is in the UGA. (See Tables LU17 & LU18 in Appendix)

VASHON SUB-WATERSHED

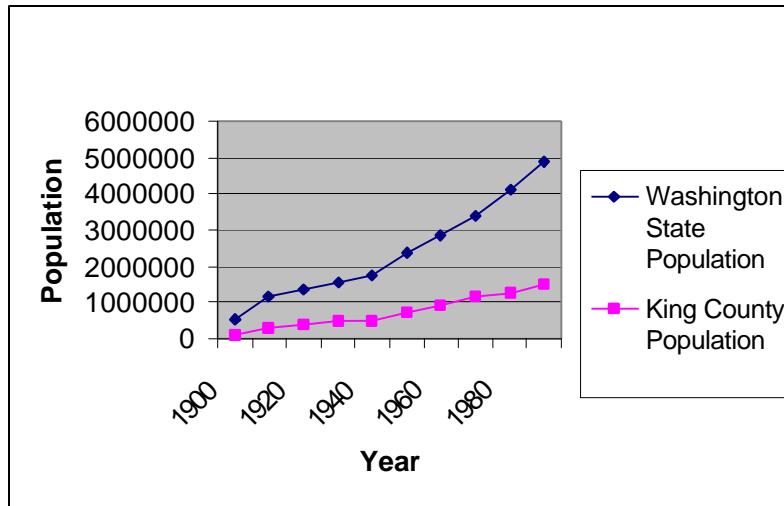
The Vashon Sub-watershed has remained far less developed than much of the surrounding area due to its isolation and finite ground water supply. Regardless, the island is designated primarily for rural residential (92 percent) land uses. Along with the residential land uses there are some agriculture and mining operations on the island. A variety of rare and pristine habitat areas are found here including two salt marshes and two of the last remaining undisturbed salmon streams in King County. Two-thirds of the island is still currently forested (Munday, 1999). None of the Vashon Sub-watershed is in the UGA. (See Tables LU19 & LU20 in Appendix).

POPULATION GROWTH

Population has increased dramatically since the beginning of the 19th century. In the early 20th century, the region experienced a dramatic increase in population predominantly in the urban areas such as Seattle and the other watershed cities. As the Puget Sound population centers continued to expand through the 1970s, 1980s, and 1990s, WRIA 9 has experienced increasing

urbanization throughout its Urban Growth Area. The Puget Sound Regional Council has found that for every 1 percent increase in population growth there is a corresponding 2 percent or higher increase in developed land (PSRC, 1998). Figure LU-3 shows population growth in Washington State and King County since 1900.

Figure LU-3: Population Growth 1900-1990 (U.S. Census Bureau, 2000).



In 1999, population in WRIA 9 was estimated at 563,980 (adapted from PSRC data, 2000). Eighty-nine percent of this population resides within the UGA. Table LU-4 shows the population numbers for the sub-watersheds. The Nearshore Sub-watershed has the largest population.

Sub-watershed	Total Population	% of Total Watershed
Upper Green River	128	0
Middle Green River	112,130	20
Lower Green River	153,755	27
Green/Duwamish Estuary	57,647	10
Nearshore	230,718	41
Vashon	9,602	2

Table LU-5 provides data on the numbers of residents in cities wholly or partially within WRIA 9 in 1990 and 1996. Except for the City of SeaTac, the populations of all the cities in WRIA 9 grew between 1990 and 1996. The cities of Algona, Black Diamond, Enumclaw, and Kent experienced the greatest growth, with an average annual growth rate of 2 percent or higher, due to both annexations and new residential development.

Table L-U5. Population Distribution in the Green/Duwamish River Basin (numbers are calculated by jurisdiction and may fall out of the WRIA boundaries (U.S. Census Bureau, 2000).				
Jurisdiction	1990a	1996b	Average Annual Growth Rate Percent per Year Relative Rate	
Algona	1,694	2,135	4.34	High growth
Auburn	33,650	36,393	1.36	Moderate growth
Black Diamond	1,422	1,967	6.39	High growth
Burien	25,507	26,882	0.90	Low growth
Covington	24,321	ND	ND	ND
Des Moines	17,283	17,811	0.51	Low growth
Enumclaw	7,227	9,500	5.09	High growth
Federal Way	67,535	68,088	0.14	Low growth
Kent	37,960	42,700	2.08	High growth
Maple Valley	1,211	ND	ND	ND
Normandy Park	6,794	6,846	0.13	Low growth
Renton	41,688	45,155	1.39	Moderate growth
SeaTac	22,760	22,723	-0.03	Negative growth
Seattle	516,259	524,704	0.27	Low growth
Tukwila	14,506	14,556	0.06	Low growth
King County (as a whole)	1,507,319	1,598,707	1.01	Moderate growth
Washington State	4,866,692	5,433,068	1.94	Moderate growth
Notes: ND = no data available. a Census Bureau data as of April 1, 1990. b Census Bureau estimate data as of March 12, 1999.				

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