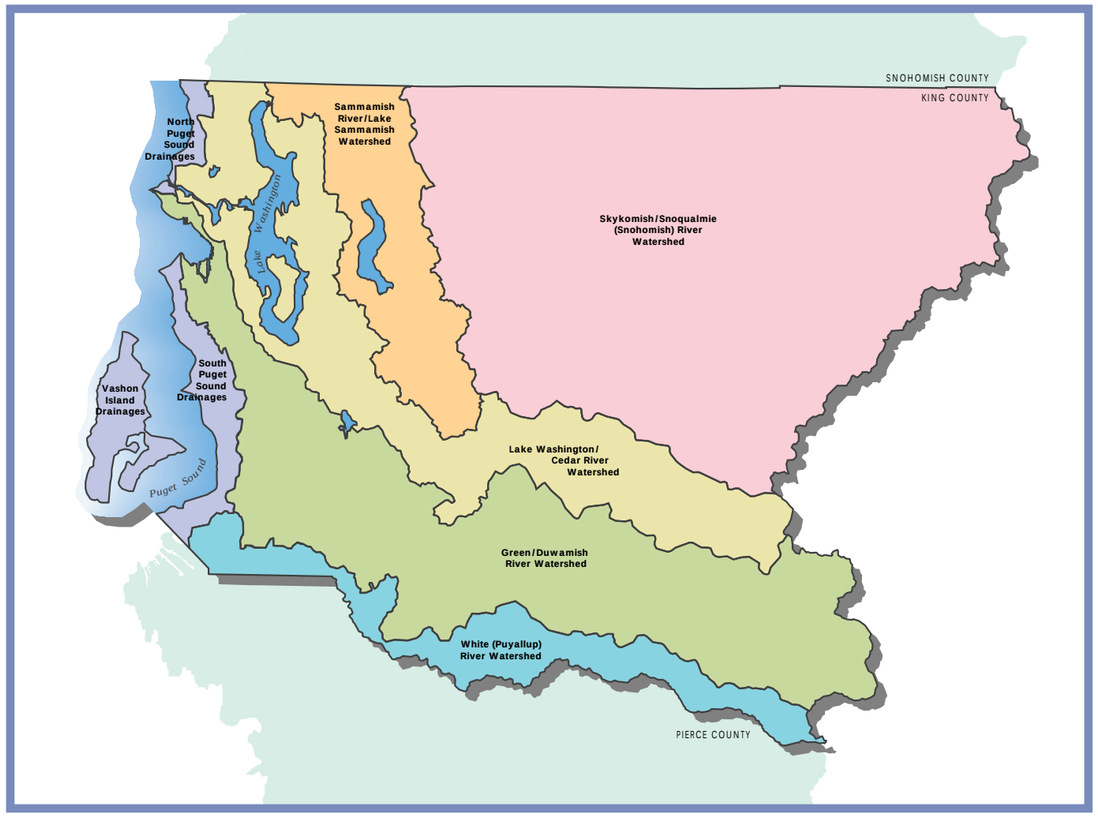
An Atlas of

The Watersheds of King County, Washington



Regional Needs Assessment for Surface Water Management

July 20, 1995

The Watersheds of King County, Washington

Water does not observe government boundaries. Fluid and infinitely mobile, it obeys no law but that of gravity. From the high mountainsides of the Cascade range to the estuaries of the Puget Sound coastline, it affects, and is affected by, every place through which it flows. It gathers minerals and rock fragments from glaciers, sediment from logged hillsides, fertilizer and organic materials from farmland, and oil and heavy metals from city streets. In rainstorms, rivers swell with runoff, carrying the discharge from one city's storm drains downstream to the next. Salmon swim to the sea and back in their ancient migratory patterns. With its interwoven networks of watercourses, land uses, and plant and animal life, each watershed is a complete natural system in which streams, wetlands, lakes, and rivers link the landscape and its residents together.

County Facts

Surface Area	**2192 square miles**
1994 Population*	**1,599,493**
ï Incorporated	1100,270
Unincorporated	499,223
1990-1994 change	6.1%
Number of cities 1995	35

*Estimated from U.S. Census Bureau data

Six major watersheds cover King County

- The Skykomish/Snoqualmie (Snohomish) River Watershed
- The Sammamish River/Lake Sammamish Watershed
- The Lake Washington/Cedar River Watershed
- The Green/Duwamish River Watershed
- The White (Puyallup) River Watershed
- Direct Puget Sound Drainages including Vashon Island

These watersheds encompass dozens of creeks, rivers, lakes, and wetlands. They also include cities, towns, the Muckleshoot Indian Reservation, unincorporated rural, forest and agricultural areas and Usual and Accustomed Areas for Treaty Indian Tribes. A significant portion of the eastern part of the county is owned by the U.S. Forest Service and the Washington Department of Natural Resources. These lands are managed for forest production. The upper watersheds of the Tolt (tributary to the Snoqualmie River) and Cedar Rivers, and the Green River watershed provide water supplies to the cities of Seattle and Tacoma respectively.

In the next twenty years, as our population grows and our natural resources are increasingly stretched, maintaining a balance between natural resources and social and economic goals will be our challenge. It will require active collaboration and management of the watersheds by all of us.

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July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

Map 1

Introduction to the
Atlas of the Watersheds of King County, Washington

The Atlas of the Watersheds in King County, Washington displays the watersheds of King County, their sub-watersheds, local government and other institutional boundaries, surface water-related historical facts and locations of significance, aquatic resource information, and current (1992) and projected (2012) land cover. The maps also provide an overview of the significant issues and challenges in surface water management for each of the watersheds, as well as issues and challenges that pertain to the major basins within each watershed.

The maps are as follows:

Map 1: The Watersheds of King County, Washington

Map 2: 1992 Land Cover in King County (characterized Landsat image)

Map 3: Land Use Zones in King County

Maps 4 & 5: Green/Duwamish River Watershed

Maps 6 & 7: Cedar River/Lake Washington Watershed

Maps 8 & 9: Lake Sammamish/Sammamish River Watershed

Maps 10 & 11: Skykomish/Snoqualmie River (Snohomish) Watershed

Map 12: White River (Puyallup) Watershed including the Hylebos Creek basin

Map 13: Puget Sound Drainages, including Vashon Island

Map 14: Salmon and Steelhead in King County Watersheds

Following Map 14, the Atlas presents facts about each watershed. Acknowledgements are the final page of the Atlas.

These maps are based on the best information currently available in Geographic Information System (GIS)-format. The current land cover information is based on a 1992 Landsat image from the Puget Sound Regional Council (PSRC), and classified by the King County Surface Water Management Division GIS staff. Future land cover projections are modified 1992 Landsat images, based on population and employment projections from the Growth Management Planning Council and the projected land uses and annexation areas developed by each jurisdiction in the county as part of their compliance with the Growth Management Act. These conditions are forecast to occur by 2012.

Background Information

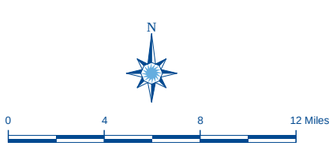
The Regional Needs Assessment (RNA) is an interjurisdictional project that was started in 1993 to define the needs, priorities, and responsibilities for surface water management in King County. The RNA has been a collaborative decision making process with surface water management staff and managers from throughout King County; staff from other involved parties such as the King Conservation District; elected officials from the Metropolitan King County Council, the City of Seattle, and suburban cities; tribes; and stakeholders. To date the RNA has identified surface water management needs, current services, and service gaps; and how and what services could be coordinated or provided locally.

The various partners in the RNA recommend that management services for mainstem river flooding, fish habitat, and water quality should be coordinated on a watershed basis. The RNA recommendations are contained in a companion document, *Report and Recommendations, Regional Needs Assessment for Surface Water Management, King County, Washington.*

1992 Land Cover in King County (Characterized Landsat Image)

Legend

- Impervious
- Single Family High Density
- Multifamily
- Single Family Rural, Forested
- Single Family Rural, Pasture
- Coniferous Forest
- Deciduous Forest
- Mixed Forest
- Grass/Shrub
- Fallow Agriculture
- Active Agriculture
- Scrub/Clearcut
- New Clearcut
- Turbid Water
- Open Water
- Shoreline
- Bare Soil/Quarry/Landfill
- Bare Rock
- Snow and Ice
- Alpine
- Areas in Shadow



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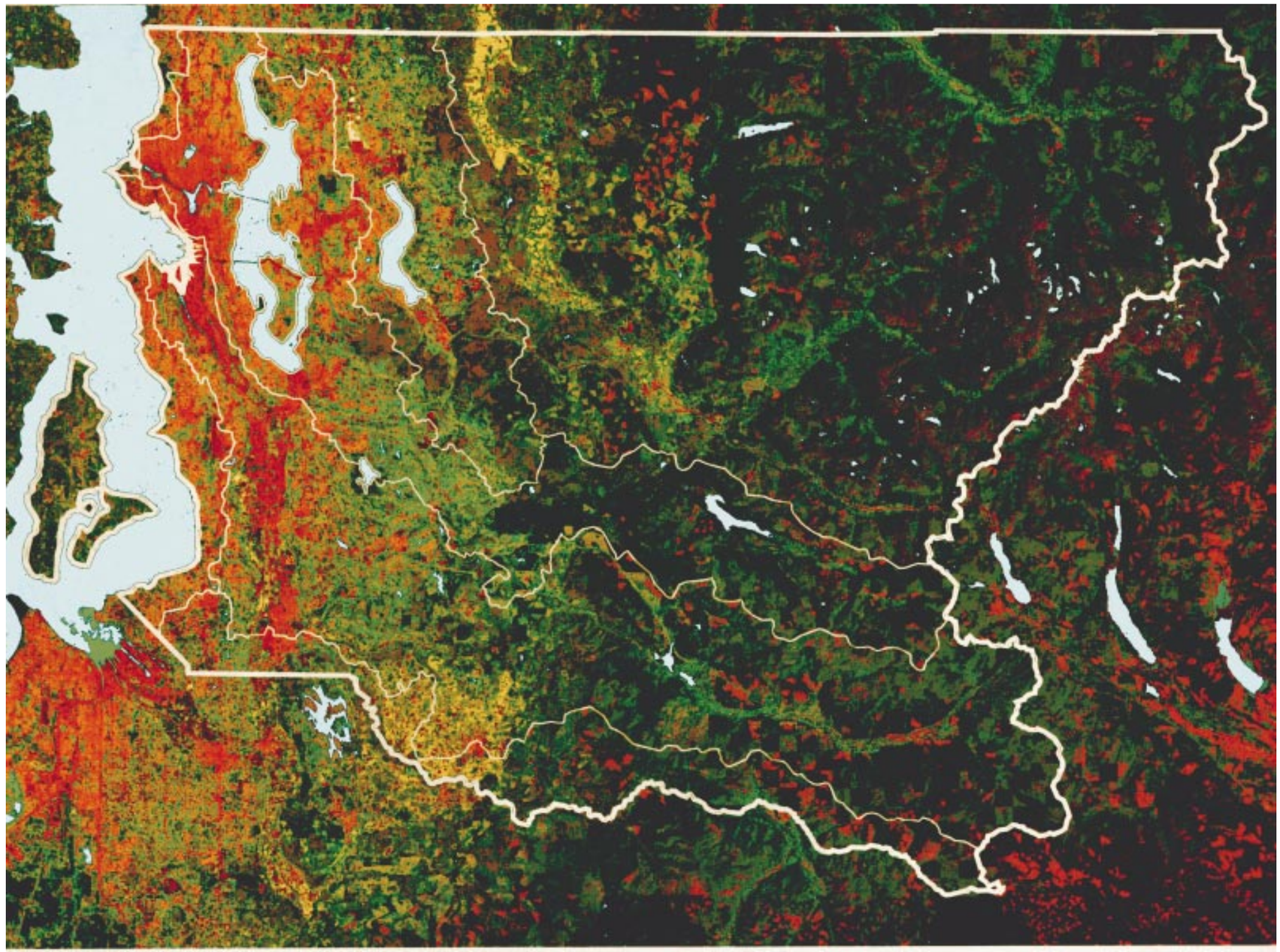
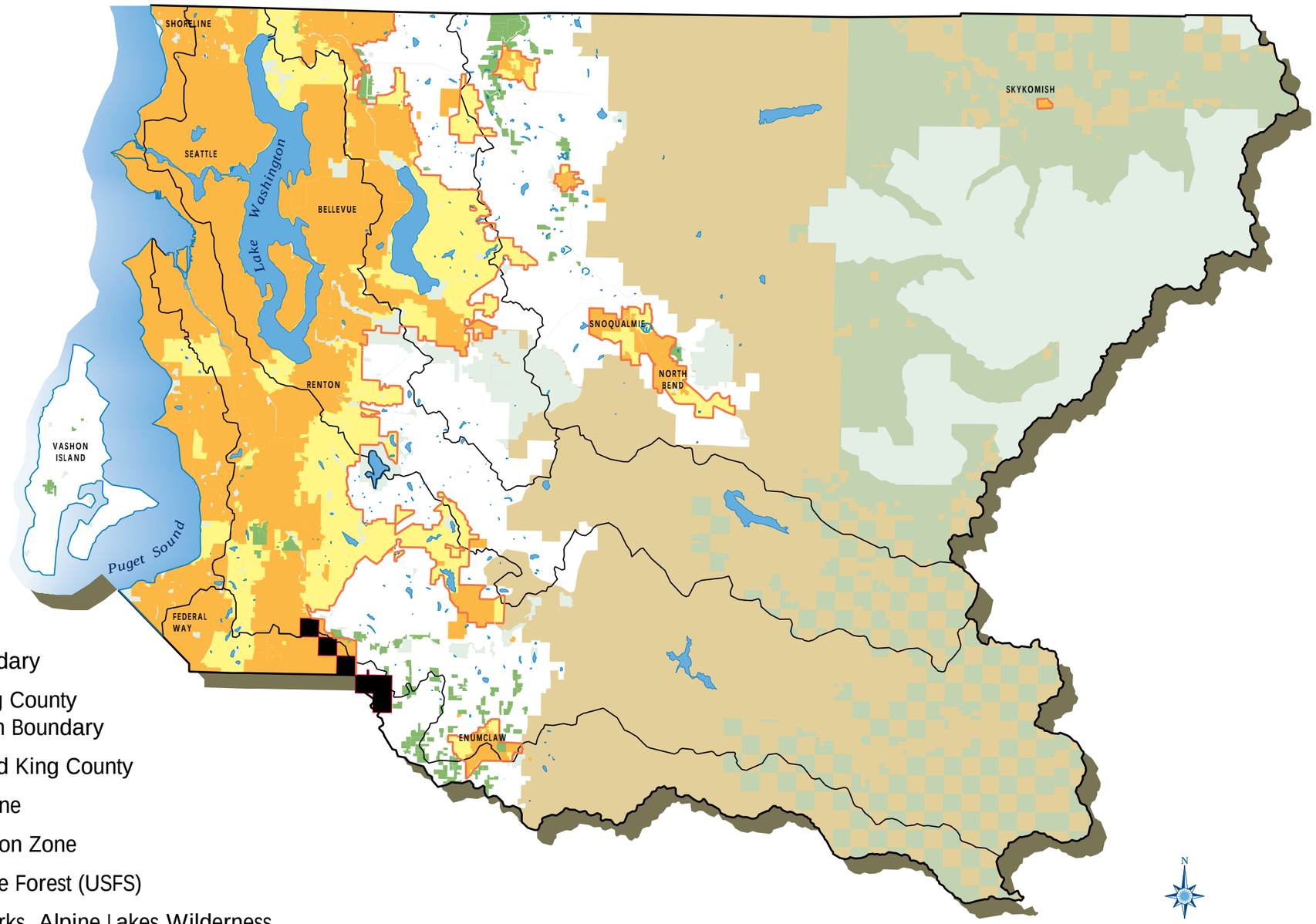
Regional Needs Assessment for SURFACE WATER MANAGEMENT



Map 2

Land Use Zones in King County



- Jurisdictions
- Urban Growth Boundary
- Unincorporated King County within Urban Growth Boundary
- Rural Unincorporated King County
- Forest Production Zone
- Agricultural Production Zone
- Mt.Baker-Snoqualmie Forest (USFS)
- State and County Parks, Alpine Lakes Wilderness
- Muckleshoot Indian Reservation

Regional Needs Assessment for SURFACE WATER MANAGEMENT

Map 3

The Green River/Duwamish River Watershed

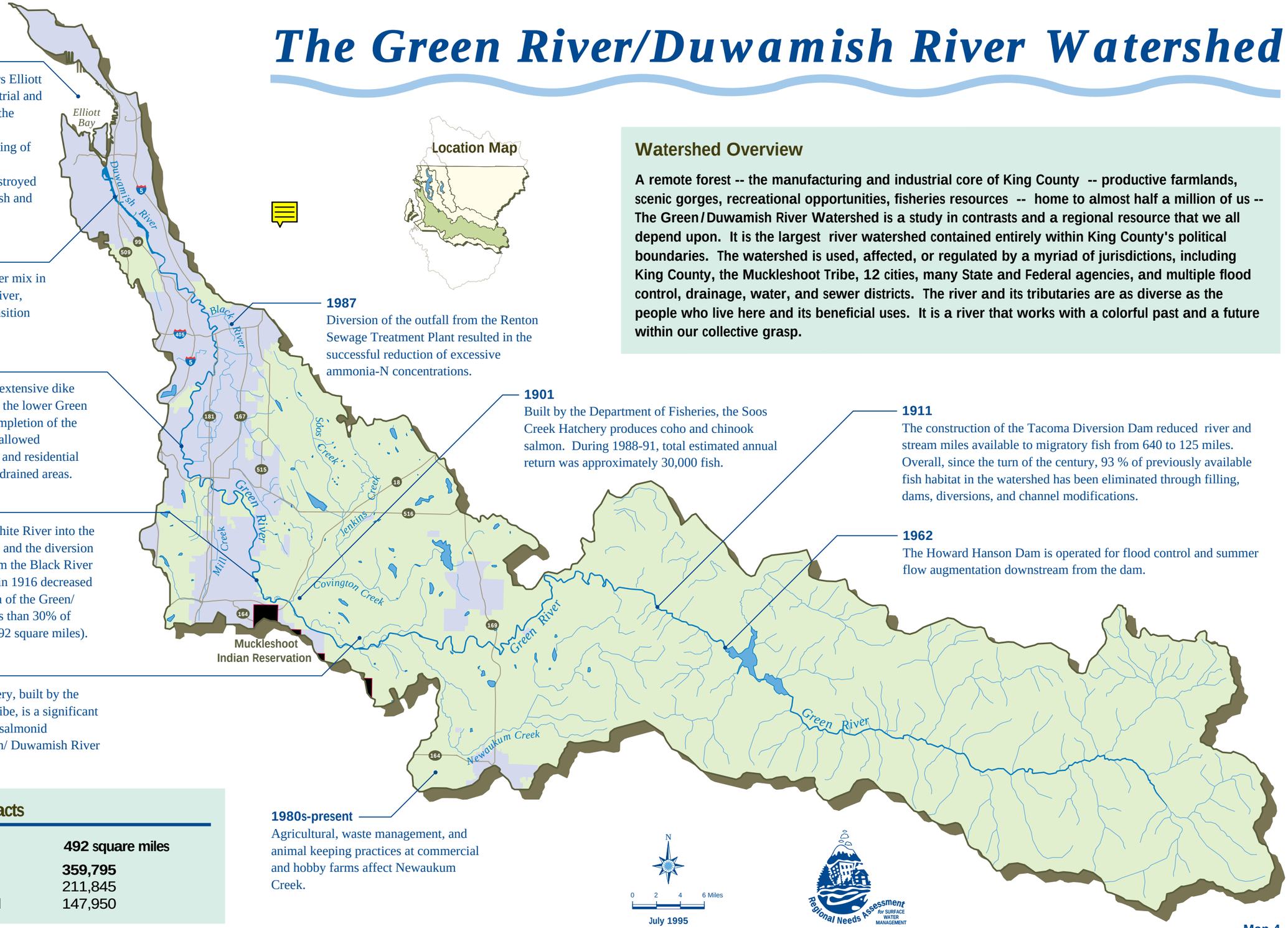
1890-1995
For more than 100 years Elliott Bay has received industrial and urban discharges from the lower Duwamish and downtown Seattle. Filling of wetlands and river channelization have destroyed most of the estuarine fish and wildlife habitat.

1995
Freshwater and saltwater mix in the lower Duwamish River, providing a critical transition area for migratory fish.

1960-1970s
The construction of an extensive dike and levee system along the lower Green River, coupled with completion of the Howard Hanson Dam, allowed commercial, industrial, and residential development in poorly drained areas.

1906-1916
The diversion of the White River into the Puyallup River in 1906 and the diversion of the Cedar River from the Black River into Lake Washington in 1916 decreased the total watershed area of the Green/ Duwamish River to less than 30% of historic size (1643 to 492 square miles).

1978
The Keta Creek Hatchery, built by the Muckleshoot Indian Tribe, is a significant contributor to the total salmonid production of the Green/ Duwamish River watershed.



1987
Diversion of the outfall from the Renton Sewage Treatment Plant resulted in the successful reduction of excessive ammonia-N concentrations.

1901
Built by the Department of Fisheries, the Soos Creek Hatchery produces coho and chinook salmon. During 1988-91, total estimated annual return was approximately 30,000 fish.

1911
The construction of the Tacoma Diversion Dam reduced river and stream miles available to migratory fish from 640 to 125 miles. Overall, since the turn of the century, 93 % of previously available fish habitat in the watershed has been eliminated through filling, dams, diversions, and channel modifications.

1962
The Howard Hanson Dam is operated for flood control and summer flow augmentation downstream from the dam.

1980s-present
Agricultural, waste management, and animal keeping practices at commercial and hobby farms affect Newaukum Creek.

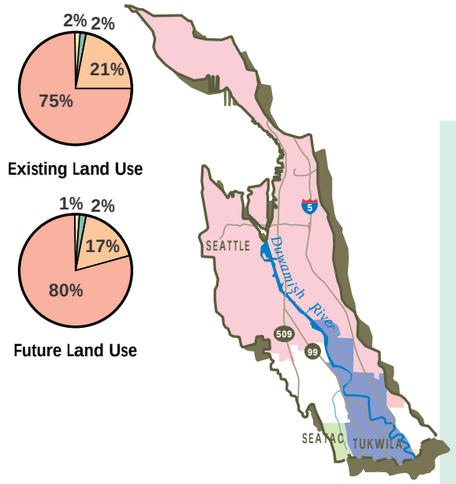
Watershed Overview

A remote forest -- the manufacturing and industrial core of King County -- productive farmlands, scenic gorges, recreational opportunities, fisheries resources -- home to almost half a million of us -- The Green/Duwamish River Watershed is a study in contrasts and a regional resource that we all depend upon. It is the largest river watershed contained entirely within King County's political boundaries. The watershed is used, affected, or regulated by a myriad of jurisdictions, including King County, the Muckleshoot Tribe, 12 cities, many State and Federal agencies, and multiple flood control, drainage, water, and sewer districts. The river and its tributaries are as diverse as the people who live here and its beneficial uses. It is a river that works with a colorful past and a future within our collective grasp.

Watershed Facts

Area	**492 square miles**
Basin Population	**359,795**
• Incorporated	211,845
• Unincorporated	147,950

The Green/Duwamish River Sub-Watersheds

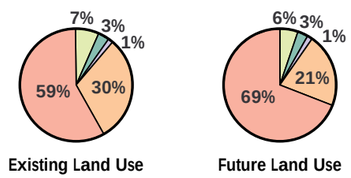


Challenges for the Duwamish River / Elliott Bay Sub-Watershed:

- How can we build upon the activities of the Duwamish Coalition in creating partnerships between business, industry, public agencies, tribes, and community groups?
- How can expenditures and actions by agencies, private industry, and community groups be better focused to achieve more tangible benefits for the money being spent?
- How can the cooperating partners develop a balance between supporting the ecological functions of this area through careful management and restoration while allowing the industrial and commercial development to thrive?

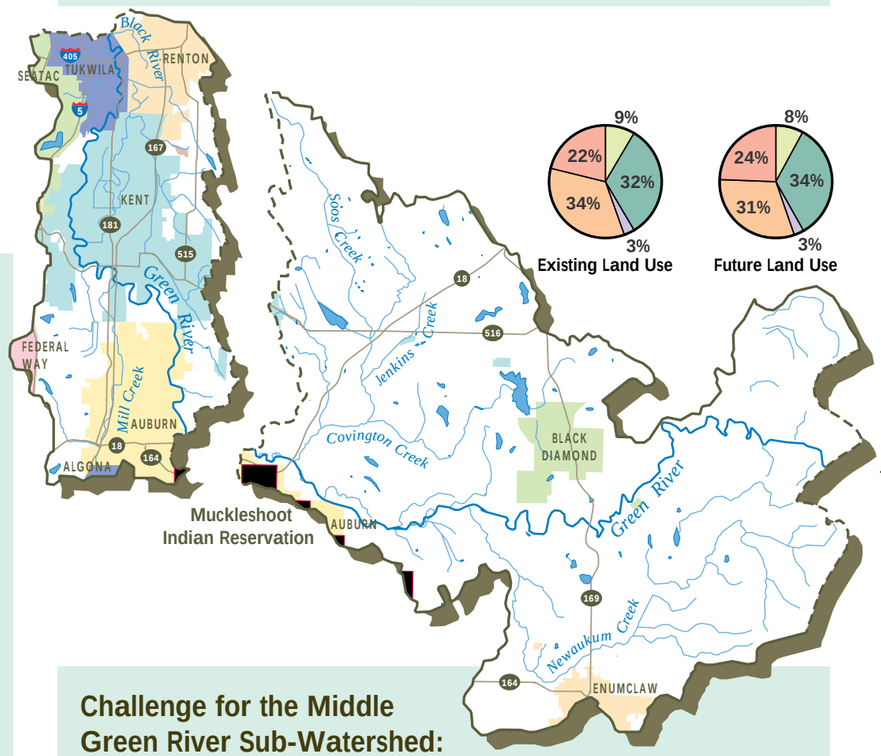
Land Use Categories

- Urban / Residential
- Rural
- Parks
- Forest
- Agricultural



Challenges for the Lower Green River Sub-Watershed:

- How can we build on the history of cooperation on flood control to address other surface water management issues in the river, streams, lakes, and wetlands in this area?
- How can operations of the Howard Hanson Dam be modified to reduce damages to levees on the lower Green as flood water recede?
- Can the high costs of maintaining and upgrading the flood facilities to protect the large investments that have been made in property development in the flood hazard areas be sustained by the communities in the valley?
- Can the historical contamination of old industrial sites be remediated at reasonable cost?
- Can the remaining habitat be protected and restored?

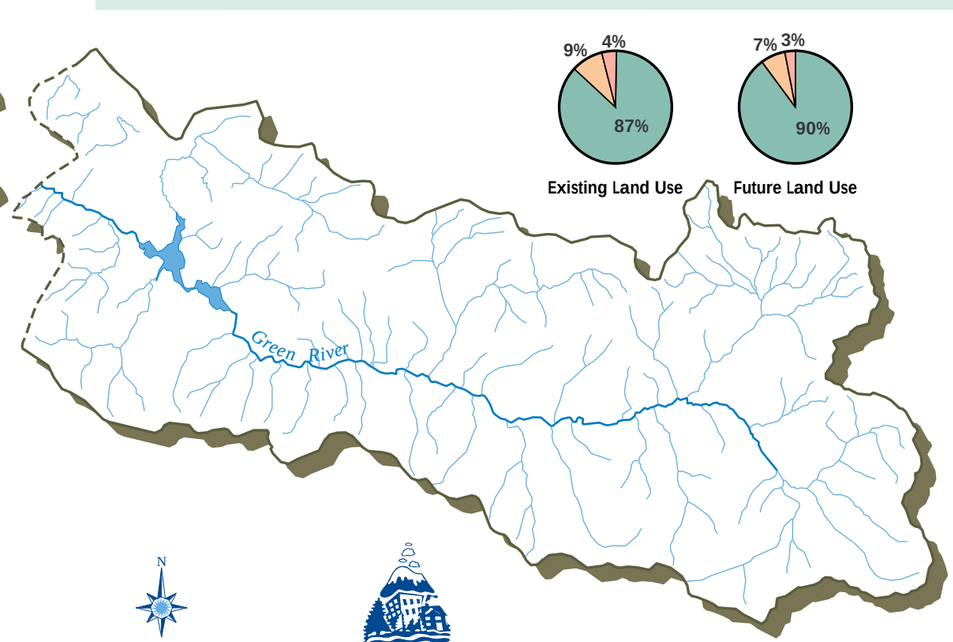


Challenge for the Middle Green River Sub-Watershed:

- How can protection of the rich natural resources of this area be balanced with the needs of a rapidly growing population and abundant recreational opportunities?
- How can operations at Howard Hanson Dam be modified to reduce stranding of out-migrant and fry dessication of eggs laid during higher water?
- How can groundwater uses that affect instream base flows be addressed?

Challenges for the Upper Green River Sub-Watershed:

- How do Tacoma, the U.S. Army Corps of Engineers, the tribes, and the forest production groups (USFS, DNR, Plum Creek, Weyerhaeser) work with downstream partners to develop cooperative management of this watershed in conjunction with the lower sub-watersheds?
- How can fish populations be restored and protected into the future?
- How can reservoir operations be optimized for all desired uses?



The Green/Duwamish River Sub-Watersheds

Duwamish/Elliott Bay Sub-Watershed

The watershed's estuary, the lower Duwamish and Elliott Bay have been the site of extensive modification and pollution for the last 100 years. The loss of more than 99 percent of the estuarine marsh habitats and the contamination of sediments have been well documented. These changes and the ontamination benthic (bottom-dwelling) biota, and high water temperatures during critical times of the year have created an inhospitable environment for fish and shellfish. Development, including the Port of Seattle facilities, has been a primary economic driver for the entire region. The future viability of both natural resources and economic opportunities in this area are partially dependent upon controlling the high costs of environmental clean-up and economic redevelopment in a challenging regulatory environment.

Lower Green River Sub-Watershed

The lower Green River and its valley is highly urbanized, consisting of dense commercial and industrial development as well as some of the fastest growing suburban communities in King County. Much of the commercial and residential development in the valley depends on the levee and dike system. Problems include contaminated stream sediments, loss of diverse habitats, and degradation of aquatic resources. A number of small lakes are threatened by increasing phosphorus loads. The restoration of these resources is an issue that the area needs to grapple with. Governments and citizens in the lower valley are already actively involved in several coalitions, including the Green/Duwamish Alliance, the River Basin Program, the Green River Flood Control Zone District and the Mill Creek Special Area Management Plan and Flood Control Project. The outlook for developing innovative and integrated management solutions to surface water management problems in this area is very promising due to the long history of cooperation between the various parties in the area.

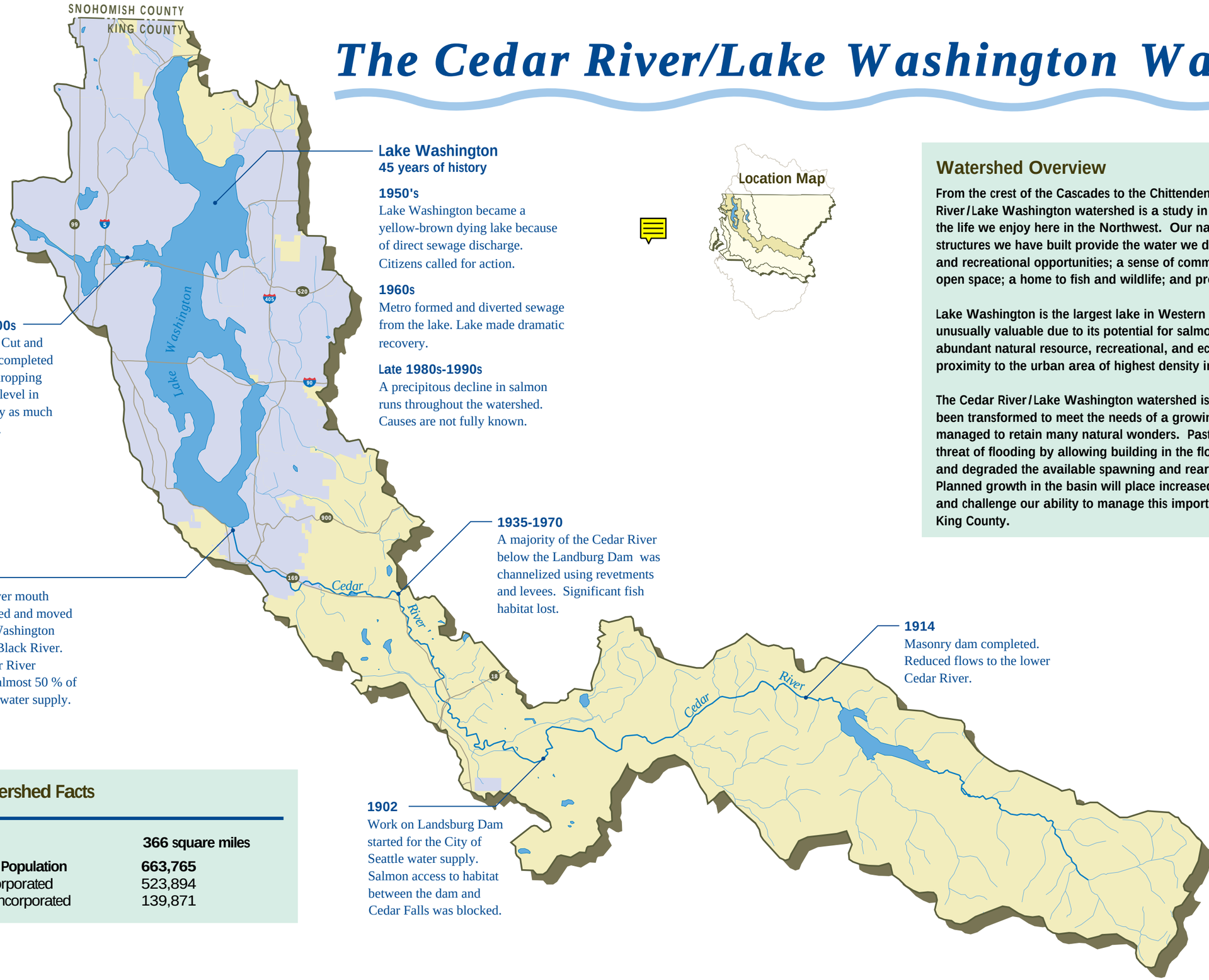
Middle Green River Sub-Watershed

The middle section of the Green River includes rich farmlands and productive forestry lands as well as the cities of Black Diamond and Enumclaw, several state and county parks, and a productive, albeit declining, salmonid fishery. The area is increasingly important as an affordable area for suburban and rural residences and hobby farms, is one of the largest remaining agricultural communities in King County, and provides extensive recreational opportunities for watershed and county residents. The stream systems in this sub-watershed, including Newaukum, Crisp, Soos, Jenkins, and Covington creeks, continue to support significant fish habitat, although the urban -designation of parts of these streams will result in future degradation. The Muckleshoot Indian Tribe is involved in monitoring, research, and restoration of salmonids and salmonid habitat in this sub-watershed and throughout the whole watershed.

Upper Green River Sub-Watershed

The upper Green River sub-watershed extends from the crest of the Cascades to the Tacoma Diversion Dam. It provides drinking water to the City of Tacoma and forest production for federal, state, and private land owners. The Tacoma Water Supply Diversion Dam blocks anadromous fish and limits public access to the upper watershed. The Howard Hanson Dam, slightly upstream from the diversion dam, is operated by the U.S. Army Corps of Engineers primarily for flood control and low flow augmentation. Recently small numbers of steelhead and coho have been planted above these dams into the upper watershed. The Bull Trout run found in this part of the watershed is considered to be at risk. The impacts of forest harvest on drinking water quality and the quality of fish habitats need to be carefully considered. Opportunitites to modify dam operation to optimize flood protection and instream flows need to be evaluated.

The Cedar River/Lake Washington Watershed



Lake Washington
45 years of history

1950's
Lake Washington became a yellow-brown dying lake because of direct sewage discharge. Citizens called for action.

1960s
Metro formed and diverted sewage from the lake. Lake made dramatic recovery.

Late 1980s-1990s
A precipitous decline in salmon runs throughout the watershed. Causes are not fully known.

Early 1900s
Montlake Cut and the locks completed in 1917, dropping the water level in the lake by as much as 10 feet.

1935-1970
A majority of the Cedar River below the Landburg Dam was channelized using revetments and levees. Significant fish habitat lost.

1912
Cedar River mouth channelized and moved to Lake Washington from the Black River. The Cedar River provides almost 50 % of the lake's water supply.

1914
Masonry dam completed. Reduced flows to the lower Cedar River.

1902
Work on Landsburg Dam started for the City of Seattle water supply. Salmon access to habitat between the dam and Cedar Falls was blocked.

Watershed Overview

From the crest of the Cascades to the Chittenden locks, the Cedar River/Lake Washington watershed is a study in changes and a symbol of the life we enjoy here in the Northwest. Our natural systems and the structures we have built provide the water we drink; swimming, boating and recreational opportunities; a sense of community pride, aesthetics and open space; a home to fish and wildlife; and protection from flooding.

Lake Washington is the largest lake in Western Washington. It is unusually valuable due to its potential for salmonid production, its abundant natural resource, recreational, and economic value, and its proximity to the urban area of highest density in the Pacific Northwest.

The Cedar River/Lake Washington watershed is a natural system that has been transformed to meet the needs of a growing population and yet has managed to retain many natural wonders. Past actions have increased the threat of flooding by allowing building in the floodplain and have reduced and degraded the available spawning and rearing habitat for fish. Planned growth in the basin will place increased pressure on this system and challenge our ability to manage this important resource in the heart of King County.

Watershed Facts

Area	**366 square miles**
Basin Population	**663,765**
• Incorporated	523,894
• Unincorporated	139,871

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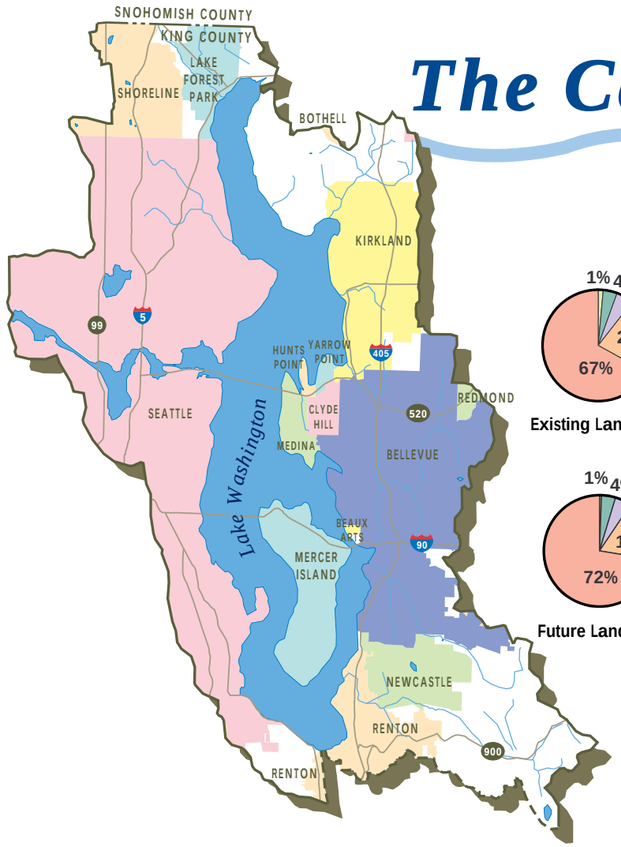
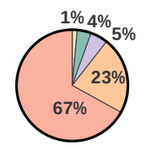
July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

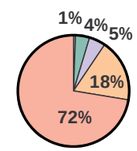
Map 6

The Cedar River/Lake Washington Sub-Watersheds





Existing Land Use



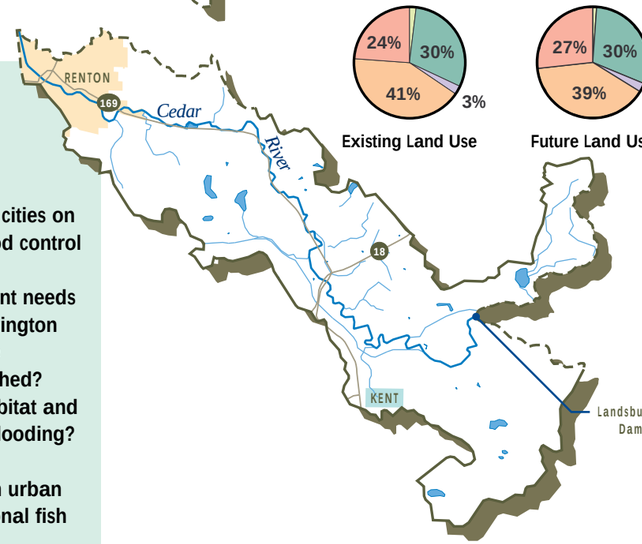
Future Land Use

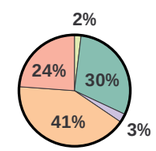
Challenges for Lake Washington and its Tributaries:

- What are the causes of the decreased Lake Washington salmon runs?
- What should be our management strategy for the lake and watershed?
- Who is ultimately responsible for the health of the lake, and who has authority to effectively induce beneficial change?
- How will we coordinate our management actions with Snohomish County which drains into the north end of the lake?

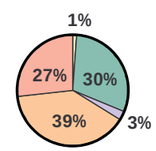
Land Use Categories

- Urban/Residential
- Rural
- Parks
- Forest
- Agricultural





Existing Land Use



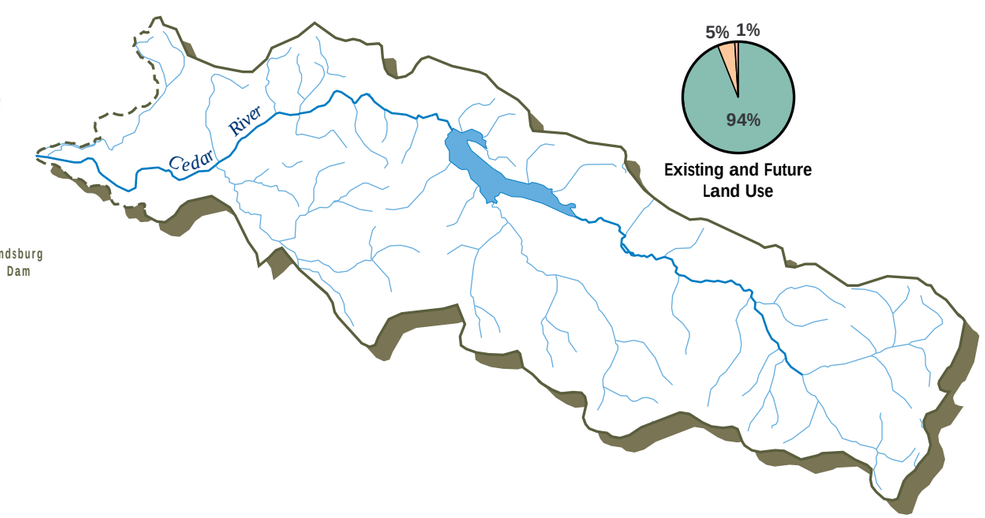
Future Land Use

Challenges for Cedar River Below the Landsburg Dam:

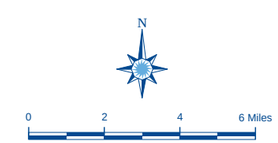
- Is it reasonable to ask citizens of cities on Lake Washington to help fund flood control efforts on the Cedar River?
- How will we prioritize the different needs of the highly urbanized Lake Washington sub-watershed against those of the urbanizing Cedar River sub-watershed?
- How can we both restore fish habitat and protect people and business from flooding?
- How do we continue to support community-based stream groups in urban areas and still address larger regional fish habitat and flooding issues?
- How will we address the groundwater issues in the basin?

Challenge for Cedar River Above the Landsburg Dam:

- How can we continue to optimize the Masonry Dam operations to meet water supply, hydroelectric power generation, flood control, and fish habitat needs?



Existing and Future Land Use



July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

The Cedar/Lake Washington River Sub-Watersheds

Lake Washington and its Tributaries

Lake Washington is a valuable resource to all residents of King County. It is the largest lake in western Washington and provides multiple benefits to the citizens of King County. The lake is the prime rearing habitat for juvenile salmon spawned in the Cedar and Sammamish Rivers, provides multiple recreational opportunities, acts as a beautiful open space, and supports a number of resident fisheries. At the same time, the hydrology, water quality, and habitat in and around the lake have been and continues to be severely impacted by intensive development in the basin.

In recent years, both naturally spawning and cultured populations of Lake Washington sockeye, coho, chinook salmon, and steelhead trout have declined precipitously. The reasons for these declines are not fully understood, but recent studies have focused on poor survival of sockeye in Lake Washington and predation of steelhead by sea lions.

The water quality of the lake is largely dependent upon the high quality of the water from the Cedar River and upon the control of pollutants that enter from the direct drainages and Sammamish River. At this time there is no unified fisheries and water quality management plan for Lake Washington. A number of jurisdictions surrounding the lake have implemented or are in the process of developing programs to reduce the pollutants that enter the lake in stormwater runoff.

Cedar River - Below the Landsburg Dam

The Cedar River Valley below the Landsburg Dam has an extensive surface water system that includes streams, wetlands, and the river. The mainstem of the river has a system of revetments and levees that, along with the dam, protect homes in the valley and commercial property in downtown Renton. There are 430 identified homes at risk from flooding. The November 1990 flood damaged a number of homes, roads, commercial properties, and levees, causing over $5 million of damage and lost labor costs in the city of Renton alone.

The Cedar River and its tributaries contain much of the best remaining aquatic habitat in the Lake Washington system, although over half of the historic habitat suitable for fish spawning and rearing has been lost or degraded. While most of the alterations to the system occurred prior to 1988, ongoing development continues to threaten many high-quality habitats. There is a substantial amount of habitat throughout the basin that is not used by salmon because of tributary blockages by the levees, revetments, and culverts. Providing access to this habitat and restoration of other areas could significantly improve fish habitat on the Cedar River.

By the year 2010 the basin's population is expected to increase 68%, from 55,500 in 1990 to 93,000. Without preventive measures, the new levels of urbanization will increase water quality problems in the basin. Pollutants in stormwater runoff also threaten a sole-source aquifer that lies largely within urbanizing areas in the lower basin. The City of Renton depends upon this aquifer for their water supply. A basin plan for the Cedar River is currently in the final stages of development. Many of the plan's $66.5 million in recommendations are unfunded at this time.

Cedar River - Above the Landsburg Dam

This part of the watershed supplies water to a number of jurisdictions in King County. It is managed by the Seattle Water Department. The watershed is entirely undeveloped and will remain so for the foreseeable future. The Landsburg Dam blocks salmon migration to the upper watershed and public access is limited to protect the quality of the drinking water supply. The City of Seattle balances fisheries, wildlife, forest production, hydro power generation, and water supply issues in their watershed. Operations at Seattle's facilities have an effect on the level and velocity of flows within the river and fish habitat within the lower basin.

The Sammamish River/Lake Sammamish Watershed

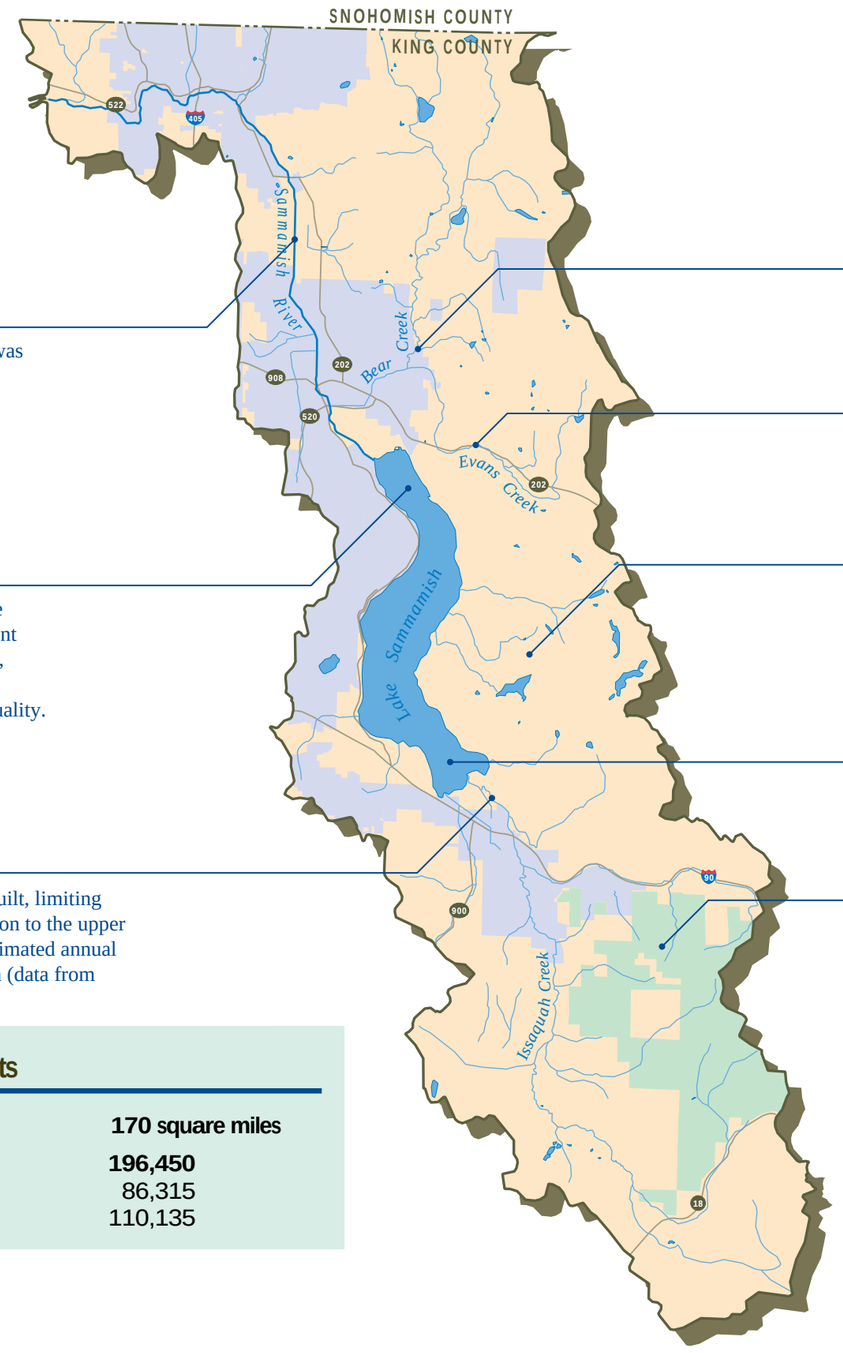
Watershed Overview

The Sammamish Watershed drains 170 square miles. It is a landscape in transition. It is a small watershed relative to the other major river watersheds within King County. The Sammamish Watershed drains into the north end of Lake Washington, connecting the hydrology and ecology of the two systems. A number of tributaries to the Sammamish River are within Snohomish County, increasing the need for cooperation in those areas.

The watershed's surface waters and areas adjacent to them provide numerous recreational opportunities, valuable open space and aesthetics, and support significant runs of salmon and other fish. Because of its location on the eastern fringe of King County's urban area, the watershed contains a mix of land uses that include urban areas, agriculture, numerous parks, and forest production zones.

The watershed is split by the Urban Growth Boundary (UGB), with approximately 50% of the watershed within the UGB. The UGB designation and growth outside the UGB will continue the pattern of forest land conversion to residential and commercial uses. If not managed properly, this can lead to increased flows and pollutant levels that will further degrade the resources in the watershed and increase the incidence of flooding and erosion.

Fish habitat and water quality are in decline or threatened throughout the watershed. Many stream systems that supported substantial runs of salmon and steelhead only 10 to 20 years ago support few of these fish today. Groundwater is a significant issue in this watershed because many residents and businesses rely on aquifers for water supply, and aquifer levels affect flows to stream systems. Our challenge in this watershed will be to balance growth and protection of the remaining natural resources while capitalizing on opportunities to restore valuable natural systems.



Early 1960s
The Sammamish River was channelized, severely impacting fish habitat.

1968
Metro diverted discharge from wastewater treatment facilities around the lake, resulting in a dramatic improvement in water quality.

1930s
Issaquah hatchery was built, limiting access of spawning salmon to the upper portion of the basin. Estimated annual returns of 11,000 salmon (data from 1988-1991).

1994
A record (40,000) sockeye returned to Bear Creek.

1980s
Significant salmon runs in Evans Creek were eliminated as forest land is converted to residential development.

1990s
The eastern portion of Lake Sammamish was included within the Urban Growth Boundary, putting increased pressure on the quality of water in the lake.

1991
Governments on Lake Sammamish set standards for lake quality.

Tiger Mountain State Forest and private forest lands comprise a significant part of the Issaquah Creek Basin.

Watershed Facts

Area	**170 square miles**
Basin Population	**196,450**
• Incorporated	86,315
• Unincorporated	110,135

N

0 2 4 6 Miles

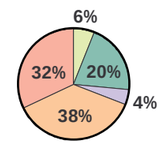
July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

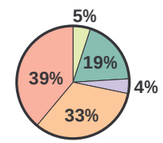
The Sammamish River/Lake Sammamish Sub-Watersheds

Challenges for Sammamish River and its Tributaries:

- How can we restore the fish habitat in the Sammamish River while maintaining existing levels of flood protection?
- How are we going to coordinate with Snohomish County in shared basins?
- How can we balance management of fish habitat with other local priorities?



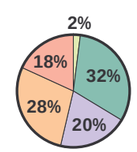
Existing Land Use



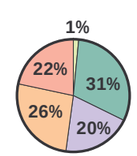
Future Land Use

Challenges for Lake Sammamish and its Tributaries:

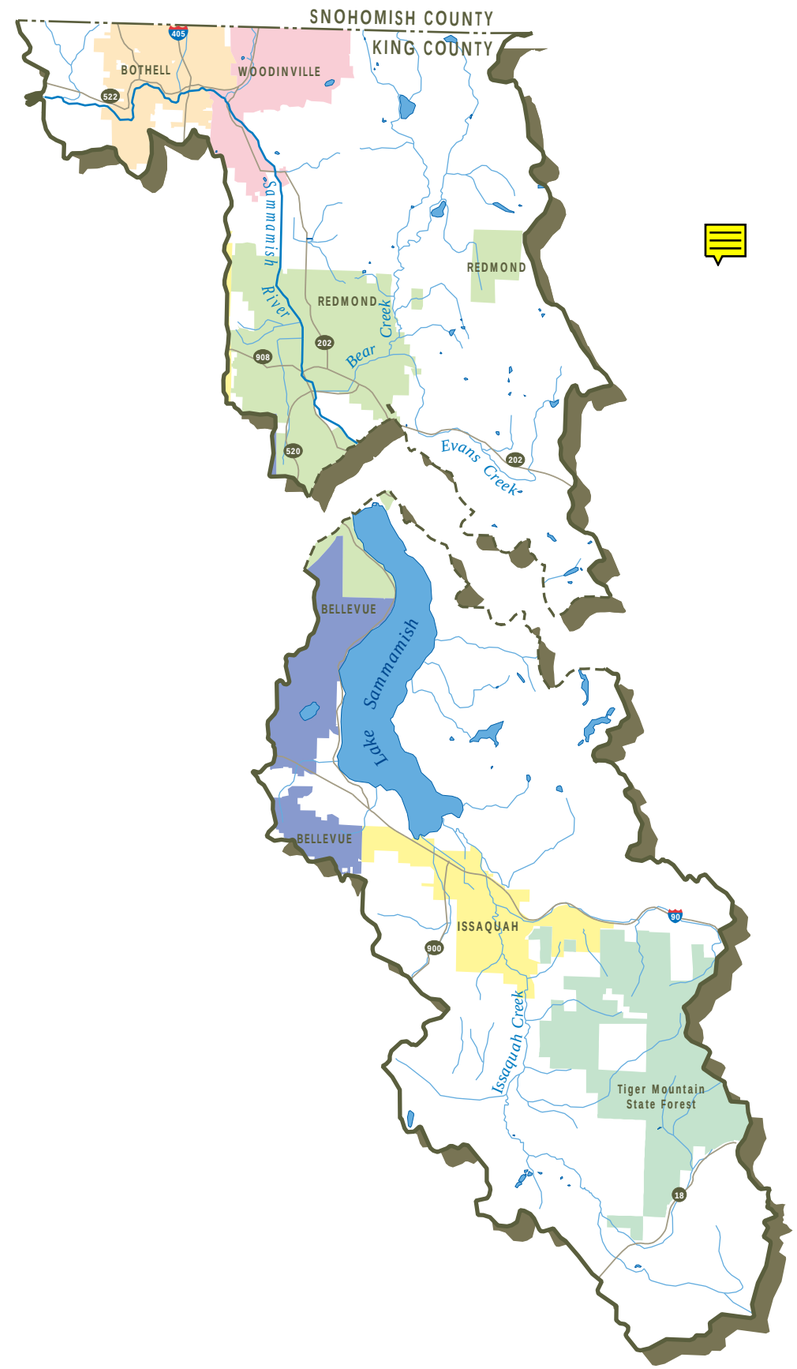
- How can we protect Lake Sammamish and productive stream systems and still meet our growth goals for this area?
- Is the management of Lake Sammamish a watershed issue or the responsibility of jurisdictions around the lake?
- How can we balance management of fish habitat with other local priorities?



Existing Land Use



Future Land Use



Land Use Categories

- Urban/Residential
- Rural
- Parks
- Forest
- Agricultural

N

0 2 4 6 Miles

July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

Map 9

The Sammamish River/Lake Sammamish Sub-Watersheds

Sammamish River and its Tributaries

The Sammamish River basins have experienced significant population growth in the last ten to fifteen years. This led to a decline in fish populations, loss of significant habitat, and degradation of water quality.

The mainstem of the Sammamish River was channelized in the early 1960s in an effort to control flooding and allow for increased use of land in the traditional floodplain. Focusing solely on flood control, the river was deepened and straightened, all bank vegetation was removed, and steep drop-offs were formed at the mouths of many side streams. The channelization effort severely impacted habitat within the river corridor and cut off tributary access for fish. While flooding problems have been substantially reduced, there are multiple opportunities to enhance fish habitat without diminishing flood protection. The *Sammamish Corridor Conditions and River Enhancement Opportunities* report, completed in December of 1993, outlines several opportunities for improving fish habitat and recreation while retaining flood protection. Limited funding is available for projects identified in the plan.

The Bear/Evans Creek system drains into the Sammamish River and is one of the major salmon producing streams in King County. The system has felt the impacts of development in the late 1970s and 1980s that degraded fish habitat and increased the incidence of flooding and erosion. The Evans Creek system, which supported significant salmon runs in the late 1970s, has few remaining salmon. The Bear Creek Basin Plan was completed in 1990. Funding is available for some high priority projects and conservation-focused land acquisitions. A large segment of the communities and jurisdictions that share the basin are actively involved in stewardship efforts and a full time basin steward has been working in the basin since 1991.

The Northern tributaries of the watershed are predominantly within Snohomish County. These basins experienced rapid development in the 1980s which led to a significant decline in salmon populations and a decrease in water quality. Two management plans, the Swamp Creek Watershed Management Plan and the North Creek Watershed Management Plan, have been developed to address these problems. Snohomish County is implementing these plans, and hired a basin steward in 1993. In King County, an additional basin steward assigned to the King County portions of all North Lake Washington basins is working with Snohomish County and local cities on cooperative watershed management.

Lake Sammamish and its Tributaries

This portion of the watershed contains highly urbanized areas, state and private forest lands around Tiger Mountain, rural lands south of Issaquah, and urbanizing areas around Lake Sammamish. It is in a state of transition that will result in significant conversion of forested lands to residential and commercial use. This conversion will put increased pressure on surface and groundwater resources.

Current problems in Lake Sammamish illustrate the challenges that we face. Phosphorus levels in the lake have continued to rise and are approaching the level where they could cause changes in water quality (eutrophication) that will result in a loss of habitat value, recreation uses, and lake aesthetics. A study of the lake shows that at projected levels of land development and in the absence of new mitigation efforts, the lake will become eutrophic. A strategy to address this problem is now being developed. Comprehensive management plans have also been completed for the East Lake Sammamish Plateau (*East Lake Sammamish Basin Plan*) and Issaquah Creek (*Issaquah Creek Basin Plan*), which drain to the lake.

The Issaquah/Tibbetts Creek system is typical of stream systems located in urbanizing areas. Overall, the system has good water quality and intact and productive stream and wetland habitats. Without adequate protection these habitats will degrade as forest lands are converted to residential and commercial uses. The Issaquah hatchery limits salmon from spawning in the upper reaches. However, juvenile salmon are planted throughout the basin.

There are significant flooding problems on Lower Issaquah Creek as it passes through the City of Issaquah. The resolution of these flooding problems will require major capital expenditures and regulation of future development in upstream areas.

Groundwater used by the City of Issaquah and the surrounding area is threatened by surface water contamination. In addition, future use of the aquifer could threaten minimum flows in productive salmon streams. The *Issaquah Basin Plan* has been completed and adopted. There is limited funding available for projects identified in the plan. A basin steward has been working in the Issaquah and East Lake Sammamish basins since 1992 to oversee plan implementation and support local jurisdictions and community groups.

The Skykomish/Snoqualmie (Snohomish) River Watershed

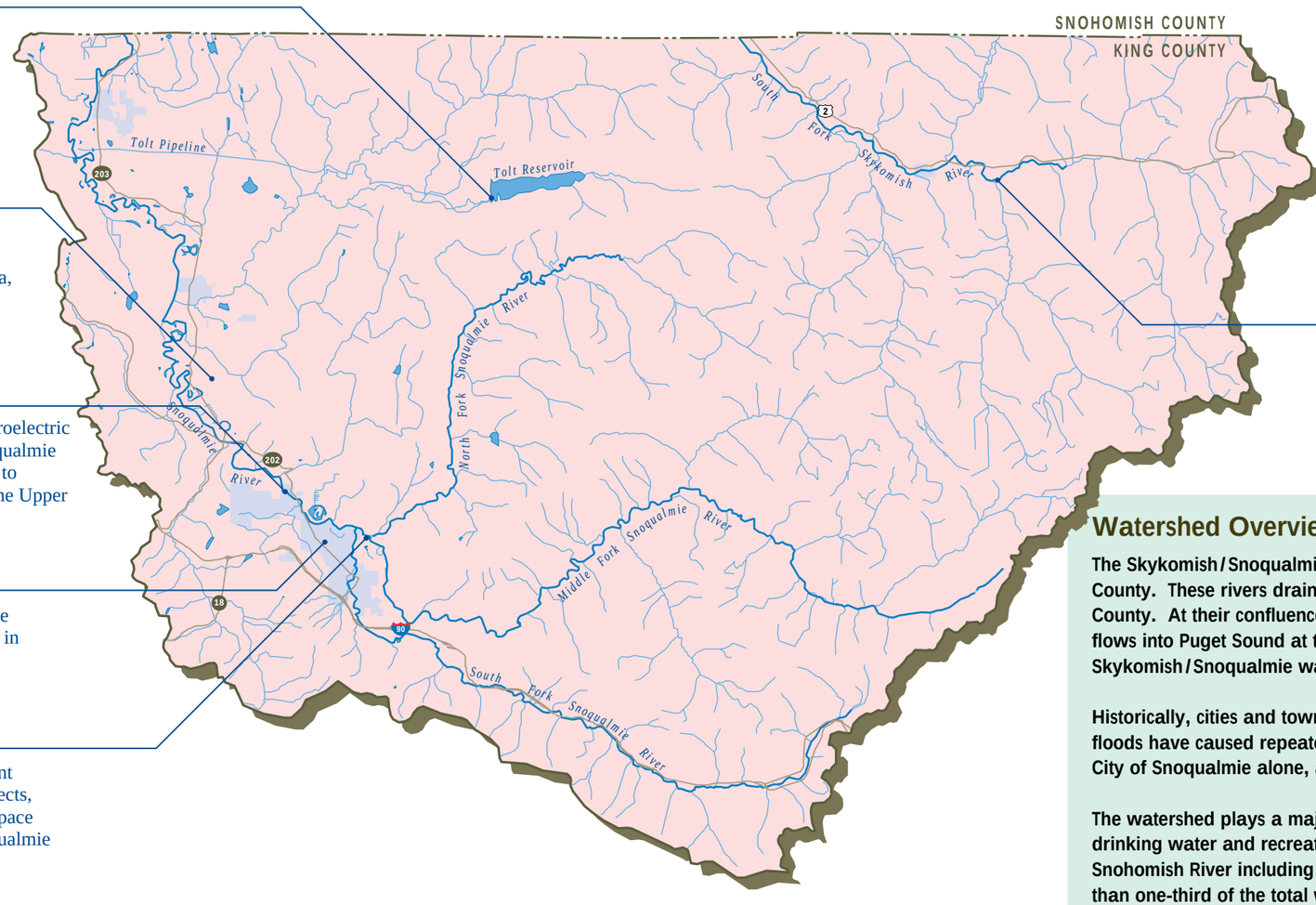
1960
Water supply dam built on the South Fork Tolt. The North Fork Tolt River has since been identified as a potential source of water for the Seattle Water Department.

1990
Floods caused two deaths, an estimated $30 million in damages in the Snoqualmie area, and the loss of hundreds of livestock in the lower Snoqualmie Valley.

1898
Puget Power constructed a hydroelectric dam at Snoqualmie Falls. Snoqualmie Falls acts as a natural blockage to anadromous fish passage into the Upper Snoqualmie.

1959
Floods in the Upper Snoqualmie damaged more than 700 homes in the cities of North Bend and Snoqualmie.

1978
Snohomish Mediated Agreement recommends flood control projects, floodplain land use, and open space acquisition, including the Snoqualmie 3-Forks area.



1977:
The Skykomish River was declared a "Scenic River" by the State of Washington, thereby prohibiting future construction of dams.

Watershed Overview

The Skykomish/Snoqualmie Watershed includes almost half of the land area in King County. These rivers drain from the crest of the Cascades northwest into Snohomish County. At their confluence, they come together to form the Snohomish River, which then flows into Puget Sound at the City of Everett. More than two thirds of the Skykomish/Snoqualmie watershed is in forest production or wilderness.

Historically, cities and towns were built in close proximity to the river. Recurrent winter floods have caused repeated damages to homes, businesses, roads and bridges; in the City of Snoqualmie alone, annualized flood damages are estimated at nearly $1 million.

The watershed plays a major role in the overall health of fish runs, and provides drinking water and recreational opportunities in the Puget Sound region. The Snohomish River including the Snoqualmie sub-watershed typically accounts for more than one-third of the total wild coho entering Puget Sound on an annual basis, as well as significant contributions to chinook, chum, and steelhead populations. Both the Skykomish and Snoqualmie sub-watersheds are heavily used for fishing, boating, hiking, and biking.

All of the Skykomish/Snoqualmie watershed is located outside King County's Surface Water Management Service Area, which means the surface water management service charges (typically $85 per residential parcel within the service area) are neither collected nor available to support services in the unincorporated areas. As a result, surface water management services are currently quite limited.

Watershed Facts

Area	**937 square miles**
Basin Population	**41,136**
• Incorporated	9,296
• Unincorporated	31,840

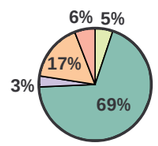
N

0 2 4 6 Miles

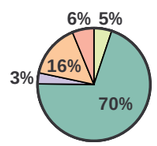
July 1995

Regional Needs Assessment for Surface Water Management

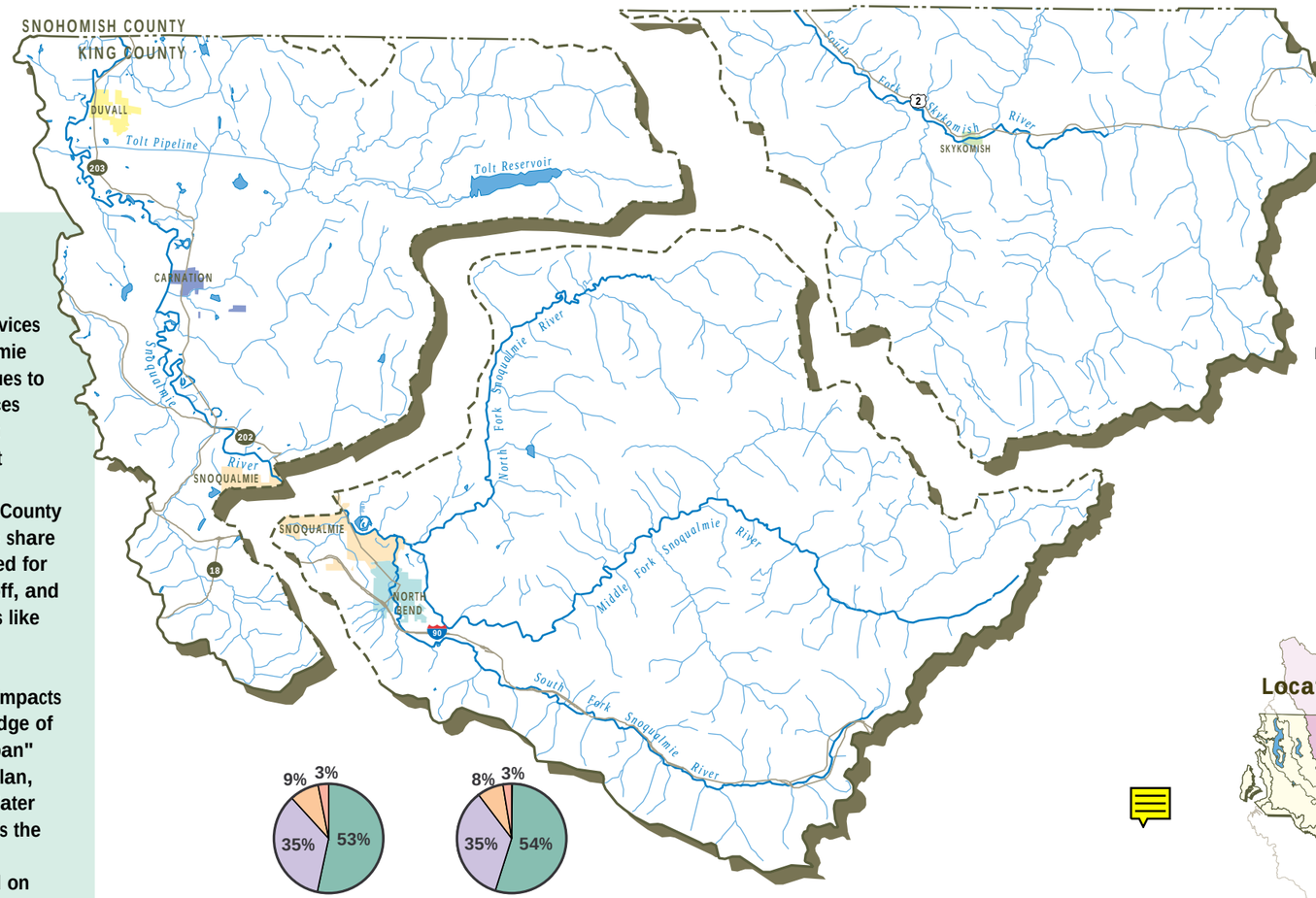
The Skykomish/Snoqualmie (Snohomish) River Sub-Watersheds

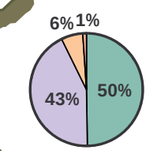


Existing Land Use



Future Land Use





Existing and Future Land Use

Challenges for the Lower Snoqualmie Sub-Watershed:

- Which surface water management services are most essential in the Lower Snoqualmie sub-watershed as the population continues to grow? (i.e.,what is the best mix of services given that this area will be developed at relatively low densities under the current County Comprehensive Plan)?
- What opportunities are there for King County and the cities of Carnation and Duvall to share technical expertise and equipment needed for managing wastewater, stormwater runoff, and review of development in sensitive areas like floodplains?
- What is the most effective strategy for addressing surface water management impacts in urbanizing areas along the western edge of the watershed that are classified as "urban" under the King County Comprehensive Plan, yet are outside King County's Surface Water Management service area (an example is the western edge of Patterson Creek)?
- How can jurisdictions continue to build on programs like Waterways 2000, to use tax incentives, community stewardship grants, and voluntary participation in open space preservation programs to enhance protection of fish habitat?
- How can jurisdictions better support efforts by farmers to meet requirements for stream buffers and fencing?
- How can jurisdictions work together to address flooding and water quality impacts that cross jurisdictional boundaries, particularly between King and Snohomish Counties?

Existing Land Use

Future Land Use

Challenges for the Upper Snoqualmie Sub-Watershed:

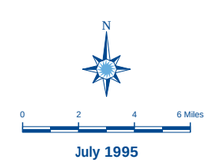
- How can the Cities of North Bend and Snoqualmie and King County accommodate population growth without exacerbating flooding?
- As the cities of North Bend and Snoqualmie continue to grow, how can stormwater management services and compliance with state and federal water quality mandates be carried out most efficiently?
- What opportunities are there for the county and cities to share equipment and technical expertise?
- How can the county and cities work together to leverage federal and state funds to implement flood hazard reduction projects?

Challenges for the Skykomish Sub-Watershed:

- How can forest harvest within King County be carried out in a manner that minimizes impacts on downstream flooding, water quality, and fish habitat?
- How can flood and erosion hazard maps and technical assistance in interpreting them be made locally available so that residents don't have to drive into Seattle?
- How can proposed improvements to Highway 2 be carried out in a manner that minimizes impacts on flooding, erosion, and fish habitat?

Land Use Categories

- Urban / Residential
- Rural
- Parks
- Forest
- Agricultural



July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

The Skykomish/Snoqualmie River (Snohomish) Sub-Watersheds

Lower Snoqualmie Sub-Watershed

The Lower Snoqualmie sub-watershed is one of King County's last remaining agricultural areas. It also is a major forest production area. While the Lower Snoqualmie sub-watershed is located almost entirely outside the Urban-Rural boundary line delineated by the King County Comprehensive Plan, the population is still projected to grow.

The Lower Snoqualmie Valley suffered major damage during the November 1990 floods; farmers in the valley lost hundreds of livestock. Key concerns raised by the flood included the impacts of development and flood control levees in neighboring Snohomish County and upland forest practices on flooding in the lower valley. Other areas with major flood and erosion damage include the Tolt and Raging Rivers, both of which are prone to dramatic movement of the river channel during flood events.

The Lower Snoqualmie sub-watershed plays a major role in the survival of Puget Sound fish stocks. The sub-watershed contributes to the Snohomish River wild coho runs, which typically comprise one-third of the total wild cohoentering Puget Sound on an annual basis.

Water quality concerns include fecal coliforms and low levels of dissolved oxygen in streams during the summer months, the need to provide wastewater treatment and water supplies for a growing population, and the impact of land uses on local groundwater supplies.

Upper Snoqualmie Sub-Watershed

Both the cities of North Bend and Snoqualmie were established in the floodplain of the Snoqualmie River. Flood damages to homes, businesses, roads and bridges have been severe. In the November 1990 floods, the South Fork Snoqualmie river experienced a flow of record, and overtopped its left bank levee in the City of North Bend. Floodwaters inundated two subdivisions and caused nearly $800,000 in damages. Numerous homes in and around the City of Snoqualmie were also damaged by Snoqualmie floodwaters. Approximately 80 homes were considered by city officials to be candidates for relocation or elevation because of severe damage.

Similar damages were experienced in unincorporated areas of the floodplain. The King County Flood Hazard Reduction Plan (adopted in 1993) estimated the cost of implementing high priority flood hazard reduction projects in the Upper Snoqualmie sub-watershed at over $20 million.

The Upper Snoqualmie is also faced with addressing wastewater treatment, stormwater management, and water quality protection needs for a growing population.

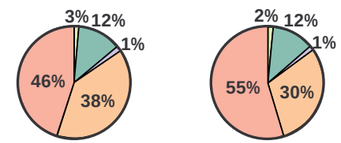
Skykomish Sub-Watershed

The South Fork Skykomish sub-watershed is one of the most beautiful and undeveloped watersheds in King County. The Skykomish River corridor has a "Scenic" designation from the State of Washington. A scenic corridor plan is currently under development. Development in the watershed is limited primarily to the narrow valley floor adjacent to the river and Highway 2. Land cover in the upland areas of the watershed is predominantly forest.

Preventing new development in flood and erosion hazard areas along the Skykomish has been complicated by a lack of maps delineating these hazard areas. King County is now completing flood hazard maps for the reaches of the South Fork Skykomish within King County. Another high priority is establishing a flood warning system for South Fork area residents and relocating homes that face the most extreme hazards.

A multijurisdictional, water resources planning effort was recently initiated for the Snohomish Basin, including the South Fork Skykomish and Snoqualmie Rivers within King County. The planning effort, which covers all of the Snohomish River Watershed, is modeled after the Chelan Agreement and pilot studies in the Methow and Dungeness/Quilcene Basins.

The White (Puyallup) River Watershed



Hylebos Creek
Existing Land Use

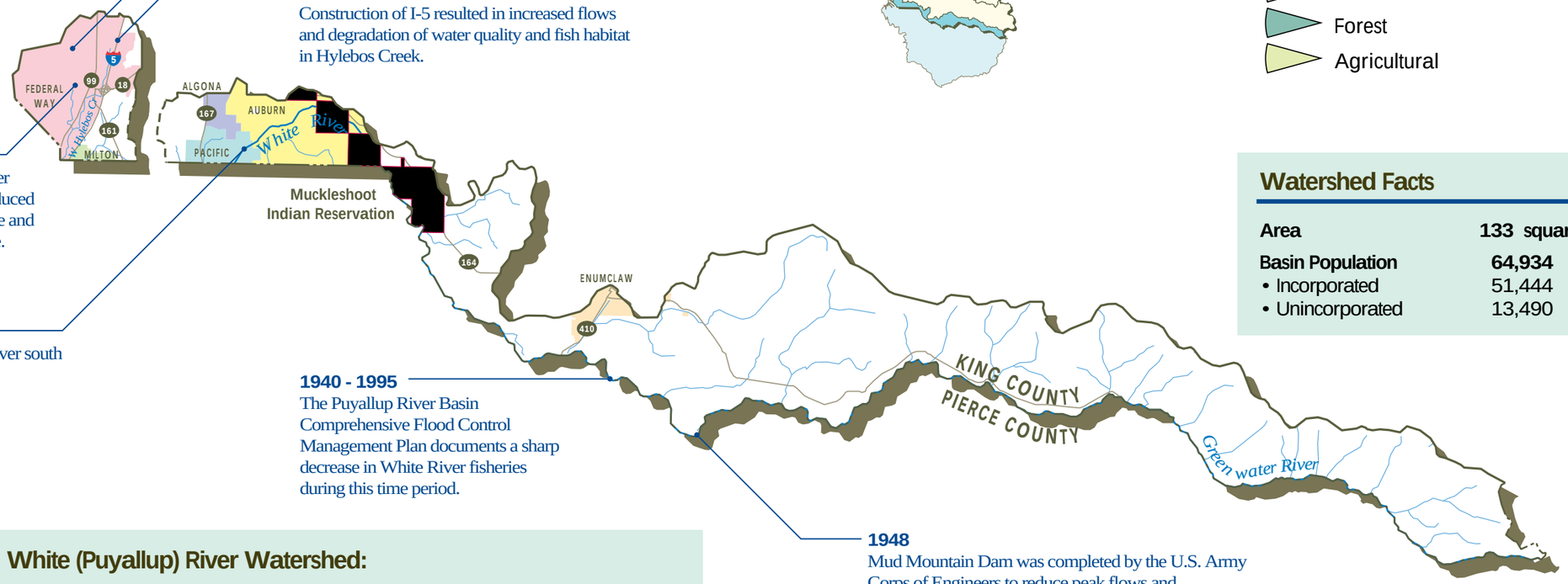
Hylebos Creek
Future Land Use

1988
Incorporation of the City of Federal Way has resulted in management of the majority of the Hylebos Creek sub-watershed by a single jurisdiction.

1962
Construction of I-5 resulted in increased flows and degradation of water quality and fish habitat in Hylebos Creek.

1994
Construction of the Panther Lake detention system reduced downstream flood damage and increased aquifer recharge.

1906
Diversion of the White River south into the Puyallup River.



1940 - 1995
The Puyallup River Basin Comprehensive Flood Control Management Plan documents a sharp decrease in White River fisheries during this time period.

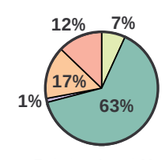
1948
Mud Mountain Dam was completed by the U.S. Army Corps of Engineers to reduce peak flows and downstream flood damage in the lower Puyallup River.

Land Use Categories

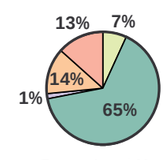
- Urban / Residential
- Rural
- Parks
- Forest
- Agricultural

Watershed Facts

Area	**133 square miles**
Basin Population	**64,934**
• Incorporated	51,444
• Unincorporated	13,490



Existing Land Use



Future Land Use

Challenges For White (Puyallup) River Watershed:

- The need for retrofits to existing levees and revetments far exceeds available funding resources. How should project needs be prioritized to achieve the greatest benefits for flood damage reduction and fish habitat restoration?
- How can jurisdictions along the White River work together to ensure that repairs to existing levees and revetments, as well as any new projects, are constructed to consistent standards?
- What improvements should be made to the flood warning system to better meet the needs of residents in the Red Creek and Greenwater confluence areas? If residents of these areas would like to pursue relocation or elevation of their homes, how can King County facilitate applications for federal flood hazard mitigation assistance?
- How can stewardship, protection and restoration opportunities be effectively supported and promoted in Hylebos Creek and the White River and important tributaries (e.g., the Greenwater River, Boise Creek)?
- As population in the Hylebos Sub-watershed and along the White River continues to grow, what opportunities are there for local and tribal governments to share technical expertise, staff, and / or equipment in managing stormwater and complying with water quality mandates?

N

0 2 4 6 Miles

July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

The White River (Puyallup) Watershed

Hylebos Creek

The majority of Hylebos Creek is located within the boundaries of the City of Federal Way. The cities of Milton and Tacoma, as well as small areas of unincorporated King and Pierce Counties, make up the remaining area. The creek flows south from King County into Pierce County and enters Commencement Bay through the Hylebos Waterway. As such, it is part of the U.S.E.P.A.'s Commencement Bay Superfund Clean-up Program. The basin includes 35 miles of streams, 11 named lakes, and numerous wetlands. The East Branch and West Branch Hylebos tributaries parallel Interstate 5 and State Route 99 respectively for much of their length. As a result of these and other roads, as well as rapid urban development in the last twenty years, the basin has experienced regional flooding and erosion problems as well as significant degradation of its water quality and fish habitat.

In September, 1993 the King County Council and the City of Federal Way adopted the Hylebos Creek Basin Plan and directed management approaches to correcting current and preventing future problems due to drainage, flooding, erosion, loss of fish habitat, and, to some extent, water quality degradation. The plan recommends a three part management strategy of regulations, programs, and capital facilities to be shared among the local governments and the Washington State Department of Transportation. Significant progress has been made towards implementating priority recommendations of this plan by King County, Federal Way, and the Department of Transportation. The West Hylebos Wetland, a regionally significant wetland located in the City of Federal Way, was dedicated in 1991 as a permanent state park preserve. This wetland provides a valuable refuge for plants and animals, as well as important storage for flood waters from upstream development.

The *Hylebos Creek/Lower Puget Sound Basin Plan* was the first systematically developed, comprehensive management plans for an urban stream in King County. The plan showed that the costs of restoration are very high, including more than $11 million of capital projects. Even if the plan is completely implemented, the aquatic systems in this basin cannot be fully restored.

White River

The White River rises on the northwestern slopes of Mount Rainier in Pierce County. From its entrance into King County at the southeastern corner of the County, to the City of Auburn, the river forms the border between King and Pierce Counties. The White River gets its name from the milky glacial runoff from Mount Rainier. The narrow half basin located within King County comprises less than six percent of the County's total land area. Over geologic time, high flows in the White have caused natural alternation of the river's course, changing the downstream confluence back and forth between the Puyallup and Green Rivers. It was permanently routed south into the Puyallup River at Auburn in 1914.

The White River is a major producer of salmonids. It supports White River spring chinook, a distinct stock not found in other basins. The Muckleshoot Indian Tribe operates the White River Hatchery for the purpose of restoring this stock, which is being considered for listing under the Endangered Species Act.

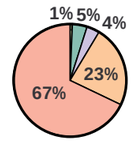
Flood hazards have been a concern in the White River throughout the twentieth century. Many of the existing levees and revetments along the lower stretches of the river were built by the Intercounty River Improvement District in the early 1900s. While these facilities have helped to protect homes and businesses along the river's banks, they have also degraded fish habitat. Most of the levees and revetments have steep concrete or rock facing, without any vegetation. In many cases, damage resistance and fish habitat could be greatly improved by reshaping the river bank, and replacing concrete or rock facing with a combination of native plants, rocks, and logs with root wads. Water quality problems in the watershed include high levels of BOD (biological oxygen demand) and total ammonia in the lower Puyallup River.

Some of the most severe flooding and erosion hazards to homes along the White River occur immediately below Mud Mountain Dam in the vicinity of the Red Creek confluence, and at the Greenwater River confluence. In response to requests from King County and local residents, the U.S. Army Corps of engineers has examined the potential for modifying dam operations to reduce flooding impacts to homes at Red Creek while meeting the original flood protection goals for the Puyallup. The Corps has concluded that dam operations can be modified to reduce, but not eliminate the flood threat in the Red Creek area.

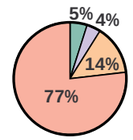
The Puget Sound Drainages

Challenges for the Puget Sound Drainages:

- How can we control flooding, erosion, sedimentation, and water quality in these highly urbanized basins?
- What impact is our surface water having on Puget Sound and what should be done to mitigate these impacts?
- How can local governments support the community groups working to protect and restore stream systems within these basins?



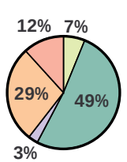
Existing Land Use



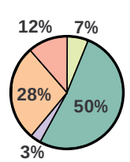
Future Land Use

Challenges for the Vashon Island Drainages:

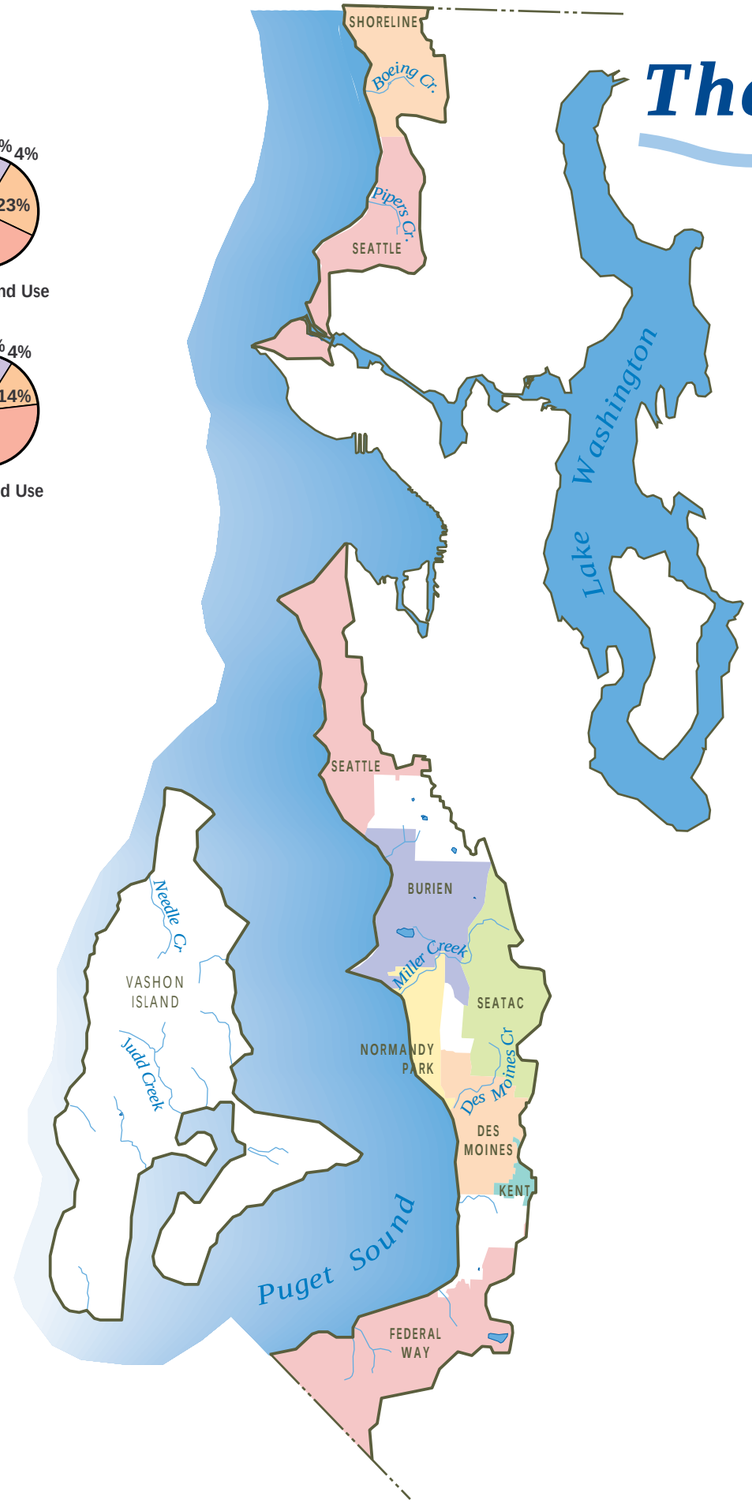
- How will King County address groundwater supply issues?
- What storm and surface water management services should be provided on Vashon Island?
- How can we support the community groups working to protect and restore stream systems within these basins?



Existing Land Use



Future Land Use



Land Use Categories

- Urban/Residential
- Rural
- Parks
- Forest
- Agricultural

Watershed Facts

Area	**92 square miles**
Basin Population	**273,413**
• Incorporated	217,476
• Unincorporated	55,937

N

0 2 4 6 Miles

July 1995

Regional Needs Assessment for SURFACE WATER MANAGEMENT

Puget Sound Drainages & Vashon Island

Vashon Island

Vashon Island is a predominantly rural island with multiple small drainages that empty directly into Puget Sound. These areas contain valuable streams and wetlands that provide fish, shellfish and wildlife habitat. Island community groups have worked to introduce coho salmon and protect cutthroat trout in many of the streams. Several hundred salmon were reported to have returned to Judd Creek this past year. Like the Puget Sound drainages, these systems do not support regionally significant numbers of fish, however, they are important locally and provide excellent educational opportunities and open space amenities.

Because of increased development and conversion of second and third growth forests, island residents are experiencing increased incidence of localized flooding problems that cause damage to property and roads. Due to the islands's rural characteristics, these flooding problems do not pose a major public safety threat. The island's rural character also accounts for the absence of any major nearshore contamination problems. Vashon Island residents are outside the King County Surface Water Management Division's service area. No comprehensive basin plan has been completed for the island's basins.

Water supply and protection of groundwater aquifers is a major concern for Vashon Island residents. Nitrates in surface water runoff are accumulating in some aquifers. Saltwater intrusion may become a major problem as aquifers are drawn down to meet rising demand. Forest conversion and development on the island increase the amount of runoff and decrease the amount of recharge water, threatening the groundwater recharge rate. A comprehensive groundwater management plan was completed in 1995 and is awaiting a decision on implementation.

Puget Sound Drainages

The direct Puget Sound drainages are small stream systems that drain highly urbanized areas. Many of the streams have been substantially altered through piping and channelization. In some cases, there has been a complete loss of fish habitat. The amount of urbanization in these basins has increased the level and frequency of storm flows, which have led to localized flooding, erosion, and sedimentation problems. As is typical of highly urbanized basins, the stormwater runoff contains high levels of heavy metals, oils, toxics, nutrients, bacteria, and sediment.

Historically these systems supported abundant fish populations. Today, many of the remaining streams still support small salmonid populations. Community-based efforts are underway in a number of basins to restore sections of the stream system and plant salmon within them. A well known success story is Pipers Creek in Seattle, where hundreds of chum salmon returned in 1994. While these systems do not support regionally significant numbers of fish, they are important locally and provide excellent educational opportunities and open space amenities. Selected basins have completed surface water plans which are being implemented.

The nearshore marine areas are impacted by stormwater runoff from the Puget Sound Drainages. Sediment loads and pollutants carried in the runoff adversely impact productive estuarine wetlands and beaches. These nearshore areas are important fish and wildlife habitat and are also used for wading, swimming, fishing, and shellfish harvest (despite signs posting closures). Pollutants in the nearshore areas are a potential health threat and degrade these valuable marine environments.

Salmon and Steelhead in King County Watersheds

Each year the Washington State Department of Fish and Wildlife (WDFW) and the Treaty Tribes work together to make an estimate of the numbers of salmon and steelhead that return to Puget Sound rivers to spawn. These estimates–called escapement–are based on catch statistics and survey data collected jointly by the WDFW and the Treaty Tribes. These estimates are shown for both wild* and cultured stocks of chinook, chum, and coho; and for wild* sockeye and steelhead. No data are collected for the Direct Puget Sound Drainages, although many of these systems have anadromous fish.

The pie diagrams on this map show the average annual estimates of various stocks (both wild* and cultured) returning to each of the King County watersheds for the four year period 1988-1991. The size of the pie diagram indicates the relative size of the run. These years include the most recent, complete data available at the time of Atlas publication for King County stocks. The estimates for the Lake Sammamish/Sammamish River Watershed are based on the proportion of each stock known to spawn in the Cedar River system since no separate escapements are calculated for this watershed.

**Wild estimates include all fish that spawn naturally.*

Regional Needs Assessment for SURFACE WATER MANAGEMENT

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0 4 8 12 Miles

July 1995

Local Areas and Assessed Values in King County Watersheds

Green / Duwamish River

11% Impervious Surface Area

	Percent of Total Area	Percent of Assessed Value
Algona	<1%	<1%
Auburn	3%	6%
Black Diamond	<1%	<1%
Des Moines	<1%	<1%
Enumclaw	<1%	1%
Federal Way	<1%	<1%
Kent	4%	13%
King County*	84%	29%
Renton	1%	5%
SeaTac	<1%	4%
Seattle	5%	31%
Tukwila	2%	8%

**Approximately 55% of this area (228 sq. miles) is within the City of Tacoma's water supply watershed.*

Cedar River / Lake Washington

18% Impervious Surface Area

	Percent of Total Area	Percent of Assessed Value
Beaux Arts	<1%	<1%
Bellevue	6%	5%
Bothell	<1%	<1%
Clyde Hill	<1%	<1%
Hunts Point	<1%	<1%
Kent	<1%	<1%
King County*	71%	13%
Kirkland	3%	6%
Lake Forest Park	<1%	1%
Medina	<1%	2%
Mercer Island	2%	5%
Newcastle	1%	<1%
Redmond	<1%	<1%
Renton	3%	4%
Seattle	13%	51%
Tukwila	<1%	<1%
Woodinville	<1%	<1%
Yarrow Point	<1%	<1%

**Approximately 50% of this area (128 sq. miles) is within the City of Seattle's water supply watershed.*

Sammamish River / Lake Sammamish

14% Impervious Surface Area

	Percent of Total Area	Percent of Assessed Value
Bellevue	4%	12%
Bothell	3%	6%
Issaquah	3%	5%
King County	78%	51%
Kirkland	<1%	<1%
Redmond	8%	21%
Woodinville	3%	5%

White (Puyallup) River

6% Impervious Surface Area

	Percent of Total Area	Percent of Assessed Value
Algona	<1%	3%
Auburn	6%	13%
Enumclaw	1%	6%
Federal Way	7%	52%
King County	84%	20%
Milton	<1%	<1%
Pacific	2%	5%

Skykomish / Snoqualmie (Snohomish) River

1% Impervious Surface Area

	Percent of Total Area	Percent of Assessed Value
Carnation	<1%	3%
Duvall	<1%	6%
King County*	99%	79%
North Bend	<1%	8%
Skykomish	<1%	<1%
Snoqualmie	<1%	4%

**Approximately 2% of this area (19 sq. miles) is within the City of Seattle's water supply watershed.*

Puget Sound

25% Impervious Surface Area

	Percent of Total Area	Percent of Assessed Value
Burien	7%	9%
Des Moines	5%	5%
Federal Way	11%	11%
Kent	<1%	<1%
King County	53%	14%
Normandy Park	3%	3%
SeaTac	7%	5%
Seattle	14%	53%

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Text will be made available in large Print, Braille, or audiotape as requested.