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OUR GREEN/DUWAMISH

PRELIMINARY BACKGROUND REPORT

June 2016

EXECUTIVE SUMMARY

OVERVIEW

Over the course of the last two centuries, in the Green/Duwamish Watershed, changing land uses, development, flood control measures, and pollution have significantly altered the river and lands it runs through. To address this, King County Executive Dow Constantine and Seattle Mayor Ed Murray created an initiative, *Our Green/Duwamish*, to develop strategies to strengthen communities and improve air, land, and water outcomes in Green/Duwamish Watershed. This initiative will increase coordination of current work at the local, state, and federal levels to manage habitat restoration, salmon recovery, flood control, public health, social equity, environmental cleanups, economic development, open space preservation, water quality and more.

The Preliminary Background Report is the first step in developing strategies to do this. This report is a working document, which provides a summary of current conditions and existing plans and programs active in the Green/Duwamish Watershed. The purpose of this document is to identify the work currently being done, gaps in activities in the watershed, consider approaches to address the gaps, and help support decision-making for *Our Green/Duwamish*. The report recommends additional air, land and water priorities that are needed to strengthen communities and create a healthy environment and quality of life for all.

BACKGROUND RESEARCH

Plans, guiding documents, policy reports, and GIS data were collected from more than one hundred collaborators, including tribal governments, city, county, and state departments, environmental non-profit organizations, active community groups, and the business/industrial community. In addition, in order to gather information from the community, the project team embarked on a Watershed Listening Tour. The purpose of the listening tour was to develop a more complete understanding of existing conditions, inventory current plans and initiatives, identify gaps in current work to conserve, restore, and protect air, land and water and identify opportunities to improve conditions in the watershed. The listening tour involved engagement with nearly one hundred residents, community leaders, subject area experts, government staff, and others actively involved in the watershed. The Preliminary Background Report synthesizes input from the Watershed Listening Tour.

In addition, the Watershed Advisory Group (WAG) was convened at the beginning of this project with the purpose to inform and help craft *Our Green/Duwamish* and watershed strategies to improve the health of the watershed. The WAG is made up of more than 40 representatives from environmental groups, community-based organizations, business leaders, trade unions, urban planners, public health organizations, regulatory agencies, tribes, and elected officials.

FINDINGS – GAPS & OPPORTUNITIES

After analyzing over ninety plan and program documents impacting the Green/Duwamish Watershed, forty-one key plans and programs were prioritized for review in greater depth. These documents were used to help identify gaps in watershed planning and opportunities for enhancement in the watershed.

Based on the background research, analysis of existing plans and programs affecting the watershed and direct input from individuals, agencies, organizations and governments, a list of 39 key concepts were identified. This list of 39 concepts reflect the most important current challenges and opportunities in the watershed.

RECOMMENDATIONS

A set of broad, preliminary recommendations were developed from the background research, analysis of community input, synthesis of gaps and opportunities and WAG input. These recommendations address the critical challenges identified within the watershed, as well as, key opportunities to improve health and well-being of the Green/Duwamish watershed overall. The recommendations are:

1. Create a watershed-wide stormwater management strategy to reduce priority toxic pollutants that impact human health and the environment. Consider innovative methods for improving and implementing stormwater programs, facilities, and infrastructure consistently across the watershed.
2. Develop a watershed-wide open space plan prioritizing areas that protect the most valuable open space, habitat, recreation lands and farmland. Strategies could focus on acquiring new, and enhancing existing lands for city, county and state parks, urban forestry, salmon habitat, water quality improvement, agriculture, recreation, trails and floodplain functions.
3. Integrate climate change resilience and preparedness activities to provide a stronger response to current and future conditions and build a more resilient landscape across the watershed.
4. Develop a strategy to improve air quality and reduce the incidence of air quality related health impacts across the watershed.

These recommendations may be further analyzed in the course of the next phases of *Our Green/Duwamish*.

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CHAPTER 1: INTRODUCTION

CALL TO ACTION

In September 2014, King County Executive Dow Constantine and Seattle Mayor Ed Murray announced a plan to develop a strategy to strengthen communities and reduce air and water pollution in the 500-square-mile Green/Duwamish Watershed.

Their vision was to better coordinate work already being done at the local, state, and federal levels to manage habitat restoration, salmon recovery, flood control, public health, waste site cleanups, economic development, open space preservation, and more.

While several agencies already oversee these priorities, the Executive and the Mayor understood the lack of a coordinated framework was a critical gap that needed to be bridged. That fall, Executive Constantine directed King County Department of Natural Resources and Parks to convene a watershed stakeholder advisory group comprised of elected officials, business leaders, trade unions, urban planners, regulatory agencies, environmental groups, community representatives and public health organizations.

Over the past 18 months, the group of over 40 people identified key priorities to build on the more than $1 billion already invested, or committed for investment, by King County and the City of Seattle for clean-up of the Green/Duwamish Watershed.

Their findings, which outline the current conditions in the watershed, serve as the foundation of this Preliminary Background Report. The purpose of this report is to examine the findings, and to highlight the actions and activities currently missing from planning efforts that could improve outcomes related to healthier air, land and water in the Green/Duwamish Watershed.

WHY A WATERSHED STRATEGY?

Over the course of the last two centuries in the Green/Duwamish Watershed, changing land uses, development, flood control measures, and pollution have significantly altered the river and valley it runs through. Within the watershed are dozens of programs, projects, regulations and techniques employed to reverse some of the negative impacts from the past and present to improve conditions for the people who live, work, and play in the watershed. Nevertheless, the watershed would benefit from a more coordinated strategy to provide stronger linkages between efforts, and identify important gaps that must be addressed to create a stronger overall community and watershed.

The watershed is not a series of isolated parts—river, uplands, habitats—it is one connected whole (Figure 1). The approach to protecting the entire watershed should be just as connected. Instead of tackling a single issue at a time, typically in response to a regulatory mandate or natural disaster the

approach is for Our Green/Duwamish to employ the wisdom of local communities, best available science and emerging technologies to link projects to outcomes for cleaner air, land, and water.

The Preliminary Background Report builds on the strong foundation of existing plans, analyses, knowledge, and on-the-ground programs and projects already exists (Figure 2), which enables a quick start to form the core of this project (e.g. the WRIA 9 Salmon Recovery Plan). The top objectives of Our Green/Duwamish will be to:

- Develop a vision and approach for addressing climate change and improving conditions to achieve the desired outcome of a cleaner, healthier watershed;
- Strengthen the linkages between the work already underway;
- Identify where current programs can be enhanced;
- Identify the high priority gaps in actions and funding that are needed to achieve the vision;
- Engage the multiple stakeholders, governments, tribes, and communities in the watershed;
- Provide opportunities for governments at all levels to work together as efficiently as possible;
- Build a coalition that is committed to making the actions and strategies a reality.

In this early phase to develop the Preliminary Background Report, King County partnered with the University of Washington Green Futures Lab (Green Futures Lab) to better understand current efforts in the watershed and identify where there are gaps and opportunities to holistically improve watershed conditions. The Green Futures Lab looked broadly at the work already being done by local, state, and federal agencies to manage toxic-site clean-ups, habitat restoration, salmon recovery, flood control and stormwater infrastructure, open space preservation, equity and social justice, and economic development. The research conducted by the Green Futures Lab consisted of the following:

1) Evaluation of current conditions and conservation and enhancement activities;
2) Analysis of gaps and opportunities with these activities; and
3) Engagement with individuals, agencies, organizations and governments.

PRELIMINARY BACKGROUND REPORT PURPOSE

This report is a working document, which represents a summary of existing air, land and water conditions and programs and plans in the Green/Duwamish Watershed. The information will be used inform the community about background conditions in the Green/Duwamish Watershed and help to support decision-making so that an action strategy can be developed.

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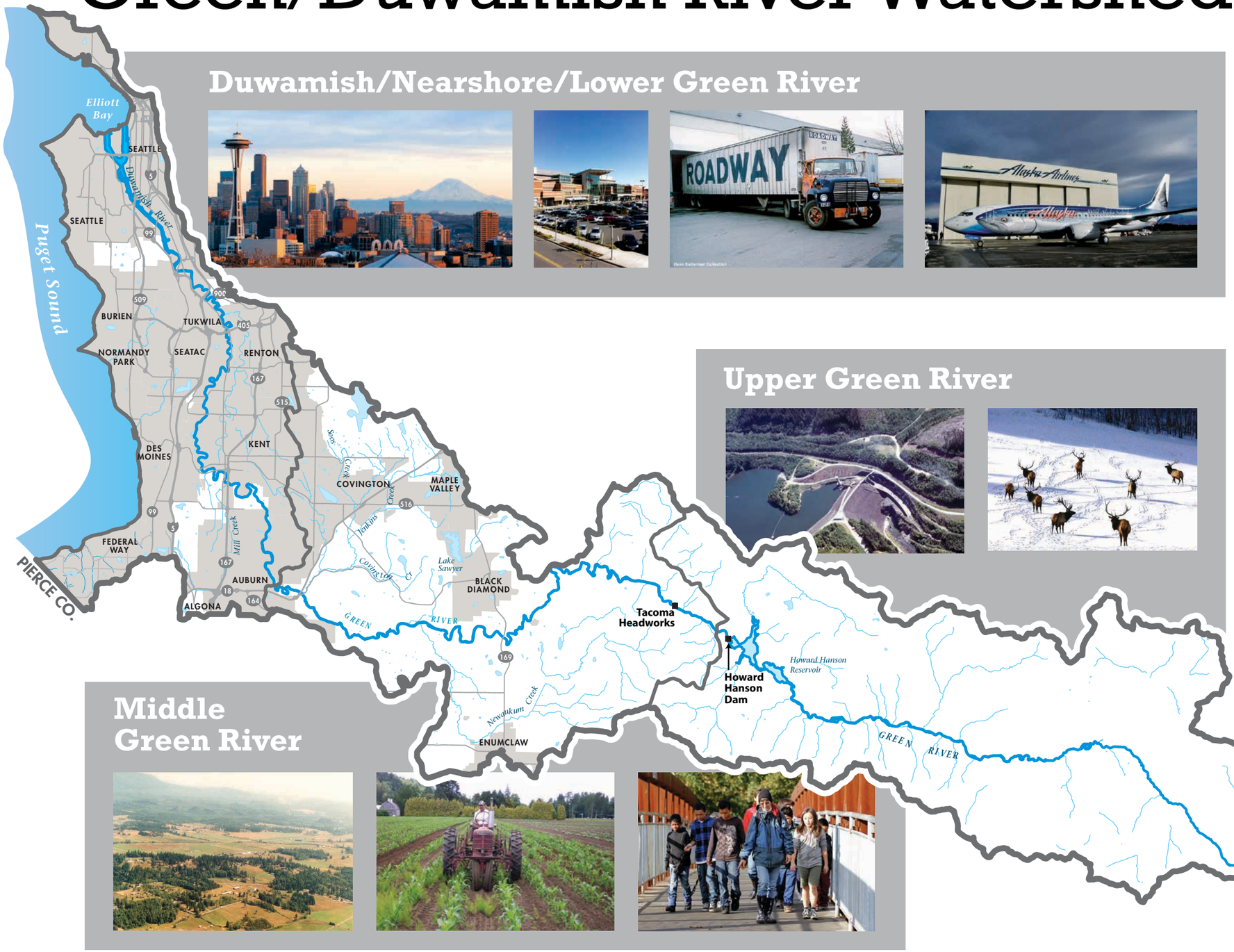
Figure 1

Green/Duwamish River Watershed



City of Seattle

King County

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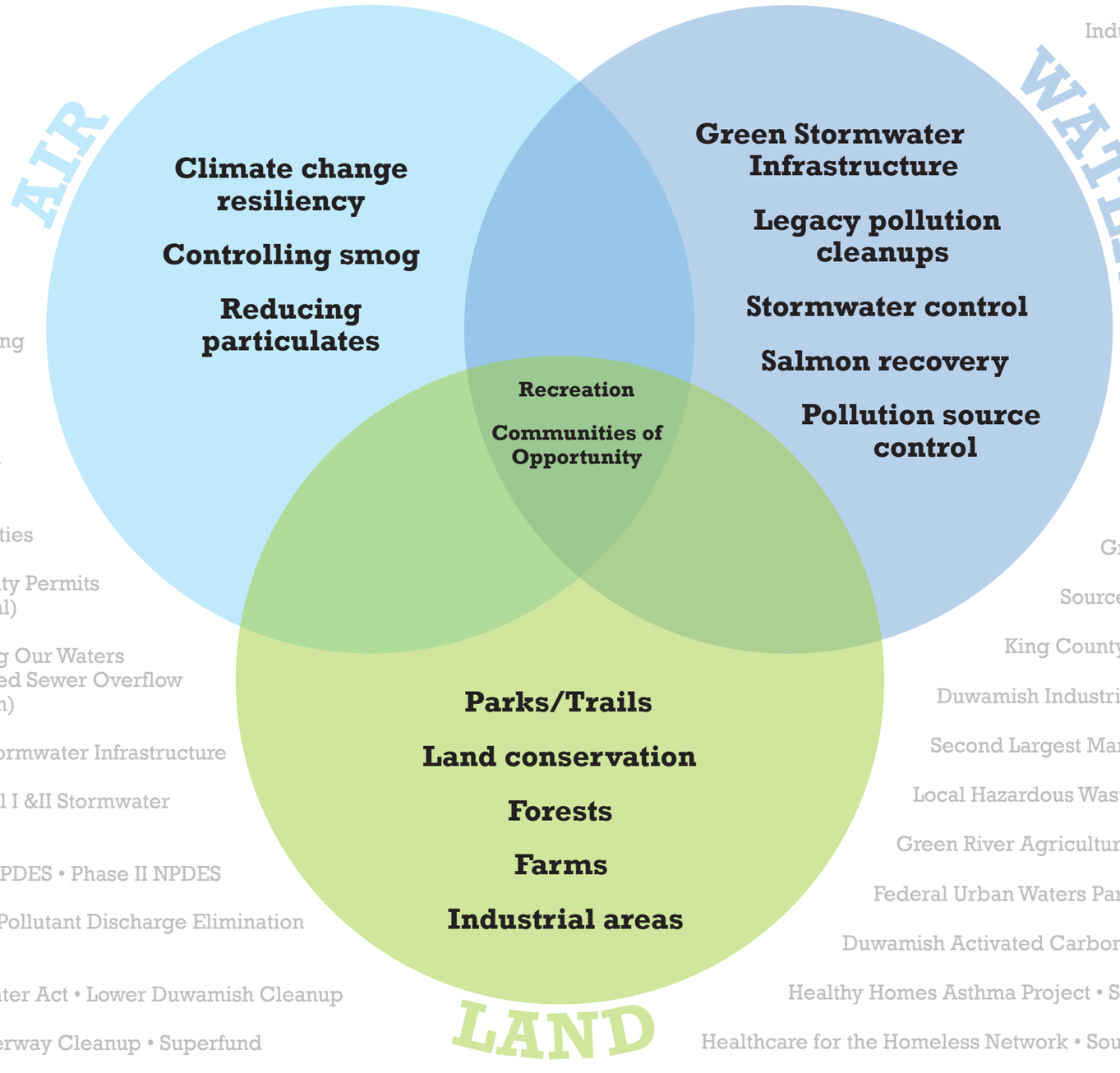
September 2014

Figure 2

Green/Duwamish Watershed Strategy

Geographically linking programs/projects to outcomes:



- **Improved Health**
- **Cleaner Air and Water**
- **Better Economy and More/Better Jobs**
- **More Open Space and Habitat**
- **Access to Recreation**

Confronting Climate Change – building resilient communities

Air Quality Permits (Industrial)

Protecting Our Waters (Combined Sewer Overflow Reduction)

Green Stormwater Infrastructure

Municipal I &II Stormwater permits

Phase I NPDES • Phase II NPDES

National Pollutant Discharge Elimination System

Clean Water Act • Lower Duwamish Cleanup

East Waterway Cleanup • Superfund

Industrial NPDES Permits

RainWise

Salmon Recovery – WRIA 9 plan update

The Salmon Habitat Plan for the Green/Duwamish and Central Puget Sound Watershed (WRIA 9)

Green River Systemwide Improvement Framework (SWIF)

U.S. Army Corps of Engineers • Howard Hanson Dam

King County Flood Control District

Ecology Water Quality Studies – toxic control strategies

Green/Duwamish Ecosystem Restoration Program

Source Control Working Group • Transportation Trails

King County Regional Trail System • Interurban Trail • Green River Trail • Soos Cr. Trail

Duwamish Industrial Center • King County Parks • Manufacturing/Warehouse Districts

Second Largest Manufacturing Center on the West Coast • Green Building

Local Hazardous Waste Management Program • US Forest Service

Green River Agriculture Production Districts • Communities of Opportunity

Federal Urban Waters Partnership • Most Diverse Population in King County

Duwamish Activated Carbon Study • King County Dirt Alert

Healthy Homes Asthma Project • Seattle & King County REACH Coalition

Healthcare for the Homeless Network • South Park Bridge

City of Seattle

King County

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Research Methods

The Green Futures Lab used the Regional Open Space Strategy (ROSS) approach, an effort to address the need to conserve and enhance open space systems that contribute to the ecological, economic, recreational and aesthetic vitality of our Central Puget Sound Region, for this project. The ROSS method looks at the Green/Duwamish watershed through the following categories:

- Biodiversity - an inclusive term for the ecological systems and environmental conditions that support the full range of native species, including human beings;
- Climate Change - mitigation through carbon sequestration and adaptation using measures such as flood hazard reduction;
- Social Equity - all people, regardless of race, color, ethnicity, age, gender, or ability, have the opportunity to benefit from the social, cultural, and spiritual aspects afforded by nature as well as the open space services as identified above;
- Economic Development - open spaces' contributions to the livability of our communities, the region's ability to attract investment and a talented workforce, support for the tourism and recreation industries, cost effective green infrastructure solutions for businesses and service providers, and the viability of agricultural and forest industries;
- Human Health - the benefits provided by clean air, land and water and active living opportunities.

Natural systems should be considered at the watershed scale, and effective efforts to enhance social equity and protect threatened resources, public health, and economic development will require inter-jurisdictional solutions. Comprehensive watershed-based strategies are the foundation of the ROSS approach.

Background Research

Plans, guiding documents, policy reports, and GIS data were collected from more than one hundred collaborators, including tribal governments, city, county, and state departments, environmental non-profit organizations, active community groups, and the business/industrial community. This work was conducted over the course of six months via email, phone, and in-person interviews with partners. Many of our collaborators also provided GIS data used to produce maps of existing conditions and activities taking place within the watershed. The literature review and analysis was simultaneously enhanced with contributions from the Watershed Advisory Group and the Watershed Listening Tour, described below.

Watershed Advisory Group

The Watershed Advisory Group (WAG) was convened at the beginning of this project with the goal of improving conditions comprehensively in the watershed across a spectrum of areas: social equity, human health, water quality, open space, land, air quality and economic development. The WAG brought together more than 40 representatives from environmental groups, community-

based organizations, business leaders, trade unions, urban planners, public health organizations, regulatory agencies, tribes, and elected officials. Their role was and continues to be to inform and help craft the Green/Duwamish Watershed Strategy.

WATERSHED LISTENING TOUR

A Watershed Listening Tour aimed at gathering additional data and insight into the conditions within the Green/Duwamish Watershed, was conducted to gain input from organizations, interested parties and community groups active within the watershed. The listening tour consisted of three primary activities: partner & expert meetings; sub-watershed open houses; and an online web survey.

The objectives of the listening tour were to:

1. Develop a more complete understanding of conditions on the ground within the watershed;
2. Become aware of the existing plans and initiatives to maintain and restore healthy air, land and water in the watershed;
3. Identify the gaps in actions needed to conserve, restore, and protect air, land and water; and
4. Identify overlapping opportunities to most effectively maintain a healthy environment and quality of life for all.

The listening tours occurred over approximately four months (April - July 2015) and involved engagement with nearly one hundred residents, community leaders, subject area experts, government staff, and more.

PARTNER MEETINGS & EXPERT SESSIONS

The Green Futures Lab conducted partner and expert meetings throughout the duration of the listening tour. King County and Seattle staff and the Green Futures lab initially identified Partners and experts. In-person and phone conversations with these partners quickly led to identification of a much broader array of interested parties, and many of these individuals and organizational representatives were engaged throughout the WLT.

The Green Futures Lab organized and facilitated four focus groups that brought together experts across a range of organizations to share insights on activities in the Green/Duwamish Watershed. The respective focus groups addressed biodiversity, climate change, human health and social equity, and economic development. At the close of the series of focus groups, a better picture of how the watershed is currently performing and how conditions are poised to change over the coming decades became clearer.

OPEN HOUSES

The Green Futures Lab conducted three open houses that were aimed at bringing together community representatives and organizational staff to verify and augment information gathered so far. The open houses were held in three different geographies of the watershed. For the purposes

of gathering environmentally cohesive information across the watershed, the open houses were grouped into three geographic regions within the watershed:

1. The Marine Nearshore and Duwamish Estuary - the most socially diverse and heavily urbanized and industrialized areas;
2. The Lower Green – semi-urban and industrial communities;
3. The Middle and Upper Green - areas that are mainly rural communities, agriculture and timber production, recreational and water supply landscapes.

Findings from these open houses were refined and then used to characterize conditions and plans in this report, and to help generate the report recommendations for focus in Phase II of this project.

Web Survey/Online Exercise

In addition to the open houses, the research team administered a web survey for watershed stakeholders, partners, and interested constituents to help verify the findings to date. The web survey was intended to collect data and recommendations of a similar nature to the open houses, and served as a complement to those meetings. It was designed to reach people who were unable to attend one of the open houses, or who preferred to provide their input in an alternative format. The survey was available online for three weeks in July 2015 on the My Sidewalk platform. This was distributed to stakeholders and partner groups via email as well as via announcements at each open house. The questions and aggregate responses are included in Appendix A.

CHAPTER 2: CURRENT CONDITIONS IN THE WATERSHED

The Green/Duwamish watershed encompasses wild, rural, suburban and urban conditions. The upper reaches of the watershed include healthy forests and habitat that is home to native elk herds and other wildlife, while the middle portions of the watershed offer recreational opportunities, historic and active farmlands and thousands of acres of preserved open space and habitat. The suburban and urban areas are home to not only sizable residential communities but also some of the most important economic engines for King County and the entire state, including the second-largest warehouse district on the west coast and the Duwamish industrial manufacturing center (**Error! Reference source not found.**).

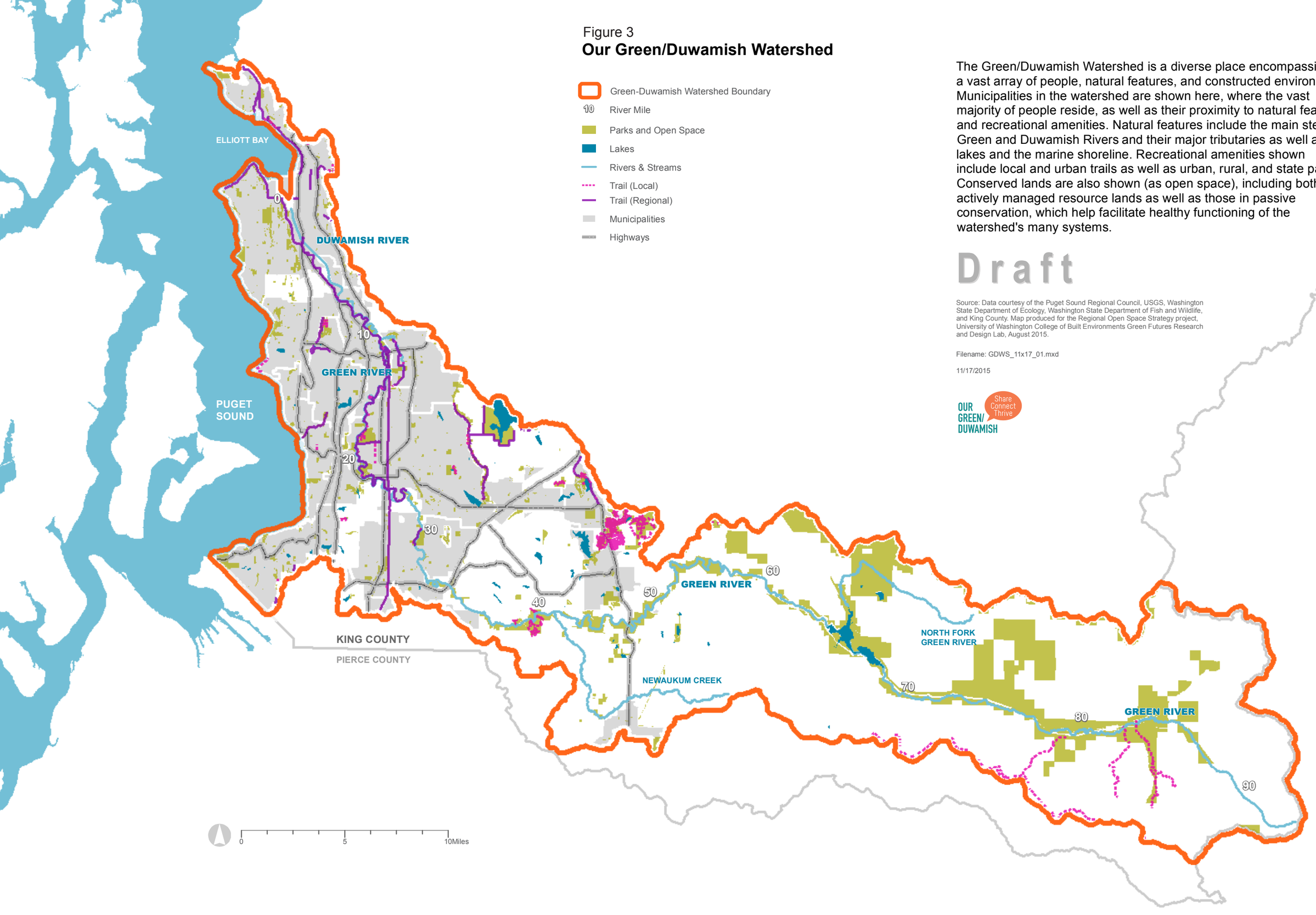
The abundance of this watershed's natural resources has long been recognized and tapped to support the local communities. Ancestors of all native people of Western Washington depended on fish, animal, and plant resources and traveled widely to harvest these resources. In the winter, when travel was difficult, they lived in villages along the watercourses in this watershed relying upon stored foods and local resources. In the summer, they dispersed throughout the watershed and moved to summer camps and resource gathering areas, where they joined with families from other winter villages in fishing, clamming, hunting, gathering, and other pursuits.

The watershed provides municipal drinking water and has provided timber and food for generations. Waterways of the Green/Duwamish have been used for recreation, commercial transport and even waste conveyance. After centuries of human settlement it is clear that these natural resources are not limitless and society's impact on the air, land and water can be found across the watershed. There are sites within the watershed that have been polluted or have impaired ecological functions, and some areas continue to receive harmful inputs. The land itself has been dramatically transformed over the past 100 years. Both human and wildlife habitat here have been significantly altered, with vegetation removal, hydrological modification to the rivers and their tributaries, and land converted to impervious surfaces no longer able to absorb and filter stormwater.

The combined effects of these changes are highlighted today by struggling salmon runs, legacy sediment contamination in the Lower Duwamish, health advisories on consumption of certain fish and shellfish, increased stormwater inputs, air quality challenges and the threatened status of various aquatic and terrestrial species in the watershed. Today's improvements in land development standards, stormwater management, contaminant cleanups and human behavior changes will shape the future of this watershed throughout the next century.

Figure 3

Our Green/Duwamish Watershed



The Green/Duwamish Watershed is a diverse place encompassing a vast array of people, natural features, and constructed environments. Municipalities in the watershed are shown here, where the vast majority of people reside, as well as their proximity to natural features and recreational amenities. Natural features include the main stem Green and Duwamish Rivers and their major tributaries as well as lakes and the marine shoreline. Recreational amenities shown include local and urban trails as well as urban, rural, and state parks. Conserved lands are also shown (as open space), including both actively managed resource lands as well as those in passive conservation, which help facilitate healthy functioning of the watershed's many systems.

Draft

Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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The following subchapters highlight current conditions in the Green/Duwamish in the following categories:

1. Geographic Setting
2. Population & Demographics
3. Physical & Natural Environment
    a. Air Quality Conditions
    b. Land Use and Land Conditions
    c. Water Conditions
4. Green Futures Lab ROSS Regional Challenges.

GEOGRAPHIC SETTING

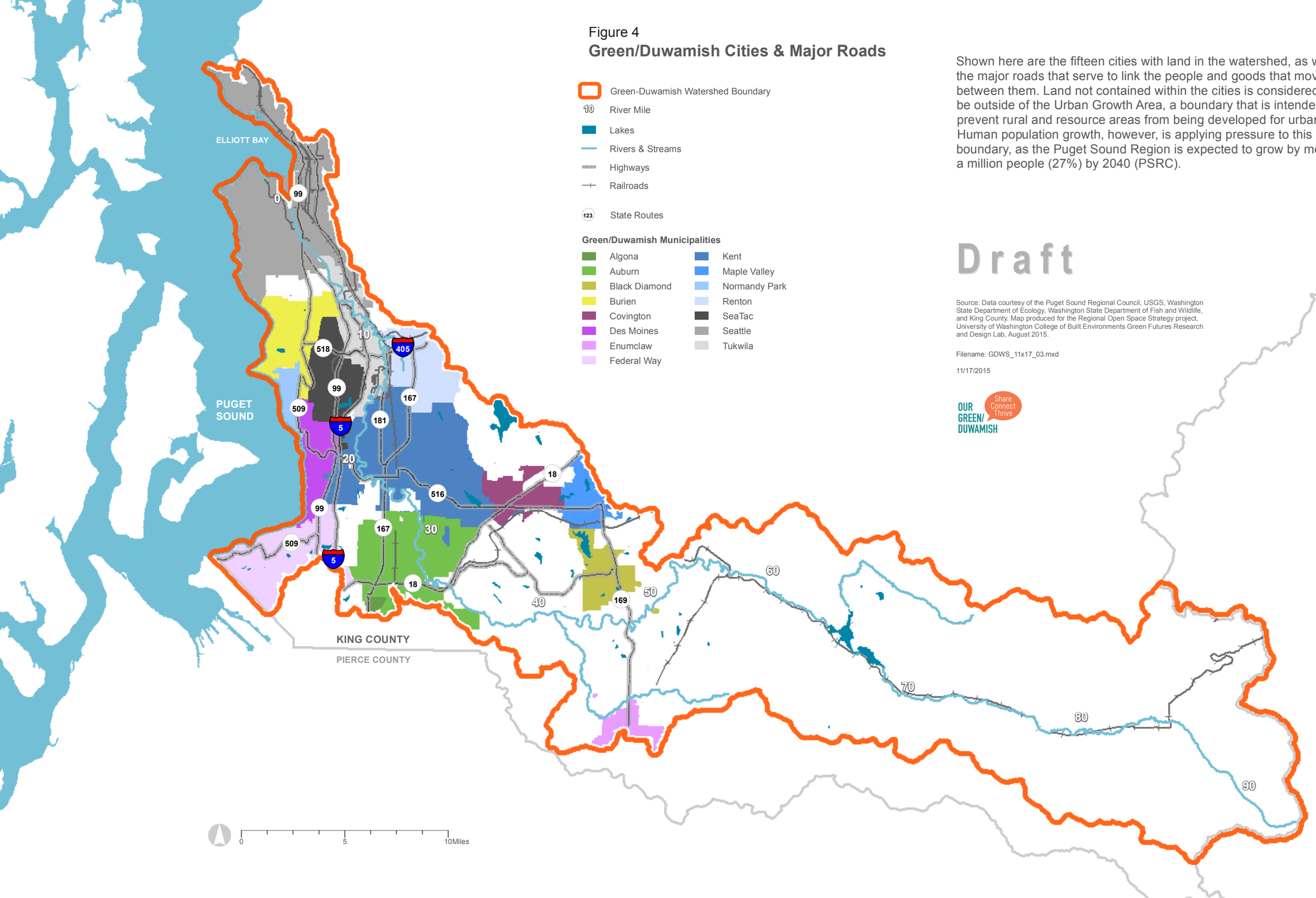
The Green/Duwamish Watershed is a 500-square mile drainage basin that stretches the length of King County's southern boundary. Making up roughly one quarter of the county's land area, this watershed is one of the most diverse in the Puget Sound region in terms of land cover and human activity, and it contains a river system that is the longest in the county. Its 95 miles of flow begin at the headwaters of the Green River, located less than a thousand feet east of the Pacific Crest Trail near Blowout Mountain, and roughly thirty miles northeast of Mount Rainier. For this project, Vashon and Maury Islands are not included in the watershed boundary. The five sub watersheds are the following: Marine Nearshore, Duwamish Estuary, Lower Green, Middle Green, and Upper Green.

The lands that comprise the Green/Duwamish Watershed in South King County cross multiple jurisdictions, which includes 15 cities, along with the central waterfront of Seattle, the Pacific Northwest's most populous city; hundreds of acres of tribal lands and waters; publicly and privately managed forest resource areas; and agricultural land (see Figure 4). The watershed is home to three state parks and Howard Hanson Dam, a major flood-control dam that includes a reservoir that serves as the primary drinking water source for the City of Tacoma.

Many of the municipalities within the watershed are expecting population growth and are planning land use changes to accommodate the influx, which may result in more dense and intensive land use patterns than what we see today. Climate change impacts in this region may exacerbate existing problems, such as the severity of urban heat islands, intensity of winter storms causing an increase in flooding, increased stream temperatures and the frequency of forest fires. In addition, issues, such as sea level rise that could inundate shoreline property and habitats. Under such conditions, population centers could shift as some neighborhoods become less habitable.

Figure 4

Green/Duwamish Cities & Major Roads



Green-Duwamish Watershed Boundary

10 River Mile

Lakes

Rivers & Streams

Highways

Railroads

123 State Routes

Green/Duwamish Municipalities

- Algona
- Auburn
- Black Diamond
- Burien
- Covington
- Des Moines
- Enumclaw
- Federal Way
- Kent
- Maple Valley
- Normandy Park
- Renton
- SeaTac
- Seattle
- Tukwila

Shown here are the fifteen cities with land in the watershed, as well as the major roads that serve to link the people and goods that move between them. Land not contained within the cities is considered to be outside of the Urban Growth Area, a boundary that is intended to prevent rural and resource areas from being developed for urban uses. Human population growth, however, is applying pressure to this growth boundary, as the Puget Sound Region is expected to grow by more than a million people (27%) by 2040 (PSRC).

Draft

Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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POPULATION &DEMOGRAPHICS

The Green/Duwamish Watershed is home to nearly three quarters of a million people, and this number is growing every year. Between 2000 and 2010, 70,000 people moved to South King County (Felt, 2012). The vast majority of the watershed's total population resides in its lower reaches, the Lower Green, Duwamish Estuary, and Nearshore subwatersheds. The Middle and Upper Green subwatersheds are more rural in character, with fewer than one hundred people inhabiting the entirety of the land in the Upper Green. Though these areas do not exhibit characteristically "urban" population growth, projected growth for the region predicts that these suburban and rural towns may transition into semi-urban or urban areas within several decades, particularly in the Middle Green subwatershed. Figure 5 shows the population density of the Green/Duwamish for each census tract.

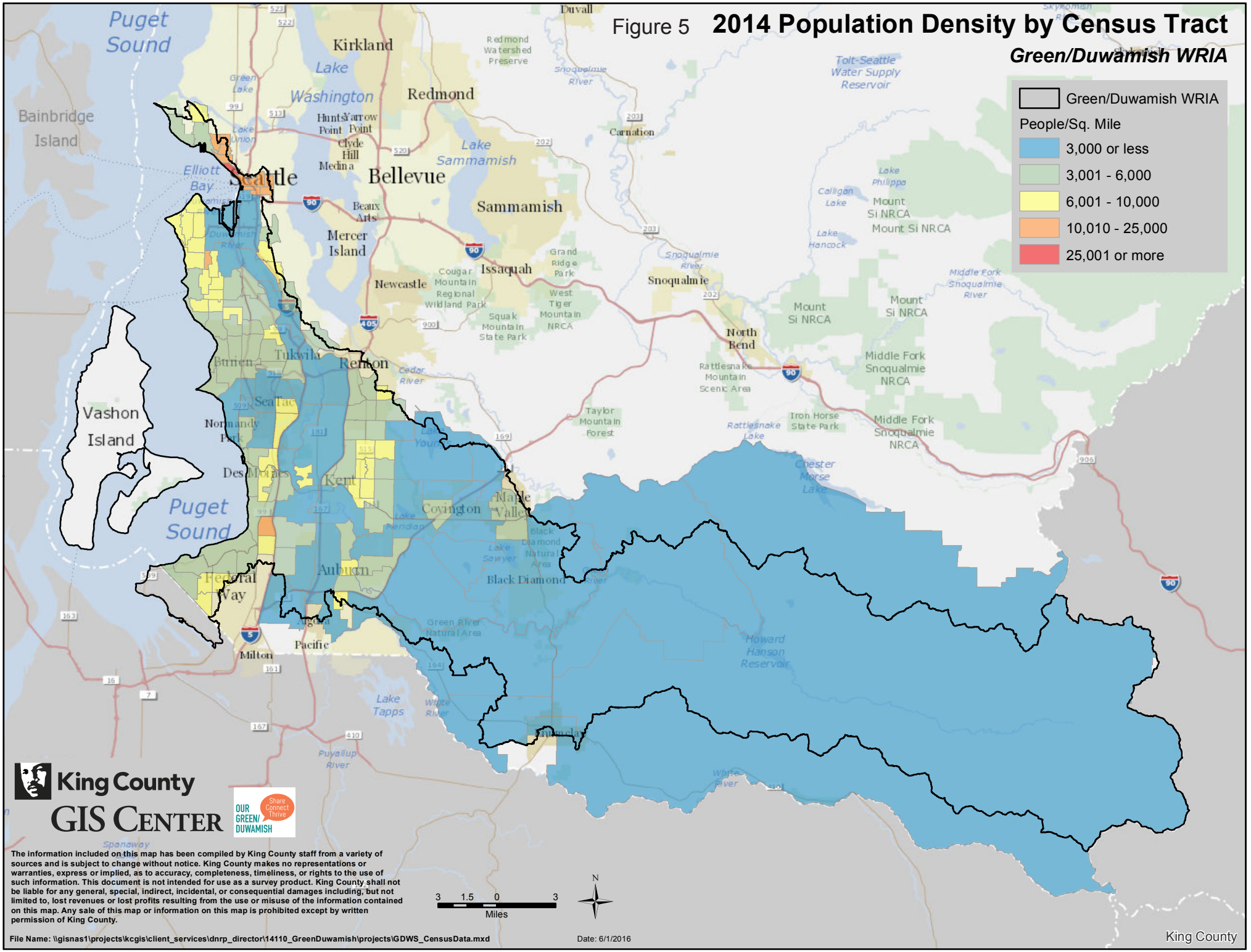
Some of the most diverse communities of people in Washington State reside here. More than 170 different languages are spoken in King County, with one quarter of the population proficient in a language other than English. Although the Green/Duwamish Watershed holds only 34 percent of the total population of the county, 42 percent of the County's total population of people of color (Figure 6), and 53 percent of the County's total population of Latinos live in this watershed. Further, between 1990 and 2010 the population growth of people of color in South King County has continued to grow while white populations decline.[i]

While there is astounding richness of human, as well as, ecological diversity in the Green/Duwamish Watershed, there are equity and social justice concerns that may require intervention. The 2010 census data shows that of the more than 700,000 people residing in the watershed, 12 percent live in poverty (Figure 7), 8.52 percent are unemployed, and rates of poverty and joblessness among people of color are much higher. The average median household income in 2010 was estimated at $63,525 in the Green/Duwamish watershed compared to $71,811 for King County as a whole.

King County is the fastest growing county in Washington State and populations are expected to continue growing over the next 25 years (State of Washington, 2012, 48). In 2014, the County's population was estimated to be 2,079,967 (U.S. Census Bureau, 2015), although by 2040 it is projected to reach 2,418,850 primarily due to migration (State of Washington, 2012, 48). South King County will continue to grow along with the rest of the county, putting stress on aging infrastructure in the region as well as creating tensions between new development and preserved open space.

Figure 5 **2014 Population Density by Census Tract**

Green/Duwamish WRIA



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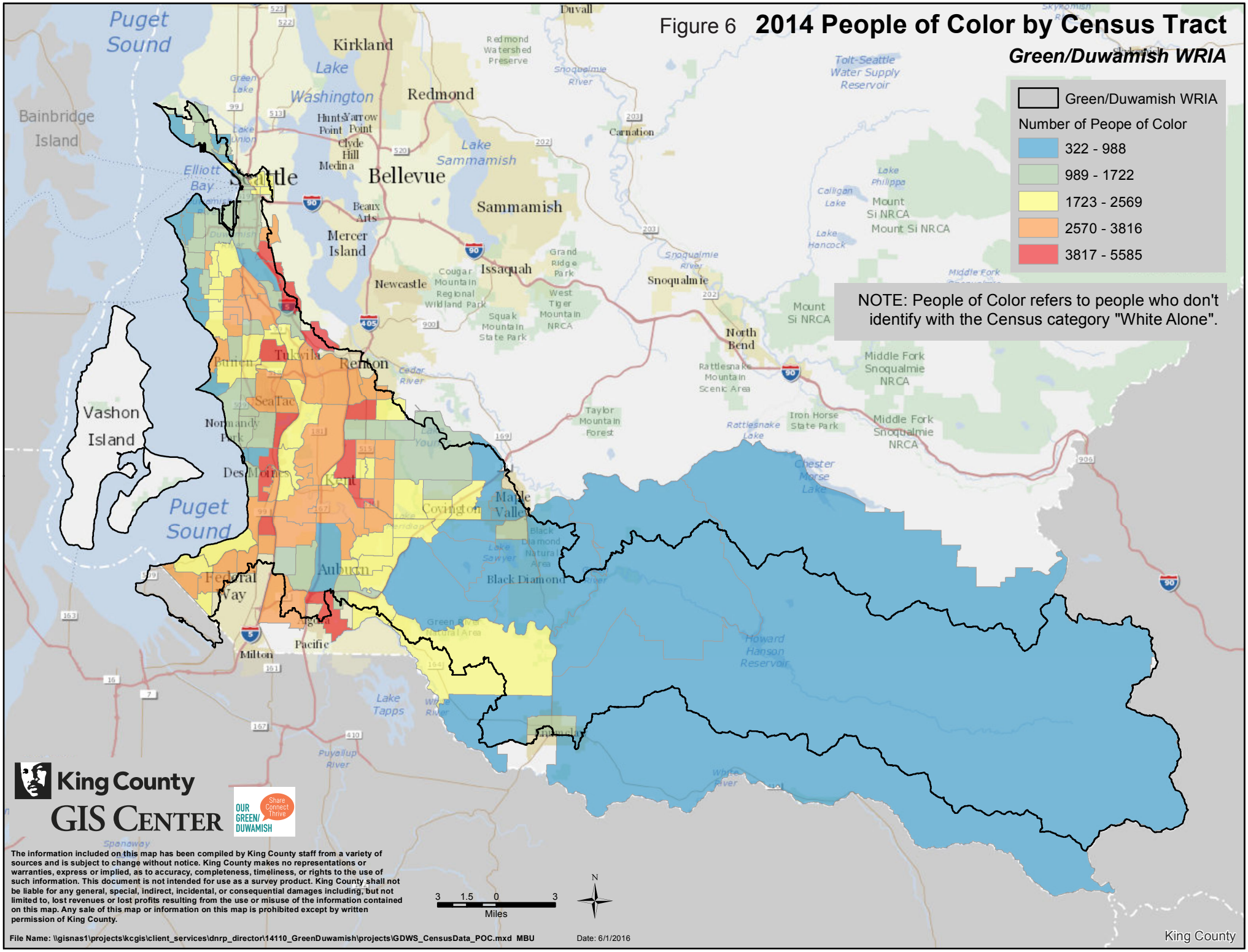
Figure 6 2014 People of Color by Census Tract
Green/Duwamish WRIA
Green/Duwamish WRIA
Number of Peope of Color
322 - 988
989 - 1722
1723 - 2569
2570 - 3816
3817 - 5585
NOTE: People of Color refers to people who don't identify with the Census category "White Alone".
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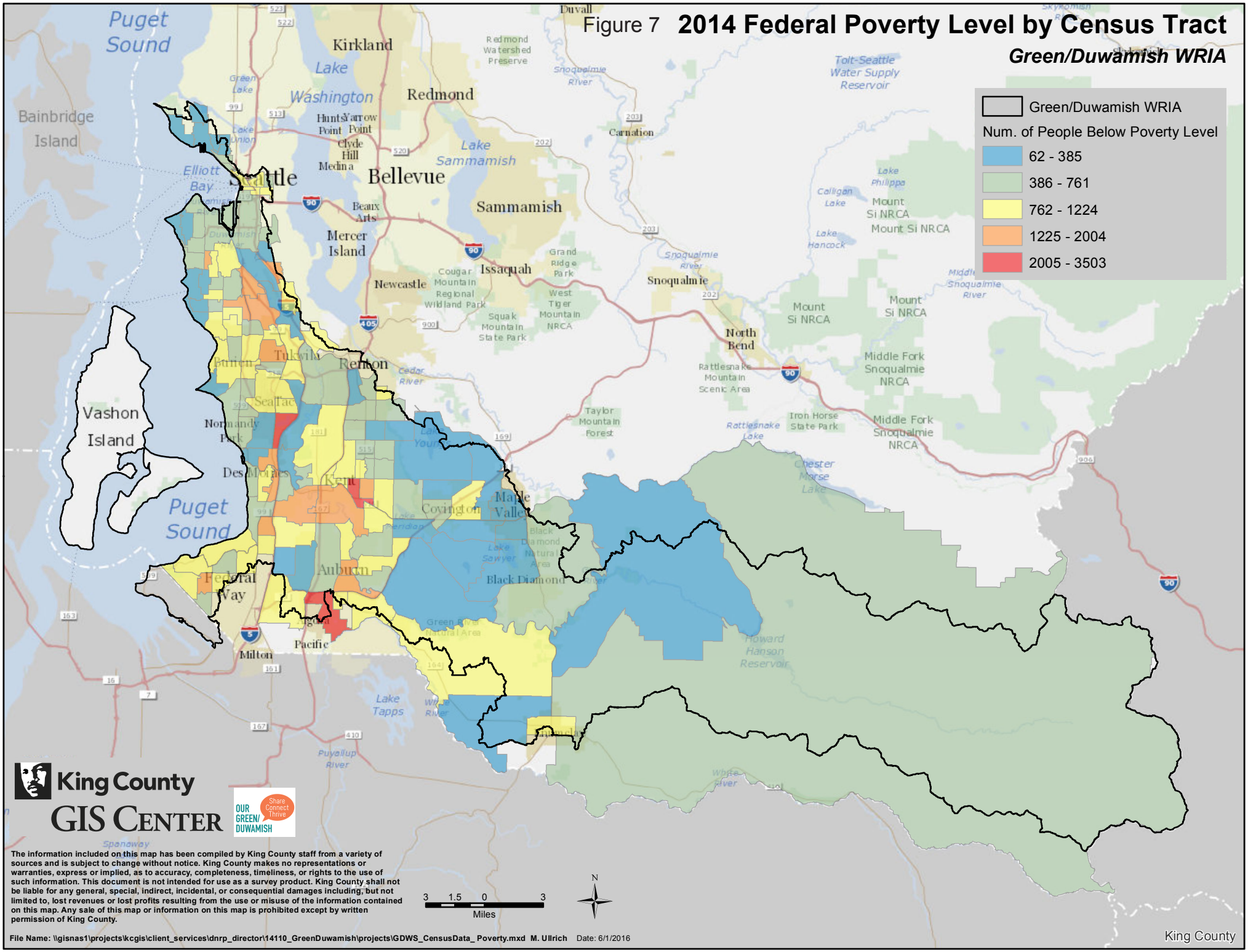
Figure 7 2014 Federal Poverty Level by Census Tract

Green/Duwamish WRIA



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King County

PHYSICAL & NATURAL ENVIRONMENT

The Green/Duwamish Watershed covers an impressive topographic gradient, starting around 5,600 feet above sea level, at the headwaters of the Green River, and then tumbling down to sea level at the Duwamish Estuary. Five ecoregions or subwatersheds piece together across the land area of the watershed, from the Central Puget Lowlands at the mouth of the Duwamish River, to Western Cascades Montane Highlands at the Green River's headwaters to the southeast (see Figure 8). Landscape characteristics within the watershed include steep-walled valleys and heavily forested terrain in the Upper Green, boulders and rock shelves, a broad lowland valley through which a channelized river passes, and a highly engineered estuary. The lower 26 miles of the river has been extensively modified, straightened and contained with levees, revetments, and floodwalls. Major streams draining to the Green River include Newaukum, Soos, Springbrook, and Mill Creeks.

AIR QUALITY CONDITIONS

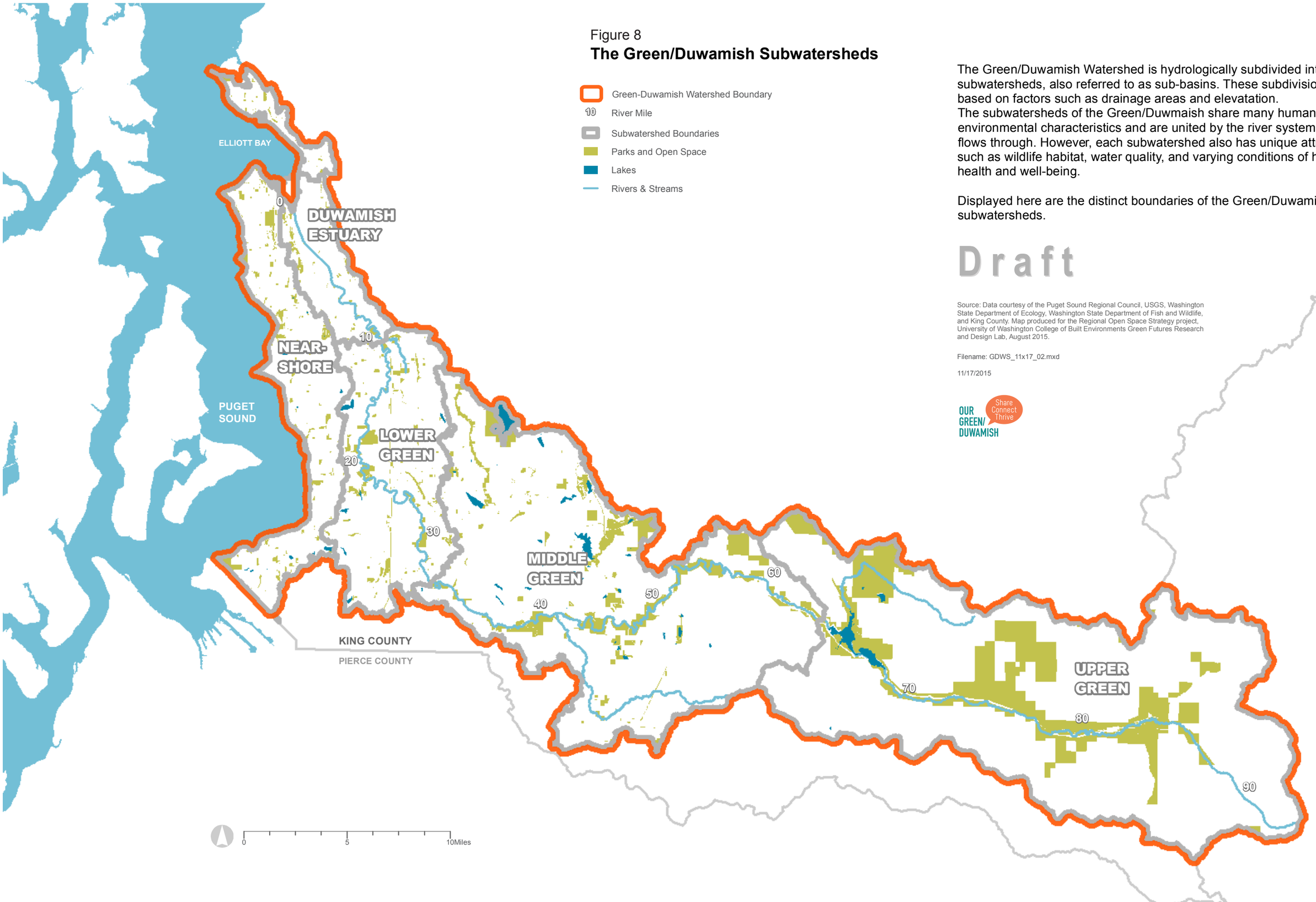
The Puget Sound Clean Air Agency (PSCAA) serves to protect public health, improve neighborhood air quality, and reduce the Puget Sound region's contribution to climate change in the King, Snohomish, Pierce and Kitsap counties. PSCAA assessed which communities in its four-county area are highly impacted by air pollution or have residents who suffer other health inequities and have barriers to addressing those issues. Across the four counties, the watershed contains seven of the top 10 most impacted communities and for King County, nine of the top 10 most impacted (see Figure 9). The table below shows the communities that are most impacted. PSCAA developed criteria to determine a score (Table 1) that identified the areas of highest disproportionate impact. The general criteria for equity were as follows[ii]:

- Diesel pollution (onroad and nonroad)
- Household income
- Health sensitivity – i.e. individuals who suffer from asthma, chronic pulmonary obstructive disease (COPD), or cardiac illness
- Industrial density – large and small air pollution sources
- Race
- Limited English proficiency
- Primary wood burning households.

Within the Green/Duwamish watershed, there are four major air quality issues that impact the people and communities. The first major issue related to air quality in the watershed is exposure to airborne toxics and fine particulate pollution to people living near major roadways and in communities with significant wood burning for home heating. In particular, residents near major goods movement/transportation corridors or facilities are exposed to significantly higher levels of the more toxic diesel particles. Particles from wood and diesel combustion contain harmful pollutants like polycyclic aromatic hydrocarbons (PAHs) that can also deposit on land surfaces and collect in rivers and water bodies.

Figure 8

The Green/Duwamish Subwatersheds



The Green/Duwamish Watershed is hydrologically subdivided into five subwatersheds, also referred to as sub-basins. These subdivisions are based on factors such as drainage areas and elevatation.
The subwatersheds of the Green/Duwmaish share many human and environmental characteristics and are united by the river system that flows through. However, each subwatershed also has unique attributes such as wildlife habitat, water quality, and varying conditions of human health and well-being.

Displayed here are the distinct boundaries of the Green/Duwamish subwatersheds.

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Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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TABLE 1 - PSCAA STUDY - IMPACTED COMMUNITIES (NOTE:* DENOTES COMMUNITIES WHO SHARE THE SAME RANK/SCORE WITH AT LEAST ONE OTHER COMMUNITY)

KING COUNTY		
Rank	**Score**	**Community**
1	20.7	Tukwila/Allentown
2	19.3	Tukwila/Kent (Midway)
3	18.7	White Center/Greater Duwamish
4	18.5*	Algona/Auburn
4	18.5*	International District
4	18.5*	Des Moines
4	18.5*	SeaTac
8	18.3	Southeast Seattle
9	17.7*	Kent
9	17.7*	Central District
11	16.3	Northgate
12	15.7	Factoria
13	15.2	Renton
14	14.5	Federal Way
15	13.7	Wilburton
16	13.2	Kingsgate

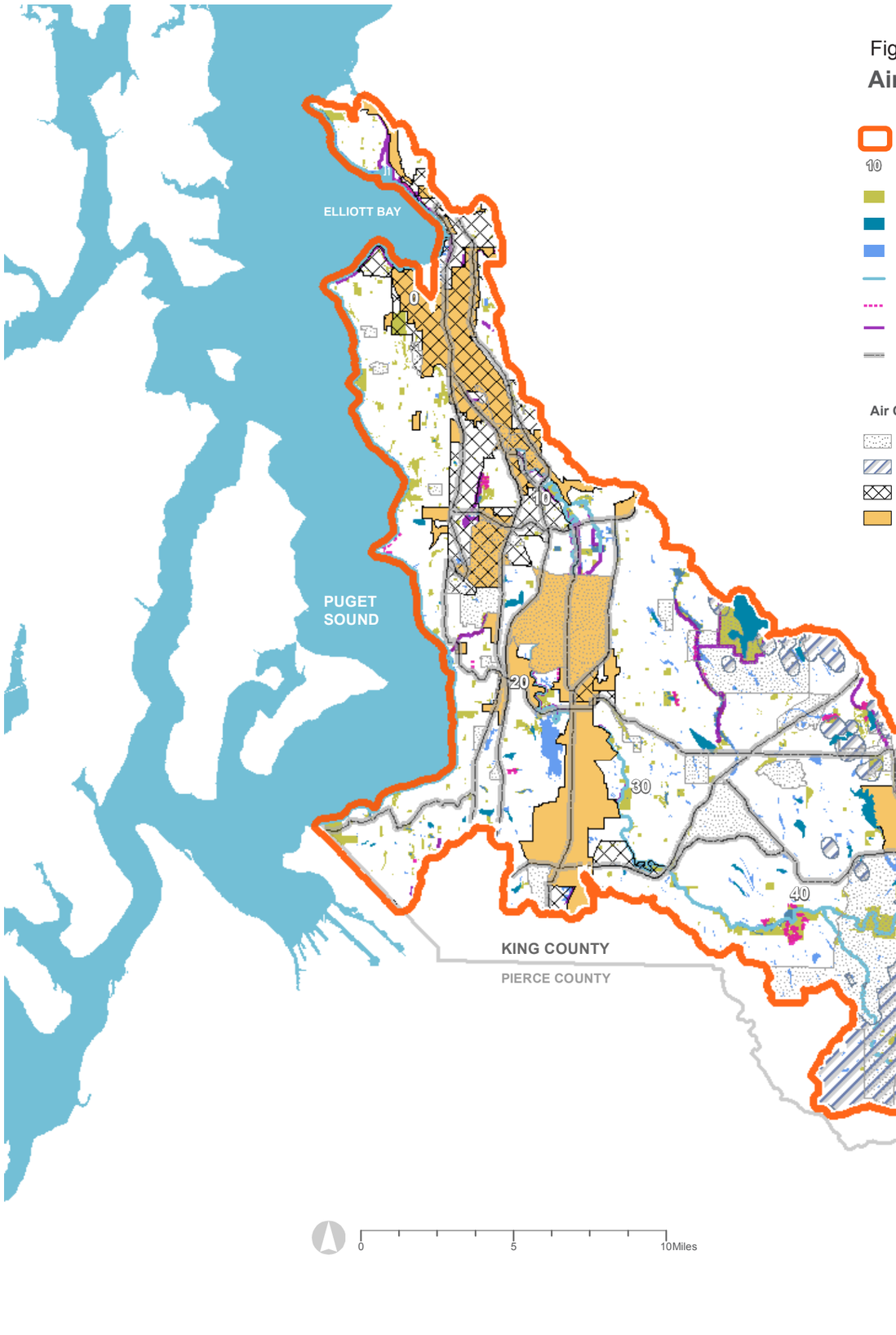
Second, the highest levels of ozone (smog) in the four county region occur in the upper reaches of the watershed. Ozone is a summertime pollutant that comes from a mixture of chemicals (in our region primarily from vehicle emissions), heat and sunlight. Because of where those emissions occur and factors such as prevailing winds, the air shed for ozone runs west to east, with lower levels in Seattle and higher levels in the Cascade foothills. Much of the emissions are generated is in the western portion of the watershed but winds cause the ozone to accumulate in the eastern part of the watershed. In addition to impacting human health, ozone impacts ecosystems and sensitive plant species.

In addition to the previous two air quality issues, the watershed contains a number of stationary sources of air pollution or a high density of sources of industrial air pollution. Those sources are subject to legal standards and regulations on the amount of pollution they can emit. Under the federal Clean Air Act, some of those sources are not required to use the latest, most current regulations and controls until they expand or modify their operations in a substantial way.

Lastly, climate change is a significant issue for air quality and is discussed in more detail later in this document. Almost all reductions in climate-forcing pollution also produce important co-benefits by reducing the emissions that cause ozone and fine particulate and air toxics emissions from vehicles.

Figure 9

Air Quality



- Green-Duwamish Watershed Boundary
- River Mile
- Parks and Open Space
- Lakes
- Wetlands
- Rivers & Streams
- Trail (Local)
- Trail (Regional)
- Highways

Air Quality Maintenance Areas

- Areas of wood burning
- Ozone impacted regions
- Diesel Particle Concentrations over 2 ug/m3
- High Industrial Source Density

The Green/Duwamish watershed suffers from high levels of air pollution that impacts air quality. People living near major roadways and in communities with significant wood burning for home heating are exposed to airborne toxics and fine particles. In particular, residents near major goods movement/transportation corridors or facilities are exposed to significantly higher levels of the more toxic diesel particles. Particles from wood and diesel combustion contain harmful pollutants like polycyclic aromatic hydrocarbons (PAHs) that can also deposit on land surfaces and collect in rivers and water bodies. Additionally, the highest levels of summertime ozone (smog) in the four county region occur in the upper reaches of the watershed, downwind of the larger urban areas where smog levels are low. In addition to important human health impacts, ozone impacts ecosystems and sensitive plants. The watershed also contains areas where there is a high density of sources of industrial air pollution. Those sources are subject to legal standards and regulations on how much pollution they can emit.

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Source: Data courtesy of the Puget Sound Clean Air Agency, US EPA, US Census Bureau, Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project,University of Washington College of Built Environments Green Futures Research and Design Lab, November 2015.

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PSCAA measures air quality in several ways. First, the region is required to meet federal standards for ozone and fine particulates (PM 2.5). While the region is currently in attainment for the existing ozone standard, the U.S. EPA is expected to tighten this standard and the region could go into violation. The area is currently meeting the fine particulate standards.

Federal pollution standards are designed to assess regional air quality. In lay terms, they assure clean air for most people, most of the time, but do not prevent disparate harmful impacts to smaller areas and some populations. Because of that, the PSCAA uses other metrics. For fine particulates, the Agency's health goal is to not exceed 25 micrograms per cubic meter in a 24-hour period (the federal standard is 35). In the Green/Duwamish, the Duwamish Valley exceeds the 24 hour standard several times a year and other parts of the watershed see elevated levels on occasion, driven largely by wood smoke. The communities along the lower Duwamish experience the highest annual average of fine particle pollution across the four counties and the highest levels of estimated diesel pollution. The PSCAA has a goal of reducing diesel particulate in highly impacted areas by 60% by 2020, compared to 2014 levels.

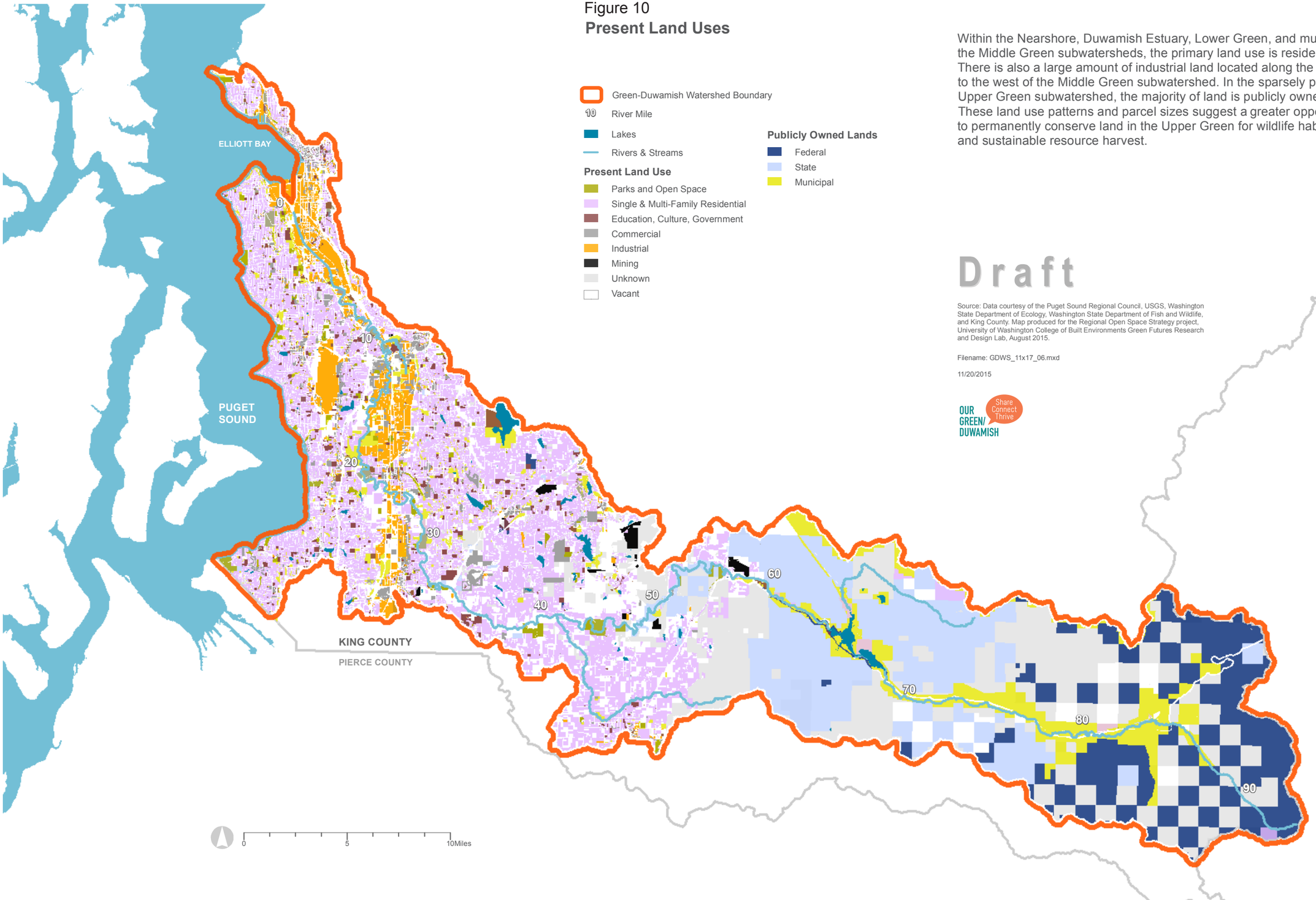
LAND USES & LAND CONDITIONS

The Green/Duwamish watershed is characterized by many land uses, which vary widely from the Upper Green subwatershed downstream to the Lower Green and Duwamish Estuary subwatersheds. Over the past few decades, this watershed has experienced a significant amount of population and development growth. The 16 incorporated cities within the watershed hold 34 percent of the land area and the remainder (66 percent) of land is in unincorporated King County. Ownership type varies significantly through the watershed.

The Upper Green subwatershed covers close to 45 percent of the area of the entire watershed. The western edge of the upper watershed begins at Howard Hanson Dam and moves east through the Cascade Mountains to the headwaters. The majority of the upper basin is managed by the City of Tacoma to protect the water supply area that serves Tacoma Public Utilities. It is public and protected land either by fee ownership or conservation easements. Approximately 12,000 acres of the upper basin is part of Tomanamus Forest owned by the Muckeshoot Tribe. There are no incorporated cities in this area.

The Middle Green subwatershed begins at the eastern edge of the City of Auburn and Kent and moves up river through the Green River Gorge and Tacoma Headworks to Howard Hanson Dam. Above the Green River Gorge, there is a significant amount of publicly-owned land. The Tomanamus Forest takes up a sizable land area along with some residential land use. Below the Green River Gorge, there are valleys with agricultural land uses including two large Agricultural Production Districts (APD). Many of the larger state and county parks in the watershed are located in this subwatershed. This subwatershed is heavily developed downstream of the gorge with mainly residential uses. The incorporated areas within this subwatershed are Auburn, Black Diamond, Covington, Enumclaw, Kent, Maple Valley, and Renton.

Figure 10
Present Land Uses



Within the Nearshore, Duwamish Estuary, Lower Green, and much of the Middle Green subwatersheds, the primary land use is residential. There is also a large amount of industrial land located along the river to the west of the Middle Green subwatershed. In the sparsely populated Upper Green subwatershed, the majority of land is publicly owned. These land use patterns and parcel sizes suggest a greater opportunity to permanently conserve land in the Upper Green for wildlife habitat and sustainable resource harvest.

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Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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The Lower Green and Duwamish/Nearshore subwatersheds are, in large part, developed with widespread residential, retail, manufacturing and industrial development throughout. In the Lower Green, the River is bordered on either side with flood protection levees, revetments or floodwalls. One APD exists in this area. The Duwamish River, in particular, has significant and extensive heavy industry and high-density development. There are several urban parks and single and multi-family residential neighborhoods scattered throughout this industrial landscape. The incorporated cities in these subwatersheds are Algona, Auburn, Burien, Des Moines, Federal Way, Kent, Normandy Park, Renton, SeaTac, Seattle and Tukwila.

FIGURE 11 - DUWAMISH RIVER - INDUSTRIAL DEVELOPMENT

PUBLIC LANDS, PARKS AND TRAILS

The Green/Duwamish Watershed contains a significant amount of public lands managed for conservation and recreation purposes, including three regional trail corridors (see Figure 12). Throughout the watershed, approximately 165,000 acres of land are preserved through fee or easement protection. Much of the protected land is owned by state, federal, and city agencies or protected by easements held by conservation non-governmental organizations.

Throughout the watershed, there are active recreation opportunities that are predominantly provided by city jurisdictions, such as Seattle, Tukwila, and Kent. Washington State manages three popular state parks, including Flaming Geyser, Kanaskat-Palmer, and Nolte State Parks, which provide river and lake access for whitewater rafting, kayaking and boating, and for shoreline activities like wildlife watching, fishing, picnicking and hiking. Trail facilities are paved or soft surface, largely interconnected, and used extensively for recreation and nonmotorized transportation. The trails are popular and span both urban and rural landscapes. Volume of use varies, but the most urban trails are estimated to facilitate hundreds of thousands of user trips annually. Within the Green River Gorge there are also subareas or sites, some of which may eventually become state parks as they become more developed with river access points or trails. They are:

1. Kummer Mines Site
2. Hanging Gardens Site
3. Old Town of Franklin Site
4. Jellum Site
5. Nolte-Green River Connection Site

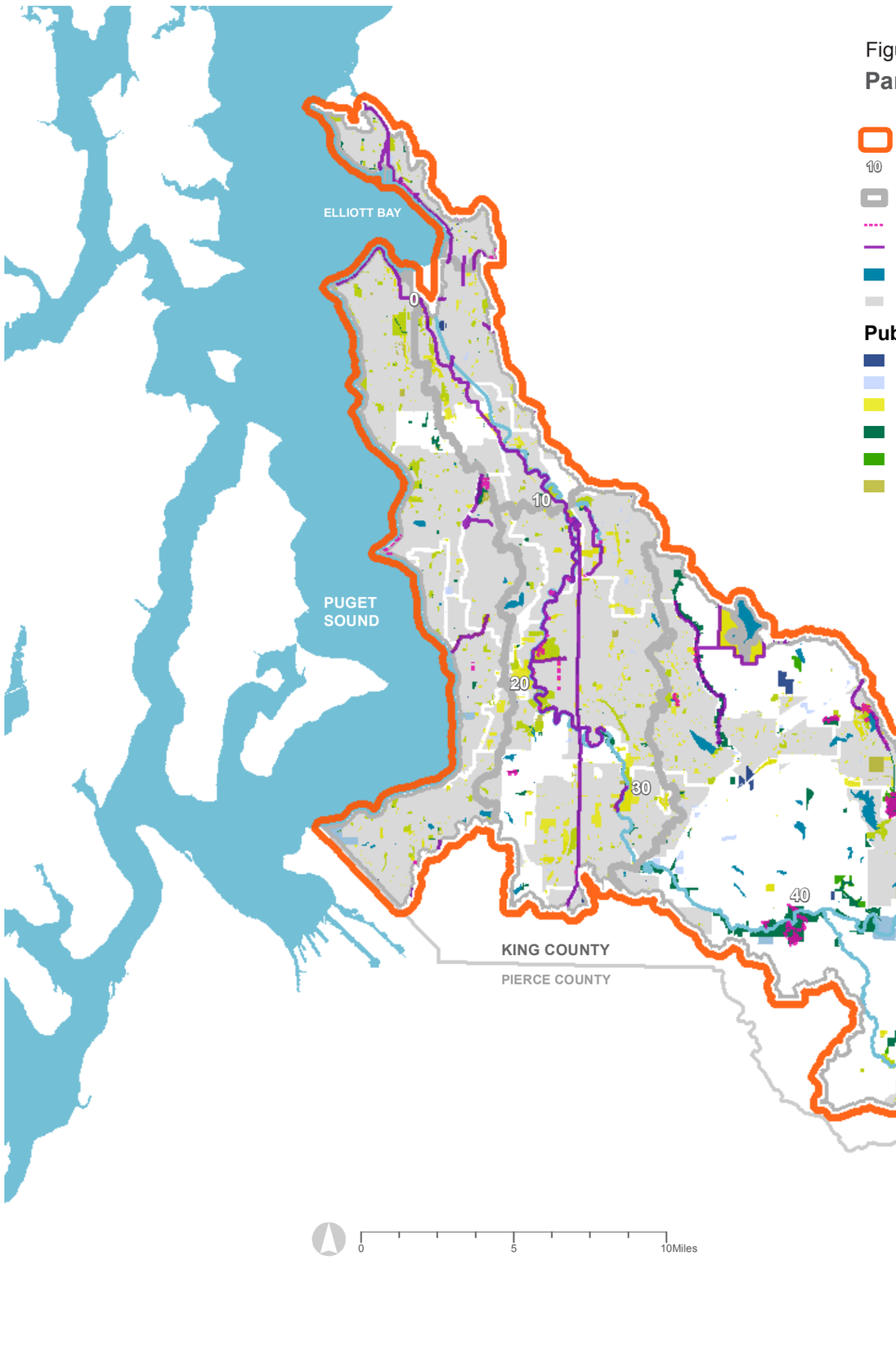
In the Middle Green River Subwatershed, the 105-acre Auburn Narrows Natural Area is a popular fishing area. The 1,110-acre Green River Natural Area includes the Metzler Park sub-area on the north side of the river with fishing and trails to the water and the O'Grady sub-area on the south side of the river with backcountry trails used primarily by hikers and equestrians. Whitney Bridge Park (30 acres) offers picnicking and developed boat access. The Flaming Geyser State Park and Kanaskat-Palmer State Park offers additional developed recreational opportunities. The Green River Gorge where the river runs through Washington State Parks-managed lands is a popular whitewater boating route. Black Diamond Natural Area between the city of Black Diamond and Maple Valley provides popular mountain-biking trails also used by hikers and equestrians.

The Soos Creek and the Green-to-Cedar Rivers trail corridors provide north-south routes through the subwatershed. The Soos Creek Trail is a 6-mile-long paved path that meanders along Soos Creek. The trail begins in south Renton and continues southward toward Covington. The landscape is dominated by Soos Creek and related wetlands. The Green-to-Cedar Rivers Trail is a 3-mile-long soft surface regional trail following a historic rail line between Maple Valley and Black Diamond. The trail, earlier known as the Lake Wilderness Trail, runs through Maple Valley and along Lake Wilderness from the Cedar River Trail to Kent-Kangley Road (SR516). Between these trails, a third regional trail, the soft surface Lake Youngs Trail, circumnavigates the City of Seattle's Lake Youngs Watershed. The Upper Green River Subwatershed is largely undeveloped with limited state, county or city owned parks and trails.

The Lower Green subwatershed includes many recreational facilities, including Kent's 310-acre Green River Natural Resources Area, the 136-acre North Green River Park with soccer fields and community gardens, the Green River Trail, and the Interurban Trail (South). The regional paths extend through most of the Lower Green River Valley. The Green River Trail is a 19-mile-long path that currently ends along the Green River near the boundary between Kent and Auburn. The landscape is generally riparian or river oriented. The Interurban Trail (South) is a 15-mile-long paved path that starts at a junction with the Green River Trail in Tukwila and stretches the length of the Lower Green subwatershed to Pacific near the King/Pierce County border. The path follows a Puget Sound Energy power line corridor known as the route of the historic Interurban electrified railway. The landscape varies but is predominantly industrial due to the nearby Burlington Northern Santa Fe and Union Pacific railway corridors. A third paved regional trail, the White River Trail, is located in Auburn. This is a short riverside trail.

Figure 12

Parks, Open Space and Trails



- Green-Duwamish Watershed Boundary
- River Mile
- Subwatershed Boundaries
- Trail (Local)
- Trail (Regional)
- Lakes
- Municipalities

Publicly Owned Lands

- Federal
- State
- Municipal
- Parks in King County
- King County Parks Conservation Easements
- Parks and Open Space

Trails, parks, and open spaces are located throughout the Green/Duwamish Watershed. The largest open spaces are located within the Upper Green subwatershed. Many small recreation facilities are spread throughout the other subwatersheds, in the form of city, county, and state parks. There are also hundreds of miles of local and regional trails available to the public. This abundance of opportunity, though remarkable, is not necessarily equitably available to the people who live in the watershed.

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Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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The Duwamish Estuary subwatershed is highly urbanized with significant commercial development. It includes portions the Duwamish Trail linking Alki and South Park communities and interlinking with the West Seattle Bridge and Alki trails to the north. The trail moves to the streets in South Park to become the designated Duwamish Route for bicyclists and pedestrians. About a mile south of South Park the Green River Trail starts near Cecil Moses Park in Tukwila and continues south generally along the Green/Duwamish River to south Kent. The Duwamish Trail consists largely of paved path segments, as well as some sidewalk and local street sections. The Green River Trail is a paved path that continues from the Duwamish Estuary into and through the Lower Green River Subwatershed. Outside of the trail system, less opportunity for passive and active recreation is present in this portion of the watershed.

King County's future plans envision the interconnection and/or extension of all these regional trails and continued acquisition of open space to provide habitat protection and passive recreational opportunities. The surrounding street network offers varying levels of bicycle/pedestrian accommodation but provides many points of access to the trails network. The Green River and Interurban trails provide the greatest opportunities for active transportation and regional connectivity.

FOREST LANDS

The Upper and Middle Green subwatersheds have significant forest cover and timber production is an important economic activity in the Upper Green. Forestlands provide many other benefits including municipal water supplies habitat for many species of wildlife, protected stream quality for salmon habitat, air quality improvement, and aesthetic and recreational opportunities.

The Upper Green River subwatershed is located in King County's designated Forest Production District. Timber production is the main economic activity. Public agencies own and manage 65 percent (92,000 acres) of the land in the Upper Green subwatershed. The US Forest Service, Washington State Department of Natural Resource (WADNR), and Tacoma Water are major public landowners in this part of the watershed. Private interests own approximately 50,000 acres of forestland in the Upper Green. Plum Creek, Olympic Resource Management and the Muckleshoot Tribe are among the major private owners of timberland in the upper watershed. In 2013, the Muckleshoot Tribe purchased the 43,000-acre Tomanamus Forest, formerly known as the White River Tree Farm from Hancock Natural Resource Group located in both the Upper & Middle Green subwatersheds. The Muckleshoot Tribe has pledged to continue managing the Tomanamus Forest for sustainable forestry, approximately 12,000 acres of which are in the forested headwaters of the Green River watershed.

The Middle Green River subwatershed is characterized by a mix of residential, commercial forestry, and agricultural land uses. Forestlands in the eastern portion of the Middle Green are within the Forest Production District. Another 12,413 acres of forest are located in Rural Forest Focus Areas,

which are designated by King County as areas where the best opportunities exist for the retention of large contiguous blocks of forest and the practice of sustainable forestry.

King County has taken significant action to encourage sustainable land management practices and to help permanently protect privately owned forestlands through support of tax incentives, transfers of development rights, conservation easements, preservation programs, and landowner education. In the Upper and Middle Green subwatersheds 45,000 public and privately owned acres are protected by transfers of development rights and conservation easements.

In the last two decades state and local governments have acquired a significant amount of ecologically valuable forest from private owners in the Upper and Middle Green sub-watersheds. For example, in 2009 Washington State Department of Natural Resources purchased 21,165 acres from Plum Creek Timberland.

FARMLAND, SOIL PRESERVATION & PRODUCTION

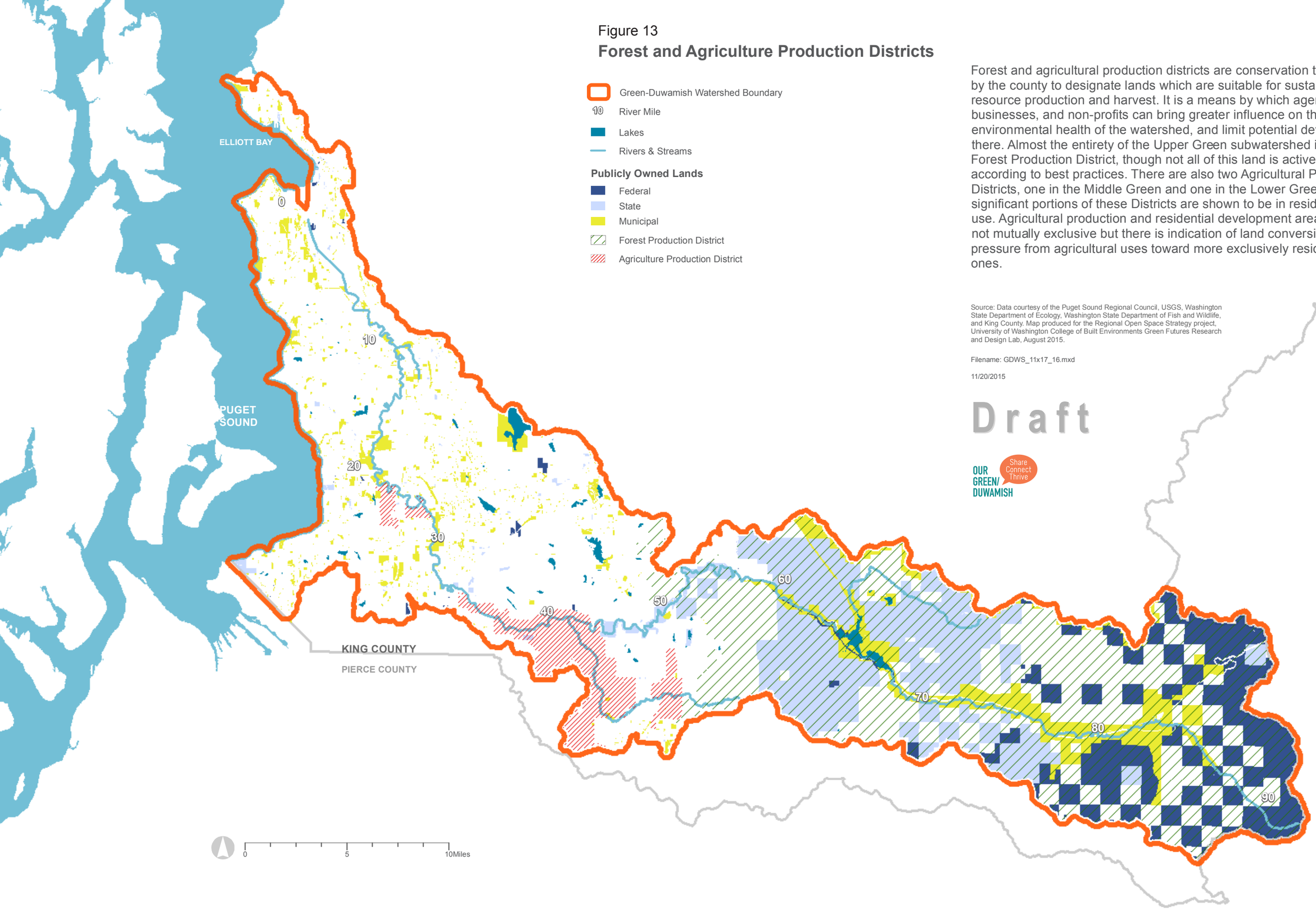
The Lower Green APD is approximately 1,460 acres and is almost entirely surrounded by the City of Kent and the City of Auburn. This APD includes 1,013 acres on 49 parcels in the FPP. There are 1,094 acres on 45 parcels participating in the farm and agricultural land program, which includes all but five of the FPP parcels. Farms in this APD are primarily growing row crops and flowers.

The Upper Green APD is approximately 3,415 acres and is located along the Green River, with Washington State Highway 18 on its western end and Flaming Geyser State Park on its eastern end. This APD includes 915 acres on 61 parcels in the FPP. There are 1,430 acres and 91 parcels participating in the farm and agricultural program, which includes all but ten of the FPP parcels. Farms in this APD are primarily growing row crops or ornamentals, and raising beef cattle.

The Enumclaw Plateau APD is approximately 20,680 acres and is located adjacent to and south of the Upper Green APD, bordered by the White River to the south, the Muckleshoot Indian Reservation to the west and the City of Enumclaw and the Forest Production District to the east. This APD includes 5,280 acres on 201 parcels in the FPP. There are 11,000 acres on 699 parcels participating in the farm and agricultural program, which includes all but fourteen of the FPP parcels. Farms in this APD are primarily used for grazing, growing hay and silage for livestock, raising beef cattle, and dairying. Figure 13 shows forest and agricultural production in the Green/Duwamish Watershed.

Figure 13

Forest and Agriculture Production Districts



Forest and agricultural production districts are conservation tools used by the county to designate lands which are suitable for sustainable resource production and harvest. It is a means by which agencies, businesses, and non-profits can bring greater influence on the environmental health of the watershed, and limit potential development there. Almost the entirety of the Upper Green subwatershed is within a Forest Production District, though not all of this land is actively stewarded according to best practices. There are also two Agricultural Production Districts, one in the Middle Green and one in the Lower Green, though significant portions of these Districts are shown to be in residential land use. Agricultural production and residential development areas are not mutually exclusive but there is indication of land conversion pressure from agricultural uses toward more exclusively residential ones.

Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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WATER CONDITIONS

WATER QUALITY

The Clean Water Act (CWA) provides structure for local development controls and permitting under the National Pollutant Discharge Elimination System (NPDES) as does the Washington Stormwater Design Manual to improve water conditions. The CWA requires that all states restore their waters to be "fishable and swimmable." Washington's Water Quality Assessment lists the water quality status for water bodies in the state under Sections 303(d) and 305(b) of the CWA. In the Green/Duwamish watershed there are 204 water body segments with 303(d) listings not meeting the water quality standards and 46 303(d) listings not meeting sediment standards.[iii]

King County maintains a water quality monitoring program for conventional pollutants such as temperature, nutrients, bacteria and dissolved oxygen. This program includes monitoring water quality on a monthly basis, and is comprised of sites near the mouths of most tributaries to the Green/Duwamish River, along with multiple spots in the river itself (more information is available here: http://green2.kingcounty.gov/StreamsData/Default.aspx). In addition, other entities such as the Department of Ecology, the Department of Health, various cities, and the Muckleshoot Indian Tribe, also occasionally collect water, sediment, or fish tissue samples from the watershed for quality testing.

The water quality testing demonstrates that conditions vary considerably depending on location in the watershed. The Department of Ecology routinely compares conditions to water quality standards to identify locations where standards are not achieved (more information available here: http://www.ecy.wa.gov/programs/wq/303d/index.html). In general the Upper Green River subwatershed has fewer water quality concerns than the other subwatersheds, owing to its largely forested conditions. The Middle and Lower Green River subwatersheds have a variety of identified concerns, with water quality restoration plans required under the CWApol for bacteria, temperature, dissolved oxygen at multiple locations. In addition, polychlorinated biphenyls (PCBs) and dioxins/furans also have been noted in fish tissue in Lake Sawyer and Lake Meridian, and toxaphene, chlordane, hexachlorobenzene, dieldrin have also been found in fish tissue in Lake Meridian.

In the Duwamish River, a variety of water quality concerns have been identified. These are associated with both conventional pollutants such as temperature and bacteria, and also with industrial chemicals that were historically released to the river and have accumulated in river sediments, and in some cases may still have ongoing releases to the river. The Environmental Protection Agency's (EPA) Final Cleanup Plan for Duwamish Waterway sediments has identified PCBs, arsenic PAHs, dioxins and furans as contributing most of the health risk to people that use the river.

WATER RECREATION

In 2013, The King County River and Floodplain Management Section conducted a study of recreational use in limited river reaches within King County. These study reaches were chosen for their proximity to future major capital investment river and floodplain management work. Understanding in-river recreational use allows for the appropriate consideration of recreational user behavior, timing, and associated risks for in-river capital project conceptualization, design, effectiveness monitoring, and adaptive management.

On the Green River, data was colleced via remote cameras and aerial flight. Both sets of data indicate that levels of use along the Green River during the summer are moderate in comparison with other areas of the county.

Within the portion of the Green River surveyed (RM15.9 to 41.3) the highest levels of floater use observed on the Green River occurred in the vicinity of the Whitney Bridge (RM41.3 to 41.1). The number of floaters in the lower area of the study (RM15.9 to 19.4) was about 1/40 of the number of floaters in the vicinity of Whitney Bridge. Nearly 9/10 of all floaters observed in the Green River system were adults and about 2/3 were male. Approximately 85 percent of the vessels used by floaters in the Green River system were either rafts or inner tubes and only a minority of floaters (13.6 percent) wore life vests.

WATER QUANTITY[iv]

Water quantity conditions, including instream flows, groundwater, habitat-forming flows, and out-of stream water use affect the quality and quantity of habitat available for different salmonid life stages. Historical changes combined to have a profound effect on water quantity conditions, including the diversion of the White River in 1906, the Cedar/Black River in 1913, the construction of the Tacoma Headworks (diversion dam) in 1911-1913, and construction of the Howard Hanson Dam for flood control in 1962. In addition, there were extensive land use changes that converted forests to urban, industrial, and agricultural uses, as well as numerous smaller water diversions and groundwater withdrawals that affected water quantity conditions.

Diversion of the White River in particular reduced summer low flows because of the loss of glacial meltwater. Tacoma Public Utilities continuously diverts up to 113 cubic feet per second (cfs) from the mainstem. As a result of the Howard Hanson Dam, flows that are greater than 12,000 cfs (formerly the two-year event at the U.S. Geological Survey Auburn stream gage) have been prevented, while the duration of moderate flows in the river (3,000 to 5,000 cfs) has increased due to metered release of floodwaters stored behind the dam.

Urban development in the Duwamish Estuary, Lower Green River, and Middle Green River subwatersheds has resulted in substantial increases in stormwater runoff from small tributary streams and subbasins. This, along with climate change impacts, which are discussed later in this document, has contributed to larger and more frequent peak flows during the winter and reduced recharge of shallow aquifers that formerly sustained flows during the late summer and fall. Water withdrawals and diversion of springs or other surface water sources also serve numerous cities and

water districts in the Lower and Middle Green River subwatersheds. These withdrawals, together with exempt wells further reduce the water available to streams and the mainstem.

River & Floodplain Management[v]

The Green/Duwamish River flows through several cities, primarily in its lower reaches, including Auburn, Kent, Renton, Tukwila and Seattle. The Green/Duwamish River's flood hazard management corridor includes the river channel and the mapped flood hazards, areas of potential levee failure and areas of deep fast flow not otherwise mapped as hazard areas, landslide hazard areas, and a riparian buffer. The Duwamish River is the tidal-influenced portion of the Green River, below River Mile 11. There is no mapped floodplain above Howard Hanson Dam in the Upper Green River subwatershed.

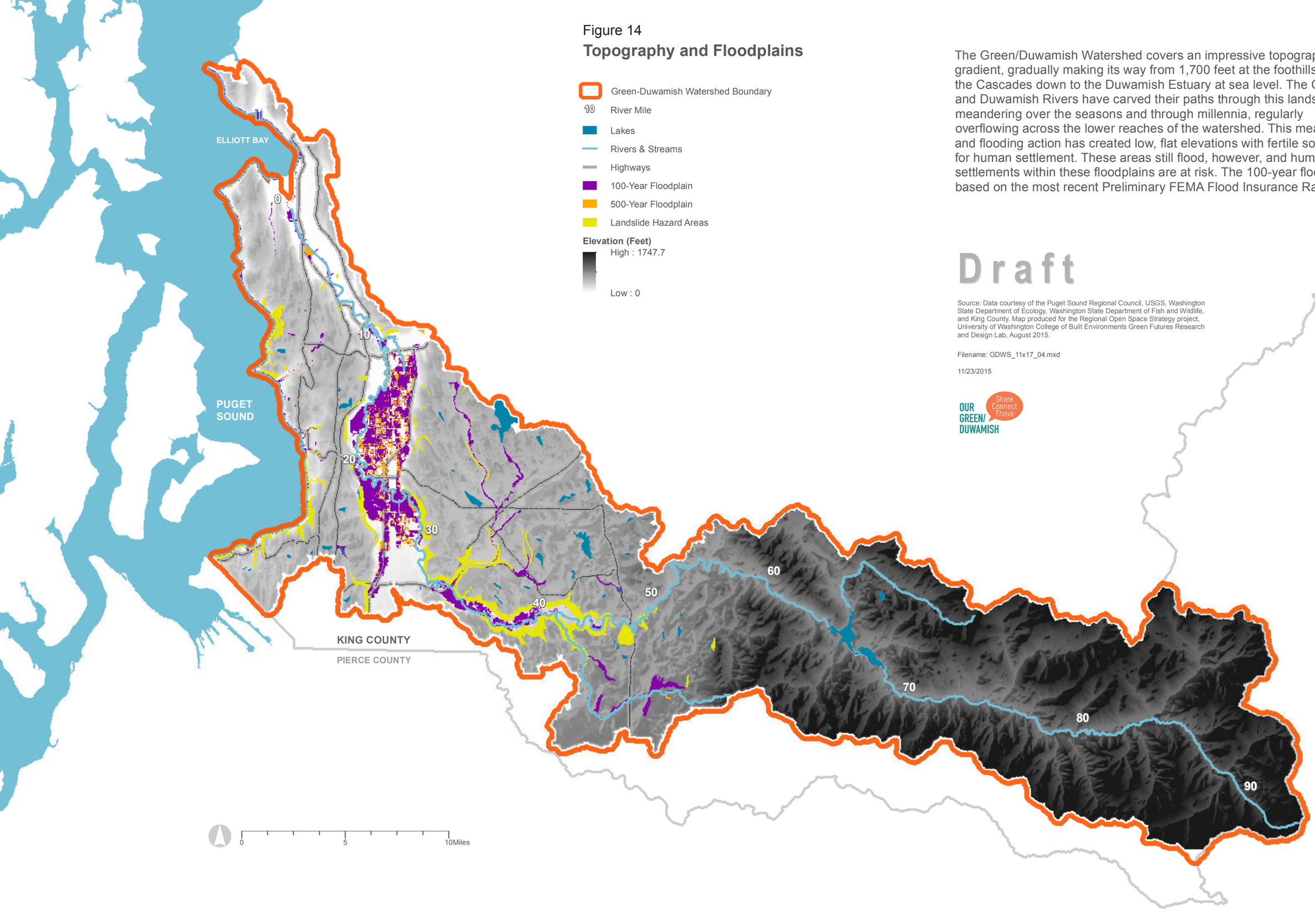
Historically, the Duwamish River consisted of three major tributaries: the Green, White, and Black Rivers. In the early 1900s, the White River was diverted south into the Stuck River, which joins the Puyallup River. The Cedar River was diverted from the Black River, a tributary to the Duwamish River and now flows to Lake Washington. These changes reduced the flow out of the Duwamish River by two-thirds of its historical discharge permanently affecting flood characteristics in the lower Green and Duwamish Rivers[vi]. Major flood control features along the Green River include Howard Hanson Dam (completed in 1962 and the levee system that lines almost all riverbanks of the Lower Green and Duwamish Rivers. Howard Hanson Dam and the levee system combine to reduce flooding in the lower river to a fraction of its historical magnitudes. Major flooding has largely been controlled by these dam operations and levees and widespread valley flooding has been prevented. However, flooding still occurs at varied depths in the valley upstream of Auburn and lower Mill Creek basin, particularly during Phase III flood events when flows at the Green River gage near Auburn exceed 9,000 cfs. The 100-year floodplain is shown in Figure 14.

The Green River Flood Control Zone District (District) was created in 1960 with the cities for Auburn, Kent, Renton and Tukwila to coordinate on floodplain management efforts on the Lower Green and Duwamish Rivers. In 1978, the participating jurisdictions signed an interlocal agreement to provide funding for District activities. The interlocal agreement was renewed in 1992 and again in 2002. In addition, the District's authority to raise revenue through a levy of its own was activated in 1990. In 2007, King County created the King County Flood Control District, a special purpose district through which King County and the cities in King County to reduce flood risk and restore rivers. The cities participating in the Green River Flood Control Zone District became a part of this larger county-wide special purpose district at this time.

The Green River Flood Control Zone District (District) was created in 1960 with the cities for Auburn, Kent, Renton and Tukwila to coordinate on floodplain management efforts on the Lower Green and Duwamish Rivers. In 1978, the participating jurisdictions signed an interlocal agreement to provide funding for District activities. The interlocal agreement was renewed in 1992 and again in 2002. In addition, the District's authority to raise revenue through a levy of its own was activated in 1990.

Figure 14

Topography and Floodplains



The Green/Duwamish Watershed covers an impressive topographic gradient, gradually making its way from 1,700 feet at the foothills of the Cascades down to the Duwamish Estuary at sea level. The Green and Duwamish Rivers have carved their paths through this landscape, meandering over the seasons and through millennia, regularly overflowing across the lower reaches of the watershed. This meandering and flooding action has created low, flat elevations with fertile soil, ideal for human settlement. These areas still flood, however, and human settlements within these floodplains are at risk. The 100-year floodplain is based on the most recent Preliminary FEMA Flood Insurance Rate Maps.

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Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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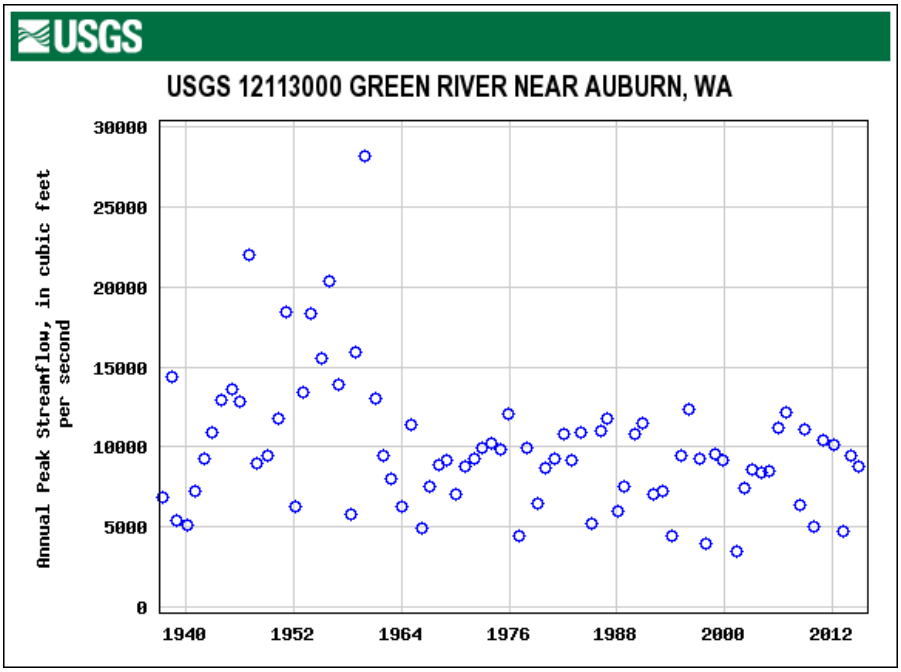
In 2007, King County created the King County Flood Control District, a special purpose district through which King County and the cities in King County to reduce flood risk and restore rivers. The cities participating in the Green River Flood Control Zone District became a part of this larger county-wide special purpose district at this time

The Green River Flood Control Zone District (District) was created in 1960 with the cities for Auburn, Kent, Renton and Tukwila to coordinate on floodplain management efforts on the Lower Green and Duwamish Rivers. In 1978, the participating jurisdictions signed an interlocal agreement to provide funding for District activities. The interlocal agreement was renewed in 1992 and again in 2002. In addition, the District's authority to raise revenue through a levy of its own was activated in 1990. In 2007, King County created the King County Flood Control District, a special purpose district through which King County and the cities in King County to reduce flood risk and restore rivers. The cities participating in the Green River Flood Control Zone District became a part of this larger county-wide special purpose district at this time.

Figure 15 shows annual peak flows at this gage from 1937 through 2014. In 2015, the Green River reached Phase III flood levels in November and December.

The Green River Flood Control Zone District (District) was created in 1960 with the cities for Auburn, Kent, Renton and Tukwila to coordinate on floodplain management efforts on the Lower Green and Duwamish Rivers. In 1978, the participating jurisdictions signed an interlocal agreement to provide funding for District activities. The interlocal agreement was renewed in 1992 and again in 2002. In addition, the District's authority to raise revenue through a levy of its own was activated in 1990. In 2007, King County created the King County Flood Control District, a special purpose district through which King County and the cities in King County to reduce flood risk and restore rivers. The cities participating in the Green River Flood Control Zone District became a part of this larger county-wide special purpose district at this time.

FIGURE 15 - ANNUAL PEAK FLOWS AT AUBURN GAGE



STORMWATER

Stormwater runoff is a major contributor to degradation of the quality of Puget Sound and other waters bodies in our region. Stormwater carries pollutants from places such as yards and streets and from the air. Conversion of forest cover to impervious surfaces, lawns, and pastures/fields causes significant hydrologic alterations, which result in changes in the quantity, quality, and timing of stormwater runoff discharged from these altered areas. These hydrologic alterations result in a "flashier" system, where stream and river flows increase quickly in even the smallest rainstorms, and there is an increase in stormwater peak flows and volumes.

These changes result in a significant increase in the discharge of pollutants from motor vehicle use and other human activities that are picked up by runoff and transported to nearby receiving waters, causing a multitude of impacts to receiving waters. Documented impacts in the Green/Duwamish watershed include increased peak flows; erosion and sedimentation of stream channel features essential to fish life stages; excessive velocities that impede fish migration and wash away food sources; increased flashiness; decreased low flows that decrease habitat and strand fish; loss of groundwater recharge critical to summer water supply for both fish and humans; and degradation of water quality leading to lethal and sub-lethal effects on fish and threats to human health. These threats were described in the WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment Report, where land development, habitat alterations, and water quality were highlighted as contributing to the decline of salmonids in the watershed.

Efforts to address these impacts have largely focused on regulations that require individual stormwater controls on new development sites. These typically consist of "flow controls" (e.g., detention facilities) to limit the peak rates and duration of discharge and "water quality controls"

(i.e., treatment facilities) to remove pollutants from the runoff prior to discharge (e.g., 50% solids removal). Initial stormwater control efforts began in the late 1970s with the application of simplistically designed flow controls. These early controls were found during the 1980s to be ineffective at preventing impacts. Substantially expanded and improved controls were adopted and required for new development in the early 1990s, though similar controls were not required for previously developed lands. In addition, other types of flow controls that resemble what are now called low impact development (LID) techniques began to be successfully used as well.

These included clearing limits in rural areas, reduced road widths, and single-family roof downspout infiltration and dispersion controls. Water quality controls such as wetponds and biofiltration swales were also applied for the first time in the 1990s. Unfortunately, roughly more than three quarters of the developed land in King County was built out prior to 1990 using no stormwater control methods or the ineffective initial methods developed in the 1970s. A similar proportion of developed land in the Green/Duwamish watershed was also built out during this time with no or relatively little flow control and virtually no water quality control. As inferred from the Puget Sound Action Agenda, the lack of stormwater controls in older developed areas is one of the most significant water quality problems affecting Puget Sound. [vii]

Wastewater & Sewer Management

The Green/Duwamish Watershed includes a mix of sewered and unsewered properties. Generally, properties within the urban growth boundary are connected to sewer and properties outside this boundary are typically on individual or community septic systems. The great portion of wastewater service in the watershed is provided by King County Wastewater Treatment Division. In addition, thirty-four communities are served by local sewer utilities that have their own collection and treatment systems. Properties with on-site septic systems are permitted by Seattle-King County Public Health. In the Green/Duwamish Watershed, 18 percent is served by the Renton treatment plant and 6 percent is served by West Point. The remaining 76 percent of the watershed is unsewered.

King County owns and operates a regional wastewater system that serves 1.6 million people in a 424-square mile area. This system was built in the 1960's and removed many untreated sewage discharges from local waterbodies. The County's wastewater system collects sewage and sends it to a regional treatment plant for physical and chemical treatment.

About 20 percent of the County's wastewater service area has combined sewers that carry both wastewater and stormwater in the same pipes. The vast majority of flows from combined sewers go to wastewater treatment plants for treatment. During heavy storms, however, untreated combined flows that exceed the capacity of sewers and treatment plants discharge through overflow pipes to the Puget Sound, the Duwamish River, the Lake Washington Ship canal, and Lake Washington. The combined sewer overflows (CSO's) serve as a safety valve in preventing sewer backups into homes and streets. Controlling CSO's protects public health and the environment by:

1. Reducing the threat to people from contact with harmful chemicals and pathogens and consumption of contaminated fish;
2. Reducing the threat to fish of exposure to chemicals at their most vulnerable life stage;
3. Helping protect Puget Sound and meet cleanup goals for the Duwamish River.

CSOs have contributed to the pollution in the Elliott Bay-Duwamish River estuary. While the discharge is primarily (90 percent) stormwater, the discharges may be harmful to public health and aquatic life because they carry chemicals and disease-causing pathogens. The Elliott Bay-Duwamish River estuary includes 15 CSO locations, which discharge approximately 450 million gallons of combined flow in each year of average rainfall. Considering that the entire King County combined system discharges a total of 808 million gallons per year, the 450 million gallons discharged into the estuary represents a very large portion of the system's CSO volume. The frequency and volume of discharges in the estuary vary with each CSO location – ranging from 0 to 25 times and from 0 to 200 million gallons per year. [i]

CSO control is required by Washington state and federal law. King County and Seattle have reduced the annual volume of untreated wastewater discharged to waterways from around 30 billion gallons to less than 1 billion gallons since the 1960s. In 2010, King County began investing an estimated $497 million (2010 dollars) in CSO control over the next 20 years in the Elliott Bay-Duwamish Estuary which reduce the number of untreated overflows from each location to once per year on average by 2030. Reducing CSO is one of many actions and integration of CSO control, stormwater management and other water quality projects is a sound approach to improving local waters.

ROSS REGIONAL CHALLENGES

Current conditions for each of the ROSS regional challenges or five value lenses are further described in this section.

BIODIVERSITY

The Green/Duwamish Watershed contains a variety of habitat types and habitat conditions for, vegetation, Wetlands, lakes & riparian zones and fish and wildlife. There are several species of concern in the Green/Duwamish Watershed, which are fish and wildlife listed as State Endangered, state Threatened, State Sensitive or State Candidate. Species of concern within the watershed are listed in Table 2.

TABLE 2-SPECIES OF CONCERN THAT MAY OCCUR IN THE GREEN RIVER WATERSHED.

Common Name	State Status*	Federal Status**	Basin
Puget Sound Chinook Salmon · Green/Duwamish River Summer/Fall Stock · Newaukum Creek Summer/Fall Stock	C	T	U, M, L

Puget Sound Coho Salmon · Green River/Soos Creek Stock · Newaukum Creek Stock		C	U, M, L
Puget Sound Bull Trout	C	T	N
Bald Eagle	S	SC	U, M, L
Northern Spotted Owl	E	T	U
Marbled Murrelet	T	T	U
Gray Wolf	E	E	N
Grizzly Bear	E	T	N
Canada Lynx	T	T	N
Pacific Fisher	E	C	U
Oregon Spotted Frog	E	T	N
Western Pond Turtle	E		N
Cascades frog	M		U, M
Cascade torrent salamander	SC		N
Van Dyke's salamander	SC		N
Larch Mountain salamander	S		U
Northern goshawk	C		U, M
Vaux's swift	C		U, M, L
Wolverine	C		N
Common loon	S		U
Pileated woodpecker	C		U, M, L
The basins in which the species are found are listed (U = Upper; M = Middle; L = Lower; N = Unlikely occur in watershed) (WDFW 2016). *State Status: E = Endangered; T = Threatened; S = Sensitive; C = Candidate, M=Monitored **Federal Status: E = Endangered; T = Threatened; C = Candidate; SC = Species of Concern; PT = Proposed\Threatened; PE = Proposed Endangered			

Elements of biodiversity are typically:

1. Habitat Extent & Quality,
2. Food Sources,
3. Water Quality,
4. Access to water,
5. Air Quality,
6. Degree of Predation,
7. Degree of Extraction.

Fish and fish Habitat

Of the abundance of aquatic life in the Green/Duwamish River and its tributaries, salmon is chief among them. It is a threatened species with broadly held public affection and profound cultural and economic significance to tribal communities. Salmon species within the Green/Duwamish Watershed include chinook, chum, coho, and pink. The Green/Duwamish River is also used by bull trout, also a listed species, for foraging, but no spawning populations have been detected thus far. Bull trout have been observed on the mainstem up to Newaukum Creek and it is presumed that bull

trout utilize the Green River up to the Tacoma Headworks at river mile 61.[viii] Figure 16 shows aquatic habitat in the watershed.

Despite the level of transformation that has occurred on the Green River, salmon continue to return to spawn every year. After the closing of Howard A. Hanson Dam in 1963, salmon could no longer migrate into the upper watershed through Eagle Gorge. This area was once the major spawning ground for salmon. Migrating salmon stop at the Tacoma Headworks so juvenile salmon are trucked above the dam to make use of the rearing capacity of the upper watershed. In the future, a fish lift will be installed to pass adult salmon above the dam. In the meantime, salmon also continue to use the river below the dam for spawning and rearing, especially the reach below the Green River Gorge downstream to the urban area. [ix]

Fish habitat in the Middle Green subwatershed has been altered from historic conditions by the constructions of dams, levees along the river banks, logging, agricultural activities and residential and industrial development. Major tributaries are Newaukum Creek and Big Soos Creek, which have good fish habitat in many reaches.

Fish habitat in the Lower Green and Duwamish subwatersheds are generally limited and significantly degraded by the armoring of the river banks and urban/industrial development. Small tributaries that feed into the lower basin such as Springbook Creek and Mill Creek provide habitat but is generally poor. Many tributaries have riparian zones significantly affected by residential, retail and commercial development.

The mouth of the river empties into Elliott Bay via the heavy industrial area of Seattle that was once the estuary of the river. Little of the estuary remains—about 28 acres in a single small area near Kellogg Island in the lowermost river. Recently, the US Army Corps of Engineers and King County have been cooperating in projects to regain some of the lost estuarine habitat.

In 2005, the Salmon Habitat Plan for the Green/Duwamish and Central Puget Sound Watershed (WRIA 9) was approved and its duration is from 2006 to 2015. The Plan provides guidance for actions to protect and restore streams, rivers, and the Puget Sound nearshore in southern King County. It covers the freshwater streams and rivers in southern King County as well as the Puget Sound marine nearshore. Since plan adoptions, WRIA 9 and its partners have secured over $137 million from all funding sources to implement Chinook salmon recovery projects and programs. Since the plans inception, significant progress has been made (some restoration sites can be seen in Figure 17:

- 918 acres protected through acquisition or easement;
- 80 acres of riparian area planted;
- 1.2 miles of levees removed or set back;
- 57 acres of floodplain reconnected;
- 3,370 feet of marine shoreline restored.

Wildlife and Wildlife Habitat

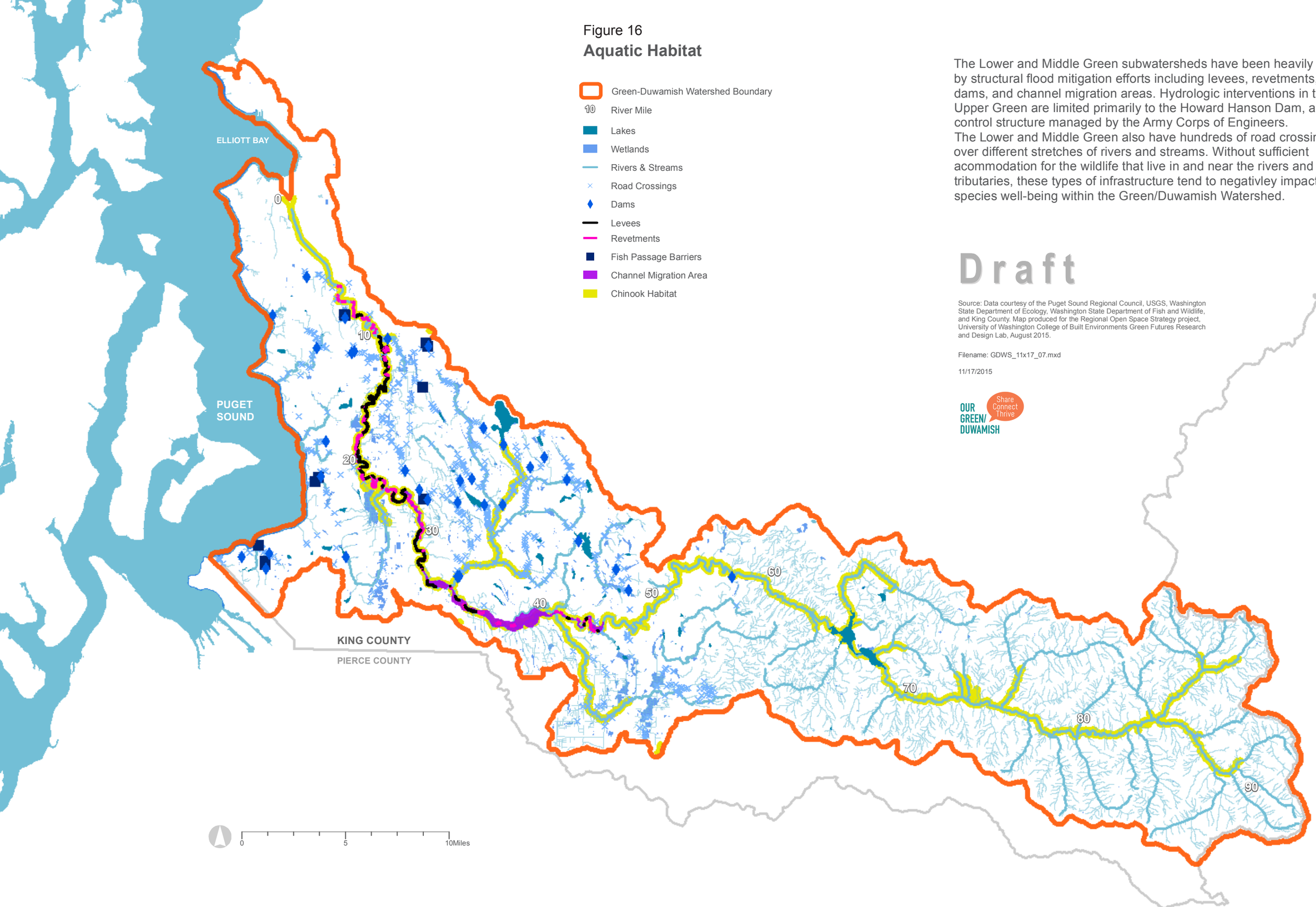
The Green/Duwamish Watershed was historically composed of large patches of contiguous forested habitat and wetlands (see Figure 18). Development activity that has taken place in the watershed over the last 150 years has altered the watershed landscape and impacted wildlife habitat and diversity. Lakes and wetlands along the river host major populations of migratory and resident birds and other wildlife. Charismatic animal species including black bear, Roosevelt elk, bald eagles, and cougar use the ecosystems of the Cascade foothills and mountain peaks in the headwaters for some or all of their life histories.[x]

Wetlands, Lakes, Ponds & Riparian zones

There are many lakes, ponds, and riparian zones throughout the Green/Duwamish Watershed. In the Upper Green subwatershed, many of the wetlands and riparian zones have been significantly affected by logging practices. Many wetlands have roads through or adjacent to them and many occur on the floodplain adjacent to the river in the flatter portions of the basin. In the Middle Green subwatershed, lakes, ponds and wetlands are found throughout. The riparian zones in this area are varied. In the Lower Green and Duwamish subwatersheds, almost 41 percent of the riparian zone is impervious surface. Many wetlands in this basin have been filled and converted to industrial, retail and residential uses. Those that remain are generally degraded and surrounded by development, which limits their potential to provide significant habitat opportunities.

Figure 16

Aquatic Habitat



The Lower and Middle Green subwatersheds have been heavily altered by structural flood mitigation efforts including levees, revetments, dams, and channel migration areas. Hydrologic interventions in the Upper Green are limited primarily to the Howard Hanson Dam, a flood control structure managed by the Army Corps of Engineers.
The Lower and Middle Green also have hundreds of road crossings over different stretches of rivers and streams. Without sufficient acommodation for the wildlife that live in and near the rivers and their tributaries, these types of infrastructure tend to negativley impact species well-being within the Green/Duwamish Watershed.

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Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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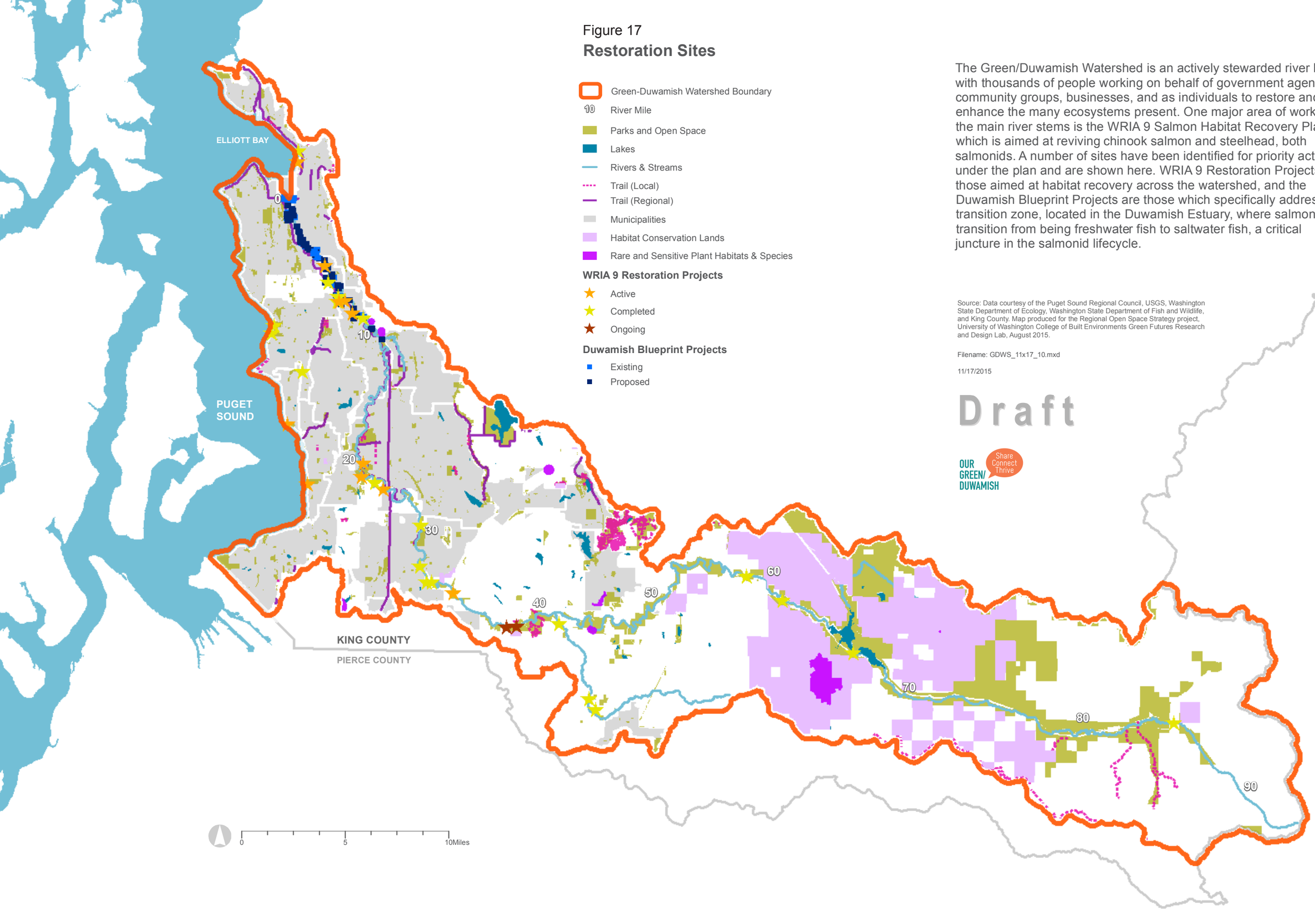
Figure 17

Restoration Sites



The Green/Duwamish Watershed is an actively stewarded river basin with thousands of people working on behalf of government agencies, community groups, businesses, and as individuals to restore and enhance the many ecosystems present. One major area of work along the main river stems is the WRIA 9 Salmon Habitat Recovery Plan, which is aimed at reviving chinook salmon and steelhead, both salmonids. A number of sites have been identified for priority action under the plan and are shown here. WRIA 9 Restoration Projects are those aimed at habitat recovery across the watershed, and the Duwamish Blueprint Projects are those which specifically address the transition zone, located in the Duwamish Estuary, where salmonids transition from being freshwater fish to saltwater fish, a critical juncture in the salmonid lifecycle.

Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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Figure 18

Terrestrial Habitat

Green-Duwamish Watershed Boundary

River Mile

Parks and Open Space

Lakes

Wetlands

Rivers & Streams

Wildlife Network

Rare and Sensitive Plant Habitats & Species

Habitat Conservation Lands

Noxious Weeds

- Class A (eradication required)
- Class B (control required)

ELLIOTT BAY

PUGET SOUND

0

10

20

30

40

50

60

70

80

90

KING COUNTY

PIERCE COUNTY

0 5 10Miles

Within the Green/Duwamish Watershed there is a clear demarcation in terrestrial habitat between the Upper Green and the rest of the subwatersheds. Within the Upper Green exist the largest swaths of rare and sensitive habitats and species, as well as habitat lands under conservation and wildlife networks. While there are some conserved habitat lands and wildlife networks within the other subwatersheds, these more suburban and urban environments are where noxious weeds thrive

Draft

Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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Vegetation

In the Upper Green Watershed, there are large blocks of coniferous forest of differing age and a variety of deciduous species. Timber harvests have occurred since the late 1900's, private landowners extensively harvested timber in the 1960s, and 1970s and large-scale replanting of Douglas fir took place. Old growth exists in this basin but is fragmented. More than 80 percent of the forest in the upper basin is less than 100 years old.

The Middle Green Watershed is made up of open hills and flat lands and all of the forest has been harvested at some time during the last 100 years. The forests are deciduous and coniferous vegetation. There are agricultural uses in this area and they are predominantly pasture.

In the Lower Green and Duwamish, subwatersheds have a mix of deciduous & coniferous forests. Agricultural lands dominate in the Mill-Creek subbasin. In the Duwamish River Estuary, vegetation is limited due to extensive industrial development.

Conditions Contributing to Loss of Biodiversity

Land use conversion and urbanization within the Green/Duwamish Watershed may alter and impair natural ecosystem functions in numerous ways. These changes can degrade the viability and connectivity of habitat, leading to reduced biodiversity. The following lists conditions that contribute to the loss of biodiversity in the Green/Duwamish Watershed.

1. **Reduced Water Quality**
   - Exceedances of water quality standards: dissolved oxygen and bacteria
   - Deposition of air pollutants into waterways & water bodies
   - Lack of shade leads to higher water temperatures

2. **Modified Hydrology**
   - Managing first flows limits peak flows and supplemental flows
   - Decreasing water quantity caused by water withdrawals
   - Flashier storms due to impervious surfaces
   - Channelized, simplified waterways reduce aquatic habitat quality and quantity

3. **Loss of Old Growth Forest and Loss of Forest Cover**
   - Pacific Northwest old growth forests provide unique habitat for multiple wildlife species uncommon in King County
   - Land development and timber harvests have essentially eliminated old growth forest from the Green/Duwamish watershed, with only a few small remnant stands remaining
   - Only about 50 percent of the watershed remains in forest cover, most of that located in the upper watershed upstream of Howard Hanson Dam

4. Loss of Habitat in Migratory Corridor

- Gaps in continuity of vegetation caused by removal during development or other land use conversions
- Severed connections between mainstream and off-channel habitats caused by existing and proposed -levees, dams, roads, sewers, etc.

5. Loss of Upland Terrestrial Migration Corridors

- Forestry harvest
- Development of land and roads limit and break up terrestrial habitat connectivity and interrupt migratory corridors for land-based species

6. Degraded Riparian Condition

- Lack of shoreline complexity caused by river and stream channelization
- Marine shoreline complexity limited by bank arming and bulkheads
- Docks marine edges

7. Alteration of Habitat-Forming Processes

- Lack of large woody debris, leaf, & insect inputs
- Flood management facilities and practices limit channel migration and habitat-forming flows
- Marine bulkheads
- Channelized, simplified waterways with armored shorelines, levees and/or floodwalls reduce access to riparian and floodplain habitat features

8. Alteration of Sediment Transport Processes & Reduced Sediment Quality

- Impervious surface conveys stormwater flows and sediment to water bodies
- Lack of sediment supply to marine habitats caused by bulk heading along Elliott Bay
- Dams limits sediment transportations from the upper watershed
- Changes in the benthic environment due to metals, PCB's in phalates

9. Fish Passage Barriers

- Culvert barriers prevent salmonids from moving upstream

10. Non-Native Species

- Invasive species proliferate along new edge conditions created during development
- Invasive shrubs proliferate along over-steepened, channelized, armored shorelines

11. Reduced Air Quality

- Air pollutants caused by vehicle emissions along transportation corridors
- Air pollutants caused by wood burning for heating homes

12. Increasing Temperatures

- Increasing water temperature caused by removal of shade-providing vegetation and runoff from warm impervious surfaces (lack of groundwater recharge is also cited in the Green River TMDL as a contributing factor to increased temps)
- Summer water temps in the Lower Green currently exceed TMDL standards and are lethal to fish

13. Decreasing Food Sources

- Adverse impacts related to land development pressures caused by population growth and sharply increasing land prices result in loss of natural areas and food sources for wildlife

CLIMATE CHANGE

The EPA states that climate change is any significant change in the measures of climate lasting for an extended period of time; includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. Across the globe, there is overwhelming evidence that increases in carbon dioxide and other greenhouse gases (GHGs) in the atmosphere are causing the climate to change. The year 2015 was the warmest on record since 1880, and the ten warmest years on record have occurred since 2000. Climate change is causing more heat waves, more extreme weather events, sea levels to rise, glaciers to disappear, the ocean to acidify, species to go extinct or change their range, and rainfall and storm patterns to change in major ways. These changes translate into economic, public health and safety, national security and environmental impacts that affect people and communities in many ways.

In recent years, scientists at the University of Washington Climate Impacts Group, among other sources, have shared new research about the likely impacts across the Pacific Northwest. While there remains uncertainty about the timing and magnitude of certain impacts there is significant consensus around what those likely impacts are, and many communities are taking action to prepare for climate change. Much is known that can inform actions in the Green/Duwamish watershed. The indicators highlighted in this section will be discussed in as much depth as possible given the best available science (i.e. data limitations). Indicators of climate change are:

- Surface Air Temperature & Extremes
- Average Precipitation & Extremes
- Mountain Snowpack
- Snowmelt and Streamflow Timing
- Sea Level
- Ocean pH
- Timing of Ecological Events
- Geographic Range of Plants and Animals
- Composition of Ecological Communities

- Air quality
- Loss of snow pack.

Climate Change Impacts in the Puget Sound Region

Measured Conditions

- Ocean water is 25 percent more acidic since the industrial revolution
- Puget Sound has risen more than 8 inches in 100 years (1913 - 2013)
- Lower river flows in summer
- Higher river flows and more flooding in fall and winter
- Over 80 percent of streams surveyed in King County exceed a salmon-safe temperature
- Flooding has closed I-5 four times since 1991
- Average Cascade snowpack is down 25 percent between 1950 and 2006
- A four-fold increase in average number of yearly wildfires between 1987 and 2003
- Four-fold increase in forest fires

Projected Future Consequences

- Disruption of marine ecosystems
- Marine-based economies suffer as fish/shellfish diminish in quality and quantity
- $29 billion worth of buildings and roads at risk of flooding
- Increase in severe storms
- Decrease in mountain snowpack up to 40 percent from pre-1960 averages
- Up to five-fold increase in acres burned by wildfires by 2080

Additional Impacts

- Increase in chronic health problems
- Impacts in forests from insects & disease outbreaks
- Increase in household costs: $1,250 per year by 2020
- Impacts to recreation and quality of life
- Impacts to salmon and wildlife

Surface Air Temperatures and Extremes

Temperatures are expected to rise by 3 – 10 F by the end of the century within the Pacific Northwest States of Washington, Oregon, and Idaho[xi]. More specifically, regional models expect an average 2°F increase by 2020, a 5.8°F increase by the 2050s relative to the 1950-1999 levels. These projections represent averages that could change drastically given specific geographic locations and seasons, with summers expected to experience the greatest temperature increases[xii].

It is also expected that the region will experience more extreme temperature days (heat waves) throughout the year that will work to exacerbate other temperature related issues such as Urban Heat Islands (UHIs). Urban areas with increased levels of impervious surfaces, such as black tops that absorb heat, can have increased surface temperatures when compared to the surrounding

more vegetated rural areas[xiii]. This phenomenon is known as the UHI effect, and as temperatures increase due to climate change in the region, the UHI effect is predicted to get more extreme. Already in 2014, the City of Seattle had one of the worst UHI temperature differentials in the United States, with temperatures in the urban core reaching up to 17°F hotter than nearby rural areas[xiv]. This is expected to get worse, and could serve as an indicator of what is to come in the other urban areas of the Puget Sound region, particularly as suburban areas within the Green/Duwamish Watershed become increasingly urban with population growth.

Vegetation within open spaces can work to counteract these temperature increases and the UHI effect through their ability to moderate local microclimates through the provision of shade, blockage of wind, transpiration, and carbon sequestration. Conversely, increasing temperatures can work to stress vegetation that is not well adapted to temperatures outside of its normal habitat range.

AVERAGE PRECIPITATION AND EXTREMES

Changes in annual and seasonal precipitation will continue to be primarily driven by year-to-year variations rather than long-term trends, but heavy rainfall events are projected to become more severe.

There will also be extreme seasonal variability with estimated decreases in summer precipitation levels, and increases in fall and winter precipitation. Severe rainfall events are expected to increase as well, primarily in the fall months, with the total number of days with more than 1 inch of rain projected to increase by 13% in the Pacific Northwest region by the 2050s (compared to 1971 to 2000 averages)[xv]. These changing precipitation patterns will also likely lead to increased flooding and drought days in the region[xvi].

Coupled with increased temperatures overall in the region, changes in precipitation are expected to decrease the snowpack in Washington's mountain ranges as more precipitation falls as rain instead of snow[xvii]. It is expected that by the end of the 21st century, all of the watersheds within Washington State, except the North Cascades, will be fed primarily by rainfall as opposed to a snowfall or a mixture of the two[xviii].

SNOWMELT AND STREAMFLOW TIMING

"Washington's water resources will be affected by projected declines in snowpack, increasing stream temperatures, decreasing summer minimum streamflows, and widespread changes in streamflow timing and flood risk."[xix]

The changes in precipitation levels, the seasonal timing of this precipitation, and the decreasing snowpack will play a significant role in the availability of water and surface water dynamics in the Puget Sound region. It is expected that in lower elevation basins of the Puget Sound, flooding will increase due to the effects of climate change. The opposite is likely true for higher elevation, snowmelt-fed basin systems that could lead to increased frequency of drought. Overall, low stream

flows during the summer months are predicted to become even lower throughout the Puget Sound, and this can negatively impact the long-term viability of aquatic species, such as salmon. Low flow will also work to decrease the amount of water available in the region for agriculture and domestic uses[xx].

Not only will the amount of streamflow change, but the timing of this flow will also be altered due to climate change. It is assumed that the spring peak flow will occur earlier in the year for several watersheds, even up to 4 to 9 weeks earlier by 2080 when compared to 1917 to 2006 averages in the Green/Duwamish Watershed. This is because winter streamflows are projected to increase for Washington State between 25 to 34 percent by the 2080s (when compared to 1970 to 1999 levels), and decline in the summer months by 34 to 44 percent[xxi]. Already, the Green River is seeing low summer flows that now longer allow recreational boating in places that were previously well used.

With these changes in stream timing and flow, as well as increases in regional temperatures, streams temperatures are also predicted to increase, further impacting plants and animals within the surface water systems of the state.

SEA LEVEL RISE AND OCEAN ACIDIFICATION

Sea levels within the Puget Sound region are expected to rise between 13 and 50 inches by 2100[xxii], and since the industrial revolution the world's oceans have absorbed 127 billion metric tons of carbon dioxide, lowering the overall pH by 0.1[xxiii] (see Figure 19). Temperature increases coupled with rising sea levels and acidifying oceans will put pressure on infrastructure and ecosystems that were not designed to withstand extreme heat, flooded, or acidic environments. These changes could therefore lead to inhospitable work environments as well as declining habitats for native species such as salmon.

Figure 19

Sea-Level Rise Projections

11' NAVD88

- 2' SLR above MHHW
- King Tide today
- monthly tide 2033 - 2064
- daily tide 2058 - 2099

12' NAVD88

- 3' SLR above MHHW
- King Tide 2033 - 2063
- monthly tide 2056 - 2095
- daily tide 2076 - 2122

13' NAVD88

- 4' SLR above MHHW
- King Tide 2056 - 2095
- monthly tide 2074 - 2119
- daily tide 2091 - 2142

14' NAVD88

- 5' SLR above MHHW
- King Tide 2073 - 2119
- monthly tide 2089 - 2139
- daily tide 2104 - 2159

Map Notes

The projections and scenarios are based on a 2012 National Research Council report ("Sea-Level rise for the Coasts of California, Oregon, and Washington: Past Present and Future"). Water levels account for the National Tidal Datum Epoch 1983-2001 (NTDE 83-01). The base digital elevation model (DEM) used in the analysis was produced using a 2001 Puget Sound LiDAR Consortium study, which notes a vertical accuracy, or margin of error, of 1 foot (NAVD88). Finally, "breaklines" were not applied; therefore some objects such as piers may not be accurately depicted.

Sea-Level Rise ("SLR") information is prepared for use by The City of Seattle for its internal purposes only, and is not designed or intended for use by members of the public. ALL SUCH SLR INFORMATION AND CONTENT IS PROVIDED ON AN "AS IS", "AS AVAILABLE" BASIS WITHOUT WARRANTIES OF ANY KIND EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY, AND NON-INFRINGEMENT. The City of Seattle makes no representations or warranty as to its accuracy, and in particular, its accuracy as to labeling, completeness, reliability, currency, dimensions, contours, property boundaries or placement of location of any map feature thereon. In no event will The City of Seattle be liable for any loss or damage including without limitation, indirect or consequential loss or damage, or any loss or damage whatsoever arising from loss of data or profits arising out of, or in connection with, the use of any SLR information.

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January 8, 2014

Coordinate System: State Plane, NAD83-91, Washington North Zone

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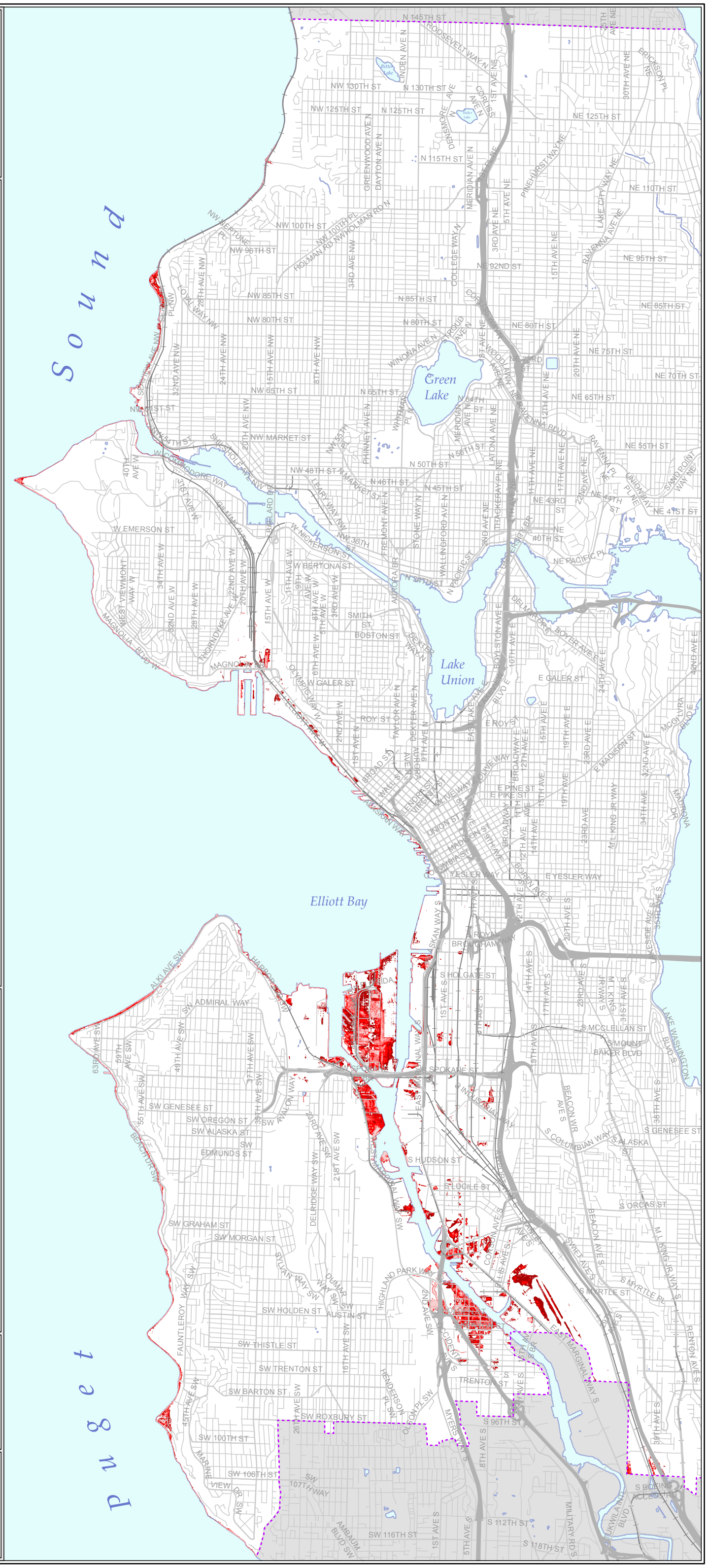


HUMAN HEALTH

The Centers for Disease Control & Prevention defines human health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Where we live, work, play and learn matters for our health. Chronic diseases are leading causes of death and illness in King County. Some chronic diseases can be prevented or controlled through healthy choices about activities, habits and diets. Healthy, natural and built environments can support healthy personal choices. Clean air, land and water are all essential components of that environment. How our neighborhoods take shape, such as with parks, places to walk or do other kinds of physical activity, and sources of affordable, nutritious foods, also influence our health. Health challenges are not just environmental; they are shaped by broader economic, social, environmental and political systems. The indicators of human health are:

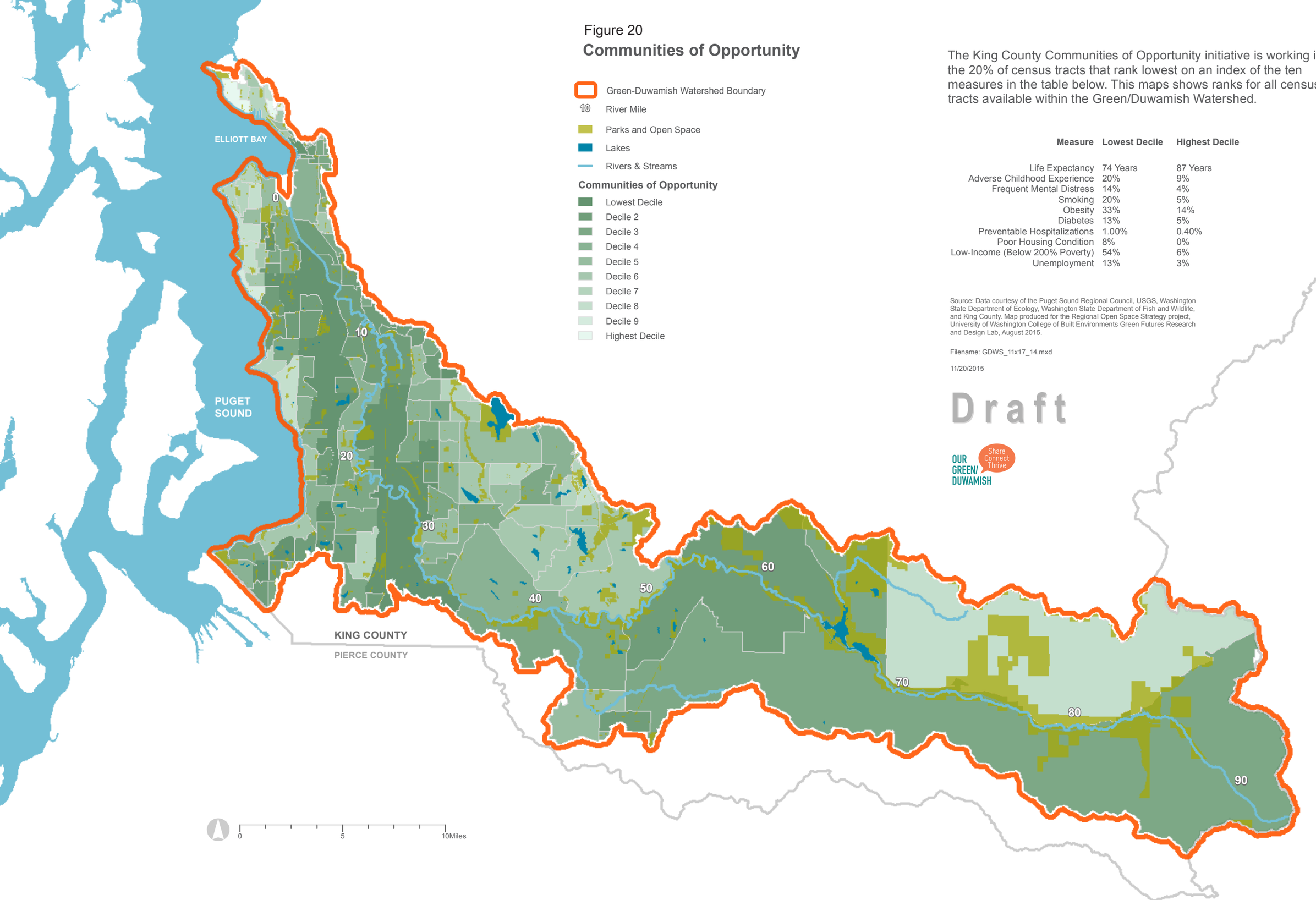
- Life Expectancy
- Chronic Diseases (Coronary Heart Disease, Diabetes, Asthma)
- Health Risk Factors (Obesity, Stress, Low Birth Weight)
- Environmental Toxic Exposure (Toxic Release Inventory (TRI) Facilities, Diesel Pollution, Contaminated Fish Consumption)
- Access to Healthy, Affordable Foods (Fruit and Vegetable Consumption)
- Physical Activity (Walkability and Bikeability)

In King County, health and social disparities remain issues to solve. In particular, people of color, those with Limited English Proficiency (LEP), and who are low-income persistently face health inequities. In 2014, King County and Seattle Foundation launched the Communities of Opportunity (COO) Initiative to improve the community features, including the physical environment, that shape the health and well-being of residents and the vibrancy of neighborhoods (Figure 20). The initiative's efforts focus in the 20 percent of census tracts that rank lowest in: life expectancy, health, housing quality and economic opportunity. Most of these priority communities lie within the Duwamish Estuary, Nearshore and Lower Green River sub-watersheds, including:

- Seattle's Downtown area (including Pioneer Square and Chinatown-International District) near Elliott Bay;
- South Seattle neighborhoods of Beacon Hill, South Park and Georgetown in the Lower Duwamish Valley;
- Unincorporated areas of White Center and Skyway;
- Nearshore communities of Burien, Des Moines and Federal Way; and
- Lower Green River communities of Tukwila, SeaTac, Renton, Kent, Auburn and Algona.

Figure 20

Communities of Opportunity



The King County Communities of Opportunity initiative is working in the 20% of census tracts that rank lowest on an index of the ten measures in the table below. This maps shows ranks for all census tracts available within the Green/Duwamish Watershed.

Measure	Lowest Decile	Highest Decile
Life Expectancy	74 Years	87 Years
Adverse Childhood Experience	20%	9%
Frequent Mental Distress	14%	4%
Smoking	20%	5%
Obesity	33%	14%
Diabetes	13%	5%
Preventable Hospitalizations	1.00%	0.40%
Poor Housing Condition	8%	0%
Low-Income (Below 200% Poverty)	54%	6%
Unemployment	13%	3%

Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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11/20/2015

Draft

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HUMAN HEALTH CONDITIONS

Many of the health data discussed in this report are presented in Health Reporting Areas (HRAs), made up of neighborhoods, individual cities, or grouped cities and unincorporated areas.[xxiv,xxv] Other data are presented for zip code 98108, which includes the Seattle neighborhoods of South Park, Georgetown, and Beacon Hill (see Figure 21).

Life expectancy at birth varies widely across the Green/Duwamish Watershed, ranging from 76.6 years in South Auburn to 79.7 years in East Kent to 84.1 years in Seattle's Magnolia/Queen Anne. The Lower-Middle Green River subwatersheds, in particular, have a high concentration of lower life expectancy (76.6 to 82.0 years). South Park/Georgetown/Beacon Hill has a life expectancy of 80.8 years. Take out Beacon Hill, and the life expectancy for South Park/Georgetown is 73.3 years[xxvi]. Many of the Lower Green River communities including Kent, Federal Way's Central/Military Road area, South Auburn, and East Federal Way (the unincorporated areas between Federal Way and Auburn, including the city of Algona and Pacific), have among the highest death rates from both heart disease and diabetes.

Between 10.8 to 17 percent of adults have current diagnoses of asthma in the Seattle's Delridge neighborhood, North Highline area, Burien, South Renton, East Kent, Federal Way's Central/Military Road area, South Auburn, and Black Diamond/Enumclaw/SE County area. In Seattle's South Park/Georgetown/Beacon Hill area, nine percent of the adults have asthma, similar to the Seattle rate. The rate of childhood asthma hospitalization in South Park/Georgetown/Beacon Hill area is 328 per 100,000 residents, higher than Seattle overall (212 per 100,000) and King County overall (137 per 100,000)[xxvii]. Figure 22 shows asthma hospitalizations by zip code.

At any stage of life, obesity can have serious health consequences, including cardiovascular disease and diabetes. Burien, South Renton, Kent, East Federal Way, South Auburn, Covington/Maple Valley, and Enumclaw/Black Diamond/SE County area have a high percentage of obese adults (29.3 to 42.7 percent) in the watershed. Notably, almost half of the adults in East Federal Way (42.7 percent) and South Auburn (40 percent) report being obese. Fifty-five percent of adults in ZIP code 98108 are overweight or obese, higher than Seattle overall (48 percent). [xxviii]

Long-term stress can increase the risk of depression, heart disease, and other health conditions[xxix]. Communities in the watershed with high percentage of adults reporting they have frequent mental distress (11.8 to 16.2 percent) and poor mental health days (11.9 to 16.7 percent) are: Seattle's Downtown and South Park/Georgetown/Beacon Hill neighborhoods, Burien, South Renton, Kent, Federal Way's Central/Military Road area, and South Auburn.

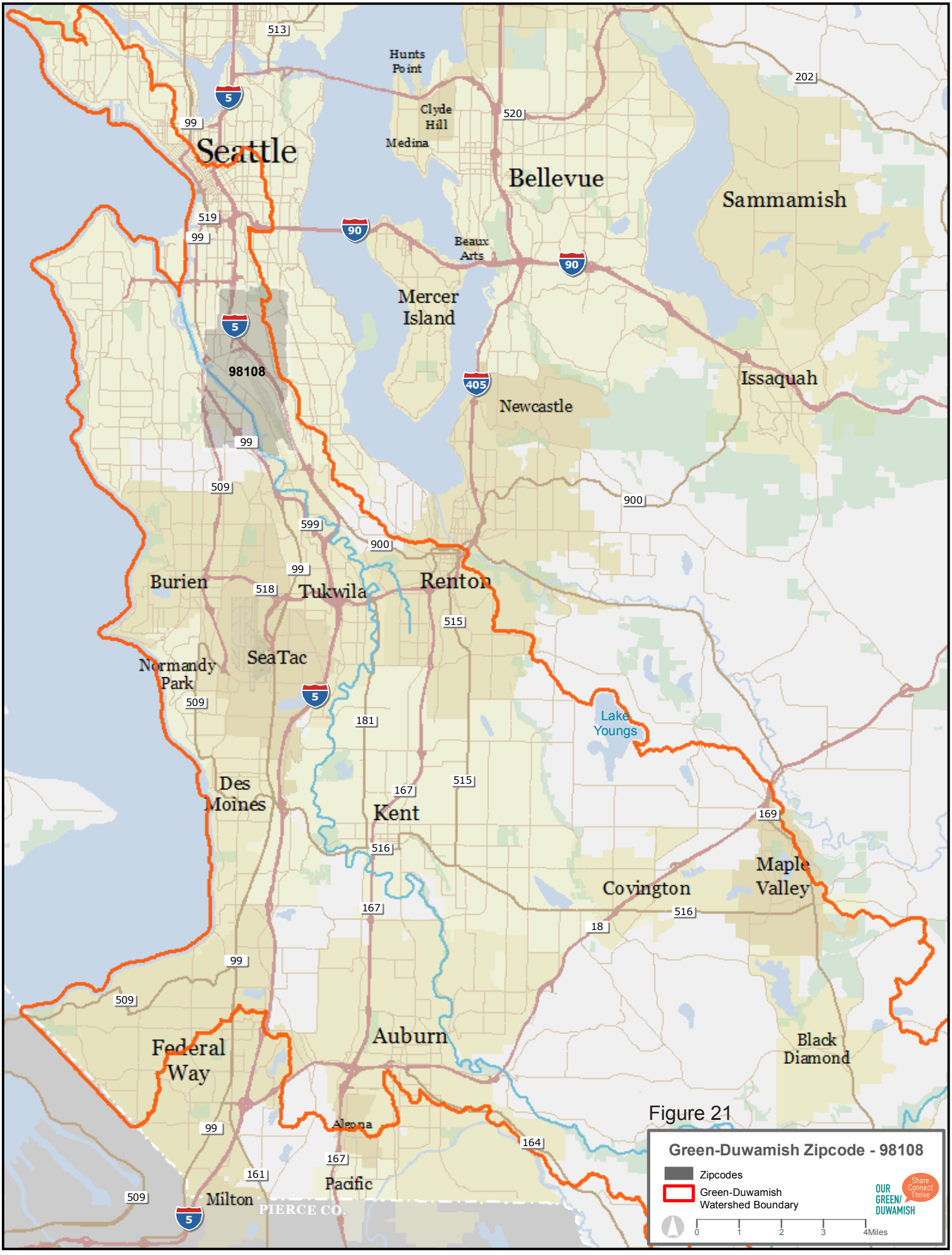
Seattle
Hunts Point
Clyde Hill
Medina
Bellevue
Sammamish
Beaux Arts
Mercer Island
98108
Issaquah
Newcastle
Burien
Tukwila
Renton
Normandy Park
SeaTac
Lake Youngs
Des Moines
Kent
Covington
Maple Valley
Auburn
Federal Way
Black Diamond
Algona
Pacific
Milton
PIERCE CO.
513
202
520
519
99
90
405
509
599
900
518
515
181
167
516
169
18
164
161
5
Green-Duwamish Zipcode - 98108
Zipcodes
Green-Duwamish Watershed Boundary
OUR GREEN/ DUWAMISH
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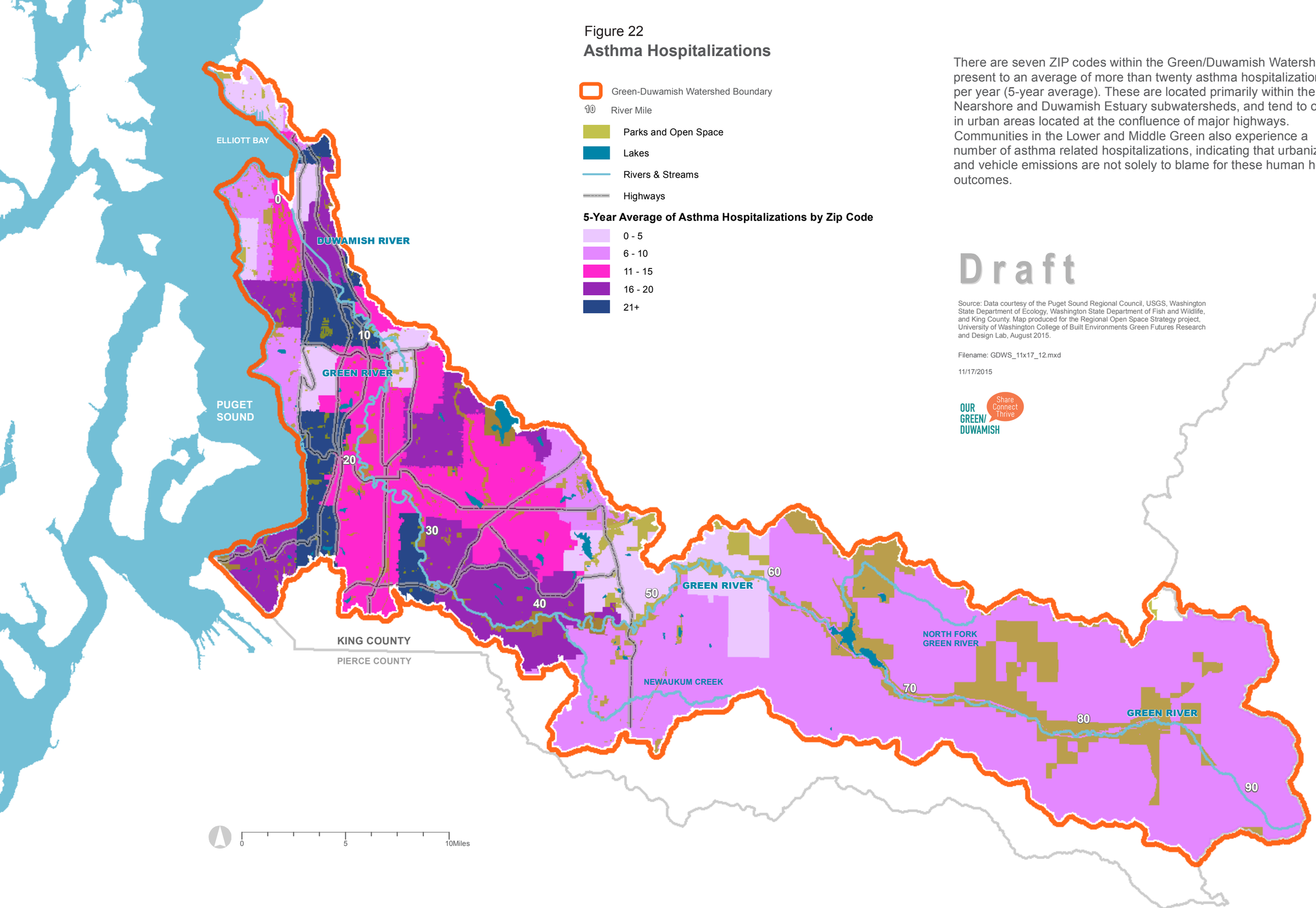
Figure 21

Figure 22

Asthma Hospitalizations



There are seven ZIP codes within the Green/Duwamish Watershed present to an average of more than twenty asthma hospitalizations per year (5-year average). These are located primarily within the Nearshore and Duwamish Estuary subwatersheds, and tend to occur in urban areas located at the confluence of major highways. Communities in the Lower and Middle Green also experience a number of asthma related hospitalizations, indicating that urbanization and vehicle emissions are not solely to blame for these human health outcomes.

Draft

Source: Data courtesy of the Puget Sound Regional Council, USGS, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and King County. Map produced for the Regional Open Space Strategy project, University of Washington College of Built Environments Green Futures Research and Design Lab, August 2015.

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11/17/2015

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According to recent studies in Portland, Oregon[xxx] and Vancouver, British Columbia[xxxi], tree canopy or residential greenness may lower the risk of low birth weights[xxxii], possibly by reducing stress. Higher rates of low birth weight babies (6.8 to 7.7 babies per 100 births) in the watershed are reported for: Seattle's Downtown, North Highline area, SeaTac/Tukwila, South Renton, Kent (West and Southeast), and North Auburn. There is a lack of vegetation in South County, particularly from Tukwila south to Algona/Pacific, which can impact quality of life[xxxiii]. Zip code 98108 has among the lowest tree canopy per acre in Seattle, and falls in the mid-range of park land per resident (6 percent in 98108, in a range of 4-27 percent citywide).

Environmental Determinants of Health

Contaminated Land and Toxic Releasing Facilities

1. The Lower Duwamish Valley contains the highest number of known or suspected contaminated waste sites and Toxic Release Inventory sites (TRIs).[xxxiv,xxxv] Zip code 98108 has 38 TRIs, more than twice as many as the next highest zip code in Seattle
2. Contaminated sites in the Lower Duwamish valley are contributing to contaminants in runoff to the Duwamish River
3. In South King County region, the air release of toxic chemicals grew by 24 percent between 2000 and 2006.

Contaminated Seafood Consumption

The Green/Duwamish Watershed has seafood consumption advisories due to chemical pollution for certain species in Puget Sound, Elliott Bay and the Lower Duwamish River. The Lower Duwamish River seafood consumption advisory is the most restrictive in the state (i.e., do not eat resident fish, shellfish and crab). It may become less restrictive after the 17-year period of active cleanup and monitored recovery, but is likely not to be removed.

Elliott Bay advisory recommends not eating rockfish, clams, mussels, oysters and scallops. Puget Sound advisory for King County recommends not eating rockfish only. Flatfish and crab species that are too contaminated to eat from the Duwamish can be safely eaten at two to three meals per week if caught from Puget Sound. Despite the consumption advisory and posted signs, local fishers and their families continue to catch and eat contaminated seafood. In King County, urban subsistence fishers are primarily from low-income, immigrant, homeless and tribal communities resulting from a lack of affordable, healthful food alternatives to low-income and vulnerable populations fishing in Lower Duwamish Waterway. Subsistence and recreational fishing populations can be exposed to contaminants in certain seafood. The developing fetus and child are the most at risk to short-term and long-term health effects from eating contaminated seafood. Chemicals, such as mercury and PCBs, can harm the growth and brain development of babies and children. Fishers and those who eat contaminated fish for years have increased risk of developing cancer.

Outdoor Air Pollution

Consistent with information from PSCAA, poor air quality is generally concentrated around industrial centers and transportation corridors. Zip code 98108, near Georgetown ranked highest among Seattle neighborhoods for diesel particulates. This zip code has an annual average diesel particulate matter of 2.3 ug/m3, less than the King County average (1.03 ug/m3). Trucks and other diesel exhaust, along with less wind and stagnant winter weather in the Duwamish Valley, contribute to the poor air quality.

Physical Activity

Regular physical activity helps control weight, boost mental health and academic performance, and reduces the risks of many chronic diseases. Communities with a higher percentage of adults that report no physical activity (21.2 to 29.4 percent) are as follows: South Park/Georgetown/Beacon Hill, North Highline, Burien, Des Moines/Normandy Park, Southeast Kent, SeaTac/Tukwila, and Federal Way's Dash Point. People who live and work in walkable neighborhoods are more likely to be physically active; and are less likely to be overweight or obese. King County's Walkability Index Map show that most of Duwamish Estuary, Nearshore and Lower Green River sub-watersheds are rated in the medium walkability range, with Middle Green River sub-watershed rated mostly as low walkability[xxxvi].

Access to Healthy, Affordable Foods

Eating fruits and vegetables lowers the risk of developing many chronic diseases, provides important nutrients for the human body, and can also help with weight management. Only 12 percent of all King County adults and 26 percent of King County middle and high school age youth consume recommended levels of fruits and vegetables, and there are significant disparities[xxxvii]. In recent community reports (including from South Seattle, Delridge, and Auburn), affordability is commonly cited as a significant barrier to healthy eating (not transportation or proximity to grocery stores)[xxxix]. Food insecurity refers to "limited or uncertain availability of nutritionally adequate and safe food or limited or uncertain ability to acquire acceptable food in socially acceptable ways."[xxxviii] In King County, 13 percent of adults live in "food-insecure" households, and 22 percent of children live in "food-insecure" households[xxxix]. In South King County, more people run out of food when compared to other parts of the County.

Social Equity

Ecotrust defines social equity as fair access to livelihood, education, and resources; full participation in the political and cultural life of the community; and self-determination in meeting fundamental needs. Differences in well-being that disadvantage one individual or group in favor of another is inequity. Studies show that in some cases, areas that are the most ecologically damaged and proven unhealthy for humans are also areas in which minority communities more often reside than the majority of the population. In the last decade growth among communities of color contributed to more than 90 percent of all population growth in the region, and immigrants alone accounted for

approximately 40 percent of that growth. Demographics for King County indicate that the majority of people of color, those with low income, and those with low educational attainment live in the Green/Duwamish Watershed.

The inequities are not random, but rather systematic, patterned and unfair caused by past and current decisions, systems of power and privilege, policies, and the implementation of those policies. Voices of minority populations continue to have limited access to planning and decision-making processes. They have resulted in higher rates of poor health and obesity and lower life expectancies. These circumstances perpetuate inequitable differences in service, access, and the quality-of-life experience the Puget Sound region prides itself on. Determinants of equity are:

- Education & Early Childhood Development
- Jobs, Job Training, & Community Development
- Health and Human Services
- Food Systems
- Parks and Natural Resources
- Built and Natural Environment
- Transportation
- Affordable & Quality Housing
- Community and Public Safety
- Civic Participation
- Digital Access

The project, together with the many other initiatives being undertaken in the watershed, is an effort to reverse these inequitable trends, with improved focus on community engagement toward a healthier environment physically, socially, and culturally.

PRIORITY POPULATIONS

South King County is the southern portion of the County that excludes the City of Seattle but is otherwise roughly contiguous with the Green/Duwamish Watershed. The population in this area is growing faster than in Seattle/Shoreline and East King County. The share of individuals in the King County metropolitan area below federal poverty thresholds living in Seattle-Tacoma-Bellevue suburbs is on the rise: 61 percent in 2000, and 66 percent in 2010[xl]. In South King County, 26 percent of people have earned a bachelor's degree, compared to Seattle, King County, and national averages (56 percent, 46 percent, and 28 percent, respectively).

As noted earlier, 74,000 or 12 percent of the population in this area live below federal poverty thresholds. Nearly all population growth in this area is comprised of people of color and it represents one-third of the county population. It also represents more than its share of children and people of color, and is home to more than half of the county's Latino population. Of the 37 tribal communities in the state, three have association in this watershed, with a total of 3,210

individuals. In many parts of South King County, more than a quarter of the population speaks a language other than English and the refugee population relative to the north and east regions. In comparison to the general population of King County, the foreign-born population in King County is:

- Three times more likely to speak a language other than English at home
- Half as likely to have a high school diploma
- More likely to have no health insurance coverage
- More likely to live in poverty.

SUBSISTENCE FISHING POPULATION[xli]

In King County, urban subsistence fishers are primarily from low-income, immigrant, homeless and tribal communities. The Duwamish Health Impact Assessment Report's Technical Study on Subsistence Fishing Population provided valuable information regarding residents in this area. Fishing and shellfish harvesting reflect cultural, lifestyle, and dietary traditions for many Asian and Pacific Islander (API) Americans and immigrants. This brings higher risk of exposure to contaminated fish through cultural and traditional consumption practices.

In addition, in a study by Public Health - Seattle & King County, researchers collected information about fishing activities through conversational surveys with 35 individuals fishing at public fishing piers along the Duwamish River. Through their surveys, researchers identified fishing practices among African American, White, Vietnamese, Filipino, Cambodian, Laotian, Hispanic, Thai, and Mongolian individuals, nearly half (49 percent) of whom primarily spoke a language other than English.

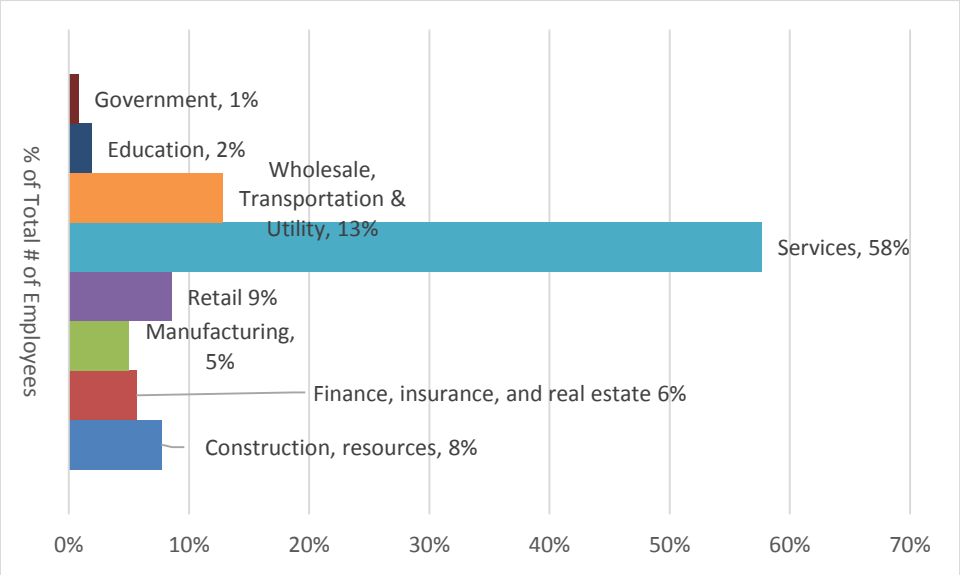
ECONOMY

Economic activity within the Green/Duwamish Watershed is as robust as it is varied. Goods and services produced here reach local and global customers, and all scales in between. The watershed is home to the largest international airport and seaport in the Pacific Northwest, the second largest warehousing district on the west coast, and holds acres of sensitive habitat and threatened species[xlii]. The Lower Green River Valley alone contributes to 1/8th of Washington State's economy.

Figure 23 shows the PSRC's 2014 Covered Workplace Estimates. Covered employment summaries, which this data is based on, are derived from the Quarterly Census of Employment and Wages

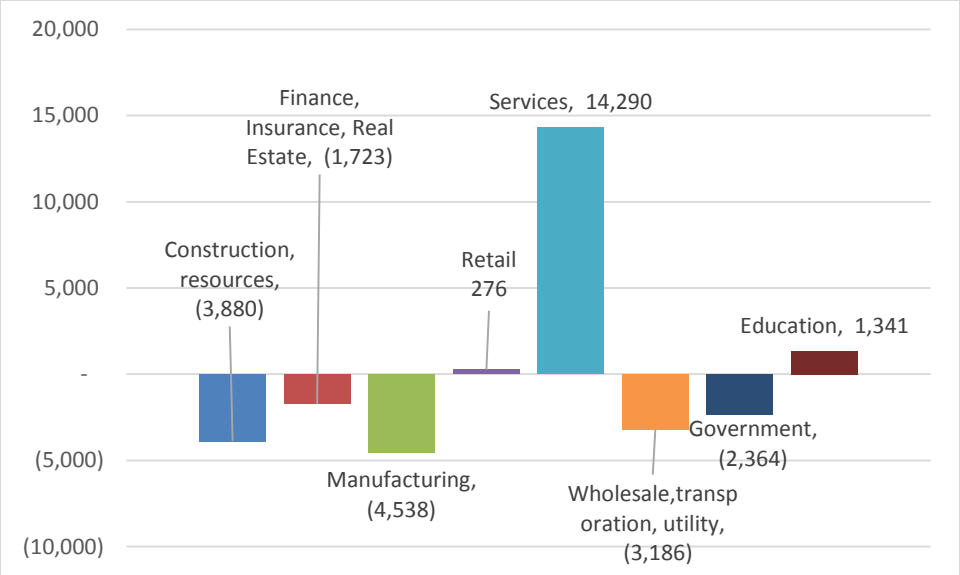
(QCEW), administrative records employers report, by law, to the Washington State Employment Security Department (ESD).

FIGURE 23 - PERCENT WORKPLACES PER SECTOR 2014 (PSRC)



During the Great Recession of 2008-2009, employment sectors suffered a significant decline. Recent data that captures job gain and loss per work sector from 2008 to 2014 indicate that since the Great Recession, job loss in the Green/Duwamish Watershed has recovered with a slight gain in jobs (Figure 24). What is noticeable from this data is that since the 2008, over the six-year period, job gains have occurred in mostly the services sector. There have been overall job losses in construction, manufacturing, fire, wholesale, transportation and utility and government sectors.

FIGURE 24- JOB GAIN & LOSS PER WORK SECTORS (2008 TO 2014) (PSRC)



Employment and industry types change gradually across the rural to urban gradient moving northwest from the upper to lower watershed. Major employment sectors include manufacturing, agriculture, aerospace, outdoor recreation/tourism, and transportation and other Port related activities.

The Green/Duwamish Watershed is an economic engine for the region and employs thousands of residents. Along with King County, the watershed's economy is expected to continue to grow over the next 10 years, although the quality and sustainability of this growth is at risk if mitigation measures are not taken concerning climate change and other factors discussed above. Indicators of economic development:

- Unemployment Rate
- Job Growth Projections
- Business Income
- Business Start-ups and Closures
- Educational Attainment
- Income Distribution
- Cost of Living.

CHAPTER 3: WATERSHED PLANS AND PROGRAMS

There are a number of actions underway within the Green/Duwamish Watershed to actively maintain and improve quality of life for the people, plants, and animals that live, work, and spend time here. Many of these actions, though not all, are captured in the official planning and programming documents of various government agencies, community groups, and businesses. Hundreds of millions of dollars have been allocated to and through these plans and programs, by federal, state, local, non-profit, private sector, and community entities.

As part of the early phases of information gathering, the Green Futures Lab collected more than ninety plan and program documents describing actions to be taken toward target goals for healthy environmental and social conditions. Green Futures Lab staff as well as King County and City of Seattle partners prioritized forty-one key plans and programs for review in greater depth. Where possible, each plan was described in the summary table in Appendix B, the "Draft Plans and Programs Inventory," listing the lead agency, key partners, geographic reach, intended outcome, metrics and targets used to measure success, the plan or program's timeframe, resources deployed to meet its goals, and the status of progress for each. Through this effort, the plan and program activities of greatest impact within the watershed were identified. Those activities are described below, in relation to the air, land, water, and socioeconomic resources they affect.

AIR PLANS & PROGRAMS

The Green Futures Lab team looked at plans that address air quality within the watershed, as well as those that address climate change as it is influenced by greenhouse gas emissions (GHGs). Many of these plans also address opportunities to adapt to present and anticipated climate change impacts. These include plans developed at the federal level, as required by Executive Orders 13514 and 13653 – "Preparing the United States for the Impacts of Climate Change." The Green Futures Lab looked at climate change plans drafted under these Orders from the following agencies: FEMA, EPA, USDA, and USDOT. While it is unclear whether these plans may include specific implementation actions within the Green/Duwamish Watershed, they offer varying levels of guidance for activities within the agencies, intended to bring about reductions to greenhouse gas emissions as well as opportunities for the agencies and their subject areas to become more resilient to climate change impacts. Related to climate change, the White House's Clean Power Plan is the most recent and potentially most impactful federal plan to-date. The plan specifies greenhouse gas emissions reductions targets for the states, each of which is required to prepare a plan by September 16, 2015, outlining steps for achieving its greenhouse gas emission reduction targets. The target established for Washington State is a reduction by 37 percent from 2005 levels.

Three significant plans already underway have goals of reducing greenhouse gas emissions to help mitigate climate change and to reduce adverse impacts of air quality on human health. These three

plans, the PSCAA's Strategic Plan, King County's Strategic Climate Action Plan, and the City of Seattle's Climate Action Plan, are ambitious and regarded as leading the nation when it comes to climate change planning.[xliii, xliv] Each plan establishes its own baseline year for measuring GHG emissions, to which future emissions will be compared for the sake of measuring progress toward reduction goals. The emissions reduction targets are more stringent for King County and Seattle than those required by the Clean Power Plan for Washington State; however, the plans refer to different baseline years, so such comparison is not wholly applicable. In addition to emission reduction goals, the three local plans aim to mitigate climate change stressors on human health. The King County and Seattle plans include goals for improving livability within their respective planning areas, and PSCAA's Strategic Plan includes targets for human health improvement and associated cost savings.

Two additional efforts, PSCAA's Highly Impacted Communities program and the Duwamish Community Action for Clean Air initiative, further address air quality in the Green/Duwamish Watershed, as it disproportionately impacts certain socioeconomic groups. These efforts focus on mitigating impacts to specific communities rather than addressing air pollution reductions overall.

Some of the current efforts and strategies PSCAA is implementing to reduce pollution in the watershed include:

- Region-wide efforts to shift to cleaner fuels and vehicles to reduce ozone;
- Scrapping older drayage trucks and replacing them with cleaner, modern engines to decrease the number of diesel trucks;
- Reducing wood smoke levels by calling burn bans in the winter and seeking funds to help residents replace older, more polluting wood stoves;
- Better defining localized pollution exposure through partnerships with communities, including the use of lower cost emerging technology monitoring devices;
- Requiring stationary sources to meet their authorized emission limits.

In addition, the PSCAA's Strategic Plan commits them to working with highly impacted communities on both issues identified by the communities and strategies to reduce pollution on all fronts.[xlv]

LAND PLANS AND PROGRAMS

In Washington State, land use and attendant land cover conditions are regulated by the State's Growth Management Act (GMA), with goals of curbing sprawl and maintaining urban and suburban habitat appropriate for people, plants, and wildlife. As required by the GMA, such objectives are embodied in the comprehensive plans of all cities within the Green/Duwamish Watershed as well as King County. The GMA also requires Shoreline Master Programs to be coordinated with each comprehensive plan, which aim to coordinate shoreline planning and avoid harmful, uncoordinated development of the state's shorelines. PSRC's Vision 2040 both informs and draws on city and county land use plans as it promotes strategies to advance environmental, social, and economic

well-being in the Puget Sound Region, while accommodating regional population growth projected to reach 5 million by 2040.

Programs addressing plant and wildlife habitat within the watershed comprise voluntary and compulsory initiatives. Voluntary efforts include Forterra's Green Cities Initiative and its Cascade Agenda, as well as the National Fish, Wildlife, & Plants Climate Adaptation Strategy. Although not addressing habitat needs at a level that can maintain or improve habitat conditions across the watershed, these voluntary efforts effectively lessen the negative impacts of urbanization and climate change. Compulsory programs addressing habitat within the watershed include those that aim to revive endangered and otherwise compromised land-dwelling species.

Plans that aim to provide recreational opportunities across the Green/Duwamish Watershed's built environments and natural areas include Washington State's Comprehensive Outdoor Recreation Plan and King County's Open Space Plan and Regional Trails Needs Report. These plans call for recreational amenities such as parks and trails to be spread equitably across communities within their respective planning areas.

WATER PLANS AND PROGRAMS

A number of agencies, primarily at the state and county level, actively and intensively, address water quality in the watershed. The Washington State Department of Ecology is the leader and primary enforcer of water quality improvement actions, with the CWA and Endangered Species Act (ESA) as main drivers of regulation within the watershed. Ecology also implements the Water Pollution Control Act, State Environmental Policy Act, and Shoreline Management Act through its various outreach, regulatory, and enforcement efforts.

Plans and programs that serve to implement these water quality laws include: the WRIA 9 Salmon Habitat Recovery Plan; the EPA Record of Decision for the Lower Duwamish Waterway Superfund Site; the System Wide Improvement Framework (SWIF) for the Lower Green River; the Puget Sound Action Agenda and its local caucus and associated action plan in the South Central Action Area (Cedar/Sammamish, Green/Duwamish, and Puyallup/White watersheds); and the National Pollutant Discharge Elimination System (NPDES) permitting program and associated Total Maximum Daily Load (TMDL) regulations. The NDPES program regulates and enforces water quality laws at the parcel level, working with landowners and municipalities as they aim to reduce runoff from roads and other impervious surfaces into storm drains. Municipalities in particular are accountable for their storm sewer discharges into waterways, including CSO, which is addressed through King County's CSO Control Plan. Together these plans and programs have dramatically reduced the flow of pollutants from point sources along the Green and Duwamish Rivers.

Non-point origins of water pollution come primarily from stormwater runoff that flows directly into water bodies. Though runoff can be regulated at the site scale through local development ordinances, there are still gaps in the regulatory framework intended to prevent non-point

stormwater runoff. Through its work program and implementation plan, King Conservation District (KCD) aims to assist landowners with site planning and best management practices that reduce stormwater runoff carrying fertilizers, chemicals, and other pollutants. KCD's array of programs aimed at reducing pollutant runoff include Farm Management Planning and its Agricultural Drainage Program.

Water purveyors also have plans for managing water supply. There are large utility agencies such as Tacoma Public Utilities and Seattle Public Utilities, as well as, smaller water purveyors have specific plans that direct capital planning and improvements.

Additional existing plans and programs address water quantity problems, including: Floodplains by Design, the King County Flood Hazard Management Plan, and the SWIF. The SWIF addresses quantity and quality, and will resolve incompatibilities between requirements of the Endangered Species Act and the Army Corps of Engineers. The Army Corps manages flood control in at least two ways, through levee and revetment projects and with its operations at Howard Hanson Dam (HHD). HHD is the primary flood control mechanism in upper portion of the Green/Duwamish Watershed, while actions taken by the King County Flood Control District along with the Corps help guide water that makes its way to the lower reaches of the watershed.

SOCIOECONOMIC PLANS AND PROGRAMS

There are a variety of plans and programs that address human social conditions within the watershed, including health, equity, and economic vitality. These plans and programs include targets for health outcomes overall as well as elimination of documented health and economic disparities between socioeconomic groups. Plans aimed at improving health and equity outcomes include the Washington State Action Plan to Eliminate Health Disparities; King County's Communities of Opportunity program and its Equity and Social Justice Strategic Plan; Seattle's Race and Social Justice Initiative as well as its Equity and Environment Initiative; and the Duwamish River Cleanup Coalitions' Duwamish Valley Vision and its Healthy River / Healthy Communities Project. Of these plans and programs, those developed by government agencies focus primarily on the systemic origins of social inequity.

These plans and programs also include actions aimed at bolstering the region's economy by building up its workforce, through job training and attracting top talent. Some programs focus specifically on preparing low-income individuals for jobs in industrial and environmental sectors, many of which face a worker supply gap. These include the King County Jobs Initiative; Career Connections, Homeless Employment Project, Communities of Opportunity, Seattle's Job Readiness Training Program for Immigrant/Refugee Youth and Families; El Centro de la Raza's Youth and Family Job Readiness Program; and the Manufacturing and Industrial Council's Core Plus Program. Economic development is also addressed in Puget Sound Regional Council's Regional Economic Strategy. With a number of goals aimed at improving conditions of the business environment, the strategy calls for actions to facilitate export opportunities, entrepreneurship, and proper infrastructure. PSRC's

Growing Transit Communities plan also addresses the need for sufficient infrastructure, focusing primarily on transportation networks and zoning practices intended to develop urban communities where housing, jobs, and transportation are arranged together in an optimal balance.

Several plans focus on health and equity planning from the grassroots level, putting planning into the hands of some of the most highly impacted communities. Those plans include the DRCC's Duwamish Valley Vision and the South Park Green Space Vision Plan. These plans have involved extensive outreach and represent the stated needs and aspirations for neighborhood residents in two of the watershed's communities that have faced historical environmental injustices. Community planning and outreach is perhaps lacking in other areas of the watershed, with few other plans led by members of highly impacted communities. Such community driven plans provide an abundance of information about what needs are most pressing for these neighborhoods, as elicited directly from community members, and identify those actions and investments that might be most impactful for improving their quality of life.

CHAPTER 4: LISTENING PHASE FINDINGS

This chapter summarizes the results of the listening tour and background research. Based on both direct input from listening tour participants, background research and analysis of existing plans and programs affecting the watershed, the Green Futures Lab compiled a list of perceptions of watershed conditions as well as associated concerns and suggestions. This information was compiled in a master database, facilitating organization of the data according to focal topics, affected sub-basins, and involved resources. Through an intensive multi-stage internal workshop process, the Green Futures Lab condensed this comprehensive content into about 75 consolidated ideas on watershed issues and responses. These 75 ideas were ultimately synthesized into a set of 39 key concepts reflecting findings regarding the most important challenges and related opportunities in the watershed. Technical aspects of these concepts were then further refined through outreach to leaders and specialists in agencies, non-profits, businesses, and community groups working in the watershed.

Findings from this work are presented in a three-column table listing first, the challenge or gap, second, and opportunities that could address the potential air, water and land management/enhancement measures, and last a list of pertinent plans & programs may impact that challenge/gap. This information and analyses of the watershed listening tour is shown in Table 3 below.

TABLE 3 - LISTENING PHASE FINDINGS

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		**Relevant Plans / Programs**
	Challenges	**Opportunities**	
	(Uncommon Acronyms: FbD - Floodplains by Design; NFWPCAS - National Fish, Wildlife & Plants Climate Adaptation Strategy; SCAP - Strategic Climate Action Plan; SHRP - Salmon Habitat Recovery Plan; SWIF– System Wide Improvement Framework)		
1	Many individuals, community groups, and government agencies are hard at work engaging in restoration and conservation efforts across the watershed. Much of this work is piecemeal, with limited opportunities for coordination and communication among the various efforts. - Current restoration and conservation efforts work with present-day conditions, but climate change has the potential to further exacerbate factors of species decline. - Most of previous environmental efforts have focused on salmon, particularly Chinook salmon. While these are significant endeavors, there are other resource management objectives besides habitat conservation, such as improved water quality, climate change adaptation, flood hazard reduction, heat reduction, etc.	**Create a watershed-wide biodiversity plan. Fund and support a process for biodiversity analysis and planning. May include:** - Investigate the possibility of a Puget Sound Partnership division (similar to how watershed and river planning was accomplished in Vancouver, BC) or a Duwamish Coalition to coordinate all efforts within the Green/Duwamish Watershed. Include cultural restoration and acquisition strategy. - Investigate and make clear the compounding impacts of growth with climate change on biodiversity. Share with agencies and the public. - Bring transportation into the conversation about biodiversity. - Address regional aspects of open space/ecological issues beyond salmon recovery, including: aquatic systems performance, terrestrial and avian species, air and water quality, invasive species, native soils conservation, etc.	• Green Cities Program (Forterra, Seattle, and Kent, 2004) • King County Open Space Plan: Parks, Trails, and Natural Areas (2010) • South Park Green Space Vision Plan (Seattle Parks Foundation, 2014) • National Fish, Wildlife, & Plants Climate Adaptation Strategy (USFWS, 2012) • Climate Adaptation Plan (USDA, 2014) • Cascade Agenda (Forterra, 2005) • Regional Trails Needs Report (KC, 2012) • SHRP (WRIA 9, 2005) • SWIF (KC Flood Control District, forthcoming) • Floodplains by Design (DOE + TNC + PSP, 2013) • Flood Hazard Management Plan (King County Flood Control District, 2013) • NPDES – TMDL Water Quality Improvement Projects (EPA + DOE) • Duwamish Valley Vision (DRCC, 2009) • Healthy River / Healthy Communities Project (DRCC) • Puget Sound Partnership • King County Biodiversity Report (2008)

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
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2	There are numerous environmental protection and enhancement efforts throughout the watershed but no clear picture or analytical evaluation of how they all add up. The public needs to know what is important, what is being done, and what requires additional attention in order to make good public decisions. The region's natural resources are an important part of Puget Sound's sense of identity.	Provide the public with a clear picture of the interconnectedness between different ecological systems, geographic areas (air, land, water) and open space enhancement and restoration efforts. This might be done through graphics, open space services analysis, and narrative stories. Explore methods to engage and educate the public about the threats and opportunities within the Green/Duwamish Watershed. Participants mentioned the need for a "road show" to be able to present to communities, businesses, and decision makers to improve understanding of the issue of multiple uncoordinated efforts. This could clarify the connection between the actual health of the region's natural resources, its livability, and its perceived identity, through compelling explanation of interconnectedness.	• This is a communications effort that could be associate all of the plans and programs available. • The EPA ROD and SHRP are the two most intensive actions within the watershed that need clarification for the public. Illustrating how other plans work alongside – or counter – to those efforts would be informative. • SWIF and FbD bring together disparate groups – are aimed at coordination, and so could offer good models for how to communicate across the spectrum of interests. • Community planning efforts such as the Duwamish Valley Vision and the South Park Green Space Vision Plan, in order to see what communities value as far as nature amenities in their built environments. • For insight into how environmental assets benefit the economy, Vision 2040 and the PSRC Regional Economic Strategy could be informative.
3	Numerous community groups are initiating restoration activities such as	Foster a watershed-wide coalition of local groups promoting and facilitating ecological	• SHRP • Puget Sound Partnership

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
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	invasive species removal, tree planting, etc. These types of groups are looking for additional support to provide education, technical assistance, and financial incentives for restoration work and ecologically protective land use actions. Furthermore, many of these restoration activities tend to happen in isolated groups. There is not a well-established avenue for shared knowledge among like-minded groups spread across the watershed. One group is starting this effort - the Green/Duwamish River Coalition.	restoration projects and ecologically responsible land use actions. Such a coalition might pool resources to employ staff that could apply and lobby for funds, provide technical assistance, communicate the groups' efforts, etc. The coalition might provide the start for an impactful organization like Portland Metro Intertwine. The Green/Duwamish River Coalition should be consulted or considered for this role.	
4	The Green/Duwamish River valley is bounded by relatively steep slopes resulting from glacial and flood erosion. These steep slopes are often forested to form greenbelts and provide habitat and other ecological functions. (For instance there is an almost continuous greenbelt along the valley's western margin from Algona to West Seattle.) There have	Expand and restore greenbelts along valley side slopes, and potentially restore vegetated riparian corridors from residential uplands through industrial areas, would provide substantial environmental benefits such as wildlife corridors, stormwater management, and water quality improvement. - Enhance and protect stream corridors. - Compile an inventory of all creeks and streams in the watershed.	• King County Regional Trails Needs Report • King County Open Space Pla • Duwamish Valley Vision • South Park Green Space Vision Plan • Regional Trails Needs Report • Cascade Agenda • SHRP • Floodplains by Design

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
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	been community-based efforts to restore some of the stream corridors running off the uplands and through the greenbelts. Some tributaries, and stream headwaters (e.g.: Soos Creek), however, have not had sufficient attention with regard to conserving and enhancing biodiversity.	- Increase connectivity throughout the watershed, particularly among already protected, public lands. This connectivity will allow for greater flow of habitat and species.	
5	Stormwater and its effects on aquatic systems are critically important. Upstream management practices have an effect downstream, across jurisdictional boundaries and land uses. Water quality issues (e.g. river temperature and pollution) have a direct impact on biodiversity and can be dictated by stormwater. Stormwater management, especially requirements for on-site treatment and percolation, is a challenge for many businesses in the lower Duwamish, and complying with new regulations can be costly. So far regulating agencies have used stringent “stick” approaches. Green	Initiate a watershed-wide stormwater management strategy. Identify and coordinate current efforts. Summarize what is known about stormwater issues and current programs at a watershed-wide scale. Examine the issue comprehensively in terms of geography, management practices (e.g.: green infrastructure.) Focus on watershed wide measures, such as off-site mitigation. Integrate with other objectives including habitat restoration and recreation. Investigate the implications of the Stormwater Action Program combining WRIA’s 8, 9, and 10. Identify benchmarks, metrics and monitoring. Identify implementation measures and organizational requirements.	• SCAP (KC) • Green Cities Program • King County Open Space Plan • South Park Green Space Vision Plan for the Duwamish Valley Vision and Healthy River / Healthy Communities. • Climate Action Plan (Seattle, 2013) • King County Regional Trails Needs Report • SHRP • EPA ROD • SWIF • Floodplains by Design • FHM • TMDL • Growing Transit Communities • Regional Economic Strategies

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
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	infrastructure and regional approaches might balance this with some "carrots" or at least more flexible options. Business owners also cite perceived arbitrary enforcement and rules that are not streamlined, or easy to follow. In recent history there has been little coordination, much less a unified direction on environmental management (including stormwater), storm surge measures, or use of green infrastructure in the lower Duwamish. Nor is there a clear "vision" for upgrading industrial lands infrastructure or private properties. There is a question as to the best way to encourage industrial uses by providing better infrastructure support while limiting costs, particularly to smaller businesses.	Explore new tools for handling stormwater, including on-site and off-site mitigation techniques, and potential collaborative approaches that are especially appropriate within the watershed. An idea to explore might be a stormwater management credit system in which credits could be transferred to off-site locations. Work with Manufacturing & Industrial Council (MIC) to identify industrial area solutions. Identify ways to bring more clarity and predictability to enforcement. Look to TPL tool for opportunities to incentivize businesses to engage in environmental interventions onsite. Explore opportunities for GSI & LID. Initiate a collaborative effort to address the common issues of stormwater, storm surge protection, flooding, development mitigation requirements, and provision of infrastructure, especially in the Duwamish & Lower Green. Identify opportunities to combine measures to address these multiple challenges. Some are already attempting to form a group to consider this. Ensure consistency with industrial lands policies and	

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		include the perspectives of industrial businesses, including the Port of Seattle. Also, the implications of industrial lands investment strategies need to be considered on a highly localized basis.	
6	Periodically parcels become available for sale which communities would like to see go into conservation. Right now there is no clear plan to determine if acquiring those properties are an appropriate investment.	Investigate the potential of a watershed-wide open space plan that prioritizes the types and general location of areas to be acquired for multiple benefits. Example components could include exploring and identifying ways to support ongoing efforts to protect public lands and maintain or create public access. In order to engender public support for these processes, stipulate that existing public lands be conserved, and provide public access to these lands. Such access should be easy to use, and available to multiple types of users.	• King County Open Space Plan • South Park Green Space Vision Plan • National Fish, Wildlife, & Plants Climate Adaptation Strategy (USFWS) • Climate Change Adaptation Policy Statement (FEMA) • Vision 2040 • Cascade Agenda • SHRP • Communities of Opportunity
7	The combined effect of current stormwater regulation (NPDES, local development controls, etc.) is insufficient to reach water quality goals. Additional regulations and/or incentives applicable to existing	Investigate models and opportunities to educate and incentivize landowners to take up water quality interventions on their own property. Examine ways of cultivating ownership for outcomes among private landowners. Strive to understand these	• PSCAA • SCAP (KC) • Green Cities Program • FEMA Climate Change Adaptation Policy Statement • SHRP

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	private land uses are needed.	populations and their needs, what would incentivize them to take action. Provide cost-sharing opportunities. King Conservation District does this work already with farmers; Seattle and King County does this through Rain Wise in Seattle where CSOs are concerned. To make greater progress, more action must be taken not only by King County and Seattle government but also by the county's residents, businesses, local governments and others.	• EPA ROD • TMDL • HR / HC
8	Many small farmers and property owners do not believe they benefit from King County's transfer of development rights (TDR) program because purchasers want to deal in large quantities of credits (28+ acres).	Explore possibilities of expanding awareness and use of King County TDR Bank and Clearinghouse for bundling TDR credits to form an attractive offering to large developers.	• King County Open Space Plan • NFWPCAS • Vision 2040 • Cascade Agenda • SHRP • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL • King County TDR Program
9	Pollutant Loading Assessment (PLA) goals vary across the watershed and measuring outcomes is difficult. There	Investigate the feasibility of a common Pollutant Loading Assessment (PLA) model for use across the watershed, such as that	• TMDL • SHRP • EPA ROD

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	are varying processes and no commonly used indicators or BMPs. Ecology recognizes the need for common sampling protocols and is working on creating them. A problem is that when the protocols are created, Ecology can recommend that people use them across the watershed, but they cannot compel adherence.	used by the Delaware River Basin Commission.	• Ecology PLA
10	In the upper watershed, one challenge is the sheer number (or miles) of roads. These forest roads should be maintained or destroyed. Both sides of the argument were heard at the open houses. Maintenance of these roads can help increase access to public space, although removing roads can help restore natural stream and ecosystem networks. Roads contribute sediment to streams and direct water to ditches which creates higher peak flows.	Establish an inventory of forest roads and carefully consider which roads are important to allow for public access to open spaces, and which could better serve the watershed by being removed. Coordinate with the US Forest Service, State DNR, and private landowners to identify which roads could be closed (obliterated, not just gated) to allow restoration of natural processes. The Upper watershed has best opportunity for real restoration, and doing projects in the right sequence is important. Jurisdictions should analyze environmental impact during development or conversion.	• King County Open Space Plan • National Fish, Wildlife and Plants Climate Adaptation Strategy • Cascade Agenda • SHRP • EPA ROD • TMDL • State Forest Practices Act Rules for road maintenance, abandonment, maps, and audits • King County Forestry Program • US Forest Service

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11	SWIF is complicated, and it appears as if there is no one group that is taking the lead. Because of intensive development, run-off, levees and flood hazard issues, the lower Green River requires additional attention. For instance, much of the Kent industrial area is in the 100-year flood plain. Considerable work has been done on these flooding issues, but difficult issues remain, especially from Southcenter to the confluence with the Black River. The Army Corps of Engineers is working on levee improvements. There is a tension between flood control levees to protect development, and protection of riparian areas and floodplain areas.	**Explore whether SWIF process can facilitate multiple benefits beyond flood protection.** Support SWIF effort to maximize opportunities for multiple objectives including habitat, recreation, and agriculture. Support integrated river and flood plain management. Current Corps of Engineers plans could be examined, to identify if there are any circumstances where planting of appropriate vegetation on levees could be encouraged. Investigate the benefits of structural versus natural policies to control flooding.	• SCAP (KC) • King County Open Space Plan • SHRP • EPA ROD • SWIF • Floodplains by Design • Flood Hazard Management Plan (KC) • TMDL • State Forest Practices Act Rules
12	Vegetated patches and corridors are key habitat and movement routes. Mature trees play an important ecological role. While many municipalities have urban forestry	**Investigate how urban forestry can play a role in the Watershed Strategy.** It may be that a watershed-wide or regional monitoring effort would be useful. Or there may be municipalities that cannot afford an urban	• SCAP (KC) • Green Cities Program • King County Open Space Plan • South Park Green Space Vision Plan • NFWPCAS

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	programs, others do not.	forestry program on their own but might join with other jurisdictions to establish a multi-city program in which costs for a forester and crew could be shared.	• Climate Action Plan (Seattle) • SHRP • EPA ROD • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL • Duwamish Valley Vision (DRCC) • Communities of Opportunity • Equity & Environment Initiative • South Park Green Spaces Vision Plan
13	Invasive species management is variable across the watershed – varying by jurisdiction and resource availability.	Investigate the potential for a watershed-wide invasive species management plan.	• Green Cities Program • King County Open Space Plan • NFWPCAS • Cascade Agenda • Regional Trails Needs Report • SWIF • King County Noxious Weeds Strategy
14	Lower Duwamish waterway industry and commerce land uses do not provide enough riparian buffering for healthful ecosystem functionality in the area. It has also been reported that there is very little land for open	Map opportunities for open space in the lower Duwamish, and explore opportunities to pursue innovative multifunctional open space and stormwater management practices. Because of the deficit in open space, the lack of access in local	• SCAP (KC) • Green Cities Program • King County Open Space Plan • South Park Green Space Vision Plan • Regional Trails Needs Report (KC) • SHRP

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	space, or even vegetation planting, in the lower Duwamish Valley.	communities, and the other environmental issues and activities in the lower Duwamish, the need for coordination may rise to a level needing regional attention. Evaluate opportunities for including wider restored riparian buffers in commercial development projects in the lower Duwamish area.	• EPA ROD • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL • Duwamish Valley Vision (DRCC) • Communities of Opportunity • Race and Social Justice Initiative (Seattle) • Equity & Environment (Seattle) • Duwamish Valley Healthy Communities Project (DRCC) • WRIA 9 Blueprint
15	While the Upper Green River corridor is largely in public ownership, and actively stewarded for ecosystem health and biodiversity, there are still some missing pieces along the river. King County, the State, NGOs and their partners are working to acquire these missing links.	Identify ways to support ongoing efforts to acquire missing links in the public property ownership along the Middle and Upper Green River reach. May include strengthening partnerships, building awareness, funding ideas, long-term stewardship tools, etc.	• SCAP (KC) • King County Open Space Plan • NFWPCAS • Cascade Agenda • SHRP
16	The Cristy Creek drainage which includes Bass, Beaver, and Sinkhole Lakes, is an area with unusually high	Identify ways to support ongoing King Co. (et. al.) efforts to acquire property areas with high biodiversity such as the Cristy Creek	• King County Open Space Plan • Outdoor Recreation in Washington • NFWPCAS

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	biodiversity and includes a spruce bog. King County and conservation advocates have been working to acquire this drainage and construct a nature trail. The Icy Creek drainage is important for water quality as it delivers very cold and pure water to the river. It also is an important spawning creek.	Drainage and Icy Creek Drainage.	• Cascade Agenda • Regional Trails Needs Report • SHRP • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL
17	The Newaukum Creek Drainage produces very cold and clear water that is important for water quality downstream. It also features a mix of natural areas, agricultural lands, and new development. The ecological functions provided by the sub-basin could be better protected and enhanced by protecting stream corridors and improving drainage methods.	**Explore a comprehensive approach to protecting and enhancing the ecological functions of the Newaukum Creek sub-basin** (part of the Enumclaw Plateau). Such an effort could be a potential model for other sub-basins in Puget Sound. Measures might include: - Compensating farmers for setting back grazing and harvesting from stream corridors. - Exploring agroforestry techniques. - Improving drainage ditch maintenance procedures. - Increase communication with farmers to address regulatory issues. - Identifying alternate drainage methods.	• King County Open Space Plan • Outdoor Recreation in Washington • NFWPCAS • Cascade Agenda • Regional Trails Needs Report • SHRP • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL
1	Longfellow Creek should be	Conduct an in-depth examination of	• King County Open Space Plan

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8	addressed in a comprehensive manner, to include hydrology issues (Roxhill Bog), fish passage, health of stream (stormwater runoff), and habitat. This is the main and only salmon spawning stream on the Duwamish apart from Hamm Creek.	Longfellow Creek within the greater comprehensive Green/Duwamish Watershed.	• Outdoor Recreation in Washington • NFWPCAS • Cascade Agenda • Regional Trails Needs Report • SHRP • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL
19	The middle and upper reaches of the Green River are a critical biodiversity resource, play an important role in water quality, are a potential recreational asset, include viable agricultural and forestry activities, and are experiencing rapid development. There is a need to address these issues comprehensively.	**Explore the concept of a "Mountains to Valley Commission"** (with a framework something like the Columbia Gorge Commission) that provides coordinated direction for land use, environmental management, community and economic development, and recreational issues.	• King County Open Space Plan • Outdoor Recreation in Washington • NFWPCAS • Cascade Agenda • Regional Trails Needs Report • SHRP • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL
20	The Green River Gorge between Flaming Geyser and Kanaskat-Palmer State Parks is a beautiful, one-of-a-kind natural resource that is largely protected State lands, but is generally	Work with appropriate groups (e.g.: Green Duwamish Watershed Alliance), King County and the State to **identify how to restart the Hanging Gardens State Park initiative.**	• King County Open Space Plan • Outdoor Recreation in Washington • NFWPCAS • Cascade Agenda • Regional Trails Needs Report

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	inaccessible. It could be a unique recreation and education attraction if a trail could be established. Citizen groups, King County, and the State have been working on proposals to establish a "Hanging Gardens" State Park and nearly achieved that goal before funding was no longer available.		• SHRP • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL
21	While the maps of flood prone areas do not show many at-risk areas in the lower Duwamish, storm surge does present a potential risk to a much larger area. King County, USGS and EPA are coordinating a coalition of local business owners, the Port of Seattle, etc. to address this issue collaboratively.	**Contact people working on storm surge issues and identify opportunities for open space measures to be part of the solution.** It may be that natural areas with flood storage capacity might help in this regard. "Bayous" in Fort Lauderdale, FL offer an example. Copenhagen, DK is also installing "climate-proof parks."	• SCAP (KC) • King County Open Space Plan • South Park Green Space Vision Plan • Climate Action Plan (Seattle) • Duwamish Valley Vision (DRCC) • Vision 2040 (PSRC) • Regional Economic Strategy (PSRC)
22	There are several priority actions that could be taken to reduce greenhouse gases in the watershed, including reducing vehicle miles traveled, conserving wetlands, generating low-carbon heating and electricity, conserving and planting forests, supporting local agriculture, using urban forests for cooling, conserving	**Incorporate priority Greenhouse Gas Reduction actions into the Green/Duwamish Watershed Strategy.** Similarly, encourage the inclusion of these priority actions as specific recommendations within city-wide climate change action plans. Providing concrete recommendations may promote more individual action toward reducing greenhouse gas emissions, and thus	• SCAP (KC) • Climate Action Plan (Seattle) • Puget Sound Clean Air Agency Strategic Plan • Puget Sound Clean Air Agency Highly Impacted Communities

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	soil carbon, the provision of better transit, discouraging idling vehicles, installing green roofs on big box buildings, and promoting alternative modes of transportation.	mitigating climate change.	
23	The over-arching farmland conservation challenge is in answer the question of how to prevent development of farmland when the land is worth as little as $40k/acre if developed and only $12k/acre as farmland. Purchase of development rights or paying for development "credits" (e.g.: stormwater credits) is currently the most effective means of compensating farmers for the services they provide in addition to food production. But to justify this expenditure, it is necessary to document and monetize the benefits different forms of agriculture provide in different situations.	Develop tools to evaluate the open space benefits of agricultural land, and working forest lands in the Green Duwamish Watershed. Investigate the feasibility of creating agricultural incentives to farmers and stop development of farm land to increase agricultural production in the watershed. The need for this information, as noted by the Farmland Trust, provides impetus for the ROSS open space services analysis. Coordinate with King Conservation District (KCD).	• PSCAA Strategic Plan • King County Open Space Plan • NFWPCAS • Vision 2040 • Cascade Agenda • SHRP • TMDL
24	The research in Phase 1 did not cover the forest practices industry, which is a key economic component.	Encourage more forestry industry representation and forest practice manager participation in the Watershed Strategy to	• Green Cities Program • NFWPCAS • Cascade Agenda

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	(Uncommon Acronyms: FbD - Floodplains by Design; NFWPCAS - National Fish, Wildlife & Plants Climate Adaptation Strategy; SCAP - Strategic Climate Action Plan; SHRP - Salmon Habitat Recovery Plan; SWIF– System Wide Improvement Framework)		
		assist in identifying issues and opportunities in that economic sector.	• PSRC Regional Economic Strategy
25	Wider stream corridor and wetland buffers and other environmental regulations take away productive land from farmers. King Conservation District facilitates much of this kind of work.	**Find a way to compensate farmers for the loss of farmland due to environmental regulations** and reduce economic impacts to farmers. This might be done as part of a model effort within the Newaukum Creek sub-basin.	• SHRP • EPA ROD • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL
26	New “agroforestry” techniques for planting “creek friendly” harvestable crops (or plants which contribute to harvestable crops) near streams are emerging. There might be some application for such practices in the Green River Watershed.	Explore possible application of agroforestry in the watershed.	• Green Cities Program • King County Open Space Plan • South Park Green Space Vision Plan • Cascade Agenda • Duwamish Valley Vision (DRCC) • King County Jobs Initiative • PSRC Regional Economic Strategy
27	Timber harvest practices may not be directly aligned with need for air quality improvements. Trees help clean air – make connections between existing capacity of forests and current and future needs.	Investigate current timber harvest practices. Facilitate multi-stakeholder cooperation concerning the diversification of forest assets in the watershed. Potential groups to bring to the table include the Forest Service as well as cities and their urban forestry staff, and private landowners. Educating private landowners on how to ecological thin their	• PSCAA Strategic Plan • King County Open Space Plan • NFWPCAS • Vision 2040 • Cascade Agenda • SHRP • TMDL

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
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		land, for instance, could provide them with an economic incentive to participate, and produce an environmental benefit.	
28	Measures to address social equity must be based on local values. A regional trail may not be the local community's priority. Often marginalized communities do not have the wherewithal to actively lobby for open space and other public resources. Much of this research and engagement has already been conducted within the watershed. Oftentimes park and open space use is narrowly understood - there is a profound diversity of open space use that needs to be taken into consideration during planning and design efforts. Inequities must be remedied upstream of conditions on the ground – this means focusing on communities rather than individuals.	Addressing local needs in regional planning may be done best through policy and program measures. The Watershed Strategy might include county-wide policy recommendations for more active local involvement or EIR-type analysis in parks and open space planning. The Watershed Strategy team could **investigate watershed-wide policy and program recommendations to ensure that decisions related to open space enhancements are made equitably.** Highlight the work already done with respect to community outreach and engagement. Make use of research and findings from previous efforts. Identify opportunities for prevention of equity concerns, rather than remedies once they occur.	• Green Cities Program • King County Open Space Plan • Outdoor Recreation in Washington • South Park Green Space Vision Plan • State Action Plan to Eliminate Health Disparities • Duwamish Valley Vision (DRCC) • Communities of Opportunity • Equity & Environment Initiative (Seattle) • Duwamish Valley Healthy Communities Project (DRCC)
29	There is a disconnection between efforts to enhance air/land/water quality "for all" and broader social/economic regional issues that	**Investigate methods to ensure that open spaces are spread equitably among the watershed.** The watershed initiative will be strengthened by active efforts to coordinate	• Green Cities Program • King County Open Space Plan • Outdoor Recreation in Washington • South Park Green Space Vision Plan

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	Challenges	**Opportunities**	
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	will determine who "all" is. If some people cannot earn a decent living wage, afford housing, or have meaningful access to public transportation, then they may not be able to remain or live in Seattle and other areas close to natural attributes of the watershed. Ecosystem enhancements could become societal benefits that disproportionately serve economically privileged populations. The maintenance and access to existing park facilities in the City of Kent, for example, is deteriorating, especially within vulnerable communities.	the watershed initiative with other city, county or regional initiatives for equitable enhancements. The watershed strategy use the County Equity Impact Review tool in early scoping and throughout all later strategy phases. Investigate funding sources for cities trying to maintain open spaces. Facilitate meetings between cities, counties, the State, and the public to brainstorm methods to protect open spaces and improve access for all stakeholders.	• State Action Plan to Eliminate Health Disparities • Duwamish Valley Vision (DRCC) • Communities of Opportunity • Equity & Environment Initiative (Seattle) • Duwamish Valley Healthy Communities Project (DRCC)
30	There is a lack of cohesive community initiative to protect and enhance environmental conditions within some subwatersheds, with the Middle Green subwatershed offering a compelling example.	Identify opportunities for community outreach and coalition building to support awareness and activism for the Green/Duwamish Watershed and to keep this topic at the forefront of civic leaders. Identify how conditions in the upper watershed impact communities lower in the watershed. Facilitate communication of these impacts to and across communities within	• Green Cities Program • South Park Green Space Vision Plan • Duwamish Valley Vision (DRCC) • Duwamish Valley Healthy Communities Project (DRCC)

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
	(Uncommon Acronyms: FbD - Floodplains by Design; NFWPCAS - National Fish, Wildlife & Plants Climate Adaptation Strategy; SCAP - Strategic Climate Action Plan; SHRP - Salmon Habitat Recovery Plan; SWIF– System Wide Improvement Framework)		
		the watershed.	
3 1	Many small farmers feel that permitting agencies unfairly target them over larger property owners.	Further explore farmers' perceptions of permitting agencies' regulatory and enforcement actions, and work with farmers and agencies to identify a process to address complaints.	• SHRP • EPA ROD • SWIF • Floodplains by Design • Flood Hazard Management Plan • TMDL
3 2	The demand for county, state and federal parks, open spaces, and recreation facilities appears to outstrip its supply. But while there is anecdotal evidence that there is a need for more parks and recreational opportunities, there is little quantitative information to support that claim. A means of measuring demand relative to carrying capacity of different recreational facilities is warranted.	Evaluate the supply and demand for parks and recreation opportunities, including cultural appropriateness of resources. Consulting with State and Federal agencies to find out if they have this data might be a first step. Convene department representatives from different jurisdictions to identify challenges and opportunities. Conduct geographic supply and demand analysis. Identify measures to address shortfalls.	• Green Cities Program • King County Open Space Plan • Outdoor Recreation in Washington • South Park Green Space Vision Plan • Vision 2040 • Regional Trails Needs Report • Duwamish Valley Vision (DRCC) • Communities of Opportunity • Equity & Environment Initiative • Duwamish Valley Healthy Communities Project (DRCC) • PSRC Regional Economic Strategy
3 3	Learning stewardship principles will benefit regional youth that seek prosperity while also facing climate change and other environmental	Train youth in restoration, community leadership, and other community and environmental stewardship professions.	• Green Cities Program • South Park Green Space Vision Plan • SHRP • EPA ROD

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
	(Uncommon Acronyms: FbD - Floodplains by Design; NFWPCAS - National Fish, Wildlife & Plants Climate Adaptation Strategy; SCAP - Strategic Climate Action Plan; SHRP - Salmon Habitat Recovery Plan; SWIF– System Wide Improvement Framework)		
	challenges.		• Duwamish Valley Vision (DRCC) • Communities of Opportunity • Equity & Environment Initiative (Seattle) • Duwamish Valley Health Communities Project (DRCC) • King County Jobs Initiative • Job Readiness Training (Seattle) • Youth & Family Job Readiness Program (El Centro) • PSRC Regional Economic Strategy • Core Plus (MIC) • Washington Conservation Corps
34	Diesel emissions are a major air quality issue in the watershed, especially in the lower Duwamish. Diesel retrofit programs such as Puget Sound Clean Air Agency's "Diesel Solutions" are making strides to reduce emissions. Open space with trees can affect airflows, pushing pollutants into upper air layers.	Continue to explore land use planning and resource management measures that would contribute to air quality improvements, and therefore, improvements in human health. Identify models for transportation planning that have shown success in improving air quality. Further, investigate opportunities to conduct comprehensive air quality monitoring and research the work already being performed.	• PSCAA Strategic Plan • SCAP (KC) • South Park Green Space Vision Plan • Vision 2040 • Climate Action Plan (Seattle) • Regional Trails Needs Report • State Action Plan to Eliminate Health Disparities • Duwamish Valley Vision (DRCC) • Growing Transit Communities • Communities of Opportunity • Equity & Environment Initiative (Seattle) • Duwamish Valley Health Communities

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
	(Uncommon Acronyms: FbD - Floodplains by Design; NFWPCAS - National Fish, Wildlife & Plants Climate Adaptation Strategy; SCAP - Strategic Climate Action Plan; SHRP - Salmon Habitat Recovery Plan; SWIF– System Wide Improvement Framework)		
			Project (DRCC)
35	Multiple regional and local trails remain unconnected and unsafe for pedestrians and cyclists seeking to go from one to the next. Examples include: - The Green River Trail, Interurban Trail and Alki Trail form an interconnected system that is a wonderful regional resource. Connections to the Mountains to Sound Greenway, Pierce County Foothills Trail, Seattle Waterfront Trail, Cedar River Trail and the East Lake Washington Trail (at Renton) are all still difficult for cyclists and difficult connections to implement. - The Green River Trail is largely an off-road connected system but there are a few "missing links" in the lower Duwamish which diminish its desirability for non-expert riders. - The connections between the Elliott Bay Trail, Duwamish Trail, Green River Trail and Interurban Trail form impressive north-south spines for	-Support the implementation of planned regional and local trail connections and articulate their value as part of evaluating project proposals under the watershed strategy. A primary obstacle is making safe connections to the Cedar River and East Lake Washington trails through the area near the former confluence of the Green and Black Rivers and into Renton. -Work with Seattle Parks and Recreation and SDOT to identify measures necessary to construct the Green River Trails missing links in the lower Duwamish. -Work with King County to identify measures necessary to complete the trail connection between the Cedar River Trail and the Pierce County Foothills Trail. The new trail connection would be located near an area of lower opportunity so this element would address equity objectives, especially if the trail connects to communities to the east. -Explore the capacity to finish trail connections, plant more vegetation and trees, and create riparian setbacks to enhance open spaces. Investigate, in	• King County Open Space Plan • Outdoor Recreation in Washington • Regional Trails Needs Report • Growing Transit Communities • Vision 2040 • Communities of Opportunity • Equity & Environment Initiative • Duwamish Valley Healthy Communities Project (DRCC)

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
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	recreation and travel in the Green/Duwamish. Missing links should be completed to provide better, safer off-street experiences; and east-west trail linkages to other open space/park destinations could be created (Horsehead Bend Natural Area to Mill Creek Earthworks Park, for example). - King and Pierce Counties have identified a potential connection between the Cedar River Trail and the Foothills trail that would connect to regionally significant systems. - Preserving and enhancing recreational facilities and land in downtown Kent and Auburn is important for human health. - The West Duwamish Trail is missing a link in South Park.	particular, best management practices for watershed-wide setback and runoff requirements in order to help establish clear setback limits and runoff standards for new buildings. Coordinate with existing building owners in order to establish possible methods to process runoff onsite. -Finish West Duwamish Trail missing link in South Park.	
36	The watershed already enjoys an abundance of trails and parks that are not intuitive to find or access. Residents and visitors could make better use of existing assets if they knew where they were and how to	Provide more and better connections to bike trails that are easy to find by local residents and regional visitors. Make local connecting trails safer, with better wayfinding. Identify locations that could be aided by the inclusion of lights or safety improvements.	• PSCAA Strategic Plan • SCAP • King County Open Space Plan • Outdoor Recreation in Washington • South Park Green Space Vision Plan • Climate Action Plan (Seattle)

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
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	access them. Not enough publicly available information about walking routes along trails. For example, many parks exist on the east side of the Duwamish River, but access is limited or not well known. Safety within and between these open spaces and trails could be enhanced with the help of lights and landscaping in overgrown areas.	Incorporate local municipal pedestrian bike plans. Create detailed topographical maps of new trails, for example those in the West Duwamish Greenbelt. Build on Feet First wayfinding maps. Put them in local pickup locations. Name trails, identify length of section / walking distance, slope, and degree of difficulty.	• Regional Trails Needs Report • State Action Plan to Eliminate Health Disparities • Duwamish Valley Vision (DRCC) • Growing Transit Communities • Vision 2040 • Communities of Opportunity • Equity & Environment Initiative • Duwamish Valley Healthy Communities Project (DRCC)
37	Increasing walkability within the watershed is a priority health concern. Installing sidewalks and ensuring safe school routes are priority actions that can be taken to address health issues at the community scale. Maintaining and enhancing pedestrian access to public health clinics, as well as mental health facilities, is of specific value.	**Evaluate opportunities to enhance walkability within the watershed.** Coordinate with public health officials to ensure pedestrian access to public health facilities. Incorporate local non-motorized transportation plans.	• PSCAA Strategic Plan • SCAP • King County Open Space Plan • Outdoor Recreation in Washington • South Park Green Space Vision Plan • Climate Action Plan (Seattle) • Regional Trails Needs Report • State Action Plan to Eliminate Health Disparities • Duwamish Valley Vision (DRCC) • Growing Transit Communities • Vision 2040 • Communities of Opportunity • Equity & Environment Initiative • Duwamish Valley Healthy Communities

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
	(Uncommon Acronyms: FbD - Floodplains by Design; NFWPCAS - National Fish, Wildlife & Plants Climate Adaptation Strategy; SCAP - Strategic Climate Action Plan; SHRP - Salmon Habitat Recovery Plan; SWIF– System Wide Improvement Framework)		
			Project (DRCC)
38	Subsistence fishing populations continue to fish in contaminated areas within the watershed. They may either continue to do so throughout cleanup and restoration process, posing further health risks, or may find themselves cut off from these food sources.	Explore models for identifying and mitigating adverse health impacts on subsistence fishing populations. Highlight the efforts already underway at the county and elsewhere.	• South Park Green Space Vision Plan • SHRP • EPA ROD • TMDL • State Action Plan to Eliminate Health Disparities • Duwamish Valley Vision (DRCC) • Communities of Opportunity • Race and Social Justice Initiative (KC) • Equity & Environment Initiative (Seattle) • Duwamish Valley Healthy Communities Project (DRC

	Listening Phase Findings (Blue=Environment; Orange=Economy; Red= Health)		Relevant Plans / Programs
	Challenges	**Opportunities**	
	(Uncommon Acronyms: FbD - Floodplains by Design; NFWPCAS - National Fish, Wildlife & Plants Climate Adaptation Strategy; SCAP - Strategic Climate Action Plan; SHRP - Salmon Habitat Recovery Plan; SWIF– System Wide Improvement Framework)		
39	Purchase of properties for conservation is logistically burdensome and time-consuming – no clear path exists.	**Examine existing acquisition programs to determine if there are ways to expedite transactions for conservation.** For example, utilities often have surplus parcels that they would like to see go into conservation. Each transaction is costly and time consuming. A more efficient process could be developed to facilitate those wishing to sell property for conservation purposes– public and private.	• King County Open Space Plan • Cascade Agenda

CHAPTER 5: RECOMMENDATIONS

A set of broad, preliminary recommendations were developed by the Green Futures Lab from the analysis of information from the listening and background research, as described below. These recommendations address critical challenges faced within the watershed, as well as, key opportunities to improve well-being for the many people, species, and ecosystems within the Green/Duwamish watershed. The recommendations are organized by general typology of proposed action, represent potentially feasible strategic measures that may warrant further exploration in the next phase of the Green/Duwamish Watershed Strategy. (The numbers following descriptions, below, refer to specific numbered challenges and opportunities that are further detailed in the Table 3 located in Chapter 4).

PRELIMINARY RECOMMENDATIONS

1. COORDINATION OF EXISTING PLANS AND PROGRAMS

While many people living and working in the Green/Duwamish Watershed are thriving in terms of health and well-being, many others are not. Similarly, plants and wildlife face significant threats to their long-term viability within the basin. It was also clear to the team that many robust efforts to improve air, land, water, and human conditions were already underway within the watershed. While many successes have been, and continue to be, achieved in the areas of habitat restoration and conservation, air and water quality improvement, and sustainable forestry practice, among others, more needs to be done.

Though there are many effective plans, programs, and initiatives underway in the watershed, a number of them would benefit from enhanced coordination with other efforts in the watershed, and in the broader region. Such coordination would help agencies share best practices, troubleshoot jurisdictional conflicts, collaborate on funding opportunities, and optimize existing resources for maximum benefit. Many stakeholders referenced the WRIA 9 Salmon Habitat Recovery Plan as having set a good example of interagency coordination at the watershed scale, and suggested that it could also be used as a model for addressing issues that extend beyond salmon recovery (See #s 3, 5, 11, 35 in Attachment 4). One issue that came up from multiple stakeholders that could benefit from such coordination is water quantity control. Water quantity is a problem with regard to stormwater runoff, flooding, and storm surge (associated with sea level rise) and it has been recommended that these should be addressed as interconnected elements in surface water management and regulation (See #s 5, 14, 21).

2. NEW WATERSHED-WIDE PLANS AND PROGRAMS

It was also found that there are gaps within the planning and programming for human and ecosystem health within the Green/Duwamish watershed, and that this is true across both subject areas and geographic reaches. Where human health is concerned, watershed-wide air quality, water quality, recreational opportunity, and access to healthy food are known concerns and have

already been extensively evaluated. Opportunities to enhance these factors in human health include facilitating efforts already underway to: improve air and water quality; evaluate access to recreational facilities and potentially recommend specific open space investments (See #s 5, 6, 10, 14, 29, 36); evaluate access to non-motorized transportation opportunities and help advance trail planning efforts (See #s 16, 19, 20, 35, 37); and provide fishing opportunities in places where resident aquatic life is not harmful to human health if consumed (See #38) and also enhance amenities at existing fishing sites. There is also an opportunity to develop a watershed-wide urban forestry plan (See #s 12, 27, 34), which could improve human health by increasing air filtration by trees and by mitigating climate change impacts such as Urban Heat Islands and severe storms.

With respect to the well-being of plant and wildlife communities in the Green/Duwamish, many participants in the Listening Phase identified gaps in watershed-scale planning. Opportunities exist to develop a watershed-wide invasive species plan (See #s 1, 3, 13), biodiversity plan (See #1), and stormwater plan (See #s 5, 7, 14), as well as a watershed-wide coalition coordinating habitat stewardship and restoration (See #s 1, 3, 30). Such watershed-wide planning would address geographic gaps that hinder current planning addressing these issues.

3. Public Outreach & Communication

Although many initiatives are underway to address conditions in the Green/Duwamish Watershed, they are not all well-understood by the general public and not all initiatives provide public and affected communities with meaningful engagement opportunities. Many initiatives, where feasible, could coordinate around engagement to avoid community involvement fatigue and ensure that agencies are listening also to communities. Efforts to recover salmonid species habitat, to clean up the Duwamish Estuary from decades of pollution, and to remove invasive species, among other efforts, are not apparent to many of the people who live, work, and spend time in the watershed. Nor are the immediate human benefits of such efforts widely understood. Accordingly, there are opportunities to better engage the public via outreach while projects are planned and carried out, to help mobilize individuals as volunteers, and to foster political will to increase funding and action at the watershed-scale (See #s 2, 3, 8, 30, 31).

Additional communication opportunities involve illustrating clear connections between ecosystem health, human health, and economic vitality within the Puget Sound Region. The growing impacts of climate change, as well as the effects of urban sprawl and habitat encroachment, could be clarified alongside opportunities for mitigating adverse outcomes (See #22). Such illustrative communication could be widely used to foster support for crucial, but sometimes poorly understood, habitat restoration and resource management practices.

4. Technical Analyses & Toolkits

Multiple Listening Phase participants observed that there are few conclusive analyses documenting problem areas within the watershed that they could readily describe anecdotally. In addition, some participants suggested that user-friendly instructional toolkits could help facilitate implementation

of watershed improvement actions by various interested agencies and individuals. There is opportunity for the content of such analyses and toolkits to be framed and preliminarily developed during formulation of the Watershed Strategy. These could eventually be handed off to agencies and non-profits for further development, fine-tuning, and distribution.

One particular suggestion of needed analysis addressed the Lower Green, where parks facilities managers cited inadequate supply and condition of parks and open space for community use (See #s 28, 29, 32). The managers suggested that analysis of supply and demand across the watershed could reveal areas that have insufficient access to appropriate open space resources. Similar supply and demand analysis was also recommended with regard to forest roads, suggesting that some roads could potentially be removed from use and environmentally restored to serve greater ecological functions (See #10). Finally, supply and demand analyses were suggested for manufacturing and industrial lands, as well as economic valuation of agricultural and forest lands as providers of continuous, connected, and essential ecosystem services (See #s 23, 24, 25, 26, 27). Research and analysis in each of these areas could support decision-making processes aimed at improving human and ecological health outcomes through provision of open space, recreation, and cleaner air and water (See #23).

A variety of instructional toolkits were recommended, that could be made available to private land owners, technical staff, and others operating within the watershed. Discussion with agency staff revealed that although ongoing government efforts are ambitious and sometimes well-funded, there are limits to what can be achieved through government intervention on private property – and privately owned parcels make up a majority of land within the watershed. With the current pace of redevelopment at 1% per year, most parcels have little chance of being improved via regulation of development action toward meeting habitat and landscape performance goals. Thus, it could be more productive for private land owners (homeowners, businesses, and others) to receive toolkits and incentives that facilitate taking up important work on their own property to improve wildlife habitat (See #7), treat stormwater onsite, and remove invasive species. Additional opportunities exist for toolkits to assist: transfer and purchase of development rights (TDRs and PDRs) (See #s 8, 15, 39); enforcement strategy design for water quality regulating agencies (See #9); and environmental compliance for business owners.

5. Geographically-Specific Opportunities

Many of the challenges and opportunities identified during the Listening Phase focused on specific geographic areas, or particular landscape features, perceived to be insufficiently addressed in current plans, programs, and initiatives. With respect to water quality, technical staff identified the lack of adequate planning and restoration efforts in many of watershed's tributary basins. Focusing on these areas could help improve water quality in the receiving waters, assisting with salmon habitat outcomes as well as human health benefits (See #4). Within the watershed's urban and suburban areas, reduced air quality disproportionately impacts people living in the Duwamish Estuary, Nearshore, and Lower Green sub-basins. This problem, largely the result of emissions from

passenger and freight vehicles traveling on nearby highways, is manifest in disproportionately high asthma hospitalizations in the local communities. Agencies and organizations are engaged in addressing this concern in the lower reaches of the watershed, as well as mitigating the impacts, but much work remains to be done and could integrate the air quality benefits of planned vegetated open space. Also within the watershed's urban and suburban areas, there is a need for job training and education access for low-income individuals. Enhancing stewardship training in these areas could provide multiple benefits, such as helping people attain living-wage restoration jobs while also improving their environments (See #33).

Several additional location-specific opportunities include: reviving an initiative to establish Hanging Gardens State Park; developing a "Mountains to Sound Commission;" and focusing habitat restoration and associated land conservation within the Icy Creek and Cristy Creek drainages (See #s 17, 18, 19, 20).

6. Equity Impact Review and Process Equity

Social equity was another major area of concern throughout the Listening Phase. With guidance from King County staff, the ROSS team worked to facilitate conversations and gain insights regarding three entwined aspects of equity in the Watershed: process equity, distributional equity, and generational equity. In considering these concerns, and toward ensuring that equitable decision-making frames the Green/Duwamish Watershed Strategy, an opportunity was noted to conduct an Equity Impact Review (EIR) regarding strategy recommendations developed in subsequent phases of the Strategy (See #29). EIR is designed to assess how proposals may address or exacerbate conditions of inequity, bringing such issues to light early in decision-making processes. For example, in light of currently inequitable provision of parks and recreation opportunities across the Green/Duwamish Watershed, an EIR may highlight ways in which Watershed Strategy recommendations might reduce or increase this imbalance.

Finally, multiple partners also identified a lack of appropriate community representation in the Listening Phase of the Watershed Strategy process itself. Most of the participants involved in the Listening Phase activities were staff from agencies or non-profits already working on watershed projects. Few participants were representatives of communities and neighborhoods within the watershed, despite outreach efforts by King County and Green Futures Lab through the open houses and the web survey.

Watershed Advisory Group Focus Areas Prioritization

At the September 2015 WAG meeting, the WAG was provided with the "Listening Findings" table (Table 3) that the Green Futures Lab developed showing challenges and opportunities identified in the Green/Duwamish watershed. Small groups, organized by theme, held discussions to prioritize greatest opportunities for focusing future planning efforts in the next phase of this project. The themes and respective top priority (ies) from each table is listed below

1. ***Land Conservation***: Investigate the potential of a watershed-wide open space plan that prioritizes the types and general location of areas to be acquired for multiple benefits.
2. ***Stormwater, Flooding & Storm Surge***: Initiate a watershed-wide stormwater management strategy that provides coordination across jurisdictions and throughout the watershed.
3. ***Agriculture & Forestry***: Develop tools to evaluate the open space benefits of agricultural land, and working forest lands in the Green/Duwamish Watershed.
4. ***Multi-use Open Space (Parks & Rec)***: Map opportunities for open space in the lower Duwamish, and explore opportunities to pursue innovative multifunctional open space and stormwater management practices.
5. ***Community Well-Being***: Incorporate priority Greenhouse Gas reduction actions into the strategy. Explore models for identifying and mitigating adverse health impacts on subsistence fishing populations.
6. ***Habitat Management***: Create a watershed-wide biodiversity plan and identify methods to support ongoing efforts to acquire areas with high biodiversity basin-wide.

In addition to this, WAG members were asked to prioritize the findings with a voting exercise to further identify if any focus areas were emerging. The top priorities based on this voting exercise were:

1. Investigate the potential of a watershed-wide open space plan that prioritizes the types and general location of areas to be acquired for multiple benefits.
2. Initiate a watershed-wide stormwater management strategy that provides coordination across jurisdictions and throughout the watershed.
3. Map opportunities for open space in the lower Duwamish, and explore opportunities to pursue innovative multifunctional open space and stormwater management practices.
4. Investigate opportunities for community outreach and coalition building to support awareness and activism for the Green/Duwamish Watershed.

From the Listening findings integrated with input from the WAG, King County concluded that 1) there is significant amount of beneficial work already happening in the watershed, 2) there are important priorities that are well-defined and need additional support and 3) there are some challenges that are not well-defined that would benefit from further explorations. Based on this criteria, King County further analyzed the findings to determine which, if any, focus areas are not as well-defined in the watershed and could, if addressed, make the greatest impact in improving air, land and water conditions in the watershed. From this analysis, the following four focus areas were identified:

1. Create a watershed-wide stormwater management strategy to reduce priority toxic pollutants that impact human health and the environment. Consider innovative methods for improving and implementing stormwater programs, facilities, and infrastructure consistently across the watershed.

2. Develop a watershed-wide open space plan prioritizing areas that protect the most valuable open space, habitat, recreation lands and farmland. Strategies could focus on acquiring new, and enhancing existing lands for city, county and state parks, urban forestry, salmon habitat, water quality improvement, agriculture, recreation, trails and floodplain functions.
3. Integrate climate change resilience and preparedness activities to provide a stronger response to current and future conditions and build a more resilient landscape across the watershed.
4. Develop a strategy to improve air quality and reduce the incidence of air quality related health impacts across the watershed.

In November 2015, King County evaluated the feasibility of investigating these focus areas further in Phase II by surveying the Green/Duwamish WAG members and interested parties. Survey participants strongly agreed that a watershed-wide stormwater strategy (#1) and open space plan (#2) were very important to develop during Phase II. There was also agreement from participants that integrating climate resilience activities (#3) were important to explore in more detail in Phase II however, there was a neutral response to focus area related to improving air quality to advance public health (#4). Detailed survey results can be found in Appendix C. In January 2016, the WAG met for the third time and the survey results were presented. WAG members strongly supported proceeding on both the watershed-wide stormwater strategy (#1) and open space plan (#2) for Phase II of the project. There was also interest in having greater discussion regarding the focus areas on climate resilience activities (#3) and air quality and public health (#4) in the future.

Development of Preliminary Metrics

To identify desirable future conditions for improved air, land and water conditions in the watershed a preliminary list of measures/metrics were developed based on existing plans.

Air Quality Metrics

The PSCAA Strategic Plan set targets for air pollution reduction and greenhouse gas emission reduction, which could be targets for this watershed strategy.

Goal 1 – Protect Public Health and the Environment from Air Pollution

2014 – 2020 – primary targets aim for 2020

- Annual economic impact of air pollution (AP) health effects drops $300 million
- Potential cancer risk from AP drops 50%
- Annual AP-related lost work days drop by 6,000
- Socio-economic disparities in AP exposure decrease

Goal 2- Become the Most Climate-Friendly Region in the U.S.

- Greenhouse gas emissions in 2020 return to 1990 levels.
- Greenhouse gas emissions drop 25 percent from 1990 to 2035.

Water Conditions Metrics

Water Quality

- Meet water quality standard in all streams and the G/D river
    - Temperature
    - Dissolved Oxygen
    - Total Dissolved Gas
    - pH
    - Turbidity
    - Bacteria
    - Nutrients
    - Toxics

Water Quantity

- Decrease in High Pulse Count: This is the number of times in each water year when discrete high flow pulses occur, with twice the mean flow rate taken as the threshold to identify a high pulse. This metric is specific to creeks.
- Decrease High Pulse Range: This is the range in days between the start of the first high-flow pulse and the end of the last high flow pulse during a water year. This is a metric only for creeks.
- Maintain or increase summer low flows for the Green/Duwamish River.

Water Quality & Water Quantity

- Increase in percentage of sites that have "good" or better *Stream Benthos Health Score*. Benthos is a holistic indicator of a streams health.

Land Conditions Metrics

Land and Resource Conservation - effectiveness of land acquisition, stewardship and incentive programs

- New privately-owned rural acres with stewardship plans or enrolled in CUT/PBRS
- New public and private rural acres in permanent conservation
- Land restored for habitat (total acres of new ecological restoration). This could include the following:
    - Salmon habitat
    - Wetland restoration
    - Forest restoration
    - Estuary and nearshore restoration
- Acres of floodplain reconnected to floodplain due to levee setbacks

Agriculture Protection and Production

- Farmland
    - Total acres in farmland preservation program
    - Total acres in production in APDs
- Local Food Initiative - Production
    - 400 net new acres in food production each year
    - 25 farmers engaged in food production each year

[i] Felt, 2012
[ii] PSCAA Highly Impacted Communities; September 2014
[iii] http://www.ecy.wa.gov/programs/wq/303d/index.html
[iv] WRIA 9 Salmon Habitat Recovery Plan
[v] 2006 King County Flood Hazard Management Plan
[vi] Fuerstenberg et al. 1999
[vii] Green/Duwamish Stormwater Retrofit Work Plan. April 2010.
[viii] WRIA 9 Salmon Habitat Plan. August 2005. King County.
[ix] King County Biodiversity Report. 2008.
[x] Green/Duwamish Stormwater Retrofit Work Plan. April 2010
[xi] USEPA, 2013
[xii] Climate Impacts Group, 2009, 6
[xiii] USEPA, 2014
[xiv] Climate Central, 2014
[xv] College of the Environment, 2015, 6-4
[xvi] College of the Environment, 2015, 6-4
[xvii] Climate Impacts Group, 2009, 1; College of the Environment, 2015, 6-1
[xviii] College of the Environment, 2015, 6-3
[xix] http://cses.washington.edu/db/pdf/snoveretalsok2013sec6.pdf)
[xx] Climate Impacts Group, 2009, 13
[xxi] College of the Environment, 2015, 6-3
[xxii] USEPA, 2013
[xxiii] Climate Impacts Group, 2009, 302
[xxiv] Health Reporting Areas (HRAs) include individual cities, groups of smaller cities or unincorporated areas, and neighborhoods in larger cities. King County has 48 HRAs. For more info, see: http://www.kingcounty.gov/healthservices/health/data/indicators/technical.aspx.
[xxv] PHSKC, December 2014. King County Health Profile, City and Health Reporting Area Comparisons. Accessed on 08/25/15 at: http://www.kingcounty.gov/healthservices/health/data/CityProfiles.aspx
[xxvi] UW, Health Impact Assessment Proposed Cleanup Plan for the Lower Duwamish Waterway Superfund Site, September 2013. Accessed at: http://deohs.washington.edu/sites/default/files/research/HIA-Tech-FINAL-Residents.pdf
[xxvii] http://www.kingcounty.gov/healthservices/health/data/~/media/health/publichealth/documents/indicators/ChronicIllness/ChildAsthmaHosp.ashx
[xxviii] Obesity is defined as having a Body Mass Index (BMI) of 30 or more.
[xxix] www.communitiescount.org
[xxx] Pacific Northwest Research Station, 2011. Growing Quality of Life: Urban Trees, Birth Weight, and Crime. Accessed on 08/25/15 at: http://www.fs.fed.us/pnw/sciencef/scifi137.pdf
[xxxi] Hystad et al., 2014. Residential Greenness and Birth Outcomes: Evaluating the Influence of Spatially Correlated Built-Environment Factors. Accessed on 08/25/15 at: http://ehp.niehs.nih.gov/1308049/
[xxxii] Low birth weight is defined as a baby born weighing less than 2500 grams (5 pounds 5 ounces).
[xxxiii] KC Determinants of Equity Report at http://www.kingcounty.gov/elected/executive/equity-social-justice.aspx
[xxxiv] http://www2.epa.gov/toxics-release-inventory-tri-program
[xxxv] Just Health Action, 2013. Duwamish Cumulative Health Impact Analysis (CHIA). Accessed at: http://duwamishcleanup.org/programs/duwamish-community-health-initiative/the-duwamish-river-cumulative-health-impacts-analysis/
[xxxvi] The Walkability Index considers residential density, the number of street connections, and the mix of homes, stores, parks, and schools in a neighborhood. 2005 King County Walkability Map is found at: http://your.kingcounty.gov/aimshigh/2006/image1.asp?LTLivableNeighbor#Graph1
[xxxvii] Behavioral Risk Factor Surveillance System, 2011 and 2013, Healthy Youth Survey.
[xxxviii] U.S. Dept. of Agriculture
[xxxix] King County Local Food Initiative Report. Accessed online at: http://your.kingcounty.gov/dnrp/local-food/documents/2015-KC-Local-Food-Report.pdf
[xl] Brookings Institute, The Suburbanization of Poverty
[xli] Health Impact Assessment: Proposed Cleanup Plan for the Lower Duwamish Waterway Superfund Site
[xlii] King County, 2015
[xliii][xliii][xliii] https://www.whitehouse.gov/the-press-office/2014/12/03/fact-sheet-16-us-communities-recognized-climate-action-champions-leaders

[xliv] http://www.norfolk.gov/DocumentCenter/View/6042

[xlv] Puget Sound Clean Air Agency. August 2015