DUWAMISH VALLEY CUMULATIVE HEALTH IMPACTS ANALYSIS: SEATTLE, WASHINGTON

Photo: Paul Joseph Brown

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Produced by

DEPARTMENT OF ENVIRONMENTAL
AND OCCUPATIONAL HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH
University of Washington

Suggested Citation

Gould L, Cummings BJ. Duwamish Valley Cumulative Health Impacts Analysis. Seattle, WA: Just Health Action and Duwamish River Cleanup Coalition/Technical Advisory Group. March 2013.

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Acknowledgments

Research, data analysis, and initial writing and preparation of this report were conducted by **Linn Gould**, MS, MPH, Principal Investigator and primary author, Just Health Action. This project was conducted under the direction of **BJ Cummings**, Project Manager, DRCC/TAG who also contributed to the report's content, proofing figures, editing, and planning of the report layout.

Paulina Lopez, Outreach Specialist, Duwamish River Cleanup Coalition/TAG, served as South Park and Georgetown Community Researcher, and designed and directed the Community Based Participatory Research component of the project.

Michele Savelle of Michelle Savelle GIS & Graphic Design prepared all maps and figures.

We would like to acknowledge the other key contributors to this project:

Morgan Barry, Public Health-Seattle & King County, for guidance, feedback, and support throughout this project.

Shari Cross, Senior GIS Analyst, Wastewater Treatment Division, King County Department of Natural Resources and Parks, for data analysis by ZIP code for many of the indicators in the Environmental Effects section.

Juliet D'Alessandro, Just Health Action intern, for research assistance and calculation proofing.

Bill Daniell, MD, MPH, Associate Professor, Department of Environmental & Occupational Health Sciences, School of Public Health, University of Washington, who served as a reviewer and sounding board for Linn Gould.

Carol Dansereau, for critical assistance with final report review, editing, and accompanying fact sheets.

Peter deFur, PhD, Environmental Stewardship Concepts, who served as a peer reviewer.

Richard Gelb, Performance Management Lead, Directors Office, King County Department of Natural Resources and Parks, for assistance retrieving key data from King County.

Marilyn Hair, University of Washington Center for Ecogenetics and Environmental Health, Ethics and Outreach Core, for funding and assistance for the design and print publication.

Alicia Moreno, University of Washington School of Social Work, Duwamish River Cleanup Coalition/TAG, Community Health Projects practicum intern, for help with all things.

Alberto Rodríguez, Program Manager, Duwamish River Cleanup Coalition/TAG, who assisted with community outreach and project coordination.

Cathy Schwartz, University of Washington, graphic design and editing for the report.

David Solet, PhD, Assessment, Policy Development & Evaluation Unit, Public Health-Seattle & King County, for advice on selection of health data for the Cumulative Health Impacts Analysis.

Eva Wong, PhD, Assessment, Policy Development & Evaluation Unit, Public Health-Seattle & King County, who advised and provided us with all of the health data for the Public Health Effects component.

Michayala Ashley, Rohan Marrero, and **Daniel Patrick Osincup,** interns from the University of Washington, for research assistance and support at critical stages of the project.

Executive Summary

South Seattle's Duwamish Valley has long been referred to as a community with environmental injustices—a community with disproportionately high environmental health burdens and risks and fewer positive environmental benefits than the rest of Seattle—but limited evidence has been available to date to validate or quantify this characterization. The Duwamish River Cleanup Coalition/ Technical Advisory Group (DRCC/TAG) received an Environmental Justice (EJ) Research grant from EPA to conduct a Cumulative Health Impacts Analysis (CHIA) to document and quantify the Duwamish Valley's environmental health status relative to other areas of Seattle. Cumulative impacts are defined as: "any exposures, public health, or environmental effects from the combined emissions and discharges, in a geographic area, including environmental pollution, from all sources, whether single or multimedia, routinely, accidently, or otherwise released" (OEHHA, 2010).

In accordance with California EPA's cumulative impacts ranking methodology, a total of 15 indicators in five categories were selected and input into a formula to calculate cumulative heath impact scores for ten representative Seattle ZIP codes. Indicators included socioeconomic factors; sensitive populations; environmental exposures; environmental effects; and public health effects (OEHHA, 2010). From an environmental exposures perspective, Beacon Hill/Georgetown/South Park (ZIP code 98108) had the highest ranking for air pollution and for exposure to confirmed and suspected contaminated sites. This area also had one of the highest rankings in the city for unhealthy environmental effects, i.e., lack of access to a healthy built environment. Cumulatively, these poor environmental scores combined with high ranks for social vulnerabilities (socioeconomic factors and sensitive populations) and a medium ranking for public health effects resulted in the highest cumulative impact score of Seattle ZIP codes in the study. The results of this cumulative analysis provide a firm basis for characterizing the Duwamish Valley as an area with disproportionate health impacts and environmental injustices.

Additional evidence, including at the larger Duwamish watershed scale and at the smaller census tract scale, reinforce these cumulative findings, and further suggests that the ZIP code level analysis may obscure even greater disparities in the riverside communities of South Park and Georgetown. In comparing residents of the Duwamish Valley to King County, Duwamish Valley residents are more likely to live in poverty, be foreign born, have no health insurance or leisure time, and are more likely to be sick. Georgetown and South Park residents have up to a 13-year shorter life expectancy (at birth) than wealthier parts of Seattle.

In light of these cumulative findings, the Duwamish Valley merits attention from decision-makers regarding health protective and proactive environmental regulations, policies, practices, and actions. The results of this analysis will inform recommendations that DRCC/TAG will make to EPA, Washington state, and local government agencies regarding the Lower Duwamish River Superfund Site. In addition, DRCC/TAG will provide this report to federal, state, regional, and local governments; community-based organizations; and other stakeholders and decision-makers, to help guide the development of policies and actions to improve overall environmental health and equity in the Duwamish Valley.

I. Introduction

South Seattle's Duwamish Valley has long been referred to as a community with environmental injustices—a community with disproportionately high environmental health burdens and risks and fewer positive environmental benefits than the rest of Seattle—but limited evidence has been available to date to validate or quantify this characterization. The Duwamish River Cleanup Coalition/Technical Advisory Group (DRCC/TAG) represents an alliance of community, tribal, environmental, and small business groups affected by ongoing pollution and cleanup plans for Seattle's lower Duwamish River, a 5.5-mile-long Superfund Site.[1] The Duwamish Valley's riverfront neighborhoods of South Park and Georgetown are home to residents who are among those most impacted by the Superfund Site, with potential exposures from contact with contaminated sediments on neighborhood beaches, swimming or wading in the river, and from fishing. South Park and Georgetown are among Seattle's lowest income neighborhoods, and South Park, in particular, is one of the city's most ethnically diverse neighborhoods. As the US Environmental Protection Agency's (EPA) Community Advisory Group for the Duwamish River Superfund Site, DRCC/TAG received an Environmental Justice (EJ) Research grant from EPA to conduct a Cumulative Health Impacts Analysis (CHIA) for the surrounding residential community, in order to document and quantify the Duwamish Valley's environmental health status relative to other areas of Seattle and inform EPA's site cleanup decisions.

Photo: Colin Wagoner, Ridolfi Inc. 2004

This report compares geographic neighborhoods in the Seattle area and provides evidence of disproportionate health, socioeconomic, and environmental impacts in the Duwamish Valley. Based on these findings, DRCC/TAG will make recommendations to EPA and other appropriate agencies to reduce or mitigate risks and impacts for Duwamish Valley residents that are related to the Superfund site. The purpose of those recommendations will be to:

1. inform EPA's Duwamish River Superfund Site cleanup decisions;
2. develop risk reduction strategies for communities impacted by the site; and
3. improve health outcomes in the affected community.

In addition, the information compiled in this report is expected to inform action by regional public and private agencies on a variety of other health risk factors affecting the Duwamish Valley and other Seattle communities where disproportionate impacts are evident.

This report reviews relevant definitions, regulations, and policies in Section II; the cumulative impacts analysis method in Section III; indicators chosen for the analysis in Section IV; discussion of results in Section V; other lines of evidence in Section VI; limitations in Section VII; and conclusions and next steps in Section VIII. More detailed information can be found in the appendices, available online at: www.duwamishcleanup.org/programs/duwamish-community-health-initiative.

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[1] A Superfund Site is one listed by the US Environmental Protection Agency on the National Priorities List, a designation for the most toxic hazardous waste sites in the country, which require cleanup under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

II. Key Definitions and Relevant EPA Regulations

The following terms mean different things to different audiences and in various contexts. For the purpose of this report, the following definitions and relevant regulations and policies are used and reflect the context of the Duwamish Valley and the Duwamish River Superfund Site.

Environmental Justice (EJ): The US Environmental Protection Agency (EPA) defines EJ as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." EPA's goal is "to provide an environment where all people enjoy the same degree of protection from environmental and health hazards and equal access to the decision-making process to maintain a healthy environment in which to live, learn, and work" (http://www.epa.gov/environmentaljustice/).

Environmental justice addresses the disproportionate environmental risks borne by low-income communities and communities of color

In Washington State, EJ is described in the *Governor's 2012 State Policy Action Plan to Eliminate Health Disparities* as "the right to a safe, healthy, productive, and sustainable environment, where 'environment' is considered in its totality to include the ecological, physical, social, political, aesthetic, and economic environment. Environmental justice addresses the disproportionate environmental risks borne by low-income communities and communities of color resulting from poor housing stock, poor nutrition, lack of access to healthcare, unemployment, underemployment, and employment in the most hazardous jobs" (Governor's Interagency Council on Health Disparities, December 2012).

Environmental Justice Executive Order 12898: In 1994, *Executive Order 12898: Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* was issued by President Clinton. The Order stated that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations…" The Order goes on to state that federal agencies shall, "at a minimum: (1) promote enforcement of all health and environmental statutes in areas with minority populations and low-income populations; (2) ensure greater public participation; (3) improve research and data collection relating to the health of the environment of minority populations and low-income populations; and (4) identify differential patterns of consumption of natural resources among minority populations and low-income populations" (EOP, 1994).

Plan EJ 2014: Inclusion of EJ principles in all of EPA's decisions has been cited as a top agency priority by former EPA Administrator Lisa Jackson. In recognition of the 20th anniversary of the EJ Executive Order, EPA has released Plan EJ 2014. The overarching strategy of the Plan is to:

1. protect the environment and health in overburdened communities;
2. help communities to take action to improve their health and environment; and
3. establish partnerships with local, state, tribal, and federal governments and organizations to achieve healthy and sustainable communities.

This strategy will be achieved by implementing and seeking to strengthen agency efforts in: (1) incorporating environmental justice into rulemaking; (2) considering environmental justice concerns in EPA's permitting process; (3) accelerating compliance and enforcement initiatives; (4) supporting community-based action programs; and (5) fostering administration-wide action on environmental justice (EPA, September 2011).

Locally, Region 10 has committed itself to Plan EJ 2014 and has adopted *EPA Region 10's Approach for Implementing Administrator Jackson's Seven Priorities: FY 2011–15,* which includes an EJ Strategic Plan (EPA, November 2011). Goals of Region 10's EJ Strategic Plan include:

1. eliminate, reduce, or mitigate the burden of pollution and disproportionate, adverse public health and environmental impacts on low-income and minority communities and vulnerable populations;
2. systematically facilitate the integration of environmental justice—principles, practices, guidance, tools, and methods—into the programs, policies, and actions of Region 10; and
3. engage communities in empowerment processes to identify existing and emerging environmental justice issues and collaboratively assist them in addressing those impacts.

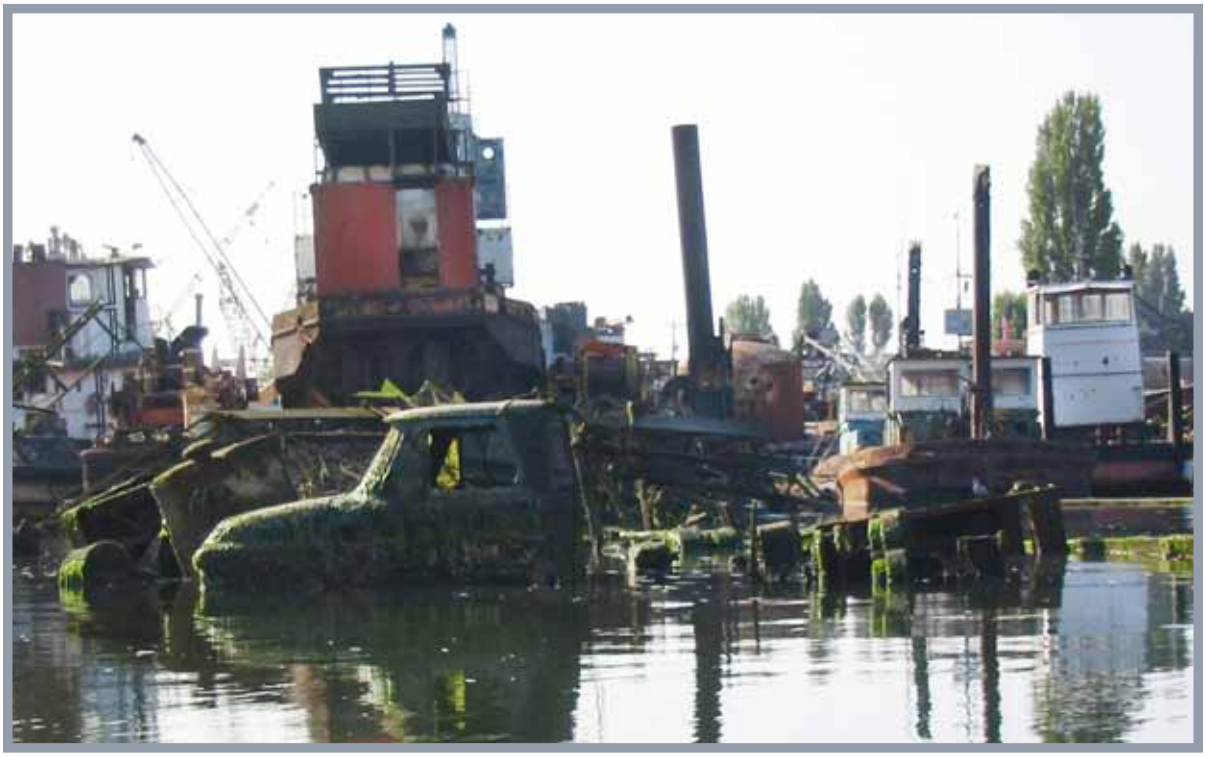


Photo: BJ Cummings

With regard specifically to Superfund cleanup decisions, the Plan EJ 2014 *Legal Tools* document states that EPA's authority to consider public health and welfare and the environment provides "the basis for considering cumulative risk in taking response actions" (EPA, December 2011). Furthermore, EPA can use its authority to accommodate EJ considerations in assessing remedial alternatives, per its nine criteria for evaluating cleanup alternatives. These considerations include: the threshold criteria of overall protectiveness of human health and the environment, compliance with state statutes, and the modifying criteria of community acceptance (EPA, October 2012).

ACHIEVING HEALTH EQUITY MEANS THE ELIMINATION OF DISPARITIES AND VALUING EVERYONE EQUALLY WITH FOCUSED AND ONGOING SOCIETAL EFFORTS TO ADDRESS AVOIDABLE INEQUALITIES.

Environmental Justice Gap: Refers to the difference between low income and/or minority communities who systematically experience disproportionately greater environmental risks and impacts, and fewer positive environmental benefits, as compared with high income/non-minority communities.

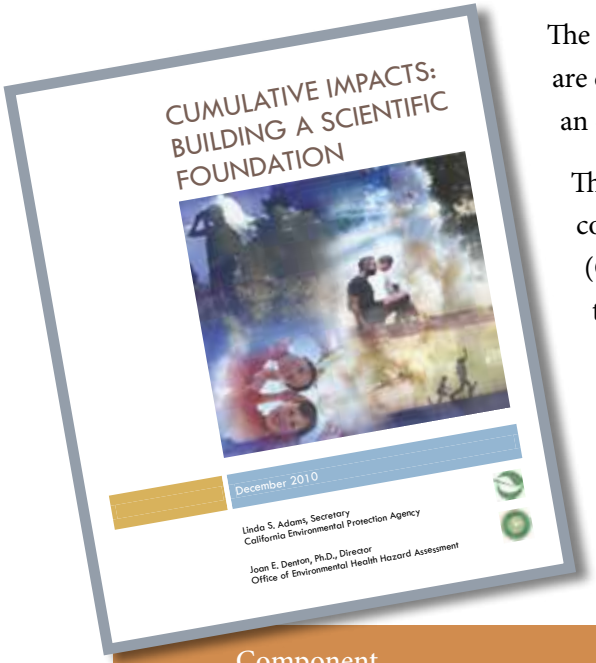
Cumulative Impacts: The EJ Executive Order specifically states that when conducting an EJ analysis, "multiple and cumulative exposures" should be identified when practicable and appropriate (EOP, 1994). While traditional human health risk assessments have been conducted for the Duwamish River Superfund Site, as well as several other contaminated sites in the Duwamish Valley, cumulative health impacts that account for all exposures and other risk factors have not yet been evaluated. Cumulative impacts are defined as: "any exposures, public health or environmental effects from the combined emissions and discharges, in a geographic area, including environmental pollution, from all sources, whether single or multimedia, routinely, accidently, or otherwise released" (OEHHA, 2010). The Order further directs that: "impacts will take into account sensitive populations and socioeconomic factors, where applicable and to the extent the data are available" (EOP, 1994).

Health disparity vs. health inequity: A health disparity (or inequality) is a "particular type of difference in health in which disadvantaged social groups—such as the poor, racial/ethnic minorities, women, or other groups who have persistently experienced social disadvantage or discrimination—systematically experience worse health or greater health risks than more advantaged social groups" (Braveman, 2006). In contrast, a health inequity is a disparity that is not only unnecessary and avoidable but, in addition, is considered unfair and unjust (Whitehead, 1992). Achieving health equity means the elimination of disparities and "valuing everyone equally with focused and ongoing societal efforts to address avoidable inequalities, historical and contemporary injustices" (US Department of Health and Human Services, Office of Minority Health, 2010).

As part of Plan EJ 2014 and its goal to achieve EJ as required by EO 12898, the EPA is collaborating with multiple federal institutions to ensure the integration of environmental justice and health equity considerations into the policies, actions, and programs across the federal government.

III. Cumulative Impacts Analysis Method

Although 23 states have developed a range of qualitative to complex quantitative methods to evaluate disproportionate impacts, Washington State has not (Payne-Sturges, 2012). As part of its goal to achieve environmental justice for low-income and minority communities, the US Environmental Protection Agency (EPA) has been developing and improving reliable scientific data for identifying disproportionate environmental and health impacts among racial and ethnic minorities, low income populations, and indigenous people and tribes, while working to address and reduce environmental disparities. The approach chosen for the Duwamish Valley Cumulative Health Impacts Analysis (CHIA) is California EPA's (Cal EPA) cumulative impacts ranking methodology, which uses a quantitative, easy to understand approach (OEHHA, 2010). For a state-of-the-science review of cumulative impacts and the selected methodology, an excellent summary can be found in California's Cumulative Impacts: Building a Scientific Foundation (OEHHA, 2010).



The Cal EPA cumulative impacts method uses multiple indicators that are divided into five categories (referred to as components), each with an established range of ranking scores.

The Cal EPA rationale for the range of ranking scores for each component is based on the certainty of evidence in the literature (OEHHA, 2010). For socioeconomic factors and sensitive populations, the relatively broad ranking of 1–3 is based on literature indicating that there are several-fold differences in the way that vulnerable populations respond to environmental contamination. For the finer environmental exposure ranking of 1–10, there is abundant evidence on the types and extent of potential expo-

Component	Definition	Ranking Score
Socioeconomic factors	Community characteristics that result in increased vulnerability to pollutants	1–3
Sensitive populations	Populations with traits that may magnify the effects of pollutant exposures	1–3
Environmental exposures	Contact with pollution	1–10
Environmental effects	Adverse built environment conditions	1–5
Public health effects	Disease and other heath conditions	1–5

sures in communities and how they are associated with health (e.g., air pollution). Environmental effects and public health effects are assigned a mid-range ranking of 1–5 because there is less certainty and less information on the link between exposure and effect than with environmental exposures, but more certainty than is available for the link between socioeconomic status/vulnerable populations and health.

Three indicators for each component are selected from specified communities or geographic areas, for a total of 15 indicators. Indicator data for each community or geographic area are then ordered from highest to lowest, divided into equal subgroups, and assigned a ranking score for input into the following formula:

Cumulative Impact = (Socioeconomic factors + Sensitive populations) x
(Environmental exposures + Environmental effects + Public health effects)

Using this formula, the total cumulative impact score can range from a minimum of 6 to a maximum of 120. High scores indicate disproportionate impacts. These highly ranked areas can then be identified as priorities for action by EPA, states, communities, and other decision-makers.

This CHIA was designed to examine whether disproportionate impacts occur in the Duwamish Valley, as compared to other Seattle neighborhoods, in order to inform Superfund cleanup decisions and other relevant policies and actions. The geographic scale of analysis is the Zone Improvement Plan (ZIP) code, because indicator data were most readily available in this format. Ten Seattle ZIP codes are included in the CHIA analysis, as shown in Figure 1 (page 10). The ten ZIP codes were chosen based on a range of factors that are representative of differences (high, medium, and low) between Seattle geographic areas. ZIP codes were chosen according to ranges in income levels, racial/ethnic makeup, and pollution concentrations, as well as differences in neighborhood's access to resources, such as housing costs, park access, and education. Finally, as part of a Community Based Participatory Research (CBPR) effort helping to inform the project, areas that are often discussed by Duwamish Valley residents themselves when they compare their circumstances to other Seattle neighborhoods are included (Appendix B, online). Additional data were collected at the smaller neighborhood scale and larger Duwamish Valley scale, using available census tract data, but were not used in the quantitative CHIA equation shown above. These results are discussed separately in Section VI.

Figure 1. ZIP codes included in the Duwamish Valley Cumulative Health Impact Analysis

IV. Indicators for Cumulative Health Impacts Analysis

Data were collected for 24 available indicators for all ten ZIP codes, as shown in Table 1 on page 12. The 15 indicators used in the cumulative impacts scoring formula are highlighted and were selected based on:

a) established indicators from the US Environmental Protection Agency's (EPA) EJ definition (e.g., percent minorities, percent poverty);
b) information from Duwamish Valley residents about their environmental health concerns (e.g., air pollution, access to green space), collected through a Community Based Participatory Research project (Appendix B, online);
c) scientific evidence compiled from public environmental, demographic, and health databases; and
d) best professional judgment.

A series of Geographic Information System (GIS) maps created for each of the 15 indicators selected are shown in Figures 2–16.

Socioeconomic component (Rank range 1-3)

A growing body of research provides evidence that low-income and/or minority communities are more vulnerable to pollution exposure than higher income, non-minority populations, which in turn affects health (OEHHA, 2010; Hicken et al, 2012). The causes of health disparities from pollution are diverse and complex. However, correlations have been drawn between various factors, such as living in low-income conditions and compromised health; lower education level and increased risk of dying from lung cancer; lower birth weight infants born to black mothers exposed to particulate pollution as compared to white mothers; violence and increased risk of asthma in children; and stress and poor health outcomes (OEHHA, 2010; Payne-Sturges et al, 2006).

Selected Indicators

- Educational attainment (Figure 2, page 13)
- Income/poverty level (Figure 3, page 14)
- Race/ethnicity (Figure 4, page 15)

Sensitive populations component (Rank range 1–3)

A growing body of scientific literature has established that certain populations are more vulnerable to pollution because of their age (e.g., children and the elderly), pre-existing conditions (e.g., diabetes, cardiovascular disease, pregnancy), and/or cultural practices (e.g., subsistence fishing in contaminated rivers) (OEHHA, 2010).

Selected Indicators

- Presence of children (Figure 5, page 16)
- Presence of elderly (Figure 6, page 17)
- Number of foreign-born (Figure 7, page 18)

Table 1. Indicators Evaluated for Cumulative Health Impacts Analysis

Component	Indicator	Data Sources	Figure #
Socioeconomic Factors (Rank 1-3)	Percent Adults 25 and older Without a College Degree, by ZIP Code, Seattle, WA, 5-year Average 2006–2010	US Census Bureau, American Community Survey. Provided by Public Health-Seattle & King County; Assessment, Policy Development & Evaluation Unit.	2
	Percent Below 200% Poverty Level, by ZIP Code, Seattle, WA, 5-year Average 2006–2010	US Census Bureau, American Community Survey. Provided by Public Health-Seattle & King County; Assessment, Policy Development & Evaluation Unit.	3
	Percent Non-white Population, by ZIP Code, Seattle, WA, 2010	US Census Bureau, Census 2010	4
	Percent Adults (18-64 years) With No Health Insurance, by ZIP Code, Seattle, WA, 5-year Average 2007–2011	Behavioral Risk Factor Surveillance System (BRFSS)	A1
	Percent Adults With No Leisure Time Physical Activity, by ZIP Code, Seattle, WA, 5-year Average 2007–2011	Behavioral Risk Factor Surveillance System (BRFSS)	A2
Sensitive Populations (Rank 1-3)	Percent Presence of Children Under 5 years, by ZIP Code, Seattle, WA, 2010	US Census Bureau, Census 2010	5
	Percent Presence of Elderly 65 years and Older, by ZIP Code, Seattle, WA, 2010	US Census Bureau, Census 2010	6
	Percent Foreign-Born by ZIP Code, Seattle, WA, 5-year Average 2006–2010	US Census Bureau, American Community Survey. Provided by Public Health-Seattle & King County; Assessment, Policy Development & Evaluation Unit.	7
Environmental Exposures (Rank 1-10)	Annual Average Diesel Particulate Matter in Human Breathing Zone (ug/m^3), by ZIP Code, Seattle, WA, 2005	Environmental Protection Agency, Community-Focused Exposure Risk Screening Tool	8
	Annual Average Benzene in Human Breathing Zone (ug/m^3), by ZIP Code, Seattle, WA, 2005	Environmental Protection Agency, Community-Focused Exposure Risk Screening Tool	9
	Summed Site Ranking for Confirmed and Suspected Contaminated Sites, by ZIP Code, Seattle, WA	Washington State Department of Ecology, Toxics Cleanup Program, Washington Ranking Method	10
Environmental Effects (Rank 1-5)	Percent Tree Canopy, by ZIP Code, Seattle, WA	King County Department of Natural Resources and Parks, USGS National Land Cover Database	11
	Square Feet per Resident of Park Area by ZIP Code, Seattle, WA	King County Department of Natural Resources and Parks	12
	Number of Toxic Release Inventory Sites, by ZIP Code, Seattle, WA	Environmental Protection Agency, Enviromapper, Toxic Release Inventory	13
Public Health Effects (Rank 1-5)	Life Expectancy at Birth in Years, by ZIP Code, Seattle, WA, 5 year average, 2005–2009	Death Certificate Data: Washington State Department of Health, Center for Health Statistics. Public Health - Seattle & King County; Assessment, Policy Development & Evaluation	A3
	Percent Adults Overweight or Obese by ZIP Code, Seattle, WA, 5-year Average 2007–2011	Behavioral Risk Factor Surveillance System (BRFSS)	A4
	Heart Disease Death rate per 100,000, by ZIP Code, Seattle, WA, 5-year average, 2006–2010	Death Certificate Data: Washington State Department of Health, Center for Health Statistics.	14
	Stroke Death rate per 100,000, by ZIP Code, Seattle, WA, 5-year average, 2006–2010	Death Certificate Data: Washington State Department of Health, Center for Health Statistics.	A5
	Percent Adults With Doctor Diagnosed Diabetes by ZIP Code, Seattle, WA, 5-year Average 2007–2011	Provided by Public Health-Seattle & King County; Assessment, Policy Development & Evaluation Unit., BRFSS	A6
	Percent Adults with Hypertension, by ZIP Code, Seattle, WA, 2003–2011 odd years	Provided by Public Health-Seattle & King County; Assessment, Policy Development & Evaluation Unit., BRFSS	A7
	Childhood (0-17) Asthma Hospitalization Rate per 100,000, by ZIP Code, Seattle, WA, 5-year average, 2006–2010	Hospitalization Discharge Data: Washington State Department of Health, Office of Hospital and Patient Data Systems.	15
	Percent Adult Cigarette Smokers, by ZIP Code, Seattle, WA, 5-year Average 2007–2011	Provided by Public Health-Seattle & King County; Assessment, Policy Development & Evaluation Unit , BRFSS	A8
	Lung Cancer Death Rate Per 100,000, by ZIP Code, Seattle, WA, 5-year average, 2006–2010	Death Certificate Data: Washington State Department of Health, Center for Health Statistics.	16
	Assault Hospitalization Rate Per 100,000 , by ZIP Code, Seattle, WA, 5-year average, 2006–2010	Hospitalization Discharge Data: Washington State Department of Health, Office of Hospital and Patient Data Systems.	A9

Selected for Cumulative Impacts Analysis (Scenario 1)

Figure 2. Percent Adults 25 and older Without a College Degree, by ZIP Code
Seattle, Washington, 5-year Average 2006-2010

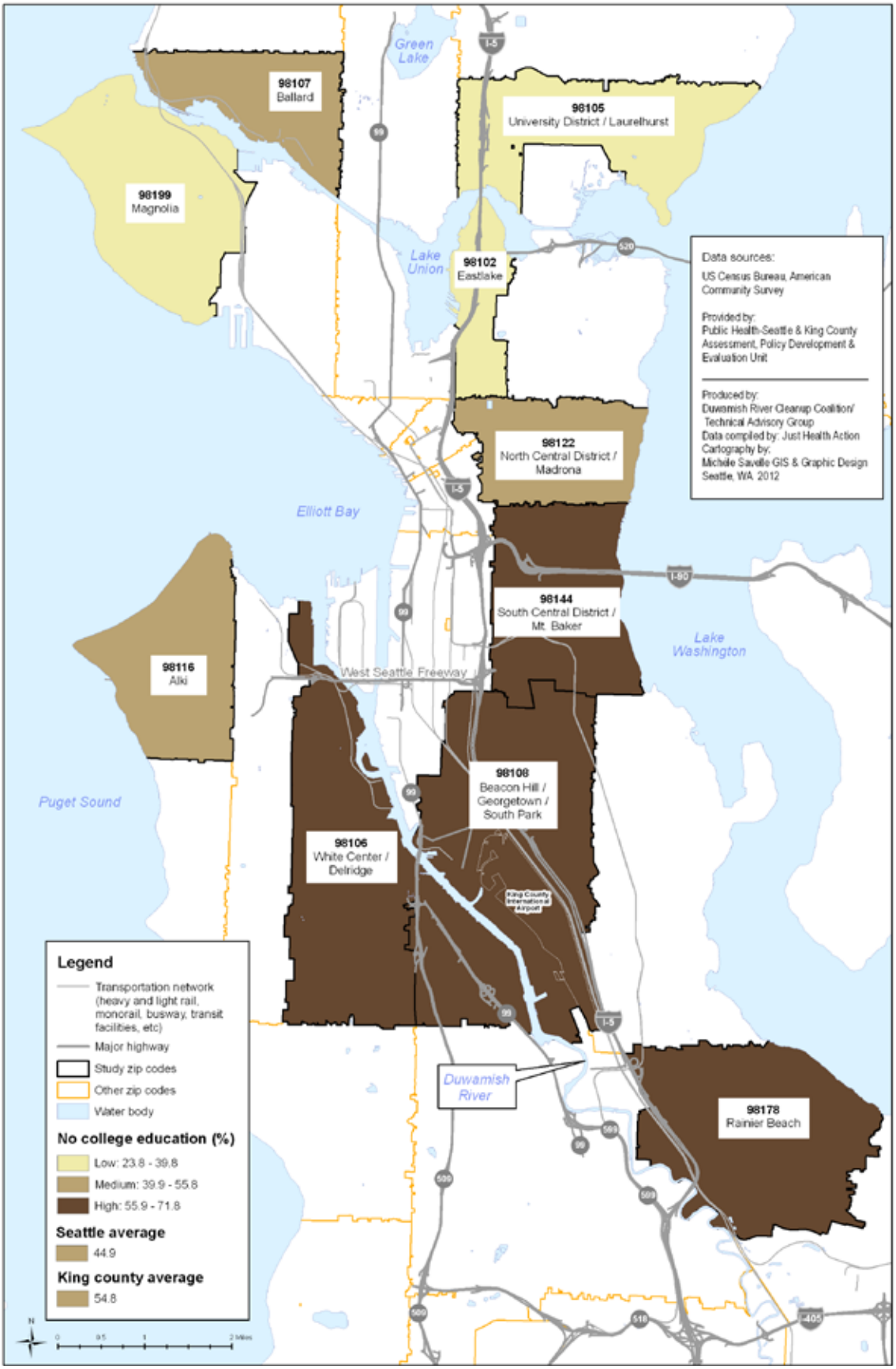


Figure 3. Percent Below 200% Poverty Level, by ZIP Code
Seattle, Washington, 5-year Average 2006-2010

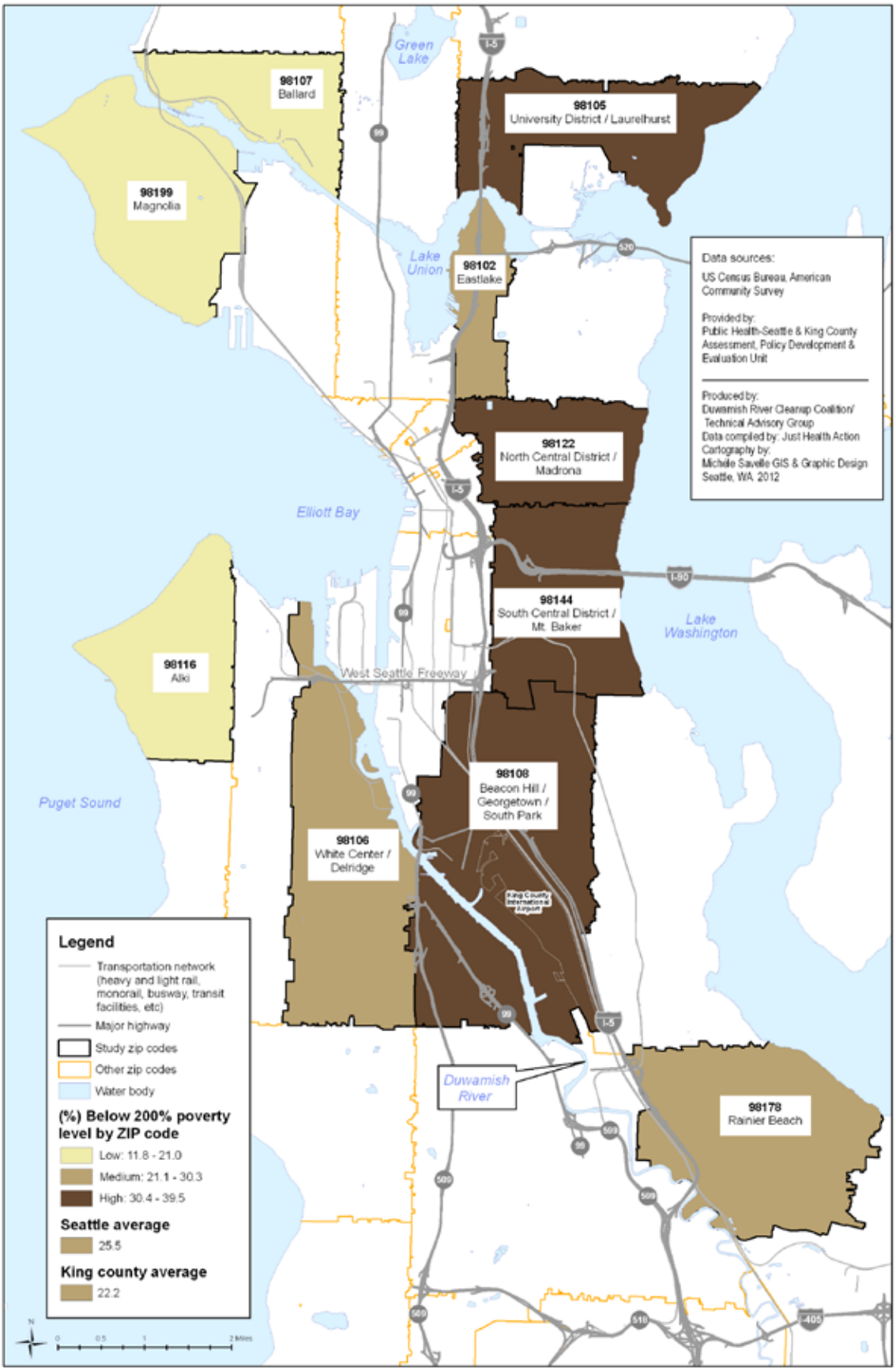


Figure 4. Percent Non-white Population, by ZIP Code
Seattle, Washington, 2010

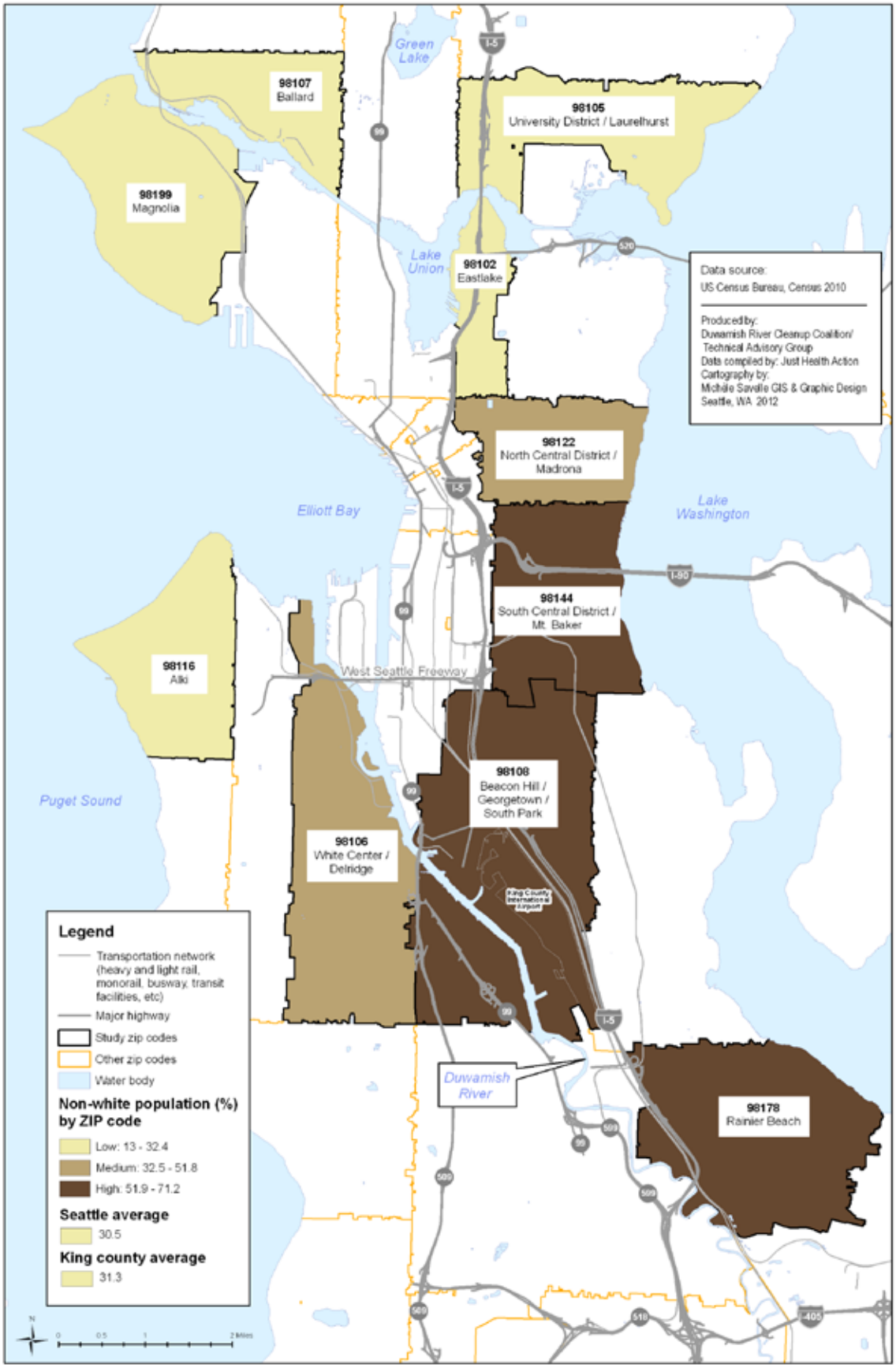


Figure 5. Percent Presence of Children Under 5 years, by ZIP Code
Seattle, Washington, 2010

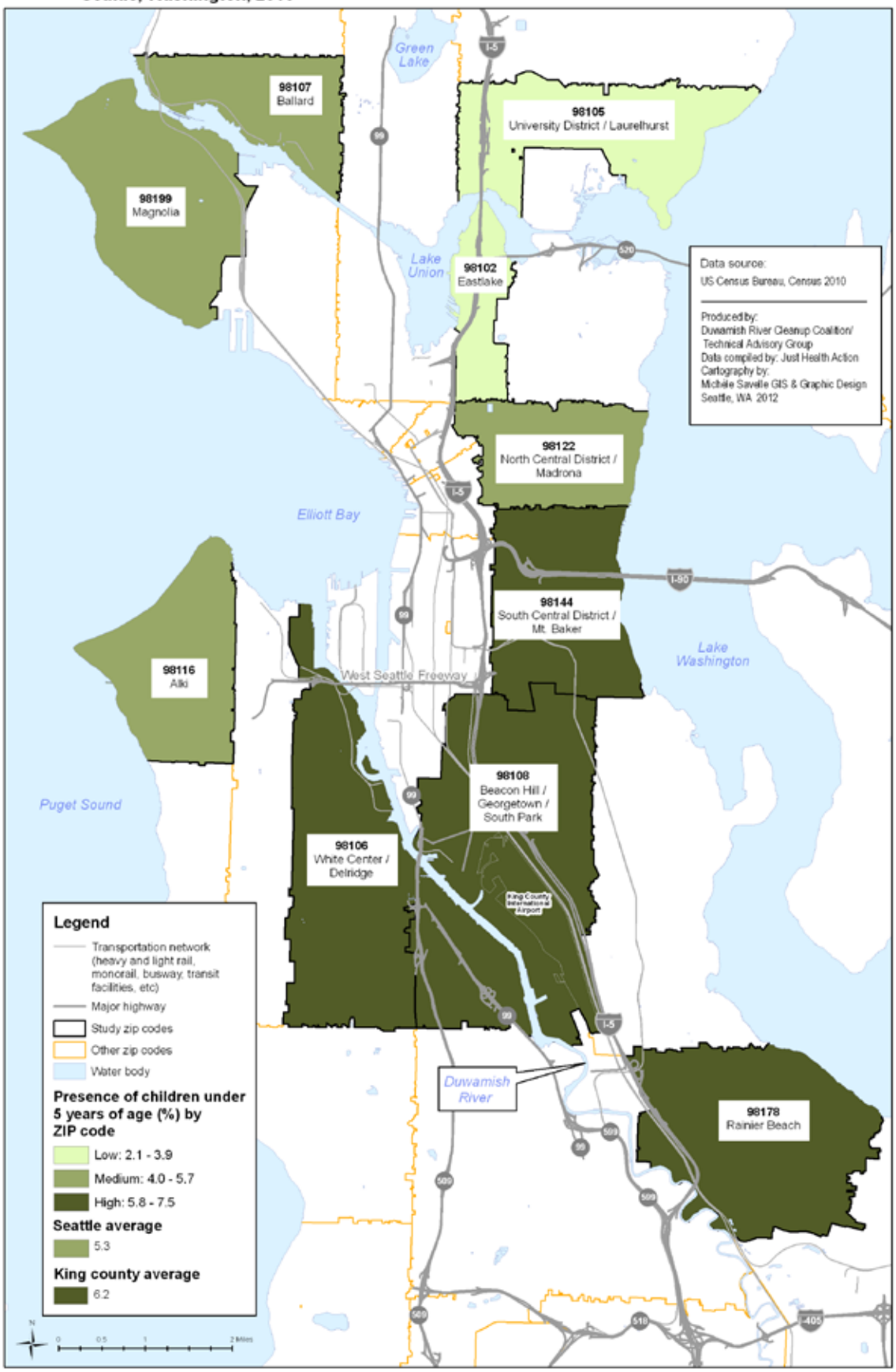


Figure 6. Percent Presence of Elderly 65 years and Older, by ZIP Code
Seattle, Washington, 2010

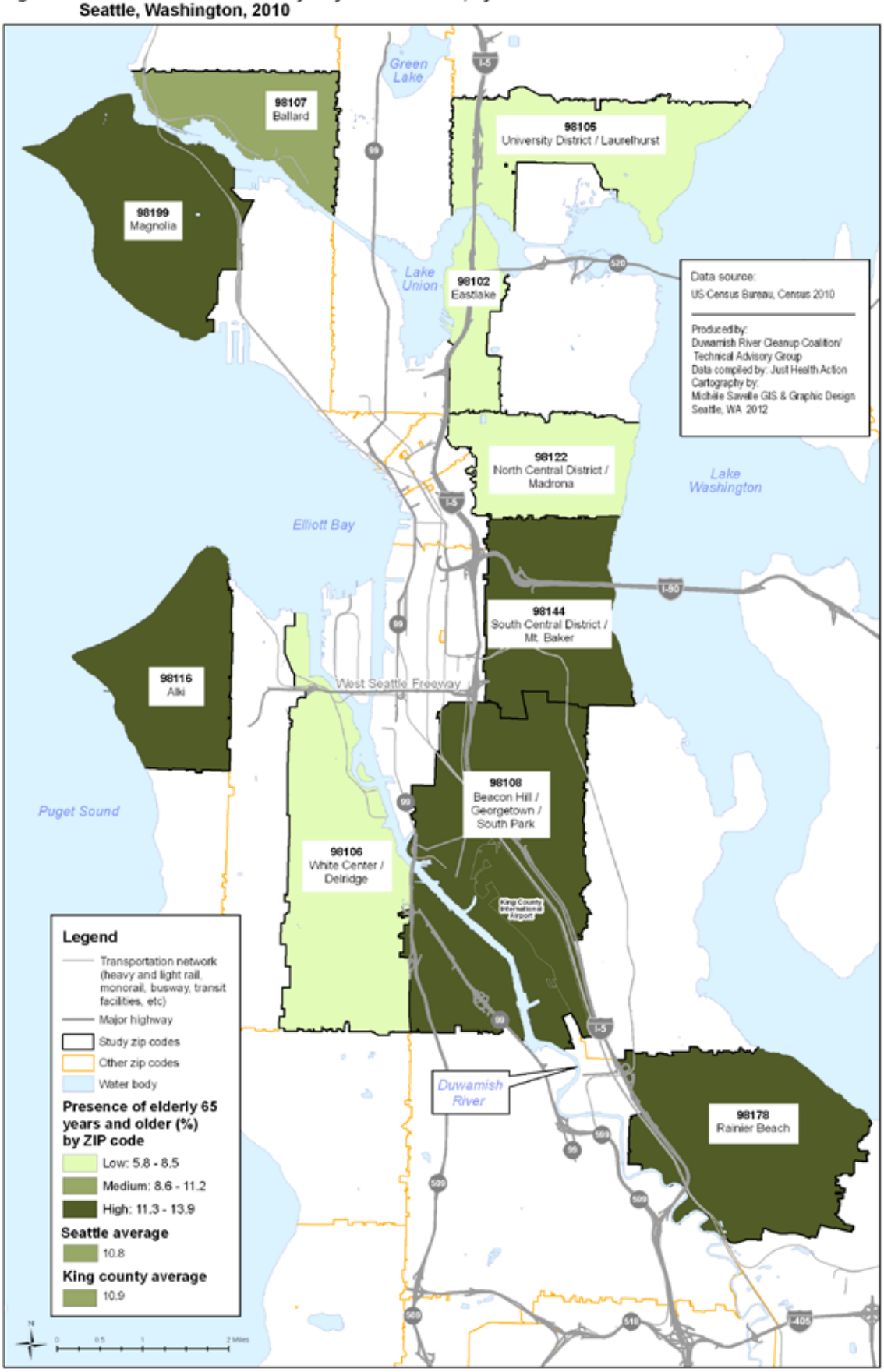


Figure 7. Percent Foreign-Born by ZIP Code
Seattle, Washington, 5-year Average 2006-2010

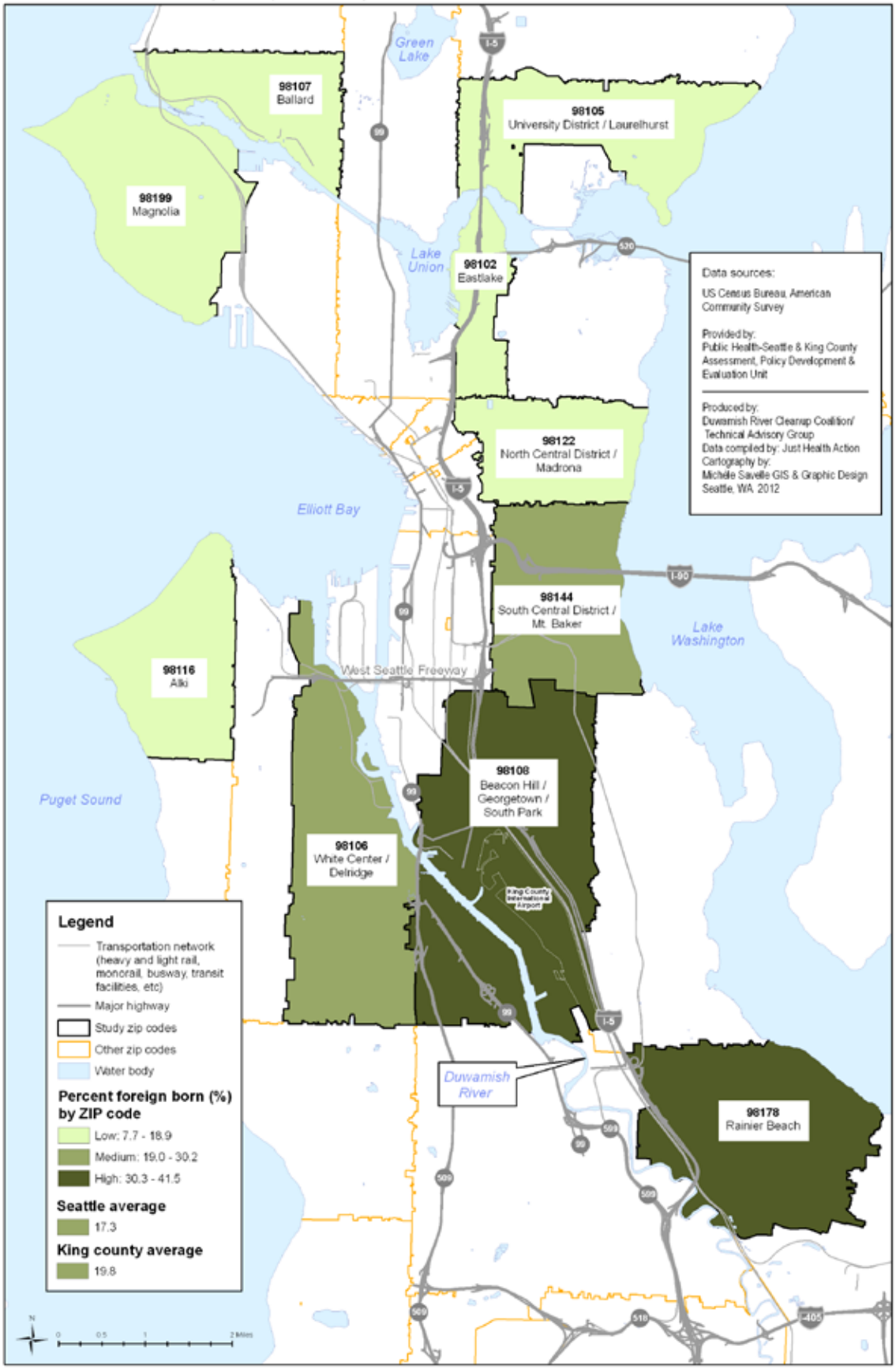


Photo: BJ Cummings

Certain populations are more vulnerable to pollution because of their age, pre-existing conditions, and/or cultural practices.

Environmental exposure component (Rank range 1–10)

Individuals can be exposed to contamination through various media (air, soils, sediments, ground water, surface water) by coming into contact with a chemical or physical agent. Examples of exposure are ingestion, inhalation, and direct contact (e.g., on the skin) with a pollutant. There is little research available that establishes a firm causal connection between contaminant exposures and health outcomes because of long latency periods, lack of body burden markers, and exposure to multiple possible causes of illness (Payne-Sturges et al, 2006). However, the health risks (potential for disease) of exposure to many pollutants is well understood, and it is well established that low-income and/or minority populations are disproportionately exposed to pollution and increased health risks because of their proximity to pollution sources such as industrial facilities, highways, low income housing (e.g, lead), and agricultural areas (e.g., pesticide application) (OEHHA, 2010).

Selected Indicators

- Concentration of diesel particulate mater in air (Figure 8, page 20)
- Concentration of benzene in air (Figure 9, page 21)
- Number and severity of confirmed and suspected contaminated sites (Figure 10, page 22)

Environmental effects component (Rank range 1–5)

Where a person lives affects their health, but not all communities are equal with respect to their exposure to pollution and access to resources or benefits that can make a community more or less healthy (http://www.kingcounty.gov/exec/equity.aspx). In addition to concerns about industry pollution, noise, and traffic, Duwamish Valley residents expressed concern through a Community

Figure 8. Annual Average Diesel Particulate Matter in Human Breathing Zone (ug/m^3), by ZIP Code Seattle, Washington, 2005

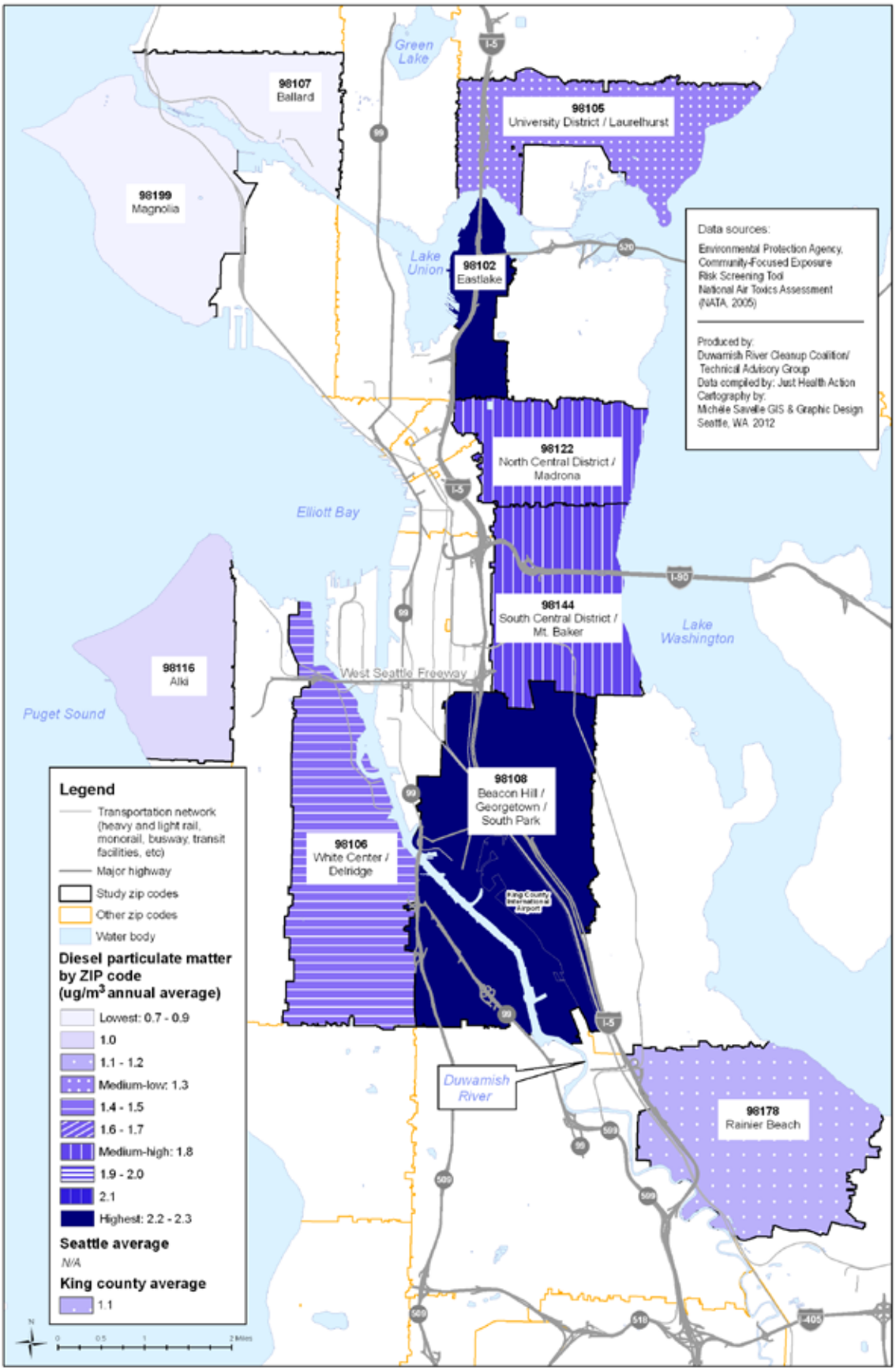


Figure 9. Annual Average Benzene in Human Breathing Zone (ug/m^3), by ZIP Code Seattle, Washington, 2005

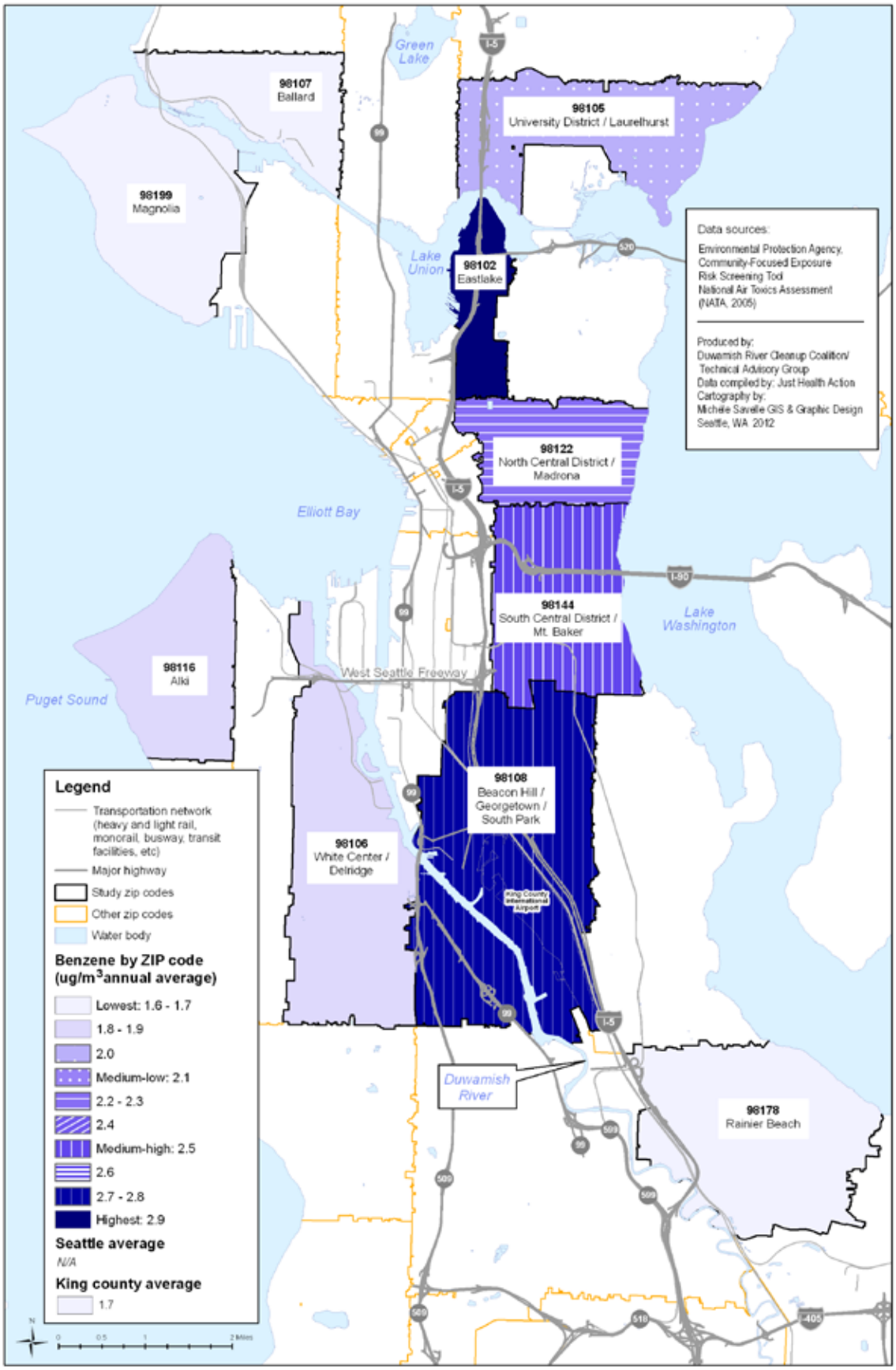


Figure 10. Summed Site Ranking for Confirmed and Suspected Contaminated Sites, by ZIP Code Seattle, Washington

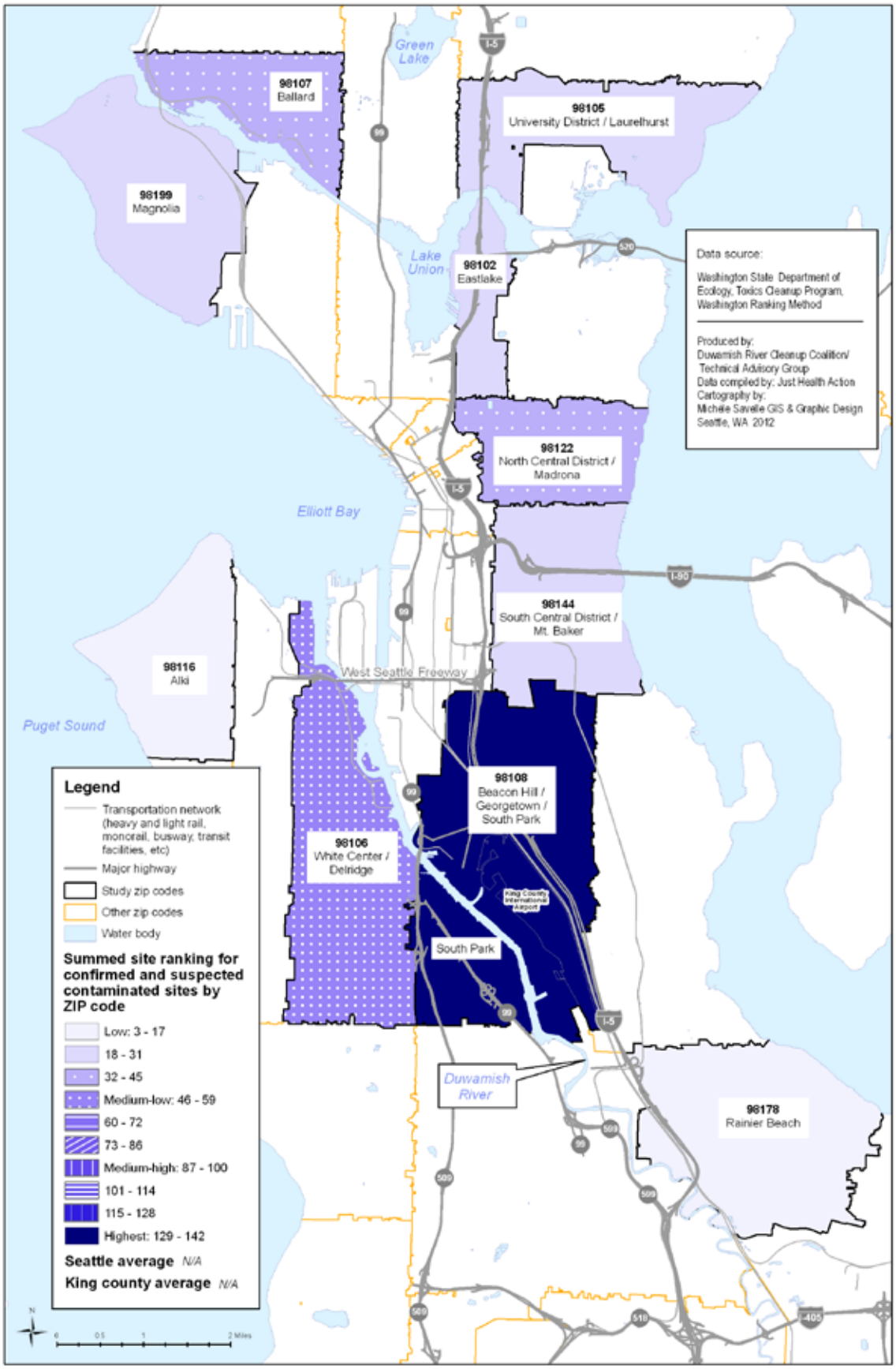


Photo: Paul Joseph Brown

Where you live affects your health

Based Participatory Research (CBPR) project (described in Appendix B) that they lacked adequate access to healthy food, green space, and places to play or exercise.

Selected Indicators

- Amount of forest canopy (Figure 11, page 24)
- Amount of park area per resident (Figure 12, page 25)
- Number of Toxic Release Inventory sites (Figure 13, page 26)[2]

Public health component (Rank range 1–5)

Health disparities have been well documented in the United States and locally and are the focus of growing community and government attention (CDC, 2011; Governor's Interagency Council on Health Disparities, 2012). Numerous public health indicators were compiled and reviewed for statistical significance and stability as well as alignment with the community's identified health concerns through the CBPR project.

Selected Indicators

- Heart disease (Figure 14, page 27)
- Childhood asthma (Figure 15, page 28)
- Lung cancer (Figure 16, page 29)

[2] Toxic Release Inventory (TRI) sites are those listed on EPA's database of facilities with large volumes of toxic chemical releases.

Figure 11. Percent Tree Canopy, by ZIP Code
Seattle, Washington

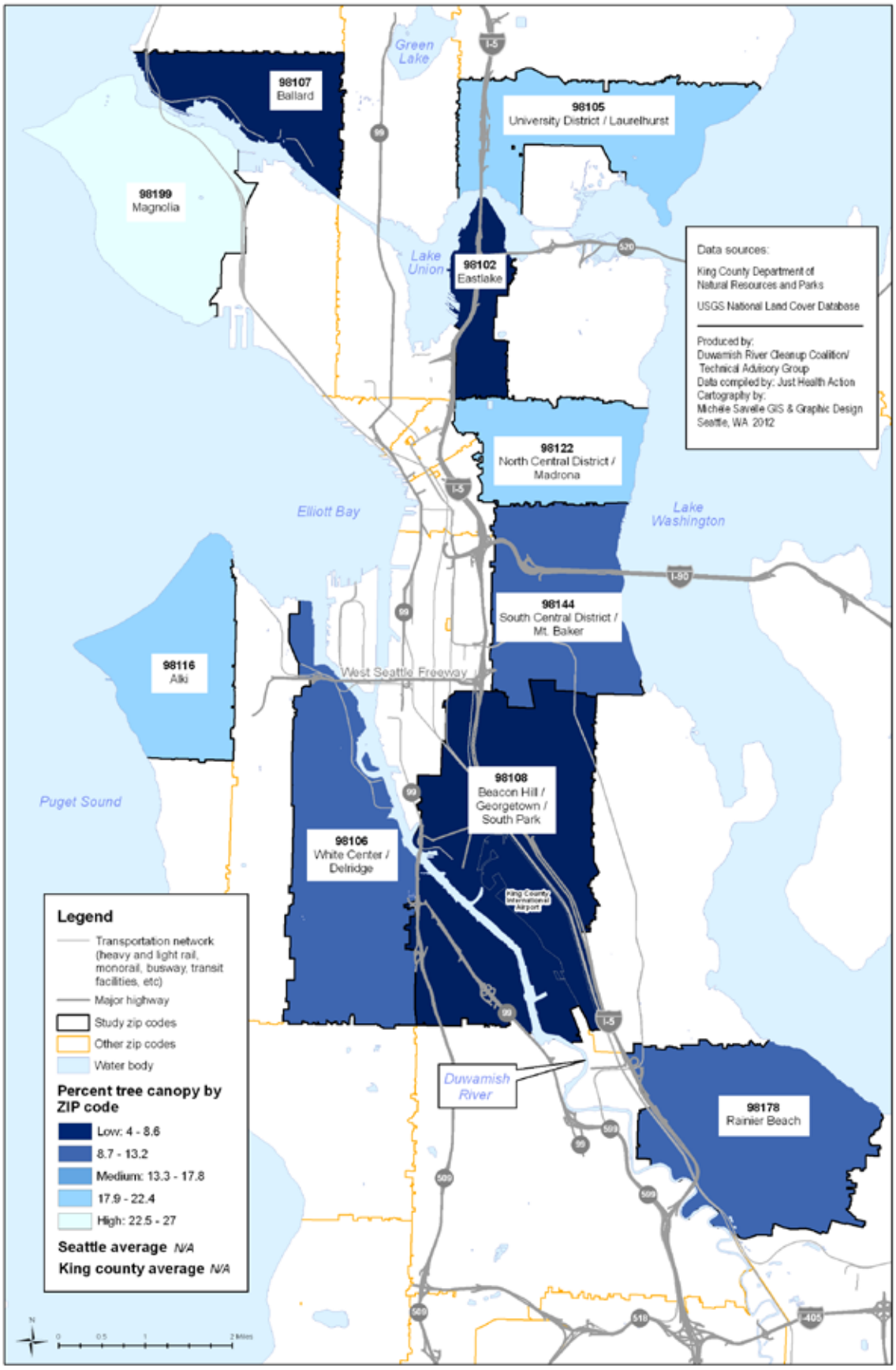


Figure 12. Square Feet per Resident of Park Area, by ZIP Code
Seattle, Washington

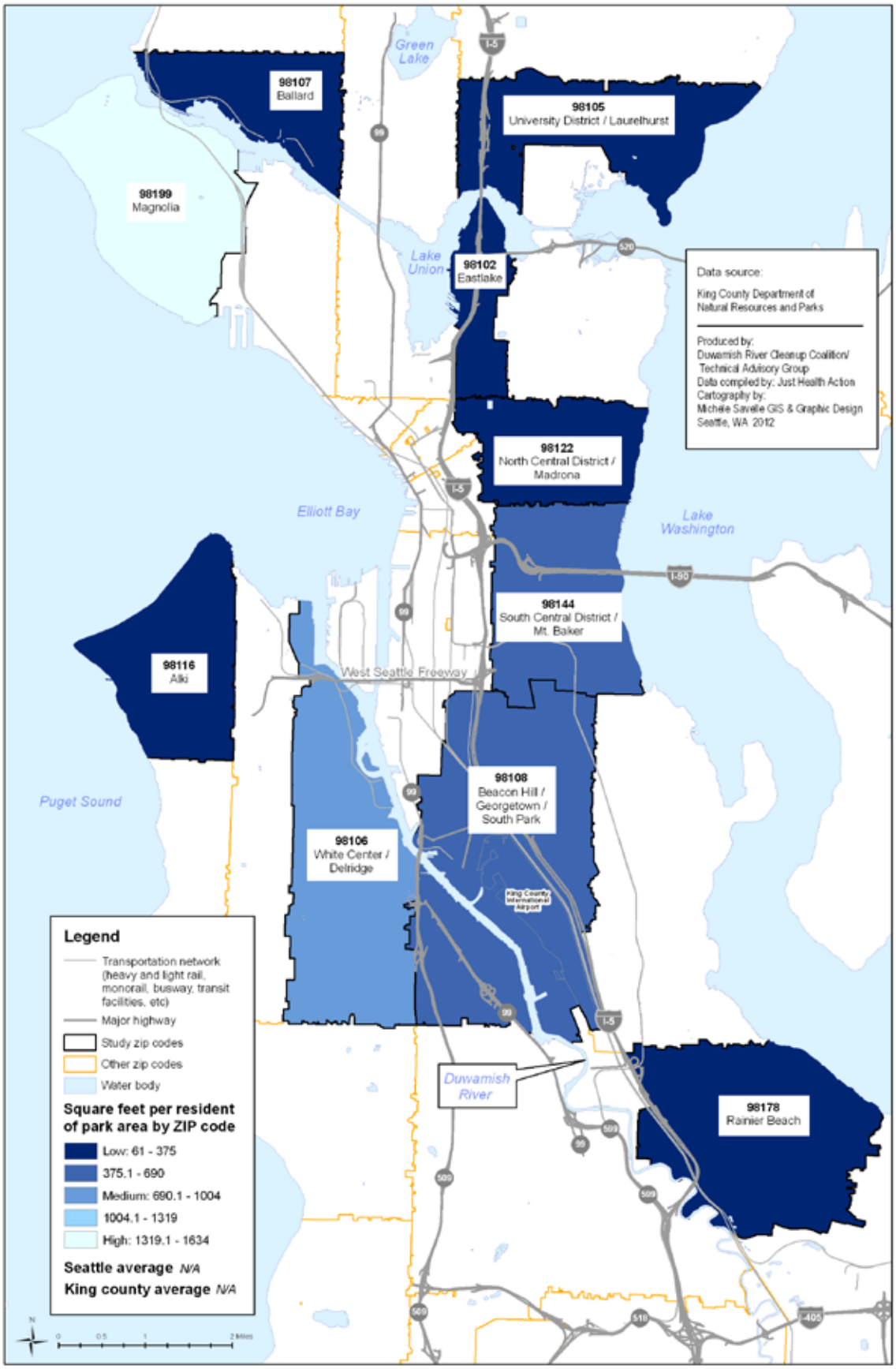


Figure 13. Number of Toxic Release Inventory Sites, by ZIP Code
Seattle, Washington

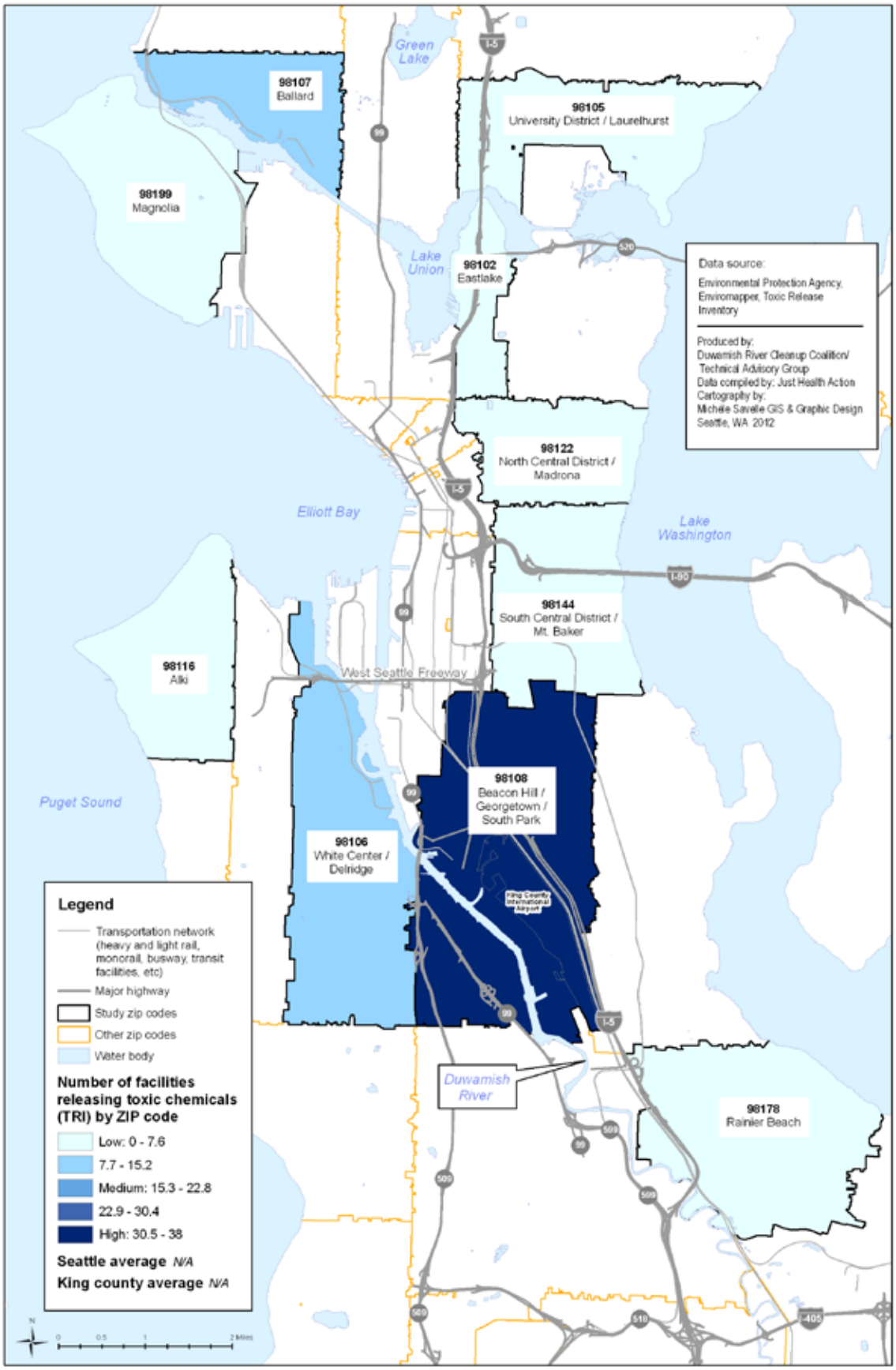


Figure 14. Heart Disease Death rate per 100,000, by ZIP Code
Seattle, Washington, 5-year average, 2006-2010

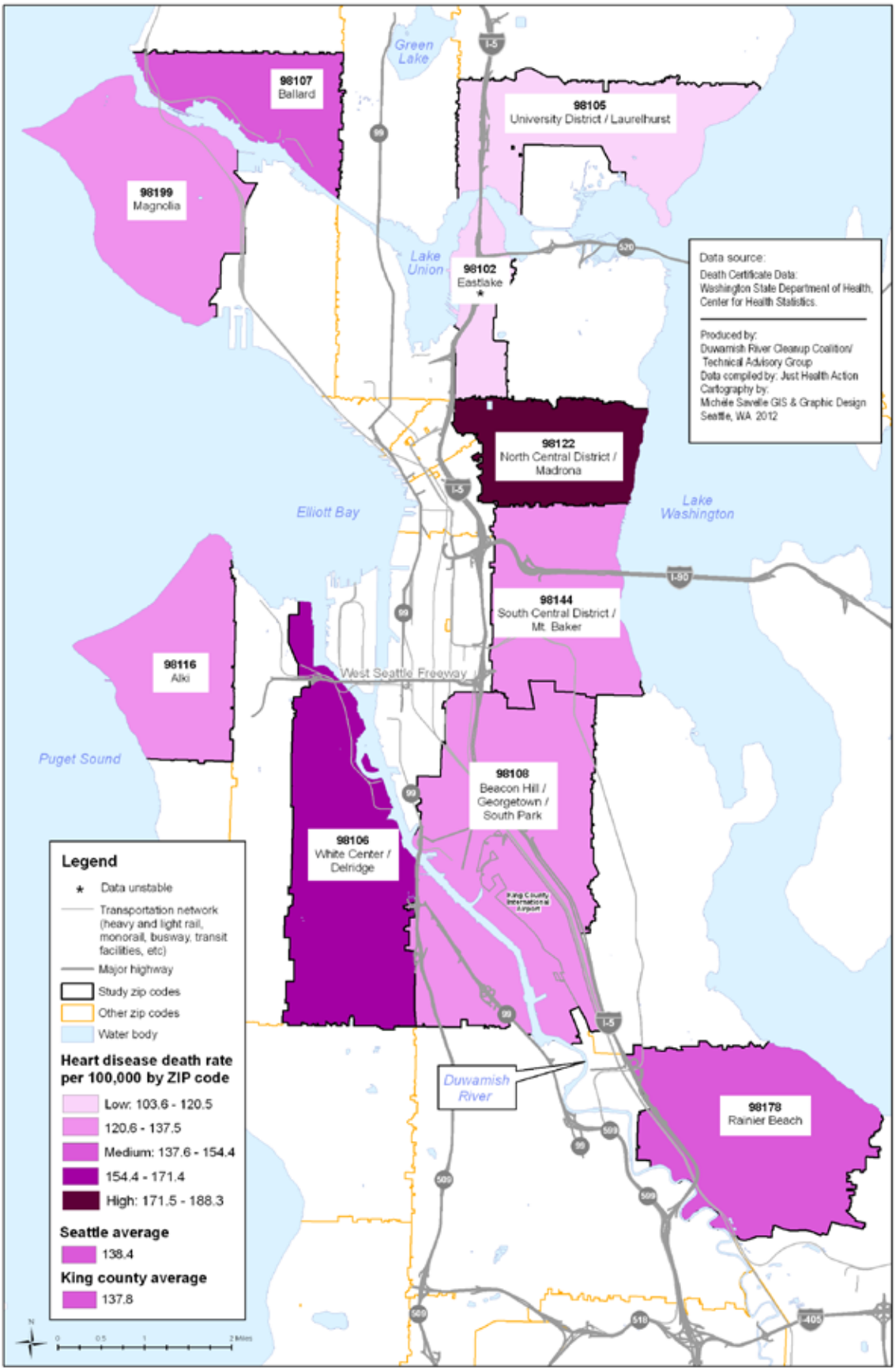


Figure 15. Childhood (0-17) Asthma Hospitalization Rate per 100,000, by ZIP Code Seattle, Washington, 5-year average, 2006-2010

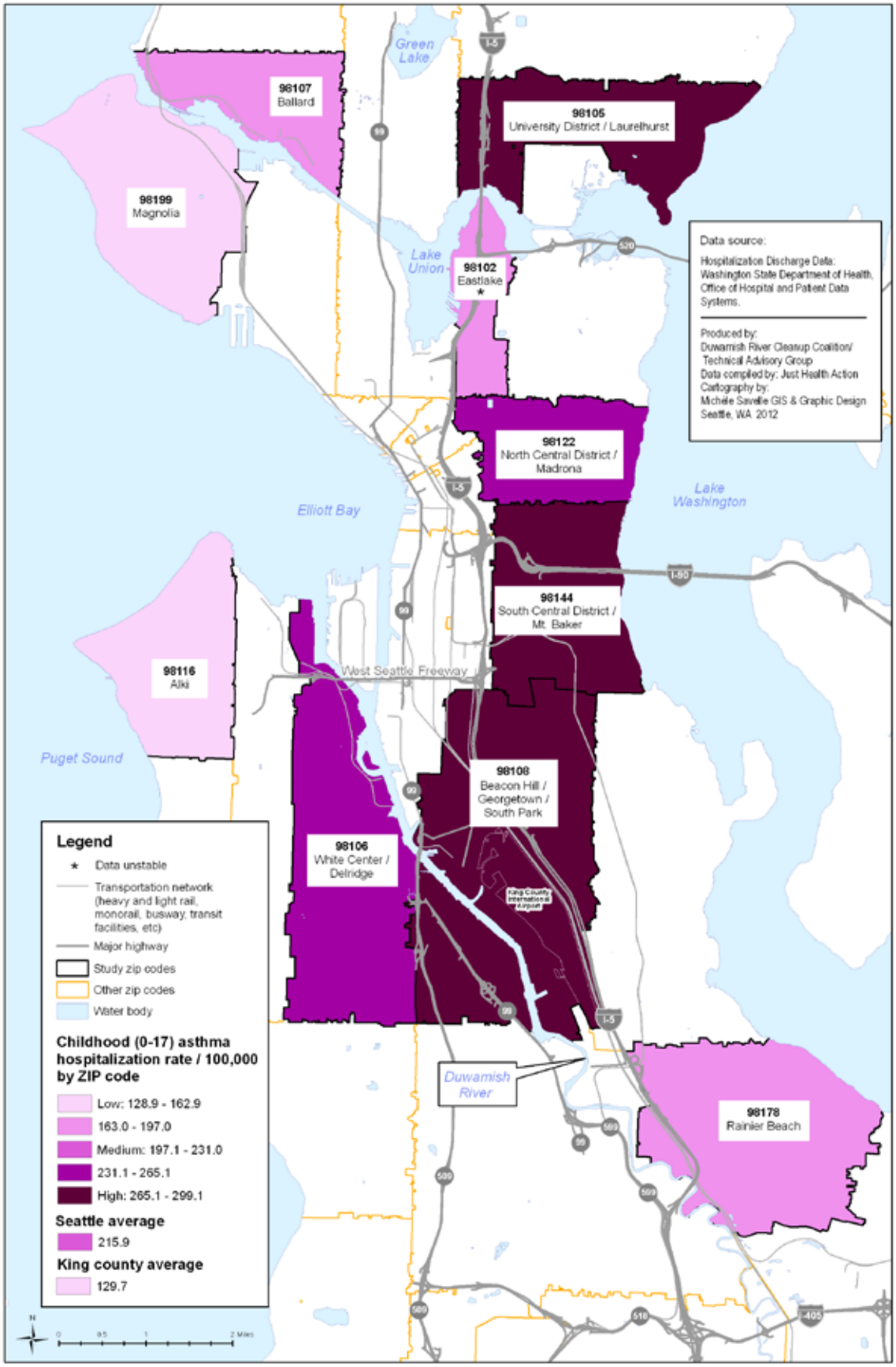
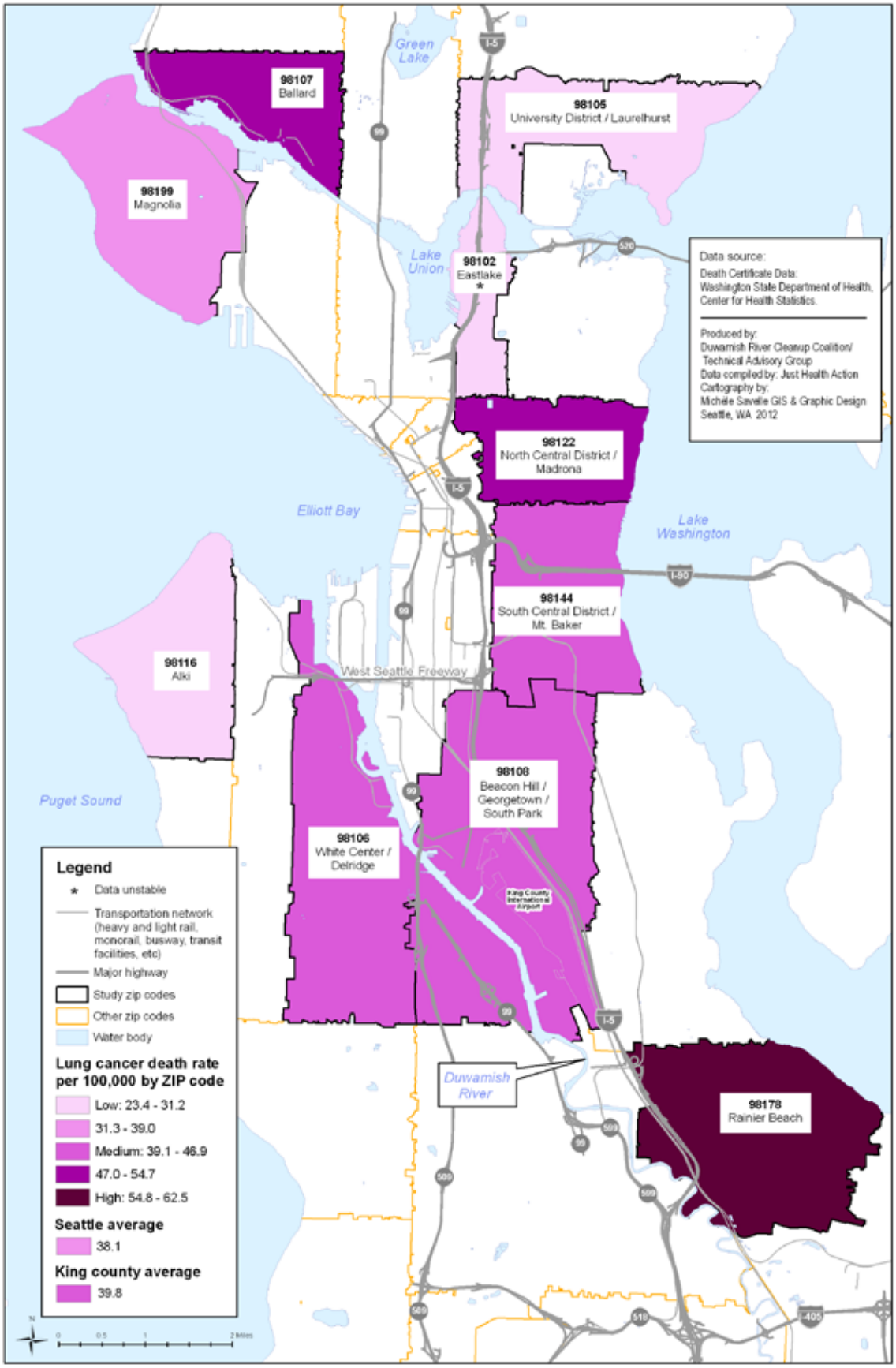


Figure 16.Lung Cancer Death Rate Per 100,000, by ZIP Code
Seattle, Washington, 5-year average, 2006-2010



V. Cumulative Impacts Analysis Results

Data for each of the selected indicators described above were ordered from high to low, divided into equivalent portions based on the range of collected data, and assigned the corresponding rankings shown in Figures 2–16 and Table 2 (page 31). In calculating the cumulative impact score, the rank sums for each indicator were first averaged for each component. For example, for the socioeconomic factors component (Rank range 1–3) in the 98108 ZIP code (Beacon Hill/Georgetown/South Park), percent college education, percent below 200% of poverty level, and percent non-white minority each received a rank of 3. The 3 indicators were totaled (3+3+3=9) and then averaged, giving the 98108 ZIP code a socioeconomic factors rank of 3 (Table 2, page 31). In Table 2, each component is color coded to match the color spectrum used in Figures 2–17: the darker the coloring, the higher ranking the characteristic, or contribution to the overall cumulative impact. For example, for the socioeconomic factors component, which is color coded in a brown spectrum, the 98108 ZIP code is a 3 and dark brown, while a 1 ranking has a light tan color.

Social Vulnerability

Socioeconomic Factors component (Rank range 1–3)

Based on a ranking of 1–3, Table 2 shows that 3 ZIP codes (98108, Beacon Hill/Georgetown/South Park; 98144, Central District; and 98178, Rainier Beach) were each given the highest average ranking of 3 for the socioeconomic factors component (No college education; Percent below 200% poverty level; Percent non-white minority population).

Photo: Aiden Duffy

Table 2. Cumulative Health Impacts Analysis, by ZIP code, Seattle, Washington (colors correspond to color keys in Figures 2–17)

Component	Indicator	98108 Beacon Hill/ Georgetown/ South Park	98144 S. Central District/ Mt. Baker	98178 Rainier Beach	98106 White Center/ Delridge	98122 N. Central District/ Madrona	98102 Eastlake	98107 Ballard	98105 University District/ Laurelhurst	98116 Alki	98199 Magnolia
Socioeconomic Factors (Rank 1–3)	No college education (%)	3	3	3	3	2	1	2	1	2	1
	Below 200% poverty level (%)	3	3	3	2	3	2	1	3	1	1
	Non-white minority population (%)	3	3	3	2	2	1	1	1	1	1
	Adults with no health insurance (%)	*	*	*	*	*	*	*	*	*	*
	Adults with no leisure time (%)*	*	*	*	*	*	*	*	*	*	*
	Average	3	3	3	2	2	1	1	2	1	1
Sensitive Populations (Rank 1–3)	Children under 5 years (%)	3	3	3	3	2	1	2	1	2	2
	Elderly—65 years and older (%)	3	3	3	1	1	1	2	1	3	3
	Foreign born (%)	3	2	3	2	1	1	1	1	1	1
	Average	3	3	3	2	1	1	2	1	2	2
Social Vulnerability	*SUM (Socioeconomic + Sensitive Populations)*	6	6	6	4	4	2	3	3	3	3
Environmental Exposures (Rank 1–10)	Diesel particulate matter (ug/m³ annual average)	10	6	3	5	6	10	1	4	2	1
	Benzene (ug/m³ annual average)	9	7	1	2	5	10	1	3	2	1
	Confirmed and suspected contaminated sites (ISIS)	10	2	1	4	3	2	3	2	1	2
	Average	10	5	2	4	5	7	2	3	2	1
Environmental Effects (Rank 1–5)	Tree canopy (%)	5	4	4	4	2	5	5	2	2	1
	Park area per resident	4	4	5	3	5	5	5	5	5	1
	Number of toxic release inventory sites	5	2	1	3	1	2	4	1	1	2
	Average	5	3	3	3	3	4	5	3	3	1
Public Health Effects (Rank 1–5)	Live expectancy at birth (years)	*	*	*	*	*	*	*	*	*	*
	Adults overweight or obese (%)	*	*	*	*	*	*	*	*	*	*
	Heat disease death rate per 100,000	2	2	3	4	5	1	3	1	2	2
	Stroke death rate per 100,000	*	*	*	*	*	*	*	*	*	*
	Adults—doctor-diagnosed diabetes (%)	*	*	*	*	*	*	*	*	*	*
	Adults—hypertension (%)	*	*	*	*	*	*	*	*	*	*
	Childhood (0-17) asthma hospitalization rate per 100,000	5	5	2	4	4	2	2	5	1	1
	Adult cigarette smokers (%)	*	*	*	*	*	*	*	*	*	*
	Lung cancer death rate per 100,000	3	3	5	3	4	1	4	1	1	2
	Average	3	3	3	4	4	1	3	2	1	2
Environmental Vulnerability	*SUM (Environmental Exposures + Environment Effects + Public Health Effects)*	18	12	8	11	12	13	9	8	6	4
IMPACT SCORE	*(Social Vulnerability x Environmental Vulnerability)*	106	66	50	46	43	30	28	21	19	13

* These indicators were evaluated and can be viewed in Appendix A.

Sensitive Populations Component (Rank range 1–3)

Table 2 (page 31) shows that sensitive populations (presence of children under 5 years, presence of elderly, and percent foreign born) were given the highest average ranking of 3 in the same three ZIP codes (98108, 98144, and 98178) as for the socioeconomic factors component.

Social vulnerability is the sum of the socioeconomic factors component rank plus the sensitive populations component rank and can range from 2–6 for the ten Seattle ZIP codes. ZIP codes 98108 (Beacon Hill/Georgetown/South Park), 98144 (Central District), and 98178 (Rainier Beach), received the highest ranking of 6 while the lowest ranked was 98102 (Eastlake), with a ranking of 2, as shown in Table 2.

Environmental Vulnerability

Environmental Exposures component (Rank range 1–10)

The environmental exposures component includes exposure to airborne diesel particulate matter and benzene via inhalation, as well as the potential to be exposed to nearby confirmed and suspected contaminated waste sites. Table 2 (page 31) shows that two areas of Seattle—Eastlake (98102) and Beacon Hill/Georgetown/South Park (98108)—have particularly high exposures to air pollution. In addition, 98108 has the highest exposure to contaminated waste sites. When the three indicators are summed, averaged and ranked from 1–10, 98108 receives the highest ranking of 10, followed by 98102 with a ranking of 7. Magnolia (98199) with a ranking of 1, has the lowest environmental exposures ranking.

Environmental Effects component (Rank range 1–5)

The environmental effects component consists of three built environment attributes: percent tree canopy, amount of park area per resident, and proximity to Toxic Release Inventory Sites, and is ranked from 1–5. Table 2 shows that two areas of Seattle—Beacon Hill/Georgetown/South Park (98108) and Ballard (98107)—have the poorest built environment characteristics, with a ranking of 5. Magnolia (98199) has the best built environment attributes, with a ranking of 1.

Public Health Effects Component (Rank range 1–5)

The three indicators used to make up the public health effects component are heart disease death rates, childhood asthma hospitalization rates, and lung cancer death rates, with a ranking from 1 to 5. White Center (98106) and North Central District/Madrona (98122) had the highest public health effects, with a ranking of 4; the lowest public health effects, with a ranking of 1, are in Eastlake (98102) and Alki (98116). Beacon Hill/Georgetown/South Park (98108) ranked as 3.

Environmental vulnerability is the sum of the environmental exposures component, plus the environmental effects component, plus the public health effects component, and can range from 3 to 20. Beacon Hill/Georgetown/South Park (98108) had the highest ranking of 18, as shown in Table 2. The next highest environmental vulnerability ranking was 13, for Eastlake (98102), and the lowest was for Magnolia (98199), with a ranking of 4.

Photo: Cari Simson

Cumulative Impacts

The cumulative health impact scores for the ten Seattle ZIP codes are shown in Table 3 (page 34) and Figure 17 (page 35).

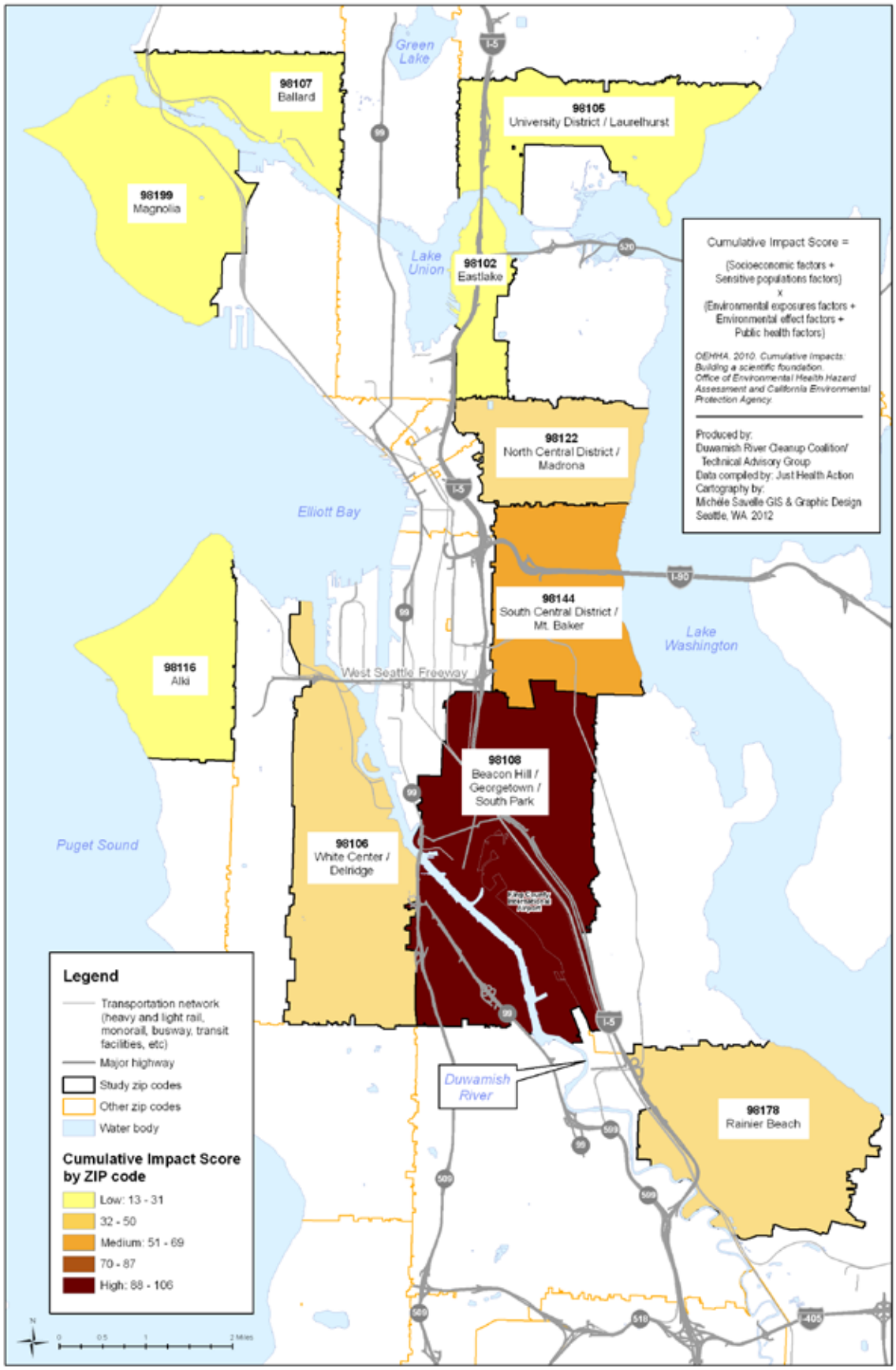
Cumulative Impact = (Socioeconomic factors + Sensitive populations) x
(Environmental exposures + Environmental effects + Public health effects)

In a cumulative impact range of 6 to 120, the highest cumulative score is 106 for ZIP code 98108 (Beacon Hill/Georgetown/South Park). The high score indicates that this area is burdened with disproportionately greater impacts relative to the other areas of Seattle. South Central District/Mt. Baker (98144), receives the second highest score of 66. Rainier Beach (98106), White Center/Delridge (98106), and North Central District/Madrona (98122) receive medium-low scores of 50, 46, and 43, respectively. Eastlake (98102), Ballard (98107), University District/Laurelhurst (98105), Alki (98116), and Magnolia (98199) all receive relatively low cumulative impact scores of 30, 28, 21, 19, and 13, respectively.

Table 3. Cumulative Health Impacts Analysis, by ZIP code, Seattle, Washington (colors correspond to color keys in Figures 2–17)

Component	98108 Beacon Hill/ Georgetown/ South Park	98144 S. Central District/ Mt. Baker	98178 Rainier Beach	98106 White Center/ Delridge	98122 N. Central District/ Madrona	98102 Eastlake	98107 Ballard	98105 University District/ Laurelhurst	98116 Alki	98199 Magnolia
Socioeconomic Factors	3	3	3	2	2	1	1	2	1	1
Sensitive Populations	3	3	3	2	1	1	2	1	2	2
Social Vulnerabillity	6	6	6	4	4	2	3	3	3	3
Environmental Exposures	10	5	2	4	5	7	2	3	2	1
Environmental Effects	5	3	3	3	3	4	5	3	3	1
Public Health Effects	3	3	3	4	4	1	3	2	1	2
Environmental Vulnerability	18	12	8	11	12	13	9	8	6	4
CUMULATIVE IMPACT SCORE	106	66	50	46	43	30	28	21	19	13

Figure 17. Cumulative Impact Score by ZIP Code, Seattle, Washington



VI. Other Lines of Evidence

While the Cumulative Health Impacts Analysis (CHIA) used 15 indicators (3 indicators per component) to measure cumulative impacts, other indicators were reviewed to examine disparities and are shown in Appendix A (www.duwamishcleanup.org/programs/duwamish-community-health-initiative). Figures A1–A9 show that residents of Beacon Hill/Georgetown/South Park (98108 ZIP code) have additional disparities, including the highest ranking in percent adults with no health insurance, percent adults with no leisure time, and stroke death rate. ZIP code 98108 also ranks medium high in assault hospitalization rates, percent adults with hypertension, percent adults overweight or obese and medium in life expectancy, percent adult cigarette smokers, and percent adults with doctor diagnosed diabetes.

While this report analyzed data at the ZIP code level, other data, where available and statistically stable, were reviewed at two other geographic levels: (1) the greater Duwamish Valley watershed, a geographic area that extends from the southern part of Elliott Bay to as far south as the southern end of the Beacon Hill ridge; and (2) the Georgetown and South Park neighborhoods. The greater Duwamish Valley data set is large and therefore contains more statistically stable data. The South Park/Georgetown data set, which is composed of two census tracts, is smaller and therefore contains fewer statistically significant and stable indicators.

Duwamish Valley Watershed

The total population included in the greater Duwamish Valley watershed is approximately 132,000, using 2010 census data. In 2011, Public Health-Seattle & King County's Policy Development & Evaluation Unit conducted a health and demographics analysis of the Duwamish Valley using this geographic scale (Appendix C–Table 3, online). In comparing the greater Duwamish Valley to King County residents, greater Duwamish Valley residents are more likely to live in poverty (17.6% vs. 9.7%), be foreign born (31.9% vs. 19%), not attend high school (20.1% vs. 8.2%), have no bachelor's degree (75.4% vs. 55.2%), have no health insurance (20% vs. 13%), and have no leisure time physical activity in the past month (24% vs. 15%). All of these differences are statistically significant. [3]

Low birth weight is an indicator commonly used to illustrate racial and income health disparities between populations because it is major factor for several chronic diseases of adulthood and is linked to long-term health effects, including intergenerational health outcomes (Collins et al, 2002; OEHHA, 2010). The low birth weight difference between greater Duwamish Valley and King County residents is also statistically significant (6.0% vs. 4.9%).

In terms of mortality characteristics represented as a rate per 100,000, lung cancer (52.3 vs. 41.4), unintentional injuries (41.3 vs. 32.7), and homicide (10.5 vs. 3.4) are significantly higher in the greater

[3] Statistical significance in this report is based on a 95% confidence interval.

Duwamish Valley than in King County overall. With regard to hospitalization rates per 100,000, Duwamish Valley residents are more likely to be hospitalized for asthma than King County residents (youth under 18 [240.4 vs. 143.4] and adults [83.4 vs. 53.6]) and more likely to be hospitalized for assault (70.9 vs. 31). In addition to air pollution, there is evidence that increased anxiety and violence can trigger asthma attacks (Wright et al, 2004).

Life expectancy, often used as a measure of overall health and well being, is significantly lower in the greater Duwamish Valley, compared to the King County average (79.4 vs. 81.5).

Georgetown and South Park

The neighborhoods of Georgetown and South Park have a total population of of approximately 5,160 (2010 Census) and are represented by two census tracts (109 and 112). Heart disease and life expectancy data available and statistically stable at the census tract level suggest that Georgetown and South Park residents' health characteristics are worse than portrayed by the 98108 ZIP code data. For example, although the heart disease death rate (Figure 14, page 27) for the 98108 ZIP code is ranked medium-low (2) relative to the other ten ZIP codes, a closer examination of data available for

Photo: Paul Joseph Brown

Duwamish Valley residents are more likely to be hospitalized for asthma than King County residents overall.

Life expectancy in Laurelhurst is 86.4 years, a full 13 years longer than for Georgetown and South Park residents.

the South Park and Georgetown census tracts show a greater health disparity. Heart disease death rates in South Park and Georgetown between 2006–2010 were 202.9 per 100,000, which falls above the highest range in the CHIA (171–188).

Residents of 98108 have an average life expectancy of 80.8 years, which is ranked as a 3, or medium (80.7–82.6 years), and is similar to both the Seattle and King County average. However, census tract data show that in Georgetown and South Park, life expectancy is 73.3 years, which is significantly lower than the Seattle and King County average of 81.5. Additionally, Georgetown and South Park residents often compare their circumstances to other Seattle neighborhoods that they perceive as more privileged, such as Laurelhurst, a relatively wealthy lakefront community located in the 98105 ZIP code. Life expectancy in Laurelhurst is 86.4 years, a full 13 years longer than for Georgetown and South Park residents.

Photo: Joe Mabel/wikipedia.com

VII. Duwamish Valley CHIA Limitations

Although the findings of this report are significant, these data have limitations. First, although the majority of data are by ZIP code, this geographical unit of analysis is not ideal for examining neighborhood differences. For example, only the residents of the west slope of Beacon Hill, which is a part of ZIP code 98108 but across the I-5 corridor from the river, live in the Duwamish Valley. It is likely that residents of Beacon Hill do not have the same exposure to contamination in the Duwamish Valley as do those in Georgetown and South Park. In addition, health data can vary by neighborhoods within the same ZIP code, as demonstrated by the limited available census tract data discussed in Section VI. Due to the availability and use of ZIP code data, the Cumulative Health Impacts Analysis (CHIA) results represent the combined characteristics of the Beacon Hill, Georgetown, and South Park neighborhoods in the 98108 ZIP code, obscuring any differences among those neighborhoods.

A second limitation of the Seattle CHIA is that the study was limited to only ten Seattle ZIP codes. It is possible that other ZIP codes merit scrutiny with regard to health disparities and/or that some disparities in environmental regulations, policies, and practices have been missed. Despite this concern, this CHIA selected ZIP codes that capture a representative range of income levels, minority vs. white status, contaminated vs. uncontaminated environments, and related community concerns, addressing the US Environmental Protection Agency's (EPA) mandate for analyzing cumulative impacts, environmental heath disparities, and environmental justice.

Third, this ranking methodology is relative. This means that it is not accurate to say that Beacon Hill/Georgetown/SouthPark (98108) with a rank of 106 is 1.6 times worse than the next highest ranking area of South Central District/Mt Baker (98144) with a rank of 66. However, it indicates that from a cumulative health impacts perspective, residents of ZIP code 98108 are disproportionately affected by multiple stressors compared to other Seattle neighborhoods.

Fourth, the indicators that were selected for analysis and the ranking applied to each component could be considered subjective or biased. To test validity, the cumulative impact algorithm was quality checked in two ways. First, an alternative cumulative impacts scenario using all indicators shown in Table 1 (page 12) was run through the cumulative impacts equation, averaged according to the number of indicators entered for each component, and a ranking for each ZIP code was calculated (Appendix A–Table A-1, online). Another cumulative impacts scenario was tested in which the environmental exposures ranking range was changed from 10 to 5, which would alter the possible range of cumulative scores from 1 through 90 (Table A-2). In both of these alternate scenarios, the ranking numbers changed by only a few points and the relative order of the ten ZIP code rankings remained unchanged, validating the CHIA results using the selected indicators.

VIII. Conclusions and Next Steps

The Duwamish Valley Cumulative Health Impacts Analysis (CHIA) supports the identification of Seattle's 98018 ZIP code (Beacon Hill/Georgetown/South Park) as a geographic area with disproportionate health burdens and fewer environmental benefits as compared with other areas of Seattle. These disproportionate burdens are a result of the cumulative impact of social and environmental vulnerabilities, including socioeconomic factors, sensitive populations, environmental exposures and effects, and public health effects. When indicators representing all of these impacts are taken into account, the 98108 ZIP code ranks highest for cumulative health impacts among the ten ZIP codes studied citywide. Additional evidence, including at the larger Duwamish Valley watershed scale and at the smaller South Park and Georgetown census tract scale, reinforce these findings, and further suggests that the ZIP code level analysis may obscure even greater health disparities in the riverside communities of South Park and Georgetown. The results of this study justify characterizing the Duwamish Valley as a community with environmental injustices, or an Environmental Justice Gap. In light of these findings, the Duwamish Valley merits attention from decision-makers regarding health protective and proactive environmental regulations, policies, practices, and actions.

The results of this analysis will inform recommendations that the Duwamish River Cleanup Coalition/Technical Advisory Group, the US Environmental Protection Agency's (EPA) Community Advisory Group for the Duwamish River Superfund Site, will make to EPA, Washington state, and local government agencies regarding cleanup of the river and related pollution source control efforts, institutional controls, and risk reduction strategies for communities impacted by the site. In addition, DRCC/TAG will provide this report to federal, state, regional, and local governments; community-based organizations; and other stakeholders and decision-makers, to help guide the development of policies and actions to improve overall environmental health and equity in the Duwamish Valley.

Photo: Paul Joseph Browns

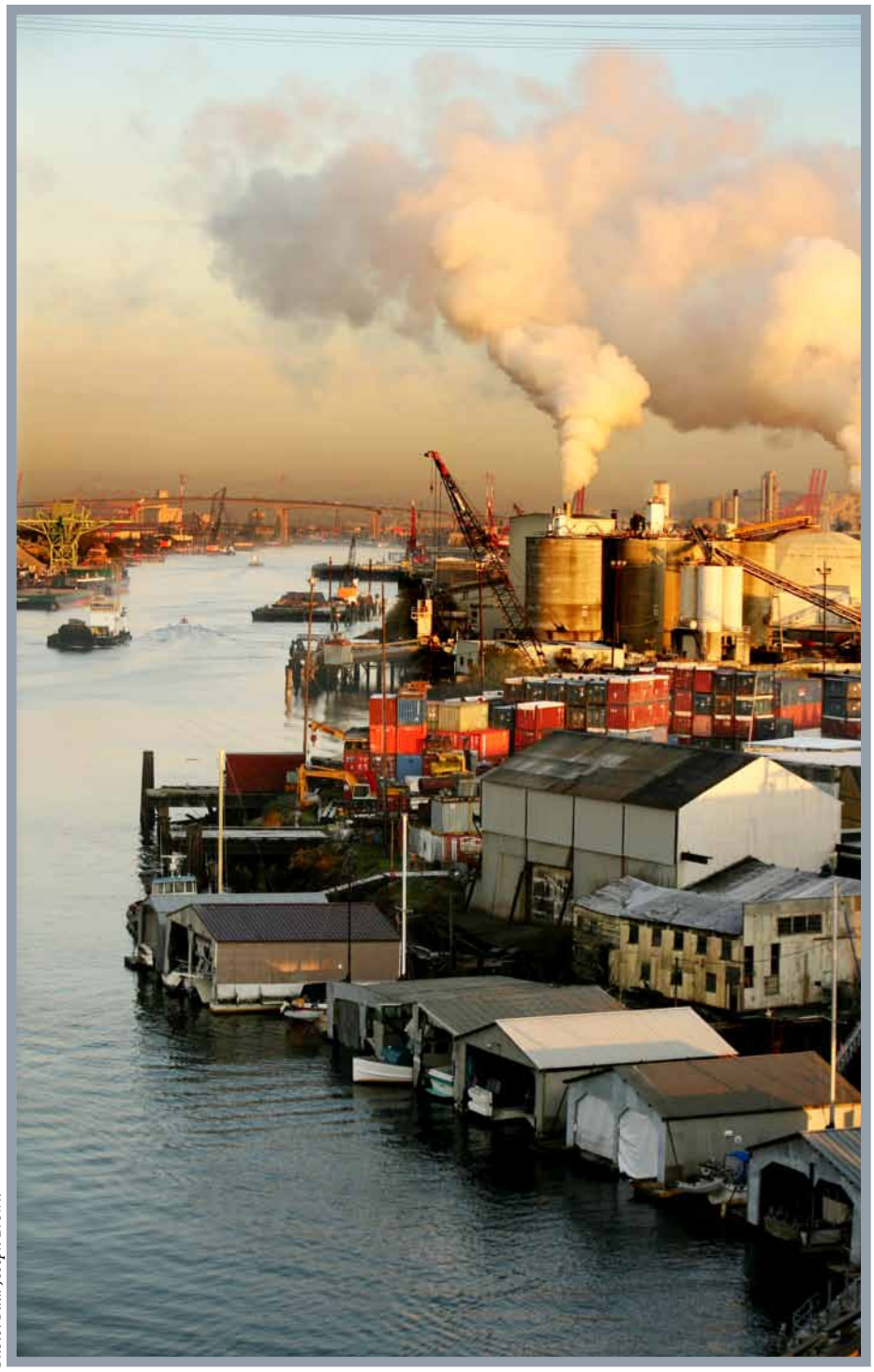


Photo: Paul Joseph Brown

The Duwamish Valley merits attention from decision-makers regarding health protective and proactive environmental regulations, policies, practices, and actions.

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