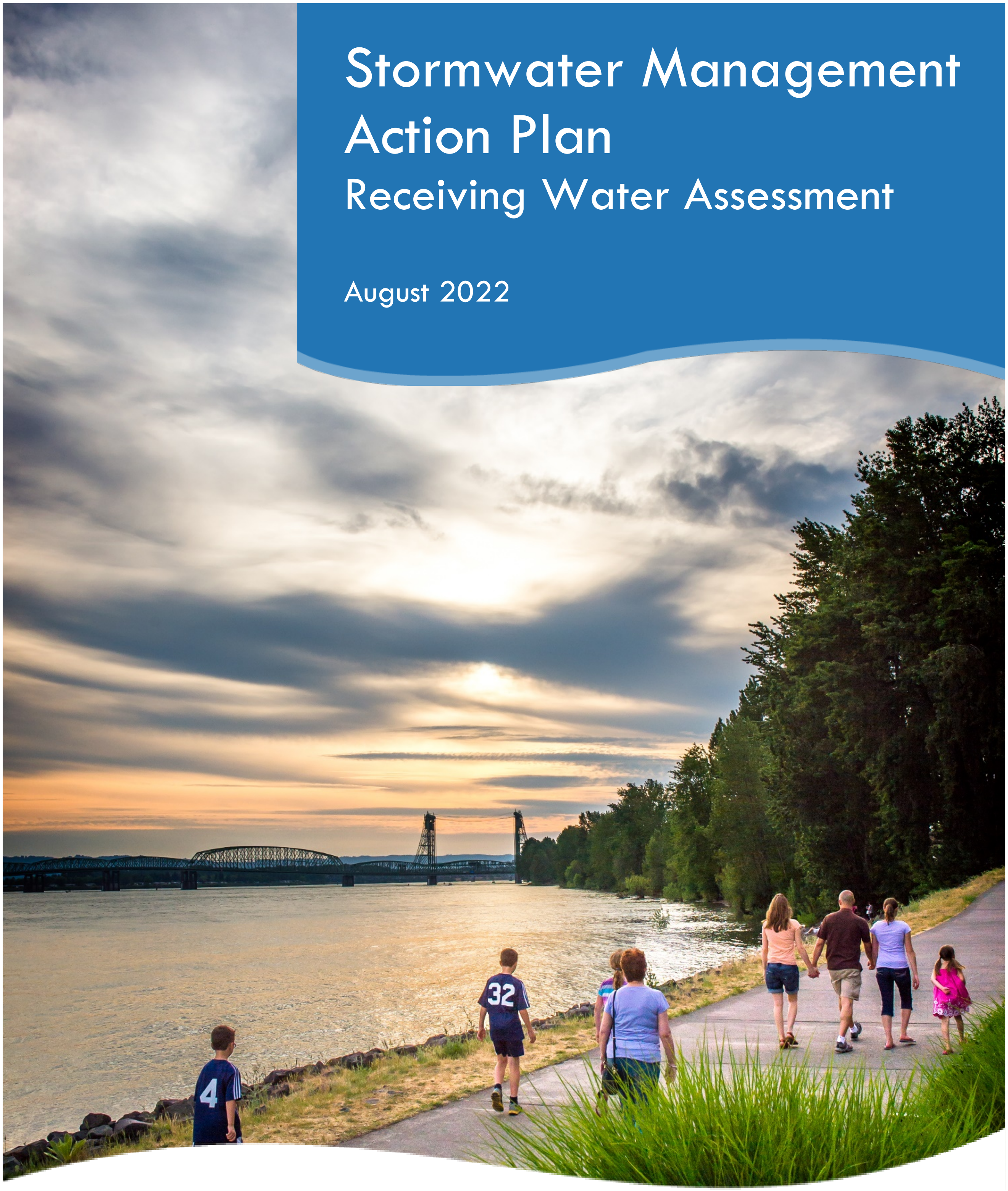
Stormwater Management Action Plan

Receiving Water Assessment

August 2022



CITY OF Vancouver WASHINGTON

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Abbreviations & Acronyms

This list contains abbreviations and acronyms used frequently in this document. Other abbreviations and acronyms are used infrequently and defined only in the text.

Term	Definition
BMP	Best management practices
City	The City of Vancouver
Ecology	Washington State Department of Ecology
EJ Screen	Environmental Justice mapping tool
EPA	Environmental Protection Agency
GIS	Geographic information system
Impervious	Surfaces that do not allow water to infiltrate.
LID	Low impact development
MS4	Municipal storm sewer system
NPDES	National Pollutant Discharge Elimination System
Permit	Western Washington Phase II Stormwater Permit
Pervious	Surfaces that do allow water to infiltrate.
SMAP	Stormwater Management Action Planning
WSDOT	Washington State Department of Transportation
Secondary Permittee	Public entities that own or operate a stormwater sewer system located in Phase I or Phase II City or County

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1.0 Introduction

1.1 City of Vancouver

The City of Vancouver (City) is located in southwest Washington along the north side of the Columbia River. Two primary watershed basins drain the majority of land within city limits, the Columbia Slope and Burnt Bridge Creek. Impervious surfaces cover more than 40% of the area within city limits and stormwater runoff can quickly move contaminants from those surfaces into our waterways. Increasing awareness of the impact of untreated stormwater on both surface and groundwater resources has led to changes in the way stormwater is managed as new development and redevelopment take place.

1.2 Permit Requirements

The current Western Washington Phase II Stormwater Permit (Permit) is effective August 1, 2019 through July 31, 2024. This Permit, issued by the Washington State Department of Ecology (Ecology) allows the City to discharge stormwater runoff into the waters of the state. It requires that local governments manage and control runoff into the City's municipal separate stormwater system (MS4) so that it does not pollute downstream waters. The City of Vancouver is classified as a stormwater National Pollutant Discharge Elimination System (NPDES) Phase II permittee. As a condition of the Permit, the City is required to complete a citywide evaluation of the watersheds within this jurisdiction. This evaluation process will help in developing a Stormwater Management Action Plan (SMAP) for one high-priority catchment area by March 31, 2023, per Ecology Guidance (2019), section S5.C.1.d

1.3 SMAP Process

In accordance with Ecology Guidance (2019), the goal of the SMAP is to target stormwater retrofits that protect and restore aquatic habitats in high-priority basins and receiving waters. The plan should emphasize protection of designated uses, and improvements to receiving water quality and aquatic habitat under both existing and anticipated future developed conditions.

Development of this report is intended to help Ecology gain an understanding of how Permittees are currently addressing stormwater needs through various types of local comprehensive planning. The process will reinforce the implementation of Low Impact Development (LID) standards. These principles further support these practices as the preferred approach in land use development, stormwater codes, rules, and standards.

The SMAP process aims to address the following questions:

1. How can we most strategically direct City efforts toward existing stormwater problems?
2. How can we meet our future population and density targets while also protecting and improving the conditions in receiving waters?

The resulting SMAP will strategically identify approaches to accommodate future growth and development while preventing water quality degradation and/or improving conditions in receiving waters harmed by past development.

2.0 Phase 1: Receiving Waters Conditions Assessment

The purpose of the Receiving Waters Assessment is to delineate the basins within City boundaries and categorize all the receiving waters. A receiving water is defined as a creek, river, or waterbody that the City's MS4 discharges to. The preferred scale for basins that are selected for the SMAP is from one to twenty square miles of total drainage area. This high-level screening process should provide comparative data on the existing conditions of each basin and the resource uses they support. The outcome of this assessment is to further support the prioritization process of candidate basins that would benefit from stormwater management planning.

Per WA Ecology Guidance (2019) this phase is split into 4 steps:

1. Delineate basins and identify receiving waters
2. Assess receiving water conditions
3. Assess stormwater management influence
4. Assess relative conditions and contributions

2.1 Step 1: Delineate basins and identify receiving waters

Five waterbodies were identified that receive stormwater runoff from the City's MS4: Burnt Bridge Creek, Columbia River, Lacamas Creek, Salmon Creek, and Vancouver Lake. The areas that drain from these watersheds into the receiving water are identified as drainage basins. The steps below were taken to populate the associated table.

1. City staff identified the receiving waters for stormwater discharge from the City's MS4.
2. Using GIS data, contributing basins for each receiving water were mapped.
3. For each receiving water, the total contributing watershed area and the percentage of the total watershed area within City limits were determined. (Table 1)

Watershed Receiving Water	Total Area (Sq. Miles)	Basin	Total Basin Area (Sq. Miles)	Area within CoV (Sq. Miles)	Total (%) Area of Contributing Basin in City
Burnt Bridge Creek	28	Burton Sink	4.82	4.82	74%
		Lower Burnt Bridge Creek	10.54	6.21	
		Middle Burnt Bridge Creek	6.44	6.15	
		Upper Burnt Bridge Creek	6.77	3.49	
Columbia River	258,000	Columbia Slope	23.10	22.00	0.009%
Lacamas Creek	67	Dwyer Creek	5.82	1.81	4%
		Lower Fifth Plain Creek	1.49	0.14	
		Lower Lacamas Creek	10.38	0.75	
Salmon Creek	90	Curtain Creek	10.72	1.33	2%
		Salmon Creek (r.m.)	9.47	0.10	
Vancouver Lake*	31	Vancouver Lake	9.76	4.67	19%
		Lake River	18.25	1.26	
		Lake Shore	3.32	0.02	

*Lake River Contributes approximately 90% of inflow/outflow due to tidal influence

Table 2.1: Watershed and basin areas

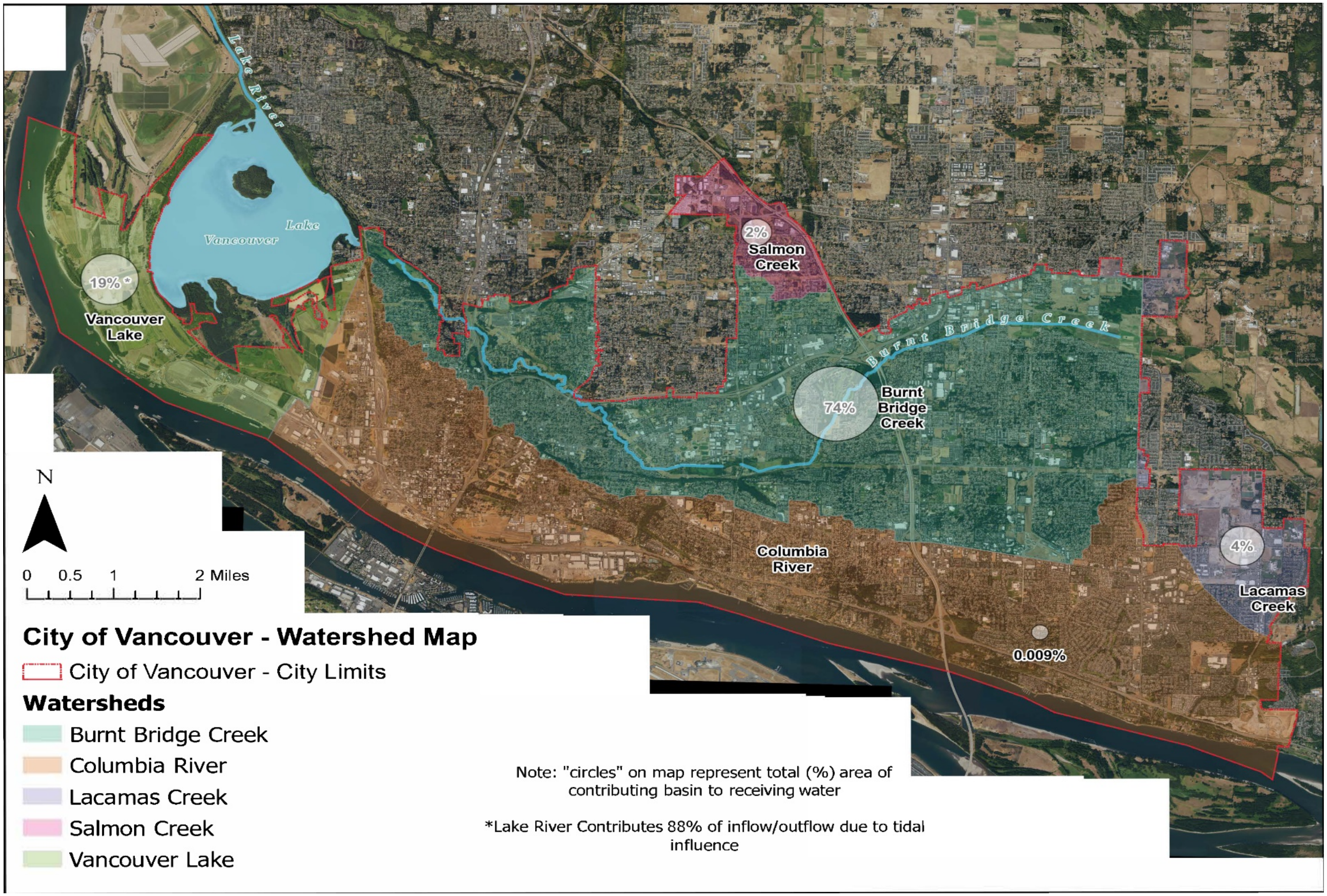

Figure 2.1: City of Vancouver delineated watershed map

2.1.1 Burnt Bridge Creek Watershed

Burnt Bridge Creek is a 28-square-mile watershed located directly in the center of Vancouver, WA. Burnt Bridge Creek (BBC) is a heavily modified, urban stream that originates from agricultural land east of Instate-205 and flows 12.6 miles west before entering Vancouver Lake.

2.1.2 Columbia River Watershed

The Columbia River Watershed is 258,000 square miles in size and stretches across seven states and one Canadian providence (Figure 2.1.3). The Columbia River collects glacial runoff from four mountain ranges and drains more water to the Pacific Ocean than any other river in North or South America. The City of Vancouver borders 18.2 miles of the river's 1,243-mile mainstem.

Figure 2.1.3 Encompassing a total area of 258,000 sq. miles, the Columbia River Watershed spans across seven U.S. States and one Canadian province (source: americanriver.org)

2.1.3 Lacamas Creek

The Lacamas Creek Watershed encompasses 67 square miles; bound on the north from the City of Camas to Hockinson, WA, with City of Vancouver limits bordering the western edge of the watershed. Five major streams contribute to Lacamas Creek; including China Ditch, Dwyer Creek, Fifth Plain Creek, Matney Creek, and Shanghai Creek. Of these five streams, only small parts of Lacamas Creek, Fifth Plain Creek, and Dwyer Creek are located within the City of Vancouver.

2.1.4 Salmon Creek

The Salmon Creek Watershed is approximately 90 square miles and located directly north of Vancouver's city limits, expanding horizontally from the base of Elkhorn Mountain west to the Columbia River (Mathieu, 2013). Six major tributaries flow into Salmon Creek; Rock Creek, Morgan Creek, Weaver Creek, Curtin Creek, Mill Creek, and Cougar creek. Curtain Creek and Salmon Creek have had small sections of their watersheds annexed into the City.

2.1.5 Vancouver Lake Watershed

The Vancouver Lake Watershed is located on the western edge of Clark County and encompasses a total area of 31 sq. miles; of which 5.96 sq. miles or 19% of that total area lies within COV jurisdiction. The receiving waters of the Vancouver Lake Watershed include Vancouver Lake and Lake River which are exclusively outside of City limits (Figure 2.1). Burnt Bridge Creek, Salmon Creek and the Columbia River also contribute flows to Vancouver Lake and are evaluated as independent watersheds for this analysis. Vancouver Lake falls under several governmental jurisdictions. Washington State Department of Ecology (Ecology) and Department of Natural Resources (DNR) share regulatory authority over the water and lakebed, respectively, while the lakeshore is comprised of shorelines primarily managed by Clark County under their Legacy Lands and Parks departments. Sections along the south and southwest are owned by Washington State Fish and Wildlife, Columbia Land Trust, Port of Vancouver (a secondary NPDES stormwater permittee), with a few undeveloped parcels under City ownership. Several privately owned parcels are distributed along the east and northeast shoreline of the lake. Secondary permittees such as the Port of Vancouver own and regulate their stormwater influence of the lake.

2.2 Step 2: Assess receiving water conditions

2.2.1 Designated Uses

Ecology has identified designated uses for a watershed in four categories: Recreational Use, Aquatic Life Use, Water Supply Use, and Miscellaneous Uses.

1. Recreational use is designated for Primary Contact Recreation. Numeric water quality criteria have been established for total fecal coliform and Escherichia coli bacteria and narrative criteria protect designated uses from toxic or aesthetic pollutants that can harm people and fish.
2. Aquatic life uses for the state of Washington include char spawning and rearing, core summer salmonid habitat, salmonid spawning and rearing migration, salmonid rearing and migration only, non-anadromous interior red band trout, and indigenous warm water species.
3. Water supply uses include domestic, industrial, agricultural, and stock.
4. Miscellaneous use designations are water body specific and may include wildlife habitat, fish harvesting, commerce and navigation, boating, and aesthetics.

Ecology, in partnership with Washington State Legislature, curated WAC-173-201A which establishes water quality standards for the state of Washington. The Washington Administrative Code (WAC) is in accordance with protecting public health, public recreation, and propagation and protection of fish and wildlife. Table 602 of the Washington Code (WAC-173-201A-602) designates uses for all surface waters within the state to assure water quality protection. Table 2.2.1 represents designated uses assigned by the state in Table 602 for the delineated basins identified in Step 1.

Designated Uses (WAC-173-201A)	Receiving Water				
	Burnt Bridge Creek	Columbia River Basin	Lacamas Creek**	Salmon Creek	Vancouver Lake**
Recreation Uses					
Primary Contact	■	■	■	■	■
Secondary Contact					
Aquatic Life Uses					
Spawning & Rearing	■	■			
Core Summer Habitat				■	
Spawning & Rearing Migration			■		■
Rearing & Migration					
Redband Trout					
Warm Water Species					
Water Supply Uses					
Stock Water	■	■	■	■	■
Agricultural Water	■	■	■	■	■
Industrial Water	■	■	■	■	■
Domestic Water	■	■	■	■	■
Misc. Uses					
Wildlife Habitat	■	■	■	■	■
Fish Harvesting		■	■		■
Commerce & Navigation		■	■		■
Boating		■	■		■
Aesthetics	■	■	■	■	■

**Water bodies not listed in WAC-173-201A-602 are protected by WAC-173-201A-600.

Table 2.2.1: designated use within each watershed

Table 2.2.1 illustrates the designated uses assigned to each waterbody that are included in this evaluation. The shaded portion represents the uses listed and protected under WAC-173-201A-602. Lacamas Creek and Vancouver Lake are not listed within Table 602 and therefore are protected under generalized use outlined in WAC-173-201A-600.

2.2.2 Water Quality Assessment

2.2.2.1 Burnt Bridge Creek

Water quality in Burnt Bridge Creek has been monitored extensively for more than 40 years, including a total maximum daily load (TMDL) study by the Department of Ecology with 19 monitoring stations along the stream and its tributaries. Monitoring data have shown that segments of Burnt Bridge Creek do not meet state water quality standards for temperature, dissolved oxygen, pH, and/or fecal coliform bacteria at varying times of the year. A Source Assessment was recently conducted that summarized water quality data (Ecology 2020) and analyzed impairments to the watershed, including a shade analysis in relation to temperature impairments. Ecology and the City have partnered to develop a TMDL Alternative Restoration Plan with the objective of identifying best management practices (BMPs) to improve water quality in the creek. The partnership is currently working on an implementation plan.

The most recent trend analysis of Burnt Bridge Creek data, collected through the City's long-term monitoring program, compared historical water quality data (2004-2007) from a subset of current monitoring locations to data collected from 2011-2017. (Herrera 2018a)

2.2.2.2 Columbia River

The reach of the Columbia River bordering the City is listed as impaired on Washington's 303(d) list for temperature, dioxin and vinyl chloride. It is also identified as a water of concern for arsenic and polychlorinated biphenyls (PCBs) and phthalates (in fish tissue). An approved TMDL plan for dioxin has been in place since 1991 and a temperature TMDL was established by EPA in 2020.

2.2.2.3 Lacamas Creek

Lacamas Creek and its major tributaries currently do not meet Washington State water quality standards for bacteria, dissolved oxygen, ph, and temperature. The Washington State Department of Ecology started a Total Maximum Daily Load (TMDL) study in 2010 to collect and assess water quality data in the Lacamas Creek Watershed. Ecology published a groundwater report from these data in 2013. In 2021, Ecology prepared a quality assurance project plan to conduct a source assessment study for Lacamas Creek and its major tributaries to support the completion of a water cleanup plan. (Ecology 2021)

2.2.2.4 Salmon Creek

Water quality improvement plans have been developed and approved by EPA for fecal coliform bacteria, turbidity (2005), and temperature (2011). In 2013, Ecology conducted a characterization study for the entirety of the Salmon Creek watershed. Identifying low dissolved oxygen and pH criteria excursions in Salmon Creek extending to their most upstream site. (Ecology 2013)

2.2.2.5 Vancouver Lake

Vancouver Lake is a category five 303(d) status impaired body of water for total phosphorus, fecal coliform bacteria, and fish tissue contamination by methyl mercury, PCBs, dioxin, toxaphene, and DDE. (Ecology 2011) It has exhibited known water quality issues, including but not limited to high water temperatures and turbidity, low dissolved oxygen, eutrophication, fecal bacteria contamination, increasingly frequent harmful algal blooms (HABs) comprised of toxin-producing algae called cyanobacteria, and large infestations of aquatic invasive (noxious) weeds. (Herrera 2022)

Table 2.2.2 is from the 2017 Trend Analysis Report showing significant water quality improvements or declines at different monitoring stations as shown in Figure 2.2.2.

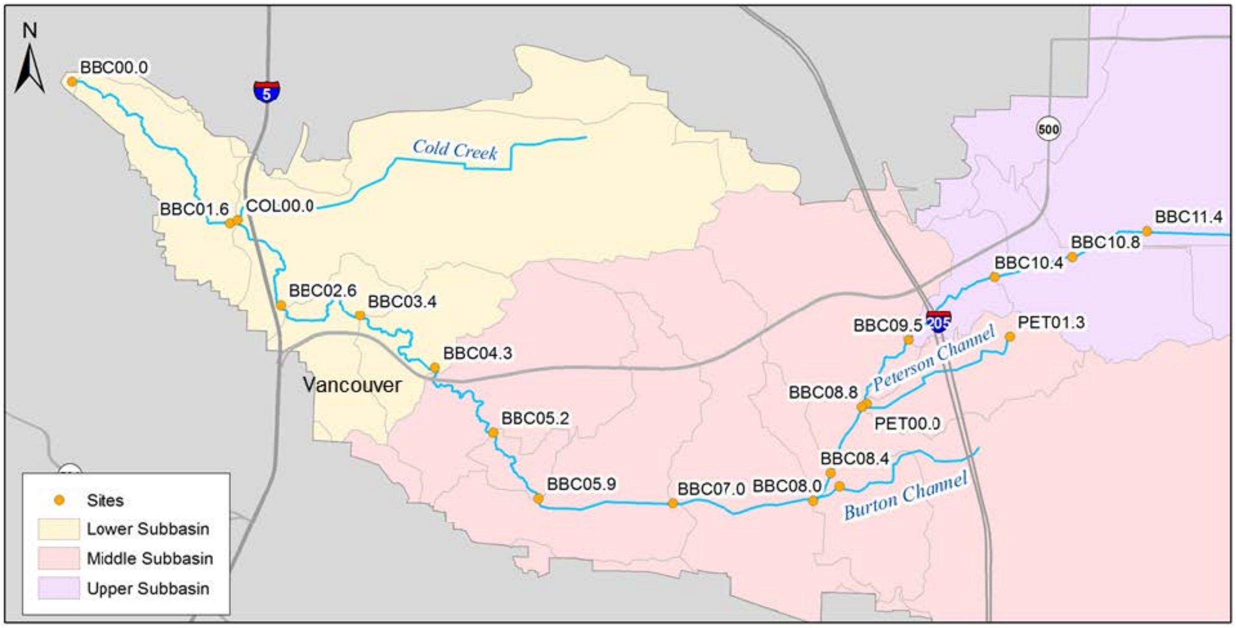

Figure 2.2.2: Map of fixed network sampling sites in Burnt Bridge Creek Watershed (source: Ecology 2020)

	BBC10.4	BBC8.8	PET0.0	BBC8.4	BUR0.0	BBC7.0	BBC5.9	BBC5.2	BBC2.6	COL0.0	BBC1.6
Temporal Trend for 2011–2017[a]											
Temperature	–	–	–	–	–	–	–	–	–	–	–
Dissolved Oxygen	–	–	–	–	–	↘	–	–	–	–	–
pH	–	–	–	–	–	↘	–	–	–	–	–
Conductivity	–	–	↗	↗	–	↗	↗	↗	↗	↗	↗
Turbidity	↗	–	↗	–	–	–	–	–	–	–	–
Total Suspended Solids	↗	–	↘	–	–	–	↘	↘	↘	–	↘
Total Phosphorus	–	–	–	–	–	–	–	–	–	–	–
Soluble Reactive Phosphorus	–	–	↗	–	–	–	–	–	–	–	–
Total Nitrogen	↘	↘	↗	–	–	↘	↘	↘	↘	↗	–
Nitrate+Nitrite	↘	↘	↗	↘	↘	–	–	–	–	–	–
Fecal Coliform	–	–	–	–	↘	–	↘	↘	–	↘	–
Percent Change from 2004–2007 to 2011–2017[b]											
Temperature	na	na	1%	-3%	na	1%	-2%	na	na	na	na
Dissolved Oxygen	na	na	-1%	-10%	na	-15%	42%	na	na	na	na
pH	na	na	1%	0%	na	4%	8%	na	na	na	na
Conductivity	na	na	9%	-4%	na	-5%	-2%	na	na	na	na
Turbidity	na	na	46%	155%	na	127%	98%	na	na	na	na
Total Suspended Solids	na	na	34%	117%	na	73%	90%	na	na	na	na
Total Phosphorus	na	na	110%	104%	na	33%	42%	na	na	na	na
Soluble Reactive Phosphorus	na	na	108%	74%	na	42%	51%	na	na	na	na
Total Nitrogen	na	na	19%	83%	na	141%	123%	na	na	na	na
Nitrate+Nitrite	na	na	29%	81%	na	291%	277%	na	na	na	na
Fecal Coliform	na	na	-48%	-46%	na	39%	-5%	na	na	na	na

[a] Temporal trend evaluated using Kendall's Tau correlation test (a = 0.05). Empty cells are not significant.
[b] Percent change in median values from 2004–2007 and 2011–2017. Significant difference between periods tested using Mann-Whitney U test (a = 0.05).

↗ = increasing trend
↘ = decreasing trend
– = no significant trend
na = not analyzed

significant water quality improvement
significant water quality decline
significant change in pH or conductivity

HERRERA PGG February 2019

Table 2.2.2: Temporal trend analysis for the City of Vancouver 2017 (source: Herrera 2018)

2.2.3 Development Pressure

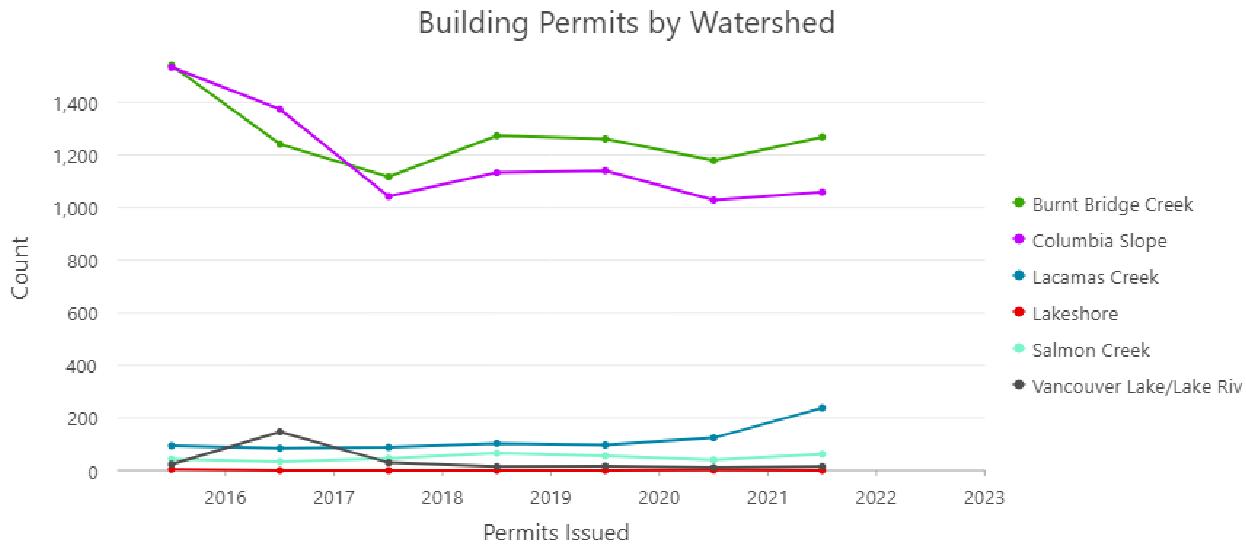

Figure 2.2.3a: Building permits issued per year for each watershed within Vancouver city limits (source: City of Vancouver Public Works)

Development pressure was assessed by aggregating building permits issued by City of Vancouver for each watershed basin delineated in Step 1. That data was transposed to a line graph showing the data from 2016-2022 (Figure 2.2.3a). Of the five watersheds listed, the two with the highest development pressure within Vancouver city limits are Burnt Bridge Creek, and Columbia Slope.

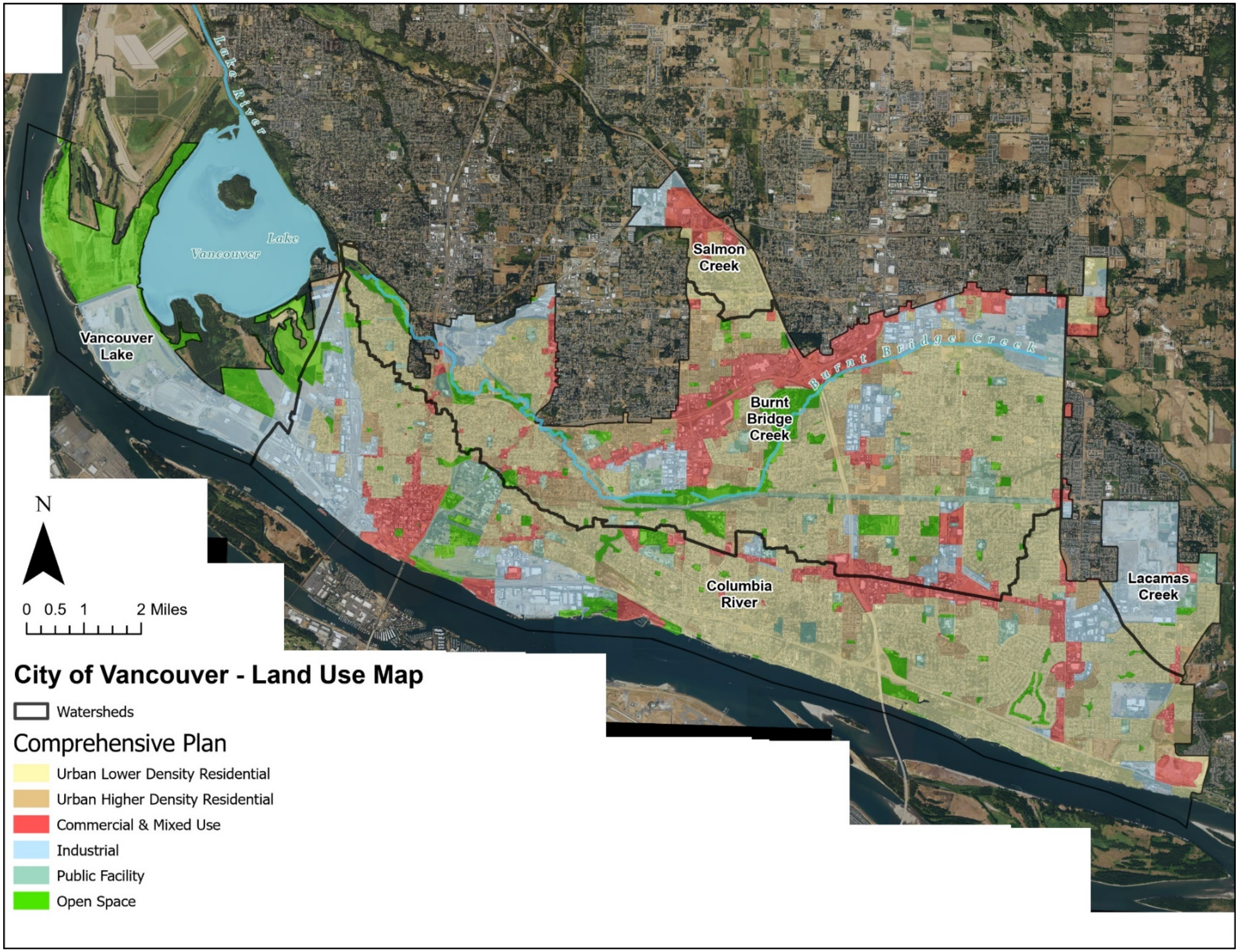

Figure 2.2.3b: Land use for each watershed with City jurisdiction

2.2.4 Public Health and the Environment

2.2.5 Environmental Justice Screening and Mapping Tool

The Environmental Justice Screen and Mapping Tool (EJ Screen) is an EPA-developed web-based tool that uses national data to support a wide range of research and policy goals. (EPA 2019) It can help in identifying overburdened and underserved communities with potential environmental quality issues. It is a combination of environmental and demographic visual indicators. Evaluating information related to overburdened communities within Vancouver's watershed basin areas can identify basins where efforts to improve water quality will also protect human health in vulnerable populations.

2.2.6 Demographic Index & Socioeconomic Indicators

EJ Screen uses demographic indicators to gauge a community's potential susceptibility to different types of environmental exposures. The impacts from a variety of pollutants depends on a combination of exposure and susceptibility to those exposures. These indicators help identify which communities may be more susceptible to a given level of exposure to environmental pollutants. Individuals may be more susceptible when they are already in poor health, have reduced access to care, lack resources, are linguistically isolated, do not possess the education that would help them avoid exposure or obtain treatment, and/or are at a susceptible life stage (EPA 2019).

Using the EJ Screen data tool, the socioeconomic indicators, environmental justice indexes, and associated tables were created. The populated information is in comparison both state-wide and across the nation.

Variables	Value	WA State		City of Vancouver		USA	
		Avg.	%tile	Avg.	%tile	Avg.	%tile
Socioeconomic Indicators							
Demographic Index	30%	29%	61	28%	62	36%	49
People of Color	28%	31%	53	28%	60	40%	46
Low Income	31%	26%	68	28%	62	31%	56
Unemployment Rate	5%	5%	60	5%	58	5%	57
Linguistically Isolated	4%	4%	69	3%	74	5%	68
Less Than High School Education	9%	9%	63	9%	61	12%	50
Under Age 5	6%	6%	54	6%	55	6%	56
Over Age 64	16%	15%	61	16%	59	16%	57

Table 2.2.6a: Socioeconomic Indicators (source: EJ Screen data tool)

Variables	Percentile in WA State	City of Vancouver	Percentile in USA
Environmental Justice Indexes			
Particulate Matter 2.5	59	61	49
Ozone	59	61	50
2017 Diesel Particulate Matter*	48	45	34
2017 Air Toxics Cancer Risk*	57	55	41
2017 Air Toxics Respiratory HI*	59	57	40
Traffic Proximity	33	33	26
Lead Paint	48	50	40
Superfund Proximity	45	38	30
RMP Facility Proximity	51	51	43
Hazardous Waste Proximity	28	25	20
Underground Storage Tanks	51	50	42
Wastewater Discharge	40	50	48

*This report show s the values for environmental and demographic indicators and EJScreen indexes. It show s environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also show s w hat percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationw ide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed.

Table 2.2.6b: Environmental Justice Indexes (source: EJ Screen data tool)

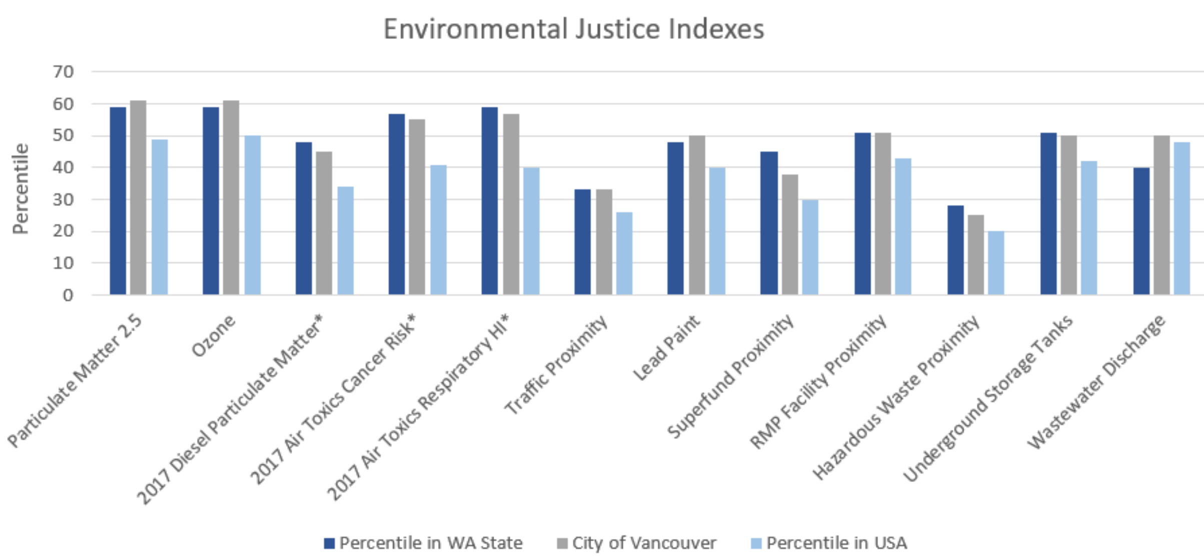

Figure 2.2.6: Environmental Justice Indexes comparison state & nationwide (source: EJ Screen data tool)

2.2.7 City of Vancouver Equity Index

The City of Vancouver's Equity Index was developed by averaging the scores from the demographic index. The Demographic Index, Environmental Opportunity Index, and Combined Equity Index will be calculated for the basin areas during the prioritization process, and each will be reviewed for the catchment areas during the ranking and screening process in the later phases of the SMAP.

The City of Vancouver's Equity Index incorporates the following variables:

- People of color (non-white and/or Hispanic/Latinx)
- Educational attainment less than a bachelor's degree (people over 25)
- Renters
- Median family income
- People 65 and over
- Households with children

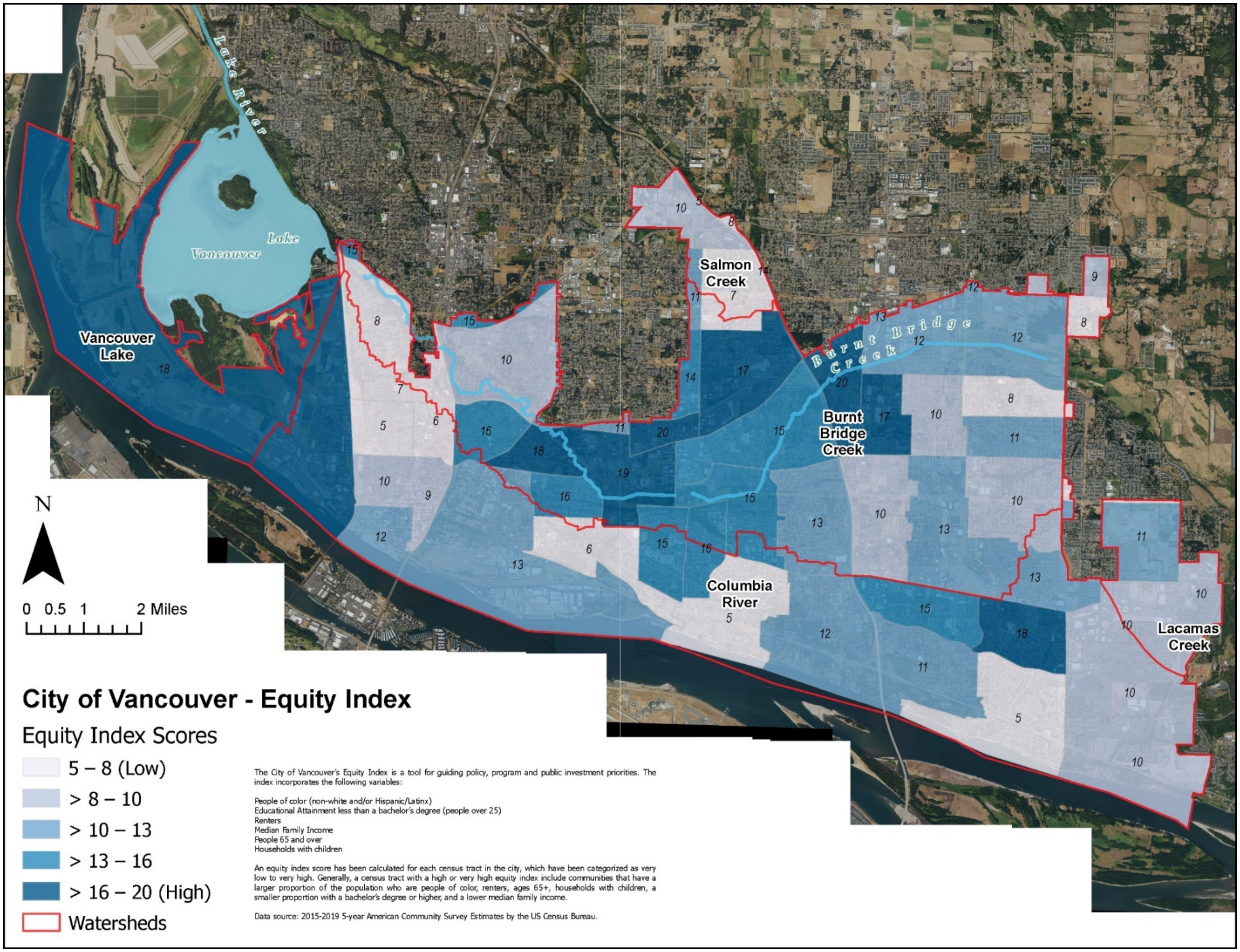

Figure 2.2.7: EJ Screen Combined Equity Index

2.3 Step 3: Assess Stormwater Management Influence

Information on receiving water conditions across the jurisdiction landscape will help determine the City's current MS4 contribution to those receiving waters and the potential stormwater management influence for future conditions. This step will provide the rationale for sorting the City's receiving waters according to their relative expected benefit from SMAP.

Future stormwater management plans can be projected by reviewing current buildable land data and modified in response to property development as it occurs. With this data, a framework will be built to identify approaches that can be applied to address or minimize negative impacts to water quality from development. Per Ecology guidance, basins that are expected to have low stormwater management influence can be excluded from further analysis with the SMAP process.

The City's Comprehensive Plan contains policy direction relating to growth and development, environmentally sensitive areas, historic places, public services and other issues. Plan policies are implemented through subarea plans and the Vancouver Municipal Code. Vancouver designates and protects critical areas (wetlands, fish and wildlife habitat, aquifers, geologically hazardous areas, and areas that flood frequently) through its Critical Areas Protection ordinance. The City also established processes and standards in code for the protection, preservation, replacement, proper maintenance and use of trees, associated vegetation, and soils within Vancouver.

New development and redevelopment projects proposing to add and/or replace hard surfaces greater than 2,000 square feet are required to incorporate stormwater management best management practices into their projects.

The following three questions were considered in completing this step for each receiving water and associated basins:

1. What are the major flow pollutants and/or flow impacts associated with individual point sources versus non-point sources? Will the loading and/or runoff volumes increase under expected future land use conditions
2. Are there approaches, other than direct stormwater treatment or controls, that could serve to limit impacts?
3. Can growth be managed to minimize adverse stormwater impacts?

The results for the above questions are summarized in tables contained in the following sections. Where a yes or no response is used in the tables, the following criteria were considered:

1. Total area of the watershed/basin within city jurisdiction
2. Current developed condition and known connection/outfalls to the receiving water
3. Potential non-developed parcels which could be acquired by the City to provide buffer to the receiving water
4. Current land uses and zoning, and potential for zoning changes to encourage higher density development or change of use
5. Ability to conduct outreach and education to homeowners and businesses, and the benefit this may have on limiting impact to the receiving water

2.3.1 Burnt Bridge Creek Watershed

Burnt Bridge Creek Watershed			
Basin	**Question 1**	**Question 2**	**Questions 3**
Burton Sink	• Flow impacts and point source pollution are negligible due to the high infiltration characteristic of the basin. • Runoff volumes are expected to remain consistent with future land use conditions.	Yes	Yes
Lower Burnt Bridge Creek	• Lower BBC has not met Washington water quality standards for temperature, fecal coliform bacteria, dissolved oxygen, and pH. Elevated nutrient concentrations are also of concern as Burnt Bridge Creek contributes nutrients to Vancouver Lake. Runoff volumes are expected to remain consistent with future land use conditions. • Ecology has recommended that an effectiveness monitoring study to be completed in 2030 after implementation of BMPs from the water quality improvement plan.	Yes	Yes
Middle Burnt Bridge Creek	• Middle BBC has not met Washington water quality standards for dissolved oxygen, fecal coliform bacteria, pH and temperature. Elevated nutrient concentrations contribute to excessive plant and algae growth. An industrial facility is permitted to discharge non-process wastewaters under a state-issued NPDES permit with a discharge limit for temperature. • Source pollution is expected to remain consistent or increase with future development unless proper management practices are implemented.	Yes	Yes
Upper Burnt Bridge Creek	• Upper Burnt Bridge Creek has a significant shade deficit and is impaired by high temperatures, fecal coliform bacteria, pH and low dissolved oxygen. Elevated nutrient concentrations are also a concern. • Increased riparian tree canopy would help reduce stream temperatures. Ecology has recommended that an effectiveness monitoring study to be completed in 2030 after implementation of BMPs from the water quality improvement plan.	Yes	Yes

Question 1:
a. What are the major pollutants and/or flow impacts associated with individual point sources versus non-point sources?
b. Will the loadings and/or runoff volumes increase under expected future land use conditions?

Question 2:
Can these sources be addressed through other land management strategies, including policies, code, or development standards?

Question 3:
Can future growth be managed to minimize adverse stormwater impacts?

Table 2.3.1: Assessment questions for Burnt Bridge Creek Watershed

2.3.2 Columbia River Watershed

Columbia River Watershed			
Basin	**Question 1**	**Question 2**	**Question 3**
Columbia Slope	• A USGS reconnaissance study found PAH, PCB, and trace element concentrations typical of urban runoff in stormwater at two outfalls from the Columbia Slope Basin. The Columbia River is a flow exempt waterbody and flow impacts are insignificant. • The City is conducting a state-funded capital improvement study that will identify and prioritize projects that provide runoff treatment and flow control. Pollutant loadings and runoff volumes are expected to be reduced with the implementation of this project.	Yes	Yes
Question 1:			
a.	What are the major pollutants and/or flow impacts associated with individual point sources versus non-point sources?		
b.	Will the loadings and/or runoff volumes increase under expected future land use conditions?		
Question 2:	Can these sources be addressed through other land management strategies, including policies, code, or development standards?		
Question 3:	Can future growth be managed to minimize adverse stormwater impacts?		

Table 2.3.2: Assessment questions for Columbia River Watershed

2.3.3 Lacamas Creek Watershed

Lacamas Creek Watershed			
Basin	**Question 1**	**Question 2**	**Questions 3**
Dwyer Creek	• Ecology's TMDL study has concluded Dwyer Creek has not met Washington water quality criteria for DO, fecal coliform bacteria, pH, aafnd temperature. • Reducing phosphorus loading to the creek from the watershed will be necessary to reduce the occurrence of algal blooms downstream. Planting for riparian shade can reduce stream temperatures and improve DO. Future development and redevelopment will need to follow stormwater treatment guidelines for nutrients to minimize increases in loadings.	Yes	Yes
Lower Fifth Plain Creek	• Ecology's TMDL study has concluded Lower Fifth Plain Creek has not met Washington water quality criteria for DO, fecal coliform bacteria, pH and temperature. • Reducing phosphorus loading to the creek from the watershed will be necessary to reduce the occurrence of algal blooms downstream. Planting for riparian shade can reduce stream temperatures and improve DO. Future development and redevelopment will need to follow stormwater treatment guidelines for nutrients to minimize increases in loadings.	Yes	No
Lower Lacamas Creek	• Ecology's TMDL study has concluded Lower Lacamas Creek has not met Washington water quality criteria for DO, fecal coliform bacteria, pH and temperature. Lower Lacamas carries nutrients from the Lacamas Creek watershed. Measurable concentrations of dissolved orthophosphate and dissolved total phosphorus were found in all sampled piezometers. • Reducing phosphorus loading to the creek from the watershed will be necessary to reduce the occurrence of algal blooms downstream. Planting for riparian shade can reduce stream temperatures and improve DO. Future development and redevelopment will need to follow stormwater treatment guidelines for nutrients to minimize increases in loadings.	Yes	No

Question 1:
a. What are the major pollutants and/or flow impacts associated with individual point sources versus non-point sources?
b. Will the loadings and/or runoff volumes increase under expected future land use conditions?

Question 2:
Can these sources be addressed through other land management strategies, including policies, code, or development standards?

Question 3:
Can future growth be managed to minimize adverse stormwater impacts?

Table 2.3.3: Assessment questions for Lacamas Creek Watershed

2.3.4 Salmon Creek Watershed

Salmon Creek Watershed			
Basin	**Question 1**	**Question 2**	**Questions 3**
Curtain Creek	• There are no individual industrial or municipal wastewater NPDES-permitted point source discharges to Salmon Creek or its tributaries. • Any new individual point source discharges would need to comply with all portions of WAC 173-201A and be able to meet the water quality discharge criteria. The best way to preserve aquatic resources and minimize future disturbance from human activity would be to protect the thermal health of the streams as much as possible.	Yes	No
Salmon Creek	• There are no individual industrial or municipal wastewater NPDES-permitted point source discharges to Salmon Creek or its tributaries. TMDL implementation plans have been developed to address impairment from elevated temperature, fecal coliform bacteria and turbidity. • Any new individual point source discharges would need to comply with all portions of WAC 173-201A and be able to meet the water quality discharge criteria. The best way to preserve aquatic resources and minimize future disturbance from human activity would be to protect the thermal health of the streams as much as possible.	Yes	No

Question 1:

a. What are the major pollutants and/or flow impacts associated with individual point sources versus non-point sources?

b. Will the loadings and/or runoff volumes increase under expected future land use conditions?

Question 2:

Can these sources be addressed through other land management strategies, including policies, code, or development standards?

Question 3:

Can future growth be managed to minimize adverse stormwater impacts?

Table 2.3.4: Assessment questions for Salmon Creek Watershed

2.3.5 Vancouver Lake Watershed

Vancouver Lake Watershed			
Basin	**Question 1**	**Question 2**	**Questions 3**
Vancouver Lake	• High nutrient levels, elevated temperature and bacteria create an environment that supports toxic algal blooms and nuisance aquatic vegetation. Fish tissue sampled from the lake has exceeded human health criteria for PCBs, TCDD, DDE, dieldrin, and toxaphene. • Future development and redevelopment will need to follow stormwater treatment guidelines for toxics and nutrients to minimize contaminant contributions.	Yes	Yes
Lake River	• USGS concluded that high concentrations of PCBs were reported near Lake River. An Ecology study concluded that fish from Lake River exceeded NTR criteria for total PCBs, dioxin, DDE, dieldrin, and toxaphene (Coots, 2007). Elevated concentrations of bacteria and nutrients also impact water quality. Salmon Creek discharges into Lake River and contributes to Vancouver Lake's water and nutrient budget. • Future development and redevelopment will need to follow stormwater treatment guidelines for toxics and nutrients to minimize contaminant contributions.	Yes	No
Lake Shore	• Lakeshore, along the northeast quadrant of the lake, contains more privately owned and residential developed properties. Contaminants in stormwater runoff that reaches the lake are expected to be typical of residential land uses. • Future development and redevelopment will need to follow stormwater treatment guidelines for toxics and nutrients to minimize contaminant contributions.	Yes	No

Question 1:
a. What are the major pollutants and/or flow impacts associated with individual point sources versus non-point sources?
b. Will the loadings and/or runoff volumes increase under expected future land use conditions?

Question 2:
Can these sources be addressed through other land management strategies, including policies, code, or development standards?

Question 3:
Can future growth be managed to minimize adverse stormwater impacts?

Table 2.3.5: Assessment questions for Vancouver Lake Watershed

2.4 Step 4: Assess relative conditions and contributions

This step evaluates the receiving waters and basins listed in Step 3 to develop a candidate list for inclusion in the Receiving Water Prioritization, Phase 2 of the SMAP process. For this assessment the City of Vancouver has referred to SMAP Guidance (Ecology, 2019) and Building Cities in the Rain-Watershed Prioritization for Stormwater Retrofits (Commerce, 2016). These two documents gauge basin impacts based on current water quality conditions of the basin, and the level of influence that the basin has on receiving water quality.

Assessing and improving water quality condition within a watershed involves extensive investigation and long-term implementation of best management practices. In underserved basins that lack water quality treatment and require significant restoration, the process often encompasses many studies completed over a number of years to determine optimum locations for effective BMP installation. This timeline is also heavily influenced by the need for data collected through long-term water quality monitoring efforts, which may not be able to demonstrate that water quality is improving from specific BMP implementations. Alternatively, the level of influence a basin has on water quality can be estimated by modeling and calculation. The SMAP process provides more rapid analysis and feedback, allowing for a more extensive assessment of watersheds using readily available information. The level of influence a basin has on receiving waters will be used to prioritize basins identified for the SMAP process.

2.4.1 Burnt Bridge Creek Watershed

Burnt Bridge Creek Watershed is in a highly developed, urban area, with 74% of the total contributing area to the creek within City limits (Table 2.1). This watershed contains the highest percentage of stormwater contribution area of any watershed within City limits. The City is studying options to improve water quality as part of a collaborative Water Quality Cleanup Plan, currently under development by Ecology. (See reference section for the TMDL website) The City has identified and mapped109 outfalls that discharge stormwater to Burnt Bridge Creek throughout the watershed, with many having no water quality treatment prior to discharge. Based on recent water quality monitoring, fecal and E. coli bacteria concentrations are high throughout the watershed, particularly in wet weather conditions (McCarthy 2020). Elevated temperature and nutrient concentrations, low dissolved oxygen, and excursion from pH criteria have also been identified through city and state monitoring (Herrera 2022).

Burnt Bridge Creek flows 12.6 miles across the city and discharges into Vancouver Lake. Although it contributes only 3 percent of the total inflow to the lake it carries elevated concentrations of nitrogen and phosphorus that support nuisance algal and plant growth in the large shallow lake (Sheibley 2012). Because of the large stormwater contribution of this watershed into Burnt Bridge Creek, the known suite of water quality impairments, and the City's ability to influence existing and future stormwater management actions (including development), Burnt Bridge Creek is the ideal candidate for the SMAP process.

2.4.2 Columbia River Watershed

As stated in Step 1, the Columbia River Watershed encompasses 258,000 square miles, spanning multiple states and Canadian providences. The Columbia Slope Basin is the sole contributing basin within City limits with direct stormwater discharge to the Columbia River. Table 1 shows that the Columbia Slope Basin, at 22 square miles, comprises only 0.009% of the extensive watershed. Although the City is actively engaged in planning stormwater retrofits in the Columbia Slope subbasin, as it encompasses a significant portion of City limits, SMAP actions alone are unlikely to result in noticeable improvement to the Columbia River. Based on these conditions, the Columbia River watershed not considered a viable candidate for the SMAP process and will be excluded from further study.

2.4.3 Salmon Creek Watershed

The area of Salmon Creek watershed within City limits contains only 6% of the total watershed area (Table 1). Management activities for stormwater in this small portion of the watershed would have minimal impact on the receiving body of water. Based on these conditions, the Salmon Creek Watershed is not considered a viable candidate for the SMAP process and will be excluded from further study.

2.4.4 Lacamas Creek Watershed

The area of Lacamas Creek watershed within City limits contains only 4% of the total watershed (Table 2.1). Due to this small percentage, City projects would have an insignificant influence in improving the overall quality of receiving waters in the watershed. In addition to the small percentage within City limits, Lacamas Creek watershed is only 22% publicly owned. Implementation efforts for cleaning up the watershed will rely heavily on private landowners (Gleason, 2020). Based on these conditions, the Lacamas Creek watershed is not considered a viable candidate for the SMAP process and will be excluded from further study.

2.5.5 Vancouver Lake Watershed

Vancouver Lake and surrounding lowlands of the Columbia River floodplain are just outside Vancouver city limits. The hydrological characteristics of Vancouver Lake are complex, making it a challenging location for implementing any stormwater BMPS to improve water quality in the lake. The large shallow lake is connected to the Columbia River by tidally influenced flows in and out through Lake River; the 11-mile

slough also transports flow from the Salmon Creek watershed and other smaller waterbodies before connecting to the Columbia River near Ridgefield.
Lake River is the dominant source of water to the lake, averaging 85 percent of water inputs. A flushing channel connecting the lake to the Columbia River was constructed at the southwest corner of the lake and contributes up to 10 percent of the water inflow based on Columbia River elevations. Although Burnt Bridge Creek is a natural surface water tributary for the Lake it contributes only 3% of the average total inflow to the 2,300- acre lake ecosystem. Average phosphorus and nitrogen contributions to the lake from Burnt Bridge Creek range from 3-7% of the overall nutrient budget (Sheibley 2012).

With Columbia River water levels influenced by rainfall, mountain runoff, tidal cycles, and controlled dam releases upstream, the river can gain or lose several feet of depth over a span of a week and cause subsequent fluctuation in water volume contained in Vancouver Lake. This complex process makes it difficult to determine the total discharge generated by surface water runoff, contributed by streams, or influenced by tidal pressures. Development along the shoreline is low, as most of the land is publicly owned and remains open as farms, pasture, forest, and park areas. Much of the land surrounding Vancouver Lake is managed under critical wetland reserve regulation, limiting development pressure within the watershed. Given the reasons listed above, the Vancouver Lake Watershed is less than ideal as a candidate for the City to undertake the SMAP process.

2.4.6 Conclusions for Receiving Water Assessment

After evaluating each of the watersheds listed within Table 2.1, several watersheds will be excluded from further evaluation in this SMAP process. Those watersheds and associated basins have a small percentage of contributing area within Vancouver's jurisdiction, are in areas of low development, or have a very small overall influence on water quality in the receiving water.

As described in Step 3, watersheds that did not meet SMAP Guidance for appropriate delineated scale (Ecology, 2019) or those that have geologic, hydraulic, or other issues were excluded from further evaluation. Based on the evaluated watersheds, the Burnt Bridge Creek watershed is the most viable watershed to include in the Receiving Water Prioritization (Phase 2 of the SMAP process).

The four basins that will be assessed in further detail during Phase 2: Receiving Water Prioritization are listed in the table below:

Watershed Receiving Water	Total Area (Sq. Miles)	Basin	Total Basin Area (Sq. Miles)	Area within CoV (Sq. Miles)	Total (%) Area of Contributing Basin in Watershed
Burnt Bridge Creek	28	Burton Sink	4.82	4.82	100%
		Lower Burnt Bridge Creek	10.54	6.21	59%
		Middle Burnt Bridge Creek	6.44	6.15	95%
		Upper Burnt Bridge Creek	6.77	3.49	52%

Table 2.4.6: Total basins within Burnt Bridge Creek Watershed

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