Memorandum

To:	Sean Mulderig, City of Washougal
From:	Trista Kobluskie, Cara Donovan, Frank Sottosanto, PE, Otak, Inc.
Copies:	Rob Charles
Date:	March 30, 2022
Subject:	Receiving Water Conditions Assessment - SMAP
Project No.:	20155

1. Introduction and Organization

The Receiving Water Conditions Assessment has been prepared pursuant to the City of Washougal's Phase II National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit and a water quality grant from the Washington Department of Ecology. The assessment generally follows the receiving water conditions assessment steps described in the *Stormwater Management Action Planning Guidance* published by the Washington Department of Ecology in 2019 (2019 SMAP Guidance). The purpose of the Receiving Water Conditions Assessment is to identify basins and receiving waters that could benefit from stormwater management action planning (SMAP). The outcome of this phase is a narrowed list of candidate basins that includes the information needed to support a prioritization process. The ultimate outcome of the process is a SMAP for a priority catchment within the City of Washougal where the City's investments in stormwater retrofits, targeted stormwater management activities, or targeted policies could benefit a receiving water.

The results of this assessment are summarized in this memorandum. Geographic input data and analyses used in or created for this assessment are presented in a web map. The URL is provided in Attachment A to this memorandum, which may be updated if the web map URL changes.

This memorandum is organized as follows:

This project has been funded in part by a grant from Washington State Department of Ecology.

Figures

Tables

Attachment A – Web Map

2. Methodologies

This section describes the methodologies used to assess the receiving waters and assess relative conditions. Assessments have been made using available information from reports, studies, and geographic information systems (GIS) of City of Washougal, Clark County, state agencies, and federal agencies.

2.1. Receiving Water Conditions Assessment Methodology

This section describes the methods used to assess conditions in each receiving water.

Setting and Flow Characteristics

The receiving waters in the City of Washougal are identified using Clark County's watershed delineations. Washougal River and Gibbons Creek watershed boundaries have both been modified for this analysis using the City's storm sewer geographic information system (GIS) and topography. Washougal River Watershed has been extended into Skamania County to its natural topographic boundary. Gibbons Creek Watershed has been modified along the Columbia River to account for new levees and along the Skamania County border based on topography, omitting the Lawton Creek drainage which is included in the County's delineation. In this document, "watershed" refers to an entire basin both within the City of

Washougal and outside of it, while “basin” refers to only the portion of the watershed within Washougal’s City limits.

Clark County's Stormwater Needs Assessment Reports were reviewed for important information about each receiving water. Receiving waters are the result of the physical characteristics of the basin as well as human intervention that has altered the natural characteristics. The characteristics considered for the receiving water assessment are listed and described below.

Information regarding flow characteristics of the receiving waters has been collected largely from the City, Clark County, the US Geological Survey (USGS), and Federal Emergency Management Agency (FEMA) flood insurance studies.

The distribution of soil types influences the flow of surface water and groundwater within a watershed. The assessment uses soil data from the Natural Resources Conservation Service (NRCS). The hydrologic-soil group designations include hydrologic soils groups A, B, C, and D. Generally, group A allows infiltration, soil group B allows for a moderate rate of infiltration, and groups C and D allow limited infiltration and produce more runoff.

Topography plays a large role in defining drainage basins and influences the flow of water within a basin. The assessment uses 5-foot contours from Clark and Skamania Counties. The assessment very generally describes watershed topography.

Changes in land cover from historic forests and prairies to impervious surfaces and lawns impacts streams by directing more runoff to them and changing the timing and duration of their peak flows. Land cover has been collected from the 2019 National Land Cover Dataset (NLCD). To estimate current impervious surfaces within City limits, a National Agriculture Imagery Program (NAIP) raster dataset has been clipped to the City limits and reclassified. Impervious surface coverage is classified by three types (dark roofs, light roofs, and roadways) and combined for analysis.

Stormwater facilities designed to control flow (flow control facilities) in Washougal mitigate some impacts of such land cover changes. Stormwater facilities within City limits are classified as flow control facilities or water quality facilities based on the City’s GIS data. The following facilities are classified as flow control facilities:

- Detention vaults
- Infiltration trenches
- Permeable pavement
- Infiltration planters
- Bio-infiltration planters
- Ponds
- Infiltration rain gardens

Flow control facilities, water quality facilities, outfalls, drywells, stormwater pipes, and ditches are counted and located within each basin to determine whether infrastructure distribution is consistent with land cover and land use.

The City protects wetlands, wetland buffers, critical aquifer recharge areas, geologically hazardous areas, frequently flooded areas, and fish and wildlife habitat conservation areas through its critical areas ordinance (Chapter 16.04). Wetlands and wetland buffers are important to hydrology and water quality

because they reduce the velocity of stormwater and provide a natural filter for sediment and metals. The presence, quality, and location of critical areas in the watershed can be key indicators in understanding the health of the watershed. Presence of critical areas may also affect where development can occur. Critical areas are mapped and listed for each basin.

Stormwater improvement projects can be most easily placed in the public right-of-way and in publicly-owned land. Major public lands in the City limits were collected from the City, Clark County, Washington State, and the federal government.

Water Quality and Aquatic Habitat

Washington State's Department of Ecology's Water Quality Atlas and Washington's Administrative Code have been reviewed for each receiving water's water quality standards. These criteria, outlined in Section 4, are used to assess the health of the surface water for recreation, drinking water, aquatic life, and other uses.

Washington State's Department of Ecology's 2016 Water Quality Assessment has been reviewed for each receiving water. Category 4 and 5 impairments are listed for each watershed. Any total maximum daily loads (TMDL)s or water quality improvement (WQI) projects are listed.

Fish use in each receiving water and contributing waterbodies has been collected from the Northwest Indian Fisheries Commission's Statewide Integrated Fish Distribution webmap.

The location and severity of fish barriers from the Washington Department of Fish and Wildlife's (WDFW) Washington State Fish Passage webmap are described for each stream and tributary.

The Puget Sound Stream Benthos webmap, Ecology's Environmental Information Management System, USGS's Water Quality Data for the Nation, and USGS's Regional Stream Quality Assessment have been reviewed for stream health of the receiving waters. Water quality data is summarized for each watershed in Section 4.

Land use has a significant impact on water quality. The City's zoning was used as a proxy for land use in the City limits. Zoning is classified as polluting or non-polluting for the purpose of this assessment. The areas zoned medium density residential, high density residential, town center, commercial, industrial, and schools/public facilities are classified as land uses that contribute stormwater pollutants such as total suspended solids (TSS), turbidity, and metals. Low-density residential and open spaces/parks are considered non-pollution generating land uses.

Large-scale pervious surfaces can be significant contributors of pollution. Pervious surfaces with areas greater than a city block that receive intensive management have been digitized in GIS by reviewing aerial imagery. Areas with this designation have been confirmed with City staff's knowledge of land management on the identified tracts.

Water quality treatment facilities mitigate the impacts of urban land uses on receiving waters. Stormwater facilities in City limits are classified as flow control facilities or water quality facilities based on the City's GIS data. The following facilities are classified as water quality facilities:

- Bio-infiltration swales
- Filter vaults
- Contech StormFilters

- Bioretention rain gardens

Heavily traveled roadways produce more pollutants in runoff than other land uses. Heavily traveled roadways and highways in the City with an average daily traffic (ADT) greater than 7,500 have been collected from the Southwest Washington Regional Transportation Council.

Environmental Justice and Cultural Review

The Washington Environmental Health Disparities Map (WEHDM) project compares communities for health disparities related to the environment. The map may assist local decision-makers to prioritize public investments where disparities exist. The map shows a "cumulative environmental health impact score for each census tract reflecting pollutant exposures and factors that affect people's vulnerability to environmental pollution" (WEHDM, 2019). Environmental exposures include, but are not limited to, ozone and toxic releases, while factors that affect vulnerability include, but are not limited to, socioeconomic factors and populations with health sensitivities. Impact ranks are calculated relative to other communities in the state and range between 1 and 10, with 10 being communities with the highest impact.

The WEHDM index scores of each census tract and the area of each census tract that falls within a basin have been collected. A weighted average based on the area of each census tract in the basin is calculated with this information. The area weighted averages are included in Section 4 for each basin.

Based on Ecology's SMAP guidance and the City's grant agreement with Ecology, the Environmental Protection Agency's (EPA) Environmental Justice (EJ) Screening was reviewed. The intent of the review was to find inequity and overburdened communities and include those as a factor in prioritizing a receiving water. In the best-case scenario, there would be factors in the EJScreen tool which would present inequity that could be addressed by stormwater solutions. However, the demographic indicators (demographic index, people of color, and low-income data) in Washougal did not significantly distinguish census block groups from one another. Therefore, the Washington Environmental Health Disparities (WEHDM) project has been used for this assessment instead, as described above.

Future analyses in the prioritized basin will include review of cultural resources data available from the Washington State Department of Archaeology and Historic Preservation.

2.2. Relative Conditions Assessment Methodology

The relative conditions assessment includes an assessment of stormwater management influence (SMI) as well as an assessment of historic conditions and current degradation to inform the selection of a basin management strategy. Each assessment process is described further below.

Stormwater Management Influence

The influence of the City's municipal separate storm sewer system (MS4) and land uses on the existing conditions of the receiving waters is assessed based on Step 3 of the 2019 SMAP Guidance, with some guidance derived from *Building Cities in the Rain: Watershed Prioritization for Stormwater Retrofits*, published by the Washington Department of Commerce in 2016. The purpose of stormwater management influence (SMI) is to discover the relative influence that the City's storm system has in maintaining or improving stream or river health. The SMI evaluation in turn informs the selection of a high priority catchment where the SMAP will be applied.

SMI for each basin is qualitatively evaluated based on information in Table 1 and Section 4, Receiving Waters Conditions Assessment Analysis and MS4 Influence. Nine factors are considered. A description of each factor and how it influences the City's SMI score for each receiving water is described below.

SMI - Hydrology Factors

The first factor is whether the receiving water is flow control exempt. A flow control exempt waterbody has a high volume of flow; therefore, the City's MS4 may have little influence on its hydrology. Flow control exempt waters receive a low score and non-flow control exempt receiving waters receive a high score.

The second factor is the percent of the watershed within City limits (Table 1). The City has a higher influence on a stream or river if a significant portion of the watershed is within City limits. This factor is a relative assessment between watersheds. A higher score is assigned to basins where the City controls a larger fraction of the basin.

The third factor is the City's location in the basin (Table 1). The City's location in the basin is an important consideration because if the receiving water is already degraded before it reaches City limits, the City's MS4 may not have a significant impact on its condition.

The fourth factor is impervious surfaces within City limits. Impervious surfaces alter the hydrology of a watershed and can increase the number of pollutants entering a receiving water. The fraction of impervious coverage of each basin within City limits is calculated in Section 4. This factor is a relative assessment between watersheds. A basin with a higher percentage of imperviousness within City limits receives a higher score.

The fifth factor is a relative assessment between impervious land cover mitigated by flow control facilities and drywells. The factor is measured by the density of flow control facilities and drywells per acre of developed surfaces. The number of flow control facilities and drywells in each basin is tabulated in Section 4. The density of these facilities is calculated based on the developed surfaces in the basin using the National Land Cover Dataset (NLCD). Higher scores are given to basins with a lower density of flow control facilities because these may have a larger impact on hydrology in the existing condition.

SMI - Water Quality Factors

The sixth factor is a relative assessment of pollutant-generating land uses within City limits. The fraction of pollutant-generating land uses for each basin is calculated in Section 4. Zoning is used as a proxy for land use, and each zone is categorized as pollutant-generating or non-pollutant-generating. For this assessment, pollutant-generating zoning includes high-density residential, medium-density residential, commercial, industrial, and school/public facilities. A higher score is assigned to a basin with a larger area of pollutant-generating land use because of its influence on water quality under existing conditions.

The seventh factor is the presence of high traffic roadways in the basin. High traffic roads and highways are known to produce more pollutants in runoff. Higher scores are given to basins with high relative area of road with average daily traffic (ADT) greater than 7,500. Area of high ADT roadways for each basin is documented in Section 4.

The eighth factor is large pollutant-generating pervious surfaces within City limits. Large pollutant-generating pervious surfaces are defined as golf courses, ball fields, maintained turf in parks and cemeteries, and manicured private yards exceeding one city block. Locations are identified using visual review of aerial imagery. The fraction of large pollutant-generating pervious surfaces within Ccity limits is calculated in Section 4. Only those identified surfaces that do not overlap pollution-generating land uses

(factor 6) are counted to ensure pollutant-generating areas are not double-counted. A higher score is assigned to a basin with a larger relative area of large pollution-generating pervious surfaces compared to other basins.

The ninth factor is a relative assessment of the density of water quality facilities per acre of pollutant-generating surfaces. Section 4 describes the area of polluting land uses, the area of large pollution-generating pervious surfaces, and the number of water quality treatment facilities in each basin within City limits. Higher scores are given to basins with a lower density of water quality facilities per area of pollutant-generating surfaces because of the impact on water quality in the existing condition.

Basin Management Strategy

The 2019 SMAP Guidance suggests the use of the *Building Cities in the Rain* "Management Matrix for Restoration and Protection" for prioritizing basins suitable for stormwater retrofit investment. A simplified version is shown in *Puget Sound Characterization: Volume 1: the Water Resource Assessments* and is reproduced in Figure 1, below. The matrix allows watersheds to be compared by level of importance and level of degradation and then sorted into one of four management strategies: protection, restoration, conservation, and development.

<table>
<tr><td rowspan="5">IMPORTANCE</td><td>High</td><td colspan="2" rowspan="2">Protection</td><td colspan="2" rowspan="2">Restoration</td></tr>
<tr><td>Med-High</td></tr>
<tr><td>Medium</td><td colspan="2" rowspan="2">Conservation</td><td colspan="2" rowspan="2">Development</td></tr>
<tr><td>Low</td></tr>
<tr><td></td><td>Low</td><td>Medium</td><td>Med-High</td><td>High</td></tr>
<tr><td colspan="5">DEGRADATION</td></tr>
</table>

Figure 1 Watershed Management Matrix, reproduced from Figure 5c (Stanley, S. et. al., 2016)

For the purposes of this plan, importance and degradation are determined qualitatively as described below.

Historic fish use and degree of recovery needed to meet regional fish recovery goals has been used to determine the level of importance of the stream or river (the Y axis of Figure 1). Historic fish use information in the basin is collected from the Lower Columbia Fish Recovery Board (LCFRB) and includes streams in the basin, fish species that were historically present in each, and their quantities. Higher importance of the historic resource is given to waters with a high number of species and high numbers of individuals present in the historic condition. The need for recovery for each fish species is also collected from the LCFRB. The relative need for recovery is based on regional recovery objectives: productive populations, abundant populations, support of multiple life history strategies, and utilization of significant portions of the subbasin. Higher importance is given to waters that require a higher functioning ecosystem to reach the recovery goal.

In order to determine degradation (the X axis of Figure 1), the following factors are considered: urbanization, fish passage barriers, and documented water quality impairments. Urbanization leads to higher imperviousness, which impacts both water flow and water quality in a receiving water. For this assessment, urbanization is calculated as the percentage of developed surfaces in each basin using the National Land Cover Dataset (NLCD) 2019 (see Land Cover Comparison graph for each basin in Section 4). Fish passage barrier data is collected from the Washington Department of Fish and Wildlife's (WDFW) Fish Passage Website. For this analysis, the number of 0-33% passable barriers in the City of Washougal

and downstream until next receiving water are tabulated. These are the most restrictive fish passage barriers and, therefore, prevent or significantly impede anadromous fish from accessing upstream reaches. Finally, water quality impairment information is collected from Ecology's Water Quality Atlas and the Washington State Water Quality Assessment 303(d)/305(b) List database. The presence, severity, and quantity of water quality impairments in the basin are considered and rated qualitatively. Water quality impairments are listed for each basin in Section 4.

Once the levels of importance and degradation for each basin are collected, the basin management strategy is assigned by plotting the results on the Figure 1 matrix. The assigned management strategy is then confirmed by reviewing Clark County's recommended stream health strategies (Clark County, 2010).

The Puget Sound Partnership includes the following list of solutions associated with each of the four management strategies:

- Typical BMPs, habitat improvements, and policies that apply to **all management strategies** include maintaining stream/wetland physical integrity, restoring floodplains and wetlands, restoring riparian zones, and protecting aquifer recharge areas.
- Typical BMPs that apply to the **conservation and the development management strategies** include all of the above plus emphasizing dispersion and on-site infiltration.
- Typical BMPs and policies that apply to the **protection management category** include all of the above plus increasing buffer widths, reducing groundwater withdrawals, reducing interception of shallow groundwater in ditches, and revegetating uplands.
- Typical BMPs that apply to the **restoration management category** include all of the above plus retrofitting structures and roads for greater infiltration, and reconstructing stream reaches or artificial wetlands. (Puget Sound Partnership, 2016).

3. Watershed Inventory

Table 1 lists each receiving water, the watershed area draining to the receiving water, and the fraction of that basin within City limits.

Table 1 Receiving Water Inventory – Watershed Area and Fraction within Washougal

Basin Name	Receiving Waters within Basin	Watershed Area (Acres) [SqMi]	Area inside Washougal (Acres)	Fraction of Watershed within Washougal	Percent of the City Occupied by the Basin
Gibbons	Gibbons Creek; Campen Creek; Steigerwald Lake	7,100 [11]	1,721	24.2%	45%
Washougal	Washougal River	78,880 [123]	1,918	2.4%	50%
Lacamas	Lacamas Creek	42,784 [67]	203	0.5%	5%

4. Receiving Water Conditions Assessment and Relative Conditions Analyses

The purpose of the Receiving Water Assessment is to identify receiving waters that could benefit from stormwater management planning. The outcome of this assessment is a list of candidate basins that includes the information needed to support a prioritization process.

4.1. Gibbons Creek Receiving

The Gibbons Creek Watershed is a largely rural basin in Clark County and water resource inventory area (WRIA) 28. Gibbons Creek drains a total of 11.1 square miles, flowing in a southwesterly direction through southeast Clark County and the City of Washougal before joining the Columbia River east of Washougal.

The main stem of Gibbons Creek flows for approximately eight miles. Roughly 24% of the Gibbons Creek Watershed is located within the City, and it occupies roughly 45% of the City. The stream's entire basin is referred to hereafter as the "Gibbons Creek Watershed." The portion of the stream's drainage basin located within the City limits is referred to hereafter as the "Gibbons Creek Basin."

Flow for the Gibbons Creek Watershed originates northeast of the City limits, near the Clark and Skamania County border. Gibbons Creek has several tributaries, the largest of which is Campen Creek. Gibbons Creek flows through the Steigerwald Lake National Wildlife Refuge before its confluence with the Columbia River. Since the refuge was established, the Columbia River has been cut off by a 5.5 mile levee (Lower Columbia Estuary Partnership, 2022a).

This memorandum presents the highlights of the Receiving Water Assessment for Gibbons Creek. The majority of the assessment is presented in a web map as a series of data layers.

Setting and Flow Characteristics

The total area of the Gibbons Creek Watershed is approximately 7,100 acres (11.1 square miles). The area within the City limits is 1,720 acres (2.7 square miles), or 24% of the watershed. The main streams within the Gibbons Creek Watershed consist of Gibbons Creek (31,730 ft/ 6.0 miles) and its tributary Campen Creek (12,170 ft/ 2.3 miles). The watershed boundary as described by Clark County and in this assessment also includes lands south of Washington State Highway 14 (SR-14) which discharge directly to the Columbia River or to wetlands that are not connected to Gibbons Creek itself. Gibbons Creek flows into the Columbia River east of the City of Washougal. No flow monitoring data was found for Gibbons Creek. However, based on information from the USGS StreamStats application, the 100-year flow is estimated to be 1,040 cubic feet per second (cfs), downstream of the culvert under SR-14.

The stream course downstream of SR-14 was significantly impacted in the 1960s when the Army Corps of Engineers constructed a 5.5-mile long flood control levee along the Columbia River from the Lawton Creek drainage (east of Gibbons) to what is now known as Steamboat Landing Park. In 1992, Gibbons Creek was rerouted west to Port of Camas-Washougal property where a pump system discharged the flows past the levee. This change left a 1.5 mile remnant channel connected to Steigerwald Lake and its wetlands (Ecology, 1996). In recent years, the Steigerwald Floodplain Restoration Project (constructed in 2019-2022) removed portions of the levee along the Columbia River, removed the fish ladder, and constructed two new cross-levees preventing Gibbons Creek from flowing to the Port pump system.

Gibbons Creek was returned to a more natural discharge pathway through the floodplain and then to the Columbia River (Lower Columbia Estuary Partnership, 2022).*

Neither Gibbons nor Campen Creeks are listed as a flow control exempt receiving water based on Appendix I-A of the 2019 Stormwater Management Manual for Western Washington; therefore, the Gibbons Creek Watershed is not flow control exempt.

Washington State Highway 14 (SR-14) and the BNSF Railroad traverse the watershed in an east-west direction, paralleling the Columbia River. The City operates a wastewater treatment plant. The watershed contains a large federal facility, the Steigerwald National Wildlife Refuge (NWR), the William Clark Regional Park (Cottonwood Beach Park), and several city parks.

Slopes are generally very steep in the northern portion of the watershed, with incised valleys that form the tributaries. Slopes remain steep until Gibbons Creek reaches Washington State Highway 14, where slopes decrease significantly (WSDOE, 2013). Elevations range from 1116 ft. at the northern border of the watershed and the lowest elevation is 8 ft at the Columbia River. The highest elevation within the City is 596 ft near the northern border.

The upper areas of Gibbons Creek Watershed outside the City limits, consists of agricultural and rural areas. The southwestern portion of the Gibbons Creek Watershed within the City limits consists of residential, commercial, and industrial areas, including the City's wastewater treatment plant. The southeastern portion of the watershed consists of agricultural and rural areas, as well as lakes and significant wetlands in the Steigerwald National Wildlife Refuge (NWR).

Soils in the watershed include hydrologic soil groups B, C, and D. The northern portion of the watershed (including the northern portion of the City limits) mainly consists of clay soils with a hydrologic soil group C, which is considered poorly to moderately drained soils. Soils near the Evergreen Way and Washington State Highway 14 consist of loam and silt loams, with hydrologic soil group B, which is considered moderately to well drained soils. South of Washington State Highway 14, where the wetlands are located, soils mainly consist of silt loams with a hydrologic soil groups B, C, and C/D, which are considered moderately to well drained soils.

Critical areas within the Gibbons Creek Watershed consist of critical aquifer recharge areas (CARAs), wetland areas, geological hazardous areas (steep slopes), and frequently flooded areas. The CARA are only located within the northern portions of the City limits. Wetlands are located just south of SR-14, concentrated in Steigerwald NWR. Geological hazardous areas with slopes greater than 15% are generally located near Gibbons or Campen Creeks, as well as their tributaries. Frequently flooded areas mainly occur south of SR-14.

The watershed remains nearly 30% forested, while grass covers another 30%, developed surfaces cover about 18%, and remaining land cover is a mix of wetlands, shrub/scrub, and cultivated/open space areas. Areas south of SR-14 and outside City limits have pasture hay, emergent herbaceous wetlands, and cultivated crops. These areas have low imperviousness values. Within the City limits (Gibbons Basin), forest cover is less than 5% while developed surfaces cover more than 60%, and remaining land cover is a mix of wetlands, shrub/scrub, grass, and cultivated/open space areas. Areas within the City limits have open space development, low intensity development (rural areas), and medium/high intensity

* Changes to the Gibbons Creek flow path are so recent that no maps yet show its path.

development (residential, commercial, and industrial). Many neighborhoods in the Campen Creek tributary basin were annexed to the City from unincorporated Clark County and have wider paved rights-of-way than required under City codes. These areas have high imperviousness values.

A comparison of land cover with the watershed and within the City limits can be found in Figure 2 below.

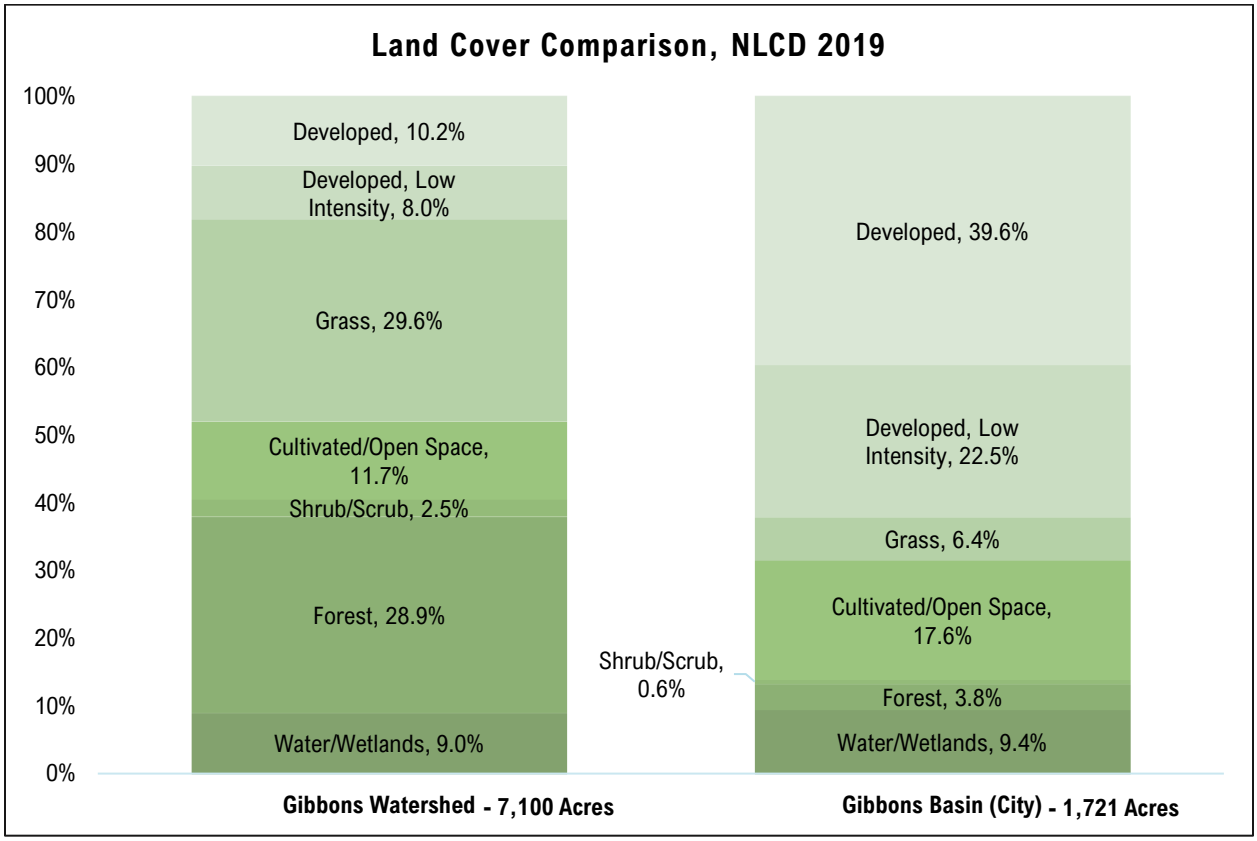

Figure 2 Land Cover Comparison, Gibbons Creek Watershed to Gibbons Creek Basin

Using a different data source (NAIP 2019) and processing technique, impervious surface in the Gibbons Creek Basin is estimated to be 761 acres, or 44% of the basin.

Within City limits, the stormwater infrastructure consists of conveyance pipes, detention ponds water quality facilities, and drywells. In the Campen Creek tributary basin, there are numerous flow control and water quality facilities serving residential subdivisions. Drywells are concentrated in the mid-basin north of Evergreen Way. The storm system outfalls to the tributaries of Gibbons or Campen Creek. Conveyances from industrial areas in the southern portion of the City often discharge directly to wetlands. Table 2 presents stormwater infrastructure counts in Gibbons Creek basin.

Table 2 Gibbons Creek Basin City-Owned and Privately Owned Stormwater Infrastructure

Stormwater Infrastructure	Measure
Outfalls (ea.)	51
Drywells (ea.)	71

Stormwater Infrastructure	Measure
Pipe[1] (ft.)	95,000 (18 miles)
Ditches (ft.)	5,145 (0.97 miles)
Flow control facilities (ea.)	26 of these 56 were installed after 2009 using the latest standards
Water quality facilities (ea.)	29 of these 63 were installed after 2009 using the latest standards

[1] includes all pipe diameters and excludes culverts

Water Quality and Aquatic Habitat

The State of Washington Department of Ecology (Ecology) has set water quality standards for surface waters. These criteria are used to assess the health of the surface water for recreation, drinking water, aquatic life, and other uses. The most stringent designated uses and associated water quality standards are outlined in Table 3 below.

Table 3 Gibbons Creek Designated Uses and Water Quality Standards

Designated Use	Parameter	Water Quality Standard (WAC 173-201A)
Aquatic Life		
Salmonid Spawning, Rearing, and Migration	Temperature	Highest 7-DADMax[1]: 17.5°C (63.5°F)
	DO	Lowest 1-Day Minimum: 8.0 mg/L
	pH	6.5 - 8.5 pH units, with a human-caused variation within the range of less than 0.5 units
	Turbidity	< 5 NTU over background[2] when the background is 50 NTU or less; or a 10% increase in the turbidity when the background turbidity is more than 50 NTU
Recreation		
Primary Contact	Bacteria	Fecal coliform organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within an averaging period exceeding 200 CFU or MPN per 100 mL
		E. coli organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL

[1] 7-DADMax is the arithmetic average of seven consecutive measures of daily maximum temperatures
[2] Background levels are not established for Gibbons Creek

Numerous reaches of Gibbons Creek do not meet water quality standards and are listed by Ecology in its 2016 water quality assessment.† Gibbons Creek upstream of SE Wooding Road in unincorporated Clark County, has a Category 5 listing for temperature and a Category 4A listing for bacteria. Two tributaries in unincorporated Clark County also have water quality listings, one of which is a Category 4A listing for

† While not included in this analysis, there are other water quality listings in the watershed available through the Washington Department of Ecology.

bacteria. The middle reach of Gibbons Creek, upstream of Campen Creek, has four listings, including a Category 5 listing for temperature. Downstream of Campen Creek, Gibbons Creek has three listings, including a Category 5 listing for temperature and a Category 4A listing for bacteria (Ecology, 2016).

The Gibbons Creek Remnant Channel receives wastewater from industrial facilities and stormwater runoff from other facilities (Ecology, 1996), and it has a Category 4A listing for bacteria among other listings (Ecology, 2016; Ecology, 2022).

Campen Creek also has several water quality listings including a Category 5 listing for temperature, a Category 4A listing for bacteria that is associated with the Gibbons Creek Watershed Bacteria TMDL. An unknown tributary to Campen Creek has a Category 4A listing for bacteria (Ecology, 2016; Ecology, 2022).

The Category 4A listings for bacteria are addressed in the Gibbons Creek Watershed Bacteria TMDL (Ecology, 2016; Ecology, 2022).

USGS's Regional Stream Quality Assessment evaluated Gibbons Creek at Evergreen Highway in 2015. Total nitrogen and total phosphorus levels were concerning, although the rest of the samples indicated Gibbons Creek's health is fair.

Using various measurements of macroinvertebrate health in Gibbons Creek, stream health appears to be good. In 2019, Clark County assessed a B-IBI score of 83.7 (excellent) just downstream of the Campen Creek confluence. In 2015, USGS's Regional Stream Quality Assessment evaluated Gibbons Creek at Evergreen Highway in 2015, and found a macroinvertebrate MMI score of 76.15 (good).

According to the Statewide Integrated Fish Distribution (SWIFD) web map, fish species present in Gibbons Creek or Campen Creek include Fall Chum, Coho Salmon, Rainbow Trout, and Winter Steelhead (Northwest Indian Fisheries Commission, 2022). There is only one fish passage barrier upstream of the City of Washougal at the headwaters of a tributary to Gibbons Creek which is not passable (WDFW, 2022).

Water quality in Gibbons Creek Basin is impacted by pollution-generating land uses, large-scale pollution-generating pervious surfaces, and highways with high traffic volumes.

Zoning in the City of Washougal is used as a proxy for land use. Within City limits, Gibbons Creek Basin is dominated by single family housing in the upper portion of the basin, industrial zoning near the Columbia River, and schools/public facilities zoning that is scattered throughout. Other zoning in the basin includes medium density residential, town center, commercial, rural estate, water, parks, open space, and greenway. For the purposes of this assessment, the following zoning categories have been defined as "pollution-generating": high-density residential, medium-density residential, commercial, industrial, and school/public facilities. Pollution-generating land uses make up 46% of the basin (Figure 3).

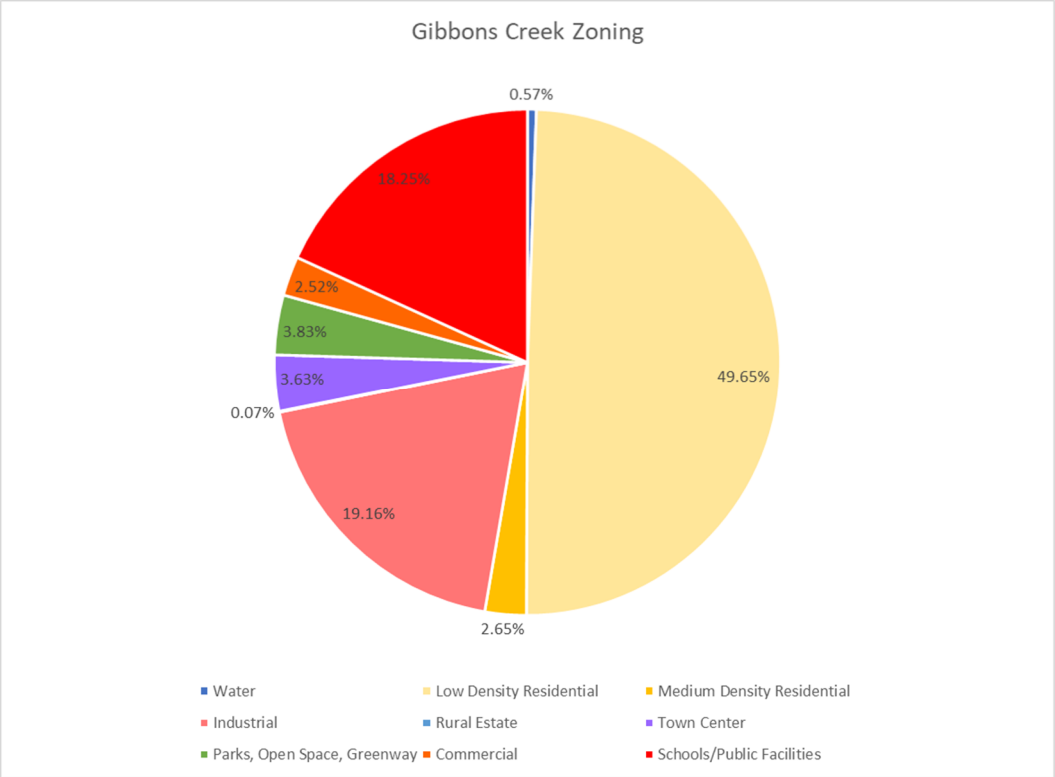

Figure 3 Gibbons Creek Basin Zoning

Several large-scale pollution-generating pervious surfaces are present in the basin, including golf courses, ball fields, parks, and large lawns on private property. Most of these are located within zoning considered pollution-generating and, for the purposes of this assessment, were not counted again. Ten acres of pollution-generating pervious surfaces (0.61% of the basin) are present outside of the pollution-generating zoning.

The roadway in Gibbons Creek Basin with high average daily traffic (ADT) is a portion of SR-14 in the western portion the basin accounting for 4,900 feet of pollution-generating surface‡.

Some pollutant-generating land uses are managed under NPDES Industrial Stormwater General Permits issued to industrial site operators by Department of Ecology. The permit holders are responsible for monitoring, measuring, and reducing stormwater pollution leaving their site. The active Industrial Stormwater General Permits in Gibbons Creek basin are:

- Advanced Drainage Systems Inc (WAR000137); 627 S 37TH ST
- ALLEN BROWN WOODWASTE INC (WAR001811); 3495 TRUMAN RD
- Burlington Environmental LLC Washougal (WAR003079); 625 S 32ND ST
- CALVERT CO INC WASHOUGAL (WAR011365); 3559 S TRUMAN RD
- Corrosion Companies Inc (WAR011162); 3725 S GRANT ST STE 3
- FIBER WEB WASHOUGAL INC (WAR000503); 3720 GRANT ST
- INTECH ENTERPRISES GRANT ST WASHOUGAL (WAR011345); 3825 GRANT ST

‡ High ADT roadway surfaces that overlap with the pollution-generating land uses were subtracted from the area in order to avoid double-counting.

- IP Maintenance Yard (CNE301470); 2197 Index street
- Kemira Chemicals Inc Washougal Plant (WAR001125); 1150 S 35TH ST
- ORBIT INDUSTRIES (WAR001814); 778 S 27TH ST
- Northwest Adhesives (CNE304754); 4325 S Lincoln Street
- Norwesco Inc (WAR304442); 3860 GRANT ST
- PILLER PLASTICS INC GRANT ST (WAR011660); 3925 S GRANT ST
- WASHOUGAL TRANSFER STATION (WAR012022); 4020 S GRANT ST
- FERGUSON INDUSTRIAL PLASTICS (WAR004479); 740 S 28TH ST
- TrueGuard LLC (WA0040029); 725 S 32nd St

Future Development and Improvement Plans

The City expects redevelopment within its Town Center East Village District consisting of higher density housing, auto-oriented retail, and open space. Upcoming redevelopment in the Gibbons Creek Basin will be required to meet current stormwater standards which will mitigate for impervious surfaces by providing flow control and water quality facilities. The City is planning major upgrades to the sewage treatment facility south of SR-14 and a few other capital improvements, including:

- J Street Water Main Installation from 32nd to 34th Street
- 39th Street/Evergreen Way Realignment near the City of Washougal Permit Center
- 32nd Street Underpass Preliminary Design - one component of a significant multi-component economic development and safety project providing improved access to the Port of Camas-Washougal and the growing Washougal Town Center, a much needed grade separated railroad crossing at 32nd Street, new connector streets in the Town Center and road improvements within the Port's industrial park. The underpass will ensure the free-flow of traffic off of SR14 by eliminating the delays at the rail crossing. This project includes a roundabout at 32nd and Main Street, a signal at 32nd Street and Evergreen Way to reduce costs and excavation, a free right turn (that does not stop) from northbound 32nd Street east on Evergreen Way, and a sidewalk and multi-use path to maximize funding support. The 32nd Street underpass also provides for a third BNSF track (which is a required request by the BNSF)
- Hartwood Bridge to install a new bridge over Campen Creek and replace existing abutments

Stormwater Retrofits and Restoration Projects in the Basin

- The collaborative Steigerwald Reconnection Project recently reconnected 965 acres of Columbia River floodplain, reducing flood risk from Gibbons Creek, improving habitat for fish and wildlife, and creating new trails for recreation at the refuge.
- The Lower Columbia Estuary Partnership collaborated with the City to select a stormwater retrofit and restoration site in the Gibbons Creek Basin, focusing particularly on the Campen Creek tributary drainage. The site, currently a ditch in the right-of-way along Washougal High School's parking lot, plans to provide treatment and flow control for the entire South parking lot.
- 32nd Street will be widened; however, cost barriers may prevent additional stormwater management projects from being included

Environmental Justice

To show the relative environmental health disparity of the Gibbons Creek basin, an area-weighted average of the combined index scores of 19 factors from 4 census tracts was calculated. Overall, the environmental health disparities indices in the basin are between 3 and 9, which is low to high. The area-weighted average of the combined index scores for Gibbons Creek basin is 5.7. This indicates that the community in the Gibbons Creek basin ranks moderately high according to the risk from environmental factors that influence health outcomes.

Relative Conditions Assessment

The relative conditions assessment includes an assessment of stormwater management influence (SMI) as well as an assessment of historic conditions and current degradation to inform the selection of a basin management strategy.

Stormwater Management Influence

The influence of the City's land uses and stormwater system (Stormwater Management Influence (SMI)) on Gibbons Creek is estimated qualitatively using the following factors and findings (Table 4). The analysis relies on selected elements that have been described above in the Receiving Water Assessment. The assessment includes influence on both hydrology and water quality and is relative to other basins in the City. Factors are listed in descending order of those that most describe the City's influence on receiving water conditions. The percentage of the watershed within the City limits is included in both the hydrology and water quality assessments.

Table 4 SMI Assessments for Gibbons Creek

SMI Parameter	Assessment Theory	Gibbons Creek Basin Characteristics	Assessment
Hydrology			
Flow Control Exempt	A flow control exempt waterbody has a high volume of flow; therefore, the City can have little influence on its hydrology. Flow control exempt receiving waters receive a low score and non-flow control exempt receiving waters receive a high score.	Gibbons Creek is not flow control exempt	High
Percent of Watershed in City Limits	This factor is a relative assessment between watersheds that indicates the amount of the basin that falls within the City limits. A higher percentage within the City results in a higher score.	24% of the watershed is in the City	High
Location of City within Watershed	The location of the City in the watershed dictates the influence the City can have on hydrology. A City at the headwaters has high influence and receives a high score while a City near the mouth has a low influence and receives a low score.	The City is located at the lower reaches of Gibbons Creek while nearly the entire Campen Creek tributary, including most of its headwaters, is within the City	Medium
Impervious Surfaces	This factor is a relative assessment between watersheds, where the basin with the higher percentage of imperviousness will receive the higher score.	761 of 1,721 acres, or 44%	High

SMI Parameter	Assessment Theory	Gibbons Creek Basin Characteristics	Assessment
Density of Flow Control Facilities and Drywells Per Acre of Developed Surfaces	This indicates what level of the developed surfaces in the basin is being managed by flow control facilities. A low density of flow control facilities will receive a high score and a high density of flow control facilities will receive a low score relative to other basins.	56 flow control facilities plus 71 drywells (127) and 682 acres developed surfaces, or 0.186 facilities/acre	Low
Influence on Hydrology			**High**
Water Quality			
Percent of Watershed in City Limits	This factor is a relative assessment between watersheds that indicates the amount of the basin that falls within the City limits. A higher percentage within the City results in a higher score.	24% of the watershed is in the City	High
Pollution-Generating Land Use	This factor is a relative assessment between watersheds of pollution-generating land use in the basin within City limits. A high percent of pollution-generating land use in the basin will receive a high score and a low percentage of pollution-generating land use in the basin will receive a low score.	790 of 1,721 acres, or 46%	High
Roadways with High Traffic Volumes	This factor is a relative assessment of high traffic volumes in the basin within City limits. A high score is assigned to a basin with a higher length of roadways with a high AADT of 7,500 or greater and a low score is assigned to a basin with a low number of roadways with a high AADT of 7,500 or greater relative to other basins. Only segments that do not overlap pollution-generating land uses are counted.	4,908 linear feet (Estimated width of SR-14 is 22 feet per lane for an area of 107,976 square feet)	Medium
Large Pollution-Generating Pervious Surfaces	This factor is a relative assessment of large pollution-generating pervious surfaces. A high score is assigned to a basin with a large area of large pollution-generating pervious surfaces and a low score is assigned to a basin with a small area of large pollution-generating pervious surfaces relative to other basins. Only those that do not overlap pollution-generating land uses are counted.	36 of 1,721 acres, or 2.1%	High

SMI Parameter	Assessment Theory	Gibbons Creek Basin Characteristics	Assessment
Density of Water Quality Facilities Per Acre of Pollution-Generating Land Use and Large Pervious Surfaces	This indicates what level of the pollution-generating land use and large pervious surfaces in the basin is being managed by water quality facilities. A high score is assigned to a basin with a lower density of water quality facilities per area of pollution-generating land uses, and a low score is assigned to a basin with a higher density of water quality facilities per area of pollution-generating land uses relative to other basins.	63 water quality facilities and 826 acres of pollution-generating land use plus large pollution-generating pervious surfaces, or 0.076 facilities/acre	Medium
Influence on Water Quality			**High**

Basin Management Strategy

The basin management strategy for Gibbons Creek has been established using several factors described in Table 5.

Table 5 Factors Used to Select a Basin Management Strategy for Gibbons Creek Basin

		Gibbons Creek
Importance	**Historic Fish Use**	High
	Explanation	The Lower Gorge Tributaries are part of the Columbia Lower Subbasin as defined by the NPPC (Figure O1). The primary streams are Gibbons Creek, Lawton Creek, Duncan Creek, Hardy Creek, and Hamilton Creek. These streams historically supported abundant winter steelhead, chum, coho, and fall chinook. (LCFRB, Vol. II - Ch. O, Lower Columbia Gorge Tribs, p. 4)
	Need For Recovery	High
	Explanation	Lower Gorge Tributaries winter steelhead and coho will need to be restored to a high level of viability, chum to a very high level of viability, and fall Chinook to a medium level of viability to meet regional recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the subbasin. (LCFRB, Vol. II - Ch. O, Lower Columbia Gorge Tribs, p. 4-5)
Degradation	**Urbanization**	High
	Explanation	Developed surfaces make up 39.6% of the land cover in the Gibbons Creek Basin.
	Fish Passage Barriers	Low
	Explanation	There are no 0-33% passable barriers in the City and downstream until next receiving water.
	Water Quality Impairments	High
	Explanation	There are 6 Category 4A and 3 Category 5 water quality impairments in the receiving water and tributaries within City limits or downstream of Washougal.

Given the high importance and high degradation of the Gibbons Creek Basin, the selected basin management strategy is restoration.

The restoration management goal requires the highest level of investment for returning an important and degraded watershed to a more functional system. The Puget Sound Partnership includes the following list of solutions associated with each of the four management strategies:

- Typical BMPs and habitat improvements and policies that apply to **all management strategies** include maintaining stream/wetland physical integrity, restoring floodplains and wetlands, restoring riparian zones, and protecting aquifer recharge areas.
- Typical BMPs that apply to the **conservation and the development management strategies** include all of the above plus emphasizing dispersion and on-site infiltration.
- Typical BMPs and policies that apply to the **protection management category** include all of the above plus increasing buffer widths, reducing groundwater withdrawals, reducing interception of shallow groundwater in ditches, and revegetating uplands.
- Typical BMPs that apply to the **restoration management category** include all of the above plus retrofitting structures and roads for greater infiltration, and reconstructing stream reaches or artificial wetlands. (Puget Sound Partnership, 2016).

Clark County assessed Gibbons Creek in its 2010 Clark Count Stream Health Report and recommended the following actions for improving the health of receiving waters in the Gibbons Basin: stream health strategies include conserving agricultural lands and promoting healthy practices; working with property owners to eliminate pollution sources; increasing infiltration and retention of stormwater runoff in developed areas; and restoring riparian vegetation in lower watershed (particularly along Steigerwald channel) (Clark County, 2010)

Conclusion

Nearly 25% of the Gibbons Creek Watershed is within City limits, and the City has a relatively high influence over both hydrology and water quality compared to other receiving waters in its jurisdiction. The Gibbons Creek Watershed is important for fish recovery and is degraded, as evidenced by several water quality impairments and a TMDL for bacteria. Several other agencies have recently or are planning to focus efforts to improving conditions in Gibbons Creek, Steigerwald Lake, and Campen Creek.

Therefore, the Gibbons Creek Basin is a likely candidate for Stormwater Management Action Planning.

4.2. Washougal River

The Washougal River Watershed is a largely rural basin in Skamania and Clark Counties and WRIA 28. Washougal River drains a total of 123 square miles, flowing in a southwesterly direction through southwest Skamania County, southeast Clark County, and the City of Washougal before joining the Columbia River in Camas, Washington.

The main stem of Washougal River flows for approximately 47 miles from Lookout Mountain in the Gifford Pinchot National Forest. Roughly 2.4% of the Washougal River Watershed is located within the City of Washougal, and it occupies roughly 50% of the City's area. The river's entire basin is referred to hereafter as the "Washougal River Watershed." The portion of the river's drainage basin located within the City limits is referred to hereafter as the "Washougal River Basin."

Flow for the Washougal River Watershed originates northeast of the City limits, in southwestern Skamania County. Washougal River has several tributaries, the largest of which are the West Fork Washougal River, Little Washougal River, and Lacamas Creek.

This memorandum presents the highlights of the Receiving Water Assessment for Washougal River. The majority of the assessment is presented in a web map as a series of data layers.

Setting and Flow Characteristics

The total area of the Washougal River Watershed is approximately 78,880 acres (123.2 square miles). The area of the Washougal River Watershed that is within the City limits is 1,918 acres (3.0 square miles), or 2.4% of the watershed. The main tributaries are the Little Washougal River (50,500 ft/9.56 miles), which enters from the north just 0.6 miles northeast of City limits at SE Blair Road, Cougar Creek, which enters from the north at N. Bon Road in Clark County, the West Fork Washougal River (59,400 ft/ 11.25 miles), which enters from the north between Skye and Northfork Roads in Skamania County, and Lacamas Creek (88,705 ft/16.8 miles), which enters from the north in Camas. Within City limits, five small unnamed tributaries flow south from the bluffs south of SE 30th Street to the Washougal River. Each of these tributaries drains a basin of less than one square mile and is highly modified, flowing through a combination of piped and open channel segments. The Washougal River flows into the Columbia River in Camas, just west of Washougal.

A stream gage is located on the main stem approximately 3.7 miles upstream of the confluence with the Little Washougal River. Based on the results from Clark County Flood Insurance Study, the 100-year flow is estimated to be 30,138 cfs at the stream gage and 56,672 cfs at the mouth of the Washougal River (FEMA, 2018).

The Washougal River is not listed as a flow control exempt receiving water based on Appendix I-A of the *2019 Stormwater Management Manual for Western Washington*; therefore, the Washougal River Watershed is not flow control exempt. However, its estimated 100-year flow at the mouth is higher than the estimated flow at the mouth of the East Fork Lewis River (26,900 cfs (FEMA, 2018) in Clark and Cowlitz counties, which has a similar watershed area and is listed as a flow control exempt water body.

Washington State Highway 14 (SR-14) and the BNSF Railroad traverse the watershed in an east-west direction, paralleling the Columbia River. The Washougal River Road follows the mainstem through the City, into Clark County, past Washougal River State Park, and into Skamania County until it reaches state Department of Natural Resources (DNR) lands in the upper watershed. The Port of Camas-Washougal is a significant landholder in the City and neighboring City of Camas.

Slopes are generally very steep in the upper watershed, with steep forested valleys that form hundreds of tributaries. Elevations range from 3790 ft. at the northern border of the watershed to 10 ft. at the Columbia River. Within City limits, slopes are steep north of the river and flatten south of the river. The highest elevation within the City is 620 ft just south of SE 30th Street.

Soils in the watershed include hydrologic soil groups B and C. Soils in the northeastern watershed in unincorporated Skamania and Clark counties includes clay loam and gravelly loam soils with a hydrologic soil group B. Soils just north of the City limits include clay loams with hydrologic soil group C. Within City limits, soils north of the river are clay loams, with hydrologic soil group C, and soils south of the river are clay loams and gravelly loams with a hydrologic soil group B. All major soil groups noted here are considered well drained.

Critical areas within the Washougal River Watershed include critical aquifer recharge areas (CARAs), wetlands, geological hazard areas (steep slopes), and frequently flooded areas. The CARAs are located within City limits, in close proximity to the Washougal River and areas south of the Washougal River.

Wetlands are located in close proximity to the Washougal River and along the Columbia River. Geological hazard areas with slopes greater than 15% are generally located near the Washougal River, as well as its tributaries. The geological hazard areas are more frequent upstream of the Washougal River. Frequently flooded areas mainly occur south of SR-14 and in areas in close proximity to the Washougal River. Critical areas in Skamania County were not assessed.

According to the National Land Cover Dataset (NLCD) 2019, the watershed remains nearly 70% forested, while grass covers another 10%, developed surfaces cover about 4%, and remaining land cover is a mix of wetlands, shrub/scrub, and cultivated/open space areas. Areas north of the City limits have pasture/hay, forests, shrub/scrub and grasslands. These areas have low imperviousness values. Within the City limits (Washougal River Basin), forest cover is less than 10% while developed surfaces cover more than 60%, and remaining land cover is a mix of wetlands, shrub/scrub, grass, and cultivated/open space areas. Areas within the City limits have open space development, low intensity development (rural areas), and medium/high intensity development (residential, commercial, and industrial). These areas have high imperviousness values. (NLCD, 2019)

A comparison of land cover with the watershed and within the City limits can be found in Figure 4 below.

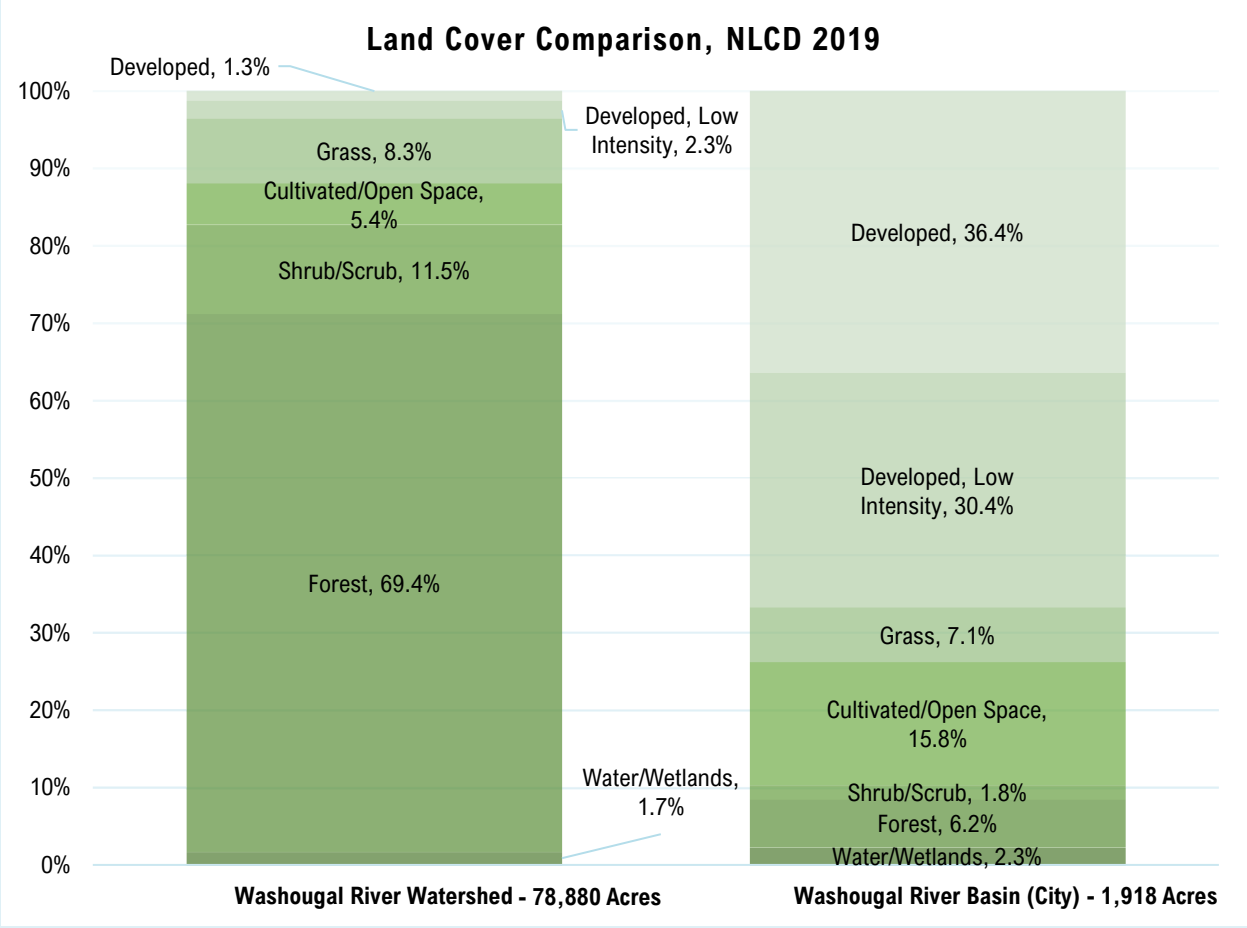

Figure 4 Land Cover Comparison, Washougal River Watershed to Washougal River Basin

Using a different data source (NAIP 2019) and processing technique, impervious surface in the Washougal River Basin is estimated to be 852 acres, or 44% of the basin.

Within City limits, the stormwater infrastructure consists of conveyance pipes, detention ponds, water quality facilities, and drywells. Drywells are concentrated in the southern portion of the City limits, south of the Washougal River. The storm system outfalls to the Washougal River. Table 6 presents stormwater infrastructure counts in the Washougal River Basin.

Table 6 Washougal River Basin City-Owned and Privately Owned Stormwater Infrastructure

Stormwater Infrastructure	Measure
Outfalls (ea.)	38
Drywells (ea.)	142
Pipe[1] (ft.)	110,770 (21 miles)
Ditches (ft.)	12,481 (2.36 miles)
Flow control facilities (ea.)	33 of these 202 were installed after 2009 using the latest standards
Water quality facilities (ea.)	43 of these 76 were installed after 2009 using the latest standards

[1] includes all pipe diameters and excludes culverts

Water Quality and Aquatic Habitat

The State of Washington Department of Ecology (Ecology) has set water quality standards for surface waters. These criteria are used to assess the health of the surface water for recreation, drinking water, aquatic life, and other uses. The most stringent designated uses and associated water quality standards are outlined in Table 7 below.

Table 7 Washougal River Designated Uses and Water Quality Standards

Receiving Water	Designated Use	Parameter	Water Quality Standard (WAC 173-201A)
Washougal River: Downstream from latitude 45.5883, longitude -122.3711 at NE 3rd Ave	**Aquatic Life**		
	Salmonid Spawning, Rearing, and Migration	Temperature	Highest 7-DADMax[1]: 17.5°C (63.5°F)
		DO	Lowest 1-Day Minimum: 8.0 mg/L
		pH	6.5 - 8.5 pH units, with a human-caused variation within the range of less than 0.5 units
		Turbidity	< 5 NTU over background[2] when the background is 50 NTU or less; or a 10% increase in the turbidity when the background turbidity is more than 50 NTU
	Recreation		
	Primary Contact	Bacteria	Fecal coliform organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within an averaging period exceeding 200 CFU or MPN per 100 mL

Receiving Water	Designated Use	Parameter	Water Quality Standard (WAC 173-201A)
			E. coli organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL
Washougal River: Upstream from latitude 45.5883, longitude -122.3711 at NE 3rd Ave, including tributaries	**Aquatic Life**		
	Salmonid Spawning, Rearing, and Migration	Temperature	Highest 7-DADMax1: 16°C (60.8°F)
		Supplemental Spawning	Salmon and trout (13°C (55.4 °F)) from 2/15 to 6/15
		DO	Lowest 1-Day Minimum: 9.5 mg/L
		pH	6.5 - 8.5 pH units, with a human-caused variation within the range of less than 0.2 units
		Turbidity	< 5 NTU over background[2] when the background is 50 NTU or less; or a 10% increase in the turbidity when the background turbidity is more than 50 NTU
	Recreation		
	Primary Contact	Bacteria	Fecal coliform organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within an averaging period exceeding 200 CFU or MPN per 100 mL
			E. coli organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL

[1] 7-DADMax is the arithmetic average of seven consecutive measures of daily maximum temperatures
[2] Background levels are not established for Washougal River

Numerous reaches of Washougal River do not meet water quality standards and are listed by Ecology in its 2016 water quality assessment.§ Outside of City limits and upstream of the Little Washougal River confluence, Washougal River has a Category 5 listing for temperature. Slightly upstream of the Clark-Skamania County border, there are two listings for Washougal River, one of which is a Category 5 listing for bacteria. Stebbins Creek is a tributary to the Washougal River near the headwaters. An unnamed tributary to Stebbins Creek has a Category 5 listing for temperature (Ecology, 2016).

§ While not included in this analysis, there are other water quality listings in the watershed available through the Washington Department of Ecology.

Using measurements of macroinvertebrate health in the upper Washougal River Watershed, stream health appears to be good. In 2020, the Washington State Department of Ecology assessed a B-IBI score of 79.8 (good) approximately six miles from the headwaters of Washougal River in Skamania County. In 2019, Clark County assessed stream health at the mouth of Cougar Creek, a tributary to Washougal River north of Washougal City limits. The B-IBI score was assessed to be 67.3 (good).

According to the Statewide Integrated Fish Distribution (SWIFD) web map, fish species present in Washougal River include fall chum, fall Chinook salmon, coho salmon, rainbow trout, summer steelhead, winter steelhead, coastal cutthroat trout, eastern brook trout, largemouth bass, mountain whitefish, and Native char/Dolly Varden/bull trout (Northwest Indian Fisheries Commission, 2022). According to WDFW, there are 12 fish passage barriers on the Washougal River, both man-made and natural. The barriers on the main stem of the Washougal River are upstream of Washougal. There are 80 additional fish passage barriers on various tributaries in the watershed that range from 0% passable to 99% passable (WDFW, 2022).

Water quality in the Washougal River Basin is impacted by pollution-generating land uses, large-scale pollution-generating pervious surfaces, and highways with high traffic volumes.

Zoning in the City of Washougal is used as a proxy for land use. Within City limits, Washougal River Basin is dominated by single family housing in the upper portion of the basin, industrial zoning near the Columbia River, commercial and town center zoning near the center of the basin, and schools/public facilities zoning that is scattered throughout. Other zoning in the basin includes urban high density residential, water, parks, and open space. For the purposes of this assessment, the following zoning categories have been defined as “pollution-generating”: high-density residential, medium-density residential, commercial, industrial, and school/public facilities. Pollution-generating land uses make up 30% of the basin (Figure 5).

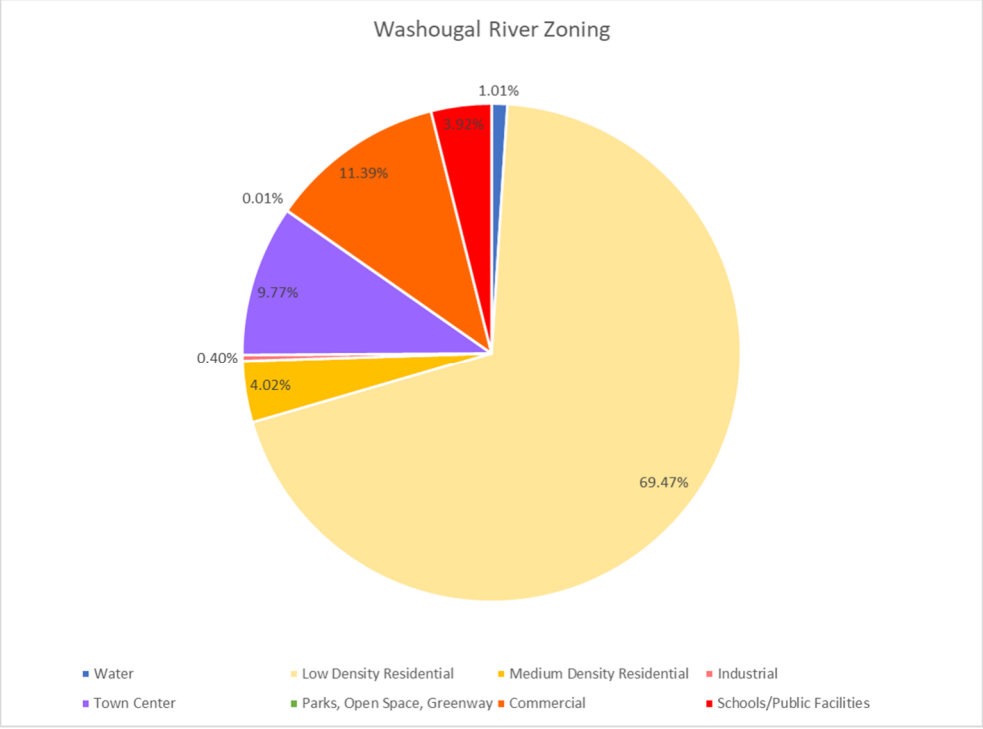

Figure 5 Washougal River Basin Zoning

Several large-scale pollution-generating pervious surfaces are present in the basin, including ball fields, parks, and large lawns on private property. Most of these are located within zoning considered pollution-generating and, for the purposes of this assessment, were not counted again. 27 acres of pollution-generating pervious surfaces (1.41% of the basin) are present outside of the pollution-generating zoning.

The roadway in Washougal River Basin with high average daily traffic (ADT) is SR-14 in the western portion of the basin. Each direction of travel is a total 9,527.5 feet in length and an estimate average width of 22 feet was applied to each direction of travel for SR-14. Therefore, the high ADT roadways in the basin account for 419,210 square feet of pollution-generating surface.

Some pollutant-generating land uses are managed under NPDES Industrial Stormwater General Permits issued by Department of Ecology. These permit holders are responsible for monitoring, measuring, and reducing stormwater pollution leaving their site. The active Industrial Stormwater General Permit in Washougal River basin is:

- PENDLETON WOOL MILL (WAR005577); 2 Pendleton Way

Future Development and Improvement Plans

The City expects redevelopment within its Town Center East Village District consisting of higher density housing, auto-oriented retail, and open space. The Port of Camas-Washougal is investing in significant development on the Columbia River waterfront including commercial, retail, mixed use, residential, and community spaces. Upcoming redevelopment in the Washington River Basin will be required to meet current stormwater standards which will mitigate for impervious surfaces by providing flow control and water quality facilities. The City is planning a few capital improvements including:

- Wastewater Pump Station #1 Relocation
- Wastewater Pump Station #2, #4, #5, and #8 Upgrades
- East County Family Resource Center Maintenance and Repair Project
- Schmid Family Park on the river may be developed in the near future, however, cost barriers may prevent the project from moving forward

Stormwater Retrofits and Restoration Projects in the Basin

- No upcoming or recent retrofits or restoration projects were identified in the City limits.
- There are several stormwater projects in the Washougal River Basin on the City's stormwater repairs and replacements list. If this basin is prioritized, these projects and other localized drainage concerns would be incorporated into future water quality and water flow capital improvement projects (CIPs) in the SMAP where possible.

Environmental Justice

To show the relative environmental health disparity of the Washougal River basin, an area-weighted average of the combined index scores of 19 factors from 6 census tracts was calculated. Overall, the environmental health disparities indices in the basin are between 3 and 9, which is low to high. The area-weighted average of the combined index scores for Gibbons Creek basin is 5.4. This indicates that the community in the Washougal River basin ranks moderate according to the risk from environmental factors that influence health outcomes.

Relative Conditions Assessment

The relative conditions assessment includes an assessment of stormwater management influence (SMI) as well as an assessment of historic conditions and current degradation to inform the selection of a basin management strategy.

Stormwater Management Influence

The influence of the City's land uses and stormwater system (Stormwater Management Influence (SMI)) on Washougal River is estimated qualitatively using the following factors and findings. The analysis relies on selected elements that have been described above in the Receiving Water Assessment. The assessment includes influence on both hydrology and water quality and is relative to other basins in the City (Table 8). Factors are listed in descending order of those that most describe the City's influence on receiving water conditions. The percentage of the watershed within the City limits is included in both the hydrology and water quality assessments.

Table 8 SMI Assessment for Washougal River

SMI Parameter	Assessment Theory	Washougal River Basin Characteristics	Assessment
Hydrology			
Flow Control Exempt	A flow control exempt waterbody has a high volume of flow; therefore, the City can have little influence on its hydrology. Flow control exempt receiving waters receive a low score and non-flow control exempt receiving waters receive a higher score.	Washougal River is not flow control exempt; however, its estimated 100-year discharge is greater than flow control exempt rivers with a similar watershed area	Medium
Percent of Watershed in City Limits	This factor is a relative assessment between watersheds that indicates the amount of the basin that falls within the City limits. A higher percentage within the City results in a higher score.	2.4% of the watershed is in the City	Low
Location of City within Watershed	The location of the City in the watershed dictates the influence the City can have on hydrology. A City at the headwaters has high influence and receives a high score while a City near the mouth has a low influence and receives a low score.	The City is located at the lower reaches of Washougal River	Low
Impervious Surfaces	This factor is a relative assessment between watersheds, where the basin with the higher percentage of imperviousness within City limits will receive the higher score.	852 of 1,918 acres, or 44%	High
Density of Flow Control Facilities and Drywells Per Acre of Developed Surfaces	This factor is a relative assessment that indicates what level of the developed surfaces in the basin within City limits is being managed by flow control facilities. A low density of flow control facilities will receive a high score and a high density of flow control facilities will receive a low score relative to other basins.	202 flow control facilities plus 142 drywells (344) and 698 acres developed surfaces, or 0.493 facilities/acre	Medium
Influence on Hydrology			**Low**

SMI Parameter	Assessment Theory	Washougal River Basin Characteristics	Assessment
Water Quality			
Percent of Watershed in City Limits	This factor is a relative assessment between watersheds that indicates the amount of the basin that falls within the City limits. A higher percentage within the City results in a higher score.	2.4% of the watershed is in the City	Low
Pollution-Generating Land Use	This factor is a relative assessment between watersheds of pollution-generating land use in the basin within City limits. A high percent of pollution-generating land use in the basin will receive a high score and a low percentage of pollution-generating land use in the basin will receive a low score.	567 of 1,918 acres, or 30%	Medium
Roadways with High Traffic Volumes	This factor is a relative assessment of high traffic volumes in the basin within City limits. A high score is assigned to a basin with a higher length of roadways with a high AADT of 7,500 or greater and a low score is assigned to a basin with a low number of roadways with a high AADT of 7,500 or greater relative to other basins. Only segments that do not overlap pollution-generating land uses are counted.	419,210 square feet	High
Large Pollution-Generating Pervious Surfaces	This factor is a relative assessment of large pollution-generating pervious surfaces. A high score is assigned to a basin with a large area of large pollution-generating pervious surfaces and a low score is assigned to a basin with a small area of large pollution-generating pervious surfaces relative to other basins. Only those that do not overlap pollution-generating land uses are counted.	45 of 1,918 acres, or 2.3%	High
Density of Water Quality Facilities Per Acre of Pollution-Generating Land Use and Large Pervious Surfaces	This factor is a relative assessment that indicates what level of the pollution-generating land use and large pervious surfaces in the basin within City limits is being managed by water quality facilities. A high score is assigned to a basin with a low density of water quality facilities per area of pollution-generating land uses, and a low score is assigned to a basin with a higher density of water quality facilities per area of pollution-generating land uses relative to other basins.	76 water quality facilities and 567 acres of pollution-generating land use plus large pollution-generating pervious surfaces, or 0.134 facilities/acre	Low
Influence on Water Quality			**Medium**

Basin Management Strategy

The basin management strategy for Washougal River has been selected using several factors described in Table 9.

Table 9 Factors Used to Select a Basin Management Strategy for Washougal River Basin

Washougal River		
Importance	Historic Fish Use	High
	Explanation	The Washougal River is one of twelve major Northwest Power and Conservation Council (NPCC) subbasins in the Washington portion of the Lower Columbia Region. The subbasin historically supported thousands of fall Chinook, chum, coho, and summer and winter steelhead. (LCFRB, Vol. II - Ch. N, North Washougal Subbasins, p. 4)
	Need For Recovery	High
	Explanation	Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook, coho, chum, and steelhead have been listed as threatened under the Endangered Species Act. Washougal River fall Chinook, and chum, will need to be restored to a high level of viability and coho and steelhead will need to be restored to a medium viability level to meet regional recovery objectives. (LCFRB, Vol. II - Ch. N, North Washougal Subbasins, p. 4)
Degradation	Urbanization	Medium
	Explanation	Developed surfaces make up 36.4% of the land cover in the Washougal River Basin.
	Fish Passage Barriers	Low
	Explanation	There are no 0-33% passable barriers in the City or downstream until next receiving water.
	Water Quality Impairments	Low
	Explanation	There are no Category 4A or 5 water quality impairments in the receiving water and tributaries within City limits or downstream of Washougal.

Given the high importance and moderate degradation of the Washougal River Basin, the selected basin management strategy is protection.

The protection management goal requires some of the highest levels of investment for maintaining a functional system. The Puget Sound Partnership includes the following list of solutions associated with each of the four management strategies:

- Typical BMPs, habitat improvements, and policies that apply to **all management strategies** include maintaining stream/wetland physical integrity, restoring floodplains and wetlands, restoring riparian zones, and protecting aquifer recharge areas.
- Typical BMPs that apply to the **conservation and the development management strategies** include all of the above plus emphasizing dispersion and on-site infiltration.
- Typical BMPs and policies that apply to the **protection management category** include all of the above plus increasing buffer widths, reducing groundwater withdrawals, reducing interception of shallow groundwater in ditches, and revegetating uplands.

- Typical BMPs that apply to the **restoration management category** include all of the above plus retrofitting structures and roads for greater infiltration, and reconstructing stream reaches or artificial wetlands. (Puget Sound Partnership, 2016).

Clark County assessed the Washougal River in its 2010 Clark County Stream Health Report and recommended the following actions for improving the health of receiving waters in the Washougal River Basin: stream health strategies include conserving agricultural lands and promoting healthy practices; implementing development regulations to minimize impacts, particularly from clearing and grading; protecting and restoring stream channels and riparian forest in tributary streams; and minimizing the impact of surface and groundwater withdrawals in tributary streams (Clark County, 2010).

Conclusion

Only 2.4% of the Washougal River Watershed is within City limits, and the City is located in the lower watershed. About 2/3 of the watershed is located in Skamania County, with significant tracts dedicated to agriculture and forestry. Tributaries within City limits each drain less than one square mile and may not be perennial. In addition, much of the City's downtown drains to drywells, thereby avoiding surface outfalls to the river. City of Washougal has a low influence on hydrology and a low or moderate influence on water quality compared to other receiving waters in its jurisdiction. The Washougal River Watershed is important for fish recovery and is moderately degraded, as evidenced by a few water quality impairments. No significant ongoing or future retrofit or restoration efforts were located for the Washougal River Watershed.

The Washougal River Basin may be a candidate for Stormwater Management Action Planning because it makes up 50% of the City's land area. However, the large size of the watershed may limit the City's ability to significantly influence receiving water conditions through stormwater management actions alone.

4.3. Lacamas Creek

The Lacamas Creek Watershed is a largely rural basin in Clark County and WRIA 28. Lacamas Creek drains a total of 67 square miles, flowing in a southeasterly direction from south of the City of Battle Ground through central Clark County and the City of Camas before joining the Washougal River approximately 1.3 miles upstream of the mouth.

The main stem of Lacamas Creek flows for approximately 24 miles. Roughly 0.5% of the Lacamas Creek Watershed is located within the City of Washougal, and it occupies roughly 5% of the City's area. The creek's entire basin is referred to hereafter as the "Lacamas Creek Watershed." The portion of the creek's drainage basin located within the City limits is referred to hereafter as the "Lacamas Creek Basin."

Flow for the Lacamas Creek Watershed originates northwest of the City limits, in central Clark County. Lacamas Creek has several tributaries, the largest of which are Fifth Plain Creek, East Fork Lacamas Creek, and Matney Creek. It flows through the regionally significant Lacamas Lake as well as Round Lake before reaching City of Washougal.

This memorandum presents the highlights of the Receiving Water Assessment for Lacamas Creek. The majority of the assessment is presented in a web map as a series of data layers.

Setting and Flow Characteristics

The total area of the Lacamas Creek Watershed is approximately 42,784 acres (66.9 square miles). The area of the Lacamas Creek Watershed that is within the City limits is 203 acres (0.32 square miles), or

0.5% of the watershed. Approximately, 5,300 acres (8 square miles) is within City of Camas, 1,700 acres (2.7 square miles) is within City of Vancouver, and the remaining area is in unincorporated Clark County.

Lacamas Creek is the main stream in the watershed (126,720 ft/24.0 miles), with numerous significant tributaries. The primary tributaries are Fifth Plain Creek (36,200 ft/ 6.86 miles), which enters Lacamas Creek from the north 7 miles northwest of City limits near the intersection of SR-500 and NE 182nd Avenue, Shanghai Creek (28,740 ft/5.44 miles), which is a tributary to Fifth Plain Creek, Matney Creek (23,670 ft/4.48 miles), North Fork Lacamas Creek (13,835 ft/ 2.62 miles), and East Fork Lacamas Creek (16,620 ft/ 3.14 miles).

Clark County designates the following nine sub-watersheds within the Lacamas Creek Watershed:

- Lacamas Lake
- Dwyer Creek
- Lower Lacamas Creek
- Upper Lacamas Creek
- Matney Creek
- Lower Fifth Plain Creek
- Shanghai Creek
- China Ditch
- Upper Fifth Plain Creek

City of Washougal is located in the Lacamas Lake sub-watershed. Neither Lacamas Creek nor any of its major tributaries flow within City limits. Lacamas Creek flows through the regionally significant Lacamas Lake, Round Lake, and Lacamas Park before passing near the City of Washougal and flowing into the Washougal River in the City of Camas. The levels of both Lacamas Lake and Round Lake are controlled by two dams on Round Lake, which are owned by the City of Camas.

Flows in the Lacamas Creek Watershed are relatively stable and are not flashy (Clark County, 2011). No stream gages were identified along Lacamas Creek. Based on information from the USGS StreamStats application, the 100-year flow is estimated to be 7,330 cfs at the mouth of Lacamas Creek.

Lacamas Creek is not listed as a flow control exempt receiving water based on Appendix I-A of the *2019 Stormwater Management Manual for Western Washington*; however, Lacamas Lake is listed as a flow control exempt receiving water. All areas draining directly to Lacamas Lake are flow control exempt.

The watershed is large with several important roads and highways. SR-500 traverse the watershed in a southeast-northwest direction north and west of City of Washougal. Within or near City limits, public roads include SE Crown Road and SE 23rd Street.

Slopes are generally steep in the upper northeast watershed, with grades ranging from 15%-25% near Lacamas Creek and tributaries while the northwestern watershed near Hockinson is nearly flat, with grades ranging from 0%-5%. Slopes become less steep south of NE 53rd Avenue. The areas near the mouth of Lacamas Creek including Lacamas Park and Lacamas Creek Park are geologically hazardous areas with slopes greater than 25% and have historic and active landslides according to Clark County data. Slopes within the City limits include slopes that are greater than 25%. Elevations range from 2,200 ft. at the northern border of the watershed to 12 ft. at the mouth of Lacamas Creek. The highest elevation within the City is 620 ft just south of SE 23rd Street.

Soils in the watershed include hydrologic soil groups B and C. Soils in the majority of the watershed includes clay loam with hydrologic soil group C. There are some large areas in the western edges of the watershed (near Mill Plain), and areas north of Lacamas Lake that include gravelly loam with hydrological soil group B. Within City limits, there is near an even mixture of clay loams, with hydrologic soil group C, and gravelly loams with a hydrologic soil group B. All major soil groups noted here are considered moderately well drained.

Critical areas within the Lacamas Creek Watershed include, wetlands, geological hazard areas (steep slopes), and frequently flooded areas. Wetlands are located in close proximity to the Lacamas Lake, Lacamas Creek and tributaries to Lacamas Creek. Geological hazard areas with slopes greater than 15% are generally located in the northern portions of the watershed north of NE 53rd Avenue, and in areas near the mouth of Lacamas Creek, that include Lacamas Park and Lacamas Creek Park are areas with slopes greater than 25% and have historic and active landslides. Geological hazard areas also include portions in the City limits include slopes that are great than 15%.

According to the National Land Cover Dataset (NLCD) 2019, the Lacamas Creek watershed remains nearly 33% forested, while grass covers another 25%, developed surfaces cover about 20%, and remaining land cover is a mix of wetlands, shrub/scrub, and cultivated/open space areas.

Areas within unincorporated Clark County are largely pasture/hay, forests, shrub/scrub and grasslands. These areas have low imperviousness values. Medium intensity development is present in and near City of Vancouver at the western border of the watershed. Areas within the City of Camas mainly consist of low and medium intensity developments, pasture/hay, some forested and wetland areas. Within the Washougal City limits (Lacamas Creek Basin), grass cover is 63%, while developed surfaces are 25%, and remaining land cover is cultivated/open space areas, forests, and shrub/scrub (NLCD, 2019). A comparison of land cover with the watershed and within the City limits can be found in Figure 6 below.

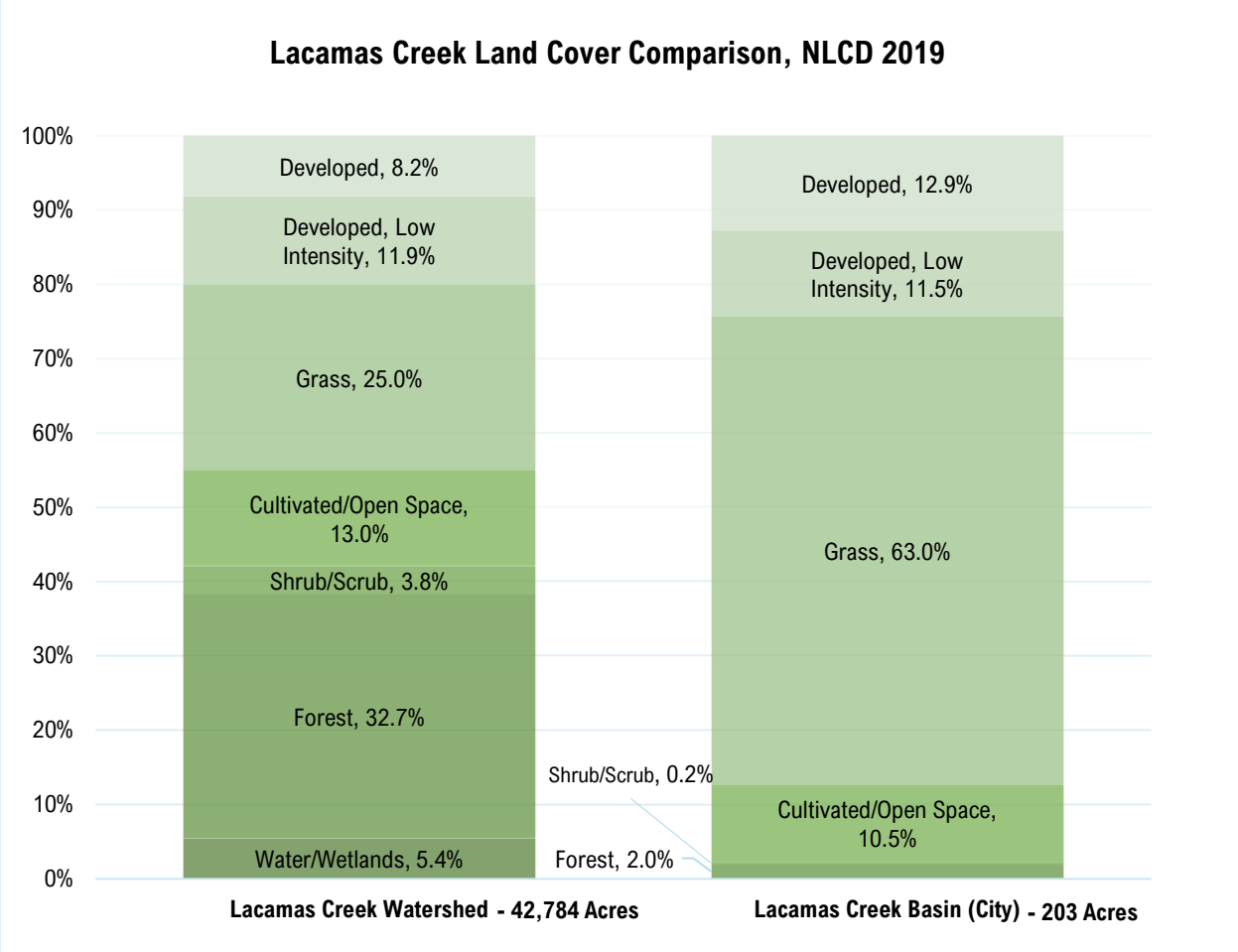

Figure 6 Land Cover Comparison, Lacamas Creek Watershed to Lacamas Creek Basin

Using a different data source (NAIP 2019) and processing technique, impervious surface in the Lacamas Creek Basin is estimated to be 54 acres, or 27% of the basin.

Within City limits, the stormwater infrastructure consists of conveyance pipes, detention ponds, and water quality facilities. The storm system outfalls to vegetated natural areas without defined channels. Table 10 presents stormwater infrastructure counts in the Lacamas River Basin.

Table 10 Lacamas River Basin City-Owned and Privately Owned Stormwater Infrastructure

Stormwater Infrastructure	Measure
Outfalls (ea.)	6
Drywells (ea.)	0
Pipe[1] (ft.)	10,433 (2.00 miles)
Ditches (ft.)	688 (0.13 miles)
Flow control facilities (ea.)	14, All installed after 2009 using the latest standards
Water quality facilities (ea.)	7, All were installed after 2009 using the latest standards

[1] includes all pipe diameters and excludes culverts

Water Quality and Aquatic Habitat

The State of Washington Department of Ecology (Ecology) has set water quality standards for surface waters. These criteria are used to assess the health of the surface water for recreation, drinking water, aquatic life, and other uses. The most stringent designated uses and associated water quality standards are outlined in Table 11 below.

Table 11 Lacamas Creek Designated Uses and Water Quality Standards

Designated Use	Parameter	Water Quality Standard (WAC 173-201A)
Aquatic Life		
Salmonid Spawning, Rearing, and Migration	Temperature	Highest 7-DADMax[1]: 17.5°C (63.5°F)
	DO	Lowest 1-Day Minimum: 8.0 mg/L
	pH	6.5 - 8.5 pH units, with a human-caused variation within the range of less than 0.5 units
	Turbidity	< 5 NTU over background[2] when the background is 50 NTU or less; or a 10% increase in the turbidity when the background turbidity is more than 50 NTU
Recreation		
Primary Contact	Bacteria	Fecal coliform organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within an averaging period exceeding 200 CFU or MPN per 100 mL
		E. coli organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL

[1] 7-DADMax is the arithmetic average of seven consecutive measures of daily maximum temperatures
[2] Background levels are not established for Lacamas Creek

Numerous reaches of Lacamas Creek do not meet water quality standards and are listed by Ecology in its 2016 water quality assessment (Ecology, 2016). Lacamas Lake, Round Lake, and tributaries to Lacamas Creek also have water quality listings. Category 5 listings for these waterbodies are presented in Table 12.** Ecology is currently developing a multi-parameter water quality improvement project for Lacamas Creek.

** While not included in this analysis, there are other water quality listings in the watershed available through the Washington Department of Ecology.

Table 12 Lacamas Creek Watershed Water Quality Listings

Waterbody (Location)	Category 5 Parameter
Lacamas Creek (Downstream of Matney Creek, at the crossing of SR-500)	Temperature Dissolved oxygen
Lacamas Creek (Upstream of Matney Creek)	Temperature Dissolved oxygen
Lacamas Creek (Immediately upstream of Lacamas Lake)	Temperature Dissolved oxygen Bacteria
Lacamas Creek (Downstream of Round Lake)	Temperature Dissolved oxygen pH
Lacamas Lake	Total phosphorus
Round Lake	Dissolved oxygen pH
Lacamas Creek Tributaries	
Dwyer Creek	Dissolved oxygen
Matney Creek	pH Dissolved oxygen Temperature Bacteria
Shanghai Creek	pH Dissolved oxygen Temperature
Fifth Plain Creek	Dissolved oxygen Temperature Bacteria Bioassessment
China Ditch	Dissolved oxygen Temperature
China Lateral	Dissolved oxygen Temperature

Using various measurements of macroinvertebrate health in Lacamas Creek Watershed, stream health appears to be fair. In 2017, Clark County assessed a B-IBI score of 36.1 (poor) at a sampling site slightly upstream of Lacamas Lake and a B-IBI score of 70.4 (good) at a sampling site slightly downstream of Camp Bonneville. Clark County also assessed several tributaries to Lacamas Creek. Matney Creek has a B-IBI score of 72 (good) based on data gathered at a sampling site slightly upstream of Lacamas Creek in 2019. Shanghai Creek has a B-IBI score of 78.8 (good) based on data gathered by Clark County in 2017. China Ditch Creek has a B-IBI score of 47.7 (fair) based on data gathered by Clark County in 2017. Finally, stream health of Fifth Plain Creek appears to be fair. There were two sampling locations, one site slightly upstream of Lacamas Creek and another site slightly upstream of Shanghai Creek which have B-IBI scores of 58.7 (fair) and 45.4 (fair), respectively.

The health of Lacamas Lake is affected by nutrients, and Clark County Public Health closes recreation sites on the lake each year due to toxic algae blooms.

According to the Statewide Integrated Fish Distribution (SWIFD) web map, fish species present in Lacamas Creek include fall Chinook salmon, coho salmon, rainbow trout, winter steelhead, coastal cutthroat trout, largemouth bass, and mountain whitefish (Northwest Indian Fisheries Commission, 2022). According to WDFW, there are 7 fish passage barriers on Lacamas Creek, both man-made and natural ranging from 0% passable to 99% passable. The barriers are not in the City of Washougal. There are 13 additional fish passage barriers on various tributaries and in Lacamas Lake that range from 0% passable to 99% passable (WDFW, 2022).

The Lacamas Creek Basin has few pollution-generating land uses and neither large-scale pollution-generating pervious surfaces nor highways with high traffic volumes.

Zoning in the City of Washougal is used as a proxy for land use. Within City limits, Lacamas Creek Basin is dominated by single family housing in the majority of the basin and schools/public facilities zoning in the southern portion of the basin. For the purposes of this assessment, the following zoning categories have been defined as “pollution-generating”: high-density residential, medium-density residential, commercial, industrial, and school/public facilities. Pollution-generating land uses make up 1% (2 acres) of the basin (Figure 7).

Some pollutant-generating land uses are managed under NPDES Industrial Stormwater General Permits issued by Department of Ecology. The permit holders are responsible for monitoring, measuring, and reducing stormwater pollution leaving their site. There are no active Industrial Stormwater General Permits in the Lacamas Creek Basin.

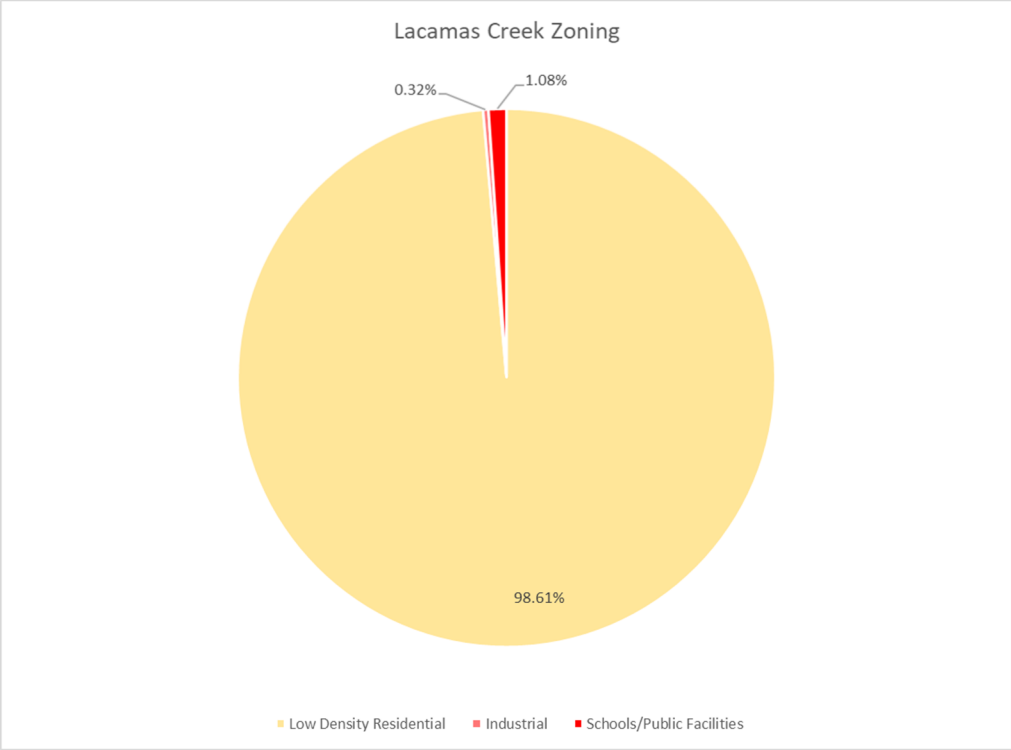

Figure 7 Lacamas Creek Basin Zoning

Future Development and Improvement Plans

Within the Lacamas Creek Basin, approximately 140 acres of the City's Northwest Urban Grown Area (UGA) has been annexed since 2017. The area is currently undergoing residential development of these former agricultural and rural lands, and the City expects available land to be developed within the next five to ten years. The City's critical areas ordinances may preserve small portions of this area as wetland (in the northeast corner downstream of Price Reservoir (in unincorporated Clark County)). The area also contains a severe erosion hazard area and potential unstable slopes as mapped by Clark County. Within the basin, approximately 90 acres of urban growth area (UGA) remain.

Significant development is expected to take place in the Lacamas Creek Watershed in City of Camas. The most notable development is a recent City of Camas annexation of largely undeveloped land on the north side of Lacamas Lake (City of Camas, 2022c). Currently, land use in this area consists of agriculture and single-family residences. The City of Camas subarea plan will be completed in 2022. The subarea plan will outline a plan for 140 acres of publicly held land along the shoreline, acquired by the City of Camas and Clark County's Legacy Land Program, and 670 acres of privately-owned land which is currently zoned largely for business parks and multifamily residential use.

Generally, Clark County is a fast growing county, and the unincorporated areas within Lacamas Creek Watershed are subject to development under Clark County's Comprehensive Plan. In upper Lacamas Creek Watershed Clark County accepted ownership of a private military post called Camp Bonneville in 2011. A master plan is anticipated in 2022 which will identify land uses. "Currently the county is implementing a forest management plan that uses selective thinning to create a healthy forest ecosystem that supports a diversity of plants and animals" (Clark County Public Works, 2021). The County and project partners intend to explore opportunities to preserve high-value riparian and upland areas along the extensive network of small streams in the project area.

In Clark County's Natural Areas Acquisition Plan, a 115-acre acquisition is planned in 2022 (Clark County Public Works, 2021). The acquisition will include the high point of Green Mountain and the area connecting Green Mountain to the Lacamas Prairie Natural Area. Another acquisition is planned for 2025 which will add 50 acres to the Lacamas Prairie Natural Area for wet meadow restoration.

The City of Camas is developing a Lacamas Lake Management Plan which will include Lacamas Lake, Round Lake, and Fallen Leaf Lake which is expected to be completed in 2023. The plan will identify goals and identify how to improve water quality and protect desired conditions of the lakes. The City of Camas will work towards objectives by "characterizing the lakes' water quality, identifying and quantifying the nutrient sources that are affecting the lakes, and evaluating potential management measures" (City of Camas, 2022b).

Stormwater Retrofits and Restoration Projects in the Basin

- The City of Camas is supporting a dam improvement project which will provide mechanical upgrade improvements to two Lacamas Lake dams. The project will also remove unnecessary equipment and conduct a hydraulic analysis (City of Camas, 2022a).

Environmental Justice

To show the relative environmental health disparity of the Lacamas Creek Basin, an area-weighted average of the combined index scores of 19 factors from 2 census tracts was calculated. Overall, the environmental health disparities indices in the basin are between 3 and 4, which is low to moderate. The

area-weighted average of the combined index scores is 3.2. This indicates that the community in the Lacamas Creek basin ranks low according to the risk from environmental factors that influence health outcomes.

Relative Conditions Assessment

The relative conditions assessment includes an assessment of stormwater management influence (SMI) as well as an assessment of historic conditions and current degradation to inform the selection of a basin management strategy.

Stormwater Management Influence

The influence of the City's land uses and stormwater system (Stormwater Management Influence (SMI)) on Lacamas Creek is estimated qualitatively using the following factors and findings. The analysis relies on selected elements that have been described above in the Receiving Water Assessment. The assessment includes influence on both hydrology and water quality and is relative to other basins in the City (Table 13). Factors are listed in descending order of those that most describe the City's influence on receiving water conditions. The percentage of the watershed within the City limits is included in both the hydrology and water quality assessments.

Table 13 SMI Assessment for Lacamas Creek

SMI Parameter	Assessment Theory	Lacamas Creek Basin Characteristics	Assessment
Hydrology			
Flow Control Exempt	A flow control exempt waterbody has a high volume of flow; therefore, the City can have little influence on its hydrology. Flow control exempt receiving waters receive a low score and non-flow control exempt receiving waters receive a higher score.	Lacamas Creek is not flow control exempt; however, Lacamas Lake is flow control exempt upstream of the City.	High
Percent of Watershed in City Limits	This factor is a relative assessment between watersheds that indicates the amount of the basin that falls within the City limits. A higher percentage within the City results in a higher score.	0.5% of the watershed is in the City	Low
Location of City within Watershed	The location of the City in the watershed dictates the influence the City can have on hydrology. A City at the headwaters has high influence and receives a high score while a City near the mouth has a low influence and receives a low score.	The City is located at the lower reaches of the Lacamas Creek Watershed and no waterbodies are located in the City.	Low
Impervious Surfaces	This factor is a relative assessment between watersheds, where the basin with the higher percentage of imperviousness within City limits will receive the higher score.	54 of 203 acres, or 27%	Low
Density of Flow Control Facilities and Drywells Per Acre of Developed Surfaces	This factor is a relative assessment that indicates what level of the developed surfaces in the basin within City limits is being managed by flow control facilities. A low density of flow control facilities will receive a high score and a high density of flow control facilities will receive a low score relative to other basins.	14 flow control facilities plus 0 drywells (14) and 26 acres developed surfaces, or 0.538 facilities/acre	Low

SMI Parameter	Assessment Theory	Lacamas Creek Basin Characteristics	Assessment
Influence on Hydrology			**Low**
Water Quality			
Percent of Watershed in City Limits	This factor is a relative assessment between watersheds that indicates the amount of the basin that falls within the City limits. A higher percentage within the City results in a higher score.	0.5% of the watershed is in the City	Low
Pollution-Generating Land Use	This factor is a relative assessment between watersheds of pollution-generating land use in the basin within City limits. A high percent of pollution-generating land use in the basin will receive a high score and a low percentage of pollution-generating land use in the basin will receive a low score.	2 of 203 acres, or 1%	Low
Roadways with High Traffic Volumes	This factor is a relative assessment of high traffic volumes in the basin within City limits. A high score is assigned to a basin with a higher length of roadways with a high AADT of 7,500 or greater and a low score is assigned to a basin with a low number of roadways with a high AADT of 7,500 or greater relative to other basins. Only segments that do not overlap pollution-generating land uses are counted.	N/A	Low
Large Pollution-Generating Pervious Surfaces	This factor is a relative assessment of large pollution-generating pervious surfaces. A high score is assigned to a basin with a large area of large pollution-generating pervious surfaces and a low score is assigned to a basin with a small area of large pollution-generating pervious surfaces relative to other basins. Only those that do not overlap pollution-generating land uses are counted.	N/A	Low
Density of Water Quality Facilities Per Acre of Pollution-Generating Land Use and Large Pervious Surfaces	This factor is a relative assessment that indicates what level of the pollution-generating land use and large pervious surfaces in the basin within City limits is being managed by water quality facilities. A high score is assigned to a basin with a low density of water quality facilities per area of pollution-generating land uses, and a low score is assigned to a basin with a higher density of water quality facilities per area of pollution-generating land uses relative to other basins.	7 water quality facilities and 203 acres of pollution-generating land use, or 0.034 facilities/acre	High
Influence on Water Quality			**Low**

Basin Management Strategy

The basin management strategy has been selected using several factors described in Table 14.

Table 14 Factors Used to Select a Basin Management Strategy for Lacamas Creek Basin

Lacamas Creek		
Importance	Historic Fish Use	Medium
	Explanation	The Washougal River is one of twelve major NPCC subbasins in the Washington portion of the Lower Columbia Region. The subbasin historically supported thousands of fall Chinook, chum, coho, and summer and winter steelhead. (LCFRB, Vol. II - Ch. N, North Washougal Subbasins, p. 4) Focal salmonid species in Washougal River watersheds include fall Chinook, summer and winter steelhead, chum and coho. (LCFRB, Vol. II - Ch. N, North Washougal Subbasins, p. 13) For this analysis, it is assumed anadromous fish species historically present were only able to access the lower reaches of Lacamas Creek due to natural barrier called Lower Falls which WDFW states currently ends anadromous access to upper portions of Lacamas Creek (WDFW, 2022)
	Need For Recovery	Medium
	Explanation	Today, numbers of naturally spawning salmon and steelhead have plummeted to levels far below historical numbers. Chinook, coho, chum, and steelhead have been listed as threatened under the Endangered Species Act. (LCFRB, Vol. II - Ch. N, North Washougal Subbasins, p. 4) Recovery goals call for restoring fall Chinook, and chum populations to a high or better viability level. This level will provide for a 95% or better probability of population survival over 100 years. Coho and steelhead will be restored to a moderate or better level of viability or a 75 to 95% probability of persistence over 100 years. (LCFRB, Vol. II - Ch. N, North Washougal Subbasins, p. 77) A spawning ground survey in 2000 found one chum salmon in Lacamas Creek (LCFRB, Vol. II - Ch. N, North Washougal Subbasins, p. 18). Although LCFRB describes the need for recovery to a high level of viability, it is assumed that only the lower reaches of Lacamas Creek will be available for anadromous fish use. Therefore, a “medium” value has been selected for Need for Recovery.
Degradation	Urbanization	Low
	Explanation	Developed surfaces make up 12.9% of the land cover in the Lacamas Creek Basin.
	Fish Passage Barriers	Low
	Explanation	There are no 0-33% passable barriers in the City or downstream of the City.
	Water Quality Impairments	Medium
	Explanation	There are no Category 4A water quality impairments and 3 Category 5 water quality impairments in the receiving water and tributaries within City limits or downstream of Washougal.

Given the moderate importance and moderate degradation of the Lacamas Creek Basin, the selected basin management strategy is conservation.

The conservation management goal requires some investment in maintaining the integrity of existing natural resources in a watershed. The Puget Sound Partnership includes the following list of solutions associated with each of the four management strategies:

- Typical BMPs, habitat improvements, and policies that apply to **all management strategies** include maintaining stream/wetland physical integrity, restoring floodplains and wetlands, restoring riparian zones, and protecting aquifer recharge areas.
- Typical BMPs that apply to the **conservation and the development management strategies** include all of the above plus emphasizing dispersion and on-site infiltration.
- Typical BMPs and policies that apply to the **protection management category** include all of the above plus increasing buffer widths, reducing groundwater withdrawals, reducing interception of shallow groundwater in ditches, and revegetating uplands.
- Typical BMPs that apply to the **restoration management category** include all of the above plus retrofitting structures and roads for greater infiltration, and reconstructing stream reaches or artificial wetlands. (Puget Sound Partnership, 2016).

Clark County assessed the Lacamas Watershed in its 2010 Clark County Stream Health Report and recommended the following actions for improving the health of receiving waters in the Lacamas Creek Watershed: stream health strategies include protecting remaining forested areas in upper watershed and Camp Bonneville; restoring stream channels and riparian forests; increasing infiltration and retention of stormwater runoff from older developments; implementing development regulations to minimize impacts, particularly enhanced nutrient control regulations to protect Lacamas Lake; and conserving agricultural lands and promoting healthy practices (Clark County, 2010).

Conclusion

Only 0.5% of the Lacamas Creek Watershed is within City limits, and the City is located in the lower watershed. The watershed also includes the cities of Vancouver and Camas, although the majority is located in unincorporated Clark County (87.6%). Neither Lacamas Creek nor any major tributaries to it are within Washougal City limits. City of Washougal has a low influence on hydrology and a low influence on water quality of Lacamas Creek compared to other receiving waters in its jurisdiction. The Lacamas Creek Basin is moderately important for fish recovery and is moderately degraded. No significant ongoing or future retrofit or restoration efforts are planned within the Lacamas Creek Basin, although the City of Washougal abuts Lacamas Park, which is a part of a matrix of parks and open spaces near Lacamas Lake preserved by a combination of Clark County and City of Camas.

Therefore, the Lacamas Creek Basin is not a likely candidate for Stormwater Management Action Planning.

5. Receiving Water Conditions Conclusion

Gibbons Creek Basin and Washougal River Basin higher relative SMI scores than Lacamas Creek Basin. In addition, Ecology's SMAP Guidance encourages cities to prioritize basins with a restoration or protection basin management strategy (Ecology, 2019). Gibbons Creek Basin and Washougal River Basin have been given restoration and protection management strategies, respectively. As a result,

Gibbons Creek Basin and Washougal River Basin have been selected to move into the receiving water prioritization step of SMAP. Table 15 summarizes the findings of the relative conditions assessment.

Table 15 Relative Conditions Assessment Summary

Basin Name	Receiving Waters within Basin	Watershed Area (Acres) [SqMi]	Area inside City (Acres)	Fraction of Watershed within City	Percent of the City that is Occupied by the Basin	SMI Score	Basin Management Strategy
Gibbons	Gibbons Creek; Campen Creek; Steigerwald Lake	7,100 [11]	1,721	24.2%	45%	High	Restoration
Washougal	Washougal River	78,880 [123]	1,918	2.4%	50%	Medium	Protection
Lacamas	Lacamas Creek;	42,784 [67]	203	0.5%	5%	Low	Conservation

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Abbreviation	Definition
7-DADMax	The arithmetic average of seven consecutive measures of daily maximum temperatures
AADT	Annual average daily traffic
ADT	Average daily traffic
B-IBI	Benthic index of biotic integrity, a measure of stream health using an assessment of the health of aquatic macroinvertebrate communities
C, °C	Celsius, degrees Celsius, a unit measuring temperature
CARA	Critical aquifer recharge areas
cfs	Cubic feet per second
CFU	Colony forming unit
CIP	Capital improvement projects
DO	Dissolved oxygen
Ecology	Washington Department of Ecology
EJ	Environmental Justice
EPA	Environmental Protection Agency
F, °F	Fahrenheit, degrees Fahrenheit, a unit measuring temperature
FEMA	Federal Emergency Management Agency (FEMA)
GIS	Geographic information system
LCFRB	Lower Columbia Fish Recovery Board
mg/L	Milligrams per liter
mL	Milliliter
MMI	Multimeric index, a measure of stream health using an assessment of the health of aquatic macroinvertebrate communities
MPN	Most probable number
NAIP	National Agriculture Imagery Program
NLCD	National Land Cover Dataset
NPCC	Northwest Power and Conservation Council
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
MS4	Municipal separate storm sewer system
NWIFC	Northwest Indian Fisheries Commission

Abbreviation	Definition
NTU	Nephelometric turbidity units
pH	Power of hydrogen (a unit measuring acidity)
SMAP	Stormwater management action plan, also Stormwater management action planning
SMI	Stormwater management influence
SR	State route
SWIFD	Statewide Integrated Fish Distribution
TMDL	Total maximum daily load
TSS	Total suspended solids
UGA	Urban growth area
USGS	US Geological Survey
WAC	Washington administrative code
WDFW	Washington Department of Fish and Wildlife
WEHDM	Washington Environmental Health Disparities
WRIA	Water resource inventory area
WQI	Water quality improvement

Attachment A

Web Map

March 2022 - The web map associated with this memorandum is located at this link:
https://otak.maps.arcgis.com/apps/webappviewer/index.html?id=403927d883fb4f9db658c541e14c316a