Olympia Enhanced Street Sweeping Plan

In urban environments, stormwater runoff from impervious (hard) surfaces is the main source of surface water contamination and a major pollutant source responsible for receiving water degradation (U.S. EPA, 2017). Olympia has over 4,000 acres of impervious surface that can generate over 4 billion gallons of stormwater runoff in a normal year. Pollutants attached to roadway sediments have been identified in multiple studies as contributing to water quality issues in stormwater and receiving waters. Removing sediment and organic materials from roadways results in roadway runoff pollutant load reductions that lessen contamination impacts in downstream water bodies (Dorfmeier et al, 2016).

Stormwater pollutant loading is closely associated with streets in high traffic count areas and a lack of stormwater treatment before runoff enters a city's stormwater conveyance system (MS4). The typical curb and gutter design promotes pollutant concentration in sediment along curbs causing high contaminant transport rates (Sutherland et al, 2014). A street sweeping program focusing on water quality improvement targeting high use roadways, curbed streets and road sections without existing treatment will remove pollutants before stormwater flows into nearby water bodies.

The purpose of this plan is to articulate the benefits of an enhanced street sweeping program for the City of Olympia and to establish a framework for the Storm and Surface Water Utility (Utility) to implement a water quality-focused street sweeping program. This plan also guides program policies, operations, equipment, sweeper schedules and routes, and sweep waste management.

Enhanced Street Sweeping Plan objectives include:

- Improve water quality in stormwater runoff originating from city streets.
- Reduce pollutants released to surface waters.
- Establish an effective water quality street sweeping program.

Background

Enhanced Street Sweeping

Street sweeping is one of the most undervalued public services in communities. Olympia has been sweeping streets as a road maintenance activity for more than sixty years. Original street sweeping values centered on aesthetics, public safety, flood prevention, and extending the life of streets. However, recent studies have highlighted the benefits of street sweeping as a water quality best management practice (BMP) known as *enhanced street sweeping*.

Enhanced street sweeping with a regenerative air sweeper has well documented, cost-effective pollutant removal results. A literature review revealed the following benefits of implementing an enhanced street sweeping program as a water quality BMP:

- Significant reduction in pollutant loading to surface water. Total suspended solids (TSS) removed at 15% to 50% of regional stormwater treatment costs (SPU 2009, Tacoma, 2016).
- Protects fish and wildlife by reducing the amount of harmful pollutants entering waterways.
- Regenerative air sweeping once every two weeks has the potential to provide treatment at a level similar to structural stormwater BMPs (SPU 2012).

- Cost is less than retrofitting all the current untreated areas with water quality treatment facilities (SPU 2009, Tacoma, 2016).
- An enhanced street sweeping program can address pollutant surface water loading citywide almost immediately, whereas installing stormwater treatment facilities to cover an entire city would take several years and may not be totally attainable.
- The cost of regular maintenance practices per nutrient and particulate matter loads is significantly lower than current structural BMPs, assuming such BMPs are maintained (Sansalone, J.J. et al, 2011).
- Dollars saved from lower maintenance costs on stormwater treatment facilities can be applied to other stormwater quality programs such as: storm pipe cleaning, culvert inspections and maintenance (currently not programs in Olympia).
- Fairly easy for local governments with sweeping programs already in place to implement.

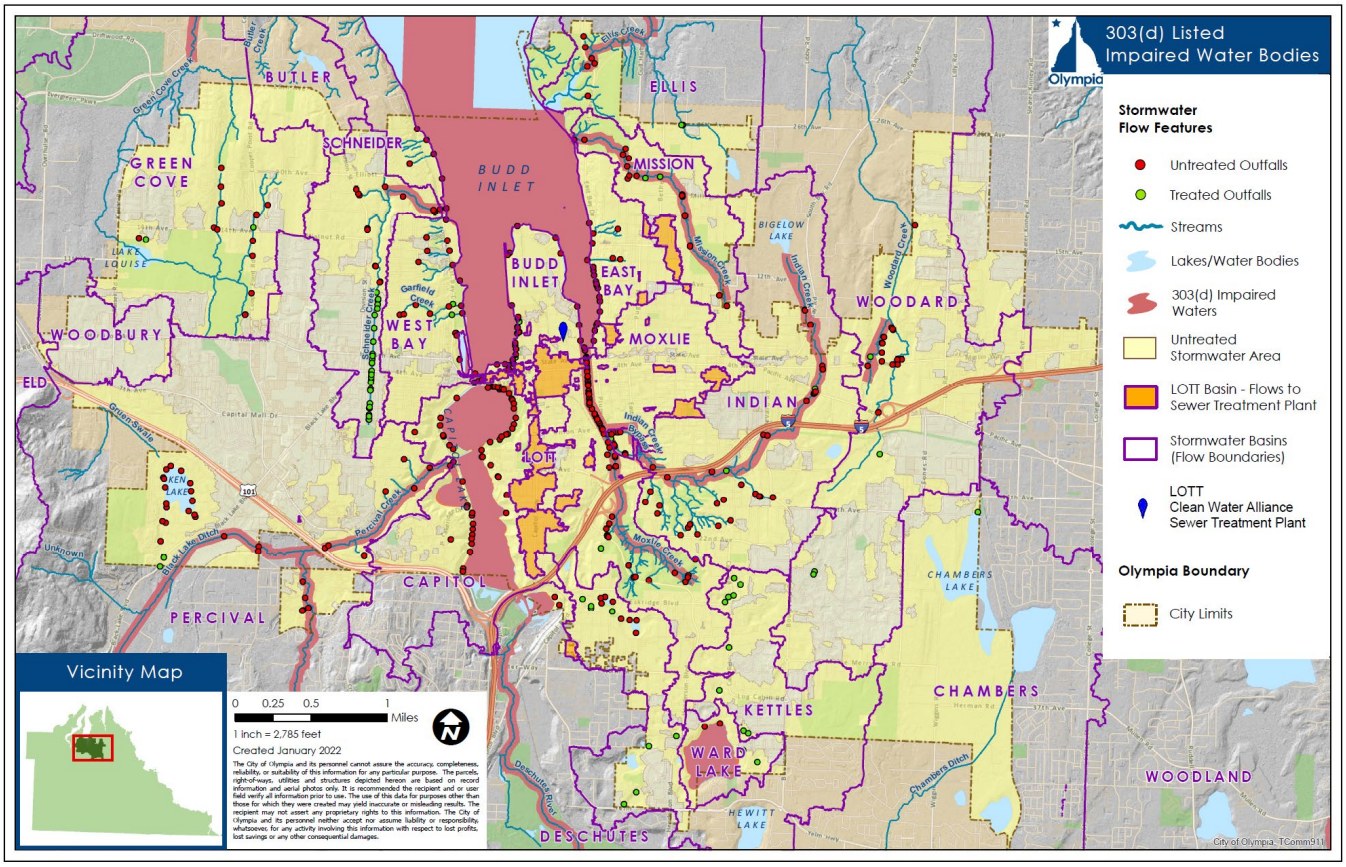
Recognizing the water quality benefits' connection to the Utility's water quality improvement mission led the Utility to pursue changing the current street sweeping program to an enhanced street sweeping program. The goal of the Enhanced Street Sweeping Program is to collect sediment and associated pollutants before reaching the MS4 and receiving water bodies.

Water Quality

Historically, Olympia's stormwater systems were often inadequately constructed to manage high flows and little thought was given to the water quality and aquatic habitat impacts of stormwater. Community expectations and regulations for managing stormwater have increased over the years, resulting in a more holistic look at stormwater management. The Utility's pollution prevention efforts are directed by the requirements of the following regulations imposed under the federal Clean Water Act:

1. The 303(d) listing of local water bodies that have not met State surface water quality standards prompt Total Maximum Daily Load (TMDL) studies to identify actions necessary for improving impaired water quality. TMDLs have been established for the Henderson Inlet and Deschutes River watersheds, and are being developed for Budd Inlet and Capitol Lake. Addressing sediment loading is part of Olympia's TMDL requirements (Olympia, 2018).
2. The City's Municipal Stormwater Permit as part of the National Pollutant Discharge Elimination System (NPDES) requires the City to develop and implement a stormwater management program. Olympia's Storm and Surface Water Plan (SSWP) includes water quality improvement goals and strategies to address this requirement. Street sweeping focused on improving water quality in stormwater is one of the strategies for pollution prevention.

City basin boundaries are defined by their drainage area and named after their initial stormwater flow water body or infiltration destination. Olympia has several untreated storm systems that flow directly into Budd Inlet, Black Lake Ditch, Capitol Lake, and Olympia's many creeks, contributing to their 303(d) Category 5 impaired status (See Map 1). Basin receiving waters are listed in Table 1.



Map 1. Basins in relation to impaired water bodies and untreated stormwater areas.

Untreated basin drainage areas are prevalent near all receiving water bodies except the headwaters of Schneider Creek. Current areas not included in the untreated areas have stormwater treatment, detention, or flow directly to the LOTT Clean Water Alliance sewer treatment plant. Outfalls that have at least one untreated stormwater runoff source before entering a surface water body are considered untreated outfalls. Olympia has 346 untreated outfalls.

Table 1. Olympia Basin Area Water Quality Information

BASIN*	Receiving Waters	Total Acres	Acres in City	% Basin Acres in City	Untreated Acres in City	% Untreated Acres in City	Untreated Outfalls in City
Budd Inlet	Budd Inlet	226.4	226.4	100.0%	196.2	86.7%	28
Butler	Budd Inlet	492.8	104.4	21.2%	104.4	100.0%	0
Capitol	Deschutes	921.2	646.1	70.1%	608.1	94.1%	56
Chambers	Deschutes	6,856.0	814.1	11.9%	766.1	94.1%	0
Deschutes	Deschutes	8,938.4	45.2	0.5%	43.8	96.8%	2
East Bay	Budd Inlet	2,626.9	319.8	12.2%	309.4	96.7%	16
Eld	Eld Inlet	3,405.5	6.1	0.2%	6.1	99.8%	0
Ellis	Budd Inlet	1,296.1	264.3	20.4%	258.7	97.9%	6
Green Cove	Eld Inlet	2,542.2	1,031.3	40.6%	831.8	80.7%	13
Indian	Budd Inlet	1,421.2	1,089.1	76.6%	896.0	82.3%	46
Kettles	Infiltration	1,355.4	868.4	64.1%	683.3	78.7%	0
LOTT**	Budd Inlet	267.1	264.6	99.1%	0.0	0.0%	0
Mission	Budd Inlet	408.2	383.6	94.0%	367.0	95.7%	17

Moxlie	Budd Inlet	1,006.1	1,006.1	100.0%	966.0	96.0%	70
Percival	Deschutes	10,289.8	1,758.4	17.1%	788.7	44.9%	34
Schneider	Budd Inlet	588.5	582.0	98.9%	292.5	50.3%	15
Ward Lake	Infiltration	182.4	145.2	79.6%	118.1	81.4%	2
West Bay	Budd Inlet	1,540.3	484.8	31.5%	424.9	87.6%	23
Woodard	Henderson	4,856.2	1,496.3	30.8%	828.3	55.4%	18
Woodbury	Infiltration	317.7	245.6	77.3%	16.0	6.5%	0
Woodland	Henderson	19,465.6	347.2	1.8%	187.2	53.9%	0
	Totals	69,004.2	12,129.2	17.6%	8,692.7	71.7%	346

*Basin areas include lakes and streams.
**All stormwater entering the LOTT basin flows to the LOTT Clean Water Alliance sewage treatment plant and is released into Budd Inlet after treatment.

Most impaired water bodies in Olympia are listed for bacteria, temperature, and a few for dissolved oxygen (See Appendix A). Thurston County actively monitors fecal coliform, pH, Dissolved Oxygen, temperature, turbidity, nitrate + nitrite and total phosphorus on City streams: Black Lake Ditch, Percival Creek, and Indian Creek. Chambers Creek and Woodard Creek samples are taken outside Olympia's city limits but are considered relevant due to the sample location within or near Olympia's urban growth area.

County data focuses on the parameters of Water Quality Index scoring. However, the 303(d) list does not capture all water quality concerns. No data is collected related to pollutants attached to roadway sediments. Monitoring these pollutants at a local level is economically infeasible. For "non-monitored" pollutants, Utility staff highly consider findings of studies performed by the Department of Ecology that include detailed monitoring in model watersheds (see Norton, 2011).

Street waste samples from studies performed in Washington State, document pollutants including total petroleum hydrocarbons (TPH), carcinogenic polycyclic aromatic hydrocarbons (c-PAHs), and several metals. These pollutants are listed in Table IV-B.1 – B.4 in the 2019 Stormwater Management Manual for Western Washington under *Contaminants in Street Waste Solids* (found here). Pollutant concentrations can be high enough to harm human health and the environment (Volume IV, 2019 SWMMWW). All of these contaminants are assumed to be present on Olympia's roadways and are considered a concern for the City.

Emerging science has shown evidence that the pollutant 6PPD-quinine, a globally ubiquitous tire rubber antioxidant, has a connection to coho pre-spawn mortality. Tests indicate toxic concentrations of 6PPD from dissipated tire rubber residues are widespread throughout stormwater-impacted creeks of the U.S. West Coast (Tian, 2021). This is a new area of concern for Olympia due to the several streams that flow through the City and into Budd Inlet.

Current Street Sweeping Program

Before 2021

Olympia's street sweeping program funding was split between the Transportation line of business and the Utility. Under Transportation's operational direction, the street sweeping program generally focused on aesthetics and debris removal targeting safety and flood prevention. Recently, the Utility recognized street sweeping as a cost-effective practice for removing sediment before it enters a stormwater collection system. Over the last five years, the Utility has taken an increasing role in redirecting the program's focus to benefit water quality.

Olympia's switch to a water quality focused street sweeping program has been on the Puget Sound Partnership's "Near Term Action" (NTA) list since 2016, under the Stormwater Initiative to recover Puget Sound. The original plan was to focus on water quality using the existing street sweeper. Redirecting focus has increased sweeping hours, created more efficient routes and schedules, identified streets that require more frequent sweeping, and provided operator training using existing funding levels.

January 1, 2021, to Present

Beginning in January 2021, the Utility now funds and directs Olympia's street sweeping program. The goal for the current water quality focused program is to remove pollutants in the path of stormwater runoff before it reaches the MS4 and flows into surface water bodies. Implementing water quality into the program was fairly easy since Olympia already owns a Tymco 600 high-efficiency regenerative air street sweeper. High-efficiency street sweepers are recommended for their water quality benefit (Sutherland et al. 2014).

The Utility has one street sweeper and one full-time sweeper operator to cover 526 street lane miles and 82 bike lane miles. Original sweep zones were set by the number of miles and by priority locations (e.g., bridges, known flooding areas, medians). Typically, downtown streets are swept twice a week, arterial streets and streets with bike lanes every other week, and residential streets at least once a year. Even though the sweeper is occasionally diverted for emergency responses and residential requests, this pattern optimizes the sweeper's ability to cover the entire city.

The current sweeper program includes seasonal and emergency sweeping processes. The operator, or a qualified substitute operator, works overtime to sweep after community events and other special needs (e.g., parades, street fairs, after work emergencies). Emergency sweeping during regular operating hours does not require overtime. During the fall, streets known for heavy leaf drop are targeted for a period of six weeks. A substitute operator takes over the sweeper in the afternoons to accommodate the extra sweep time needed for leaf pick up. After the winter snow melts, the City rents a broom sweeper to concentrate on sweeping streets along the sanding route. The rental is operated by a substitute operator.

Community sweeper requests are received through the Public Works 24/7 phone number, Public Works email, or the City's service request portal found online or as a mobile application. The locations of all service requests are added to the GIS database once a year to analyze possible trends.

Zonar Ground Traffic Control is used to track the street sweeper using GPS. The data collected through Zonar includes start, stop, sweep broom up, sweep broom down, sweeper path and speed. Downloadable data are pulled from the Zonar website to capture sweep date, time, speed, and distance. Zonar GIS sweep data points are pulled from the Zonar website and placed in the City's GIS database to map the sweepers daily path for viewing on the sweeper map.

The sweeper map is a tool used to show swept streets (gray) versus upswept streets (yellow gold). Layers showing swept streets can be set at different date intervals (e.g., yesterday, past 6 weeks, past 3 months) helping the operator see missed streets and where a substitute operator swept to prevent inefficient duplicate sweeping. Selecting any street segment on the map identifies the dates it was swept (see Figure 1). Grey streets have been swept within the time frame selected and all sweep dates are identified.

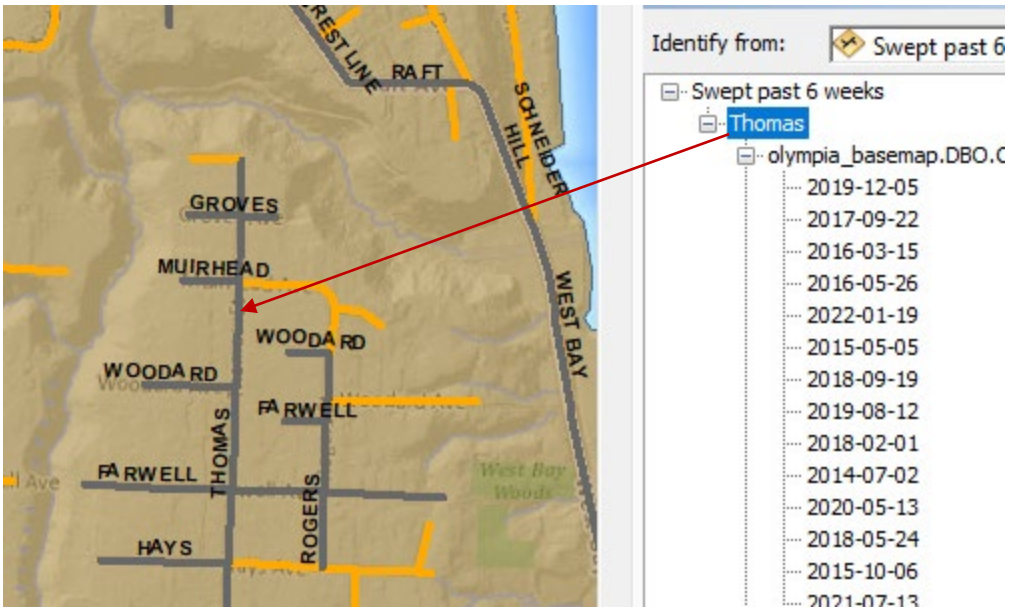


Figure 1. Selected street segment with identified sweep dates.

Recent operator training involved onsite instruction to demonste operator efficiency aimed at water quality, from a Tymco company representative and a Tymco dealer representative. Training included equipment cleaning, maintenance, and safety. Additional training, offered on location in Texas by the manufacturer, is planned as part of the enhanced street sweeping program.

Street waste is stored undercover at the City's maintenance facility, in an area that allows the solids to settle and the liquids to drain into the sanitary sewer. The wet sweep material is periodically turned, to aid in drying it out. When dry, the solids are hauled to an approved waste facility. The waste is weighed at the facility and released for proper handling and disposal. The City tests sweep waste for pollutants once each year to obtain a special waste permit required by the waste facility. The current decant bay is sufficient for the additional enhanced program's street waste since the bay currently needs waste removed only twice each year and has the ability for five to six total waste removals per year.

Current program effectiveness is measured by comparing total miles swept, tons of sediment removed, and tons of sediment per mile removed each year (see Table 2). Routes are adjusted as needed for efficiency improvement using traffic counts, catch basin sediment trends, and operator input (e.g., time of day, right hand turns, weather issues, seasonal issues).

Table 2. Street Sweeping Program Measures

Sweeping Program Measure	2016	2017	2018	2019	2020
Tons Sweep Waste	670	673	684	585	384
Tons/Mile	0.16	0.17	0.14	0.18	0.09
Total Miles	4,064	4,071	4,925	3,210	4,126

From 2016 to 2018, total miles swept per year increased by 861 miles and tons of sediment collected per year increased by 14 tons. In 2019, snow kept the sweeper parked for several weeks as well as sweeper breakdowns throughout the year keeping it out of commission for many more weeks. Progress implementing a water quality sweeper program has been slow due to maintenance issues and the competition for sweeper attention (e.g., sweep emergencies, spills, bike lanes, litter, leaves, winter sand cleanup, resident requests). Both maintenance costs and operator downtime have increased by

approximately 13%. The additional wear and tear on the street sweeper shortened its lifecycle. The current street sweeper was replaced in October 2021.

The figures for 2020 reflect results affected by a response to COVID-19. The Utility continued working as normal as possible in a remote capacity. Operations continue to make adjustments as reports on virus protocol change. Mechanical issues plagued sweeper operation through 2020 and continued until the new Tymco 600 high-efficiency regenerative air sweeper was operational in mid-October 2021.

An additional street sweeper is essential for Olympia to move forward with an effective enhanced street sweeping program. Two sweepers, each with a full-time operator, will make it possible to have one sweeper designated solely to the water quality effort and one sweeper designated with a water quality approach to other priorities such as: sweep emergencies, spills, bike lanes, litter, leaves, winter sand cleanup and resident requests as needed.

Second Sweeper Acquisition Analysis

Effectiveness results from the current street sweeping program are promising but limited. Transforming the program to a full-fledged enhanced street sweeping program requires an additional street sweeper and an additional operator dedicated to a water quality focus. The distractions from the original program (e.g., sweep emergencies, spills, bike lanes, litter, leaves, winter sand cleanup, resident requests) with its single street sweeper make achieving water quality goals unattainable. The enhanced street sweeper program will utilize two street sweepers, one to maintain current sweeping levels and one to concentrate on enhanced street sweeping.

The following cost analysis tables compare options for securing a new sweeper (purchase, lease, rent, and contract) and running the program. Costs include program implementation, yearly cost, and total cost for the eight-year program.

Table 3. Sweeper Purchase Estimates *** New Sweeper

Description	Purchase Implementation Cost	Yearly Cost*	Total Cost For 8 Yr Program
Operator Salary + Benefits**	$121,783	$121,783	$1,009,000
Rental for Downtime	$0	$5,000	$40,000
Disposal Fees	$0	$40,000	$320,000
Fleet Repair & Maintenance	$0	$45,000	$360,000
Fuel Consumed	$0	$16,000	$128,000
Training/2 Operators	$5,000	$0	$5,000
Sweeper Replacement Cost	$0	$37,500	$300,000
New Sweeper Cost	$300,000	$0	$300,000
Total	**$426,783**	**$265,283**	**$2,462,000**

*Assume no cost increases other than salary

**Salary increases 1%/yr

***Costs are from current sweeper program

Table 4. Sweeper Lease Estimates – New Sweeper

Description	Lease Implementation Cost	Yearly Cost*	Total Cost For 8 Yr Program
Operator Salary + Benefits**	$121,783	$121,783	$1,009,000
Lease ***	$69,964	$69,964	$559,712
Disposal Fees	$0	$40,000	$320,000
Fleet Repair & Maintenance	$0	$45,000	$360,000
Fuel Consumed	$0	$16,000	$128,000
Training/2 Operators	$5,000	$0	$5,000
Sweeper Replacement Cost	$0	$70,000	$560,000
Total	**$196,747**	**$362,747**	**$2,941,712**

*Assume no cost increases other than salary

**Salary increases 1%/yr

Table 5. Sweeper Rental Estimates – Sweepers are 5+ years old

Description	Rental Implementation Cost	Yearly Cost*	Total Cost For 8 Yr Program
Operator Salary + Benefits**	$121,783	$121,783	$1,009,000
Rental = $10,700/4 wks***	$133,750	$133,750	$1,070,000
Disposal Fees	$0	$40,000	$320,000
Fleet Repair & Maintenance	$0	$0	$0
Fuel Consumed	$0	$16,000	$128,000
Training/2 Operators	$5,000	$0	$5,000
Sweeper Replacement Cost	$0	$133,750	$1,070,000
Total	**$260,533**	**$445,283**	**$3,602,000**

*Assume no cost increases other than salary

**Salary increases 1%/yr

***Average monthly fee from two quotes.

- One yr paid upfront = 50 wks/yr (excludes 10 holidays)

All repairs and maintenance must be performed at the rental company's facility

- *Towing = $165/hr - 4 hrs to transport Sweeper to Kent*
  - *-- includes tow truck drive time = $660*
- *4 hrs, 2 Crew members to drive sweeper to shop in Kent = $500*

Table 6. Sweeper Contract/Agreement Estimates – Sweepers are 5+ years old.

Description $59/Mile for Sweeper & Operator	Contract Implementation Cost	Yearly Cost*	Total Cost For 8 Yr Program
RFP Posting/Selection/Admin	$30,000	$30,000	$240,000
4,500 miles/year**	$265,500	$265,500	$2,124,000
Disposal Fees	$0	$0	$0
Fleet Repair & Maintenance	$0	$0	$0
Fuel Consumed	$0	$0	$0
Training Operators***	$0	$0	$0
Sweeper Replacement Cost	$0	$265,500	$2,124,000
Total	**$295,500**	**$561,000**	**$4,488,000**

*Assume no cost increases

**Average cost/mile from two bids.

- One yr paid upfront = 50 wks/yr (excludes 10 holidays)

***Contract would require advance operator training

- Advance training is not included in this contract/agreement pricing

Research and analysis on the most economic approach for securing a second street sweeper revealed that an outright purchase is the most cost-effective alternative. The comparisons are not exactly cost for cost. However, there are particular elements that stand out pointing to the purchasing option choice.

Leasing a sweeper is similar to purchasing but costs more over time and has restrictions on wear and tear. Contracting does not require a City operator, whereas all other alternatives do require a City operator and paid training. The option to include upfront operator training could be required in the contract proposal process to assure operators are trained.

Rentals require maintenance at the rental company's facility. Transporting the sweeper for maintenance and downtime while the sweeper is not in service, adds cost to the rental alternative total. In the past, it has been very difficult to secure a rental after a fleet sweeper is taken out of commission for maintenance or repairs. There is high demand for the small supply of local rental sweepers. Another downside with both renting and contracting companies is that the sweepers in their fleets are five years and older. Older sweepers do not use the latest technology and are prone to breakdowns.

Enhanced Street Sweeping Program

Program Goals and Objectives

One of the Utility's strategies for pollution prevention listed in the SSWP is to implement an enhanced street sweeping program that removes sediment before it enters the MS4. The goal of the enhanced street sweeping program is to *improve water quality in stormwater runoff originating from city streets by reducing pollutants before flowing into Olympia's MS4 and continuing into surface waters*.

The main objectives of the enhanced street sweeping program are:

- To improve stormwater runoff water quality through a significant increase in the amount of street waste collected.

- To Increase the number of miles swept.
- To identify areas with pollutant concentrations where street sweeping efforts are well suited to improve stormwater runoff water quality.

Program Measures

A water quality focus will apply to both the current street sweeper and the new second street sweeper. However, the current sweeper will be the first response for sweeping emergencies, spills, bike lanes, litter, leaves, winter sand cleanup, and resident requests. Measures from both sweepers will be combined.

Tons of sediment and number of miles swept will continue as key measures of the enhanced street sweeping program. Less downtime is anticipated with a two-fleet sweeper program, allowing for more than double the average miles swept. The new enhanced street sweeping program is expected to increase the annual miles swept from 4,100 to 8,600 and increase the amount of street waste collected from 600 to 1,000 tons (see Table 3). Past trends have shown there is less street waste collected per mile when streets are swept more often, yet more sediment is collected overall.

Table 7. Sweeping Program Goals

Sweeping Program Measure	Average Results 2016 – 2019*	Enhanced Street Sweeping Program Goals
Tons Sweep Waste	653	1,000
Tons/Mile	0.16	0.14
Total Miles	4,067	8,600

*Figures from 2020 were omitted due to COVID-19 and mechanical issues skewing results.

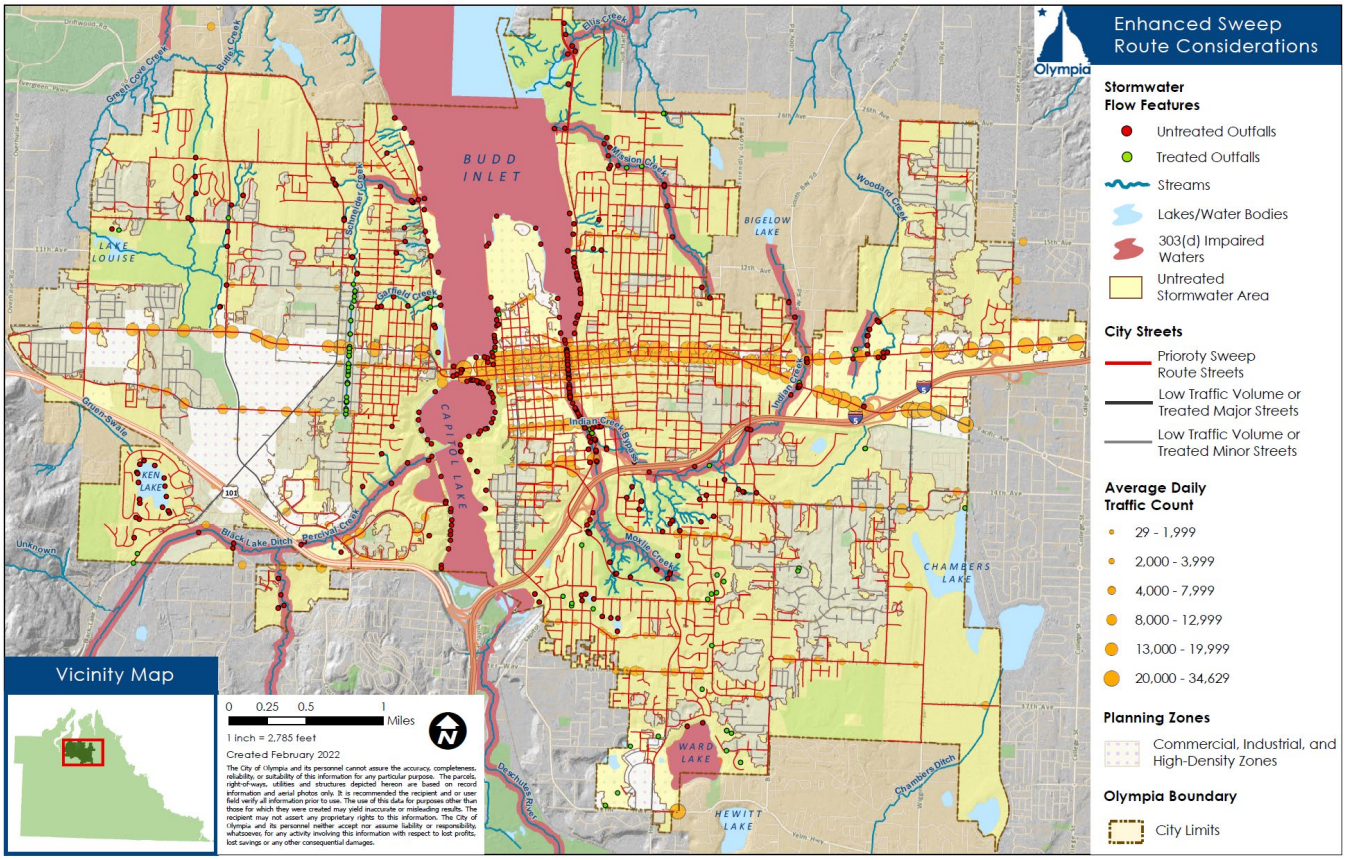
The City currently does not calculate the amount of contaminant per ton of sediment collected because of data gaps. Water quality benefits are difficult to measure due to the diverse character of street sweeping material and concentrations of components making up its composition (Eisenberg, 2007). It is challenging to create pollutant removal estimate formulas that have a high level of confidence for a universal application. A review of several publications pointed out important variables that affect water quality benefit estimates such as: weather, topography, age of urbanization, pavement type and condition, distribution of particle size and weight, and processes and timing of sample testing. Olympia does not have the funds to collect, monitor, and test sediment in the manner necessary for reliable contaminant removal quantity estimates. Future research may present improved processes and formulas for estimating contaminants removed through enhanced street sweeping that do not require additional resources.

Through more frequent and targeted street sweeping, the enhanced street sweeping program is expected to reduce TPH, c-PAHs, 6PPD-q, and heavy metals including zinc, lead, copper, and nickel in the City's stormwater runoff. Many of these pollutants (PAHs in particular) have been found in samples taken from Budd Inlet (see Parameter list in Appendix A). Targeting oil, tire wear, combustible emissions, sediment, and organics in our street sweeping program will reduce pollutants that are known to contribute to water quality impairments. Additionally, sweeping sediment and organic materials from Olympia's roadways will result in nutrient load reductions that decrease dissolved oxygen impacts to our local water bodies (e.g., Black Lake Ditch, Percival Creek, Woodland Creek, Woodard Creek tributary, and Budd Inlet as listed in Appendix A).

Initial Enhanced Street Sweeper Priority Route Analysis

GIS data identified areas with the greatest potential to contaminate surface water flowing from roadways into the MS4 (See Map 2). The GIS analysis criteria used to highlight sweep route priority streets in Map 2 includes untreated stormwater catchment flow areas, untreated outfalls, commercial, industrial, and high-density zones, and high daily traffic count locations.

Nearly all City water bodies or parts near their flow destination are on the 303(d) list. Sweep routes under the enhanced sweeper program will be prioritized by location. First priority streets are located in untreated areas with proximity to untreated catchments that flow directly into water bodies.



Map 2. Targeted streets for priority enhanced street sweeping routes.

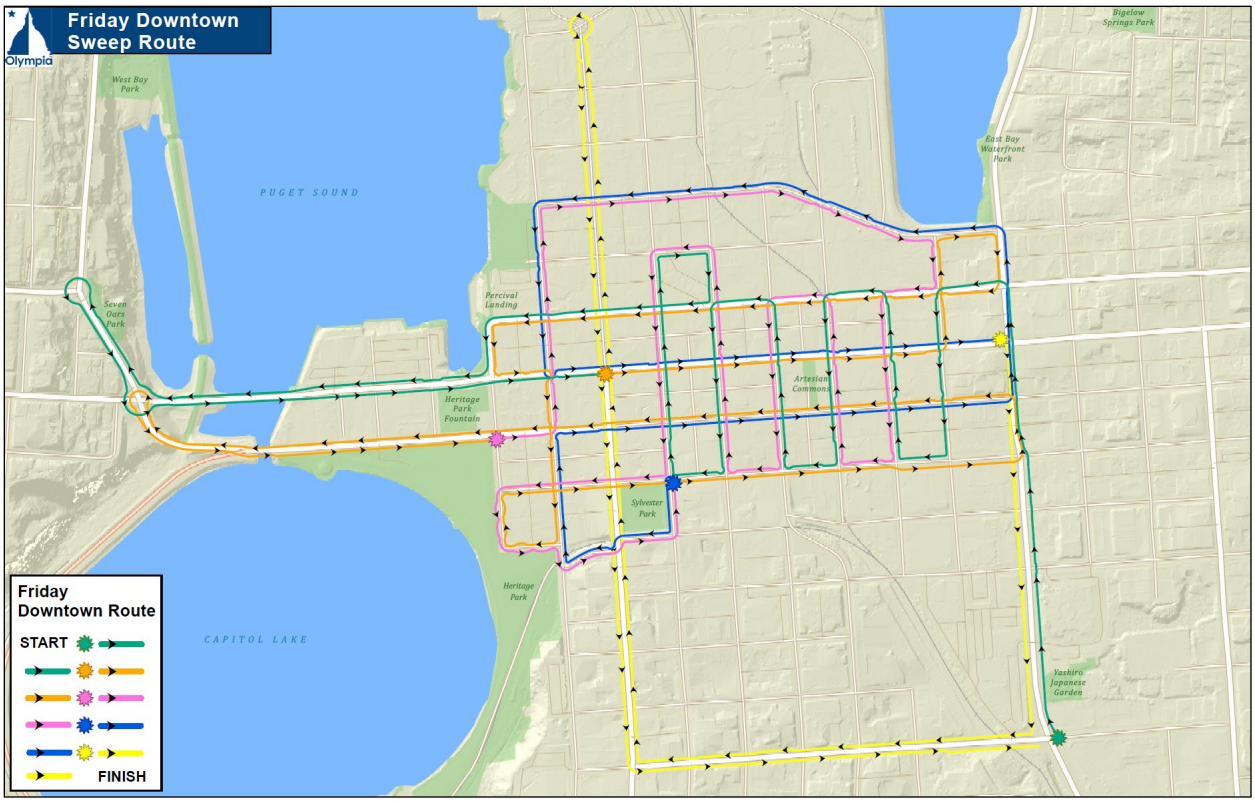
Program Strategies

Taking cues from past studies, the enhanced sweep plan will first begin by incorporating water quality components from the current street sweeping program to structurally organize and strategically implement the following water quality strategies:

- Expand on the water quality components of the current sweeper program
  - Operate regenerative air street sweepers
  - Collect Zonar Ground Traffic Control data
  - Create a layer for the second sweeper to display its swept streets in the sweeper map
  - Add an additional operator to operate the enhanced street sweeper
    - The Initial operator will be a lateral transfer from within the Stormwater Operations group
  - Continue and update operator training
  - Continue sweep waste processes and review for efficiencies

    - Develop a street parking strategy to coincide with the sweeper schedule
        - Possibly post route schedule signs; no fines or vehicle removals
        - Review parking status with operator at monthly check-in
    - Develop a community outreach program
        - Inform community regarding benefits and cooperation
        - Create a community sweep schedule and frequently asked questions webpage
        - Name the sweeper campaign
        - Sweeper funded by Ecology/EPA and logos on new sweeper
- Sweep every two weeks (demonstrated as effective in Seattle's street sweeping pilot study, 2009).
    - Streets in high traffic count areas
    - Arterials and bike lanes
    - Curb and gutter design streets in high and moderate traffic areas
        - Create a curb feature class (layer)
- Sweep low traffic residential streets once or twice each year depending on their stormwater flow destination
    - Sweep more frequently if stormwater flows into MS4 or direct into water bodies with no prior treatment
- Sweep downtown streets twice a week
- Periodic sweep program analyses for water quality goal efficiency improvements
    - Review data trends for priority route adjustments
    - Review analytes tested in sweep waste for trends and possible adjustments
        - Add or subtract analytes for testing as future research recommends
    - Check in with operator monthly for updates (operator needs, route inefficiencies, seasonal issues)

For greatest efficiency, sweep routes utilize right hand turns to avoid waiting at stop lights and also to avoid sweeping a street segment more than once on the scheduled route (See Map 3). This strategy allows for the least amount of emissions, tire wear, and brake use keeping the sweeper's pollution contributions at a minimum and optimizes the number of miles swept.



Map 3. Enhanced street sweeper route example map.

Program Analysis for Adaptive Management

Data collection requires Zonar for tracking sweep miles, sediment weight measurements at the disposal site scales, traffic count software that is GIS compatible, pulling service requests initiated by the community for street sweeping, and Utility crews that perform catch basin condition and assessments using Environmental Systems Research Institute's (ESRI) Collector app. These data are collected and recorded for analysis as presented in Table 4.

Table 4. Sweeping Program Data Records

Data Collected	Collection Frequency	Analysis Review	GIS Record
Sweep Miles	Daily Miles	Monthly, Annually	Street Swept, Date Swept
Sweep Waste	Daily Collection for Hauling to Disposal Site - 2 to 3 Times Annually	Tons Annually	N/A
% Sediment in each Catch Basin	Annual or Bi-Annual per Catch Basin	Total Tons Annually	Location, % Sediment Level, Year Inspected
Sweeping Requests	24/7 as requests are logged	Total Requests Annually	Location, Date, Reason
Traffic Counts	Average Daily Count	As Required. Varies by Street Segment.	Location, Traffic Count, Year Counted

The Street Sweeper Program's Senior Program Specialist compiles and organizes these data for trend analysis. Data is assessed yearly for overall review that includes seasonal influences. Route adjustments for water quality improvement are prompted by the amount of sediment found in each catch basin with regards to their location and the date(s) associated with their nearest street's sweep date(s). Seasonal route adjustments include timing of the fall leaf drop, winter street sanding, rainfall, and summer's accumulated

dry sediment. Changes in land use zoning, development growth, and garbage routes plus operator observations are also considered in determining needed route adjustments.

The enhanced sweeper will concentrate on priority contaminant areas and adapt to route changes as trend analyses reveal adjustments are necessary. The current sweeper will be assigned routes to assure all streets remain swept on schedule. Sweep routes will allow the sweepers to work in tandem toward water quality goals. As new science reveals improvements in street sweeping best management practices, the enhanced street sweeping program will adjust accordingly.

In addition to ongoing adaptive program management, the Utility is currently in the process of developing a stormwater management action plan that will include a receiving water conditions assessment and water quality management strategies. The plan creates another opportunity for sweep route water quality improvements. It is expected to reveal strategies for stormwater management actions that include enhanced street sweeping program adjustments. The strategic modifications proposed for the enhanced sweeper in the action plan will be implemented according to the recommended application. The completion date of the stormwater management action plan is unknown at this time.

Community Outreach

The enhanced street sweeping program will include a community outreach component. The intent is to communicate the water quality benefits of street sweeping with an understanding for the need of temporary parking restrictions and highlighting connections to popular stormwater topics (e.g., erosion, lawn/yard care, car leaks) and unfamiliar stormwater topics (e.g., sediment, turbidity, pollution sources).

Public awareness teaching opportunities include E-Newsletters to the City's self-subscribed lists, Five Things utility brochure sent six times each year with utility bills, unscheduled utility billing inserts, Storm and Surface Water Utility webpage, Transportation webpage, and Engage Olympia subscribers (subscribers receive City news, updates, and other information).

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