TECHNICAL MEMORANDUM

Date: February 03, 2023

To: Chance Berthiaume, Sarah Wilson – City of Bremerton

From: Phil Struck, Struck Environmental

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SUBJECT: RECEIVING WATER CONDITIONS AND STORMWATER INFLUENCE ASSESSMENT

INTRODUCTION

This Receiving Water Conditions and Stormwater Influence Assessment describes the City of Bremerton's receiving waters, stormwater contributing areas, existing water quality conditions, and the potential impacts of land use activities on those receiving waters. This assessment will be used to guide stormwater basin prioritization, and to identify the receiving waters that are most likely to benefit from stormwater management planning and implementation.

Purpose and Scope

The purpose of this assessment is to document existing stormwater related conditions in City of Bremerton stormwater basins. The scope follows the general assessment process recommended in Stormwater Management Action Plan (SMAP) guidance (Ecology 2019), as follows:

- Delineate all of the basins and receiving waters in the City's jurisdiction for stormwater basins that have areas of approximately one square mile or greater;
- Perform a relatively rapid assessment of existing information about water quality, habitat and land use conditions in each stormwater basin;
- Assess the relative current and potential future influence of the City's stormwater system on receiving waters; and
- Evaluate and summarize the information to identify the basins/receiving waters that are to be advanced to a more detailed prioritization analysis.

Specific technical analysis presented in this Technical Memorandum (TM) reflects the scope of Task 2 of the Ecology grant agreement with the City, as follows:

- Describe basins including size, jurisdictional area, and land use;
- Perform a pollutant loading analysis;
- Evaluate and map shoreline sediment deposition potential;

- Estimate the level of water quality treatment and flow control at the basin scale;
- Assess stormwater influence in each basin, and
- Develops a ranked list candidate basins for the Receiving Water Prioritization, which will be described in a future TM.

BASIN INVENTORY

The basin inventory provides a description of relative conditions of receiving waters and runoff contributing areas. The number of basins is dependent upon the scale used. Ecology's SMAP guidance (Ecology 2019) recommends a scale of 1 to 20 square miles.

The City of Bremerton is located in west Puget Sound (Figure 1). A total of twenty-four stormwater basins have been delineated in the City using ArcMap GIS (Figure 2). Basins were aggregated based on receiving waters into 12 stormwater basin areas which are between 0.7 and 23.8 square miles in size.

Tier 1 Basin Screening

Pursuant to the project Technical Approach TM (City of Bremerton 2022a), a tiered analysis was used for this assessment, which is consistent with the Receiving Water Assessment (RWA) that was approved by Ecology as part of the City's NPDES Permit compliance process (City of Bremerton, 2022b). The Tier 1 analysis consisted of screening the existing basins to identify those that have low potential for stormwater impacts. This was determined by evaluating each basin relative to the criteria shown in Table 1. Refer to Table 2 for a complete listing of Tier 1 and Tier 2 basins.

Table 1. Tier 1 evaluation thresholds.

Criteria	Tier 1 Threshold
Percent basin developed	≤ 10%
Percent of basin in City	≤ 50%
Basin Area	< 100-acres

As shown in Table 2, a total of 18 basins in six separate stormwater basin/receiving water areas were selected for more detailed Tier 2 analysis.

RECEIVING WATER CONDITIONS ASSESSMENT

The goal of the receiving water conditions assessment (RWCA) is to develop data to provide a comparison of existing conditions in the City's stormwater basins relative to water quality and stormwater conditions. Information and attributes were developed to allow a consistent, quantitative comparison of basins.

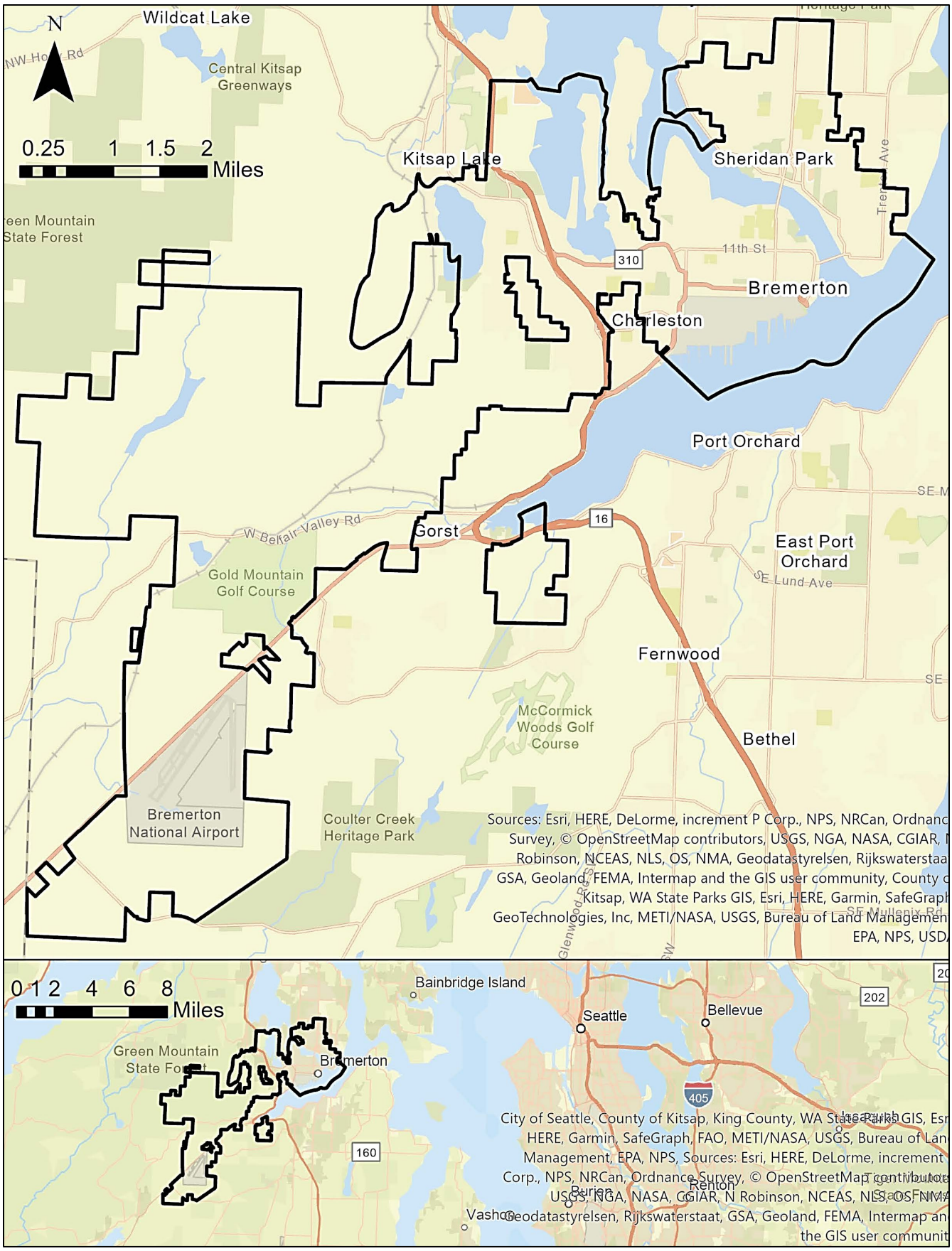
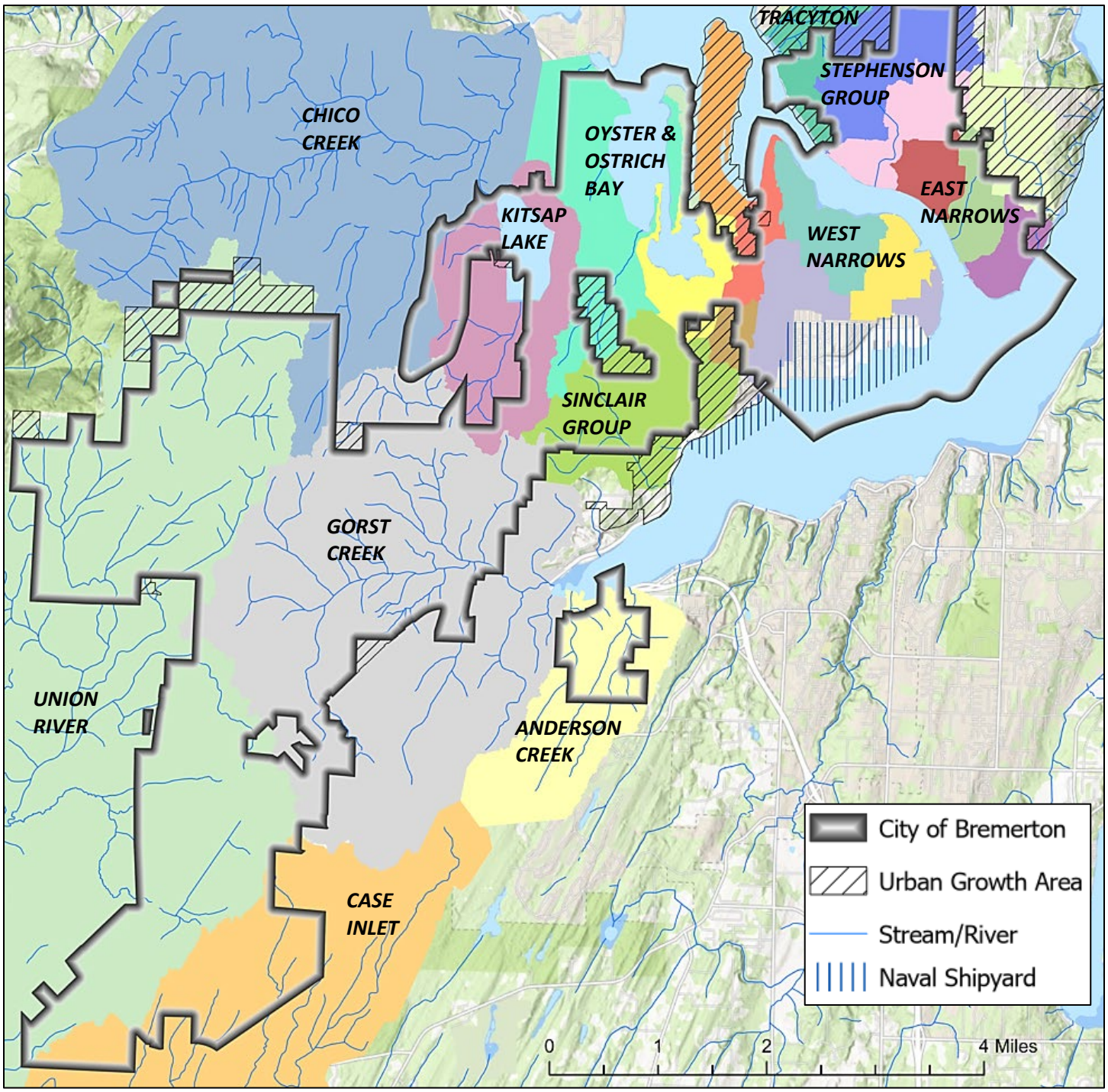


FIGURE 1. CITY OF BREMERTON
Stormwater Management Action Plan



Stormwater Basins

Anderson Cove	Ostrich Bay	East Park	Sinclair Park
Anderson Creek	Oyster Bay	Enetai Creek	Stephenson Creek
Callow Ave	Pacific Ave	Gorst Creek	Tracyton
Cherry Ave	Phinney Bay	Kitsap Lake	Trenton Ave
Chico Creek	Pine Road	Marine Drive	Union River
Coulter Creek	Rocky Point	Marion Ave	Warren Ave

FIGURE 2. STORMWATER BASINS AND RECEIVING WATERS MAP
Stormwater Management Action Plan

Table 2. Primary Receiving Waters and Basins.

Stormwater Basin	Receiving Water	Tributary To	Basins	Total Acres	Total Sq. Mi.	Acres in Bremerton	Percent in Bremerton	Percent Developed
OYSTER & OSTRICH BAY	Oyster Bay	Dyes Inlet	Oyster Bay	358		331	92%	94%
	Ostrich Bay	Dyes Inlet	Ostrich Bay	1,166		904	78%	80%
	Mud Bay	Dyes Inlet	Marine Drive	61		52	85%	85%
			Subtotal	*1,585*	*2.48*	*1,287*	*81%*	*83%*
KITSAP LAKE	Chico Creek	Dyes Inlet	Kitsap Lake	1,256	1.96	820	65%	40%
EAST NARROWS	P. W. Narrows	Dyes Inlet	Trenton Ave	278		251	90%	80%
	P. W. Narrows	Dyes Inlet	East Park	277		259	94%	90%
	P. W. Narrows	Dyes Inlet	Cherry Ave	226		222	98%	95%
	Enetai Creek	P.O. Passage	Enetai Creek	456		54	12%	70%
			Subtotal	*1,237*	*1.93*	*786*	*64%*	*81%*
STEPHENSON GROUP	P. W. Narrows	Stephenson Cr.	Stephenson Cr.	451		429	95%	90%
	P. W. Narrows	Dyes Inlet	Pine Road	963		564	59%	80%
			Subtotal	*1,414*	*2.21*	*993*	*70%*	*83%*
WEST NARROWS	P. W. Narrows	Dyes Inlet	Anderson Cove	410		410	100%	90%
	P. W. Narrows	Dyes Inlet	Warren Ave	265		265	100%	98%
	Sinclair Inlet	Dyes Inlet	Pacific Ave	88		88	100%	100%
	P. W. Narrows	Dyes Inlet	Phinney Bay	253		214	85%	80%
	Phinney Bay	Dyes Inlet	Rocky Point	357		4	1%	80%
			Subtotal	*1,373*	*2.15*	*981*	*71%*	*88%*
SINCLAIR GROUP	Sinclair Inlet	Sinclair Inlet	Sinclair Park	1,294		854	66%	50%
	Sinclair Inlet	Sinclair Inlet	Callow Ave	411		403	98%	95%
	Groundwater	Infilt. Pond	Marion Ave	129		70	54%	65%
			Subtotal	*1,834*	*2.87*	*1,327*	*72%*	*61%*
Stormwater Basins Eliminated from Further Assessment [1]								
UNION RIVER	Union River	Hood Canal	Union River	15,259	23.84	5,524	36%	< 5%
CHICO CREEK	Chico Creek	Dyes Inlet	Chico Creek	9,873	15.43	902	9%	10%
CASE INLET	Coulter Creek	Case Inlet	Coulter Creek	8,679	13.56	1,127	13%	12%
GORST CREEK	Sinclair Inlet	Gorst Creek	Gorst Creek	6,573	10.27	3,737	57%	10%
ANDERSON CREEK	Anderson Cr.	Sinclair Inlet	Anderson Cr.	1,450	2.27	461	32%	35%
TRACYTON	Dyes Inlet	Dyes Inlet	Tracyton	427	0.67	177	41%	50%

[1] Red text indicates basin meets elimination criteria. See Table 1 for criteria.

The RWCA compiled and reviewed a variety of available information to describe conditions within each basin. This information and the associate data variables were identified based on a combination of designated beneficial uses and available data sets, consistent with both NPDES permit guidance (Ecology 2019) and guidance from *Building Cities in the Rain* (Commerce 2016). As shown in Table 3, data used in the RWCA consisted of a combination of national, state and local data sets.

Table 3. Summary of Data Sets and Beneficial Uses for RWA.

Data Category	Beneficial Use/Criteria	Data Sets Used in RWA [1]
WATER QUALITY	Aquatic Life	Ecology 303(d) List/Water Quality Atlas
	Shellfish Harvesting - Recreational	Kitsap Health Dist.(KHD) and Wash. Dept of Health (WDOH)
	Shellfish Harvesting - Commercial	KHD and WDOH marine ambient monitoring data
	Aquatic Life	WDFW Mussel Tissue Monitoring SAM Report
	Primary Contact Recreation	KHD and WDOH ambient monitoring data
POLLUTANT LOADING	Aquatic Life/Shellfish	Nature Conservancy Heat Map
	Aquatic Life	Ecology NPDES Data Characterization
	Aquatic Life	Dyes/Sinclair Inlet TMDL Study
	Sediment Deposition	Washington Coastal Atlas
HYDROLOGY	Aquatic Life	Ecology Watershed Characterization
HABITAT	Aquatic Habitat	Ecology Watershed Characterization
	Salmonid Habitat	WDFW Salmonscape GIS
	T&E Listed ESA Species	WDFW Salmonscape GIS
	Forage Fish Spawning	WDFW Forage Fish Spawning GIS
	ESA Critical Habitat	NOAA and USFWS Critical Habitat
SHELLFISH AND FINFISH CONSUMPTION	Shellfish Harvesting - Recreational	WDOH Commercial Shellfish and Beach Closure GIS
	Shellfish Harvesting - Commercial	WDOH Commercial Shellfish and Beach Closure GIS
	Finfish Harvesting - Recreational	WDOH Commercial Shellfish and Beach Closure GIS
LAND USE	Water Quality, Water Flow and Habitat	City of Bremerton Zoning
		High ADT Road miles, City of Bremerton
		City of Poulsbo Parks Plan
		Land Cover and Impervious Surfaces
STORMWATER INFRASTRUCTURE	Water Quality, Water Flow and Habitat	City of Bremerton GIS

[1] Also see References list for additional details on data sources.

Jurisdictional Areas and Land Use

As shown in Table 2, City jurisdiction ranges from 65 percent to 81 percent in the top 6 receiving water areas. Kitsap County has jurisdiction in basin areas that are outside the City.

Federal jurisdiction within the Naval Base Kitsap – Puget Sound Shipyard was not considered in this assessment as this facility is regulated under a separate federal stormwater NPDES Permit. Land use in the City is shown in Figure 3.

Existing Water Quality Conditions

Existing water quality conditions were assessed using available information and are summarized in Table 4. Existing water quality data was derived from the following sources:

Marine Water Quality

Marine water quality was analyzed for compliance with the fecal coliform (FC) standard using data obtained by the Kitsap Public Health District (KPHD). The KPHD historically monitored 15 marine water stations near Bremerton on a monthly basis up to 2017. Marine water quality data collected by KPHD in 2017 met all water quality standards and showed a long term improvement trend (KPHD 2017).

KPHD data was supplemented with marine water quality data collected by Washington Department of Health (WDOH) Shellfish Section from 14 locations in Oyster and Ostrich Bay over the 2017 -2021 period. Marine water quality data collected by WDOH met all water quality standards (WDOH 2022).

Stream/Fresh Water Quality and Public Health Advisories

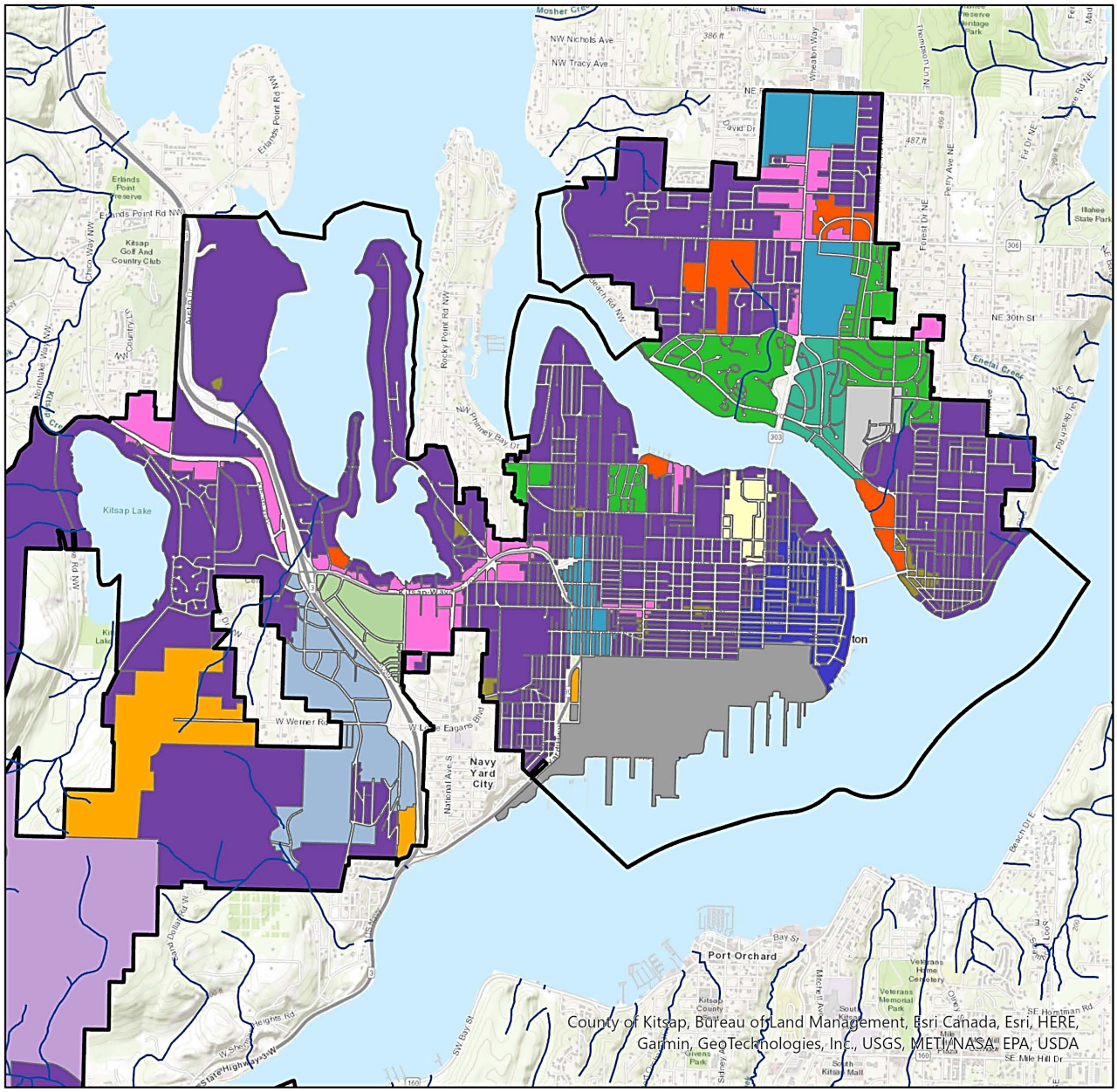
Stream and lake water quality data collected by the KCHD over the 2019-2020 period showed the following streams did not meet bacterial water quality standards:

- Kitsap Lake
- Ostrich Creek
- Enetai Creek
- Phinney Creek

Wright Creek, which drains much of the Sinclair stormwater basin, met FC water quality standards. Public health advisories for direct contact recreation posted by either the City or the KPHD in 2021-22 due to microbial or toxic algae pollution of freshwater bodies was also considered and is reflected in Table 4.

Mussel Tissue Monitoring

Mussel tissue monitoring was performed at four locations in the Bremerton vicinity by the WDFW in 2017/2018 as part of the Stormwater Action Monitoring (SAM) program (Langness 2020). Table 4 shows the parameters in mussel tissue at each location that exceeded the 75th percentile for the Puget Sound region.



0 0.5 0.75 1 Miles

N

Zoning

- Bay Vista Subarea Plan (BVSAP)
- City Utility Lands (CUL)
- District Center Core (DCC)
- Downtown Subarea Plan (DSAP)
- East Park Subarea Plan (EPSAP)
- Eastside Village Subarea Plan (EVSAP)
- Freeway Corridor (FC)
- General Commercial (GC)
- High Density Residential (HDR)
- Industrial (I)
- Institutional (INST)
- Low Density Residential (LDR)
- Medium Density Residential (MDR)
- Naval Base Kitsap (NBK)
- Neighborhood Business (NB)
- Puget Sound Industrial Center Bremerton (PSIC-B)
- Watershed (WS)
- Stream/River
- City Limits

FIGURE 3. BREMERTON ZONING
Stormwater Management Action Plan

Table 4. Summary of existing water quality conditions.

SMAP Stormwater Basin Group	Basins	WDFW/SAM Tissue [1]	303d listings [2]		Fecal Coliform			FC Rating [5]	City/KPHD WQ Public Health Advisories [6]	Summary of Ratings	Overall Rank
					KPHD Monitoring [3]		WDOH Marine Monitoring [4] (Mts Stdrd. Y/N)				
			Parameters	Conv. & Toxics Rating	Freshwater (Mts Strd. Y/N)	Marine Water (Mts Strd. Y/N)					
OYSTER & OSTRICH BAY	Oyster Bay	PCBs, PBDEs, DDT, Hg, Cu/Zn/Pb	Freshwater: DO, TEMP	HIGH	NO	YES	YES	MODERATE	YES/HIGH	H/M/H	2
	Ostrich Bay		Marine Water: FC, DO, Temp								
	Marine Drive		Tissue: Hg								
			Sediment: Bioassay								
KITSAP LAKE	Kitsap Lake	NA	Freshwater: FC, P	HIGH	NO	NA	NA	HIGH	YES/HIGH	H/H/H	1
			Marine Water: NA								
			Tissue: Hg, pesticides								
			Sediment: None								
EAST NARROWS	Trenton Ave	PCBs, Hg	Freshwater: FC, Temp,	HIGH	NO	YES	NA	MODERATE	NO/LOW	H/M/L	4
	East Park		Marine Water: FC, Temp, pH								
	Cherry Ave		Tissue: PAHs, PCBs, pesticides								
	Enetai Creek		Sediment: None								
STEPHENSON GROUP	Stephenson Cr.	PAHS, PCBs, DDT, Hg	Freshwater: None	MODERATE	NA	YES	NA	LOW	NO/LOW	M/L/L	6
			Marine Water: FC, Temp, pH								
	Pine Road		Tissue: PAHs, PCBs, pesticides								
			Sediment: None								
WEST NARROWS	Anderson Cove	PAHs, PCBs, DDT, Hg	Freshwater: FC	HIGH	NO	YES	NA	MODERATE	NO/LOW	H/M/L	3
	Warren Ave		Marine Water: FC, DO, Temp								
	Pacific Ave		Tissue: PAHs, PCBs								
	Phinney Bay		Sediment: PCBs								
	Rocky Point										
SINCLAIR GROUP	Sinclair Park	PAHs, PCBs, PBDEs, DDT, Hg, Cu/Zn/Pb	Freshwater: FC	HIGH	YES	YES	NA	LOW	NO/LOW	H/L/L	5
	Callow Ave		Marine Water: FC, PAHs, DO, Temp, PCBs, Hg								
	Marion Ave		Tissue: PAHs, PCBs, pesticides								
	Subtotal		Sediment: Hg, PCBs								

[1] Parameters in mussel tissue, upper 75th percentile of Puget Sound region, WDFW 2020.

[2] Assessment Category 2-5. Rating criteria: High: Elevated or does not meet standards for Tissue, Freshwater, Marine Water. Moderate: Elevated for Tissue, and Marine Water but Meets Freshwater Standard.

[3] KPHD monitoring; marine water 2017; freshwater 2020.

[4] Wash. State Dept. of Health marine water data, 2017 -2021.

[5] Rating Criteria: High = Fails both parts FC standard; Moderate = Fails 1 part of FC standard; Low = Meets both parts of FC standard.

[6] Source: KPHD 2022. Does not include advisories due to sanitary sewer spills/overflows.

State 303(d) List

Impaired waters as shown on Ecology's Water Quality Atlas (2022) were summarized for each basin and media (marine water, freshwater, tissue and sediment) for parameters identified in Ecology's Water Quality Assessment Categories 2 through 5.

POLLUTANT LOADING ANALYSIS

The objective of the pollutant loading analysis is to develop estimates of stormwater pollutant loading in each Tier 2 basin group. Estimated pollutant loads for Tier 2 basins were calculated using data available from StormwaterHeatmap.org (Nature Conservancy 2022), the Sinclair and Dyes Inlet Fecal Coliform TMDL Study (May 2005) and relative loading calculated using the Simple Method (Schueler 1987). Table 5 summarizes parameters that were used from each of these sources and additional detail on each data source is provided below.

Table 5. Tier 2 Pollutant Loading Parameters and Data Sources.

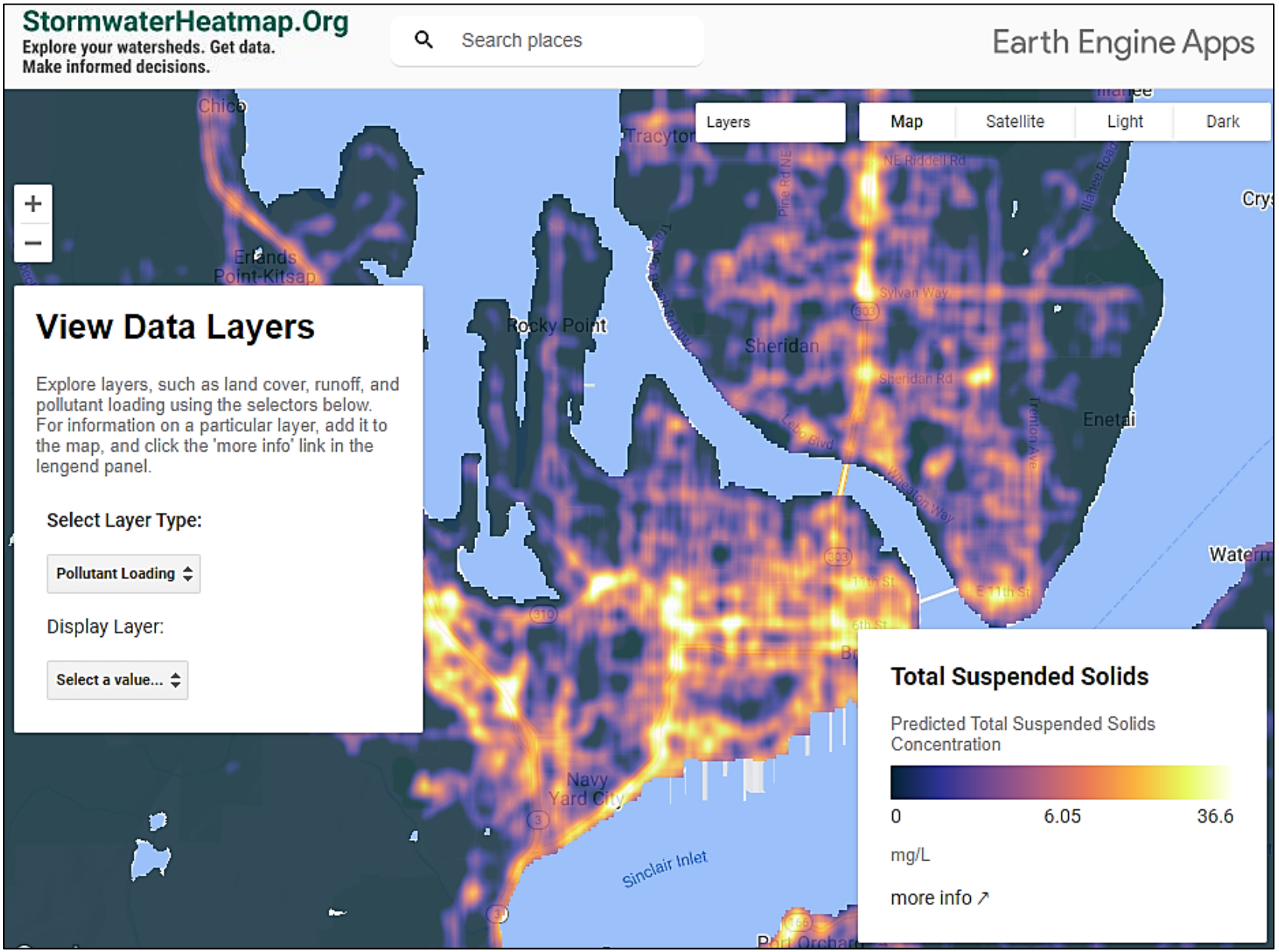
Data Source	Parameters
StormwaterHeatmap.org	Copper, Zinc, TSS, Total N, Total P
StormwaterHeatmap.org	Mean annual runoff volume
Sinclair and Dyes Inlet FC Model	Fecal coliform bacteria
Kitsap Public Health District	Fecal coliform bacteria
Simple Method	TPH - Dx, Total PAHs,

StormwaterHeatmap.org

The recently completed Stormwater Heat Map interactive watershed tool developed by the Nature Conservancy (2022) was used to derive loading estimates of selected metals and nutrients. The Nature Conservancy (NC) tool utilizes water quality data from Ecology's *Western Washington NPDES Phase 1 Stormwater Permit: Final Data Characterization 2009-2013 (2015)* and hydrology from continuous Hydrological Simulation Program-FORTRAN (HSPF) using regional pre-calibrated parameters. Figure 4 depicts the typical NC Heat Map visual presentation.

ENVVEST Fecal Coliform Model and KPHD Data

The ENVEST model used an HSPF hydrologic model in combination with site specific FC monitoring data to develop FC loading estimates from all primary stormwater outfalls and streams in the City. The model was calibrated and shown to be Fair to Exceptional in predicting FC concentrations (Johnston 2009). FC data used in the ENVVEST model is over 15 years old and was therefore updated and/or supplemented by more recent data collected by the KPHD ambient water quality monitoring program.



Source: The Nature Conservancy 2022.

FIGURE 4. STORMWATER HEAT MAP
Stormwater Management Action Plan

Simple Method

The Simple Method (Schueler 1987) was used to supplement data from the NC Heat Map and ENVVEST study for selected organic chemicals (see Table 4). The Simple Method provides general planning level estimates of pollutant loading that are suitable for a relative basin comparison where a ranked outcome is desired. This method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where: L = Annual load (lbs.)

R = Annual runoff (inches)

C = Pollutant concentration (mg/L)

A = Area (acres)

0.226 = Unit conversion factor

Pollutant loading estimates were developed for organic chemical parameters shown in Table 4 since these parameters are not available from the NC Stormwater Heatmap tool. Runoff volumes used in Simple Method calculations were derived using the Stormwater Heatmap tool.

Pollutant Loading Results

Pollutant loading results are shown in Table 6. Overall, pollutant loading was highest in the Ostrich/Oyster Bay basin, followed by the West Narrows (west Bremerton area), East Narrows (east Bremerton area) and Sinclair basins. Pollutant loading was strongly influenced by basin size and impervious area, with older, more developed areas of the City typically generating higher pollutant loads. On a total load weight basis, Total Suspended Solids generated the highest load, followed by nutrients (Total N and Total P), petroleum hydrocarbons and zinc.

SEDIMENT DEPOSITION POTENTIAL

The objective of the shoreline deposition analysis was to identify shoreline stormwater depositional potential to support evaluation of potential impacts of stormwater on sediments. The technical approach reflects the findings of the *Nearshore Sediment Monitoring for the Stormwater Action Monitoring (SAM) Program, Puget Sound, Western Washington* (USGS 2018). This study found that sediment chemical concentrations were significantly higher in drift cells with limited sediment movement compared to those with higher energy. Sediment grain size and watershed characteristics were only weakly related to sediment concentrations.

Table 6. Pollutant loading analysis results.

SMAP Stormwater Basin Group	Receiving Water	Tributary To	Basins	Total Acres	Acres in Bremerton	Annual Runoff Volume (Mgal) [1]	Annual Load (lbs./year) [1]					Annual Runoff (inch) [1]	Annual Load (lbs./year) [2]		FC Load (Million/Rel.Avg. Day) [3]	Overall Rank [4]
							Cu	Zn	TSS	Tot. N	Tot. P		TPH - Dx	Total PAHs		
OYSTER & OSTRICH BAY	Oyster Bay	Dyes Inlet	Oyster Bay	358	331	153.04	25.49	159.31	63,882	1,752.41	159.31	15.72	550.72	0.21	487	1
	Ostrich Bay	Dyes Inlet	Ostrich Bay	1,166	904	249.23	41.51	259.44	104,031	2,594.35	259.44	7.86	896.85	0.34	225	
	Mud Bay	Dyes Inlet	Marine Drive	61	52	7.82	2.17	13.57	5,442	54.29	8.14	4.72	28.15	0.01	15	
			Subtotal	1,585	1,287	410.09	69.17	432.32	173,354	4,401.05	426.89	-	1,475.72	0.55	727	
KITSAP LAKE	Kitsap Creek	Chico Creek	Kitsap Lake	1,256	820	185.24	11.18	55.89	78,442	838.38	100.61	5.42	666.59	0.25	32	6
EAST NARROWS	P. W. Narrows	Dyes Inlet	Trenton Ave	278	251	103.99	24.74	98.97	37,205	1,237.10	148.45	13.76	374.20	0.14	128	3
	P. W. Narrows	Dyes Inlet	East Park	277	259	59.21	4.93	36.98	17,300	246.53	36.98	7.86	213.06	0.08	18	
	P. W. Narrows	Dyes Inlet	Cherry Ave	226	222	120.77	24.14	130.74	44,360	1,206.84	130.74	19.65	434.58	0.16	15	
	Enetai Creek	P.O. Passage	Enetai Creek	456	54	60.92	24.35	121.75	48,821	811.68	101.46	4.91	219.21	0.08	18	
			Subtotal	1,237	786	344.88	78.16	388.44	147,686	3,502.15	417.63	-	1,241.05	0.46	179	
STEPHENSON GROUP	P. W. Narrows	Stephenson Cr.	Stephenson Cr.	451	429	98.81	20.07	100.35	40,238	802.78	140.49	8.06	355.57	0.13	239	5
	P. W. Narrows	Dyes Inlet	Pine Road	963	564	200.69	68.57	299.97	85,919	2,142.68	257.12	7.66	722.19	0.27	674	
			Subtotal	1,414	993	299.50	88.64	400.32	126,157	2,945.46	397.61	-	1,077.75	0.40	913	
WEST NARROWS	P. W. Narrows	Dyes Inlet	Anderson Cove	410	410	175.27	32.84	127.72	43,896	1,824.50	127.72	15.72	630.71	0.24	39	2
	P. W. Narrows	Dyes Inlet	Warren Ave	265	265	141.61	28.30	141.51	42,558	1,533.03	129.72	19.65	509.57	0.19	190	
	Sinclair Inlet	Dyes Inlet	Pacific Ave	88	88	56.43	10.96	58.74	19,628	548.24	58.74	23.58	203.06	0.08	125	
	P. W. Narrows	Dyes Inlet	Phinney Bay	253	214	40.56	18.01	45.03	27,087	337.76	56.29	5.90	145.95	0.05	267	
	Phinney Bay	Dyes Inlet	Rocky Point	357	4	66.77	12.71	111.21	31,852	317.73	47.66	6.88	240.27	0.09	45	
			Subtotal	1,373	981	480.63	102.83	484.20	165,021	4,561.25	420.12	-	1,729.56	0.65	666	
SINCLAIR GROUP	Sinclair Inlet	Sinclair Inlet	Sinclair Park	1,294	854	373.39	23.03	57.58	57,725	575.83	115.17	10.61	447.88	0.17	37	4
	Sinclair Inlet	Sinclair Inlet	Callow Ave	411	403	263.55	43.89	237.76	66,005	2,011.85	237.76	23.58	948.38	0.35	387	
	Groundwater	Infilt.. Pond	Marion Ave	129	70	26.19	6.89	22.96	11,509	114.81	22.96	7.47	94.26	0.04	0	
			Subtotal	1,834	1,327	663.13	73.82	318.31	135,240	2,702.49	375.89	-	1,490.52	0.56	424	
			TOTALS	8,699	6,194	2,383	424	2,079	825,901	18,951	2,139	-	7,681	2.87	2,941	

[1] Values derived from NRC Heat Map, 2022.

[2] TPH-Dx and PAH median concentrations from Ecology 2013.

[3] Fecal coliform loads from May 2005.

[4] Rank based on sum of annual total load of all parameters.

Drift Cell Mapping and Analysis

Existing drift cell mapping, available from Ecology's Coastal Atlas Map and mapping completed as part of the *East Kitsap County Nearshore Habitat Assessment and Restoration Prioritization Framework* (2009) was utilized to identify drift cell locations and nearshore characteristics including net shore drift direction and transport/depositional zones. Hydrodynamic mapping from the study area was used to supplement drift cell information and was based on modeling results presented in the *An Integrated Watershed and Receiving Water Model for Fecal Coliform Fate and Transport in Sinclair and Dyes Inlets, Puget Sound, WA* (Johnston, et.al 2009). This study/model identified current speeds and directions of nearshore drift in both Dyes and Sinclair Inlet.

Sediment Deposition Potential – Results

Figure 4 depicts sediment deposition potential based on a combination of drift cell transport zones and sediment delivery estimates for specific discharge locations (streams or storm outfalls). Annual estimated outfall sediment delivery volumes were derived from the Nature Conservancy Heat Map model described in the Pollutant Loading section above. This model computes annual Total Suspended Solids (TSS) load based on a combination of an HSPF model and TSS data from Ecology's *Western Washington NPDES Phase 1 Stormwater Permit: Final Data Characterization 2009-2013 (2015).* Sediment delivery volumes are depicted on Figure 4 across a generalized scale from High to Low.

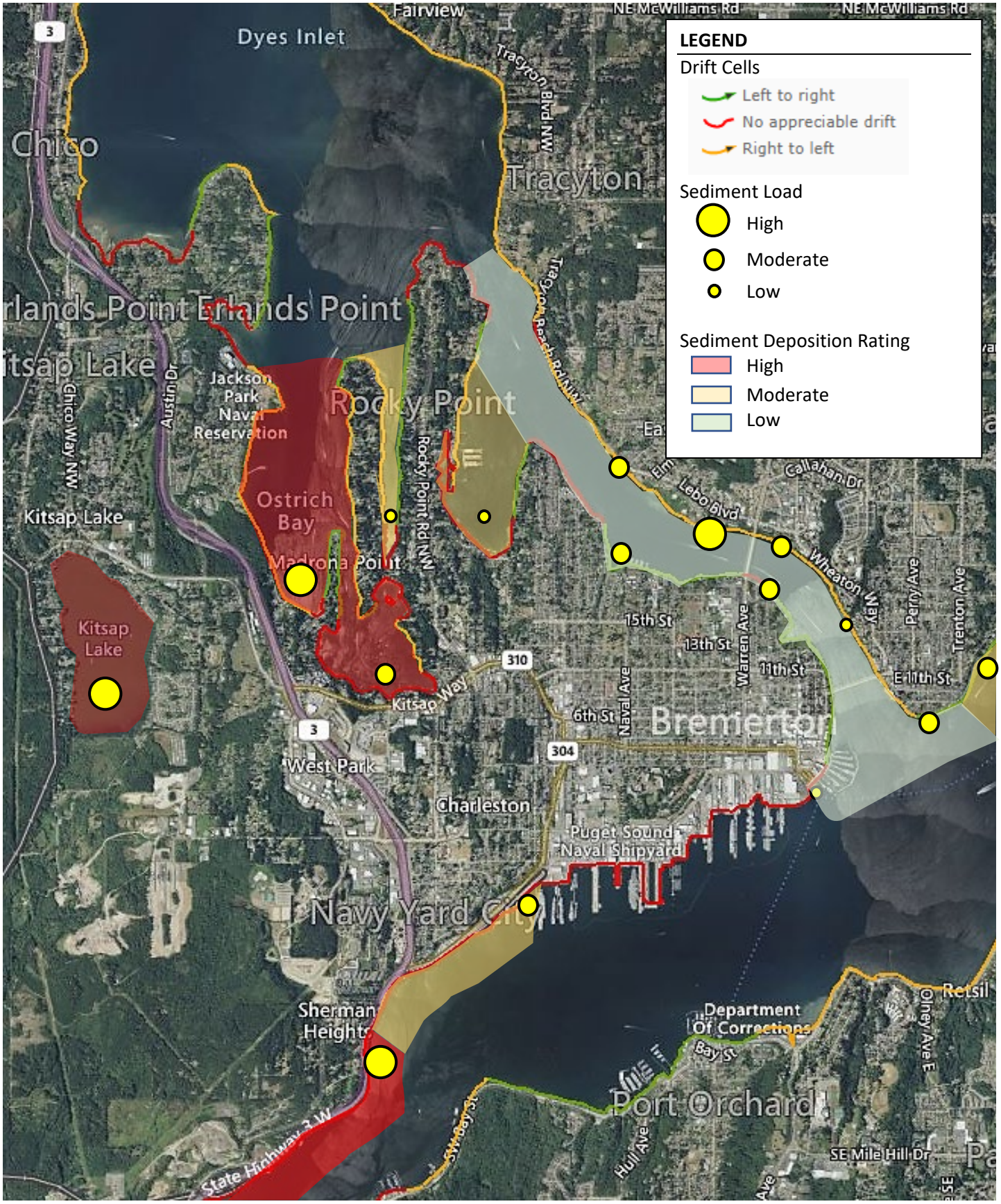
Sediment depositional potential was highest in shallow, sheltered water bodies that also receive relatively large sediment loads. These areas are shown in Figure 4 and include Oyster and Ostrich Bay, Kitsap Lake and the west end of Sinclair Inlet.

STORMWATER MANAGEMENT INFLUENCE ASSESSMENT

The assessment of stormwater management influence (SMI) considers the relative conditions of receiving waters and identifies the receiving waters that are most likely to benefit from stormwater management planning and associated implementation. This then becomes the list of candidate basins for the prioritization process. The prioritization process and associated criteria will be addressed in a TM that will be prepared at a later date.

The stormwater management influence assessment incorporates the results of the receiving water assessment described above as well as the following additional criteria:

- Total Impervious Area (TIA),
- High average daily traffic (ADT) road density,
- Development pressure, and



SCALE IN FEET

0 2,500 5,000

FIGURE 4. SEDIMENT DEPOSTIONAL POTENTIAL

Stormwater Management Action Plan

- Estimates of existing flow control and water quality treatment.

Figure 5 depicts TIA in the six east and west Bremerton areas of the City. High ADT roads were derived from the NC Heat Map. Development pressure was determined by comparing land use zoning to percent of basin developed. Basins with high density zoning designations but lower percent existing development were considered to have higher development pressure.

Estimated levels of flow control and water quality treatment from BMPs at the basin scale were developed based on City mapping of treatment and flow control facilities and knowledge of City staff. Treatment and flow control estimates are reported on a high/medium/low basis, with relative effectiveness considered based on the type and age of the treatment facility and the City's knowledge of performance. Exiting treatment and flow control facility locations are shown in Figures 6 and 7.

Scoring Methodology

The stormwater management influence scoring methodology uses a rating scale of High, Medium or Low for each rating criteria. The basis for each rating are described in Table 7. Stormwater management influence rating and overall basin rankings are shown in Table 8.

Table 7. Stormwater management influence scoring methodology.

Criteria	Basis for Score		
Jurisdictional Control	High: > 80% in City	Moderate: < 80% and > 50% in City	Low not used
Pollutant Loading	High: One of top 3 highest load basins	Moderate: One of lower 3 load basins	Low not used
Hydrology [1]	High = High Waterflow importance	Moderate = Mod High/Moderate water flow Importance	Low = Low water flow importance
Zoning and Development	High > 80% res+com+ind zoning & High development pressure [2]	Moderate < 80% res+com+ind zoning &/or Moderate development pressure	Low not used
Total Impervious Area	High > 40% TIA & High Road Density	Moderate 10% - 40% TIA and/or Moderate Road Density	Low < 10% TIA and/or Mod-Low Road Density
Existing Treatment and Flow Control	High: High: > 90 of basin not treated	Moderate: 10 - 20% of basin treated	Low < 10% basin treated

[1] Data source: Ecology Watershed Characterization tool (2022).
[2] Development pressure rating: High < 80% developed & > 80% residential (res) +commercial (com) +industrial (ind) zoning; Moderate > 80% developed &/or < 80% res+com+ind zoning; Low not used.

The summary rating for each receiving water was determined by summing the individual High/Medium/Low ratings as shown in Table 8. Overall, Kitsap Lake had the highest stormwater management influence rating, followed by the West Narrows and Oyster and Ostrich Bay basins, respectively.

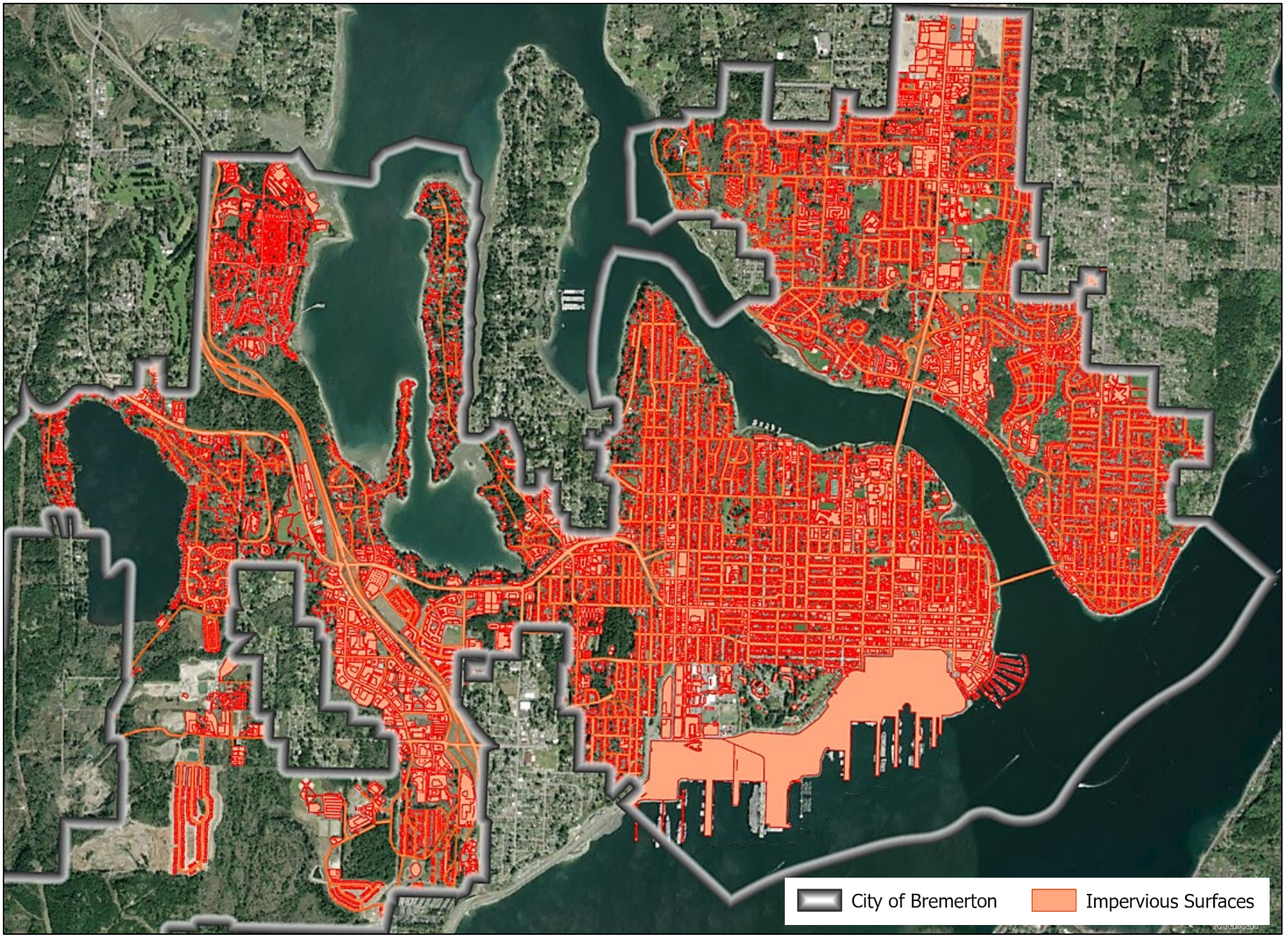


FIGURE 5. IMPERVIOUS AREAS
Stormwater Management Action Plan

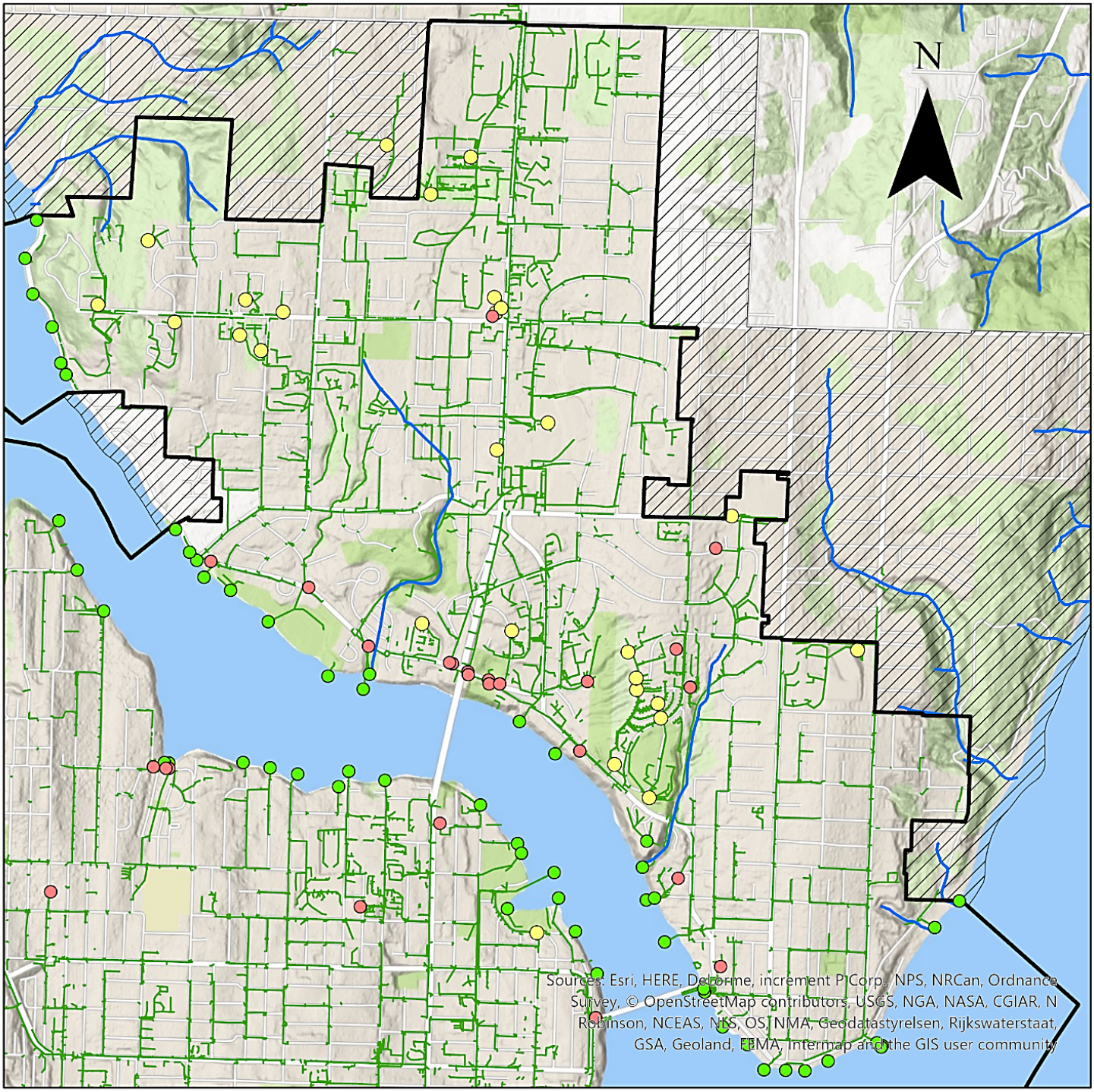


FIGURE 6. TREATMENT AND FLOW CONTROL FACILITY LOCATIONS, EAST BREMERTON AREA
Stormwater Management Action Plan

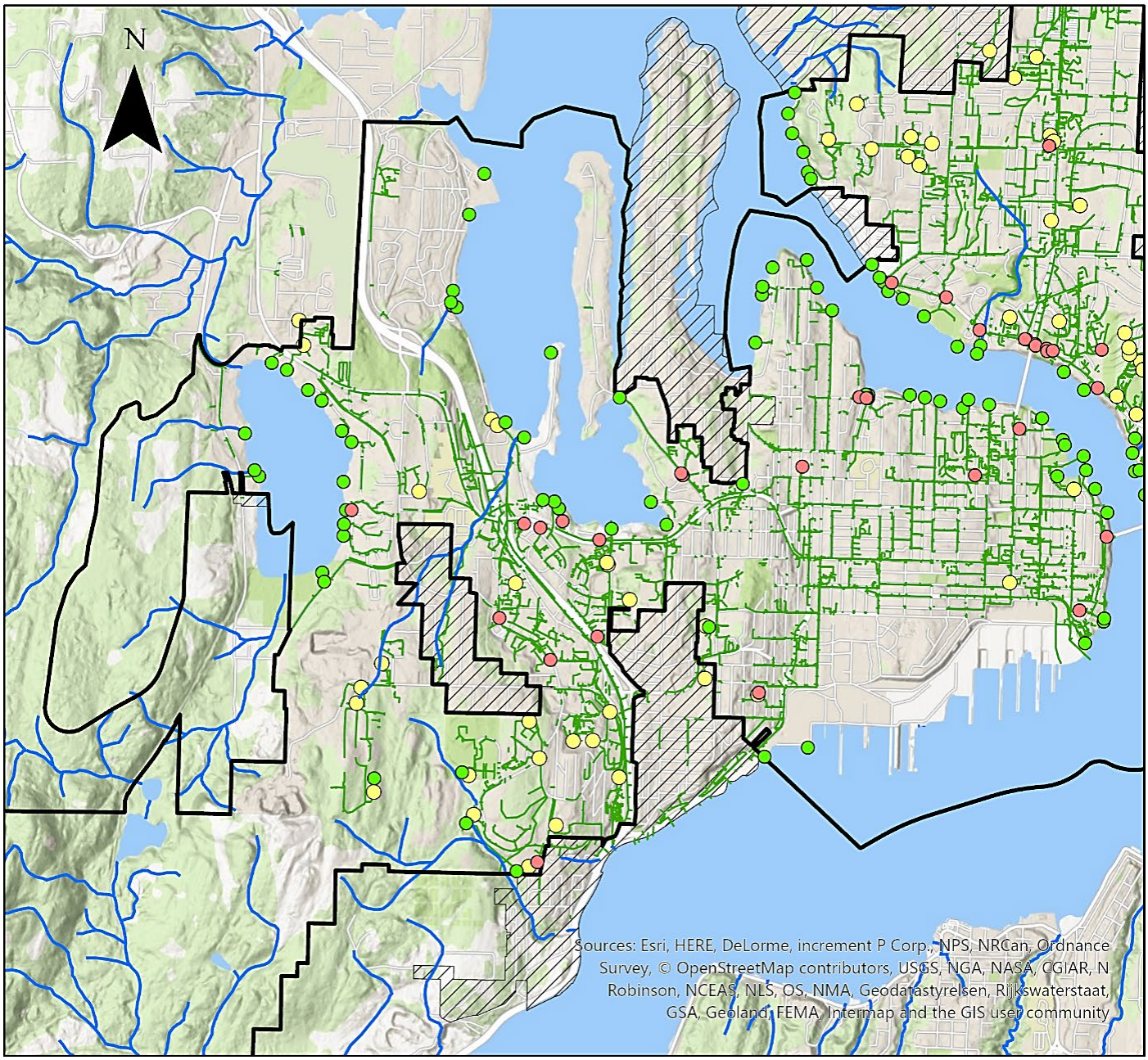


FIGURE 7. TREATMENT AND FLOW CONTROL FACILITY LOCATIONS, WEST BREMERTON AREA
Stormwater Management Action Plan

Table 8. Stormwater management influence summary.

SMAP Stormwater Basin Group	Basins	Jurisdictional Control		Pollutant Loading (H/M/L) [1]	Hydrology (H/M/L) [2]	ZONING & DEVELOPMENT [3]							Existing Impervious Areas			Existing Treatment [10]	Summary of Ratings	Overall Rating	Overall Rank
		Percent in Bremerton	Rating (H/M/L)			Residential	Commercial & Institutional	Industrial	Other [4]	Percent Developed	Development Pressure (H/M/L) [5]	Z&D Rating [6]	% TIA [8]	High ADT Road Density (H/M/L) [7]	TIA Rating [9]				
OYSTER & OSTRICH BAY	Oyster Bay	92%	H							94%			38%	H	H				
	Ostrich Bay	78%	M							80%			28%	M	M				
	Marine Dr.	85%	H							85%			14%	L	L				
	Subtotal	81%	H	H	M	68%	11%	3%	18%	83%	M	M	30%	H	M	M	H/H/M/M/M/M	M-H	3
KITSAP LAKE	Kitsap Lake	65%	M	M	H	66%	5%	22%	7%	40%	H	H	11%	M	M	H	M/M/H/H/M/H	H	1
EAST NARROWS	Trenton Ave	90%	H							80%			31%	M	M				
	East Park	94%	H							90%			36%	M	M				
	Cherry Ave	98%	H							95%			39%	H	H				
	Enetai Creek	12%	L							70%			33%	L	M				
	Subtotal	64%	M	H	M	72%	3%	0%	25%	81%	M	M	35%	M	M	H	M/H/M/M/M/H	M-H	4
STEPHENSON GROUP	Stephenson Cr.	95%	H							90%			34%	M	M				
	Pine Road	59%	L							80%			38%	M	M				
	Subtotal	70%	M	M	L	59%	33%	4%	4%	83%	M	M	36%	M	M	H	M/M/L/M/M/H	M	6
WEST NARROWS	Anderson Cove	100%	H							90%			40%	H	H				
	Warren Ave	100%	H							98%			58%	H	H				
	Pacific Ave	100%	H							100%			79%	H	H				
	Phinney Bay	85%	H							80%			35%	M	M				
	Rocky Point	1%	L							80%			25%	L	L				
	Subtotal	71%	M	H	M	55%	13%	0%	31%	88%	M	M	47%	H	M	H	M/H/M/M/H/H	H	2
SINCLAIR GROUP	Sinclair Park	66%	M							50%			22%	L	L				
	Callow Ave	98%	H							95%			49%	H	H				
	Marion Ave	54%	L							65%			31%	L	L				
	Subtotal	72%	M	H	H	49%	25%	3%	24%	61%	H	M	31%	M	M	M	M/M/H/M/M/M	M	5

[1] Rating scale: High = top 3 loading basins; Moderate = lower 3 loading basins. See Pollutant loading table for detail.

[2] Rating scale: High = High Waterflow Importance; Moderate = Mod High/Moderate Importance; Low = Low Importance.

[3] Bremerton zoning map 2022. Land use aggregated according to general zoning category.

[4] Other zoning including right of way, utility lands, parks.

[5] Development pressure rating: High < 80% developed & > 80% res+com+ind zoning; Moderate > 80% developed &/or < 80% res+com+ind zoning;

[6] Zoning and development rating scale: High > 80% res+com+ind zoning & High Dev.Pres.; Moderate < 80% res+com+ind zoning &/or Moderate Dev.Pres.

[7] Data derived from NRC Heat Map, 2022. Road density rating key: High: > 3 miles ADT > 20,000. Moderate: 1-3 miles ADT > 20,000. Low: < 1 mile ADT > 20,000

[8] TIA is for areas within City of Bremerton city limits.

[9] TIA rating scale: High >40% TIA & High Road Density.; Moderate 10% - 40% TIA and/or Mod Rd.Den.; Low < 10% TIA and/or Mod-Low Rd.Den..

[10] Existing treatment and flow control scale: High: > 90 of basin not treated; Moderate: 10 - 20% of basin treated; Low < 10% basin treated

H = High, M-H = Moderate-High, M = Moderate, L = Low

COMBINED RECEIVING WATER AND STORMWATER INFLUENCE ANALYSIS

In summary, 12 stormwater basin groups, made up of 24 separate stormwater basins were evaluated based on physical characteristics, receiving water conditions and stormwater management influence. A total of six basins were eliminated in the Tier 1 evaluation due to low levels of development or relatively low portion within City jurisdiction. The remaining six basin groups (comprised of 18 individual basins) were evaluated relative to existing water quality conditions, pollutant loading, existing treatment, and existing and potential future development.

The combined existing receiving water quality and stormwater influence assessment results provides a comparison of relative conditions across the six primary basins (Table 9). The purpose of the combined scoring is to identify the list of basins to move forward for prioritization. Based on the results in Table 9, it is recommended that top three basins with highest combined scores move forward to prioritization. As shown in Table 9, the top three basins have a significantly higher summary rating than the remaining three Tier 2 basins. Accordingly, Kitsap Lake, Oyster and Ostrich Bay and the West Narrows basins groups are proposed to be advanced to the prioritization phase of the SMAP.

Prioritization will consider rating, weighting and rationale for protection and restoration of beneficial uses as well as input from internal and external stakeholders.

Table 9. Combined receiving water and stormwater influence rating and ranking.

Stormwater Basin	Receiving Water Rank	Stormwater Influence Rating	Summary Rating	**Final Rank**	Advanced to Prioritization Step
Kitsap Lake	1	1	2	**1**	Yes
Oyster & Ostrich Bay	2	3	5	**2**	Yes
West Narrows	3	2	5	**2**	Yes
East Narrows	4	4	9	**3**	No
Sinclair	5	5	9	**3**	No
Stephenson	6	6	12	**4**	No
Anderson Creek	**Eliminated in Tier 1 screening**				No
Gorst Creek					No
Tracyton					No
Chico Creek					No
Union River					No
Case Inlet					No

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