Appendix C1.
Point Source Water Quality Updates

This appendix describes updates to point source water quality time series and associated changes to nutrient loadings.

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Introduction

Currently, 101 marine point sources (Figure C1-1) are represented in the Salish Sea Model (SSM) domain. These include 81 municipal WWTPs and industrial discharges that are under Washington State jurisdiction, nine WWTPs under U.S. federal government jurisdiction, and 11 under Canadian jurisdiction (some of the Canadian point sources are represented as a single outfall called 'Gulf Islands' but include discharges from multiple facilities). Mohamedali et al. (2011a) developed the original marine point source flow and water quality time series for 1999 through 2008 using a multiple linear regression approach to fill in missing data. Ahmed et al. (2019) used a similar approach to extend this to 2017, and no changes were made to this in the Optimization Phase 1 (Opt1) Technical Memo by Ahmed et al. (2021).

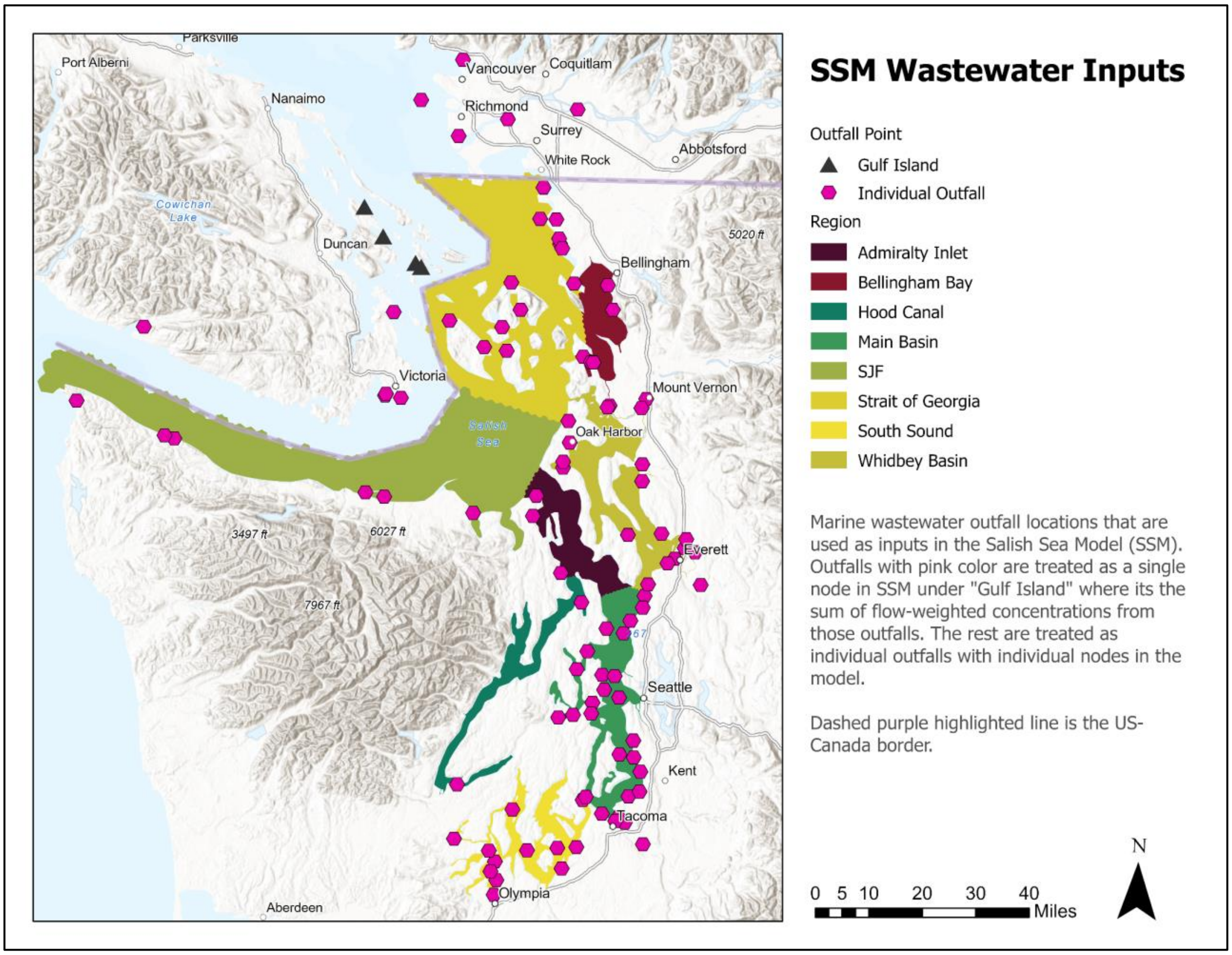


Figure C1-1. Location of marine point source inputs in the Salish Sea Model.

This section describes updates to the methods used to date to fill in missing water quality data in point source time series between 1999 and 2017, which includes the model years 2000, 2006, 2008, and 2014, which are the focus of this report.

For US municipal wastewater treatment plants (WWTPs), updates were limited to using monthly averages to fill in missing data for NH_4^+-N and organic nitrogen at seven WWTPs where regressions were poor ($R^2 < 0.1$). For industrial point sources, updates included reassessing the approaches used to compile water quality data for these facilities (e.g., data borrowed from similar industry, using industry-wide averages, or other assumptions). For Canadian WWTPs, the only update included correcting the location of one facility's outfall, which resulted in adding this facility (Port Renfrew) as a new Canadian point source (previously erroneously grouped with other WWTPs).

Updates to Seven US WWTPs

For **Brightwater** WWTP, the previous regression (Ahmed et al. 2019) used to fill missing NH_4^+-N data in late 2011 was poor ($R^2 < 0.1$). Therefore, monthly averages from years after November 2012 were used to backfill the missing data. Subsequently, because of this change, total organic nitrogen (TON) was recalculated as TKN minus NH_4^+-N for this period. TON was split between DON and PON based on DON/TON and PON/TON ratios in the large WWTP template built during the South Puget Sound DO study (Ahmed et al. 2014; Mohamedali et al. 2011a, 2011b). Previously (Ahmed et al. 2019), these ratios for this time period were borrowed from West Point WWTP, but we found some zero values for TON in West Point during times when Brightwater TON was non-zero. This update did not change the water quality for the modeled years 2000, 2006, and 2008, as Brightwater WWTP was not online during these years. This update also did not impact the model year 2014 because there were no missing data gaps in this year.

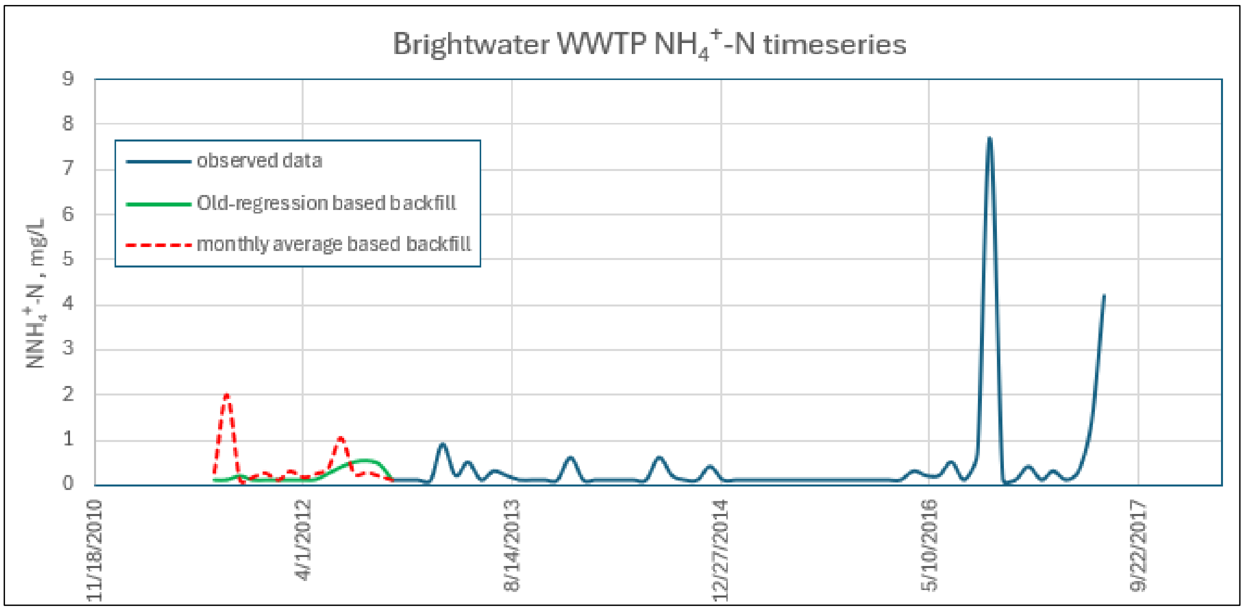


Figure C1-2. Brightwater NH_4+-N time series showing backfilling missing data with old regression data (Ahmed et al. 2019) and the new monthly average method.

For **Carlyon** WWTP, two regressions for NH_4^+-N were previously used (Ahmed et al. 2019) — one before 2007 and one after 2007 — to fill in missing data because there was a jump in NH_4^+-N concentrations in 2007 despite no change in the treatment system. Since one of the regressions was poor ($R^2 = 0.02$) and there were sufficient data (> 5 years) in each of these periods, monthly averages were used to fill in missing data for NH_4^+-N data in both periods. Previously (Ahmed et al. 2019), a constant value of 0.49 mg (as N)/L was used for dissolved organic nitrogen (DON) associated with plant-specific average data in the South Sound DO study (Ahmed et al. 2014). This study discovered additional plant-specific quarterly data beyond 2013 for TKN. This data set was used with NH_4^+-N (TKN minus NH_4^+-N) data to estimate an average concentration of TON. As was concluded in the South Sound DO study (Ahmed et al. 2014), all the TON was assumed to be DON.

For **Hartstene**, **McNeil**, and **Tulalip** WWTPs, the previous regressions (Ahmed et al. 2019) used for filling in missing data for NH_4^+-N were poor (R2 < 0.1), so long-term monthly averages were used to fill in missing data instead. In addition, for Hartstene WWTP, Ahmed et al. 2019 used PON and DON concentrations from the small WWTP template, built previously during the South Puget Sound DO study (Ahmed et al. 2014; Mohamedali et al. 2011a and 2011b). However, we found quarterly TKN data for this facility since 2011. Using the associated NH_4^+-N concentrations, an average TON (TKN minus NH_4^+-N) was estimated, which was assumed to be half PON and DON.

For **Sequim** WWTP, the previous NH_4^+-N regression (Ahmed et al. 2019) was kept as is for the period before the treatment change in 2010. However, after 2010, monthly averages were used instead since there were only a few missing data points. For nitrate/nitrite, Ahmed et al. (2019) used the small WWTP template. However, we discovered plant-specific nitrate/nitrite data for this facility, and missing data were filled in using a regression based on this data set. Ahmed et al. (2019) used the small WWTP template for PON and DON. However, we found plant-specific TKN data for before and after the 2010 treatment change. Regressions were used to fill in missing TKN data. TON was estimated from the difference between TKN and NH_4^+-N. The TON was split between DON and PON based upon the ratio of DON/TON and PON/TON in the small WWTP plant template.

For **Rustlewood** WWTP, Ahmed et al. (2019) used a regression to fill in missing NH_4^+-N data for periods before and after the treatment change in 2009. In this study, we filled the historical missing data for the period before the treatment change with the small WWTP template concentrations, and the missing data after the treatment change with plant-specific monthly average values.

Updates to Aluminum Facilities

The **Intalco** aluminum manufacturing facility has two waste streams. One is treated domestic wastewater, and the other is process wastewater with minimal treatment. No changes were made to the quality of treated domestic wastewater as described previously (Ahmed et al. 2019). Mohamedali et al. (2011) obtained data on the quality of process wastewater, which is reported during permit renewals. In this phase, we updated NH_4^+-N, nitrate/nitrite, TON, and TOC concentrations in consultation with Ecology's Industrial Section permit manager (Greg Gould, personal communication, June 12, 2023), by using data from more recent EPA Form 2C used for permit renewal (U.S. EPA 2019a). As before, we used long-term averages from this data set as constant monthly averages. We assumed TON to contain equal proportions of PON and DON, and TOC to contain equal proportions of DOC and POC.

Following these updates, we calculated a flow-weighted concentration to represent the total effluent quality for Intalco.

Updates to U.S. Pulp and Paper Industry

For **WestRock**'s discharge, we used an average of observed NH_4^+-N data in Ahmed et al. (2014) as a constant monthly concentration instead of the poor regression used in Ahmed et al. (2019).

For **Port Townsend Paper** and **Kimberly Clark**, Ahmed et al. (2019) used the long-term average of WestRock to describe water quality. This was maintained except for DOC, which was calculated from plant-specific BOD by estimating the ultimate BOD and then converting it to DOC using a conversion factor of 2.7 g O_2/g C ratio.

Since Kimberly Clark started (Nov 2004) discharging to a combined outfall (Everett WWTP, Kimberly Clark, and Marysville WWTP) labelled "OF100" in Port Gardner, flow-weighted water quality effluent concentrations were recalculated for OF100, because of updates to Kimberly Clark's water quality.

We should note that the Kimberly Clark facility shut down discharge to its independent outfall in November 2004 and started discharging to the combined outfall "OF100." The facility completely shut down in 2012. So, the modeled years 2000, 2006, and 2008 were impacted by the updates at Kimberly Clark, but 2014 remained unimpacted.

For **McKinley Paper Company** (previously Nippon Paper), Ecology permit managers advised that the previous assumption of using WestRock's water quality (Ahmed et al. 2019) was inappropriate, as the two plants are very different (E. Toffol, personal communication, June 2, 2023). In this phase, we found facility-specific data beyond 2017 for NH_4^+-N, nitrate/nitrite, TOC, and DOC. These data sets were not previously available (Ahmed et al. 2019). Therefore, in this phase, we used plant-specific regressions for NH_4^+-N, nitrate/nitrite, TOC, and DOC using data beyond 2017 to backfill historical missing data. POC was then calculated as the difference between TOC and DOC.

Updates to U.S Petroleum Refineries

For oil refineries (US Oil, BP Cherry Point, Philips 66 Ferndale, Shell Oil and Tesoro), we applied long-term averages which were either provided by Ecology permit managers (G. Gould, personal communication, June 8, 2023, and L. Nguyen, personal communication, June 20, 2023) or obtained from their permit reports (Shell Oil and Tesoro; U.S. EPA 2019b and 2019c).

Ahmed et al. (2019) assumed all inorganic nitrogen from these facilities to be in the form of NH_4+-N. So, nitrate/nitrite concentration was assumed to be zero. In this phase, we obtained plant-specific nitrate/nitrite data (EPA Form 2C) or used the long-term averages provided by Ecology permit managers (listed above). These were then used as constant monthly averages.

Ahmed et al. (2019) assumed PON and DON for all the oil refineries at 0 mg/L. In this phase, we updated the long-term averages for NH_4+-N and TKN based on EPA Form 2C and discussions with Ecology permit managers (listed above). Based on updated NH_4+-N and TKN long-term average concentration, the TON for BP Cherry Point was estimated at 1.569 mg/L. This was split equally between PON and DON. For US Oil, there was not much difference between filtered and unfiltered TKN. As a result, we assumed all organic nitrogen to be DON, and PON was set to zero. For Conoco Phillips, there was no long-term concentration data for TKN. However, since NH_4+-N concentration was similar to that of US Oil, we assumed that DON was the same as that of US Oil, with zero concentration for PON. For Tesoro and Shell Oil, concentrations of TON were available in their EPA Form 2C, and we split TON equally between PON and DON. All these concentrations were used as constant monthly average values.

For all the refineries, Ahmed et al (2019) assumed a constant TOC concentration of 9.5 mg/L, consistent with Mohamedali (2011a) and based upon data for US Oil permit renewal at the time. POC was set to zero, which means that all TOC was in the form of DOC. In this phase, long-term averages for each plant were updated, which were either provided by Ecology permit managers (listed above) or obtained from recent EPA Form 2C. These were applied as monthly average concentrations. For Shell Oil, Tesoro, and BP Cherry Point, only TOC data were available, which we split equally between DOC and POC. US Oil had both DOC and POC data. Conoco Phillips did not have any data, so we used US Oil data for DOC. We split DOC 9:1 and POC 2:1 between fast and slow (as in Ahmed et al. 2019).

For all the refineries, Ahmed et al (2019) assumed a value of 0.4 mg/L for OP based on a 2004 EPA report as a national average for the refineries, and a zero concentration for DOP and POP. In this update, the Ecology permit manager (G. Gould, pers. comm., June 8, 2023) provided a complete set of long-term average concentrations for OP, TP, and DTP for US Oil. We applied the US Oil concentration based on this data set (0.7 mg/L OP) to the time series for all other refineries. With the same data set, we obtained DOP as DTP minus OP and POP as TP minus DOP. We used these concentrations for all oil refineries' time series as monthly average concentrations.

Changes in Point Source Nutrient Loading

This section presents the changes in point source nutrient loading due to the updates made between Optimization Phase 1 (Opt1) and this phase of the project — Optimization Phase 2 (Opt2). As mentioned earlier, point source nutrient loads in Opt1 (Ahmed et al. 2021) were the same as those in Ahmed et al. (2019). As in other sections of the report and Appendices, “anthropogenic” refers to local and regional human loads or influence.

Between Opt1 and Opt2, flows from all point sources, as well as flows and nutrient loads from Canadian point sources, remained the same. This section, therefore, focuses on comparisons in nutrient loading from U.S. point sources only.

Total nitrogen load changes

Figure C1-3 and Table C1-1 show that the total nitrogen load estimates for point sources changed very slightly between Opt1 and Opt2 due to the updates, with an overall increase in existing and anthropogenic TN loads across all US facilities of less than 5%. However, locally, the increases were higher. The largest increase in TN loads was in SOG, SJF, and Northern Bays. In SOG, anthropogenic TN loads increased by 52.6% and 60.3% in 2006 and 2014, respectively. In SJF and Northern Bays, anthropogenic TN loads increased by 10.7% – 16.5%. These increases are due to the changes made to the way NO_3-NO_2, PON, and DON are estimated for facilities located in these three basins (Figure C1-4). Oil refinery facilities were the cause of the TN load increase in SOG and Northern Bays, while McKinley Paper and Sequim WWTP were the facilities influencing the increase in SJF (see earlier discussion on updates made to these facilities).

In all other basins, there were either no differences between Opt1 and Opt2 anthropogenic TN loads when these loads are rounded to the 3 significant digits, or these differences are below 1%.

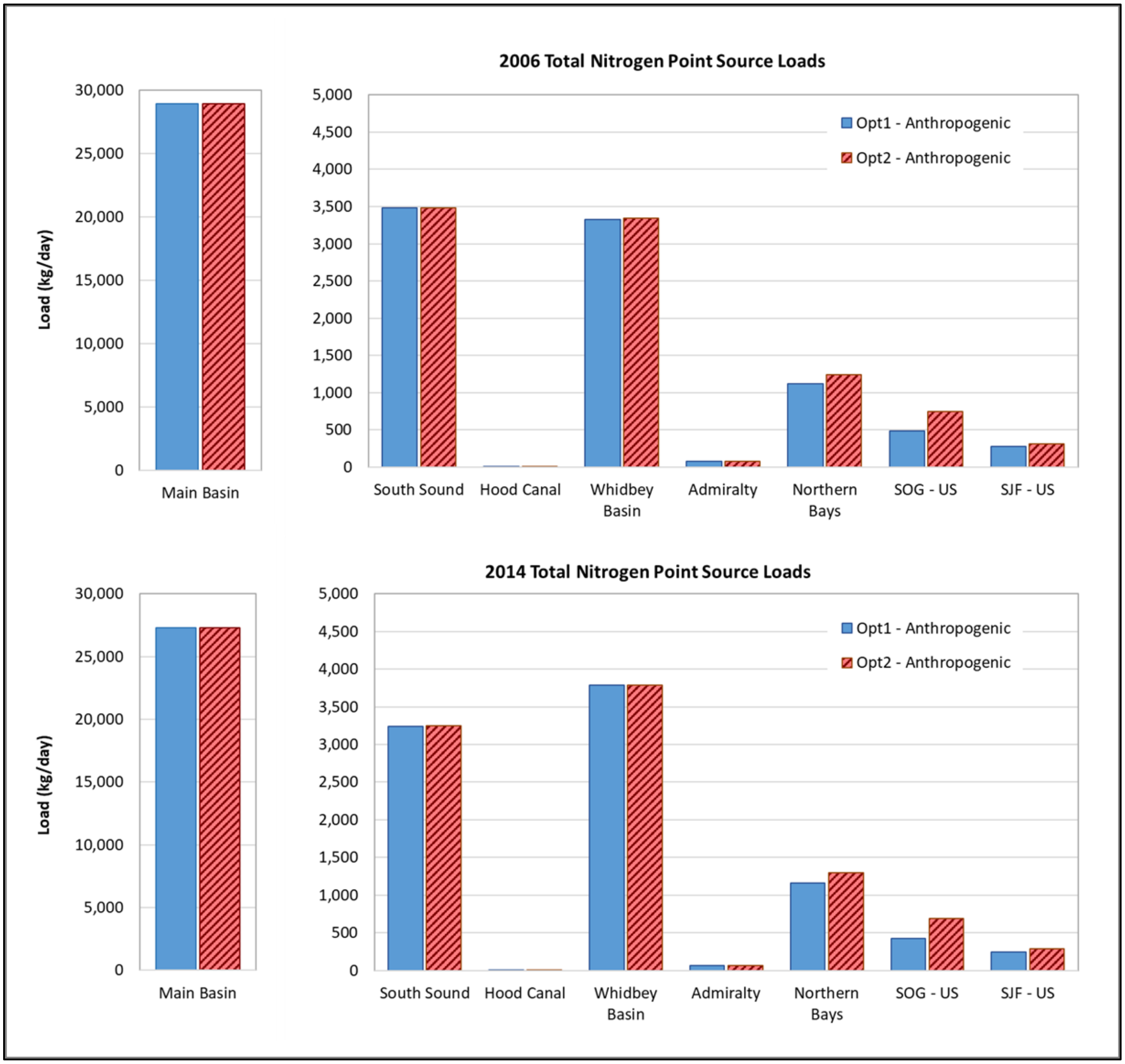
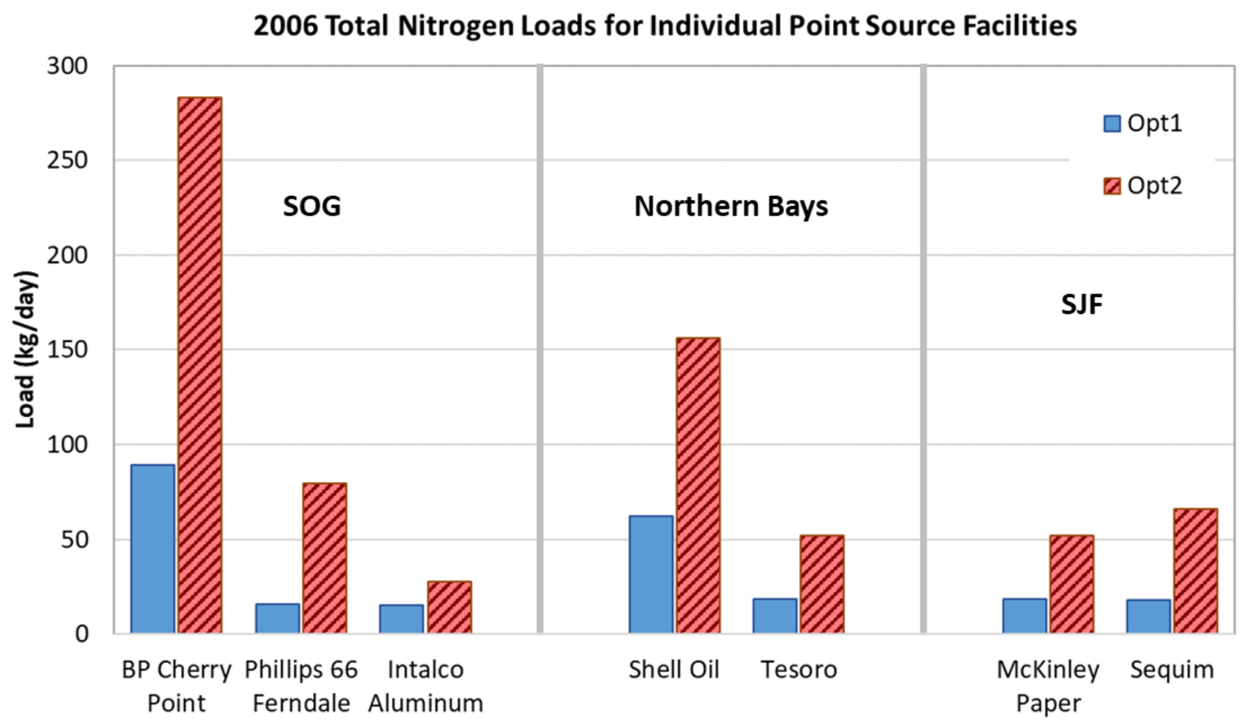


Figure C1-3. Comparison of annual daily average anthropogenic total nitrogen (TN) point source loads entering different basins in the Salish Sea in Optimization Phase 1 (Opt1) and Optimization Phase 2 (Opt2) during 2006 (top plot) and 2014 (bottom plot.
The y-axis range for Main Basin loads plot is much larger.

Table C1-1. Comparison of annual daily average existing, reference, and anthropogenic total nitrogen (TN) point source loads entering different basins in the Salish Sea in Optimization Phase 1 (Opt1) and Optimization Phase 2 (Opt2) during 2006 and 2014.

Total Nitrogen: Existing Loads by Basin	2006 Opt1 load (kg/day)	2006 Opt2 load (kg/day)	2006 Diff. in load (kg/day)	2006 Diff. in load (%)	2014 Opt1 load (kg/day)	2014 Opt2 (kg/day)	2014 Diff. in load (kg/day)	2014 Diff. in load (%)
South Sound	3,510	3,510	0.00	0.0%	3,260	3,270	10.00	0.3%
Main Basin	29,100	29,100	0.00	0.0%	27,500	27,500	0.00	0.0%
Hood Canal	1.22	1.21	-0.01	-0.8%	1.02	1.02	0.00	0.0%
Whidbey Basin	3,360	3,370	10.00	0.3%	3,810	3,810	0.00	0.0%
Admiralty	75.1	75.1	0.00	0.0%	67.4	67.4	0.00	0.0%
Northern Bays	1,120	1,250	130	11.6%	1,170	1,310	140	12.0%
SOG—US	496	758	262	52.8%	434	697	263	60.6%
SJF—US	278	316	38.0	13.7%	250	290	40.0	16.0%
Salish Sea US Total	**37,940**	**38,380**	**440**	**1.2%**	**36,492**	**36,945**	**453**	**1.2%**
Total Nitrogen: Reference loads by Basin	**2006 Opt1 load (kg/day)**	**2006 Opt2 load (kg/day)**	**2006 Diff. in load (kg/day)**	**2006 Diff. in load (%)**	**2014 Opt1 load (kg/day)**	**2014 Opt2 (kg/day)**	**2014 Diff. in load (kg/day)**	**2014 Diff. in load (%)**
South Sound	29.1	29.1	0.00	0.0%	22.6	22.6	0.00	0.0%
Main Basin	197	197	0.00	0.0%	186	187	1.00	0.5%
Hood Canal	0.006	0.006	0.00	0.0%	0.006	0.006	0.00	0.0%
Whidbey Basin	31.3	31.3	0.00	0.0%	16.9	16.9	0.00	0.0%
Admiralty	1.84	1.84	0.00	0.0%	1.76	1.75	-0.01	-0.6%
Northern Bays	8.04	13.30	5.26	65.4%	8.32	13.7	5.38	64.7%
SOG—US	6.74	11.60	4.86	72.1%	5.79	10.7	4.91	84.8%
SJF—US	1.67	1.54	-0.13	-7.8%	1.64	1.50	-0.14	-8.5%
Salish Sea US Total	**276**	**286**	**10.0**	**3.6%**	**243**	**254**	**11.1**	**4.6%**
Total Nitrogen: Anthropogenic loads by Basin	**2006 Opt1 load (kg/day)**	**2006 Opt2 load (kg/day)**	**2006 Diff. in load (kg/day)**	**2006 Diff. in load (%)**	**2014 Opt1 load (kg/day)**	**2014 Opt2 (kg/day)**	**2014 Diff. in load (kg/day)**	**2014 Diff. in load (%)**
South Sound	3,480	3,480	0.00	0.0%	3,240	3,250	10.00	0.3%
Main Basin	28,900	28,900	0.00	0.0%	27,300	27,300	0.00	0.0%
Hood Canal	1.21	1.20	-0.01	-0.8%	1.01	1.01	0.00	0.0%
Whidbey Basin	3,330	3,340	10.00	0.3%	3,790	3,790	0.00	0.0%
Admiralty	73.3	73.3	0.00	0.0%	65.6	65.7	0.10	0.2%
Northern Bays	1,120	1,240	120	10.7%	1,160	1,300	140	12.1%
SOG—US	489	746	257	52.6%	428	686	258	60.3%
SJF—US	277	314	37.0	13.4%	248	289	41.0	16.5%
Salish Sea US Total	**37,671**	**38,095**	**424**	**1.1%**	**36,233**	**36,682**	**449**	**1.2%**



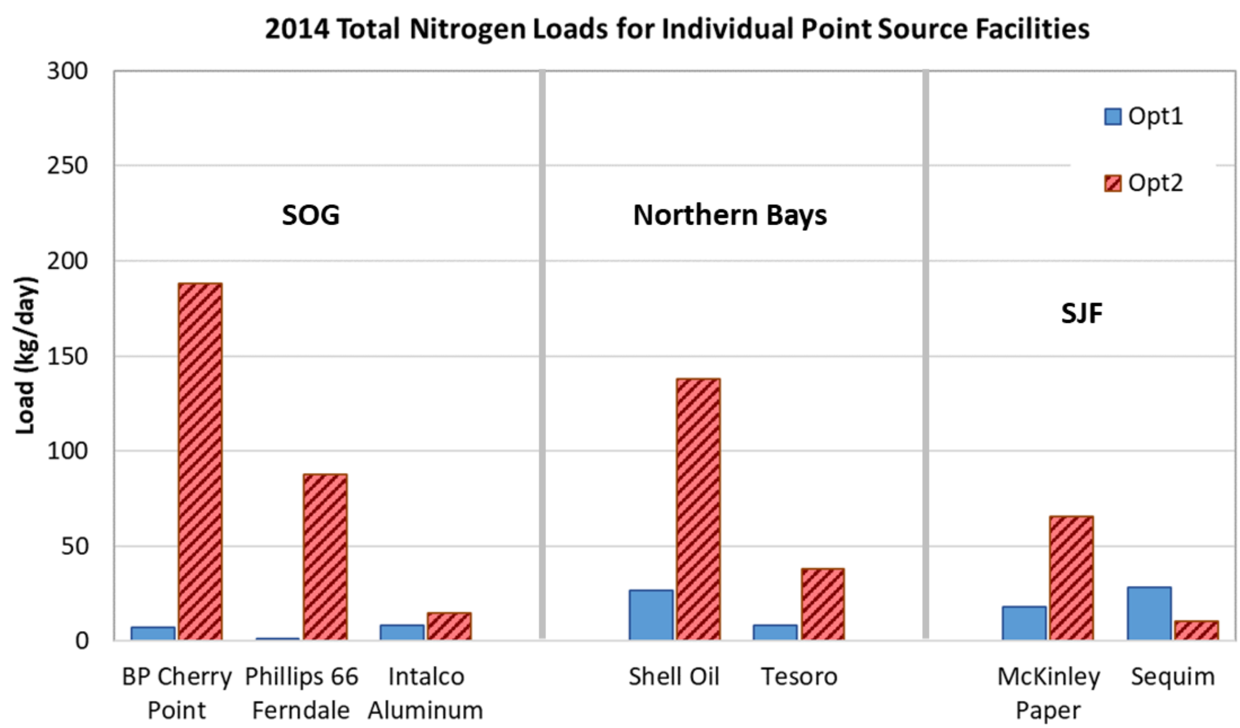


Figure C1-4. Comparison of existing Opt1 and Opt2 annual daily average total nitrogen (TN) loads for the individual facilities that resulted in TN load increases in SOG, Northern Bays, and SJF in 2006 (top plot) and 2014 (bottom plot).

Total organic carbon load changes

Figure C1-5 and Table C1-2 show changes in TOC load estimates for point sources between Opt1 and Opt2 due to the updates discussed in this appendix. Across all US facilities, there was a 22.4% and 12.7% decrease in anthropogenic TOC load in 2006 and 2014, respectively. The largest change in the magnitude of TOC loads was in Whidbey Basin, where estimated anthropogenic TOC loads decreased by 1,780 kg/day in 2006 (but only decreased by 10 kg/day in 2014). This change was primarily due to the changes in how the DOC (a component of TOC) was estimated for Kimberly Clark. In Opt1 and in Ahmed et al. (2019), DOC for this facility was estimated using DOC observations at West Rock. However, with Opt2 updates (see discussion above under "Updates for US pulp and paper industry"), DOC is now calculated from plant-specific BOD. This method change did not affect 2014 loads since Kimberly Clark fully ceased operations in 2012 and is not included in 2014 estimates.

Like TN loads, the largest percent changes in anthropogenic TOC loads were in SOG, SJF, and Northern Bays. In SOG, anthropogenic TOC loads increased by 92.8% and 183% in 2006 and 2014, respectively, while in the Northern Bays, anthropogenic TOC loads increased by 66.2% and 56.6% in 2006 and 2014, respectively. These increases are due to changes made to organic carbon estimates for oil refineries and the Intalco aluminum facility (Figure C1-6). Ahmed et al. (2019) assumed a TOC value of 9.5 mg/L, all of which was in the form of DOC, and POC was set to zero. However, in this update, we acquired recent facility-specific data and used these data to calculate a long-term average concentration of TOC, which was split equally between DOC and POC (see discussion above under "Updates for Aluminum Facilities").

In SJF, anthropogenic TOC loads decreased by 57.9% and 49.8% in 2006 and 2014, respectively. This decrease is due to the changes made to the TOC concentration of McKinley Paper Company (Figure C1-6). Ahmed et al. (2019) applied the long-term average concentration of DOC and POC of WestRock for McKinley Paper. In this update, we utilized plant-specific regression built with observed TOC and DOC data beyond 2017 up to 2022 to backfill TOC and DOC data (see discussion above under "Updates for US Pulp and Paper Industry"). This resulted in a decrease in TOC load at this facility since the long-term average TOC concentration for WestRock that was used previously was higher than McKinley Paper's range in TOC concentrations.

In the Main Basin and Hood Canal, the regional reference concentrations were updated to now include estimated reference lake concentrations (Lake Washington and Lake Cushman). This resulted in a decrease of anthropogenic TOC loads between Opt1 and Opt2 of about 20% in Main Basin, and 12%–14% in Hood Canal. In the remaining basins (South Sound, Hood Canal, and Admiralty), differences in anthropogenic TOC load between Opt1 and Opt2 were all below 10%.

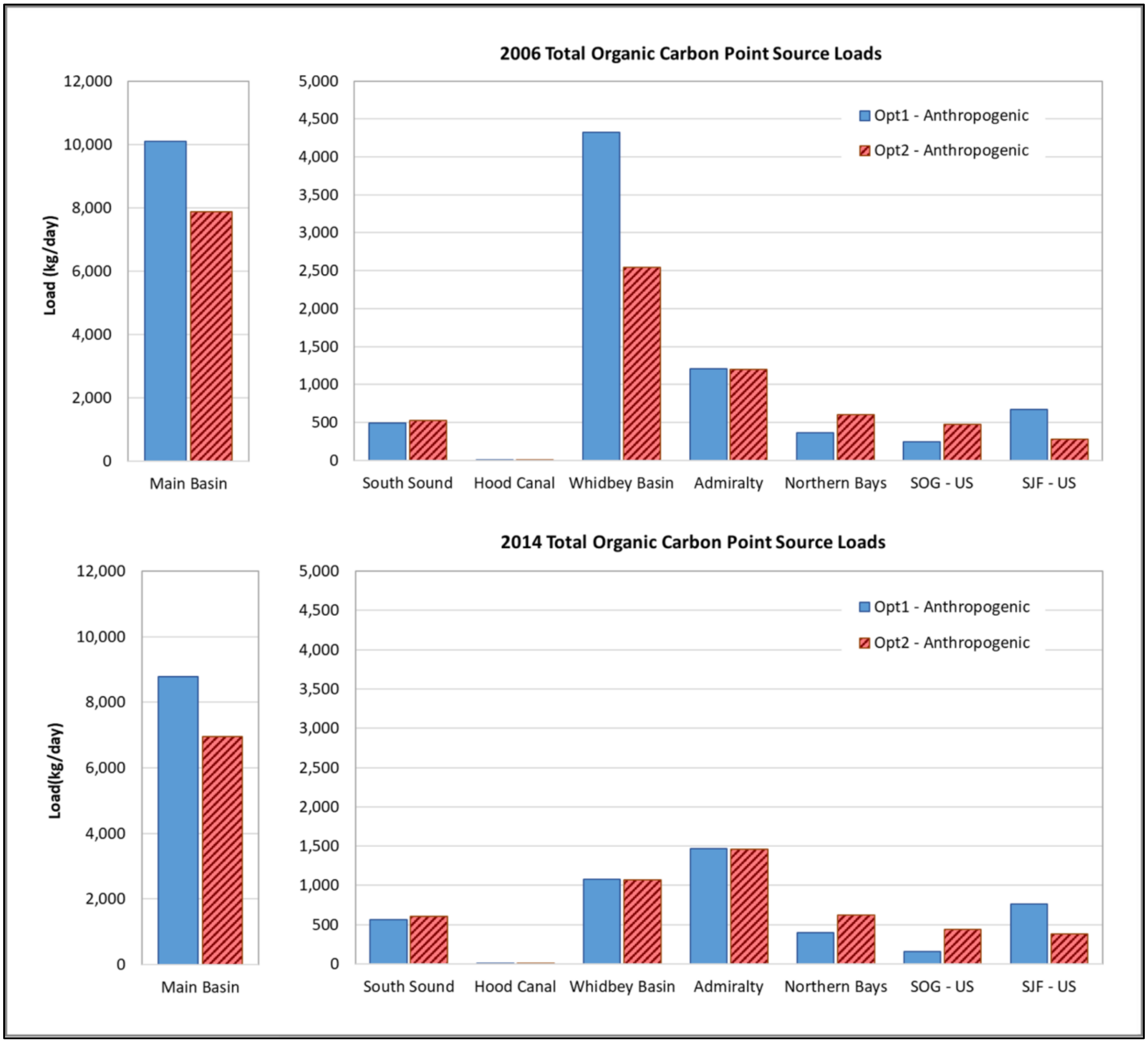


Figure C1-5. Comparison of annual daily average anthropogenic total organic carbon (TOC) point source loads entering different basins in the Salish Sea in Optimization Phase 1 (Opt1) and Optimization Phase 2 (Opt2) during 2006 (top plot) and 2014 (bottom plot).

The y-axis range for Main Basin loads plot is much larger.

Table C1-2. Comparison of annual daily average existing, reference, and anthropogenic total organic carbon (TOC) point source loads entering different basins in the Salish Sea in Optimization Phase 1 (Opt1) and Optimization Phase 2 (Opt2) during 2006 and 2014.

Total Organic Carbon: Existing loads by Basins	2006 Opt1 load (kg/day)	2006 Opt2 load (kg/day)	2006 Diff. in load (kg/day)	2006 Diff. in load (%)	2014 Opt1 load (kg/day)	2014 Opt2 load (kg/day)	2014 Diff. in load (kg/day)	2014 Diff. in load (%)
South Sound	766	767	1.00	0.1%	808	808	0.00	0.0%
Main Basin	10,900	10,900	0.00	-0.2%	9,550	9,580	30.0	0.3%
Hood Canal	0.449	0.448	0.00	-0.3%	0.518	0.518	0.00	0.0%
Whidbey Basin	4,600	2,760	-1,840	-40.0%	1,240	1,200	-40.0	-3.4%
Admiralty	1,220	1,220	0.00	0.0%	1,480	1,480	0.00	0.3%
Northern Bays1	456	703	247	54.3%	483	728	245	50.8%
SOG—US	314	534	220	70.3%	216	508	292	135%
SJF—US	693	303	-390	-56.3%	791	405	-386	-48.8%
Salish Sea US Total	**18,949**	**17,187**	**-1,762**	**-9.3%**	**14,569**	**14,710**	**141**	**1.0%**
Total Organic Carbon: Reference loads by Basins	**2006 Opt1 load (kg/day)**	**2006 Opt2 load (kg/day)**	**2006 Diff. in load (kg/day)**	**2006 Diff. in load (%)**	**2014 Opt1 load (kg/day)**	**2014 Opt2 load (kg/day)**	**2014 Diff. in load (kg/day)**	**2014 Diff. in load (%)**
South Sound	278	238	-40.0	-14.4%	241	206	-35.0	-14.6%
Main Basin	831	3,020	2,189	264.0%	773	2,630	1,857.0	240%
Hood Canal	0.097	0.138	0.041	42.6%	0.108	0.167	0.059	54.9%
Whidbey Basin	279	223	-56.0	-20.0%	163	131	-32.0	-19.9%
Admiralty	9.14	19.4	10.3	112.0%	8.28	17.6	9.32	113%
Northern Bays1	95.2	104	8.80	9.3%	83.8	103	19.2	23.0%
SOG—US	68.3	61.0	-7.30	-10.6%	59.1	63.7	4.60	7.8%
SJF—US	27.8	22.4	-5.40	-19.4%	26.7	21.1	-5.60	-21.1%
Salish Sea US Total	**1,589**	**3,688**	**2,099**	**132.2%**	**1,355**	**3,173**	**1,817.6**	**134.1%**
Total Organic Carbon: Anthropogenic loads by Basins	**2006 Opt1 load (kg/day)**	**2006 Opt2 load (kg/day)**	**2006 Diff. in load (kg/day)**	**2006 Diff. in load (%)**	**2014 Opt1 load (kg/day)**	**2014 Opt2 load (kg/day)**	**2014 Diff. in load (kg/day)**	**2014 Diff. in load (%)**
South Sound	488	529	41.0	8.3%	566	602	36.0	6.3%
Main Basin	10,100	7,880	-2,220	-21.9%	8,780	6,950	-1,830	-20.8%
Hood Canal	0.352	0.310	-0.042	-12.0%	0.410	0.351	-0.059	-14.4%
Whidbey Basin	4,320	2,540	-1,780	-41.2%	1,080	1,070	-10.0	-1.0%
Admiralty	1,210	1,200	-10.0	-0.8%	1,470	1,460	-10.0	-0.4%
Northern Bays1	360	599	239	66.2%	399	625	226	56.6%
SOG—US	245	473	228	92.8%	157	444	287	183%
SJF—US	666	281	-385	-57.8%	764	384	-380	-49.8%
Salish Sea US Total	**17,389**	**13,502**	**-3,887**	**-22.4%**	**13,216**	**11,535**	**-1,681**	**-12.7%**

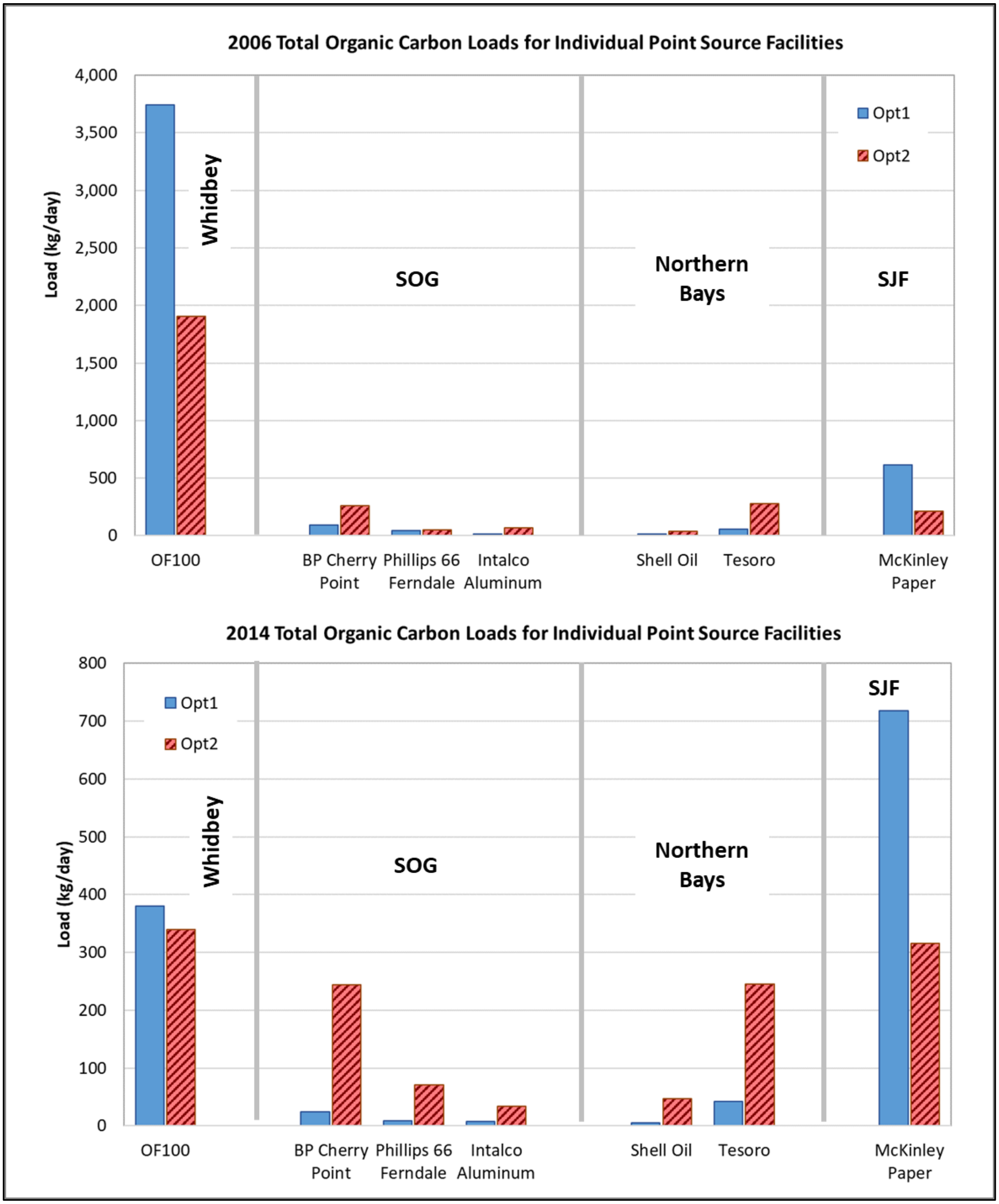


Figure C1-6. Comparison of existing Opt1 and Opt2 total organic carbon (TOC) loads for the individual facilities that resulted in the largest changes in TOC loads in Whidbey Basin, SOG, Northern Bays, and SJF in 2006 (top plot) and 2014 (bottom plot).

Updates for Canadian WWTPs

In reviewing the water quality data for Canadian WWTPs, we noticed that Port Renfrew WWTP was grouped with other Gulf Island WWTPs. The outfall locations of the four Canadian Gulf Island WWTPs (Cannon, Ganges, Maliview Estate, and Schooner) are near to each other and therefore grouped together and assigned a single node in the SSM under the umbrella of Gulf Island WWTP. This is not an update, but has been the approach used in previous SSM modeling efforts to date. However, this group previously (Ahmed et al. 2019) erroneously contained Port Renfrew WWTP. The total flow and flow-weighted water quality for the Gulf Island WWTP (four in total) were updated, along with moving the outfall for Port Renfrew to its correct location (Figure C1-7) and updating its associated flow and water quality time series. The water quality time series were built as before (Ahmed et al. 2019). Aggregated loading estimates for all Canadian WWTPs only changed slightly (<0.03%) due to regrouping of Gulf Island WWTP and relocation of Port Renfrew WWTP compared to loadings in Ahmed et al. (2019).

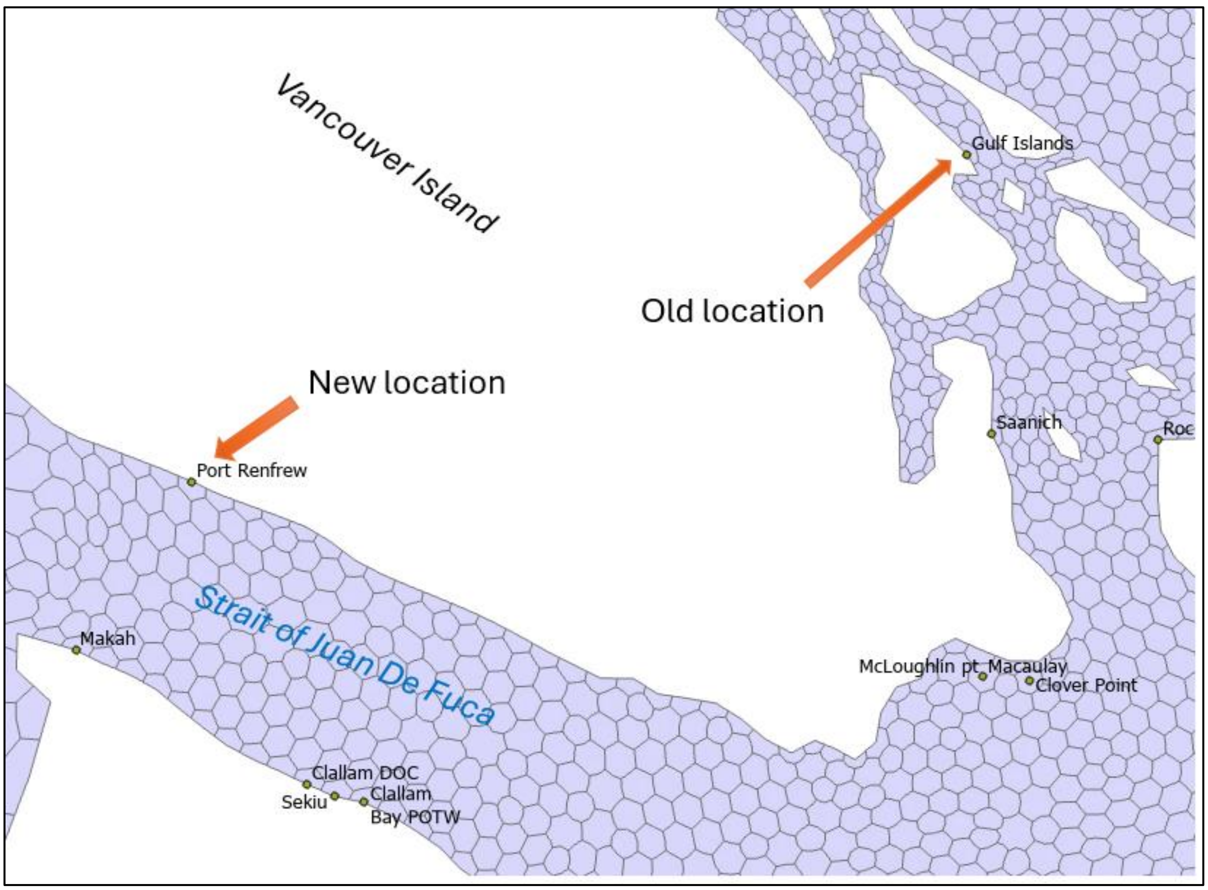


Figure C1-7. Location of Port Renfrew WWTP, old versus new.

References

Ahmed, A., Pelletier, G., Roberts, M. Environmental Assessment Program. Kolosseus, A. Water Quality Program. 2014. South Puget Sound Dissolved Oxygen Study Water Quality Report. Washington State Department of Ecology. https://apps.ecology.wa.gov/publications/SummaryPages/1403004.html.

Ahmed, A., C. Figueroa-Kaminsky, J. Gala, T. Mohamedali, G. Pelletier, S. McCarthy. 2019. Puget Sound Nutrient Source Reduction Project Volume 1: Model Updates and Bounding Scenarios. Washington State Department of Ecology, Olympia, WA. https://apps.ecology.wa.gov/publications/SummaryPages/1903001.html.

Ahmed, A., C. Figueroa-Kaminsky, J. Gala, T. Mohamedali, S. McCarthy. 2021. Technical Memorandum: Puget Sound Nutrient Source Reduction Project — Optimization Scenarios Phase 1. Washington State Department of Ecology, Olympia, WA. https://www.ezview.wa.gov/Portals/_1962/Documents/PSNSRP/OptimizationScenarioTechMemo_9_13_2021.pdf

Mohamedali, T., M. Roberts, B. Sackmann, and A. Kolosseus. 2011a. Puget Sound dissolved oxygen model nutrient load summary for 1999 – 2008. Publication 11-03-057. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1103057.html

Mohamedali, T., M. Roberts, B. Sackmann, A. Whiley, and A. Kolosseus. 2011b. South Puget Sound dissolved oxygen study: Interim nutrient load summary for 2006–2007. Publication 11-03-001. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1103001.html.

U.S. EPA. 2019a. National Pollution Discharge Elimination System (NPDES) Permit Renewal Application, Intalco Aluminum Corporation. U.S. Environmental Protection Agency, Office of Enforcement, Washington, D.C.

U.S. EPA. 2019b. National Pollution Discharge Elimination System (NPDES) Permit Renewal Application, Tesoro Refining & Marketing Company Corporation. U.S. Environmental Protection Agency, Office of Enforcement, Washington, D.C.

U.S. EPA. 2019c. Application Form 2C, Existing Manufacturing, Commercial, Mining, and Silvicultural Operations, NPDES Permitting Program, Shell Oil Products. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.