

SFD Lite Report

King County, WA United States of America

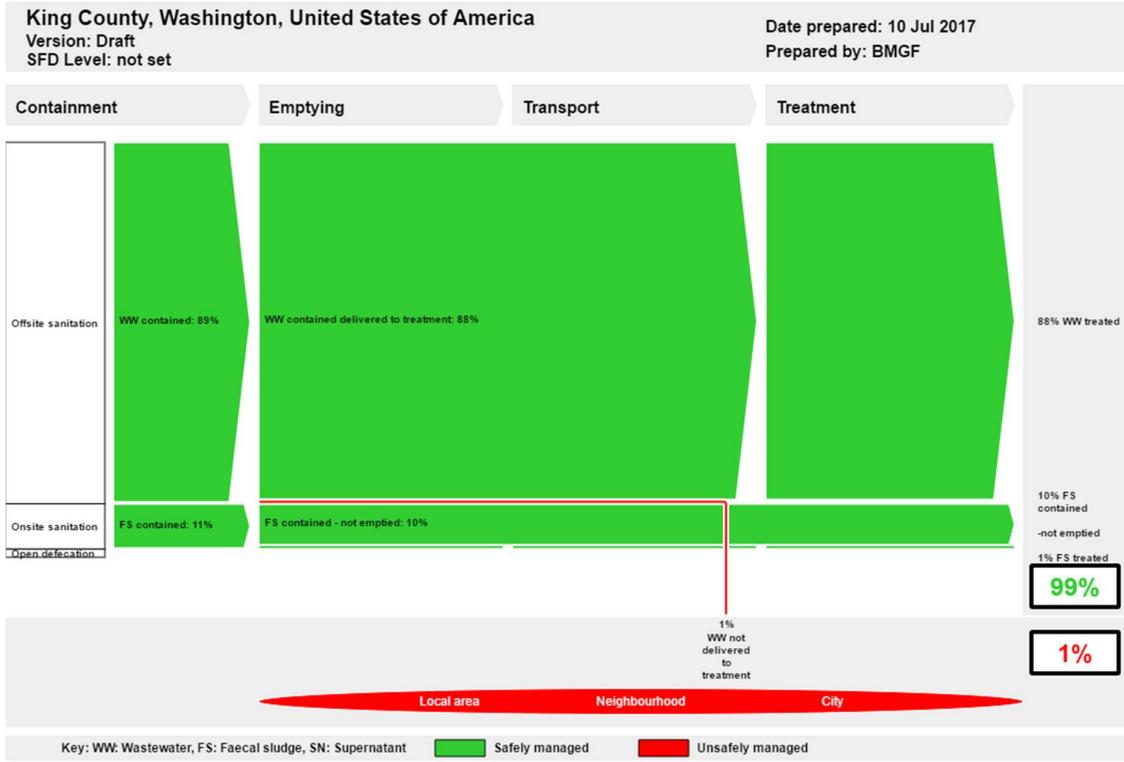
Final Report

This SFD Lite was prepared by the Bill & Melinda Gates Foundation as part of the SFD Promotion Initiative.

Date of production: 22/06/2017

Last update: 05/2018

1 The SFD Graphic



2 SFD Lite information

Produced by:

The Faecal / Excreta / Shit Flow Diagram (SFD) for King County was created using the SFD Generator tool on the SuSanA website through desk-based research by the Bill & Melinda Gates Foundation in Seattle, Washington.

Date of production: 10/072017

3 General city information

King County is located in the state of Washington in the Pacific Northwest region of the United States of America. It has a population of 2.1 million people and is the most populous county in the state. The population growth in King County is greater than that of most other counties in the US, mainly due to urban growth and the inclusion of formerly unincorporated areas into cities. The seat of the county is Seattle, which is the state's largest city.

King County covers an area of 2,131 square miles and is bounded by the Puget Sound and Olympic Mountains to the west, Snohomish County to the north, Pierce County and Mount Rainier to the south and the Cascade Range to the east. The region has been worn by ice-age glaciers that carved Puget Sound, Lake Washington and Lake Sammamish and shaped lowland hills, leaving behind patches of conglomerate till and gravelly outwash soil.

Except for rural Vashon Island in the Puget Sound, the county is covered by cities while the development pattern becomes gradually sparser to the east, with suburban developments, then rural residential lands, then farms and forestlands. The eastern half of King County is mountainous, and mostly set aside as wilderness areas, forestlands or restricted watersheds that capture and store the region's drinking water.

King County experiences a mild Pacific maritime climate, with its weather heavily influenced by atmospheric conditions over the Pacific Ocean. About two-thirds of the Pacific Northwest precipitation occurs from October to March, with most of it captured in the mountains. On average, King County gets about 46 inches of precipitation annually.

The topography of the King County Area ranges from nearly level to very steep. Depressions occur in various places. Soils in depressions show characteristics associated with wetness, namely gray and bluish mottles. Examples are soils of the Bellingham and Puget series. Soils formed on the highest mounds of the valley bottoms are well drained. Sloping soils on the upland terraces and in very steep mountainous areas are well to moderately well-drained.

King County has a variety of water resources including 760 lakes and reservoirs, 975 wetlands, 6 major river systems, 3,000 miles of streams and 100 miles of marine coastline. The King County Groundwater Protection Program oversees the county's five groundwater management areas (GWMAs): East King County, Issaquah Creek Valley, Redmond Bear Creek Valley, South King County and Vashon-Maury Island.

4 Service outcomes

King County, Washington, United States of America, 10 Jul 2017. SFD Level: not set
Population: 1866600

Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

System label	Pop	W4a	W5a	F3	F4	F5
System description	Proportion of population using this type of system	Proportion of wastewater in sewer system, which is delivered to centralised treatment plants	Proportion of wastewater delivered to centralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C1 User interface discharges directly to a centralised combined sewer	59.0	99.0	100.0			
T1A1C2 User interface discharges directly to a centralised four/separate sewer	30.0	100.0	100.0			
T1A2C5 Septic tank connected to soak pit	11.0			7.0	100.0	100.0

Table 1: SFD Matrix for King County (BMGF 2017)

It is estimated that 99% of faecal sludge and wastewater is treated and safely managed in King County. Part of the remaining 1% that is discharged untreated also goes through some primary treatment, although it was not possible to estimate the proportion of CSOs undergoing primary treatment from secondary sources of data. Given the Protect Our Waters initiative that aims to control all CSOs by 2030, it is likely that the county will be able to achieve 100% treated and safely discharged faecal waste by 2030.

4.1 Groundwater contamination

Approximately one-third of King County residents rely on groundwater wells for drinking water. Although data on the relative elevation of groundwater sources to on-site sanitation facilities was unavailable, data on septic tank proximity, water table depth and protection of groundwater sources were collected (section 5). This information, together with qualitative data from KIIs (Table 6) with septic tank designers, confirmed that septic tank licenses are issued by the King County Waste Water Treatment Division based on a thorough land assessment to ensure that there is no risk of groundwater contamination by on-site sewage facilities.

4.2 Containment

Most of King County (89%) is sewered with separate, partial and combined sewage systems. Combined sewers are predominantly found in older Seattle neighbourhoods where two-thirds of the sewage system is still combined or partially separated. However, due to lack of additional data, it was assumed that two-thirds of all sewage systems in the county were combined or partially separated. This assumption might have resulted in a slight overestimation of wastewater not safely transported and managed as combined sewers are prone to outfalls during heavy rainfall.

There are also 85,000 septic tanks in the county, including 192 in Seattle and a community septic tank on Vashon Island. Together, these septic systems are calculated to serve 11% of the population based on the assumption that each septic tank has on average 2.5 users.

4.3 Emptying

Septic tank inspection is required every six months to every year depending on the type of septic system. However, emptying of tanks is recommended once in three to five years. However, based on septage collection fees imposed on septic tank pumpers by county-managed wastewater treatment plants, it is estimated that only 7% of septic tanks are regularly emptied. All septage collected from tanks is transported to wastewater treatment plants.

4.4 Transport

All faecal sludge from on-site sanitation facilities and in separate sewers is assumed to be safely transported to treatment plants. It is estimated that the CSO of King County is between 0.8 and 1.06 billion gallons, which makes up only 1.5% of the total sewage treated or discharged untreated. This percentage is likely to be an overestimate as some CSOs undergo primary treatment at one of four CSO treatment facilities.

4.5 Treatment

It is assumed that all wastewater transported to treatment plants is safely managed and treated. Treatment plant failures, such as the 2017 failure of the West Point Treatment Plant that resulted in the discharge of raw, untreated sewage into the Puget Sound are not factored into the main King County SFD, on account of their being an irregular occurrence (past failures were in 2009, 2006, and 2000) and deviation from the regular sanitation service delivery chain in the County (Willmsen & Mapes, 2017). In addition, even if these were factored into the SFD, the amount of waste untreated that is discharged into the environment would not rise significantly. During the 2000 failure of the West Point Treatment Plant, a total of 20 million gallons of untreated wastewater was discharged into the Puget Sound; in 2006, 59 million gallons were discharged; in 2009, 9 million gallons were discharged and only was it most recently in 2017, were 235 million gallons of wastewater (including 30 million gallons of raw sewage) discharged into the Puget Sound. An independent investigation on the 2017 plant failure is underway and King County is likely to be fined for the incident.

An SFD for the quarter during which the West Point Treatment Plant failure occurred in Q1, 2017 is in Table 8 and Table 9.

4.6 Reuse and disposal

The King County Recycled Water Program is responsible for recycling wastewater for landscape and crop irrigation, industrial processes, wetland enhancement and drinking. King County produces high-quality recycled water at the South Treatment Plant, Brightwater Treatment Plant and Carnation Treatment Plant. Additionally, water is recycled for many non-potable internal process uses at the West Point Treatment Plant.

Recycled drinking water is generated with the use of advanced filtration and disinfection to kill bacteria and viruses that may be harmful to people. It is strictly regulated by the state of Washington and is closely monitored and rigorously tested before delivery to customers to ensure that it meets or exceeds quality standards for safety. As with lake or river water, "Class A" reclaimed water is safe for human contact, but it is not approved for drinking. This means it is safe to use recycled water for industrial processes like heating or cooling, or for watering crops and sports fields.

In total, the system produces 711 million gallons of filtered water a year that is reused at the county's wastewater treatment plants, 83 million gallons of reclaimed Class A water for non-potable uses and 300 million gallons of high-quality recycled water used outside of the plants for other purposes. (King County Department of Natural Resources and Parks, 2016a; kingcounty.gov)

In addition to recycling of water, the King County Wastewater Treatment Division recycles about 120,000 tons of biosolids annually. Biosolids are the nutrient-rich organic products of the wastewater treatment process that contain water, organic matter, sand, nutrients, as well as microorganisms, trace metals, and trace organic compounds. Because of their moisture content, carbon-rich and humus-like characteristics, essential nutrients for plants, and very low levels of pollutants, biosolids are effective, safe, and sustainable to use as a soil conditioner, fertilizer for forest trees and agricultural crops, and as a feedstock ingredient in compost for landscaping. Biosolids are classified as "Class A" or "Class B" based on the level of pathogen reduction. Class A biosolids are treated to eliminate pathogens and can be used in landscaping and home garden, but this process is generally more energy intensive or costly. Class B biosolids are treated to significantly reduce, but not eliminate, pathogens. King County produces Class B biosolids under the brand-name Loop® biosolids. King County's Loop® biosolids are recycled as a fertilizer and soil conditioner in agriculture and forestry, and a portion of these biosolids is composted by a private company and sold as GroCo compost for use in landscaping and gardening.

4.7 Sanitation on Vashon Island

Vashon Island is a part of King County relying heavily on septic systems. In 1991, 40% of the homes on the island had failing septic systems. In response, the Beulah Park wastewater treatment system was built in the late 1990s. It serves several dozen households on Vashon Island, treating an average of 5,274 gallons of wastewater every day. Besides those served by the community septic tank on this island, there are 263 homes that rely on their own individual septic systems that, until 2008, had not been upgraded for many years, and were a cause of pollution in the Puget Sound, killing shellfish. In 2008, King County imposed a fee on residents of \$25 per day until systems were upgraded, resulting in most homes complying with this requirement issued by King County. However, upgrading septic tanks is an expensive process that can cost up to \$30,000. King County does have an 'Onsite Septic Loan' program that provides homeowners on Vashon Island with financial aid to upgrade and maintain septic systems, especially for residents who live in shellfish protection areas.

4.8 The Last 1%

Although King County has been monitoring and controlling CSOs since 1979, on July 3, 2013, a Consent Decree, Civil Action No. 2:13-cv-677, between the United States Department of Justice, United States Environmental Protection Agency, Ecology, and King County was finalized that required King County to provide an annual report on controlling its CSOs. In 2015, King County began a comprehensive update of the CSO control program and the 2012 Long Term Capital Projects (LTPCs). The Nine Minimum Controls are actions that can be taken to minimize CSO impacts while LTPCs are under way. King County has implemented a number of programs to satisfy the requirements of the Nine Minimum Controls, which are a part of EPA's codified CSO Control Policy and included in the West Point Treatment Plant NPDES permit. These include reducing CSOs through operations and maintenance, storing CSOs in a collection system, optimizing pretreatment, maximizing flow to a treatment plant, preventing dry weather overflows, controlling solids and floatables, preventing pollution, notifying the public and monitoring outfalls. The county now has four CSO treatment facilities at Alki, Carkeek, Mercer/Elliott West, and Henderson/Norfolk in Seattle. Through 2030, King County will complete a total of 14 projects to control pollution in the Duwamish River, Lake Washington Ship Canal, and Puget Sound including treatment plants and wet weather storage facilities, that will improve the treatment of wastewater even during periods of heavy rainfall and mitigate the discharge of untreated sewage into the environment almost entirely.

4.9 Sanitation for the Homeless in Seattle

There is a growing population of homeless individuals in King County, especially in the city of Seattle. In 2017, there were 11,600 homeless people in the county (Coleman, 2017), with 5,485 of them (47%) living on the streets, in motor vehicles and tent encampments, and the remaining living in emergency shelters or transitional housing. The homeless population living in emergency shelters or transitional housing have access to toilets and showers, and those living on the street, vehicles and tents use Rest Stops (Peace Heathens' Crisis Resource Directory, 2015) that have Hygiene Centers (including separate Hygiene Centers for women). Since 2013, the county has legislation that makes public urination and defecation an infraction (Campbell & Spencer, 2013) that could result in fines of up to \$125, however, with limited 24-hour public restrooms in the county, it is estimated that open defecation and urination still takes place. On report shows that over a recent five-year period, 1,004 citations (~200 per year) were issued in the Seattle area for open defecation. If these citations were issued to unique individuals who regularly practice open defecation and that open urination or defecation occurred at the same frequency throughout the county, it can be assumed that 558 individuals (<0.1% of the population) in the county practice open defecation.

5 Data and assumptions

Table 2: Total Population Served

	West Point	South	Brightwater	Vashon	Carnation	Septic Tank Users	Total
Population served	683,000	742,000	226,000	1,100	2,000	212,500	1,866,600
Proportion / Percentage	37%	40%	12%	0%	0%	11%	100%

Assumptions:

- (1) Total number of septic tank users calculated at the rate of 2.5 users per tank * 85,000 tanks = 212,500
- (2) Septic tank users are not already counted in the population served by the five different treatment plants
(ie, no double counting of individuals served in the county)

Table 3: Population Served by Sanitation System

	Offsite Sanitation		Onsite Sanitation	
% population served	89%		11%	
	Centralized Combined Sewer	Centralized separate sewer	Septic tank without significant risk of groundwater pollution	Septic tank with significant risk of groundwater pollution
% of total type (of sewer or septic system)	66%	33%	100%	0%
% population served	59%	30%	11%	0%

Assumptions:

- (1) Based on [definitions of centralized vs. decentralized sewerage systems](#) (sewage can be treated close to where the sewage is created, which may be called a "decentralized" system or even an "on-site" system (in septic tanks, biofilters or aerobic treatment systems) or it can be collected and transported by a network of pipes and pump stations to a municipal treatment plant or a "centralized" system), the three regional treatment plants – West Point, South and Brightwater are assumed to be part of the central sewerage system that serve 89%. Vashon and Carnation being local treatment plants are therefore assumed to be decentralized. However, Vashon & Carnation serve <1% of the population and therefore decentralized sewers are not accounted for while generating the SFD.
- (2) As [2/3 of all Seattle's sewers are combined or partially separated sewers](#), $2/3 * 89\% = 59\%$ of all King County sewers are assumed to be combined sewers, with the remaining $1/3 * 89\% = 30\%$ being separate sewers. This might be an overestimate of combined sewers in the county as a whole, because [combined sewer outflows \(CSOs\) are more common in Seattle](#) than in other parts of King County but this could be due to higher sewer density and / or because CSO storage and treatment facilities are concentrated in the Seattle area.

Table 4: Total Sewage Treated or Discharged in a Typical Year (eg. 2016)

	<u>West Point</u>	<u>South</u>	<u>Bright water</u>	<u>Vashon</u>	<u>Carnation</u>	CSO	Total
Wastewater volume / day (2016) (mgd)	98.5	71.4	18.1	0.17	0.09	-	
Wastewater volume / year (2016) (mgy)	68,729.5 (=68.7 billion)					1,060	69,789
% Wastewater treated or discharged / year	98.5%					1.5%	100%

*Note: In the SFD diagram, 98.5% gets rounded up to 99%, and 1.5% gets rounded down to 1%. This was not changed as part of the 1.5% that is discharged in CSOs undergoes some primary treatment at the CSO treatment plants.

Table 5: Wastewater Treated or Discharged by Transportation Channel in a Typical Year (eg. 2016)

	Centralized Sewers			
	Combined Sewer		Separate Sanitary Sewer	
% Population Served	89%			
	59% (=66% of 89%)		30% (=33% of 89%)	
Billion gallons / year	62			
	41 (=66% of 62 billion)		21 (=33% of 62 billion)	
Transport + Treatment	Delivered for Treatment	Discharged Untreated	Delivered for Treatment	Discharged Untreated
Billions of gallons	40	1	21	0
%	97.5%	2.5%	100%	0

Assumptions:

- (1) As 1.06 billion gallons of wastewater were discharged in CSOs in 2016. Although the SFD denotes this as untreated waste, some CSOs in King County are connected to [one of four CSO treatment facilities for primary treatment](#) (physical settling of solids), disinfection (usually chlorination), and dichlorination.
- (2) All the wastewater delivered to centralized treatment plants is treated in a typical year or quarter
- (3) Separate sewers deliver 100% of wastewater to centralized treatment plants (ie, no sanitary sewer overflows or leakages)

Table 6: Groundwater Contamination Risk

Question	Response	Calculations & Assumptions
What is the rock type in the unsaturated zone?	Coarse sand / gravel	(1) <i>The unsaturated zone is the portion of the subsurface above the groundwater table. The soil and rock in this zone contains air as well as water in its pores.</i> (2) Soil data not available just for Seattle but for the King County area. > 50 % of the area is covered by gravelly sandy loams. Choice between medium sand and coarse sand / gravel ; however, picked coarse sand / gravel because the typical soil profile is predominantly gravelly sandy loams with particle size described as 35-65% rock fragments.
What is the depth to the groundwater table?	> 10 m	(1) The preferred way to map the water-table configuration is to obtain one or more synoptic (collected simultaneously) sets of measurements of the depth to water in wells that encompass the entire area of interest (2) Derived from average well depths in the King County area and examples of well depth and water level data from East King County .
What is the % of sanitation facilities located < 10m from groundwater sources?	< 25%	Sanitary Control Area Protection : The Washington State Department of Health requires water systems to maintain a sanitary control area of 100 feet around wells, and 200 feet around springs.
What is the % of sanitation facilities, if any, located uphill of groundwater sources?	Data unavailable	Nil
What is the % of drinking water produced from groundwater sources?	> 25%	An estimated 30% of King County's population relies on groundwater wells for drinking water. That's > 0.5 million people .
What is the water production technology used?	Protected boreholes, protected wells or protected springs where adequate sanitary measures are in place	(1) Public Health – Seattle & King County has regulatory oversight for individual private wells under Board of Health Title 13, 13.04.070 B and Title 12, 12.24.010 and WAC 246-291. <i>5.1.1 (2) A bacteriological test is required once each year and a nitrate test once every three year.</i>

Table 7: On-Site Sanitation

On-Site Sanitation Indicators	Proportion / Percentage
Proportion of septic tanks from which faecal sludge is emptied regularly	7%
Proportion of faecal sludge emptied which is delivered to treatment plants	100%
Proportion of faecal sludge delivered to treatment plants which is treated	100%

Assumptions:

- (1) From Table 1 above, 11% of King County's population uses septic tanks
- (2) There is no significant risk of groundwater contamination from septic tanks connected to soak pits
- (3) [Septic tank owners are required to get their systems inspected once in three years.](#) Which means 33% of 85,000 septic tanks ought to be inspected every year (=28,000). However, the Department of Health only estimates only 2,035 septic tanks (7%) of septic tanks being inspected regularly.
- (4) All faecal sludge emptied from septic tanks is delivered to wastewater treatment plants and that all (100%) of the faecal sludge / wastewater reaching treatment plants is treated

Table 8: Total Sewage Treated or Discharged During the West Point Treatment Plant Failure in Q1, 2017

	West Point	South	Bright water	Vashon	Carnation	CSO	WWTP failure	Total
Wastewater volume / year (mgy)	68,729.5 (=68.7 billion)					1,060		69,762.1
Wastewater volume / typical quarter (mg)	17,182.4 (=17.2 billion)					265		17,447
% Wastewater treated or discharged/typical quarter	98.5%					1.5%		100%
Wastewater volume during the quarter of the West Point Plant failure (mg)	16,947.4 (=16.9 billion)					265	235	17,447
% Wastewater treated or discharged / Q1 2017	97.1%					1.5%	1.4%	100%

Assumptions:

- (1) Wastewater volume treated versus discharged per quarter was calculated by dividing 2016 (typical year with no treatment plant failures) annual volume by 4

- (2) For the first quarter of 2017, when the West Point Wastewater Treatment Plant failed, it is reported that 235 million gallons of wastewater were discharged into the Puget Sound, as such, this volume has been subtracted from the volume that would typically be treated in any other quarter, and counted under the WWTP failure column.

Table 9: Wastewater Treated or Discharged by Transportation Channel During the West Point Treatment Plant Failure in Q1, 2017

	Centralized Sewers					
	Combined Sewer		Separate Sanitary Sewer			
% Population Served	89%					
	59% (66% of 89%)		30% (33% of 89%)			
Billion gallons per quarter	17.447					
	11.6 (=66% of 17.4)		5.8 (=33% of 17.4)			
Transport	Delivered		Discharged Untreated	Delivered		Discharged Untreated
Billions of gallons in a typical quarter (100% treated in a typical quarter)	11.3		0.3 (265 million rounded up)	5.8		0
%	97.5%		1.5%	100%		0%
Treatment	Treated	Untreated	NA	Treated	Untreated	NA
Billions of gallons in a typical	11.3		NA	5.8		NA
Billions of gallons in Q1, 2017	11.1	0.2		5.8	0	
% in Q1, 2017	98%	2%		100%		

Assumptions:

- (1) All the untreated wastewater discharged into the environment during the West Point Treatment Failure was that which was transported by combined sewers (although this assumption would not make a difference to the final SFD generated had we assumed this was all transported by sanitary sewers).

6 List of data sources

- Campbell, C. & Spencer, A., 2013. *The Seattle Times*. [Online] Available at: <http://www.seattletimes.com/news/king-county-adopts-125-fine-for-public-urination-defecation/> [Accessed 03 July 2017].
- Coleman, V., 2017. *King County's homeless count rises above 11,600 people*. [Online] Available at: <http://www.seattletimes.com/seattle-news/puget-sound/king-countys-homeless-count-rises-above-11600-people/> [Accessed 03 July 2017].
- ECFR, 2017a. *Code of Federal Regulations*. [Online] Available at: https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr503_main_02.tpl [Accessed 11 July 2017].
- ECFR, 2017b. *Code of Federal Regulations*. [Online] Available at: <https://www.ecfr.gov/cgi-bin/text-idx?SID=fb3251957978534805da15d6af7268ea&mc=true&node=pt40.32.503&rgn=div5> [Accessed 11 July 2017].
- King County Department of Natural Resources and Parks, 2016a. *Ratepayer Report 2016, s.l.: s.n.*
- King County Department of Natural resources and Parks, 2016b. *King County Wastewater Treatment Division*. [Online] Available at: <http://www.kingcounty.gov/services/environment/wastewater/cso/about/working-together.aspx>
- kingconty.gov, n.d. *Facts*. <http://www.kingcounty.gov/depts/dnrp/wtd/system/facts.aspx>
- King County Department of Natural Resources and Parks, November 12, 2008. *Quartermaster Harbor Communities Wastewater Management Options*. [Online] Available at: <http://www.kingcounty.gov/depts/health/environmental-health/piping/onsite-sewage-systems/focus/marine-recovery-area/~media/depts/health/environmental-health/documents/oss/quartermaster/Quartermaster-Harbor-Report-Chapter-4.pdf>. [Accessed June 22, 2017].
- King County, Board of Health. *Solid Waste Regulations*. [Online] Available at: <http://www.kingcounty.gov/depts/health/board-of-health/~media/depts/health/board-of-health/documents/code/BOH-Code-Title-10.ashx>. [Accessed June 22, 2017].
- King County. *Wastewater Program*. [Online] Available at: <http://www.kingcounty.gov/depts/health/environmental-health/piping/onsite-sewage-systems.aspx>. [Accessed July 10, 2017].
- Olson, J. & MacDonald, S., 2015. *Washington's War on the Visibly Poor: A Survey of Criminalizing Ordinances & Their Enforcement*. [Online] Available at: <https://caseyjaywork.files.wordpress.com/2015/0/> [Accessed 03 July 2017].
- Peace Heathens' Crisis Resource Directory, 2015. *Showers, Etc*. [Online] Available at: <http://seattlecrisis.org/showers.html> [Accessed 03 July 2017].
- Public Health Seattle & King County, 2016. *King County On-Site Sewage System Management Plan*. [Online] Available at: <http://www.kingcounty.gov/depts/health/environmental-health/piping/onsite-sewage-systems/focus/~media/depts/health/environmental-health/documents/oss/plan/2016-draft-OSS-management-plan-update.ashx>
- Seattle Public Utilities, 2016. *Map of Seattle CSO Location*. [Online] Available at: http://www.seattle.gov/util/cs/groups/public/@spu/@usm/documents/webcontent/02_008043.pdf
- Seattle Public Utilities. March 28, 2017. *Protecting Seattle's Waterways: Wastewater Collection System 2016 Annual Report*. [Online] Available at: http://www.seattle.gov/util/cs/groups/public/@spu/@drainsew/documents/webcontent/1_060955.pdf. [Accessed June 22, 2017].
- Thompson, Lynn. *Stink rises over proposed fee for septic systems in King County*. *The Seattle Times*. June 27, 2016. [Online] Available at: <http://www.seattletimes.com/seattle-news/eastside/stink-rises-over-proposed-fee-for-septic-systems-in-king-county>. [Accessed June 22, 2017].
- United States District Court for the Western District of Washington, July 3, 2013, *Consent Decree* [Online] Available at: http://kingcounty.gov/~media/services/environment/wastewater/cso/docs/130703_KingCountyCSOConsentDecree.ashx?la=en
- Washington State Legislature, 2007. *Chapter 173-308 WAC: Biosolids Management*. [Online] Available at: <http://apps.leg.wa.gov/wac/default.aspx?cite=173-308>

- *Washington State Legislature, 2017. RCW 70.95J, Municipal Sewage Sludge-Biosolids. [Online] Available at: <http://app.leg.wa.gov/rcw/default.aspx?cite=70.95J&full=true>*
- *Willmsen, C. & Mapes, L., 2017. The Seattle Times. [Online] Available at: <https://projects.seattletimes.com/2017/west-point/> [Accessed 22 June 2017].*

7 Supplementary data

7.1 Policy & institutional roles

At the federal level, wastewater treatment in the US is regulated under the Clean Water Act (1972), which is implemented by the Environmental Protection Agency (EPA). The EPA has developed evidence-based technical standards for biosolids (ECFR, 2017a) and implements them through the issuance of permits (ECFR, 2017b).

At the state level, Washington state legislature authorizes the Department of Ecology to implement a program that meets or exceeds federal requirements on the management of sewage sludge (Washington State Legislature, 2017) and the state's technical regulations (Washington State Legislature, 2007) are based on federal standards for biosolids (ECFR, 2017a).

The Department of Ecology engages local health departments as regulatory partners. The Seattle Public Utilities and King County oversee sewage collection and treatment in Seattle and the rest of the county. In King County, the Board of Health stipulates solid waste regulations (Code of the King County Board of Health Chapter 10), on-site sewage regulations (Board of Health On-Site Sewage Regulations) as well as waste management regulations for the community septic system and decentralized treatment of faecal waste on Vashon Island (Quatermaster Harbor Communities Wastewater Management Options).

Finally, a Technical Advisory Committee consisting of at least nine members, including a health officer and other relevant representatives are appointed for a period of three years to examine on-site sewage regulations by the King County Board of Health, make recommendations thereon as week as review and recommend new methods and techniques of on-site sewage and disposal.

7.2 Service provision

King County's Wastewater Treatment Division (WTD) serves 1.87 million people within a 424-square mile service area, comprising 17 cities and 17 local sewer utilities across King, Snohomish and Pierce counties.

The wastewater system includes 391 miles of sewer pipelines, three large regional wastewater treatment plants (the West Point plant in Seattle, the South plant in Renton and the Brightwater plant near Woodinville), two small wastewater treatment plants (in the city of Carnation and on Vashon Island), one community septic system (in Beulah Park and Cove on Vashon Island) and four combined sewer overflow (CSO) treatment facilities in Seattle.

The County's Public Health Wastewater Program, a convening workgroup comprised of industry and homeowner stakeholders, also helps to ensure that over 85,000 septic systems, including 192 in Seattle, that are not connected to the public sewer systems, are regularly maintained.

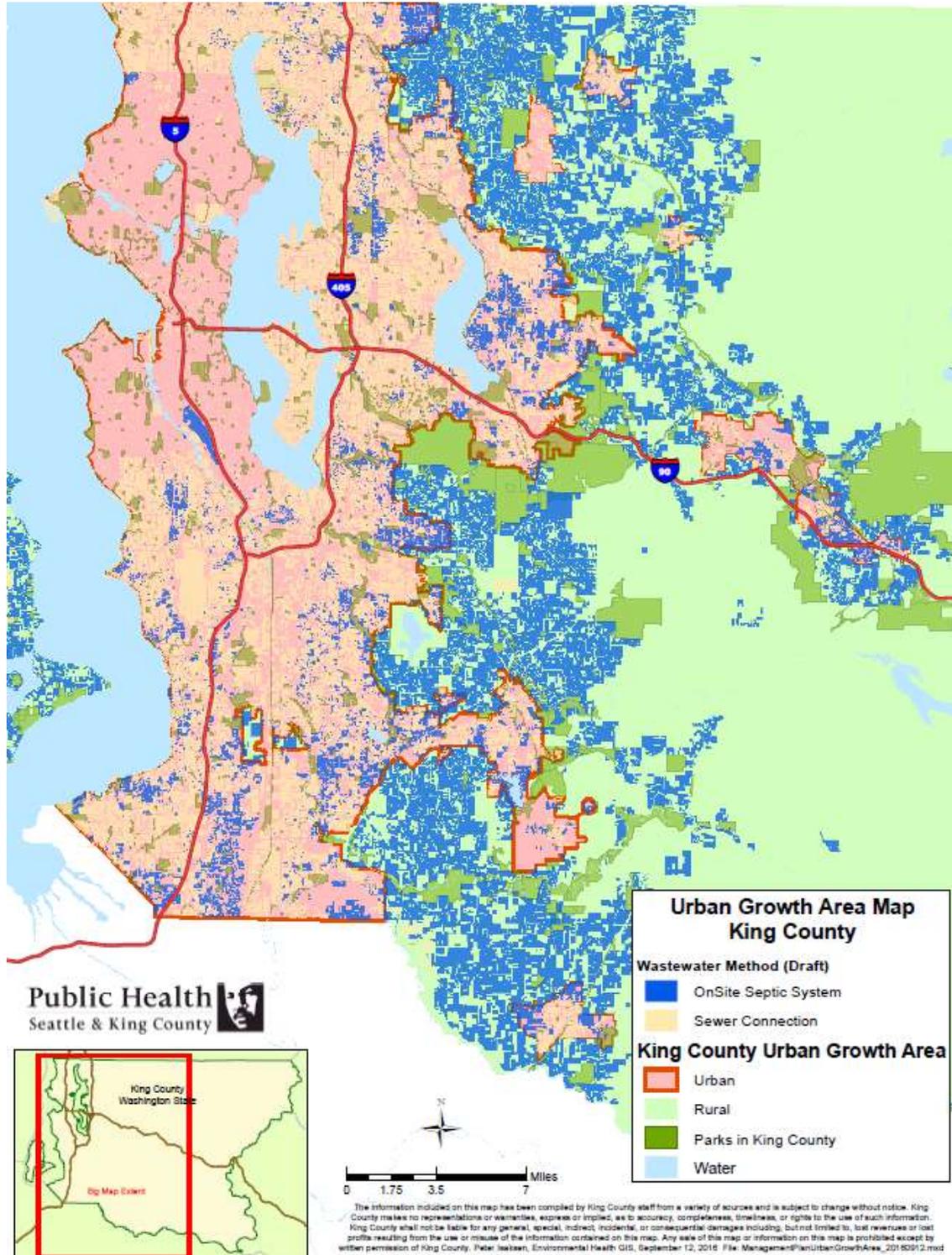


Figure 1: King County Sewer Connection and On-Site Sanitation Facilities (Public Health Seattle & King County, 2016)

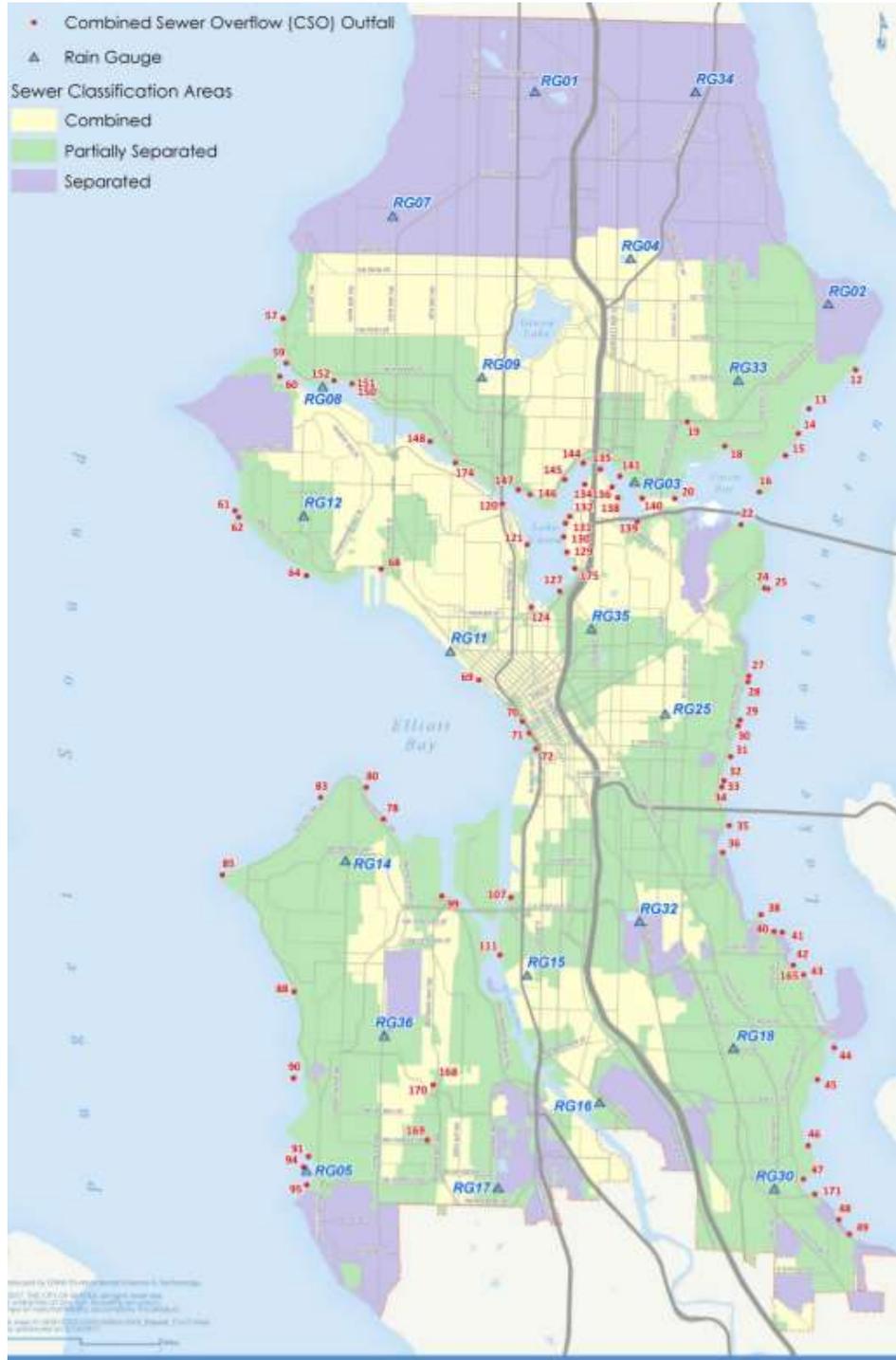


Figure 2: Seattle Public Utilities Sewage Map (Seattle Public Utilities, 2017)

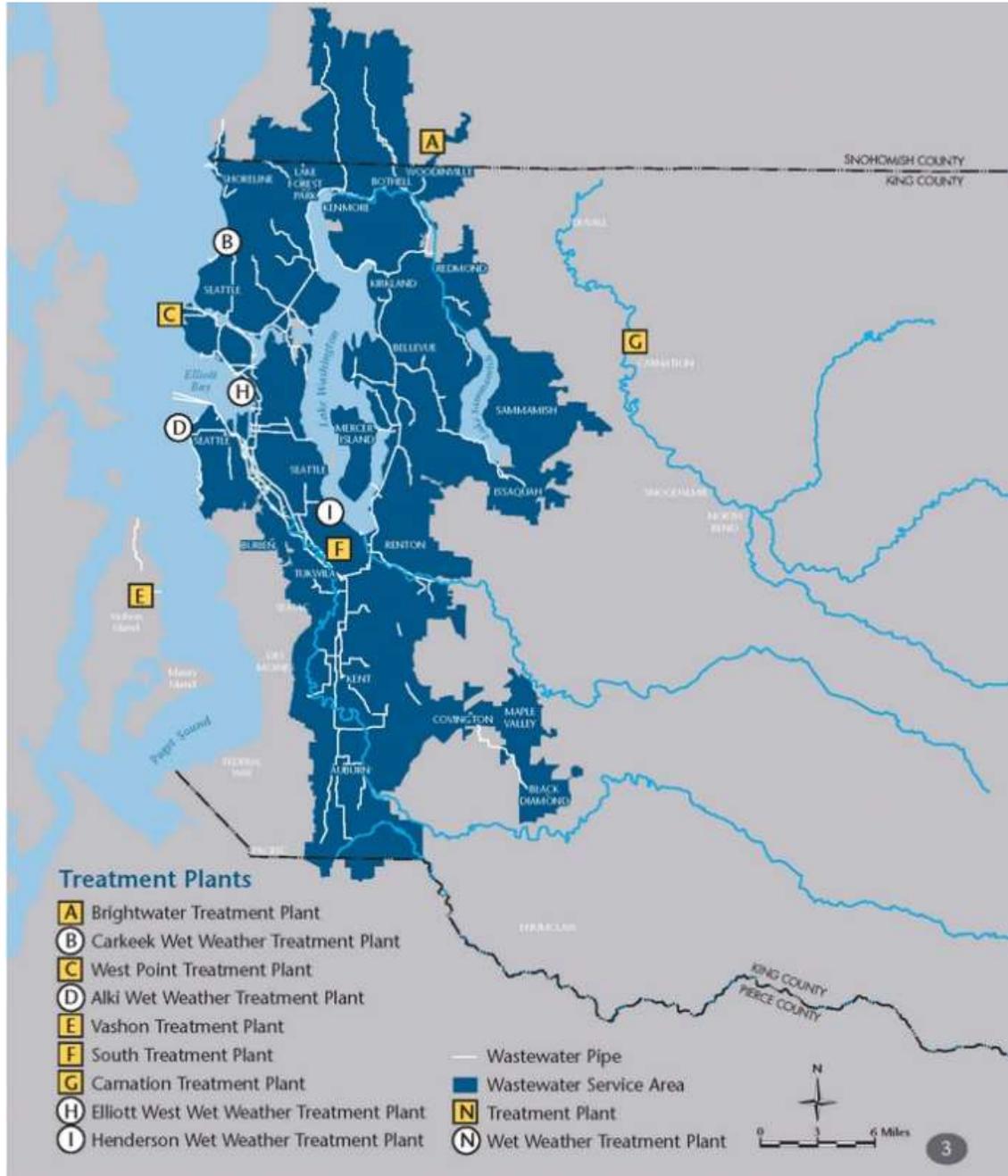


Figure 3: King County Wastewater Treatment Services and Facilities (King County Department of Natural Resources and Parks, 2016a)

7.3 Evolution of King County's sanitation service chain

Sewage

King County's first sewer lines were designed and constructed in the late 1890s and early 1900s by the Chief Engineer for the City of Seattle, Reginald H. Thomson. Thomson designed a brick sewer 12 feet in diameter across the north end of Seattle, called the North Trunk Sewer, that discharged untreated sewage into the Puget Sound.

By the mid-1950s, the pipe carried 40 million gallons of city sewage a day through an outfall that ended a short distance offshore, about 25 feet deep. Untreated wastewater also flowed from combined sewers into Lake Washington, Lake Union, Green Lake and various other water bodies, contaminating them.

In 1958, voters created Metro and developed a regional wastewater treatment system based on watersheds. As the population grew in communities surrounding Lake Washington, 10 small sewage-treatment plants discharged 20 million gallons of phosphorus-rich effluent into the lake daily.

In the 1950s, only about 47% of all sewage got any treatment. Sixty outfalls discharged untreated waste into the Duwamish Waterway, Elliott Bay and Puget Sound.

Shortly after Metro was formed, construction began on the county's two existing regional treatment plants, West Point in Seattle's Magnolia neighborhood and South Treatment Plant in Renton, which were officially running by 1966. By the late 1960s, regional water quality began improving dramatically.

In 1994, King County assumed authority of Metro and its legal obligation to treat wastewater for 34 local jurisdictions and local sewer agencies that contract with King County.

Since the 1960s, King County and Seattle have reduced the amount of untreated wastewater released to waterways, from 30 billion gallons of untreated water in the 1960s flowing into regional waterways, to 2.3 billion gallons by 1979 when the county began its CSO Control Program (Protecting Our Waters). From 1979 to 2012, the County invested \$389 million to control CSOs. Today, CSOs exist only in older Seattle neighborhoods where two-thirds of sewers contain both sewage and storm water. Most often, water from CSOs goes into wastewater treatment plants. During heavy rainfall however, CSOs may release sewage and stormwater into regional waterways to prevent sewer backups and flooding.

King County's CSOs are regulated through the West Point Treatment Plant's National Pollutant Discharge Elimination System (NPDES) permit. The US EPA has delegated management of NPDES permits in Washington State to the Washington State Department of Ecology (Ecology). A "controlled" CSO can overflow no more than one time each year, based on a long-term average. This limit is set by the Washington State Department of Ecology and King County's own policies based on Nine Minimum Controls that the US EPA codified as part of their CSO Control Policy. In 2013 King County signed an agreement with the U.S. Department of Justice and the Environmental Protection Agency (EPA). This agreement, called a consent decree, requires King County to complete its CSO control plan by 2030 which it has begun to do with the establishment of CSO treatment facilities, CSO storage facilities and several related initiatives to treat wastewater and reduce pollution. About 50% of CSOs were controlled in 2010.



Figure 4: Map of Seattle CSO Locations (Seattle Public Utilities, 2016)

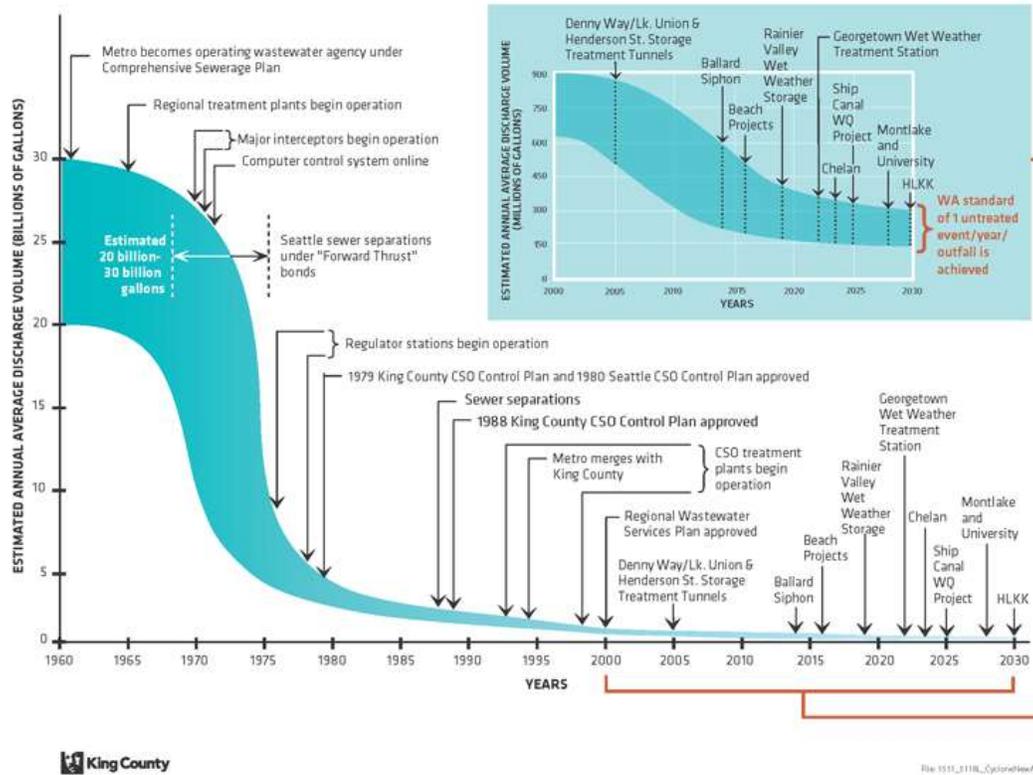


Figure 5: King County CSO Reduction Timeline (King County Department of Natural resources and Parks, 2016b)

On-site Sanitation

There are approximately 85,000 septic tanks in in King County. The County developed its first On-Site Sewage (OSS) Management Plan in 2007, which included the following eight elements: electronic database enhancement, identification of sensitive areas and Marine Recovery Areas, education, quality assurance, enforcement, funding strategy, performance measurement, and implementation strategy. While that 2007 Plan attempted to address all the components that make up a comprehensive OSS Program, it was never funded, and consequently many of the actions outlined within it have not been completed. In 2016, as OSS problems, and the pressure to address them, has increased, the King County Board of Health passed Resolution 16-03 to update the 2007 plan and seek sustainable funding to implement the updated plan. A Work Group composed of representatives from the OSS industry including realtors, builders, home and business owners with OSS, unincorporated area councils, cities with OSS, and relevant state agencies convened from March to August 2016 to produce the 2016 On-Site Sewage (OSS) Management Plan. There was also an attempt to introduce a septic tank fee for OSS owners which was unsuccessful and has been tabled.