Current Status of On-site Sewage Systems in King County: Location, Age, and Failure Mapping Project

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Public Health
Seattle & King County

Environmental Health Services Division
401 Fifth Avenue, Suite 1100
Seattle, WA 98104
206-263-9566 Fax 206-296-0189
TTY Relay: 711
www.kingcounty.gov/health

Prepared by:

Peter Isaksen & Meagan Jackson
On-site Sewage Systems Operation & Maintenance Program
Environmental Health Services Division
Public Health – Seattle & King County

Acknowledgements:

Julie Horowitz
Lynn Schneider
Environmental Health Services Division, Public Health – Seattle & King County

Doug Navetski
Debra Bouchard
Tim Clark
King County Water and Land Resources Division, Department of Natural Resources and Parks

Alternative formats available. Please call 206-477-4800 or TTY:711.

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On-site Sewage Systems for Wastewater Treatment

On-site sewage systems (OSS), commonly known as septic systems, are widely used in both rural and urban areas of King County, Washington. When properly designed, installed, and maintained, OSS are an effective and safe method of treating and discharging sewage to protect public health. They also contribute to groundwater recharge and prevent water pollution, which helps to preserve valued water resources. OSS combine these benefits while enabling residential development in areas of the county that are not served by sewer, and recent advancements in OSS technology have allowed for development in areas that were previously unbuildable due to topography or soil conditions. Despite these benefits, OSS do have a limited lifespan, and can fail due to age, system malfunction, or improper operation and maintenance. When they fail, their discharges are not only a significant health risk to residents and the public, but they can also contaminate and degrade groundwater, streams, lakes, and marine waters.

OSS Inventory and Mapping

To minimize failures and their impacts on public health, Public Health – Seattle & King County (Public Health) seeks to use accurate and current information about OSS infrastructure. The need for an improved and expanded OSS inventory has been recognized throughout the Puget Sound region, where over 600,000 OSS are part of a large network of wastewater infrastructure.[1] Due to regional and statewide planning efforts to protect water quality and public resources, there is much interest in information about the current state of OSS infrastructure. Local health jurisdictions are required by state code to develop and maintain an OSS inventory and identify where OSS could pose an increased public health risk (Washington Administrative Code, WAC 245-272A-0015). Local health jurisdictions' OSS management plans are also required to develop and maintain an electronic data system for all OSS within a marine recovery area, where existing OSS contribute to threatened shellfish harvesting and other significant impacts on water quality (Revised Code of Washington, RCW 70.118A.060). Information about the age, type, and status of OSS allows for a more complete understanding of how OSS are contributing to wastewater treatment and the potential risks for public health.

A detailed OSS inventory also facilitates interagency coordination around comprehensive land use policies, management plans, and water pollution prevention efforts. With a mapped OSS inventory, locations of OSS and their associated failures can be identified, which allows for better oversight and distribution of services. By identifying OSS density, Public Health can assess the relationships between OSS, water pollution, and other community risks, and data-driven decisions can be made for risk-based action to protect public health and improve water quality. By creating a comprehensive and current depiction of zoning plans, utility service availability, demographic data, and environmental impacts, King County can more efficiently use public resources and improve the services provided.

[1] Washington State Department of Health, 2014, pg. 1.

Project Methods

This project aimed to determine the location of parcels in King County that rely on OSS to treat wastewater and the key characteristics of these OSS. Information about the parcels served by OSS was overlaid with current data from Public Health's OSS Program and King County Geographic Information Systems (GIS) files to determine the OSS age and status. Using data from OSS program activities in the five-year period of 2013 to 2017, failing OSS were also mapped.

GIS data includes shapes of all parcels and associated attributes in King County and are available for use from the King County GIS server. ArcMap version 10.3.1 was used to compile all associated data for this analysis. To identify parcels served by OSS, staff first excluded all parks and forest land. The 42 sewer companies with jurisdiction over sewer connections in the county provided documentation of which parcels have been connected to sewer, and these parcels were also excluded. Using 2015 and 2017 aerial photos from the King County GIS server and other resources, such as Assessor Detail lists, the remaining parcels were classified as vacant or developed with a structure that has plumbing. All parcels that had a building with plumbing and were not served by sewer were expected to be served by an OSS.

To ensure the accuracy of this database, Public Health continues to update this list when sewer agencies report new sewer connections or parcel changes occur that may affect OSS status, for example redeveloped or short-platted parcels. The number of OSS in King County also changes due to new OSS installations or conversions from OSS to public sewer. Additionally, some parcels have more than one OSS, so currently the number of OSS in King County is greater than the number of parcels served by an OSS. These additional OSS will be added to the database as the project continues.

To better characterize the OSS that are used in King County, real estate and OSS information were overlaid with the OSS parcel list. OSS ages were estimated in a stepwise process. First, the age of buildings was extracted from a list of residential parcels, which is maintained by the King County Department of Assessments and available on the King County GIS server (resbldg_extr, Residential Building Assessor extract table). The year that the building was built was replaced with the year of a substantial remodel if one was indicated in the Assessor's table. For those parcels that are included in the Public Health OSS Program's Envision Connect (EC) database, a more recent As-built approval date showing a permit for an OSS install or repair was used to replace the date from the Assessor's data.

Failing OSS data were compiled from historical database entries from the EC and Online RME databases. EC is used to track OSS site design applications, installation permits, repair permits, and complaints. A checkbox is employed to indicate an OSS that has been associated with a failure. This checkbox system was not used prior to 2013, and data before 2013 did not identify all relevant failures. Therefore, OSS failures during the five-year period between 2013 and 2017 were used for this analysis.

The OnlineRME database compiles information submitted by on-site system maintainers and pumpers in maintenance inspection reports. When reports identified the deficiencies listed in Table 1, that OSS was included in this analysis as associated with a failure or a suspected failure. These deficiencies were selected because they correspond most closely with the King County Board of Health Title 13 definition of an OSS failure, which is a condition "that threatens the public health by inadequately treating sewage or by creating a potential for direct or indirect human contact [with] sewage." Specific failure examples included in the code are sewage surfacing on the ground, sewage backing up into a residence or other structure, sewage leaking from an OSS

component, cesspools and seepage pits, and inadequately treated sewage that contaminates groundwater or surface water (13.08.152).

Table 1. Deficiencies Reported in Maintenance Reports Considered OSS Failures

Reported Deficiency	Failure Classification
Effluent leaking onto the surface of the ground from any component	Failure
Surfacing dye during dye test	Failure
Unsatisfactory stress test results	Failure
Effluent level within operational limits of septic tank or trash tank	Suspected Failure
Distribution box or serial distribution does not appear to be functioning as intended	Suspected Failure

To avoid duplicate counts of failures tracked through both the EC and OnlineRME databases, only a single failure report was included for each parcel with multiple reports. The failure parcels were then converted from polygon shapes to centroids, or points, for display on the map.

To estimate the number of documented repairs of OSS failures that have been confirmed by Public Health staff, the list of OSS failures was compared to the OSS installation or repair permits that have been classified as "installed" or "completed with supporting record drawing documentation," as well as the complaints that have been resolved. If an OSS failure report was followed up with a complete installation, repair, or complaint resolution, the failure was considered corrected.

Project Results: OSS in King County

Number and Age of OSS in King County

The total number of OSS parcels identified at the time of this analysis in September 2018 was 85,787. This number has changed due to further analysis or additional data over time, so the approximate number of OSS parcels is estimated to be between 85,000 and 86,000. With an estimated per capita water use of 69 gallons per day and an estimated household size of 2.45 persons, approximately 14.7 million gallons of sewage are treated each day (MGD) by OSS in King County.[2] OSS in King County are an important contribution to wastewater treatment, as they treat approximately 10% of the 154 MGD of wastewater that is estimated to be generated in King County.[3]

Of these 85,787 OSS, 20,054 (23%) have had at least one maintenance inspection reported since 2009, when Public Health started tracking maintenance inspections electronically. Public Health has an electronic record of a permit for OSS installation or repair for 12,939 of all parcels with an OSS (15%). Many OSS parcels have no electronic records because the installation or repair of their OSS pre-dated electronic record keeping, which began in 1989. For some parcels, no permit for repair or install has ever been recorded, nor has an inspection been recorded within the last 30 years. The number of OSS with no electronic records is 35,390 (41%).

[2] Wastewater generation estimate from Whiley, 2010, p. 3-4. Household size from U.S. Census Bureau, 2013-2017 estimate, 2018.

[3] Total wastewater generation calculated by multiplying 69 G per capita water use with the average household size and estimate of all housing units in King County (934,522 per U.S. Census Bureau, 2017 estimate, 2018).

Estimated ages of OSS in King County are shown in Table 2 (estimated for the 85,566 OSS parcels that were in the list at the time of this analysis). Sixty-two percent of these OSS are over 30 years in age, which is near the end of the typical lifespan of a conventional gravity OSS, when failures are more likely to occur. Because of the old age of two-thirds of the OSS inventory, it is likely many of these OSS will need to be repaired or replaced soon, which can be very expensive, especially on small parcels with poor soil. Many of the older OSS in the urban areas were originally installed in neighborhoods that were expecting sewer service to expand to their area, but these expansions have not yet occurred.

Table 2. Estimated Ages of On-site Sewage Systems in King County, 2018

Age Range	Number (Percent) of OSS in Age Range
0–9 years	5,386 (6%)
10–19 years	9,902 (12%)
20–29 years	12,443 (15%)
30 years or more	53,168 (62%)
No age known	4,665 (5%)

Recorded OSS Failures in King County

Between 2013 and 2017, 1,335 parcels in King County had an OSS failure of some kind, and 1,327 cases of a suspected failure were identified. About two thirds of these failures were reported during maintenance inspections (68%), and only 9% were recorded in the OSS complaint tracking system. Some of the failures were identified through the site application and permitting process when a permit was requested to repair or replace an OSS that was failing.

The OSS failures that have occurred in the past five years are distributed across King County, in both urban and rural areas. There appear to be some clusters where OSS failures occurred in higher density, which are primarily located in areas with older OSS, soils that are not conducive to on-site wastewater treatment, and small parcels. Additional work is needed to determine the characteristics that might be associated with higher OSS failure density and to determine how these clusters may be affecting water quality in nearby surface water.

Of the 2,662 identified failures or suspected failures, 730 have been repaired through the permitting process or resolved by complaint follow-up. Additional failures have been repaired during maintenance inspections, but these repairs cannot be easily tracked with Public Health's current database structure. Although the exact number or unresolved failures is unknown, we do know that many failures have not yet been identified nor addressed, and they are a potential threat to public health and source of environmental pollution.

Conclusion

King County residents rely on more than 85,000 OSS to provide treatment of approximately 10% of the wastewater generated in the County. Those OSS that are properly designed, installed, and maintained are an excellent technology for wastewater treatment that protects public health, especially in regions with quickly-expanding development and no sewer available. New technology has enabled treatment in areas where development was previously limited due to poor soils or uneven terrain. OSS also directly contribute to groundwater recharge and help to protect local waterbodies. However, over half of King County OSS are over 30 years of age (62%) and are entering the end of their expected lifespan, and 1,335 OSS failures have been identified in the past five years. This number of failures likely underestimates the true number of failures due to a lack of discovery and reporting on all failing OSS. With the information collected during this project, the locations of OSS and their failures can be used for improved OSS management to identify and repair OSS failures and help mitigate their impacts, providing better public health protection and water pollution prevention.

The results of this project can also be combined with other King County GIS studies and databases to create a more comprehensive approach to providing public health services and preventing water pollution. With the use of demographic data and results from equity analyses, OSS management can apply an Equity and Social Justice lens to better understand how to engage communities that rely on OSS wastewater treatment and partner to provide improved services. Recent analysis by King County Department of Natural Resources and Parks has also shown that the number of OSS within a watershed, in addition to population density and agricultural activities, is associated with poorer water quality.[4] Effective public policy and public health planning can benefit from the expanded inventory of King County OSS as County agencies and partners use this data to consider the contribution of OSS to living healthy lives in a healthy environment for many generations to come.

[4] King County 2018 Fecal Bacteria report, p. *v*, pp. 20-22.

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On-site Sewage System Parcel Ages and Failures 2013-2017 by Council District
King County Washington February 26, 2019

District 1
District 4
District 2
District 4
District 6
District 3
District 2
District 6
District 8
District 8
District 5
District 7
District 9

Legend

OSS 2013-2017 Failures

- Failure by Code N= 1,335

OSS by Estimated System Start Year

- No Age Known, N= 4,665
- 1894 - 1988, N= 53,168
- 1989 - 1998, N= 12,443
- 1999 - 2008, N= 9,902
- 2009 - 2018, N= 5,386
- State Routes
- Metropolitan King County Council Districts
- Water

Washington State Counties

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2.5 1.25 0 2.5 5 7.5 Miles

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Data sources: Environmental Health GIS, May 3, 2018