

ES.1 INTRODUCTION

King County Environmental Health (EH) has identified failing septic systems in communities adjacent to Quartermaster Harbor on Vashon Island. This area was the subject of a 1993 Facilities Plan¹ that addressed alternatives to on-site septic systems for four communities on Vashon Island that were declared Health Hazard Areas (HHAs) by the Washington State Department of Health (DOH). The Facilities Plan provided an evaluation of costs and environmental issues as well as preliminary design of a preferred alternative for each community and steps to implementation.

In 2002-2003 the DOH evaluated 59 parcels along 6 miles of the Quartermaster Harbor area for the purpose of determining impact of shellfish harvesting². Failing septic tanks were identified as a source of elevated bacterial counts that would result in prohibiting of shellfish harvesting.

In support of EH, King County Department of Natural Resources and Parks has prepared the following report to provide an update of technical portions of the 1993 Facilities Plan and a general evaluation of the feasibility and management of alternatives to on-site septic systems for communities adjacent to Quartermaster Harbor, which includes one of the remaining HHAs (Burton) from the 1993 study.

This report identifies treatment and disposal alternatives, estimates life cycle costs, and discusses the jurisdictional structure already in place for establishing community wastewater treatment in the study area.

ES.2 STUDY AREA

The Quartermaster Harbor communities in the 1993 study area were expanded to include the Burton, Magnolia Beach, Harbor Heights, and Shawnee neighborhoods that are located within areas of shoreline where shellfish harvesting is currently prohibited. The area was selected to include parcels that drain toward Quartermaster Harbor and to a Prohibited Shellfish Harvesting Area³. The study area is bounded by Judd Creek to the north, SW 273rd Street to the south, Vashon Highway to the west and the Harbor to the east, except for the Burton Peninsula, where the eastern boundary is generally 97th Ave SW. The study area is shown in Figure ES.1.

¹ Seattle/King County Department of Public Health, November 1993, *Facilities Plan - Vashon Island Health Hazard Areas*. Prepared by Barrett Consulting Group.

² Washing State Department of Health, July 2003, *2003 Shoreline Survey of the Quartermaster Harbor Shellfish Growing Area*.

³ Ibid.

Figure ES.1 Magnolia Beach - Greater Burton Study Area

The study area includes parcels that are part of a Marine Recovery Area (MRA) as established by EH (see Appendix F) in 2008. A MRA is a management area recognized by the DOH where on-site sewage systems are a “significant factor contributing to concerns associated with” the following areas: 1) threatened or downgraded shellfish growing areas, 2) marine waters on the Washington State 303(d) list for exceeding Clean Water Act standards for low-dissolved oxygen or fecal coliform bacteria, or 3) marine waters where EH has identified nitrogen as a contaminant of concern.

There are approximately 433 parcels in the study area. Of these, 311 contain taxable land improvements, which are typically single-family residences. The project team reviewed 2,000 census data and estimated that 750 people reside in the study area; about 2.4 persons per residence.

Water meter records from Burton Water Company, which serves the Burton community, were evaluated as a way to estimate wastewater flows. The evaluation found that water use is below the national average, or about 42 gallons per capita per day (gpcd).

Wastewater generation is influenced by several factors, primarily, water use, and parcel occupancy. Many developed parcels are unoccupied and occupancy at many parcels is seasonal. Another factor is that many “vacant” parcels as well as “single family” parcels are owned by the same owner as an adjacent parcel and are likely to remain undeveloped property. A door-to-door survey determined that absentee ownership in the study area is likely greater than 25 percent⁴. This study assumes that 100 percent of all parcels could be developed. Future design of wastewater facilities would refine this assumption to consider only the actual number of developable parcels, occupied homes, and the impact of seasonal residents.

Estimated wastewater flow for the study area is summarized in Table ES.1.

ES.3 SYSTEM MANAGEMENT

State regulations (Washington Administrative Code (WAC) 173-240-104) require domestic wastewater facilities to be owned, operated, and maintained by a public entity. Public entity management of large on-site sewage systems is required per WAC 246-272B-08001. Management and ownership by a public entity helps ensure systems are operating as designed and are properly maintained. Federal and state grants and loans are awarded to public agencies for the purpose of design, permitting, and construction. To initiate implementation of a wastewater system for the study area the parcel owners must be represented by a public entity.

⁴ Public Health Seattle & King County, July 2007, *King County On-Site Septic System Management Plan*.

Table ES.1 Wastewater Design Flows Quartermaster Harbor Communities Wastewater Management Options King County Department of Natural Resources and Parks				
Land Use Designation	Greater Burton		Magnolia Beach	
	Occupied Parcels	Total Parcels	Occupied Parcels	Total Parcels
Single Family Residential, ERUs ⁽¹⁾	180 ⁽²⁾	216	120	199
Non-Residential, ERUs	11	18	0	0
Total	191	234	120	199
Average Wastewater Flow at 120 gpd per ERU (gpd) ⁽³⁾	23,000	28,000	14,000	24,000
Peak Hour Flow (4 x Avg Day) (gpd)	92,000	112,000	56,000	96,000
Notes:				
(1) Equivalent Residential Unit				
(2) Includes 2 additional "parcels" for an apartment building.				
(3) Source: US Census and Burton Water Company.				

The most likely way for wastewater facilities serving the study area to be managed under a public agency is to become part of the Vashon Sewer District (VSD), which provides sewer service on other parts of the island. The VSD is an established agency recognized by King County. Alternatively, property owners could form their own wastewater management entity, but the additional legal and planning start-up work plus ongoing staffing costs may be difficult to justify financially compared to joining VSD.

The steps required for a wastewater management solution managed by VSD are listed below. These steps would be accomplished by a combination of community members, VSD Commissioners, and King County.

- Annex the study area into the VSD Service Area
- King County Boundary Review Board approves annexation
- Revise the VSD Sewer Comprehensive Plan
- Utility Technical Review Committee approves revised plan
- Apply for State grants/loans
- Form a Utility Local Improvement District (ULID) encompassing the study area to generate funds for system design and construction
- Prepare an Engineering Report/Facilities Plan for any Decentralized Treatment Option
- Prepare Construction Documents

Financing and funding the wastewater management solution can be accomplished using a variety of sources including grants, loans, and debt financing.

ES.4 TREATMENT AND DISCHARGE OPTIONS

This study considered three approaches to wastewater management which are discussed in the following sections:

- Centralized treatment and discharge
- Decentralized treatment and discharge
- Holding Tanks

Centralized treatment and discharge and the decentralized treatment and discharge options evaluated in this study require construction of a local wastewater collection system within the boundaries of the study area.

ES.4.1 Centralized Treatment and Discharge Option

Centralized treatment involves collection and conveyance of wastewater from the study area to the Vashon Wastewater Treatment Plant (WWTP) via the VSD collection system. The VSD collection system includes a network of 8-inch gravity lines throughout the Vashon Town area. Conceptually, flow from the study area would tie into the existing system at the southern most point on the gravity system. The existing conveyance system is expected to have sufficient capacity to accommodate the additional flow.

The Vashon WWTP was recently expanded to treat a design average annual flow (AAF) of 0.18 million gallons per day (mgd), the expected AAF for 2025. There is sufficient capacity to treat both the current Vashon WWTP flow of 0.12 mgd and the additional flow from the study area, 0.05 mgd, although it would displace much of the capacity available for future demand.

Within the study area, sewage would be collected from individual parcels to a central point by gravity, vacuum, low-pressure, or a combination of these technologies. One option to convey wastewater from the collection system to the VSD collection system is by a combination of pump stations, force mains, and limited gravity sewerage along the Vashon Highway as shown in Figure ES.2.

The centralized treatment system would likely be owned and managed by VSD and King County Wastewater Treatment Division (KC WTD) similar to the centralized treatment system at Bunker Trail on Vashon Island. At Bunker Trail, VSD owns, operates, and maintains the local vacuum collection system within the community and KC WTD owns, operates, and maintains the force main and pump stations along the Vashon Highway that connects to the VSD collection system.

Figure ES.2 Centralized Treatment Option Conceptual Conveyance System

Estimated capital costs and annual operation and maintenance (O&M) costs for this option are shown in Table ES.2. Annual O&M costs include the electricity and labor needed to operate the pump stations and an equipment replacement allowance. It may be expected that VSD would charge customers for O&M costs through their sewer rate. Additionally King County treatment costs that would be incurred by each equivalent residential unit (ERU) include a capacity charge and a monthly sewer charge. The annual cost per ERU is about \$1,645 a year.

Table ES.2 Centralized Treatment Options Capital and Annual O&M Cost Summary Quartermaster Harbor Communities Wastewater Management Options King County Department of Natural Resources and Parks	
System Capital Cost - Low Est ⁽¹⁾	\$10,382,000
System Capital Cost - High Est ⁽²⁾	\$20,766,000
Annual O&M and Treatment Cost (2012) ⁽³⁾	\$720,000
Notes:	
(1) Construction cost with no contingency.	
(2) Construction cost with 100 percent contingency.	
(3) Includes labor, electricity, and equipment replacement based on a 20 year period and King County treatment costs (a capacity charge and a monthly sewer charge per ERU for 433 ERUs). VSD management costs are not included.	

ES.4.2 Decentralized Treatment and Discharge Option

A decentralized wastewater treatment and discharge system comprises a collection system, a treatment unit, and a land discharge system. Either DOH or the Ecology would regulate the system depending on the design flow. Use of multiple smaller systems (less than 14,500 gpd) or a system permitted following the anticipated rule change by the state in 2009 (systems up to 100,000 gpd) would be regulated by DOH. Systems with design flow greater than 14,500 gpd or those producing reclaimed water for discharge would be permitted by Ecology. A new surface water disposal (outfall) to Quartermaster Harbor is not recommended for further evaluation since the permitting process would be resource intensive and the outfall may not be approved ultimately.

Land disposal options include land treatment, conventional drainfield, subsurface drip system (SDS), percolation ponds, or irrigation. Land disposal systems require a significant land area, up to 45 acres.

Wastewater must be treated to a level suitable for the disposal system selected. Higher levels of treatment (lower BOD and TSS) will allow for a smaller land disposal system area. Reduction of total nitrogen will likely be required for any land discharge option to meet anticipated nitrogen discharge requirements imposed due to the Critical Aquifer Recharge Area classification of the island. DOH maintains a list of approved systems meeting treatment level requirements. In addition to the approved list, a membrane bioreactor (MBR) is a treatment system option that can produce reclaimed water quality.

Four decentralized systems were selected for schematic development:

- Individual septic systems and community discharge
- Community recirculating gravel filter with SDS discharge
- Community sequencing batch reactor (SBR) and sand filter with percolation pond discharge
- Community MBR with percolation pond discharge

Evaluation indicates:

- There are approximately 60 potential parcels of five acres or more within 2 miles of the study area that are suitable for treatment or discharge facilities.
- Wastewater would be pumped to the discharge areas by two or more pump stations to an approximate elevation of 350 feet.
- Non-mechanical treatment systems with land discharge require a significant area (16-45 acres).
- Land discharge for a treatment system producing Class A reclaimed water requires approximately four acres using percolation pond discharge.
- Two treatment processes capable of producing Class A reclaimed water are a SBR/sand filter and a MBR. Facility footprints are similar for both systems.
- The decentralized treatment options presented are based on all parcels in the study area, and 433 ERUs producing wastewater. Currently approximately, 72 percent of the parcels in the study area are occupied (contain taxable structural improvements). Implementation of any of the options presented could be accomplished in phases, taking into account near term wastewater flow and adding additional capacity as growth requires. Land required for discharge options could be acquired in phases. Underground pipelines of the conveyance and collection systems should be designed for ultimate capacity to optimize system life cycle cost.
- If conventional drainfields or SDS discharge system are further evaluated use of a lower design flow per ERU (less than 450 gpd/ERU) should be discussed with DOH to reduce the area needed for these systems.

The capital and O&M costs for each of the four considered options are summarized in Table ES.3. For the most expensive option (the recirculating gravel filter with SDS discharge) the capital costs range from \$24 to \$48 million while the capital costs for the least expensive option (MBR with percolation pond discharge) range from \$14 to \$28 million.

Table ES.3 Decentralized Treatment Options Capital and Annual O&M Cost Summary Quartermaster Harbor Communities Wastewater Management Options King County Department of Natural Resources and Parks				
	Septic Tank/ Conventional Drainfield	Recirculating Gravel Filter/SDS	SBR/ Percolation Pond	MBR/ Percolation Pond
System Capital Cost - Low Est ⁽¹⁾	\$16,411,000	\$23,954,000	\$13,950,000	\$13,921,000
System Capital Cost - High Est ⁽²⁾	\$32,823,000	\$47,909,000	\$27,901,000	\$27,842,000
Annual O&M Cost ⁽³⁾	\$317,000	\$300,000	\$319,000	\$341,000
Notes:				
(1) Construction cost with no contingency.				
(2) Construction cost with 100 percent contingency.				
(3) Annual O&M cost includes labor, electricity, chemicals, and equipment replacement based on a 20-year life cycle. VSD management costs are not included.				

ES.4.3 Holding Tanks

The use of holding tanks are generally reserved for limited use and emergency situations or where no other on-site treatment/disposal or centralized treatment options are feasible. EH is the regulating authority for the single-family holding tank systems (design flow less than 3,500 gpd). DOH is the regulating authority for multi-family holding tank systems (design flow up to 14,500 gpd). Systems with design flow greater than 3,500 gpd are required to be managed and maintained by a public agency. There must be a plan for eventual connection to a sewage treatment facility.

The number of houses connected to a holding tank and the service frequency governs the size of the holding tank. DOH guidelines recommend planning on a one to two times per week pumping frequency. Two holding tank configurations were developed: single-family and multi-family. Each configuration assumes a design flowrate of 120 gpd per single-family residence. The system consists of a holding tank, a grinder pump at each residence, and connecting laterals from the residence to the tank. Tank size for the single-family system with weekly service is 1,250 gal. Up to seven single-family residences with individual holding tanks could be serviced using the maximum hauling capacity of 6,000 gal/trip. The multi-family system uses one 7,000 gal tank and assumes twice weekly service at 6,000 gal each. Eight single-family residences could be served in this configuration.

Capital and O&M costs for the two configurations were estimated and are summarized in Table ES.4. Annual recurring costs, which are primarily septic pumping and hauling service charges, are significant. Local rates for septic hauling are currently \$0.30 to \$0.52 per gallon depending on volume. A single-family residence will generate approximately 44,000 gallons per year.

Table ES.4 Holding Tank Option Capital and Annual O&M Cost Summary Quartermaster Harbor Communities Wastewater Management Options King County Department of Natural Resources and Parks		
	Single-Family	Multi Family (8 ERU)
System Capital Cost - Low Est ¹	\$15,600	\$125,800
System Capital Cost - High Est ²	\$31,200	\$251,600
Annual O&M Cost ⁽³⁾	\$19,300	\$123,200
Notes:		
(1) Construction cost with no contingency.		
(2) Construction cost with 100 percent contingency.		
(3) Includes electricity for operating the grinder pump at each ERU, weekly pumping/hauling of the holding tank, and equipment replacement based on a 20-year period.		

ES.5 COST ESTIMATE SUMMARY AND LIFE CYCLE ANALYSIS

The present value of life cycle costs shown in Table ES.5 are based on the average of the high and low capital costs and the Wastewater Treatment Division Discount rate⁵. The difference between the present value of cost of the centralized treatment option, the SBR/percolation pond option, and the MBR/percolation pond option is insignificant for this planning level study. The option with the highest present value of cost is the recirculating filter/SDS. This option is more than 50 percent greater than the present value of the centralized treatment option. Based on economics, the options that should be considered for further evaluation are centralized treatment or decentralized treatment with a SBR or MBR system to produce reclaimed water quality effluent and discharge to a percolation pond.

ES.6 STUDY CONCLUSIONS AND RECOMMENDED NEXT STEPS

ES.6.1 Conclusions

A community wastewater system for the study area would most likely be managed by VSD. Legal documents, system planning documents, and funding applications must be prepared in order for a ULID to be formed and wastewater treatment service constructed and maintained.

While the present value of cost of the decentralized septic tank/community drainfield option is only 12 percent greater than the centralized treatment option, acquisition of 45 acres of drainfield land may be difficult.

Based on life cycle cost analysis, where appropriate, three options should be taken forward for future evaluations of a wastewater management solution - centralized treatment and decentralized treatment comprising either SBR/percolation pond discharge or MBR/percolation pond discharge.

⁵ 2007 King County WTD Life-Cycle Cost Spreadsheet.

Ground water recharge via percolation pond offers the benefit of returning island water resources to the island. The percolation pond site must be carefully sited taking into account ground water resources.

ES.6.2 Next Steps

A system capacity study should be conducted to determine the actual number of residences needing community wastewater treatment. Parcels in the study area and within the MRA should be evaluated for occupancy, existing treatment, and proximity to other parcels to identify the scope of the wastewater management solution.

Collectively, parcel owners needing an alternative to a conventional on-site treatment system should work together with VSD and/or the County to form a ULID. The options presented in this study should be reevaluated based on the actual scope of the wastewater management solution.

Table ES.5 Wastewater Management Options Cost Summary/Life Cycle Cost Analysis Quartermaster Harbor Communities Wastewater Management Options King County Department of Natural Resources and Parks					
	Centralized Treatment	Septic Tank/ Conventional Drainfield	Recirculating Gravel Filter/Subsurface Drip System	SBR/Percolation Pond	MBR/Percolation Pond
Land Required (Acre)	n/a	56	28	7	7
Number of Systems Required	1	14	11	1	1
ERUs Served	433	433	433	433	433
System Capital Cost -Low Est	\$10,384,000	\$16,411,000	\$23,954,000	\$13,950,000	\$13,921,000
System Capital Cost -High Est	\$20,765,000	\$32,823,000	\$47,909,000	\$27,901,000	\$27,842,000
Cost per ERU ^(1,2)	\$48,000	\$75,800	\$110,600	\$64,000	\$64,000
Annual O&M Cost	\$720,000	\$317,000	\$300,000	\$319,000	\$341,000
Annual Cost per ERU ⁽³⁾	\$1,663 ⁽⁴⁾	\$732	\$693	\$736	\$788
Present Value of Costs ⁽⁵⁾	\$25,139,000	\$27,602,000	\$37,707,000	\$24,185,000	\$24,464,000
Net Equivalent Annual Cost	\$1,565,000	\$1,718,000	\$2,347,000	\$1,506,000	\$1,523,000
Notes: (1) Based on High Estimate. (2) Simple calculation for comparison purposes and does not include considerations for financing or outside funding sources. (3) Annual O&M Cost divided by 433 ERUs. VSD management fees not included. (4) Includes conveyance/collection operating cost and King County treatment cost - capacity charge (15 years) and sewer rate for 433 ERUs. (5) Assumes average capital cost between high estimate and low estimate, annual cost per ERU as shown, 20-year period, KC WTD discount rate 2.2% = KC borrowing rate 5.25% - general inflation 3%.					