HOOD CANAL COORDINATING COUNCIL

HOOD CANAL REGIONAL POLLUTION IDENTIFICATION AND CORRECTION PROGRAM

PHASE II – IMPLEMENTATION (October 2014 – December 2016)

Final Report

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Prepared by HCRPIC Program Co-coordinators:

Leslie Banigan, Kitsap Public Health District
Haley Harguth, Hood Canal Coordinating Council

Program Partners:

Jefferson County Public Health
Jefferson Conservation District
Kitsap Public Health District
Kitsap Conservation District
Mason County Public Health
Mason Conservation District
Port Gamble S'Klallam Tribe
Skokomish Tribe

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Jefferson County Public Health, Kitsap Public Health District, Mason County Public Health, Port Gamble S'Klallam Tribe, Skokomish Tribe, Jefferson Conservation District, Kitsap Conservation District, Mason Conservation District, University of Washington, Tacoma – Puget Sound Institute, Washington State University – Extension, PetersonGIS.

More information on the Hood Canal Regional Pollution Identification & Correction Program is available at www.HCCC.wa.gov, and www.OurHoodCanal.org.

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BACKGROUND

Hood Canal is a natural, glacier-carved fjord more than 60 miles long, forming the westernmost waterway and margin of the Puget Sound basin. It begins in the north in Admiralty Inlet and extends southwesterly about 45 miles to the Great Bend at Annas Bay. From there its "hook" extends northeasterly 15 miles to its head at the Union River estuary near Belfair.

The Canal has great cultural, economic, and recreational value to Washington State residents and tribes. Hood Canal shellfish and finfish resources have important economic, subsistence, and recreational value to the community.

The Hood Canal Regional Pollution Identification and Correction (HCRPIC) Program partners include Jefferson, Kitsap, and Mason Counties, the Port Gamble S'Klallam and Skokomish Tribes, and the Hood Canal Coordinating Council (HCCC). A regional pollution identification and correction (PIC) approach enables efficient, prioritized, and coordinated responses by the jurisdictions sharing a common watershed.

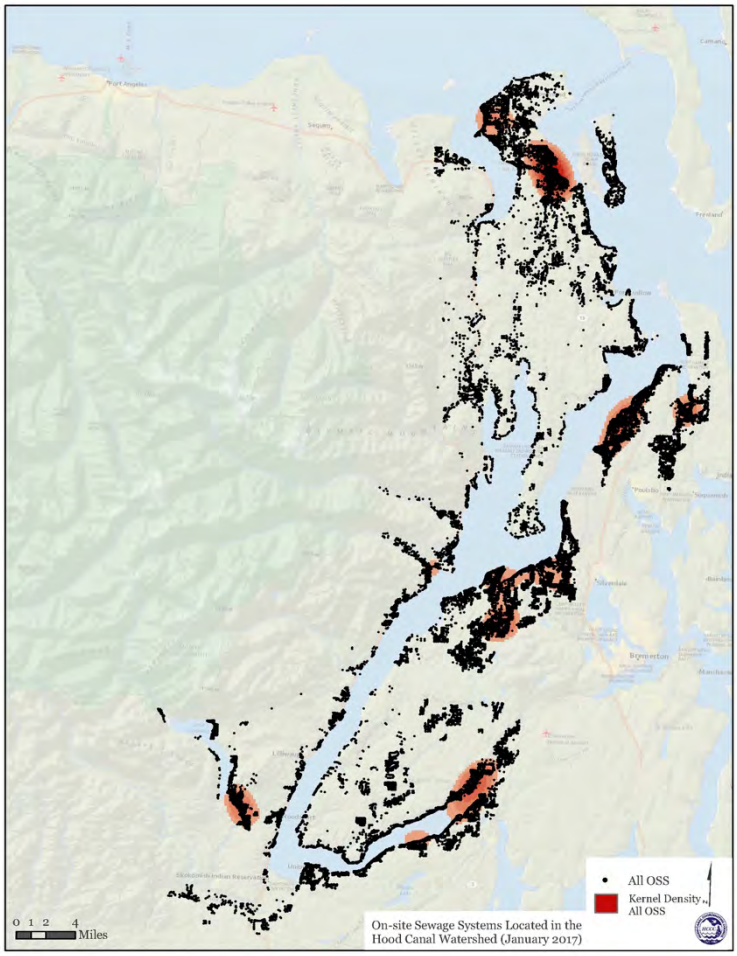

Figure 1: Map of all OSS locations in Hood Canal, with the densest concentration of OSS highlighted in red (Appendix A, Figure A-1)

The Hood Canal watershed has approximately 25,000 on-site sewage systems (OSS), many in close proximity to water bodies (Figure 1; Appendix A, Figure A-1). PIC and water quality programs have been essential to maintain and improve water quality by reducing bacterial and nutrient pollution sources.

GOALS AND OBJECTIVES

The goals of the regional HCRPIC Program are to:

- Protect and restore water quality by correcting fecal pollution sources in order to protect and enhance public health and shellfish growing areas
- Restore and protect Hood Canal habitat

The HCRPIC program improves efficiency and efficacy in each Hood Canal jurisdiction, with the following objectives:

- Develop a regional PIC program
- Coordinate regulatory oversight and policy development
- Coordinate water pollution investigation and cleanup work

RESULTS

The Hood Canal Coordinating Council has partnered with its member jurisdictions to develop the regional PIC partnership for the Hood Canal Action Area. The program has provided a unique opportunity to combine and share strengths and experience of each of the partners' PIC and water quality programs in order to build a robust regional program. The HCRPIC program was designed to be rolled out in two phases.

Phase I: Planning (2012 – 2014)

HCCC received funding from the U.S. Environmental Protection Agency (EPA) National Estuary Program (NEP) through Washington State Department of Health (WSDOH) between 2012 and 2014 to develop the multi-jurisdictional work group and guidance documents. The regional HCRPIC coordinators commenced building the regional work group by meeting with each partner early in the project. This group was initially built with representatives from local health jurisdictions and tribal natural resource departments. Local conservation districts were brought in to develop the animal waste strategy and local stormwater recommendations were used to develop the stormwater strategy.

The regional work group met quarterly and collaborated closely to develop the relationships and materials needed for regional implementation work. They developed a coordinated watershed-wide project framework, producing guidance documents that include a regional monitoring plan and technical guidance document. Seven regional team meetings were conducted during Phase I.

The HCCC Aquatic Rehabilitation Technical Advisory Committee Wastewater-OSS Workgroup developed the first phase of a project in 2010 to create GIS maps of wastewater infrastructure (OSS, sewer, planned sewer, and large OSS) in the Hood Canal watershed. Local jurisdictions provided on-site sewage system permit data to update the GIS maps during Phase I. We also added WSDOH shellfish growing areas and developed kernel cluster maps showing denser areas of old or unpermitted OSS.

The planning documents and meeting minutes are posted on the HCCC website at:
www.hccc.wa.gov/content/pollution-identification-correction

In May 2014, the Skokomish Tribe recognized an opportunity to work with the HCRPIC Program to asses and improve water quality in a rich shellfish resource area in Hoodsport that WSDOH has closed due to historical pollution concerns. Kitsap Public Health District (Kitsap Health) and HCCC invested in early action in Hoodsport between the HCRPIC Phase I and Phase II grants. WSDOH, Mason County Public Health (Mason Health) and the Skokomish Tribe worked together to assess shoreline drainages and marine water in the area and refer bacterial "hotspots" for PIC work with the long-term goal to document water quality improvements to support WSDOH opening the Hoodsport shellfish beds for harvest.

Phase II: Implementation (2015 – 2017)

In October 2014, HCCC received additional NEP funds to conduct the first implementation phase of the HCRPIC Program. Our unique partnership with WSDOH helped us quickly identify and prioritize Hood Canal shoreline work areas based on robust marine water data and prior water quality studies. See Appendix A, Figure A-2 for a map of WSDOH marine water quality ratings for Hood Canal shorelines and shellfish growing areas. The HCRPIC Guidance Group identified 8.2 priority shoreline miles in Mason County and 8.5 priority shoreline miles in Jefferson County for shoreline survey. Table 1 lists the priority shoreline locations identified. The HCRPIC guidance document defines shoreline survey as "the

inventory and bacterial assessment of all flowing fresh water discharges to the shoreline within a project area."

Table 1: HCRPIC Phase II Priority Shoreline Survey Areas

Location	Miles	Location	Miles
Mason County		Jefferson County	
West Shore		Hood Canal 1	
Hoodsport	1	Paradise Bay: North of Hood Head	1
HC 6: Potlatch Area, West shore	0.5	Hood Canal 3	
South Shore		Dosewallips/Brinnon/South of estuary	3
Big Bend/Union	1.8	Pleasant Harbor	1
HC 8/9: South shore	1.5	Duckabush	2
Forest Beach	0.5	Chimacum	
15851 SR 106	0.4	Chimacum Creek Tidelands & Irondale Beach Park	1.5
North Shore			
Northshore: West of Tahuya	2.3		
HC 8: West of 265	0.1		
HC 6: Summertide Resort	0.1		
Total Miles	**8.2**	**Total Miles**	**8.5**

The Quality Assurance Program Plan (QAPP) for this project was submitted in December 2014 (Banigan 2014). Field work started in February 2015 following QAPP approval. Between February 2015 and December 2016, the partners completed the following tasks:

Guidance Group

Project coordinators grew the regional work group into the Guidance Group. The five jurisdictions have formed a working team that has resulted in shared tools and techniques, field work partnerships, problem solving, and networking opportunities. Guidance Group meetings were held quarterly, with an option of joining on-line, and were well attended by regional team partners. Nine guidance group meetings were conducted during Phase 2. Meeting minutes are posted on the HCCC website.

Field Work

Partners conducted shoreline surveys, parcel surveys and investigations in priority areas of the Hood Canal shoreline. Figure 2 shows a map of the Phase II shoreline survey areas (Appendix A, Figure A-3). Detailed maps of each work area showing shoreline surveys and parcel surveys are included in Appendix A, Figure A-4. Table 2 below summarizes the implementation work conducted for HCRPIC Phase II. The remaining OSS repairs are in the correction process.

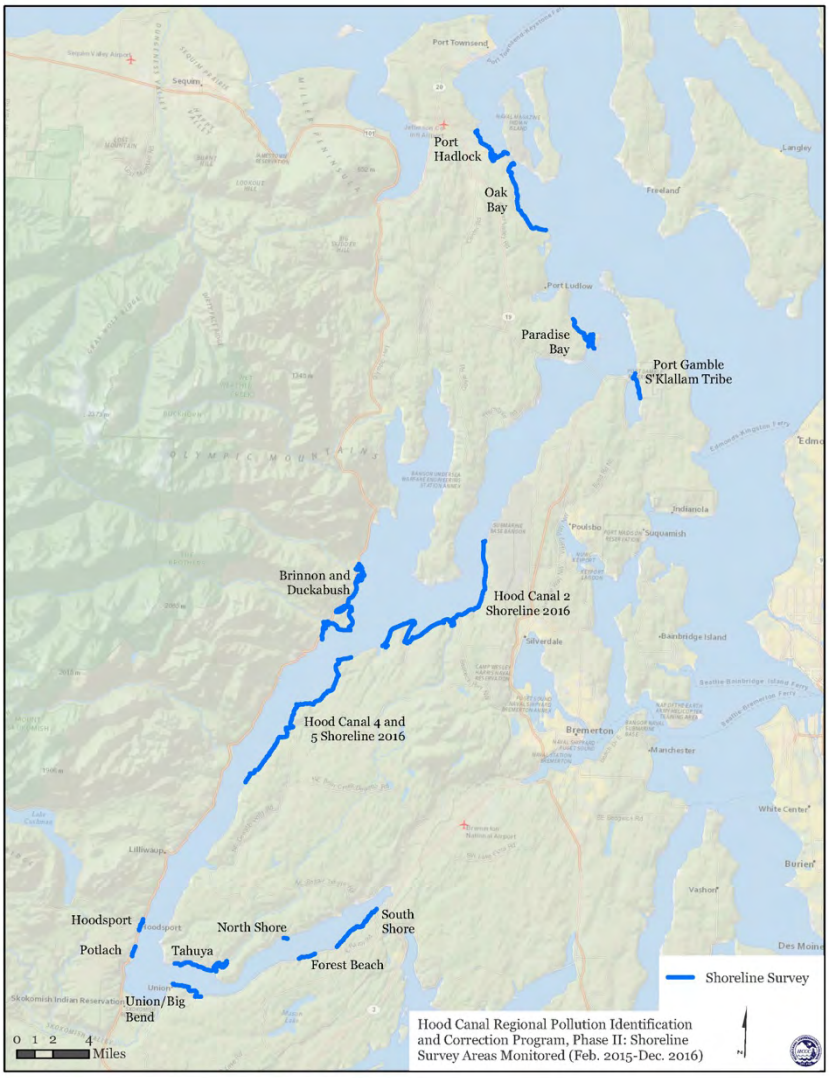

Figure 2: Map of HCRPIC Phase II shoreline survey areas monitored, Feb. 2015 – Dec. 2016 (Appendix A, Figure A-3)

Table 2: HCRPIC Phase II Implementation Work

	Shoreline Surveys		Parcel surveys		OSS Failures	OSS Repairs
Agency	Miles Committed	Miles Conducted	Number Committed	Number Conducted	Number Identified	Number Completed
Jefferson County Public Health	8.5	25.5	140	353	46	42
Kitsap Public Health District	25.9	25.9	0	282	14	14
Mason County Public Health	8.2	13.1	140	143	16	11
Port Gamble S'Klallam Tribe	0	1.6	0	0	0	0
Total	**42.6**	**66.1**	**280**	**778**	**76**	**67**

Detailed maps showing shoreline pollution hotspots, OSS failures identified and their repair status are included in Appendix A, Figure A-5 and 6.

Figure 3 summarizes the OSS failure causes found during the project. Multiple conditions may have been reported for a single OSS failure. Failure conditions were grouped into three categories: Poor OSS Operation, Poor OSS maintenance, and Poor OSS design/installation. Forty-eight of the sixty-one (78.6%) failure conditions reported were related to poor OSS maintenance including surfacing sewage or greywater, saturated drainfield, unpermitted repairs, no maintenance, and unsecure tank. Twelve of the failure conditions (19.6%) were related to poor OSS operation including occupied RVs, building or parking, and using a holding tank, outhouse, or pit privy. Only one failure condition, proximity to surface water, was related to Poor OSS design/installation. Table 3 lists the detailed conditions reported when OSS failures were found during parcel surveys across Jefferson and Mason Counties. Although these conditions do not directly imply causation, they are informative in learning what conditions are most common, and how outreach efforts may better address landowners' situations on their properties to prevent premature OSS failures.

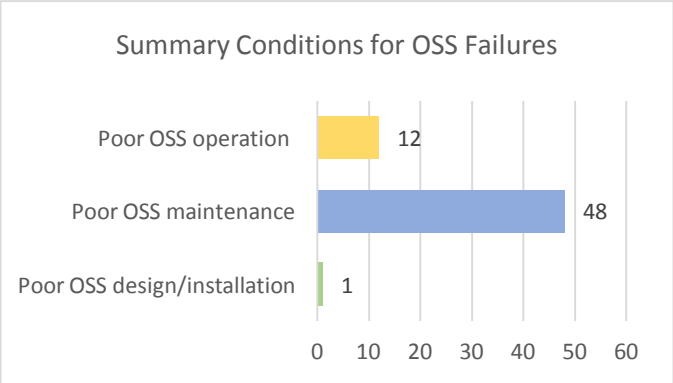

Figure 3: Summary conditions for OSS failures identified across Jefferson and Mason Counties during parcel surveys

Table 3: Conditions reported when OSS failures found via parcel surveys across Jefferson and Mason Counties

Conditions contributing to OSS failures	Occurrence	Percent of Total
No conditions reported	15	17.9%
OSS equipment/structure failure	15	17.9%
Surfacing sewage	11	13.1%
Old OSS failure identified prior to Phase II	7	8.3%
Drainfield saturated and/or failed	6	7.1%
Greywater discharge	5	6.0%
No maintenance	4	4.8%
RV(s) connected to OSS	4	4.8%
RV(s) occupied, not connected to OSS	3	3.6%
Unpermitted repairs	3	3.6%
Drainfield or OSS built over/in use	2	2.4%
Old OSS	2	2.4%
Holding tank used	1	1.2%
Outhouse or pit privy	1	1.2%
Proximity to hotspot	1	1.2%
Proximity to surface water	1	1.2%
Seepage pit	1	1.2%
Unsecure riser/tank/lid	1	1.2%
Vehicle/RV(s) driving/parking on OSS or drainfield	1	1.2%

Figure 4 below summarizes the rating criteria for the parcels that were rated Suspect, Concern, or Violation. Table 4 lists the detailed conditions found during the parcel surveys rated Concern, Suspect, Violation across Jefferson and Mason Counties.

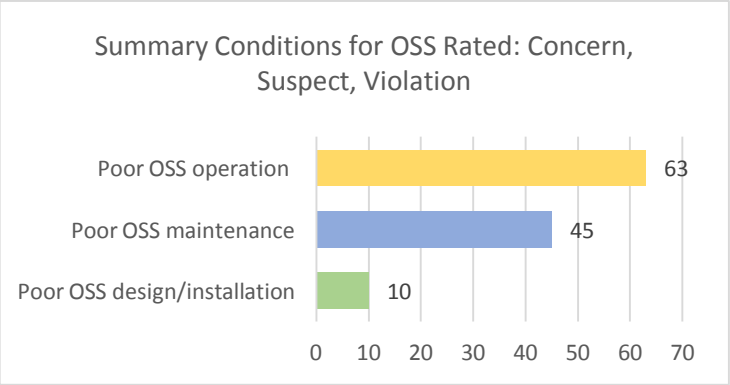

Figure 4: Summary conditions for parcel surveys rated: concern, suspect, or violation, across Jefferson and Mason Counties

Fifty-five (61.1%) of the 118 rated parcels have serious conditions that can cause premature OSS failure including:

- Twenty-eight (23.7%) are potentially exceeding the capacity of the OSS
  - Eleven had RVs connected into the OSS
  - Nine are exceeding the OSS capacity
  - Three had water leaks in the house
  - Two had rainwater entering the OSS
  - Three occupied RVs were not connected into the OSS
- Fourteen (11.8%) were driving or parking on OSS
- Nine (7.6%) had unpermitted repairs
- Eight (6.7%) had no record of maintenance
- Seven (5.9%) drainfields have been built upon
- Six (5.0%) had unsecured septic tanks
- Four (3.3%) had saturated drainfields
- Two (1.6%) had equipment or structure failures
- Two (1.6%) had repairs that have not been completed

Table 4: Conditions reported for parcel surveys rated Concern, Suspect, or Violation across Jefferson and Mason Counties

Conditions contributing to rating	Occurrence	Percent of Total
Proximity to hotspot	23	15.9%
Vehicle/RV(s) driving/parking on OSS or drainfield	14	9.7%
RV(s) connected to OSS	11	7.6%
Drainfield overgrown	9	6.2%
Occupancy over-capacity of OSS	9	6.2%
Unpermitted repairs	9	6.2%
No maintenance	8	5.5%
Drainfield or OSS built over/in use	7	4.8%
Old OSS	7	4.8%
Unsecure riser/tank/lid	6	4.1%
Flood risk to OSS	5	3.4%
Proximity to surface water/shoreline	5	3.4%

Drainfield saturated	4	2.8%
No conditions reported	4	2.8%
Permit issues	4	2.8%
Poor site conditions	3	2.1%
RV(s) occupied, not connected to OSS	3	2.1%
Water leaks in house	3	2.1%
Holding tank used	2	1.4%
OSS equipment/structure failure	2	1.4%
Rainwater entering OSS	2	1.4%
Repairs not completed	2	1.4%
Greywater discharge	1	0.7%
Outhouse or pit privy	1	0.7%
Seepage pit	1	0.7%

OSS GIS Mapping

The regional team worked with the same consultant used in Phase I (PetersonGIS) to update the HCRPIC OSS GIS Maps in Phase II (Appendix A). Local Hood Canal Jurisdictions provided updated on-site sewage system permit data and implementation work locations including shoreline surveys, shoreline hotspots, parcel surveys, and on-site sewage system failures identified and repaired. The updated OSS status maps (Appendix A, Figure A-7-13) illustrate the locations of all OSS across Hood Canal, and categorize them by OSS type and age. Analyzing these locations for clusters of problematic types of OSS, or very old OSS, enables the HCRPIC team to prioritize its field work. The maps will be provided to the jurisdictions to inform workplanning for future phases of the HCRPIC program, and will be available on the HCCC website. HCRPIC Phase II data is best viewed using the interactive web maps found on the HCRPIC Program website: http://hccc.wa.gov/content/pollution-identification-correction.

Pilot Nutrient Study – Mason County

HCRPIC worked with University of Washington's Puget Sound Institute to design and conduct a pilot study to evaluate whether seepage pits located on near-shore parcels in Mason County are a significant source of bacteria or nitrogen to the Hood Canal shoreline (James et al. 2017). A QAPP Addendum was submitted and approved for the Hood Canal Regional PIC Nutrient Study in April 2016 (Banigan 2016).

Thirty seepage pits within 100 feet of the Mason County shoreline were identified and sampled in 2016 during the wet weather season and the dry weather season. It is difficult to make a direct link between seepage pits and shoreline discharges because of complex sub-surface transport and potential mixing. The study utilized known seepage pit locations and expert site evaluation to identify representative shoreline sampling locations.

Only six of the thirty sites (20%) could be used in this study. Many sites had no shoreline flows and many were tidally influenced. Sites with chloride levels consistently greater than 100 mg/L were excluded from the study analysis. Sites were sampled for fecal coliform bacteria, ammonia nitrogen, nitrate/nitrite nitrogen, chloride, phosphate, and sulfate and results were compared to "reference data" derived from Mason Health work conducted in Hood Canal between 2007 and 2011.

University of Washington's Puget Sound Institute statistically analyzed sample results. When compared to other sites in southern Hood Canal, the seepage pit-associated sites were not significantly greater sources of bacteria or nutrients to the shoreline and were not more likely to have shoreline discharges. These finding are limited by the number of sample sites. More research is needed to make conclusive recommendations about seepage pit use in Hood Canal. One of the six sites had elevated bacteria and nutrients and is under investigation by Mason Health. The full report of the pilot nutrient study in Mason County is included in Appendix B.

Pilot Nutrient Study – Jefferson County

HCRPIC worked with University of Washington Puget Sound Institute to design a pilot nutrient study to characterize the short and long-term in-stream nitrogen concentrations at three streams in Jefferson County (Irondale Creek, Little Goose Creek, and Chimacum Creek) (James et al. 2017). Specific objectives were to:

- Characterize concentrations in two creeks which have not yet been evaluated (Irondale Creek and Little Goose Creek)
- Develop methodologies for field probe deployment and use
    - Characterize accuracy and uncertainty utilizing existing testing regime
- Characterize the short term temporal patterns

Jefferson County Public Health (Jefferson Health) selected nine sample stations in the Chimacum Creek basin: six on the main stem and one station on each tributary (East Chimacum Creek, Naylors Creek, and Putaansuu Creek) based on:

- Only three of the nine Chimacum stations met Washington State's water quality standard for bacteria in 2016.
- The tributary Putaansuu Creek flows from the outlet of Anderson Lake, and tributary Naylors Creek flows from Gibbs Lake - both experience frequent cyanobacteria blooms.

A sample station was located at the mouth of Irondale Creek, and one at Little Goose Creek, because those were confirmed as shoreline hotspots during the HCRPIC Phase II project. Jefferson Health was unable to establish representative upstream sample stations in these small basins.

Jefferson Health conducted five months of monthly sampling at the eleven stations between October 2016 and February 2017. The October sampling took place before any significant rain events had occurred.

A YSI ProDSS Multimeter with a nitrate probe was used for four of the five sampling events and grab samples were collected to verify accuracy and precision of the field instrument. In general, meters perform better in the mid-to-upper ranges of the nitrate-nitrogen scale because the meter has an accuracy of 0.2 mg/L compared to the 0.015 mg/L accuracy of the nitrate laboratory test.

Jefferson Health conducted a nutrient study in the Chimacum watershed in 2007-2008. The nitrate-nitrogen levels ranged from 0.0 mg/L to 6.5 mg/L (Gately et al. 2015). Nitrate-nitrogen levels in the Chimacum watershed during this study ranged from 0.07 to 1.72. Naylors Creek, which drains Gibbs Lake, had the highest consistent nitrate-nitrogen levels of the tributaries to Chimacum Creek.

Irondale Creek is the smallest basin in the study. It is approximately 0.25 miles long and the primary source is groundwater from several springs in a wooded area surrounded by a residential neighborhood served by older septic systems. The mouth station has a history of very high E.coli results. In August

2015, the E.coli geomean was 15.647 mpn/100mL. Bacteria levels during this study have been relatively low.

Little Goose Creek has mixed residential and wooded lots but many of the septic systems in the basin are older. Nitrate-nitrogen levels in Little Goose Creek levels ranged from 1.20 to 5.76 mg/L. The highest reading (5.76 mg/L) occurred in October 2016 before any significant rainfall. The lowest reading (1.2 mg/L) was in December 2016.

The nitrate probe was used for four of the five sample events. The YSI nitrate-nitrogen probe was most useful for nitrates in the range that were found in Irondale Creek, where the nitrate levels were higher.

Jefferson exceeded their HCRPIC Phase II grant commitments by conducting 25.5 miles of shoreline surveys (8.5 miles committed), and 353 parcel surveys (140 parcel surveys committed). They experienced significant challenges during the course of the HCRPIC Phase II implementation project including:

- They spent most of their grant money by mid 2016. Project funding was shifted to provide Jefferson with additional funding to conduct remaining grant commitments.
- Jefferson experienced significant staff losses that delayed the start of the nutrient study.

In conclusion, Jefferson's nutrient study was delayed by funding and staffing challenges and a preliminary report was submitted March 24, 2017. During Phase III, The HCRPIC Guidance group will review the study design and nutrient work conducted and will recommend how to proceed during Phase III.

The Guidance group should review the nutrient study and determine how to proceed. Any future nutrient study work will need to be carefully targeted to build on and further nutrient research in Hood Canal. The group should consider how to respond to:

- Study design requirements
- Little Goose Creek had the highest nitrate-nitrogen concentrations during the dry weather season.
- Irondale Creek had consistently higher nitrate-nitrogen concentrations. The creek is supplied primarily by groundwater and has a small catchment area. Jefferson concluded that Irondale Creek does not exhibit a significant response to rain events.

Outreach and Education

HCRPIC worked with Washington State University Extension – Jefferson County (WSU-Ext) to build on outreach and education work conducted in 2015 by WSU-Ext and the Washington Conservation Commission (Joy et al. 2015). Follow-up interviews for the 2015 project were conducted 1.5-2 months after the site visit to measure whether the recommended best management practices (BMPs) were implemented and what barriers may have prevented implementation. A key finding was that follow-up interviews were conducted too soon.

For the HCRPIC Phase II project, WSU-Ext. conducted supplemental follow-up interviews one year after the 2015 site visits and gathered audience research information to design and implement effective outreach methods to encourage adoption of BMPs by landowners in Hoodsport, Union, and the North Shore area of Tahuya (Simmons et al. 2017; Appendix C). The supplemental interviews found that follow-up was a common need, and the primary barriers to implementation were physical limitations and need for information or assistance.

WSU-Ext. utilized the audience research to design and conduct audience research with fifteen Hood Canal landowners within 250 feet of the Hood Canal shoreline (Simmons et al. 2016; Appendix D). Five respondents were from the Hoodsport area and ten were from the Union area. Information was gathered about barriers to, and motivations for accepting a water quality advisor site visit; and how best to communicate about water quality issues.

Most of the participants were interested in site visits once they understood what a site visit entailed. They were most motivated to have a site visit because of water quality and health concerns. Most participants were concerned about runoff and how to control it. Respondents wanted to know that site visits would be conducted by qualified organizations and that regulatory agencies would not receive any information from the site visit. The most popular incentive for a site visit was a rebate or coupon for septic system maintenance. The most preferred methods of contact were letters or phone calls. However, door-to-door visits have been more effective in practice and have resulted in more diverse participants.

WSU Ext. also conducted outreach and education in shellfish growing area Hood Canal 6 (Simmons et al. 2017; Appendix E), 464 door-to-door visits were made in Hoodsport, Hood Canal's North Shore and Union, offering water quality advisor site assessments. One hundred and nineteen residents were at home and 40 agreed to site visits.

Nearly all of the 2016 site visits required follow-up, partly due to more challenging stormwater circumstances. Some drainage issues were too complex for the scope of this project. Almost all the site visits in North Shore and Hoodsport had severe stormwater impacts from very steep uplands. There is a clear need for stormwater technical assistance.

At the conclusion of field work, WSU Ext. produced a two-page handout summarizing HCRPIC Phase II highlights for decision-makers (included in Appendix F).

Reports and materials for HCRPIC Phase II audience research and outreach efforts are included in Appendices C, D, E, and F.

Port Gamble S'Klallam Tribe

The Port Gamble S'Klallam Tribe (PGST) has been an active partner in the planning and development of the Hood Canal regional PIC team. They received a separate NEP grant that funded Hood Canal "PIC Plus" water quality research work. "PIC Plus" work is designed to support HCRPIC work by conducting research and investigating techniques to address regional data gaps identified by the Guidance Group and to provide new tools to help identify fecal pollution sources in areas where traditional PIC methods have not been successful (Daubenberger et al. 2017).

PGST is responsible for identifying and correcting nonpoint pollution on tribal lands. To this end, PGST developed their own PIC program to identify and correct nonpoint pollution on tribal lands. They utilize collection and analysis methods consistent with the HCRPIC program protocols.

The PGST PIC Program conducted wet and dry season shoreline surveys on the PGST reservation in 2015. The wet season survey was conducted on February 24 and the dry season survey on September 25. Kitsap Health was a critical partner for the shoreline surveys and provided valuable support to PGST personnel and contractors throughout the planning, field work, laboratory coordination, sample results review. PGST reservation shoreline survey results filled a lingering data gap in water quality records and allowed Kitsap Health to assess and account for all shorelines in Kitsap County.

The wet season shoreline survey results led to one hotspot confirmation. PGST coordinated with Kitsap Health and conducted a joint home visit and dye test in April 2015. The results of this dye test were negative, meaning the source of pollution remained unconfirmed, and subsequent monitoring results showed that water quality improved. Dry season shoreline survey bacteria results yielded no hotspot confirmation and required no investigation.

A second hotspot investigation was initiated in response to a sewer overflow on the PGST reservation sewer system. PGST determined the source of the spill to be near Bud Purser Lane and began sampling streams in the vicinity. PGST worked with Kitsap Health to confirm the hotspot and developed a dye testing strategy for the neighborhood.

PGST conducted the dye testing campaign and continued weekly sampling in coordination with US Health and Human Services (USHHS). PGST closed the associated beach to shellfish harvest to protect tribal members until water quality improves sufficiently. As of March 2017, correcting this pollution source on the reservation is an ongoing effort.

PGST led planning for regional gap studies based on available pollution trend analysis. They worked with partner jurisdictions to prioritize sample locations for the temporal investigation, microbial source tracking (MST) study, and the optical brightener and tryptophan evaluation.

PGST coordinated sample collection of E. coli over a 24-hour period, to test for temporal variation in sample results. PGST used a portable autosampler to collect a water sample every hour during the 24-hour sampling periods. Variability in results between samples was enough to warrant a second test, to determine the range of variability between split and replicate samples. A second collection period was coordinated with personnel collecting samples by hand four times a day over 72 hours. Temporal studies were conducted on the PGST Reservation, and in Jefferson County at Irondale Creek and the Duckabush River. A time of day study planned at Lofall Creek in Kitsap County during the wet season of 2015-2016, was eventually canceled after excessive rainfall. Results showed that EC levels did vary significantly with time of day, beyond the variability found between split and replicate samples.

Water quality monitoring and clean-up programs have relied heavily on fecal indicator bacteria (FIB), including *Escherichia coli* and *Enterococcus,* to indicate the presence of sewage, feces, and pathogens. These conventional indicators cannot discern between human and animal sources. It is important to be able to distinguish between human and animal fecal pollution sources because of the different remediation strategies for mitigating contamination from sewage versus surface runoff carrying animal waste. PGST conducted a literature review of published methods which have been used to identify microbial sources. This resulted in the development of a DNA-based microbial source tracking study utilizing PCR and high throughput sequencing. Results of the microbial source tracking study are expected to be available Spring 2017.

Tryptophan is an amino acid, one of the building blocks of life. All natural water bodies contain tryptophan at some level but natural levels will be far exceeded in the case of fecal contamination. Coliform bacteria, like E. coli, synthesize high levels of tryptophan in their cells, making tryptophan a useful biomarker of fecal contamination in a water system. L-tryptophan is used for insomnia, sleep apnea, depression, anxiety, facial pain, a severe form of premenstrual syndrome called premenstrual dysphoric disorder (PMDD), smoking cessation, grinding teeth during sleep (bruxism), attention deficit-hyperactivity disorder (ADHD), Tourette's syndrome, and to improve athletic performance.

Optical brighteners are present in detergent whitener, paper brightening, fiber whitening, textile whitening, and color-correcting or brightening additive in advanced cosmetic formulas (shampoos, conditioners, eye makeup).

PGST used a Turner Designs Cyclops 7 Submersible Fluorometer with tryptophan and optical brightener sensors to determine if *in situ* measurements of tryptophan and optical brighteners are a useful proxy for identifying fecal pollution hotspots. Results showed no correlation between optical brighteners and EC at the three temporal investigation sites where the fluorometer was deployed. At one of the three sites, there was a weak correlation between E. coli and tryptophan

PGST identified two priority audiences for outreach and education, tribal members, and regional policy-makers. To engage with these audiences, PGST developed its own outreach materials. This encouraged PGST to increase its field documentation, associated training and photographs of relevant field activities in U&A areas with actual PGST tribal members and personnel. PGST prepared outreach materials for social media, such as the PGST website and Facebook page. The materials are PowerPoint slides that stand alone to introduce PGST PIC priorities. Additionally, PGST created two PowerPoint presentations that are tailored to tribal members and policy-makers. PGST and Kitsap Health conducted outreach and education with property owners and onlookers during field sampling events. Natural Resources Department staff offered presentations to college and grade school students on the reservation.

The newly strengthened relationship with Kitsap Health provided excellent networking opportunities for engaging with local policy-makers.

The PGST PIC implementation report is attached in Appendix G.

Kitsap Health also partnered with the Port Gamble S'Klallam Tribe to conduct a shoreline survey along the 1.6 miles of tribal shoreline in Port Gamble Bay. Kitsap has conducted routine shoreline surveys of the Kitsap County portion of Port Gamble Bay since WSDOH closed the Cedar Cove shellfish beds to harvest in 1996 due to high bacteria. WSDOH re-opened the shellfish beds in 1999, after Kitsap Health conducted extensive PIC work in the area. Kitsap provided technical assistance to the tribe for shoreline surveys, fecal pollution investigations, dye testing, and data management.

Skokomish Tribe

The Skokomish Tribe has been very active in the HCRPIC Program Guidance Group and was an important contributor in the development of the Phase I program guidance materials. They utilized their general assistance program funds during Phase II in order to transfer its participation funds to targeted implementation in and around their reservation lands.

The Skokomish Tribe chose to use its Phase II grant funding to provide rebate vouchers to inspect, pump, or install risers on septic tanks in high-priority neighborhoods in the Mason County portion of Hood Canal. Forty-six vouchers were utilized and twenty (43.4%) had no current record of OSS maintenance. Another ten (21.7%) had only one record of OSS maintenance.

Related Work Funded by Other Sources

Kitsap Health conducted Hood Canal PIC work through Clean Water Kitsap funding. Jefferson Health utilized multiple grants to fund its Hood Canal PIC work.

Complimentary outreach efforts to support the HCRPIC Program were also funded by HCCC's Local Integrating Organization:

- Kitsap Health mailed two hundred high priority Hood Canal shoreline properties rebate vouchers on November 8, 2016. These offered up to $250 rebates for septic tank inspection, required

tank pumping, operation and maintenance, and tank riser installation. Seventeen vouchers were utilized by the December 14, 2016 deadline. Seventeen tank inspections were conducted and a riser was installed on one septic tank. Of the seventeen tank inspections, four deficiencies were identified and corrected (23.5%): one had effluent above normal operating level, one repaired a septic tank with root intrusion, one drainfield was jetted and is now accepting water, and one tank inspection resulted in pumping the pre-treatment device.

- WSU Ext. developed and distributed a "Hood Canal Report Card" brochure mailer to all Hood Canal shoreline residences within the Hood Canal LIO area boundary, totaling 37,421 residences. The brochure is available on HCCC's website library: www.hccc.wa.gov/resources.

CONCLUSIONS

The planning phase was very valuable because it allowed the region to develop a regional guidance group and planning documents to guide regional pollution identification and correction work. The regional partners had the following comments about the guidance group:

- "One of the best things was getting to meet in person and sharing information. The meetings were very beneficial."
- Learned about different approaches to addressing PIC work through this process, which was very helpful.
- Appreciated that the process was consistent and structured.

The project field work commitments under our Phase II grant were exceeded:

- More than 66 miles of shoreline surveys conducted - 23 miles (54%) more than committed
- 778 parcel surveys conducted – nearly 500 (177%) more than committed
- 88% of the 76 on-site sewage system failures have been repaired and the remainder are in progress

The partnership with the Port Gamble S'Klallam Tribe and the Skokomish Tribe has been valuable. Their science and technical staff conducted research and tested investigative techniques to find tools to identify fecal pollution sources in areas where traditional PIC methods have not been successful.

Seepage pit-associated sites were not significantly greater sources of bacteria or nutrients to the shoreline when compared to other sites in southern Hood Canal. More research is needed to make conclusive recommendations about seepage pit use in Hood Canal.

Jefferson Health was unable to complete their pilot nutrient project and report as designed during Phase II. This was due to their focus on shoreline surveys and parcel surveys in high priority shoreline areas and staffing challenges.

Their preliminary work is described in this report. The Guidance Group will need to review the materials and recommend a course of action for Phase III.

HCRPIC jurisdictions can use updated GIS maps to prioritize work by identifying areas where clusters of old or unpermitted OSS coincide with water quality concerns. These maps also report field work locations and results to the public and decision-makers.

This project coordinated with and built on WSU-Ext. and Washington Conservation Commission outreach and education work conducted in 2015. Their short grant timeline limited the amount of field

work they could conduct and resulted in audience research and field work recommendations that HCRPIC utilized in the Hood Canal 6 shellfish growing area.

HCRPIC has resulted in unique partnerships to share and leverage resources. These partnerships have resulted in:

- Streamlined grant management and lessened administrative burden for project partners
- Partnership with WSDOH, allowing us to quickly identify and rank high priority areas for PIC work
- Skokomish Tribe funded Mason County OSS maintenance vouchers
- Inter-jurisdictional field work, some funded by the jurisdictions due to the timing of grant funding
- Strategic partnerships, sharing and developing investigation, dye testing, enforcement, and reporting techniques and resources.
- Partner-funded related field work and outreach and education through other sources

RECOMMENDATIONS

The HCRPIC Program partners are looking forward to Phase III of the HCRPIC Program; lessons learned from previous phases and newly gathered information have resulted in the following recommendations:

- The regional partners should present any Phase II hotspots for closure at the first guidance group meeting for Phase III. Partners should investigate Phase II hotspots that are not closed and repair pending failures during Phase III.
- The HCRPIC Program should work with WSDOH to prioritize Hood Canal shoreline areas for Phase III field work based on current marine water quality data.
- Conduct a field training workshop after the QAPP is approved and before samples are collected. Consider developing a field work guide with important QA/QC considerations (survey ratings and criteria, failure causes, sample site nomenclature, necessary sampling parameters).
- The HCRPIC Program should consider developing a PIC Surface Water Action Team (SWAT Team) to brainstorm potential investigation and enforcement options for challenging parcels.
- Field work partners commit to using a common reporting template to streamline project reporting.
- Technical reporting is more robust when regional field work and reporting consistently meets quality assurance and quality control (QA/QC) measures. Partners must conduct QA/QC on their data before it is submitted to the coordinators.
- Enhance Mason County's pilot nutrient study by revisiting sites that had tidal influence during very low tides, verify occupancy or water use of residences served by seepage pits, and investigate potential bacterial sources.
- The Guidance Group will need to review Jefferson's pilot nutrient study and preliminary results and recommend a course of action for preparation and submission of the study final report deliverable.
- Continue to work with WSU-Ext. to conduct audience research and to develop effective reporting materials for the public and decision-makers.
- Some drainage issues were too complex for the scope of this project. Future outreach and education projects in Hoodsport, Union, and the North Shore of Tahuya should work with local stormwater agencies to develop strong stormwater components.

- Vouchers have been useful to encourage septic tank maintenance and to assess the OSS functional status. Twenty of the 46 vouchers redeemed in Mason County (43.4%) had no current OSS maintenance. Four of the 17 vouchers redeemed in Kitsap County (23.5%) had deficiencies that were corrected. Phase II outreach and education audience research found the most popular incentive for a site visit was a rebate or coupon for septic system maintenance.
- Existing regional organizations can effectively lead a regional effort because they already have a functioning structure and a relationship with their jurisdictions.
- Regional PIC implementation can be more affordable because the preparation of the grant application, contracts, quality assurance plans and reporting are coordinated and submitted once. The regional approach also provides additional resources and experience that can be useful in addressing challenging PIC problems.
- Regional projects benefit from a planning phase to develop a work group and documents to guide work.

REFERENCES

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APPENDICES

Appendix A – HCRPIC Program Phase II: Maps

Appendix B – HCRPIC Program Phase II: Pilot Nutrient Study - Mason County

Appendix C – HCRPIC Program Phase II: Outreach and Education - Supplemental Evaluation of 2015 Site Visits

Appendix D – HCRPIC Program Phase II: Outreach and Education - Audience Research Report

Appendix E – HCRPIC Program Phase II: Outreach and Education - Site Visit Report

Appendix F – HCRPIC Program Phase II: Outreach and Education - Highlights

Appendix G – Port Gamble S'Klallam Tribe PIC Implementation Report

APPENDIX A – HCRPIC Program Phase II: Maps

The basemap used on the following maps is by National Geographic. Content may not reflect National Geographic's current map policy. Source information for the basemap includes: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Note: HCRPIC Phase II data is best viewed using the interactive web maps found on the HCRPIC website: http://hccc.wa.gov/content/pollution-identification-correction.

HCRPIC Program Phase II Map Index

All HCRPIC maps created by Gretchen Peterson at PetersonGIS.

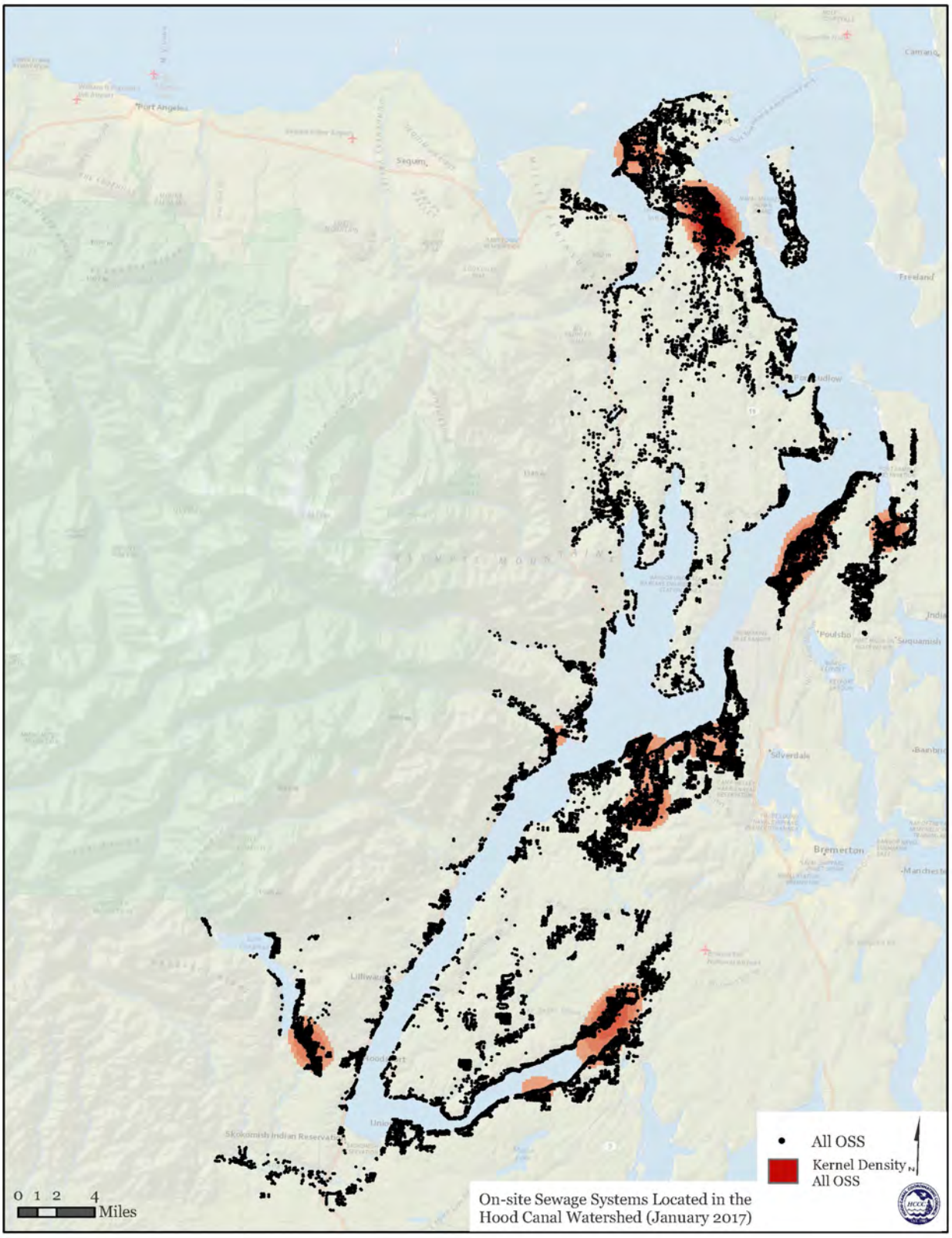

Figure A-1: On-site Sewage Systems Located in the Hood Canal Watershed (January 2017)

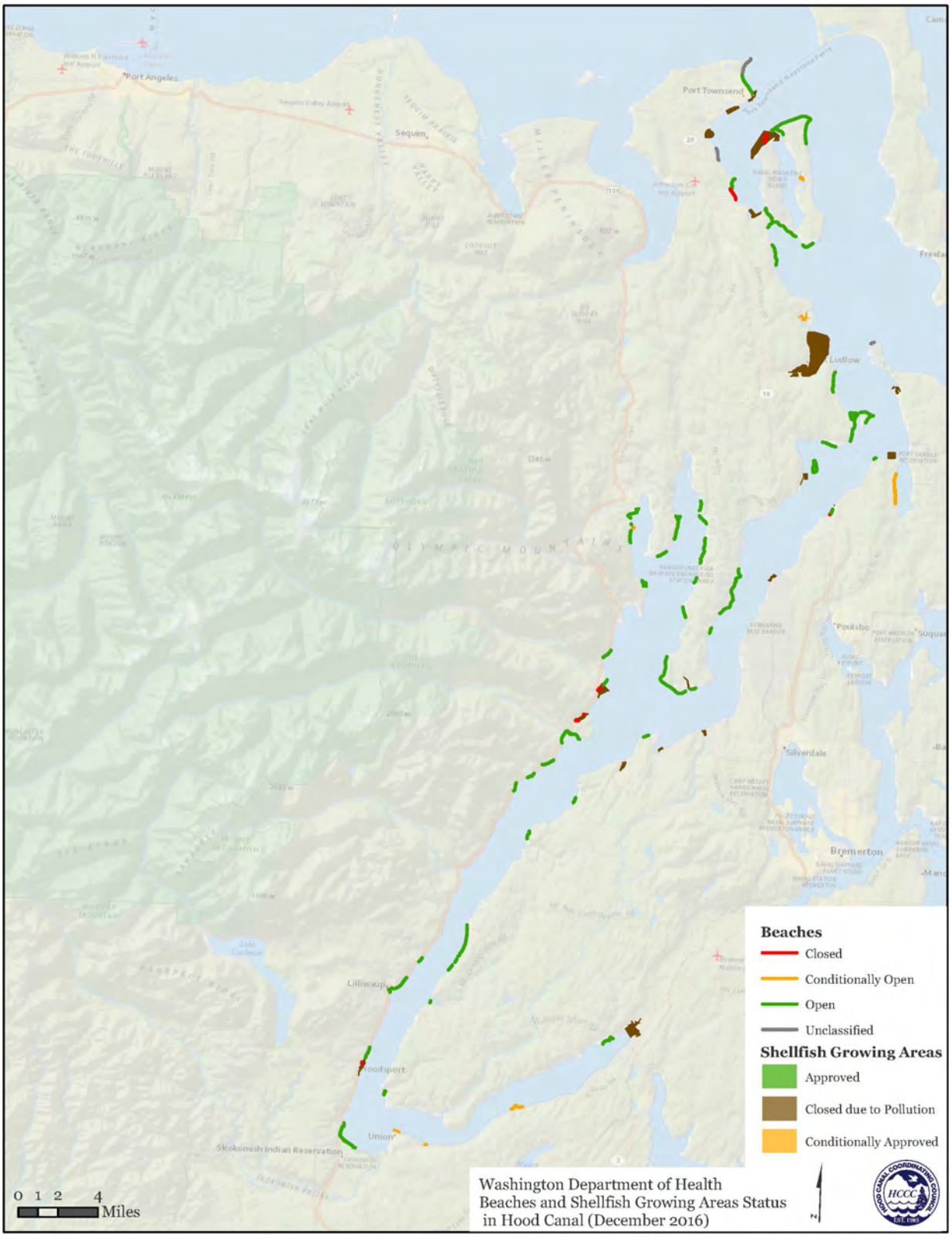

Figure A-2: Washington Department of Health Beach and Shellfish Growing Areas Status in Hood Canal (December 2016)

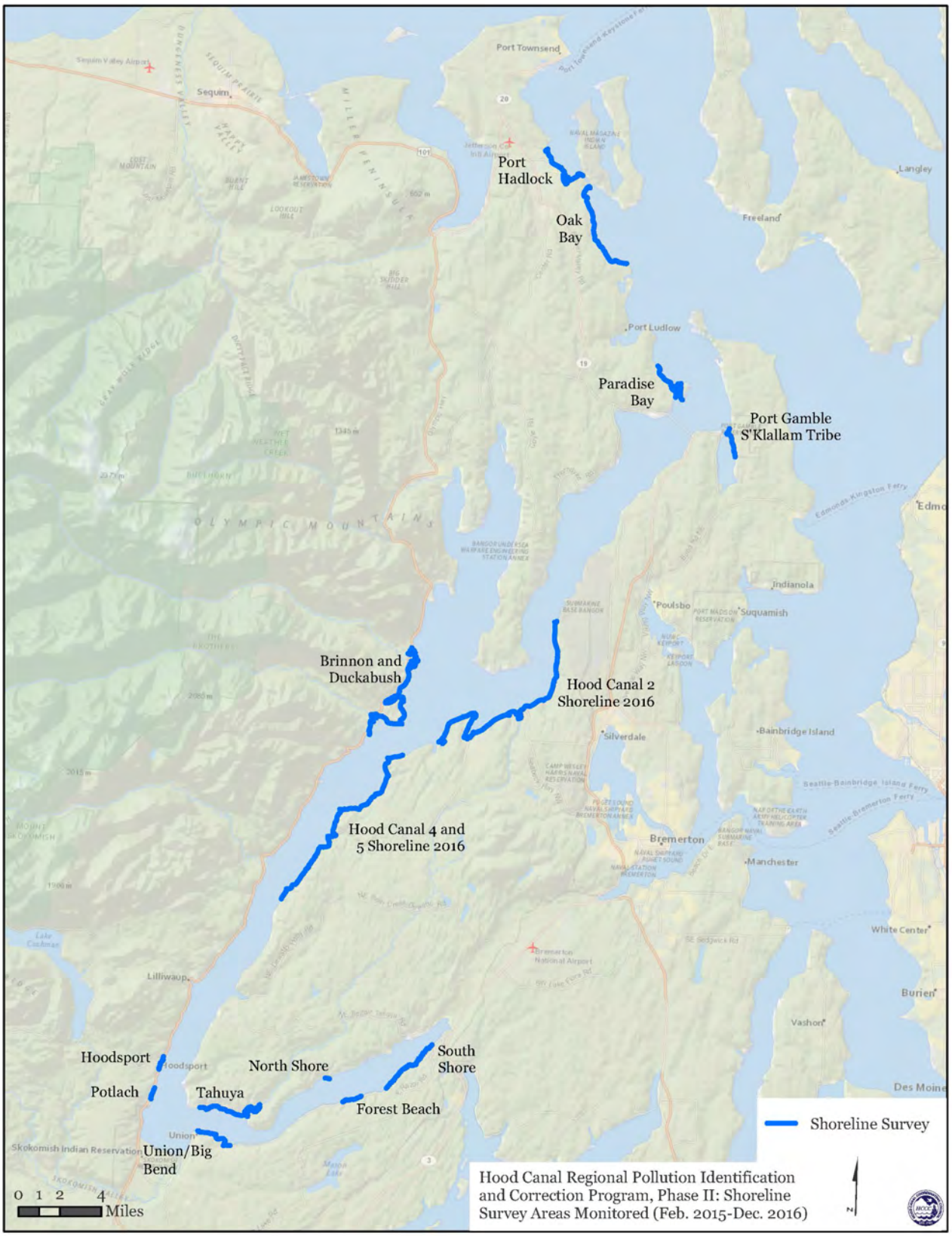

Figure A-3: Shoreline Survey Areas Monitored (Feb. 2015-Dec. 2016)

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 1 of 9

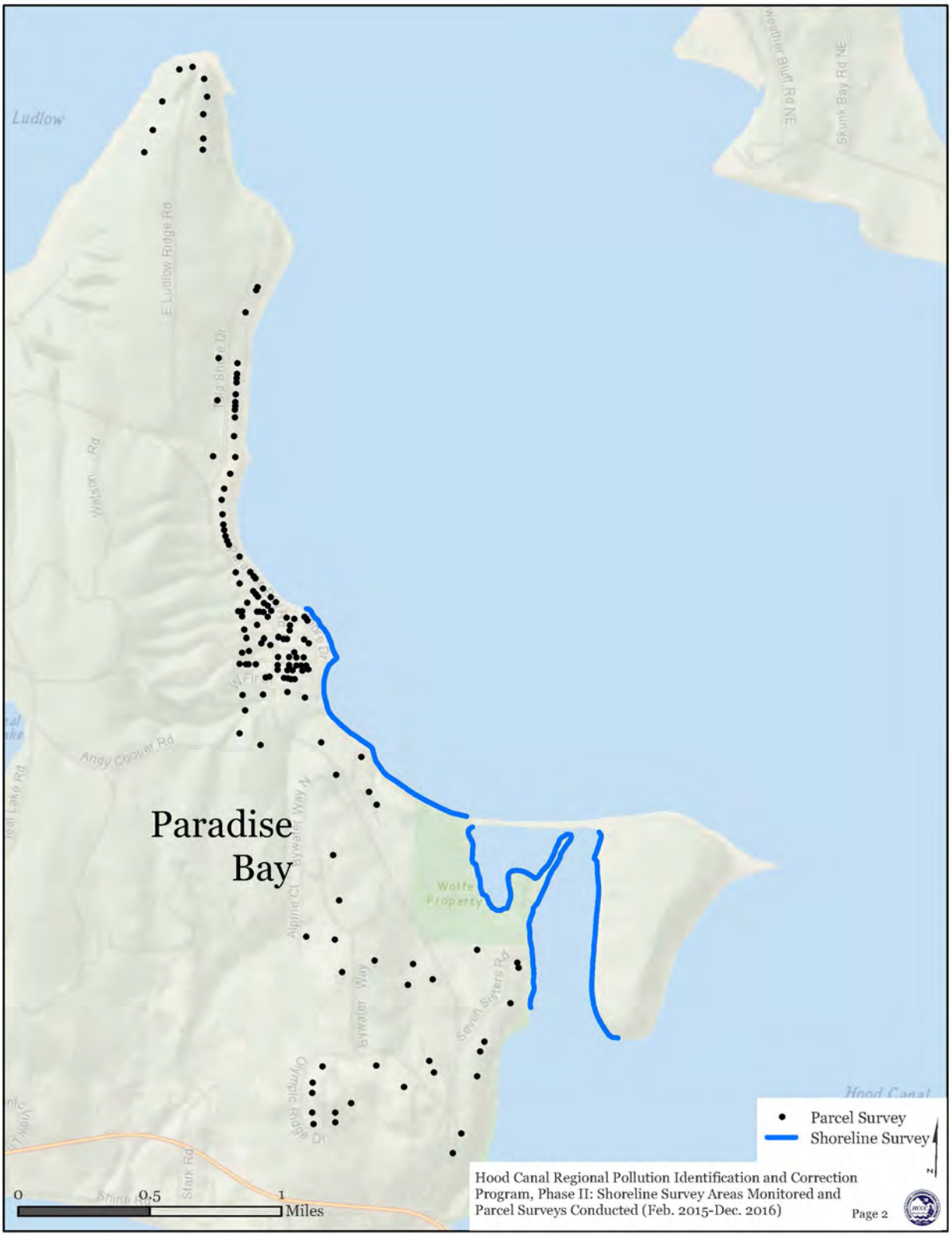

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 2 of 9

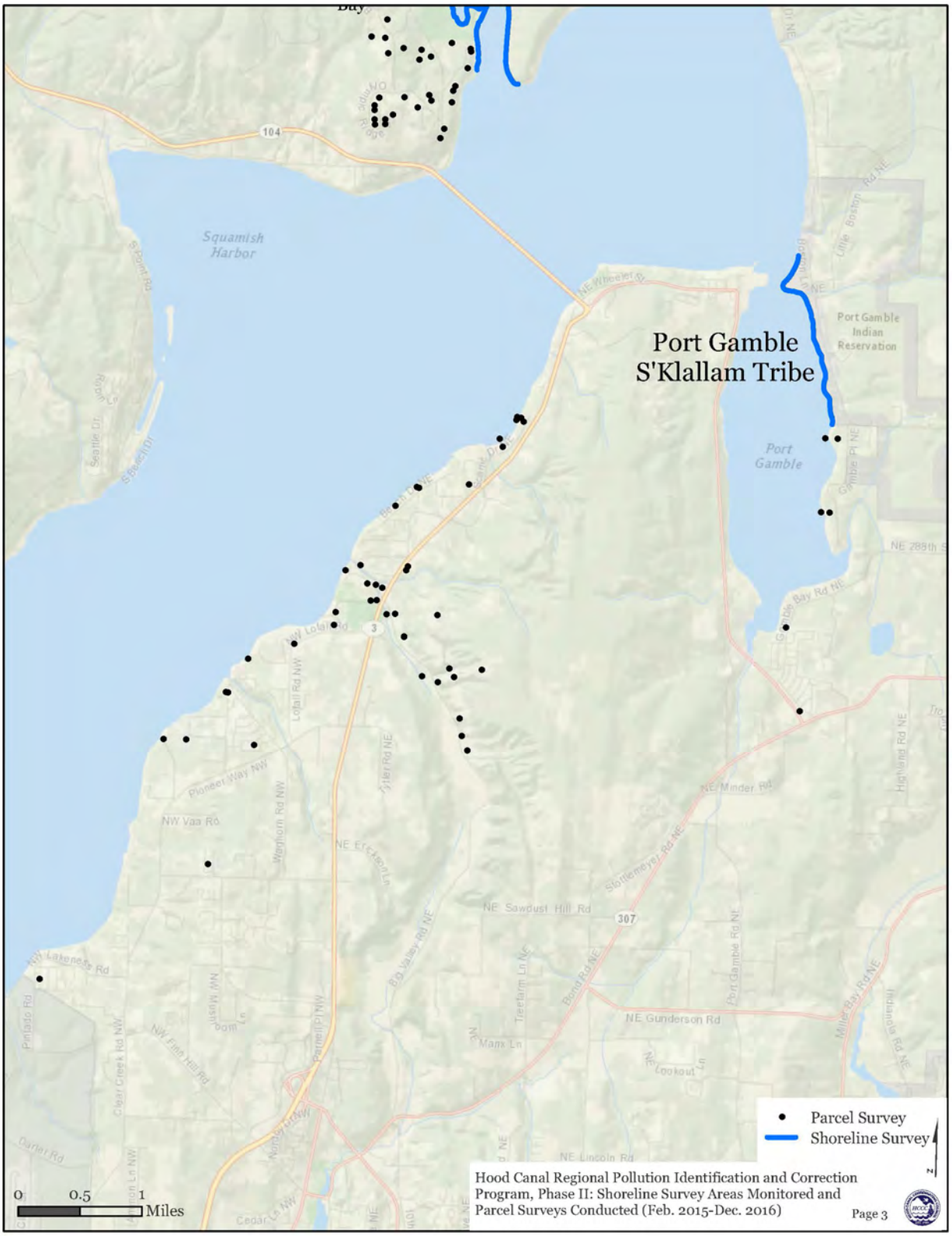

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 3 of 9

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 4 of 9

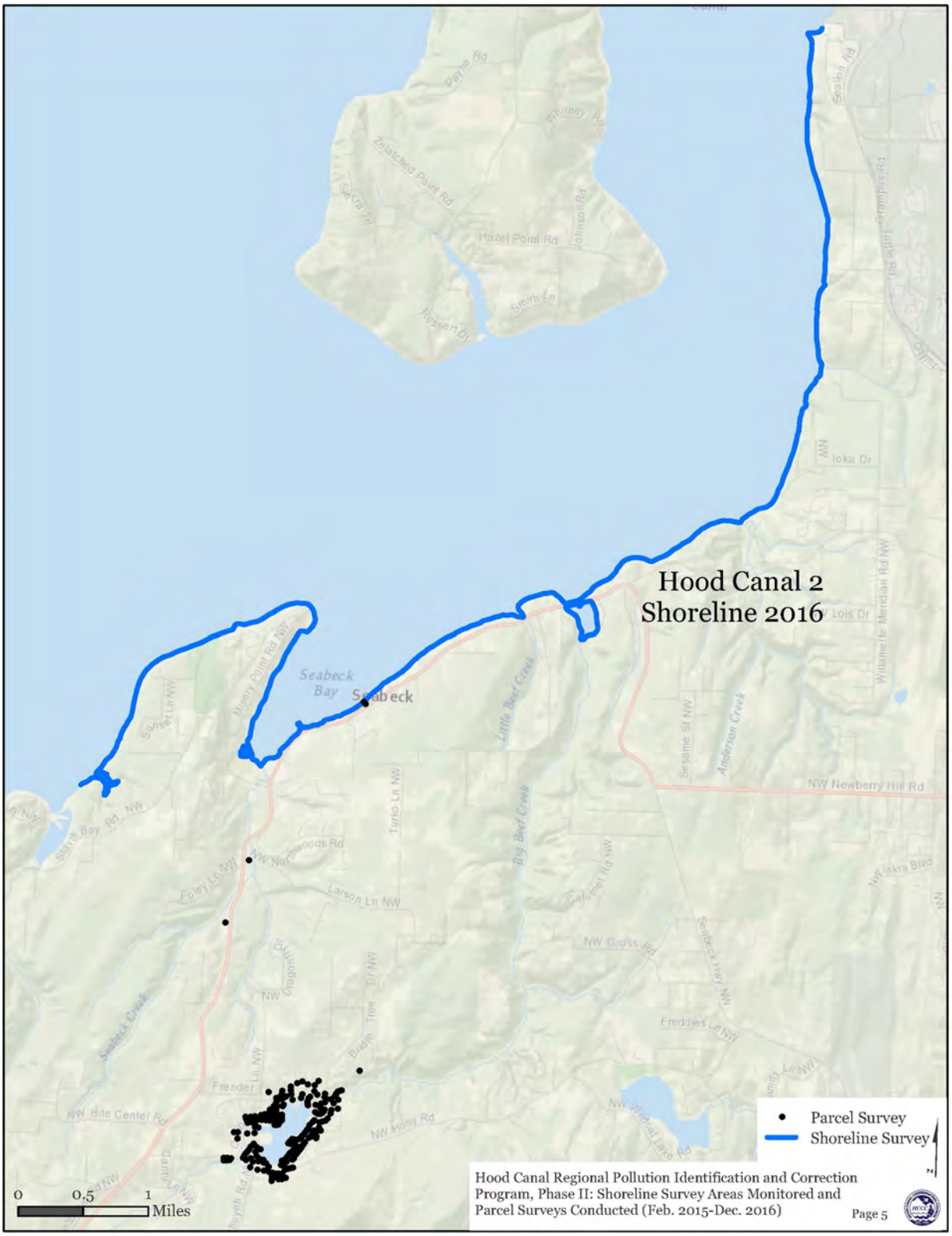

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 5 of 9

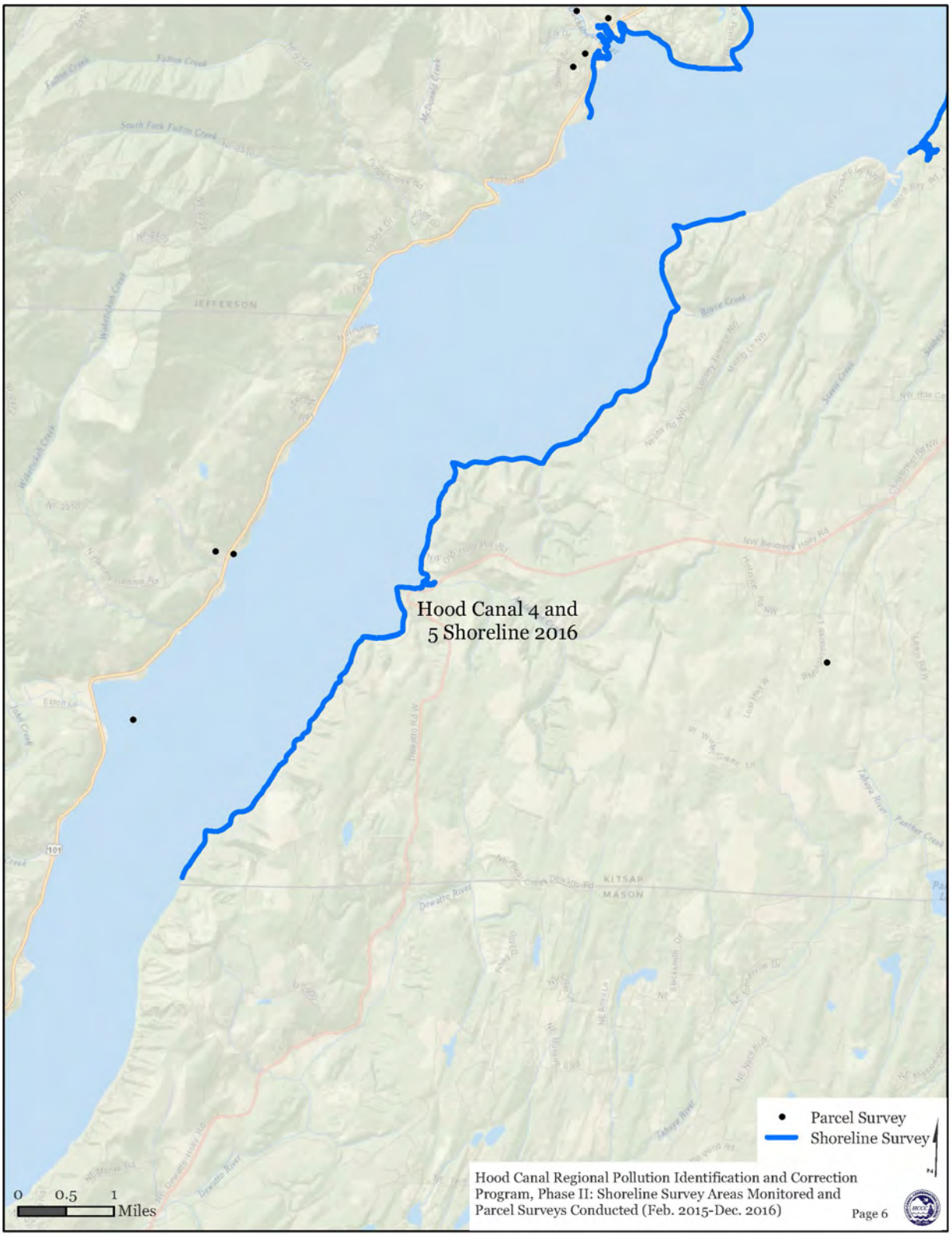

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 6 of 9

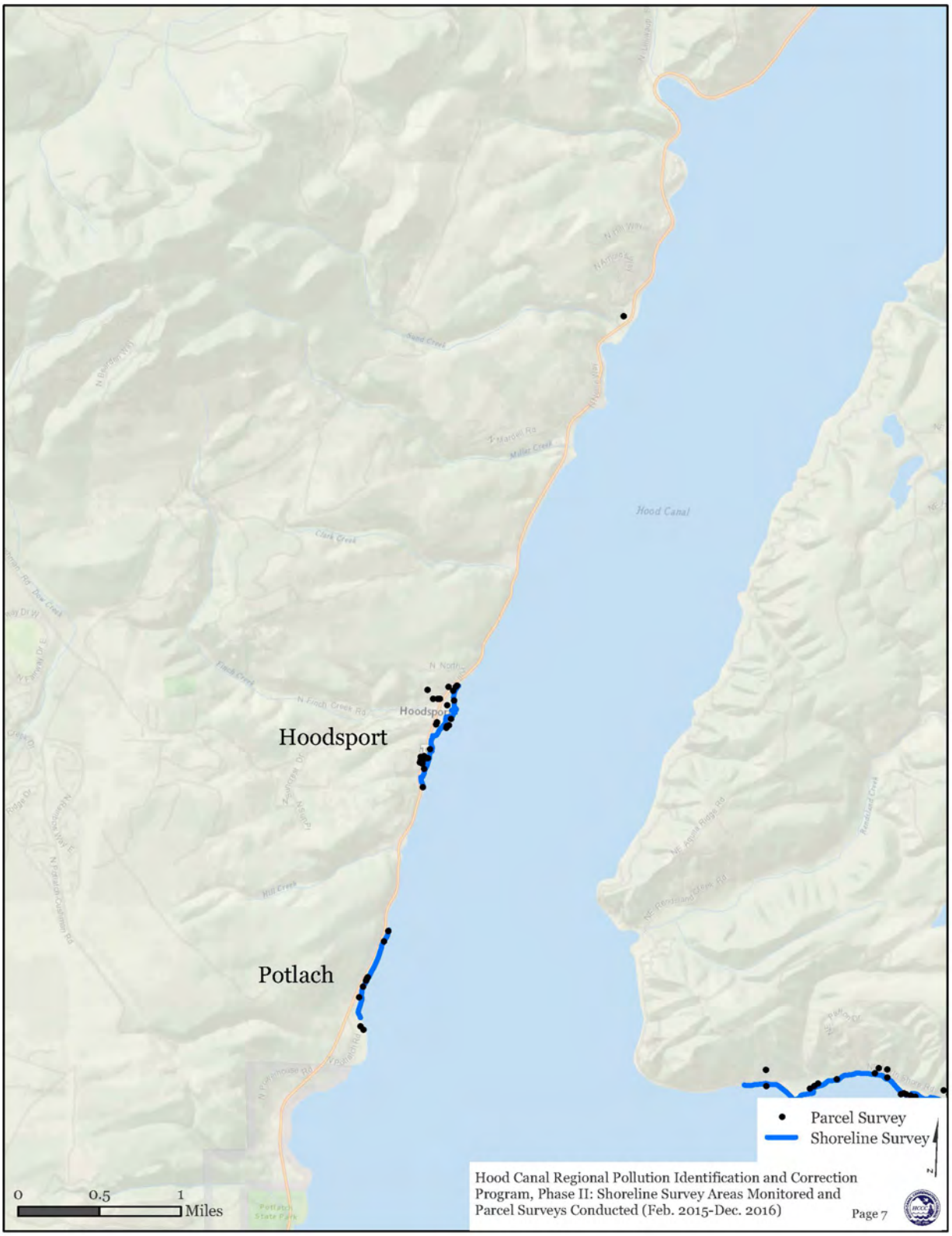

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 7 of 9

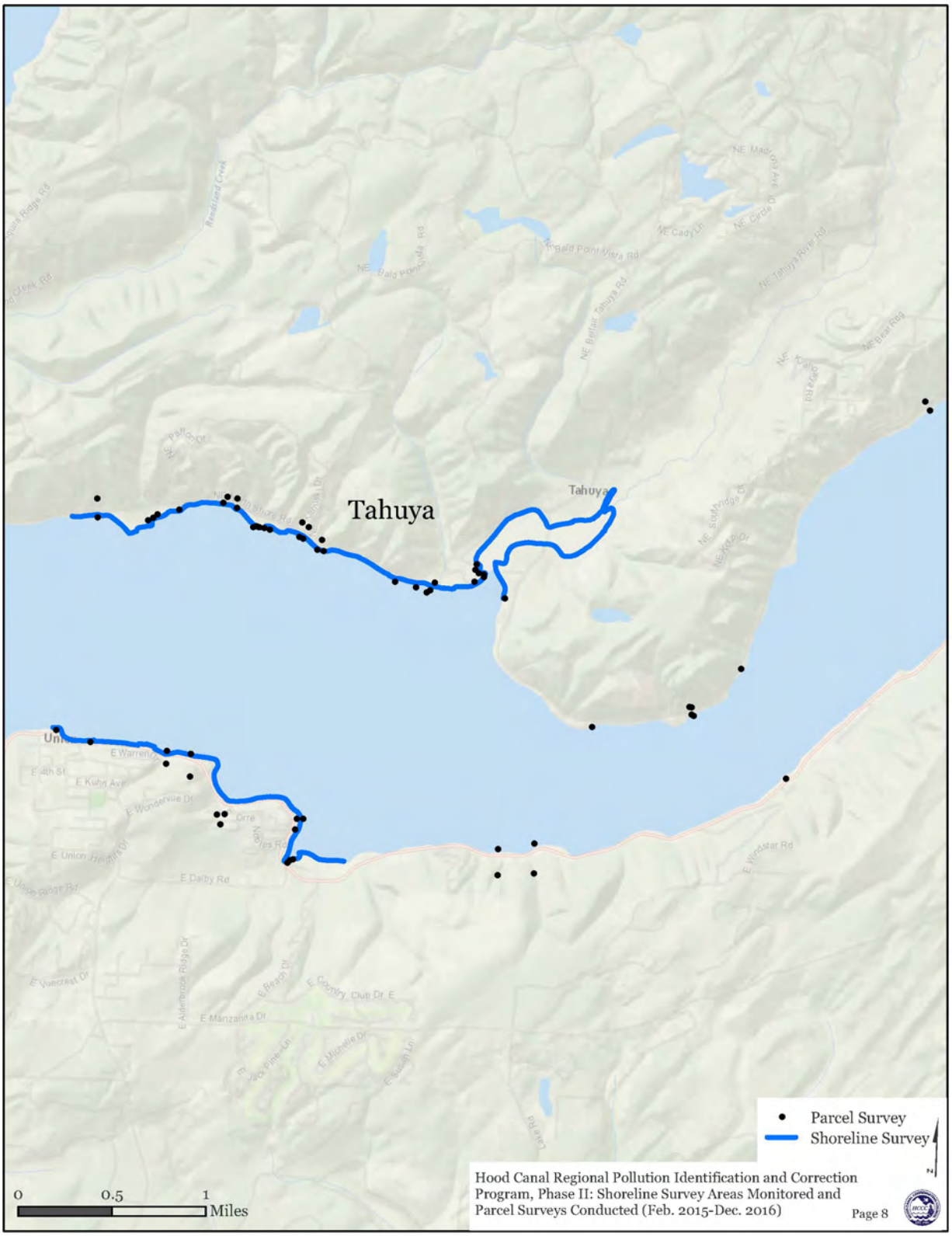

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 8 of 9

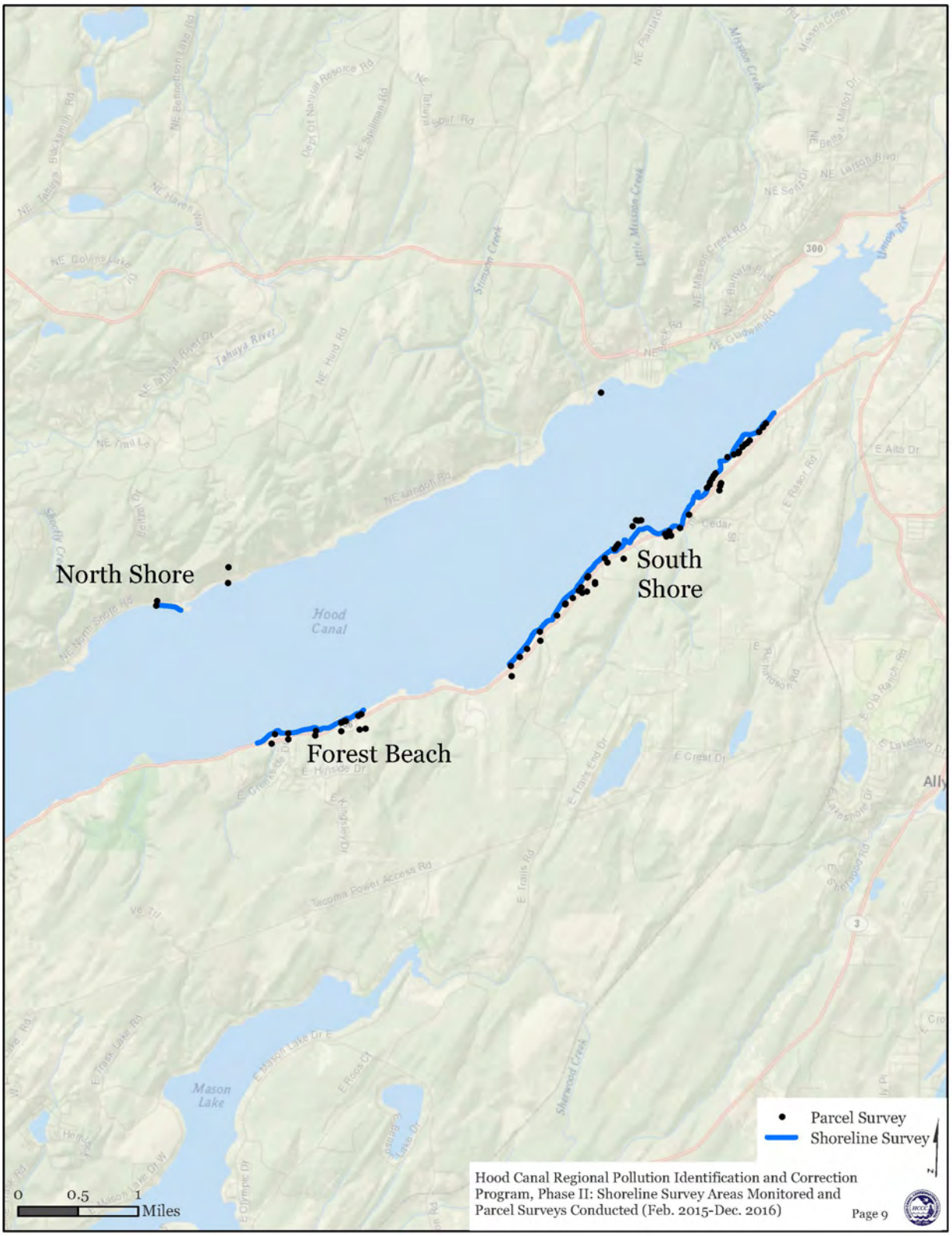

Figure A-4: Map Atlas of Shoreline Survey Areas Monitored and Parcel Surveys Conducted (Feb. 2015-Dec. 2016), page 9 of 9

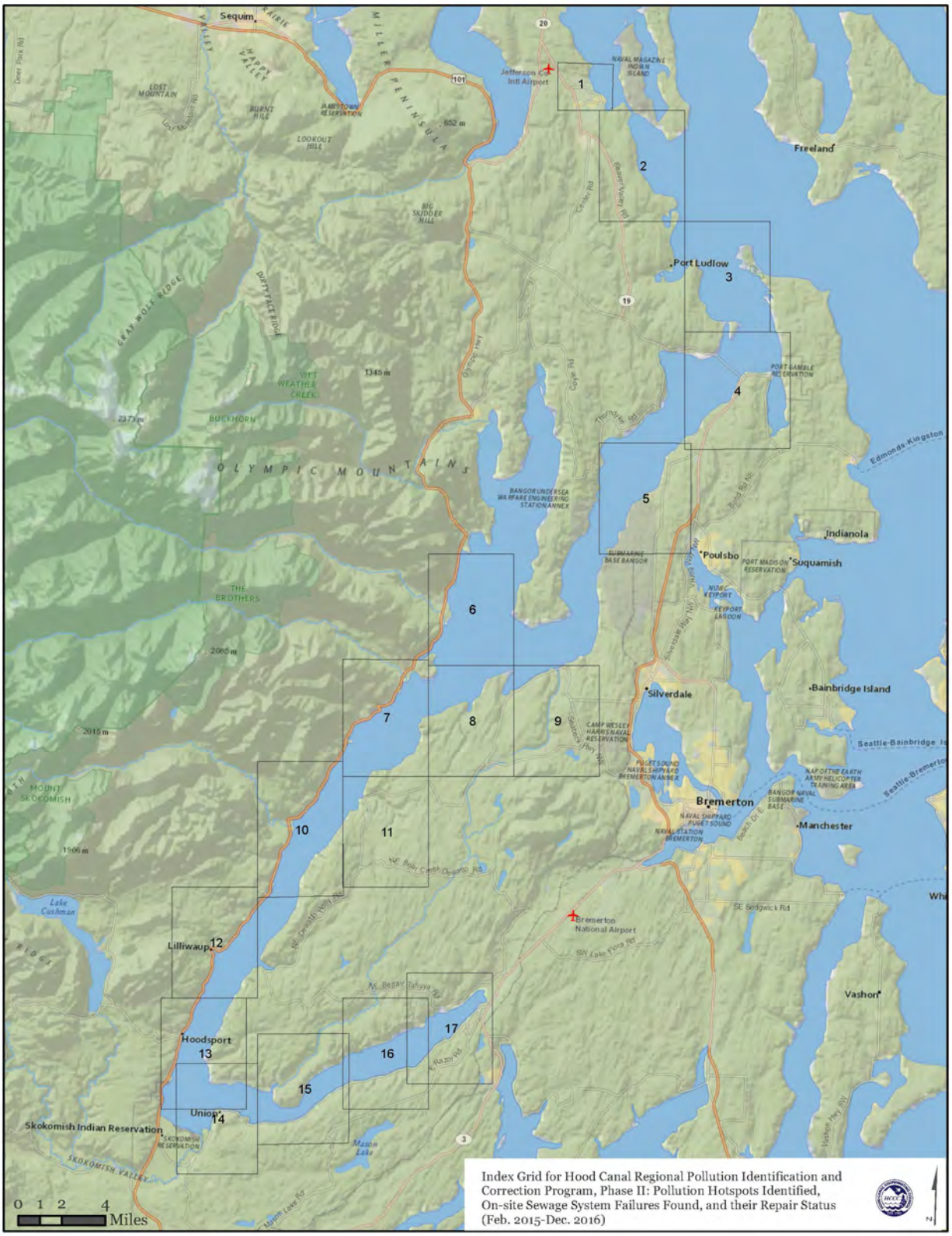

Figure A-5: Map Index of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016) – Detailed maps in Figure A-6

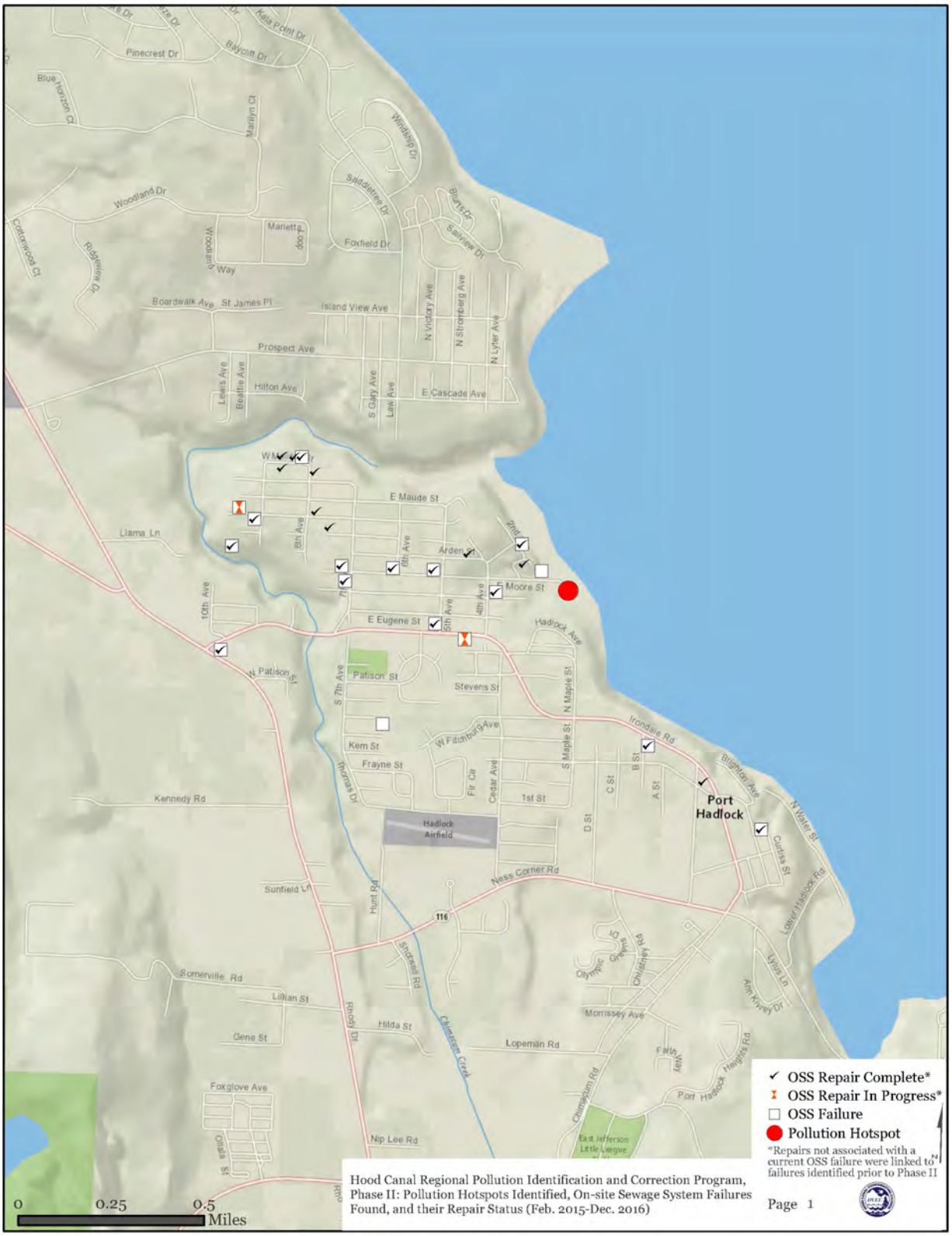

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 1 of 17

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 2 of 17

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 3 of 17

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 4 of 17

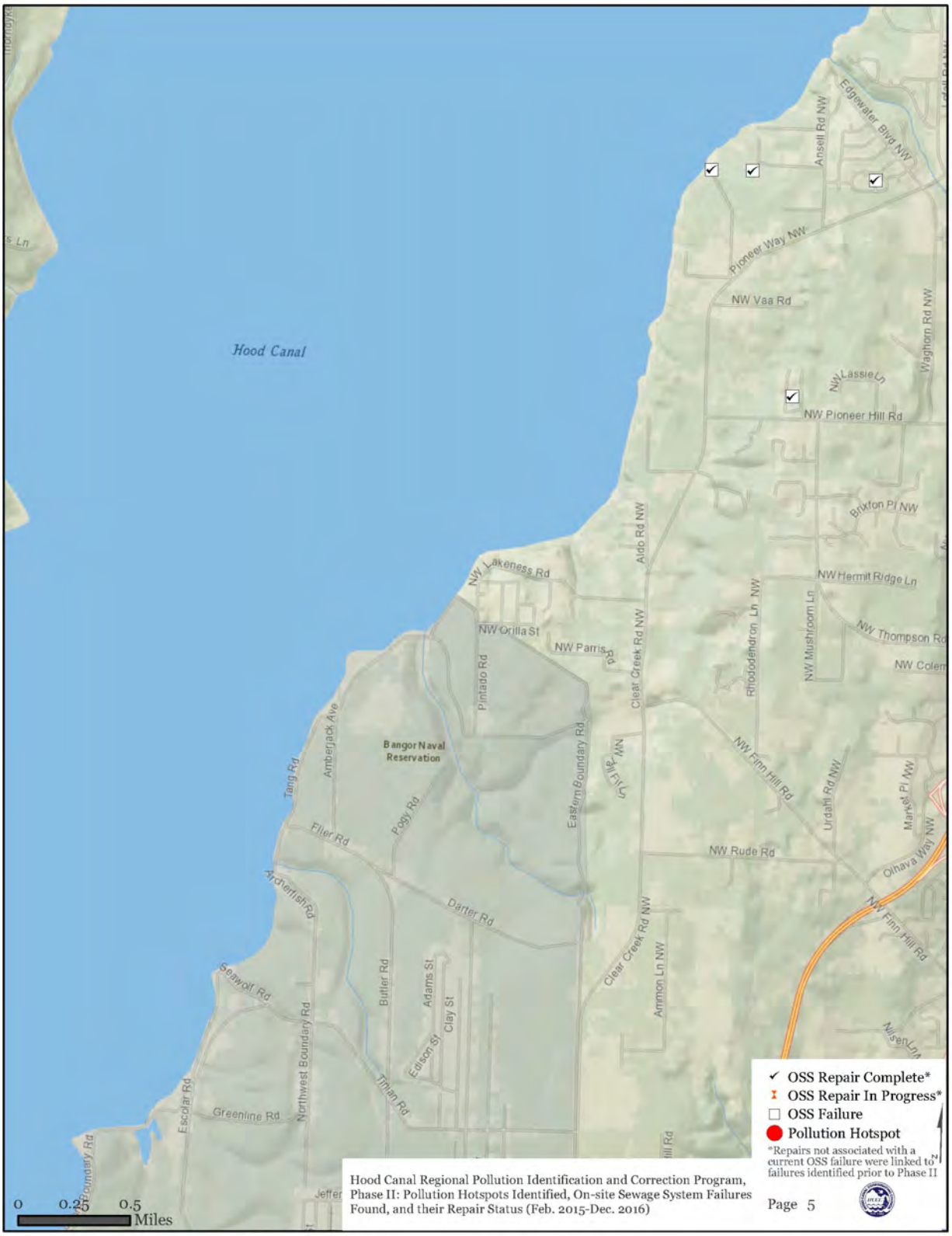

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 5 of 17

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 6 of 17

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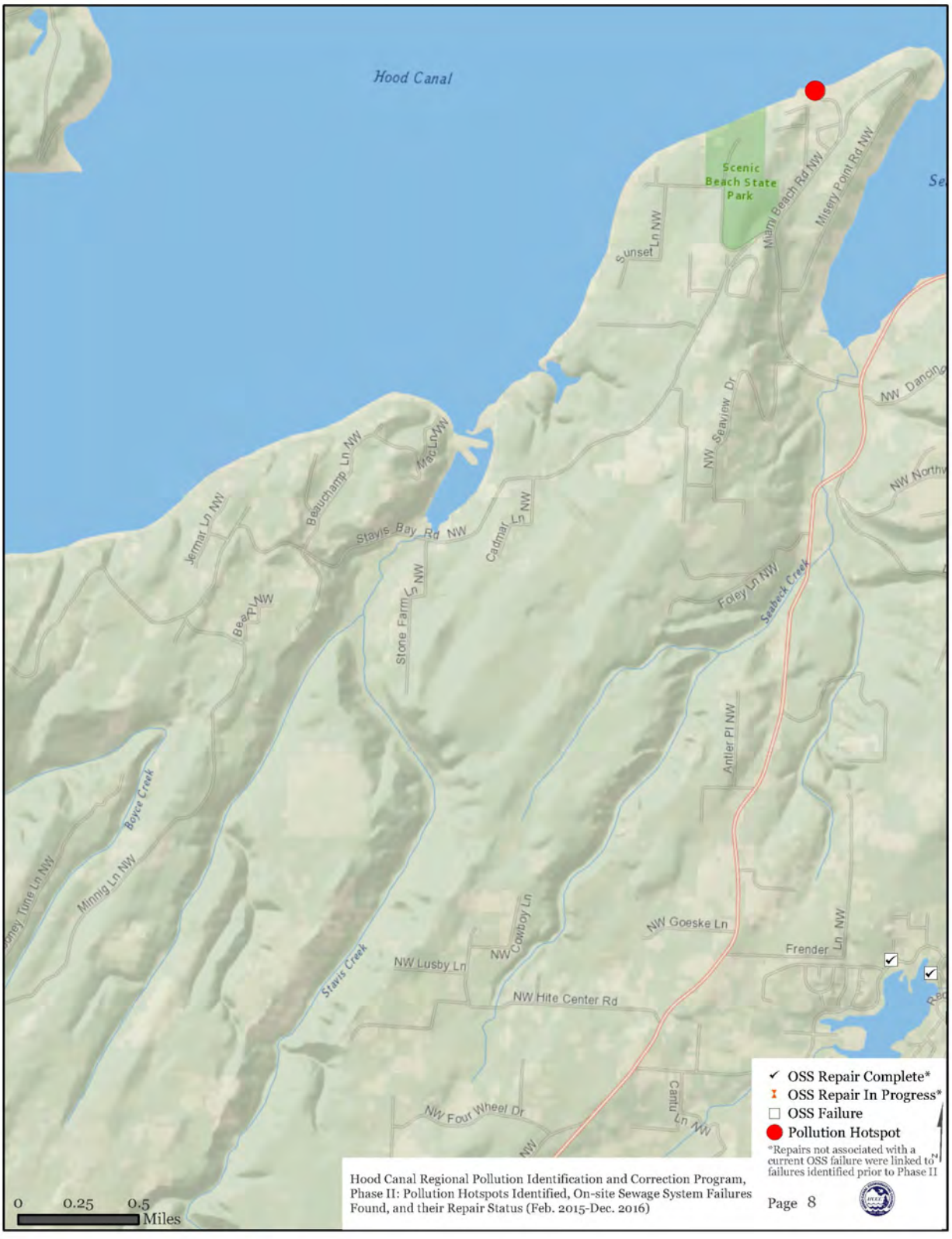

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 8 of 17

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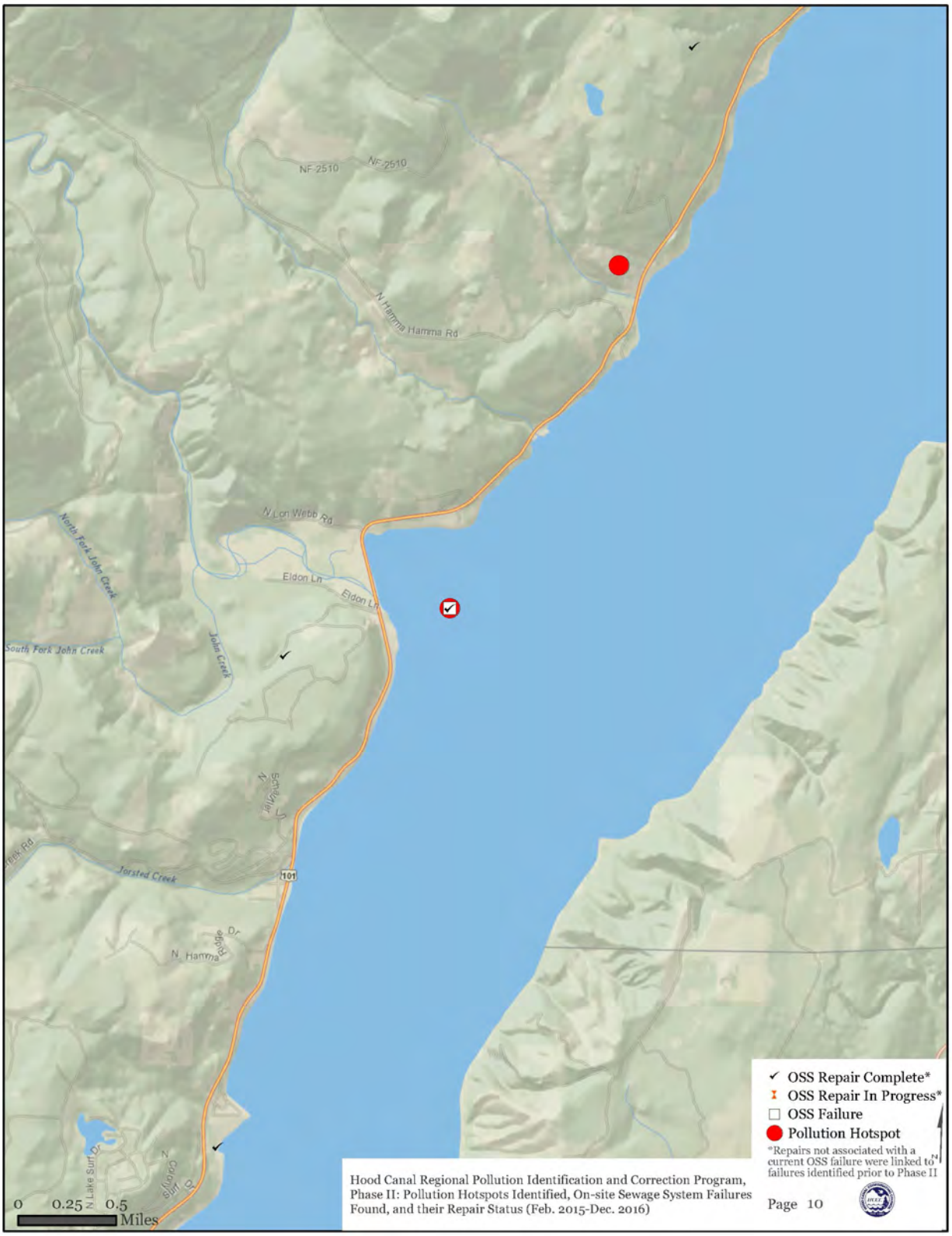


Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 10 of 17

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 11 of 17

Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 12 of 17

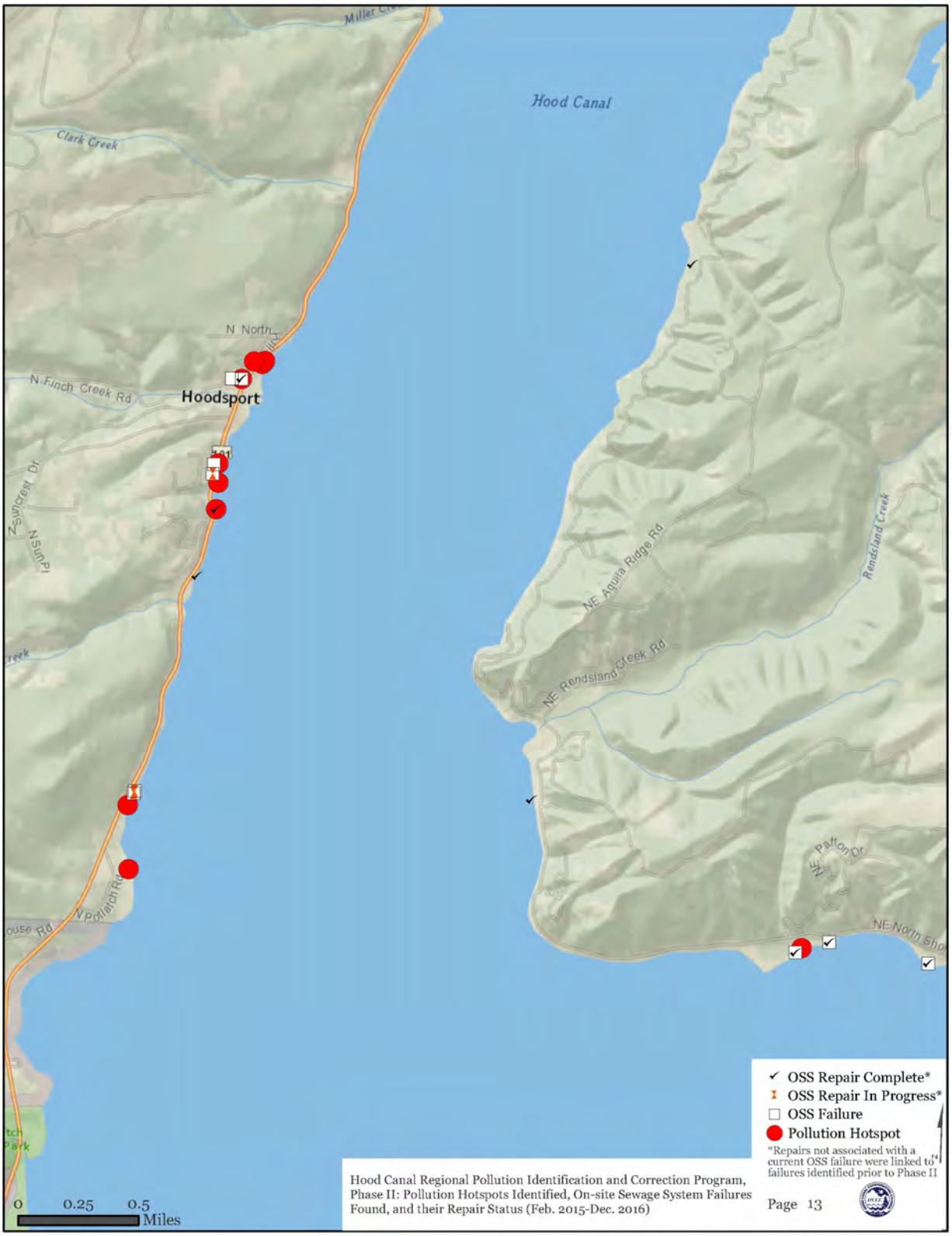
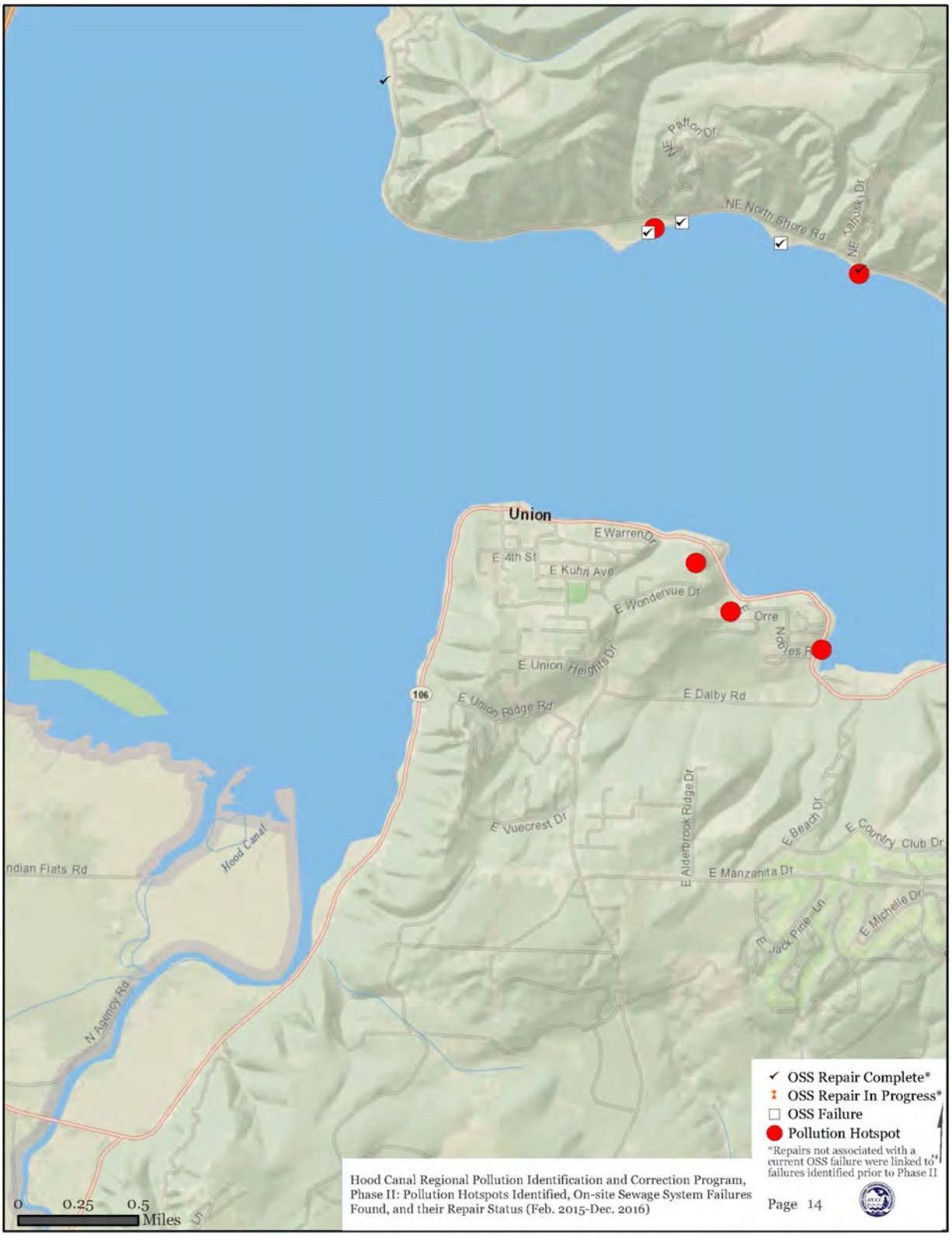


Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 13 of 17



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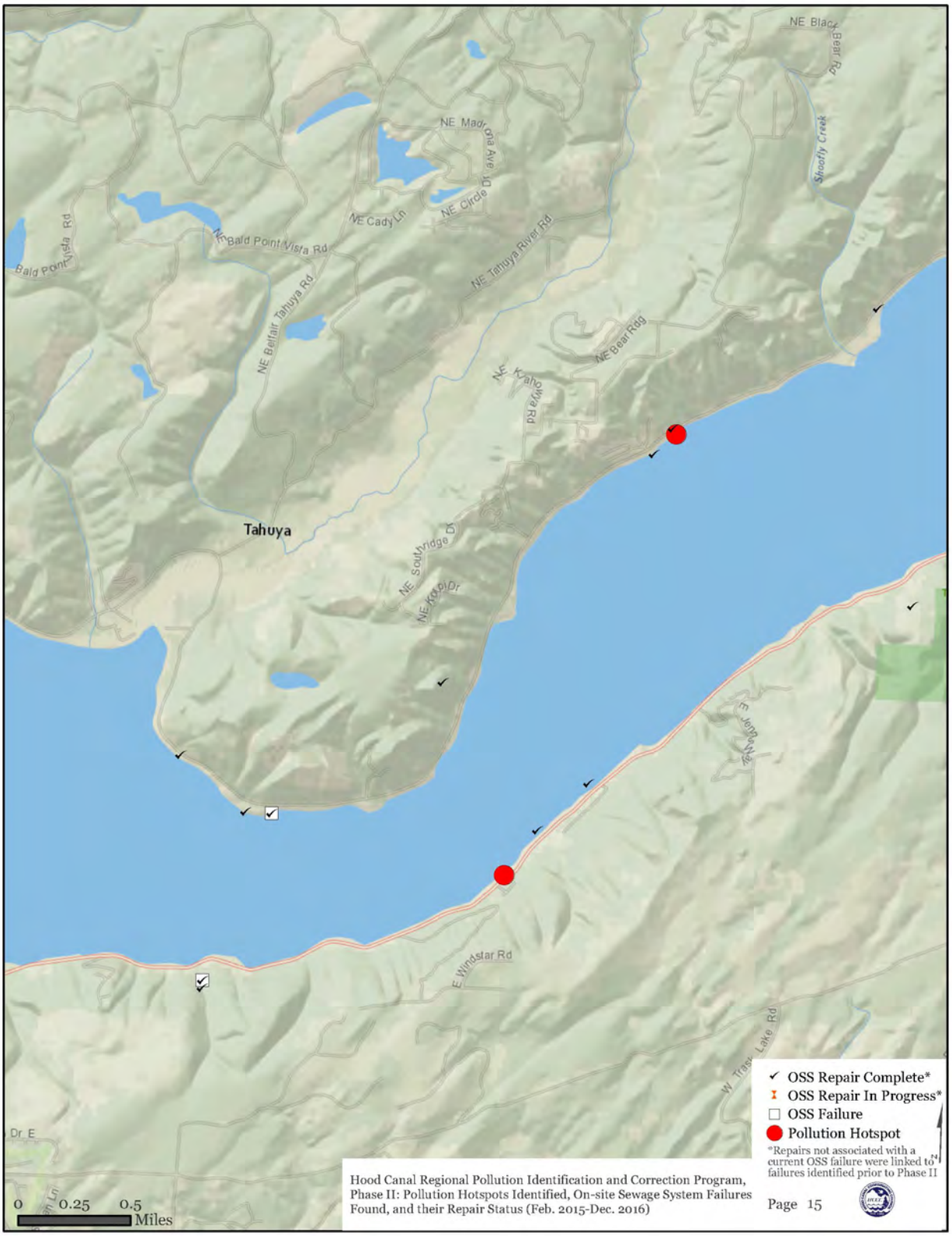
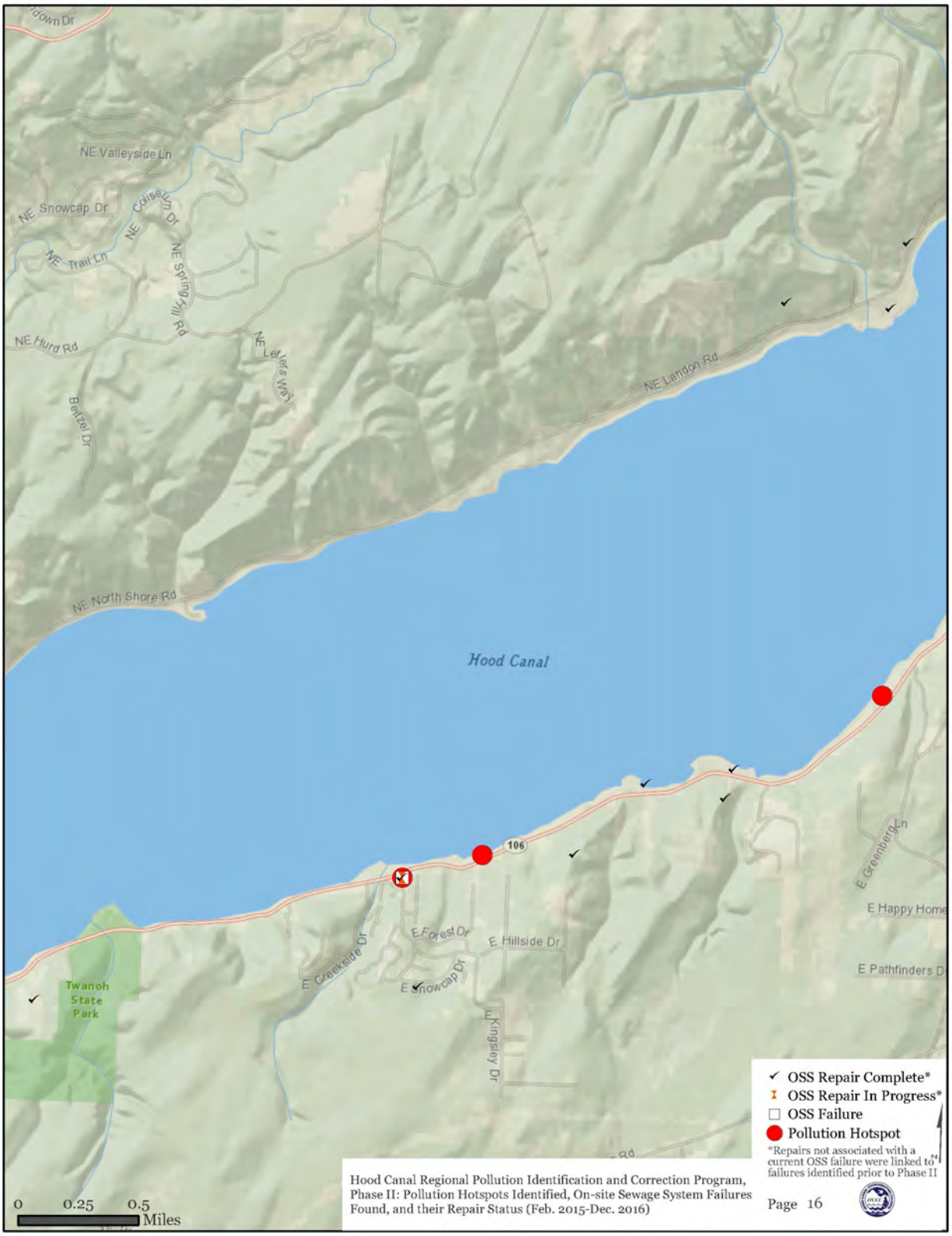


Figure A-6: Map Atlas of Pollution Hotspots Identified, On-site Sewage System Failures Found, and their Repair Status (Feb. 2015-Dec. 2016), page 15 of 17



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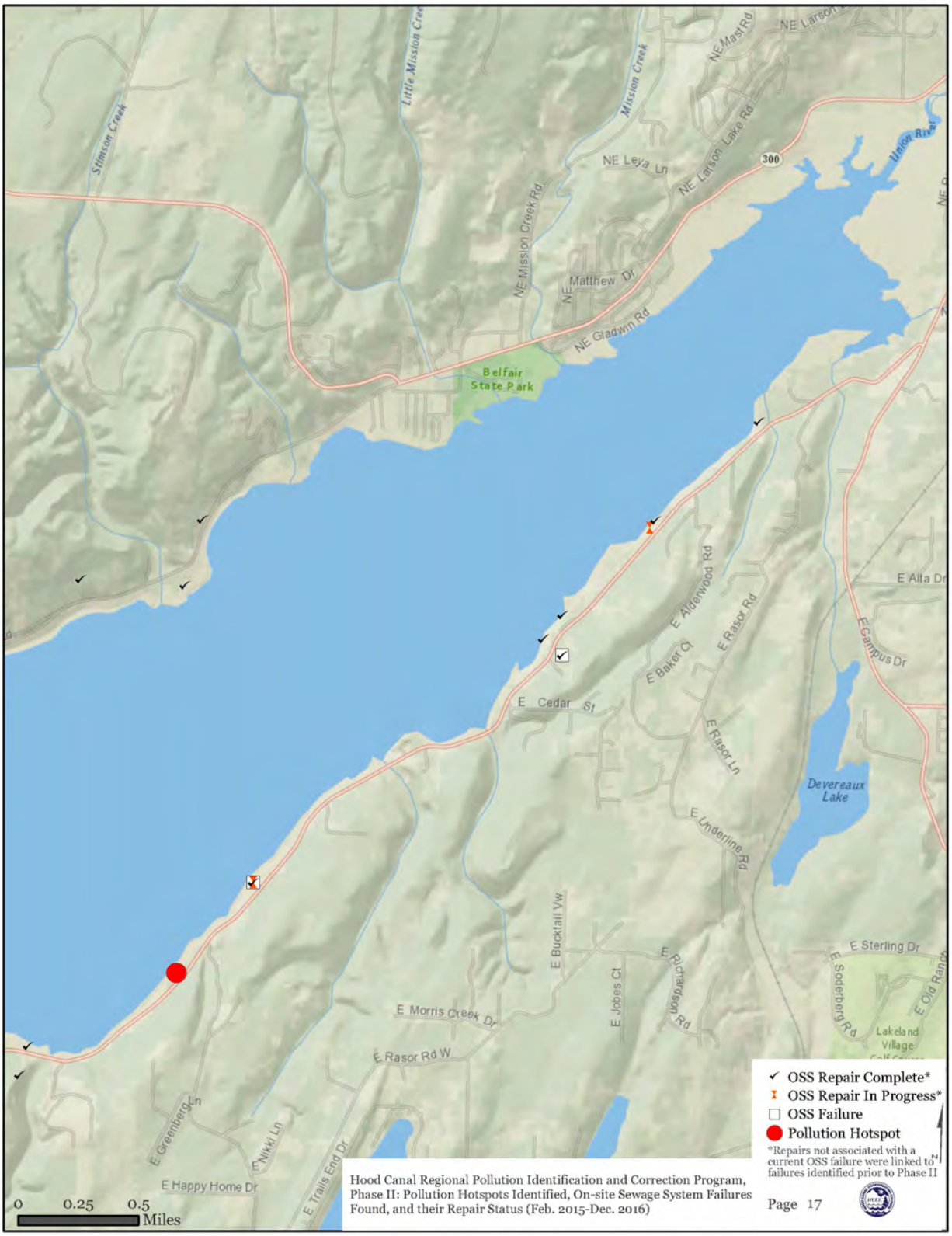

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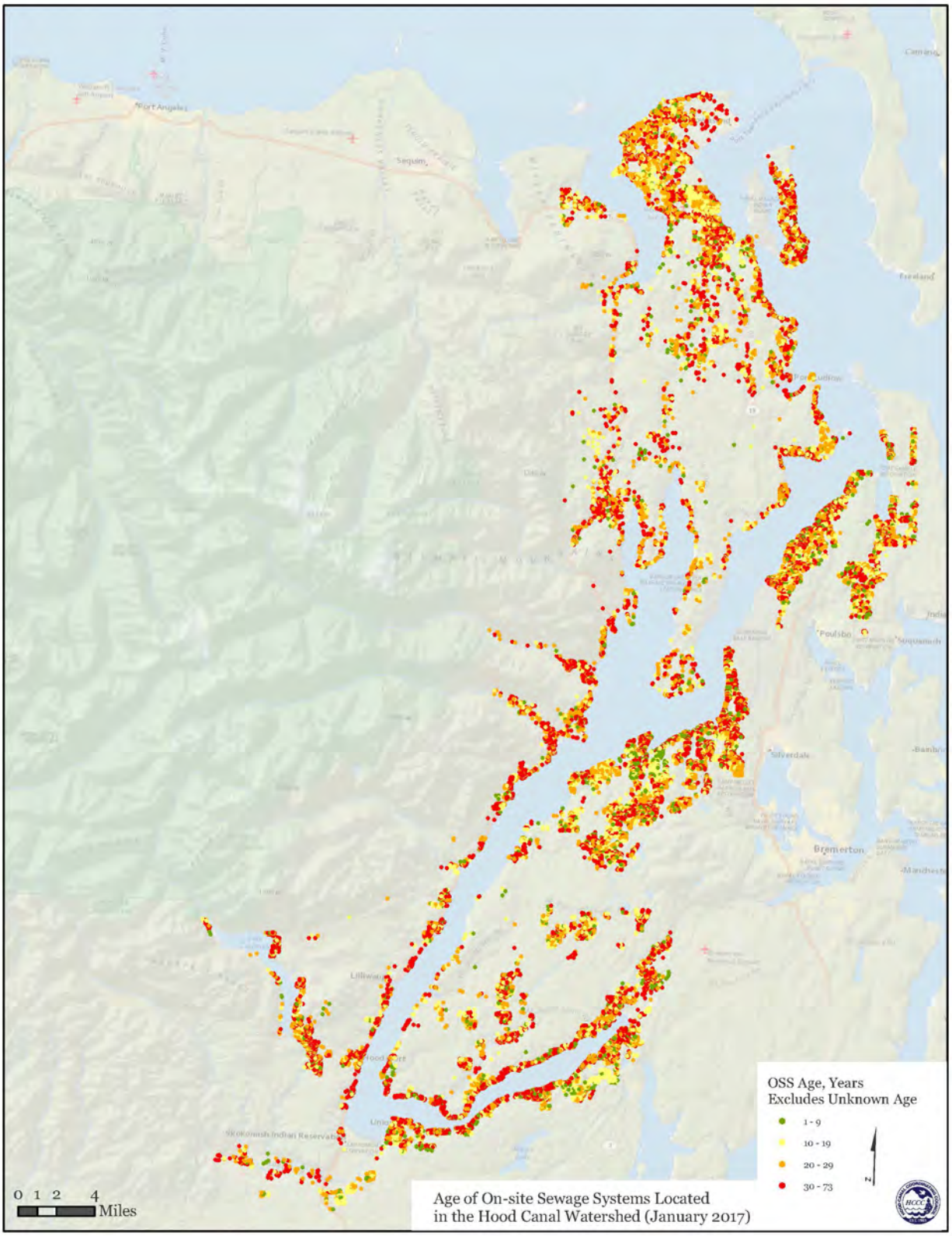

Figure A-7: Age of On-site Sewage Systems Located in the Hood Canal watershed (January 2017)

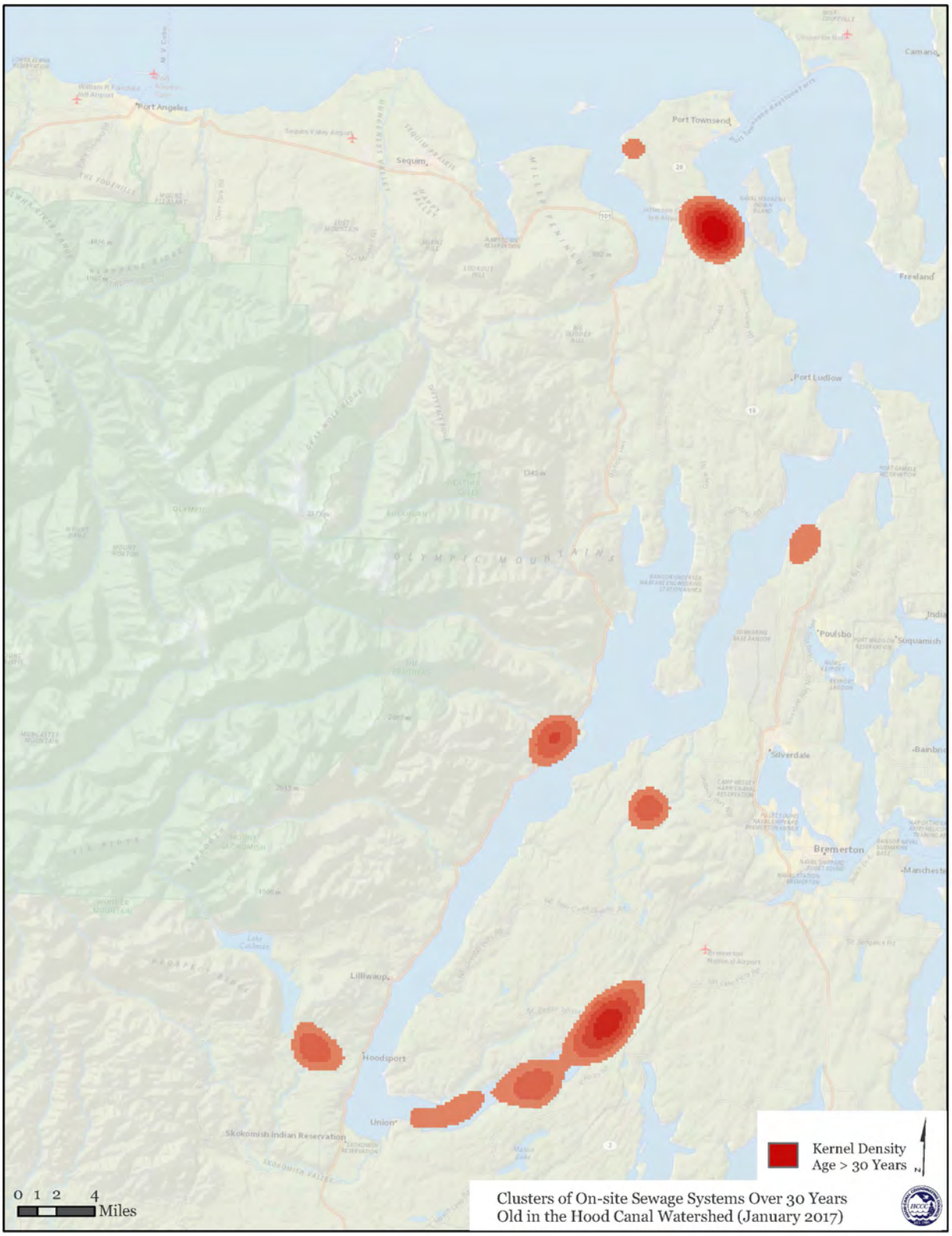

Figure A-8: Clusters of On-site Sewage Systems Over 30 Years Old in the Hood Canal Watershed (January 2017)

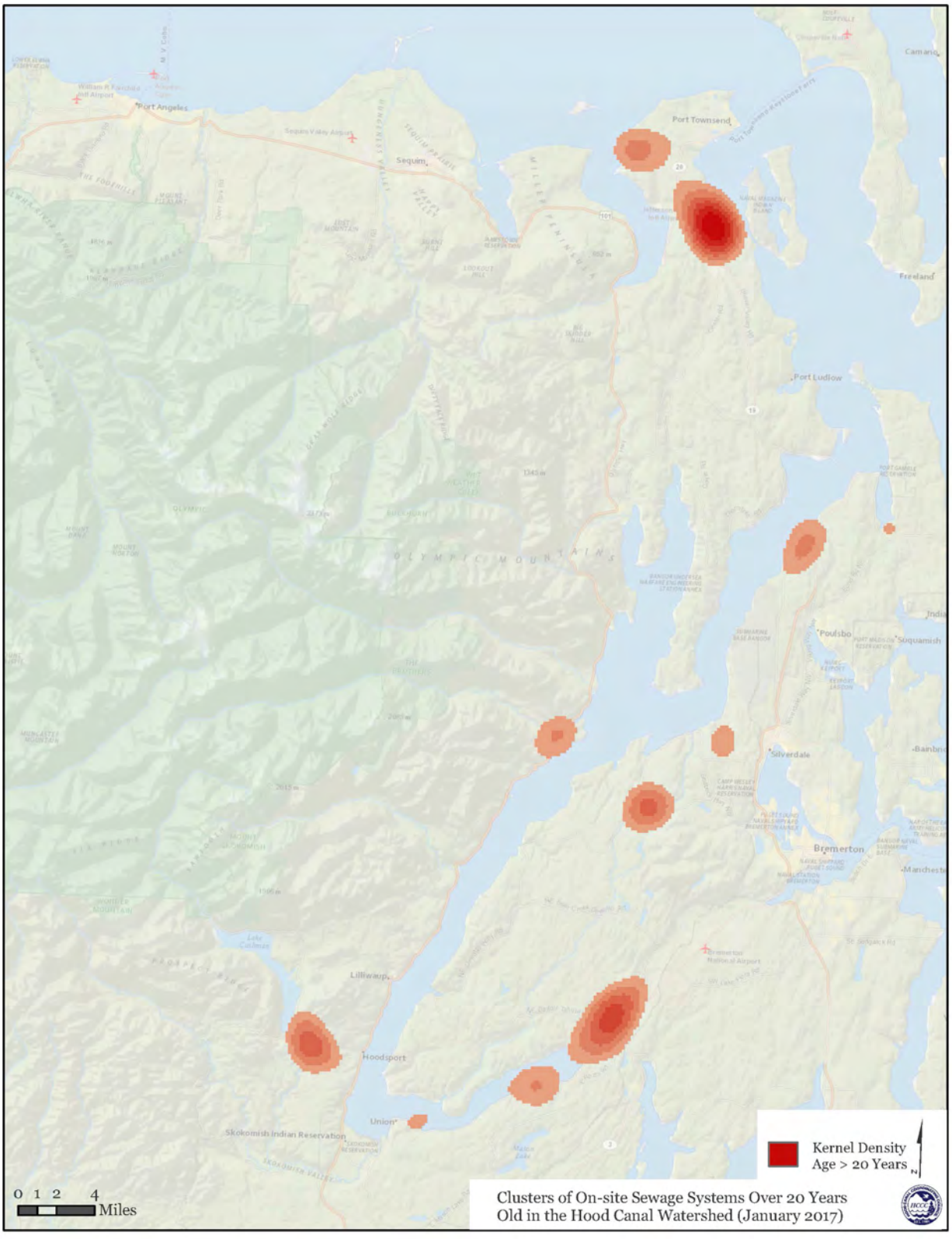

Figure A-9: Clusters of On-site Sewage Systems Over 20 Years Old in the Hood Canal Watershed (January 2017)

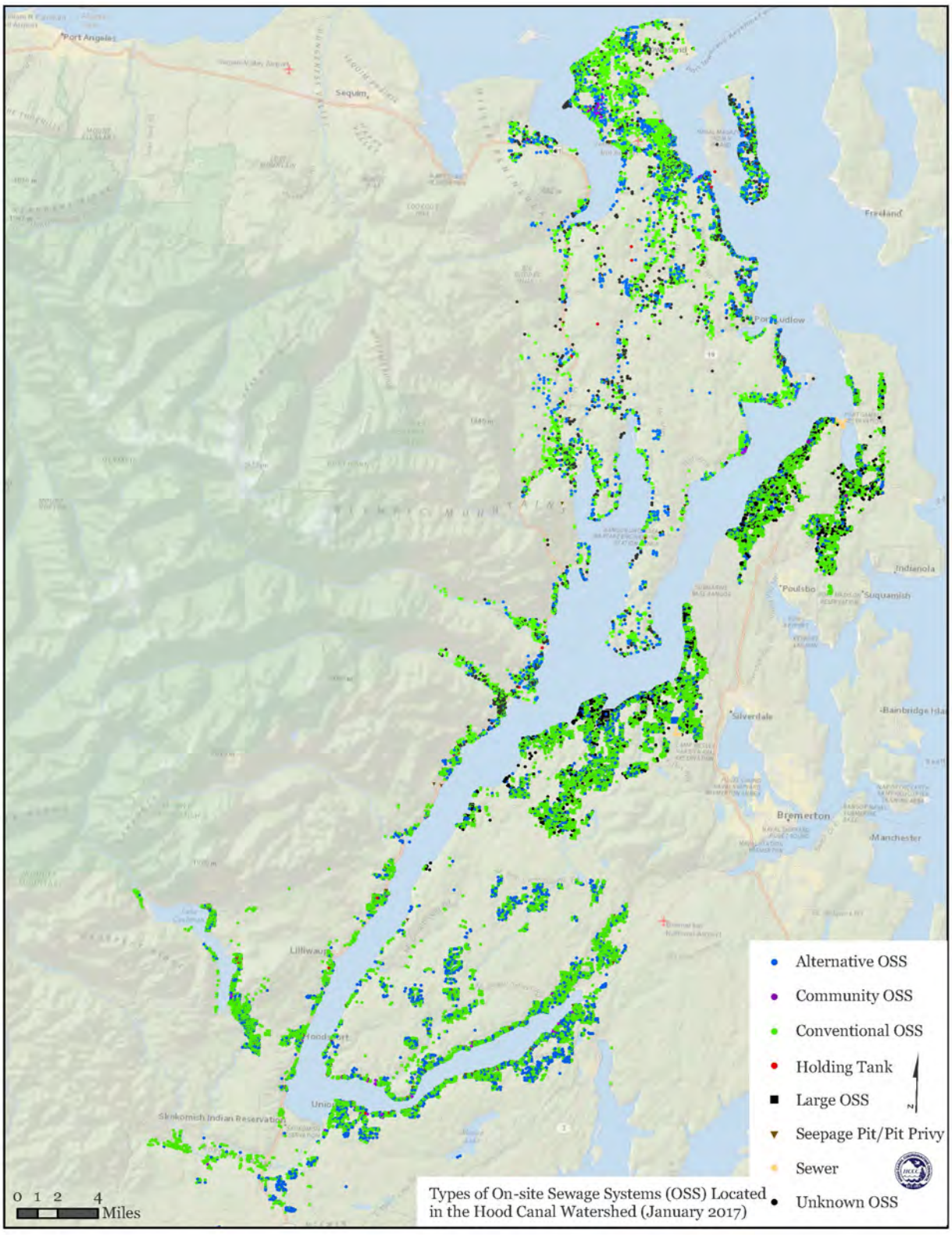

Figure A-10: Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017)

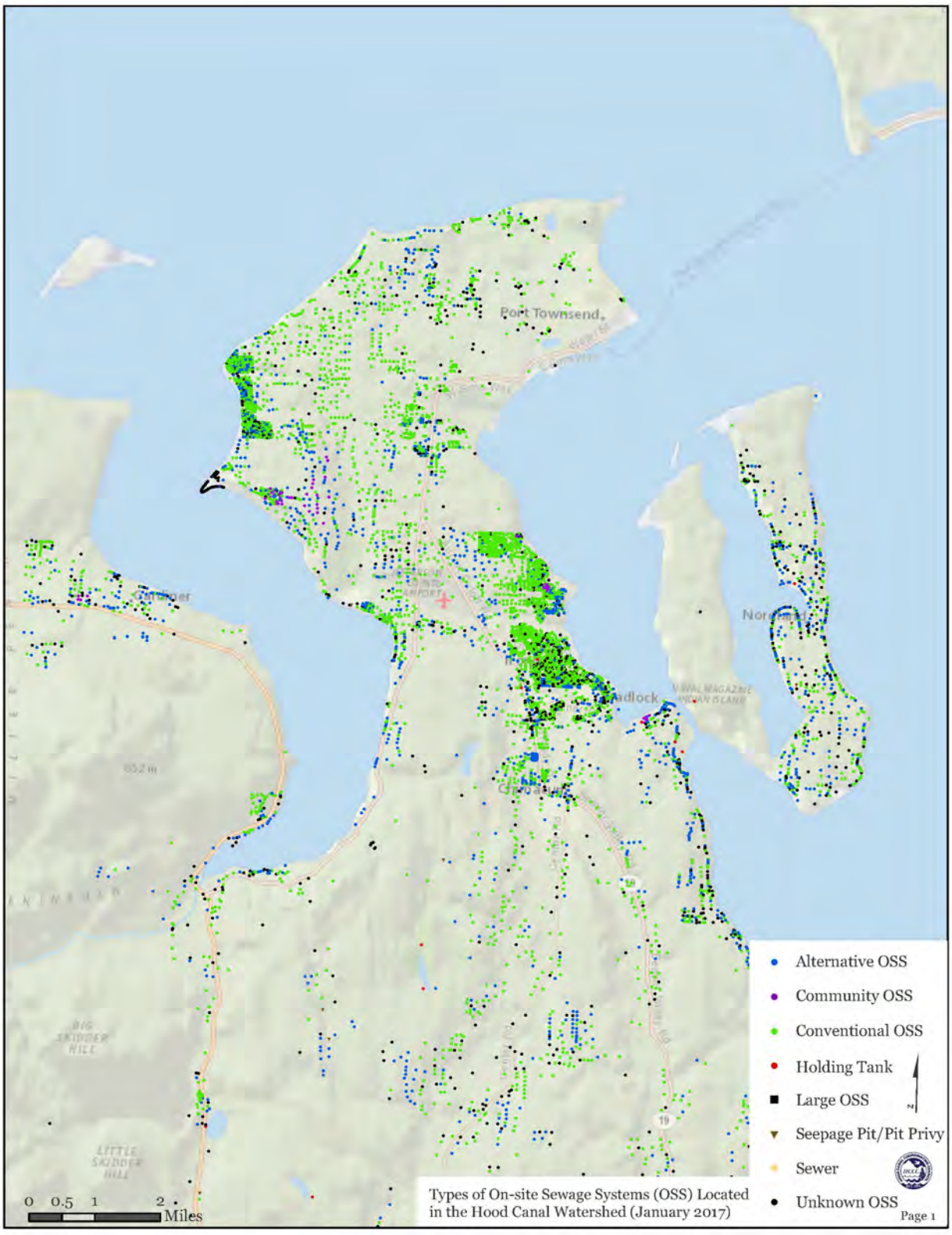

Figure A-11: Map Atlas of Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017), page 1 of 7

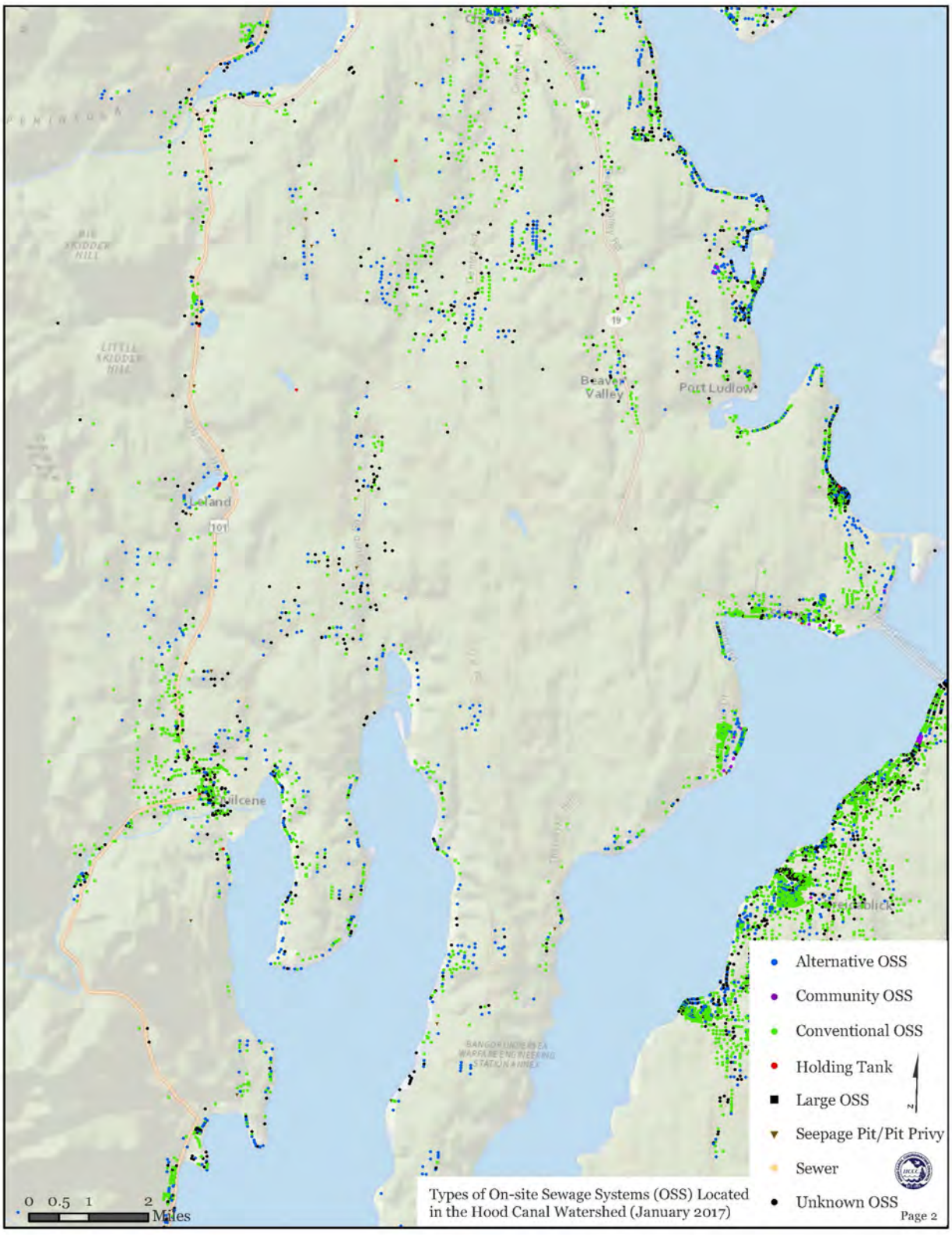

Figure A-11: Map Atlas of Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017), page 2 of 7

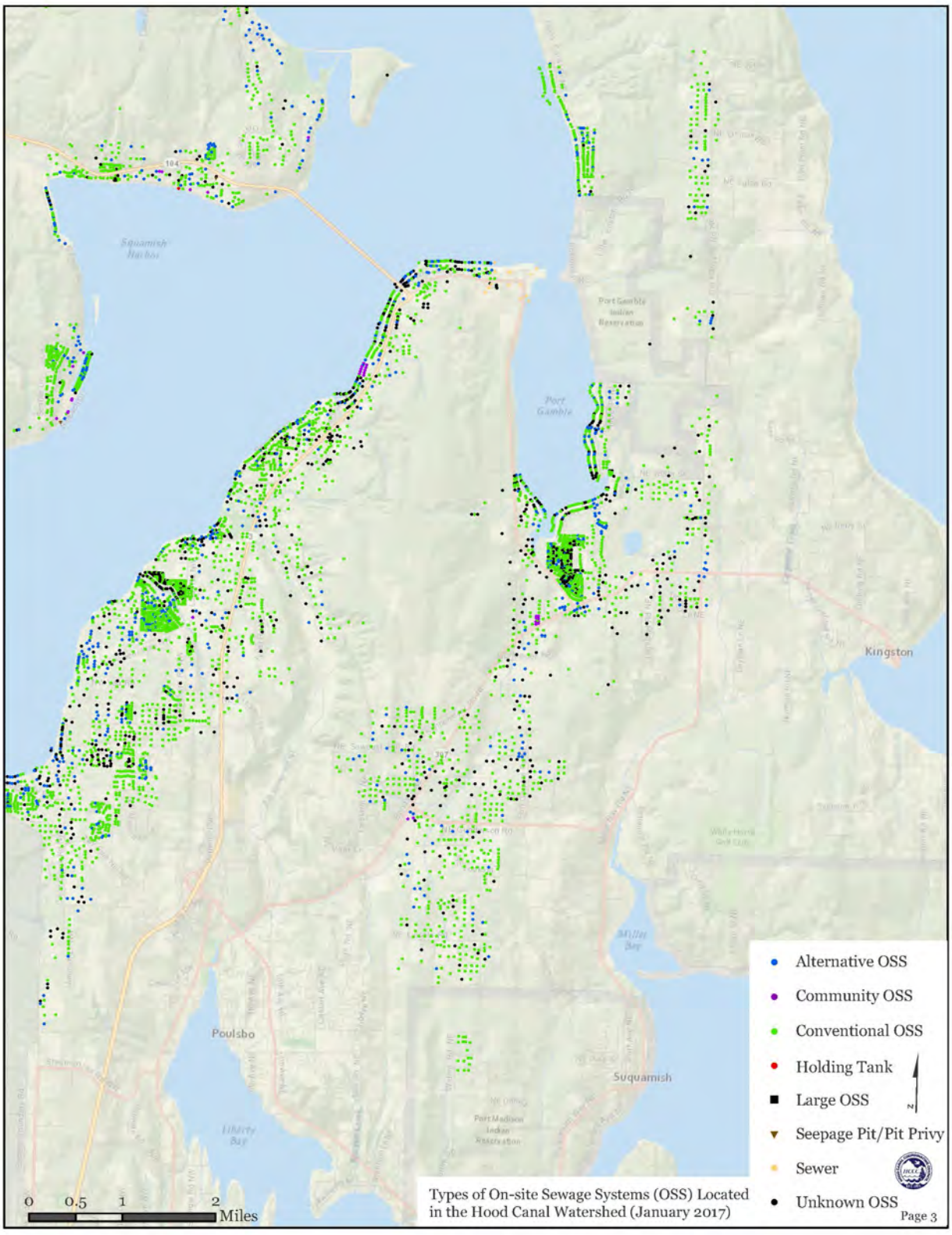

Figure A-11: Map Atlas of Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017), page 3 of 7

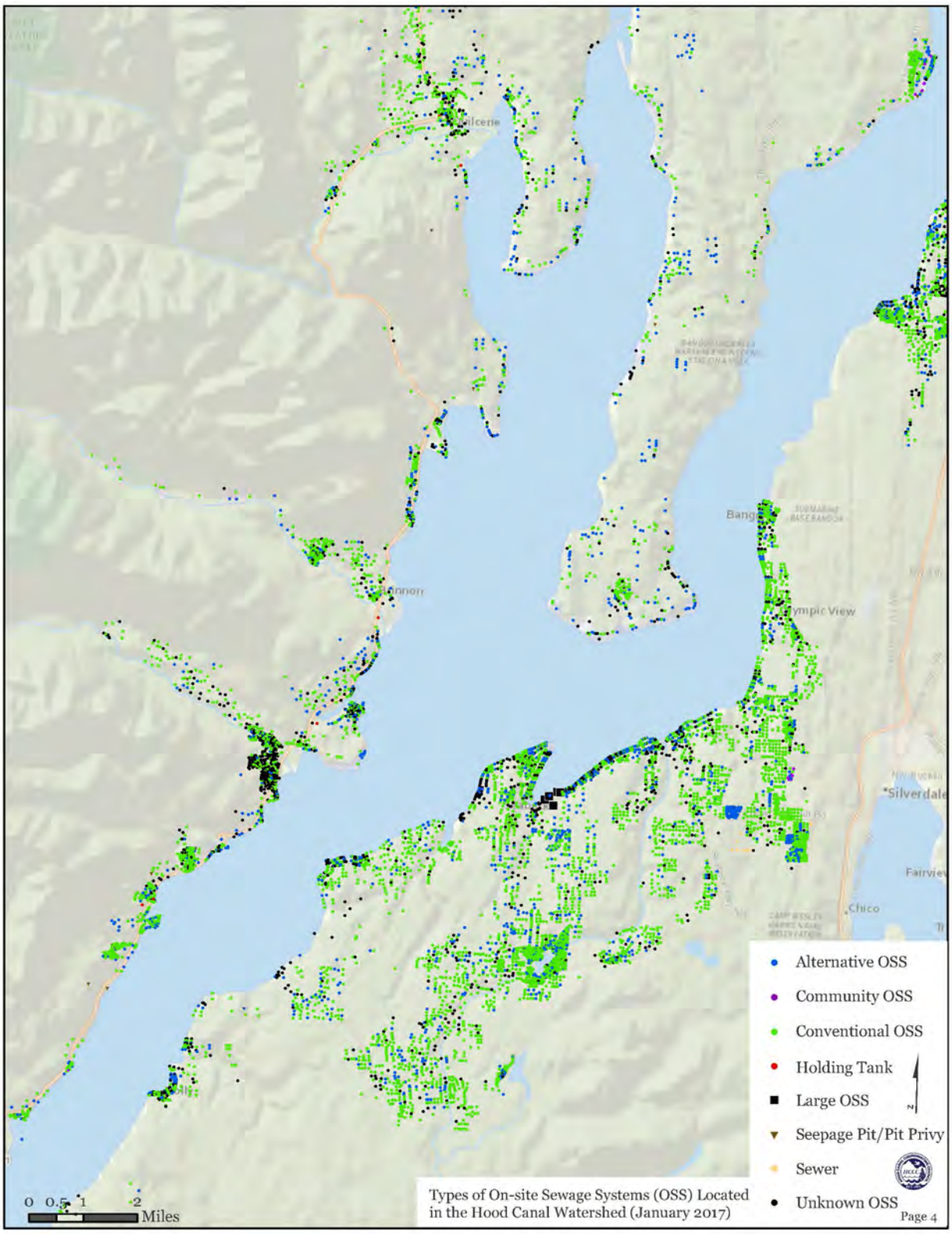

Figure A-11: Map Atlas of Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017), page 4 of 7

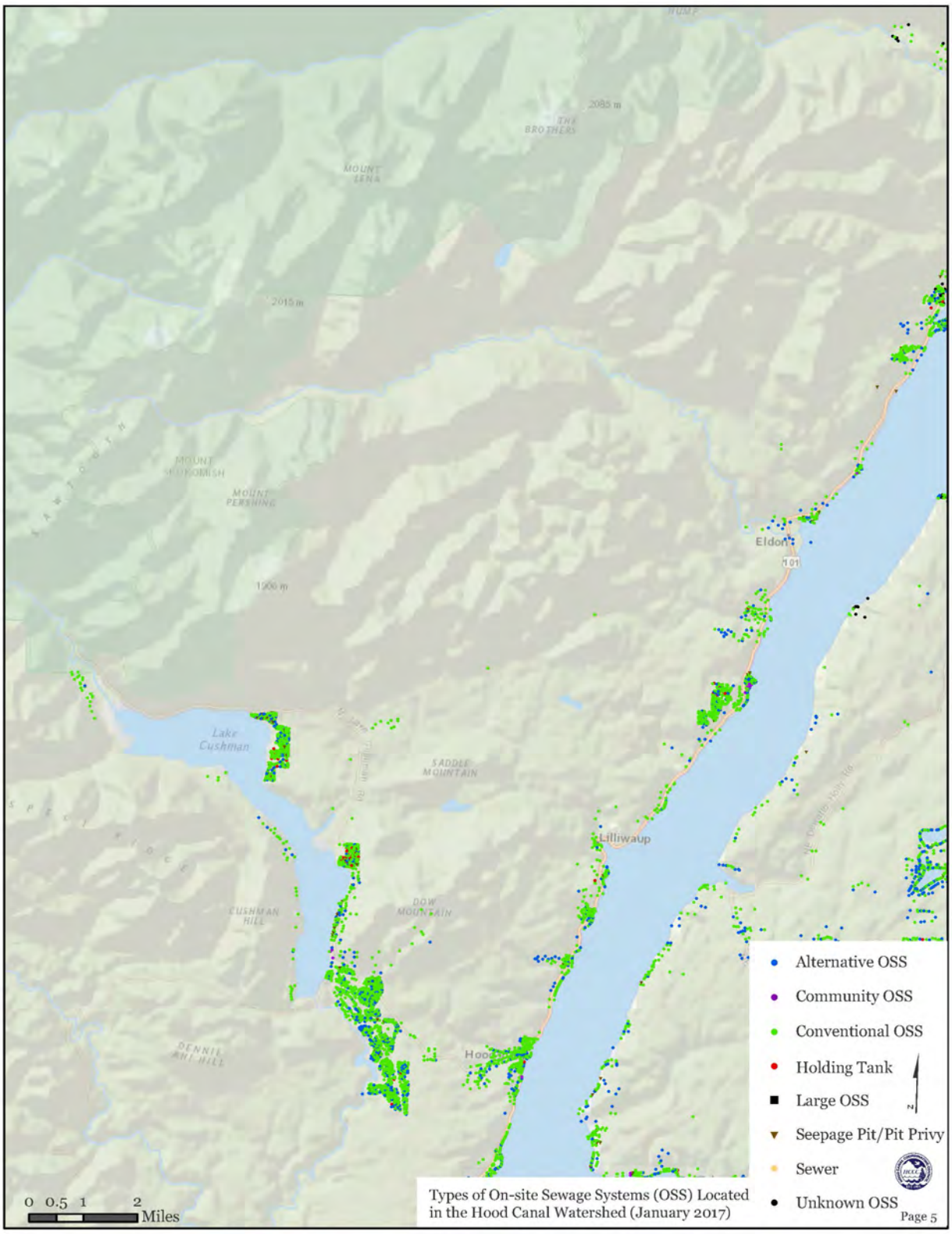

Figure A-11: Map Atlas of Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017), page 5 of 7

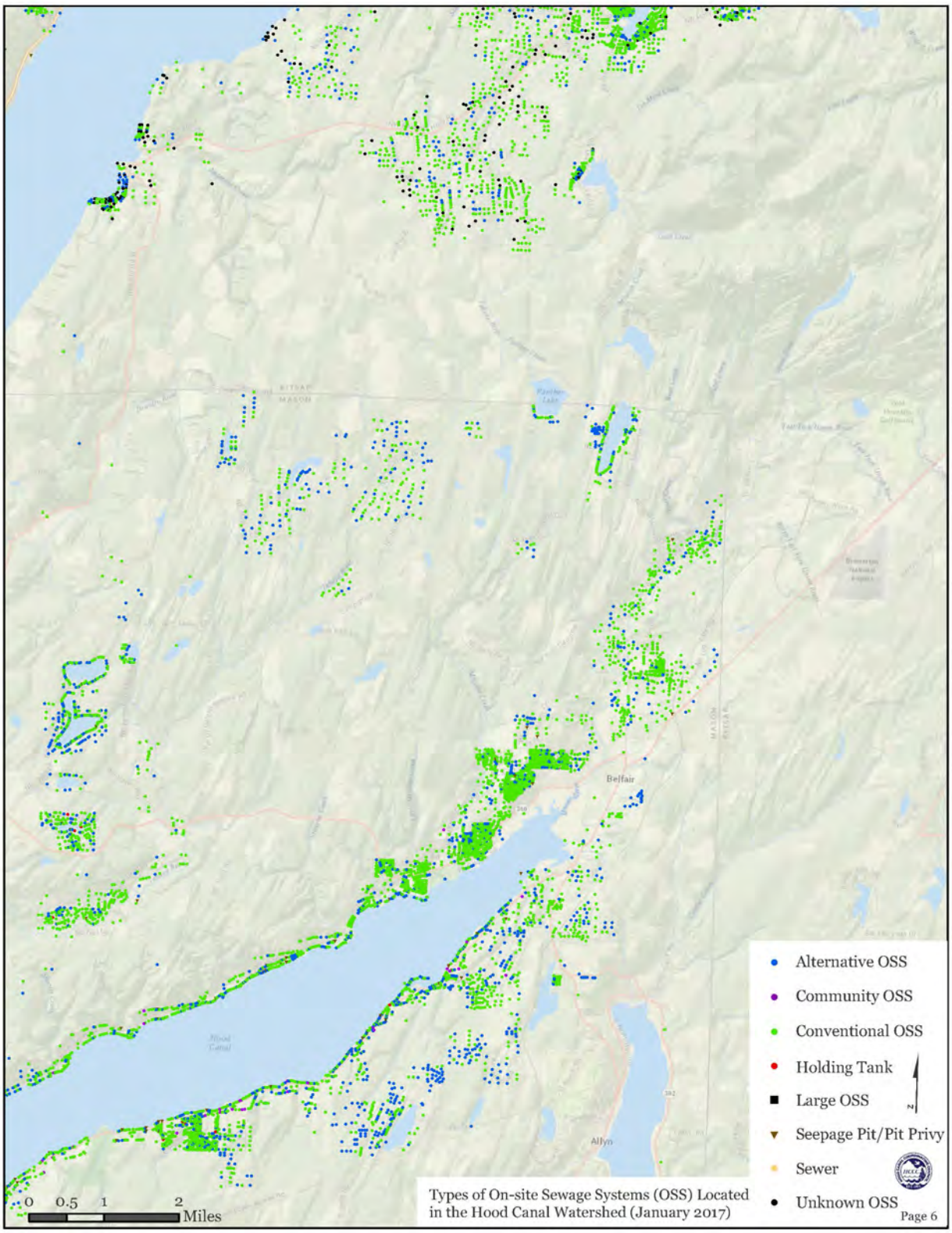

Figure A-11: Map Atlas of Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017), page 6 of 7

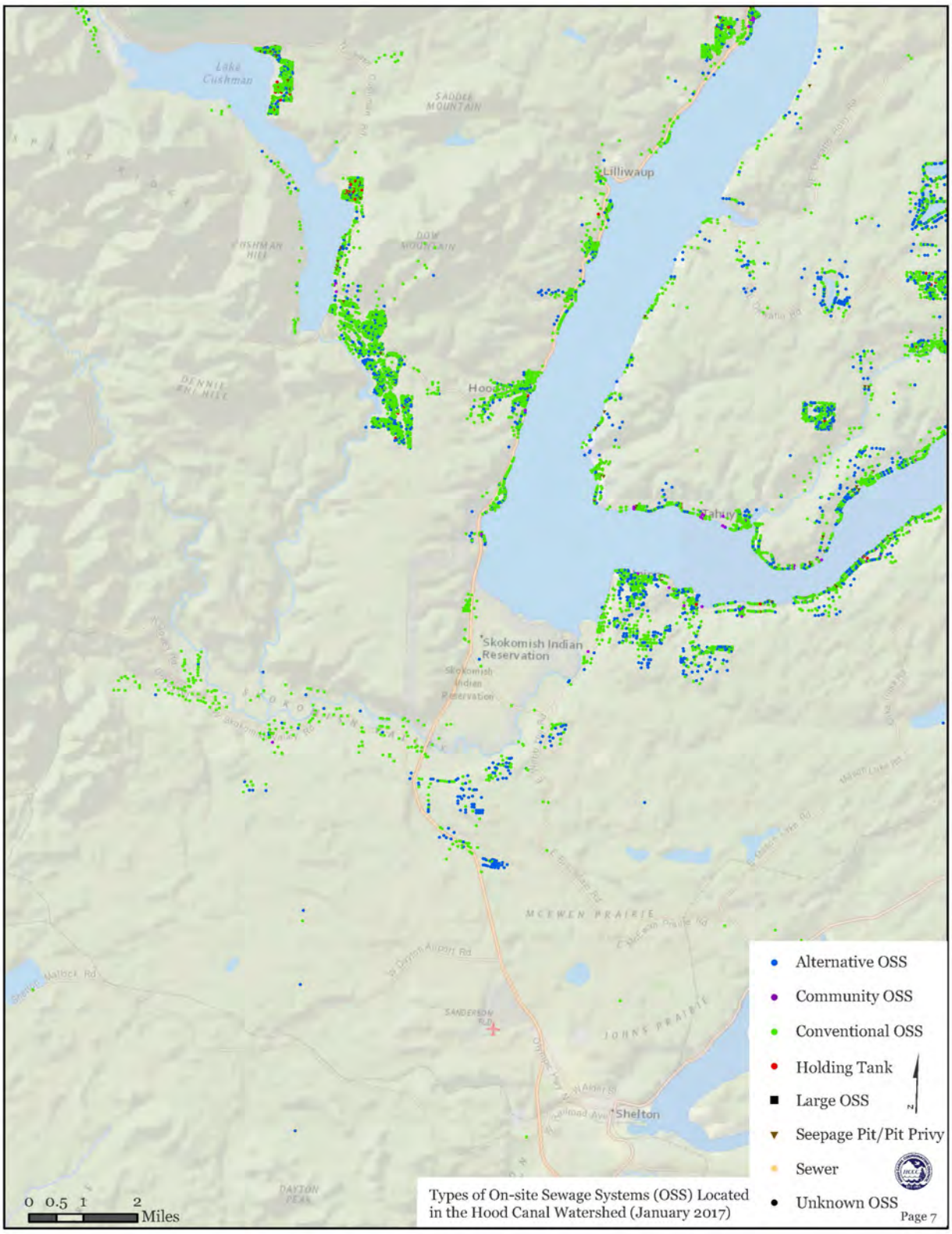

Figure A-11: Map Atlas of Types of On-site Sewage Systems (OSS) Located in the Hood Canal Watershed (January 2017), page 7 of 7

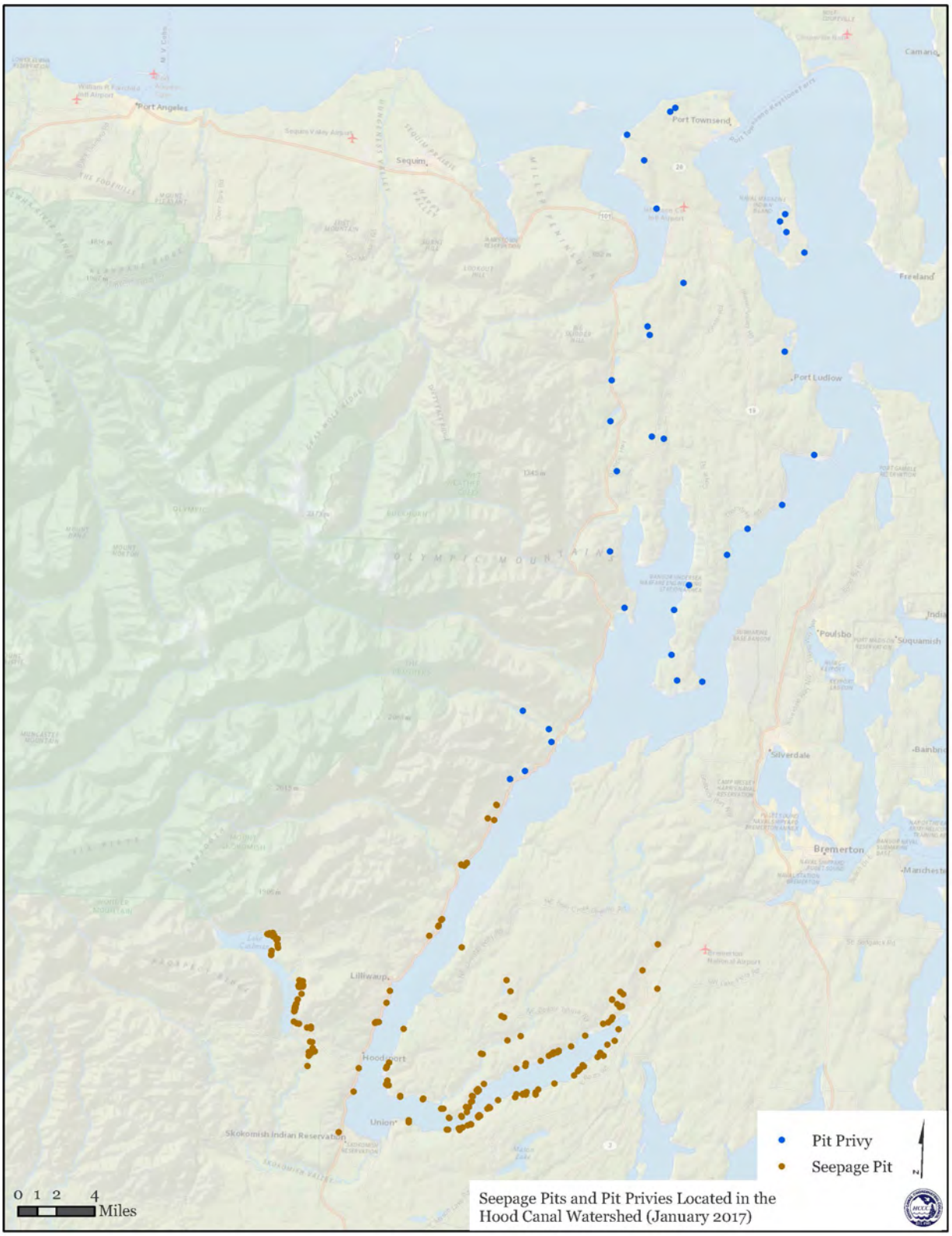

Figure A-12: Seepage Pits and Pit Privies Located in the Hood Canal Watershed (January 2017)

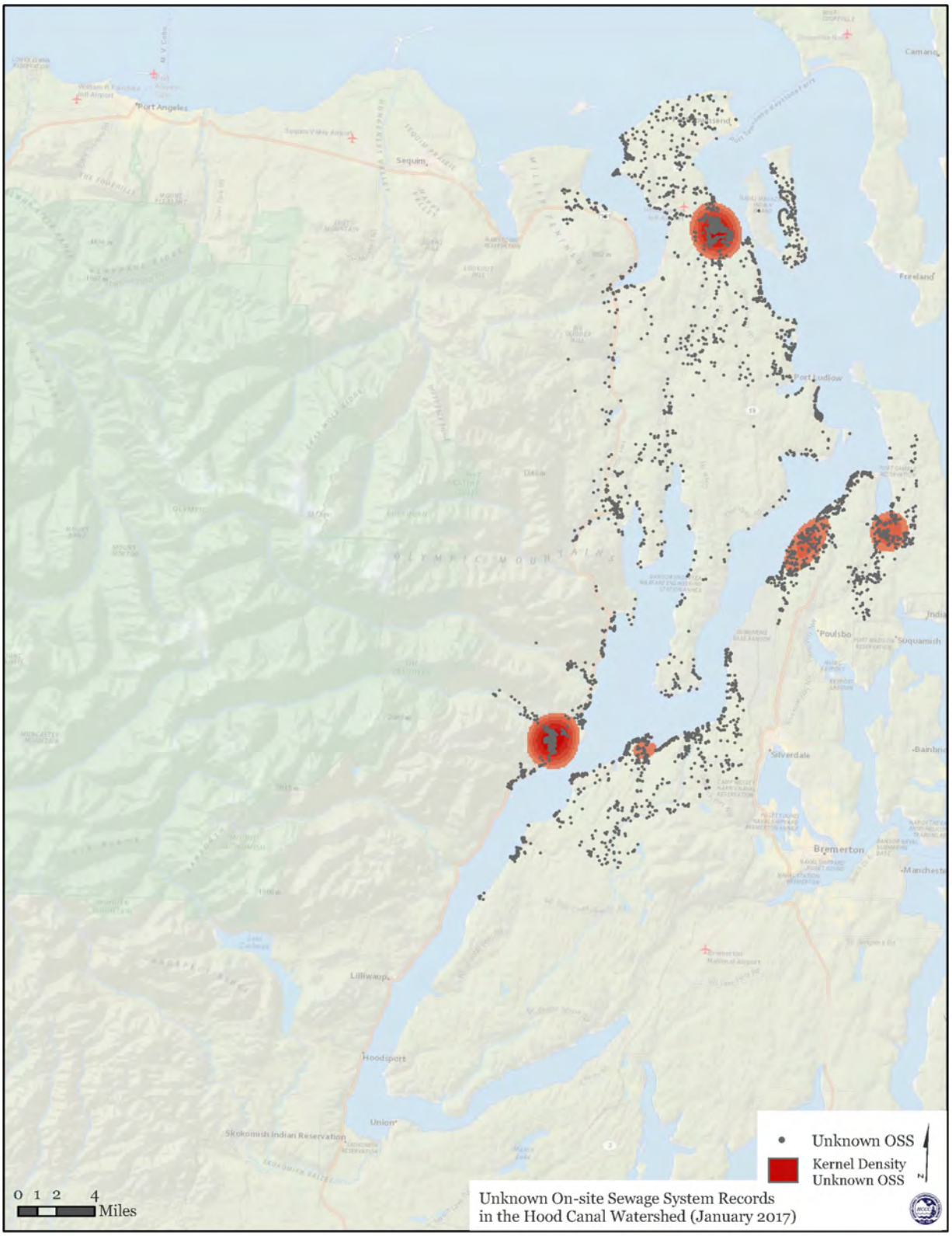

Figure A-13: Unknown On-site Sewage System Records in the Hood Canal Watershed (January 2017)

Hood Canal Coordinating Council

Hood Canal Regional Pollution Identification and Correction Program – Phase II

Evaluation of Nutrient Loading from Seepage Pits in Hood Canal

February 10, 2017

Andy James (UW Tacoma), Leslie Banigan (Kistap Public Health District), Haley Harguth (Hood Canal Coordinating Council), Katie Otañez (Mason County)

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Objective:

The objective of this work was to perform a focused field sampling program to evaluate whether seepage pits located on near-shore parcels are a significant source of nitrogen or bacteria loading to Hood Canal.

Background:

The land along Hood Canal shoreline has been largely developed over the last century with single family houses, with nearly all of them being served by on-site septic systems (OSS). Modern OSS require both a septic tank and a drain field. Both components must be properly designed, located, and maintained to ensure wastewater treatment. A number of OSS were historically constructed without a drain field, where the septic tank effluent was plumed into a single pit. The soil treatment area was limited, often resulting in poor contaminant removal. These systems are known as seepage pits; seepage pits are no longer allowed in new construction or retrofits.

Mason County identified approximately 30 parcels within 100 ft. of the Hood Canal shoreline and which have household seepage pit systems (Figure 4). Further work was done to identify full-time vs part-time residences, with a priority going to those parcels with full-time residences. A field sampling program was performed from March to October 2016 to collect water quality data from locations associated with these sites. Resulting data were compared with regional data to evaluate whether seepage-pit locations were significantly different than non-seepage pit locations throughout Hood Canal.

It was understood that, for most locations it would not be possible to directly link the shoreline sampling location (e.g., seeps, weep holes, surface drainage, etc.) with individual seepage pits. Sample sites were

selected based on the known locations of the seepage pits and expert evaluation of the sites by field personnel.

Sampling Program:

Three sets of field samples were collected at each site in April, August, and October 2016 pursuant to the approved Quality Assurance Project Plan (Banigan 2016). Mason County Department of Environmental Health personnel performed a shoreline survey of all seepage pit parcels in April 2016 to identify suitable sample collection locations. This survey revealed that there were no shoreline seeps or flow associated with many of those sites. The sites with no flow were not sampled. A sample log showing date and location of all samples collected is included in Table 1.

All samples were analyzed for fecal coliform bacteria by method SM9222B (Thurston County Water Laboratory, Olympia, WA), and nitrate/nitrite, ammonia, chloride, phosphate, and sulfate (University of Washington Analytical Services Center, Seattle, WA).

Results and Discussion:

Field assessments of the shorelines below the seepage pits sites discovered that many of the sites had no shoreline seeps or flows and could not sampled.

Analytical results are included in Table 2 and Table 3. A complete summary of results is included in Figure 5. The chloride results (Table 3) indicate that many of the sampling sites were likely tidally influenced. Household wastewater generally has a chloride concentration ranging from 100-500 mg/L (Henze & Comeau, 2008). Sample sites with higher chloride concentration would contain a large fraction of marine water and, as such, it is not possible to determine whether water quality parameters are reflective of local groundwater. Sites with chloride concentration consistently greater than 100 mg/L were not included for evaluation of potential impacts from seepage pit locations.

In order to understand if seepage pits parcels were associated with higher nitrogen or bacteria loading, the results from the seepage pit locations were compared with analytical results collected from locations throughout Hood Canal. This reference data was collected during sampling programs in Mason County from 2007-2011. Data was screened to only include samples from sites with low chloride concentrations. The results are shown in Figure 6 and summarized in Table 2. One Way Analysis of Variance on Ranks was used to determine if there were significant differences between any of the sample groups. Results indicated that the dissolved inorganic nitrogen (DIN) concentration from only one site (U-075) was greater than the reference data ($P<0.05$). No other site was significantly different than the reference sites.

Additional comparisons were made utilizing data reported in the Mason County North Shore Hood Canal Pollution Identification and Correction Project Final Report (2011; Table 4). Field sampling data was used to determine a median DIN concentration in addition to a "level of concern" which was defined as the 90th percentile of measurements. The median concentrations for the sites sampled in this work were generally greater than the median values reported in the 2011 Mason County report (Table 4), though only measurements from site U-075 exceeded the "level of concern."

There are temporal differences in the DIN concentrations observed in the reference data. The median concentration of samples collected in early winter (December - March) was greater than the median concentrations of samples collected in late-spring, summer, or early-fall. This suggests that the time of year when samples are collected may matter. In order to reduce the potential for time-bias, the Mason seepage pit sample results were compared to a subset of the reference data that only included samples

collected from April-October. There were no changes in the outcome of the comparison; U-075 was the only site with DIN concentrations significantly different than the subset of the reference sites.

These results do not support the notion that seepage pits are, on a whole, significantly greater in terms of nitrogen loading compared to other sites sampled throughout the area. It is, however, important to consider the following:

1) there were only six sites with samples without marine influence. This is likely an insufficient number to support broad characterization of seepage pit impacts; and
2) the N concentrations of the freshwater samples were generally higher than the regional median.

The results of the bacteria sampling do not support the conclusion that seepage pits are uniformly more likely to be sources of bacteria to the near shore. One site did have high fecal coliform concentrations (U-075); this was the same site that was associated with high DIN concentrations.

Finally, all of the seepage pit sites were surveyed in both April and October and water samples were collected at those sites with visible discharges. These field surveys did not find any evidence that seepage-pit associated sites were more likely to have discharges compared to other areas around Hood Canal.

There are limits to the conclusions that should be acknowledged. These are:

- For most locations it is not possible to directly link the shoreline sampling location (e.g., seeps, weep holes, surface drainage, etc.) with individual seepage pits. Sites were evaluated by highly qualified field personnel prior to sample collection and samples were collected from all identifiable locations. However, subsurface transport can be complex and it is not possible to conclude that there were not other locations possibly influenced by seepage pit effluent (sub-tidal seeps, for example).
- The occupation status of each household was not verified prior to each sampling event.
- Saltwater intrusion at many sites affected the ability to discern potential seepage-pit related discharges. High nitrogen concentrations were observed at many of the sites with high chloride concentrations.

Recommendations

The results support the following recommendations:

- Investigate occupancy status of the sites with known seepage pits.
  As mentioned above, the occupancy status was not verified during the sampling. Households with part-time or seasonal occupancy would be less likely to generate a measurable signal when the houses were unoccupied (there would be no throughput into the seepage pits). Sampling during these periods would not accurately characterize seepage pit performance.
- Revisit sites with evidence of marine water influence.
  It was not possible to attribute N in samples with high chloride concentration due to the likelihood of marine water influence. These sites should be revisited in order to evaluate if freshwater samples can be collected during different tidal conditions. It is recommended that field personnel survey shoreline seeps with a conductivity probe and only collect samples which might be representative of groundwater (not marine) conditions.
- Undertake a formal PIC investigation at site U-075.
  Samples collected at site U-075 indicate both high fecal coliform and N concentrations, which is

consistent with a failing household septic system. Source confirmation and corrective action should be considered.

- Source identification.
  Source identification techniques could provide additional evidence to evaluate whether seepage pits are significant sources of N and bacteria to Puget Sound shorelines. This could include household dye testing, the sampling and analysis for chemical tracers, and/or evaluation for specific genetic markers.
- Education
  It is generally understood that seepage pits are less effective at wastewater treatment than a properly designed septic system with a functional drain field. An educational campaign highlighting this concern might improve public support.

References

Banigan, Leslie. *Quality Assurance Project Plan Addendum: Hood Canal Pollution Identification and Correction Phase 2 – Implementation: Hood Canal Regional PIC Nutrient Study.* Poulsbo: Hood Canal Coordinating Council, 2016.

Figures

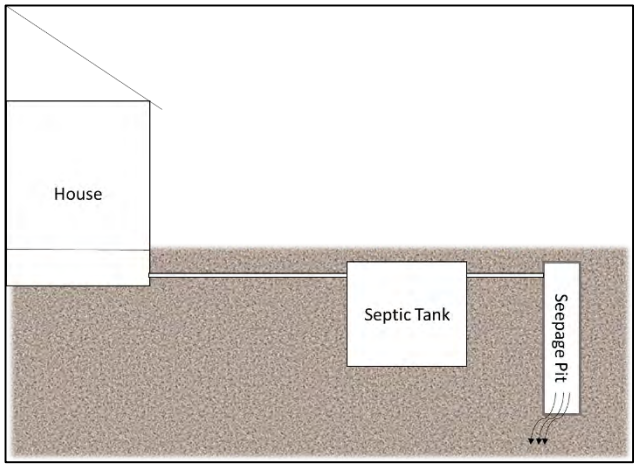

Figure 3. Generalized schematic of septic system with seepage pit.

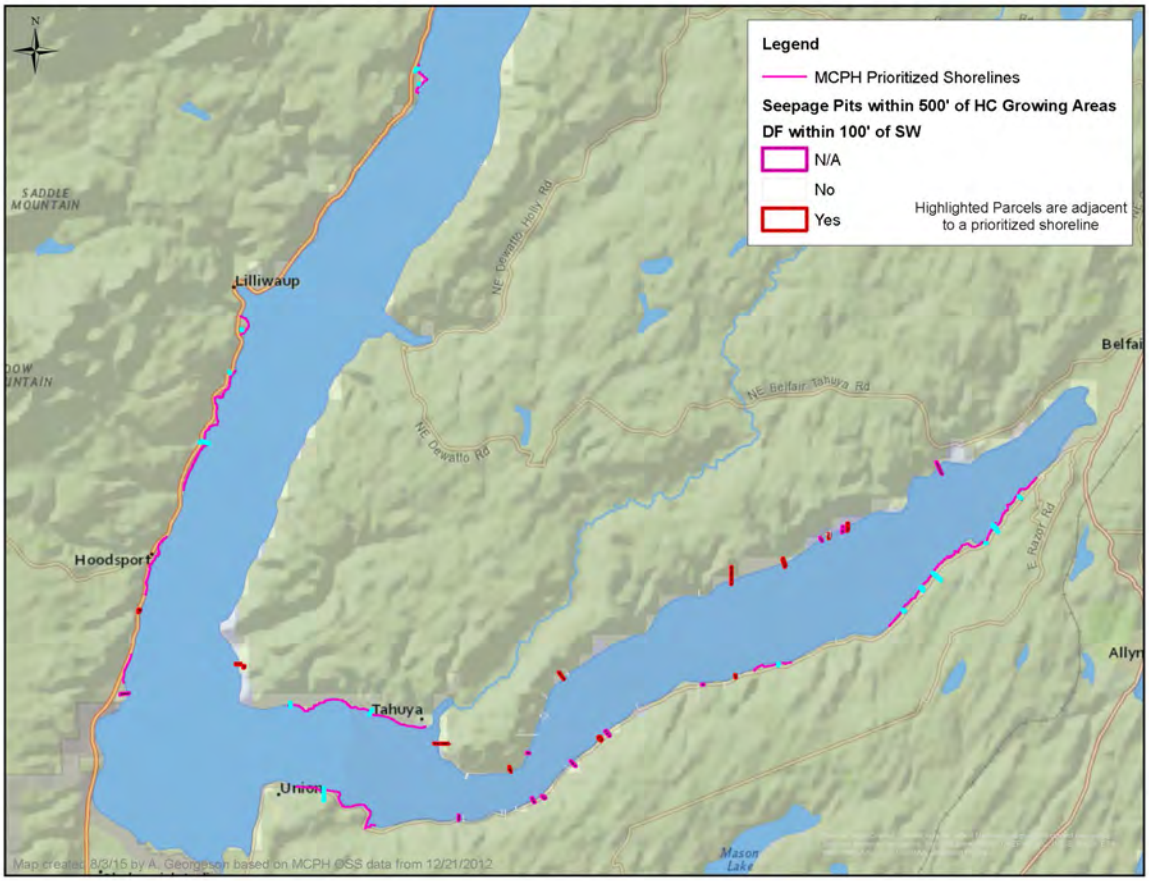

Figure 4. Approximate locations of household seepage pit systems in Mason County located within 100 ft. of the Hood Canal shoreline. Map produced by Washington State Department of Health

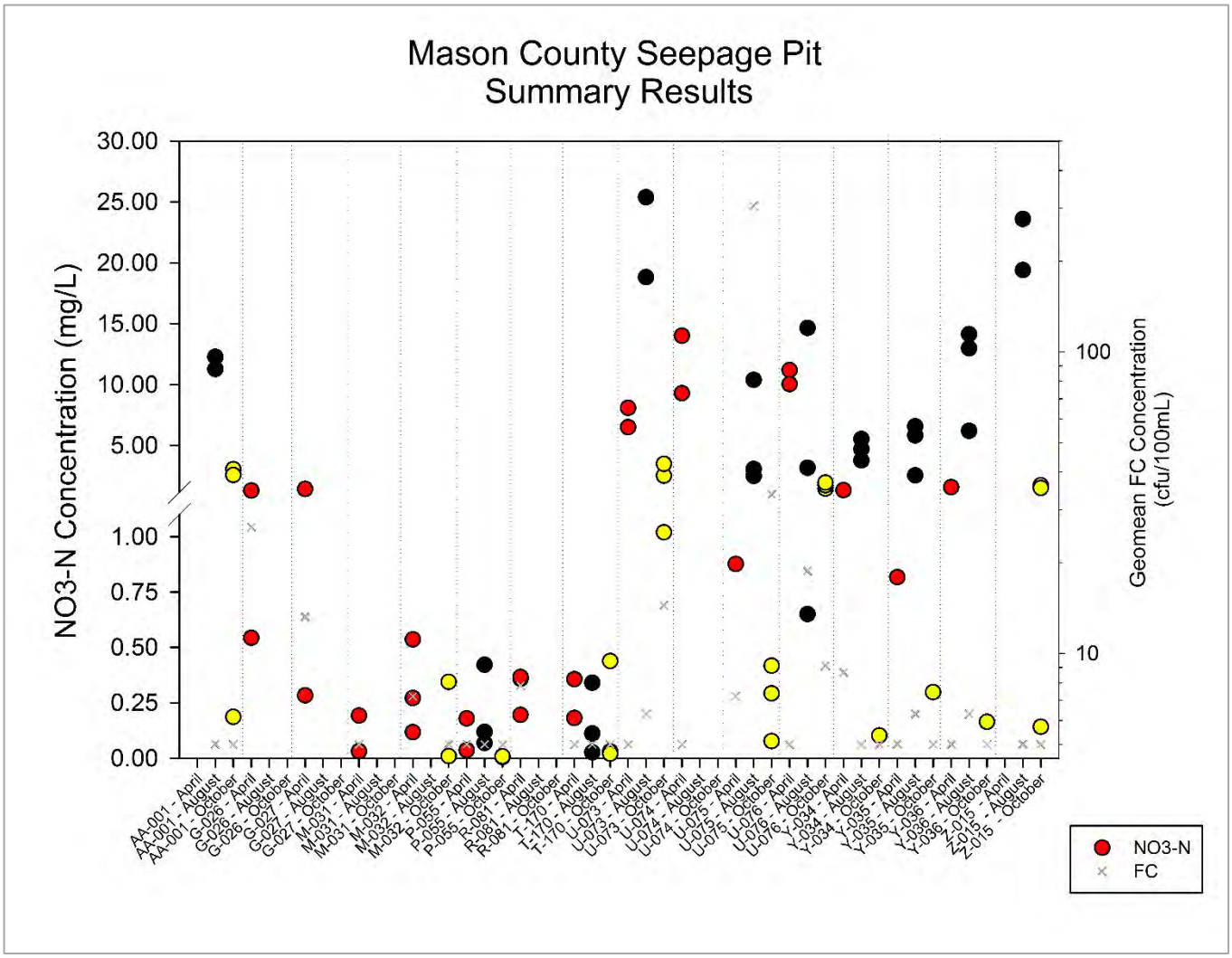

Figure 5. Summary of sampling results by site and sampling month. Analytical results for chloride (Table 4) indicate that several of the sampling sites were influenced by marine water and are likely not indicative of local groundwater conditions. These sites include: AA-001, G-026, G-027, U-073, U-074, and Y-034.

● - NO3 for April sampling; ● - NO3 for August sampling; ● - NO3 for October sampling.

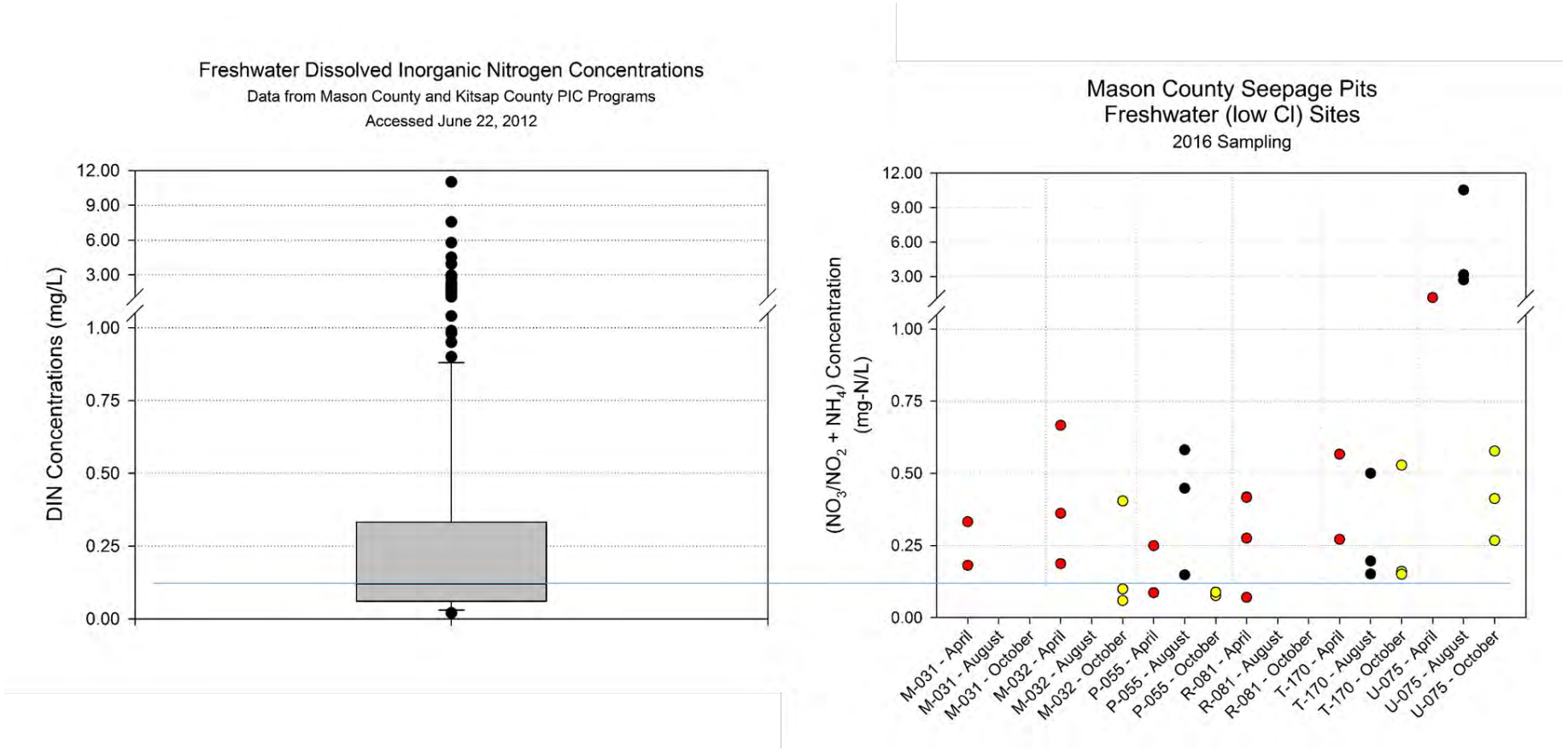

Figure 6. Comparison of Dissolved Inorganic Nitrogen (DIN) concentrations for data from sites associated with seepage pits (right pane) compared to a reference distribution from samples collected from the Hood Canal between 2007-2011 (n=560; left pane). All data was screened to exclude samples with probable marine water influence based on chloride or salinity values. Blue horizontal line marks median DIN concentration at reference sites. The DIN concentration at seepage pit site U-075 was significantly greater than the reference sites (ANOVA on ranks; p<0.05). DIN concentrations at all other seepage sites were not significantly different than the reference sites.

Data Tables

Table 1: Sample log. All samples were analyzed for nitrogen and fecal coliform bacteria.

			Sample Date												
Site ID	LAT	LONG	4/18/2016	4/19/2016	4/20/2016	4/25/2016	4/26/2016	4/27/2016	8/2/2016	8/3/2016 (A)	8/3/2016 (B)	10/11/2016	10/12/2016	10/25/2016	10/26/2016
AA-001	47.408317	-122.932933							x	x	x		x	x	x
G-026	47.430078	-123.123502					x	x							
G-027	47.429830	-123.123569			x		x	x							
M-031	47.366699	-122.999772			x	x									
M-032	47.368374	-122.997375	x			x	x	x				x		x	x
P-055	47.380254	-122.957410	x		x	x			x	x	x	x		x	x
R-081	47.394270	-122.904420	x			x	x	x							
T-170	47.412059	-122.875618				x	x	x	x	x	x	x		x	x
U-073	47.429338	-122.854761				x		x		x	x	x		x	x
U-074	47.428523	122.855650	x			x		x							
U-075	47.428196	-122.855409	x			x		x	x	x	x	x		x	x
U-076	47.429175	-122.855632	x			x		x	x	x	x		x	x	x
Y-034	47.425486	-122.893958		x			x		x	x	x		x		
Y-035	47.425506	-122.893839		x			x		x	x	x		x		
Y-036	47.425479	-122.893816		x			x		x	x	x		x		
Z-015	47.408400	-122.932733							x	x	x		x	x	x

Table 2. Data summary for Dissolved Inorganic Nitrogen (DIN) concentration from reference sites and sites sampled in this Mason County Seepage pit study.

Sample Set	**DIN Concentration (mg/L)**			
	Median	**25%**	**75%**	**90%[1]**
Reference Samples (this study)	0.12	0.06	0.33	
Hood Canal PIC – North Shore only[1]	0.09			0.52
Hood Canal PIC – all samples[1]	0.19			0.89
M-031	0.26	0.18	0.33	
M-032	0.27	0.09	0.47	
P-055	0.12	0.09	0.40	
R-081	0.35	0.12	0.42	
T-170	0.23	0.15	0.52	
U-075	1.12	0.45	3.05	

Notes:

1. Values reported in Mason County Public Health North Shore Hood Canal Pollution Identification and Correction Project - Final Report (2011). The 90th percentile values were reported as levels of concern; sites with N concentrations above these values were flagged for follow up investigation.

Table 3. Mason seepage pit sampling fecal coliform results. Samples analyzed by SM9222 B by Thurston Water Laboratory (Olympia, WA)

Date	SITE ID	Fecal Coliform (CFU/100 mL)
8/2/2016	AA-001	<5
8/3/2016	AA-001	<5
8/3/2016	AA-001	<5
10/12/2016	AA-001	<5
10/25/2016	AA-001	<5
10/26/2016	AA-001	<5
4/20/2016	G-026	30
4/26/2016	G-026	15
4/27/2016	G-026	40
4/26/2016	G-027	35
4/27/2016	G-027	5
4/18/2016	M-031	<5
4/20/2016	M-031	<5
4/25/2016	M-031	<5
4/25/2016	M-032	<5
4/26/2016	M-032	15
4/27/2016	M-032	<5
10/11/2016	M-032	<5
10/25/2016	M-032	<5
10/26/2016	M-032	5
4/18/2016	P-055	<5
4/20/2016	P-055	<5
4/25/2016	P-055	<5
8/2/2016	P-055	<5
8/3/2016	P-055	<5
8/3/2016	P-055	<5
10/11/2016	P-055	<5
10/25/2016	P-055	<5
10/26/2016	P-055	<5
4/18/2016	R-081	5
4/25/2016	R-081	30
4/26/2016	R-081	5
4/27/2016	R-081	<5
4/25/2016	T-170	<5
4/26/2016	T-170	<5
4/27/2016	T-170	<5
8/2/2016	T-170	5
8/3/2016	T-170	5
8/3/2016	T-170	<5

Date	SITE ID	Fecal Coliform (CFU/100 mL)
10/11/2016	T-170	<5
10/25/2016	T-170	<5
10/26/2016	T-170	<5
4/18/2016	U-073	<5
4/25/2016	U-073	<5
4/27/2016	U-073	<5
8/3/2016	U-073	5
8/3/2016	U-073	<5
10/11/2016	U-073	<5
10/25/2016	U-073	<5
10/26/2016	U-073	120
4/18/2016	U-074	<5
4/25/2016	U-074	<5
4/27/2016	U-074	<5
4/18/2016	U-075	<5
4/25/2016	U-075	15
4/27/2016	U-075	5
8/2/2016	U-075	10
8/3/2016	U-075	1000
8/3/2016	U-075	2820
10/11/2016	U-075	<5
10/25/2016	U-075	5
10/26/2016	U-075	1540
4/25/2016	U-076	5
4/27/2016	U-076	<5
8/2/2016	U-076	265
8/3/2016	U-076	<5
8/3/2016	U-076	<5
10/12/2016	U-076	<5
10/25/2016	U-076	15
10/26/2016	U-076	10
4/19/2016	Y-034	<5
4/26/2016	Y-034	15
8/2/2016	Y-034	<5
8/3/2016	Y-034	<5
8/3/2016	Y-034	<5
10/12/2016	Y-034	<5
4/19/2016	Y-035	<5
4/26/2016	Y-035	5
8/2/2016	Y-035	<5
8/3/2016	Y-035	<5

Date	SITE ID	Fecal Coliform (CFU/100 mL)
8/3/2016	Y-035	10
10/12/2016	Y-035	<5
4/19/2016	Y-036	<5
4/26/2016	Y-036	<5
8/2/2016	Y-036	5
8/3/2016	Y-036	10
8/3/2016	Y-036	<5
10/12/2016	Y-036	<5
8/2/2016	Z-015	<5
8/3/2016	Z-015	<5
8/3/2016	Z-015	<5
10/12/2016	Z-015	<5
10/25/2016	Z-015	<5
10/26/2016	Z-015	<5

Table 4. Mason seepage pit sampling water quality analytical results. Samples analyzed by University of Washington Analytical Services Center (Seattle, WA). ND – analyte not detected above method detection limit (NO2-N = 0.005 mg/L; PO4-P = 0.002 mg/L). Cl – chloride; NO3 – nitrate; NO2 – nitrite; PO4 – phosphate; SO4 – sulfate; NH4 – ammonium.

Sample Date	Site ID	Cl (mg/L)	NO3-N (mg/L)	NO2-N (mg/L)	PO4-P (mg/L)	SO4-S (mg/L)	NH4-N (mg/L)
8/3/2016	AA-001	12515	12.28	ND	0.204	411	0.13
8/3/2016	AA-001	12104	11.27	ND	0.089	397	0.12
10/12/2016	AA-001	2060	0.186	ND	0.128	81.7	0.14
10/25/2016	AA-001	2216	3.041	ND	1.164	116	0.12
10/26/2016	AA-001	1646	2.561	ND	ND	90.2	0.15
4/26/2016	G-026	1429	1.287	ND	0.058	70.42	0.09
4/27/2016	G-026	717	0.543	ND	0.201	34.52	0.06
4/26/2016	G-027	1012	1.409	ND	0.065	53.15	0.07
4/27/2016	G-027	319	0.283	ND	0.193	16.41	0.07
4/21/2016	G-026	676	0.619	ND	0.019	30.35	0.14
4/21/2016	M-031	1.30	0.031	ND	0.058	0.385	0.15
4/25/2016	M-031	0.90	0.192	ND	0.045	0.378	0.14
4/25/2016	M-032	3.32	0.536	ND	0.023	0.062	0.13
4/26/2016	M-032	6.17	0.271	ND	0.021	0.091	0.09
4/27/2016	M-032	8.94	0.117	ND	0.024	0.362	0.07
10/12/2016	M-032	2.60	0.009	ND	0.004	0.145	0.09
10/25/2016	M-032	3.16	0.009	ND	0.002	0.222	0.05
10/26/2016	M-032	3.30	0.344	ND	0.789	1.319	0.06
4/18/2016	M-031	1.66	0.014	ND	0.049	0.432	0.041
4/21/2016	P-055	1.40	0.036	ND	0.031	0.255	0.05
4/25/2016	P-055	1.61	0.179	ND	0.032	0.287	0.07

Sample Date	Site ID	Cl (mg/L)	NO3-N (mg/L)	NO2-N (mg/L)	PO4-P (mg/L)	SO4-S (mg/L)	NH4-N (mg/L)
8/2/2016	P-055	1.56	0.068	ND	0.055	0.311	0.38
8/3/2016	P-055	3.12	0.118	ND	0.031	0.127	0.03
8/3/2016	P-055	1.99	0.421	ND	0.041	0.351	0.16
10/12/2016	P-055	1.42	0.005	ND	0.033	0.297	0.08
10/25/2016	P-055	1.45	0.006	ND	0.033	0.320	0.07
10/26/2016	P-055	1.26	0.008	ND	0.036	0.337	0.08
4/18/2016	P-055	2.86	0.032	ND	0.043	0.344	0.032
4/18/2016	R-081						0.07
4/25/2016	R-081	1.70	0.358	ND	0.024	0.874	0.06
4/26/2016	R-081	4.62	0.366	ND	0.008	1.011	0.05
4/27/2016	R-081	9.49	0.195	ND	0.068	1.249	0.08
4/26/2016	T-170	12.51	0.356	ND	0.027	0.563	0.21
4/27/2016	T-170	37.26	0.181	ND	0.041	1.478	0.09
8/2/2016	T-170	6.16	0.111	ND	0.019	0.709	0.04
8/3/2016	T-170	9.23	0.34	ND	0.041	0.399	0.16
8/3/2016	T-170	7.28	0.026	ND	0.034	0.609	0.17
10/12/2016	T-170	7.14	0.030	ND	0.021	2.417	0.13
10/25/2016	T-170	6.79	0.020	ND	0.017	1.881	0.13
10/26/2016	T-170	3.83	0.438	ND	0.037	1.317	0.09
4/25/2016	T-170	7.88	0.196	ND	0.028	0.404	0.09
4/25/2016	U-073	8207	6.492	ND	0.409	377	0.24
4/27/2016	U-073	10125	8.083	ND	0.871	447	0.07
8/3/2016	U-073	20165	18.82	ND	0.318	714	0.09
8/3/2016	U-073	17990	25.39	ND	0.421	624	0.19
10/12/2016	U-073	16636	1.019	ND	ND	619	0.11
10/25/2016	U-073	4130	2.506	ND	4.156	222	0.15
10/26/2016	U-073	1702	3.486	ND	ND	83.1	0.13
4/25/2016	U-074	10229	14.01	ND	0.271	444	0.11
4/27/2016	U-074	10591	9.287	ND	0.626	417	0.08
4/25/2016	U-075	30.4	0.876	ND	0.045	1.038	0.19
4/27/2016	U-075	11.91	1.127	ND	0.377	0.872	0.04
8/2/2016	U-075	38.08	2.491	ND	0.130	1.701	0.21
8/3/2016	U-075	98.67	3.063	ND	0.142	1.971	0.10
8/3/2016	U-075	106	10.38	ND	0.235	5.023	0.15
10/12/2016	U-075	0.927	0.292	ND	0.183	1.377	0.12
10/25/2016	U-075	3.57	0.077	ND	ND	0.908	0.19
10/26/2016	U-075	2.46	0.417	ND	0.052	0.684	0.16
4/25/2016	U-076	2384	11.19	ND	0.262	128	0.14
4/27/2016	U-076	2628	10.03	ND	0.936	110	0.07
8/2/2016	U-076	28.33	0.65	ND	0.171	1.618	0.13
8/3/2016	U-076	18535	14.65	ND	0.201	642	0.07

Sample Date	Site ID	Cl (mg/L)	NO3-N (mg/L)	NO2-N (mg/L)	PO4-P (mg/L)	SO4-S (mg/L)	NH4-N (mg/L)
8/3/2016	U-076	40.78	3.163	ND	0.025	0.402	0.14
10/12/2016	U-076	16032	1.436	ND	ND	593	0.10
10/25/2016	U-076	1609	1.714	ND	1.546	75.9	0.18
10/26/2016	U-076	2389	1.936	ND	4.177	133	0.17
4/18/2016	U-073	11056	6.289	ND	0.175	392	0.19
4/18/2016	U-074	11980	5.561	ND	0.143	423	0.104
4/18/2016	U-075	5.81	0.853	ND	0.013	0.89	0.06
4/26/2016	Y-034	1140	1.314	ND	0.063	49.3	0.11
8/2/2016	Y-034	3610	3.763	ND	0.170	124	0.11
8/3/2016	Y-034	5683	5.523	ND	0.134	157	0.09
8/3/2016	Y-034	3093	4.691	ND	0.401	83.04	0.19
10/12/2016	Y-034	1276	0.102	ND	ND	16.8	0.16
4/26/2016	Y-035	797	0.817	ND	0.048	34.83	0.14
8/2/2016	Y-035	16072	2.541	ND	0.041	596	0.12
8/3/2016	Y-035	4276	5.822	ND	0.232	119	0.03
8/3/2016	Y-035	3078	6.569	ND	231	85.59	0.13
10/12/2016	Y-035	1376	0.298	ND	0.212	56.5	0.18
4/26/2016	Y-036	1133	1.561	ND	0.168	53.01	0.12
8/2/2016	Y-036	12991	14.14	ND	0.009	473	0.16
8/3/2016	Y-036	4262	12.97	ND	0.258	118	0.15
8/3/2016	Y-036	4183	6.194	ND	0.116	115	0.13
10/12/2016	Y-036	644	0.164	ND	0.154	36.4	0.08
4/19/2016	Y-034	2093	1.292	ND	0.092	72.4	0.103
8/2/2016	AA-001	4862	12.12	ND	0.005	166	0.11
4/19/2016	Y-035	1588	0.255	ND	0.022	54.9	0.049
8/2/2016	Z-015	2855	3.13	ND	0.007	126	0.05
4/19/2016	Y-036	1024	0.744	ND	0.014	39.5	0.042
8/3/2016	Z-015	16547	19.4	ND	0.211	526	0.11
8/3/2016	Z-015	10981	23.6	ND	0.253	401	0.11
10/12/2016	Z-015	2799	0.141	ND	0.097	105	0.12
10/25/2016	Z-015	1961	1.715	ND	ND	106	0.11
10/26/2016	Z-015	1734	1.496	ND	ND	93.2	0.18

APPENDIX C – HCRPIC Program Phase II: Outreach and Education - Supplemental Evaluation of 2015 Site Visits

Hood Canal Coordinating Council

Hood Canal Regional Pollution Identification and Correction Program

Phase II Outreach and Education: Supplemental Evaluation of 2015 Site Visits

March 2017

Authors and Contact Information

Bob Simmons, simmons@wsu.edu
WSU Extension
380 Jefferson St.
Port Townsend, WA 98368
(360) 379-5610

Darcy McNamara, WSU Extension
Erica Bates, WA Dept. of Ecology (formerly with WSU Extension)
Wendy Mathews, Active Consulting

Research conducted and report written by: Washington State University Extension

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Introduction and Background

In the spring and summer of 2015 the Washington State Conservation Commission and WSU Extension collaborated with Pierce, Kitsap and Mason Conservation Districts to conduct an outreach project in targeted watersheds in the three counties. The Focused Watershed Outreach and WSU Shore Stewards' Model Stewardship Project was designed to educate landowners on Best Management Practices (BMPs) to reduce fecal coliform pollution in marine waters and tributaries, and to increase the likelihood that the BMPs would be implemented.

This report focuses on activities in Mason County, where the target area was the Hood Canal Shellfish Growing Area #6 watershed in the population centers of Hoodsport and Union. Landowners with properties within 250 feet of Hood Canal and its tributaries were offered a site visit by Clean Water Advisors from WSU Mason County Extension and the Mason Conservation District. The outreach resulted in site visits with 32 landowners. Evaluation of the 2015 project included calls to site visit recipients to ask about their site visit experience. Results of those calls are discussed in the *Focused Watershed Outreach and Model Stewardship Final Report* (Joy et al., 2015). One key finding was that the timing of the follow-up interviews was too soon after the site visits (1.5 – 2 months) to measure whether the BMPs were implemented and what barriers may have prevented implementation. Therefore, the follow-up interviews were re-conducted approximately a year after the site visits to better inform the 2016 outreach and education project. The results of these interviews are provided in this report.

Methodology

There were 32 site visits conducted with landowners owning 35 properties in Mason County in 2015. Site visits were conducted by two staff members for all but one property. A WSU Mason County Extension Clean Water Advisor was present for all site visits, accompanied by one of three Mason Conservation District staff, including an engineer and a shoreline specialist, depending on the issues to be addressed. Working in pairs allowed Clean Water Advisors to focus on their primary area of expertise to address the target Best Management Practices (BMPs) which were:

- Inspect septic systems at least every three years and make repairs when needed.
- Pick up, bag and dispose of dog waste in the garbage.
- Install buffers of (native) plants to absorb and filter water.
- Improve management of runoff.

Door knocking began in mid-March 2015 and site visits on 35 properties took place from March to June. The number of site visits ramped up from seven in March, peaked in April with 20, then declined in May (5) and June (3) when outreach ended. The number of site visits on upland properties (20) were greater than those on the shoreline (15), and greater in Hoodsport (19) than in Union (16), but the relatively small difference provided a good spread over those communities.

Follow-up calls also were made to the 32 recipients of site visits to gather information about the landowners' implementation of the recommended BMPs.

Calls were made over a two-day period, followed by additional attempts on different days and different times of day (morning, midday, early evening). At least three attempts were made for each landowner. Once contact was made, interviews were either conducted at that time, or an interview was scheduled.

Survey questions focused on the success of the site visit as measured by implementation of recommended BMPs. The landowner was first asked about his/her preferred method of contact. The first question about the site visit asked what recommendations were made to the landowner since not all landowners had the same issues and the BMP recommendations were tailored to each. The answers to this question was designed to measure the lasting impression of the recommendations and what the landowners considered the most useful. The following questions asked about factors surrounding implementation:

- Which, if any, BMPs were applied?
- What were the obstacles to implementation?
- What did and what could help?

The final questions asked if the landowner had suggestions about incentives or what might improve outreach efforts in the future. Survey questions can be found in Appendix 1 and grouped individual responses in Appendix 2.

Results

Fifteen of the 32 site visit recipients could not be contacted due to disconnected phones (2), contact information could not be found (4), or they did not return the call (9). One landowner chose not to participate.

Of the 16 recipients that responded, eight live in Hoodsport and eight in Union. All landowners were full time or mostly full time residents.

Successful contacts were defined as when a person could be reached or a person called back. Contacts made between noon and 4:30 pm and between 5:00 pm and 7:00 pm resulted in more contacts than morning hours. The 16 interviews were conducted at the landowners' preferred time. Only one landowner abstained.

Summary of Responses: Key Points

When summarizing responses, an additional assessment was used to capture the participants' memories of the *wording* of a BMP and the understanding of the *intent* of the BMP (See Appendix 2). This might better reflect the motivation for implementation. Summaries of responses also include the frequency of use of the term "fecal coliform" or other specific reference to the contaminant most used as an indicator of water quality.

The survey questions are in Appendix 1. The sum of responses in each question below will not always total to 16 (recipients), but will reflect the total number of times a subject, topic and/or choice is mentioned.

Letters are the preferred method of contact (8). Letters were also mentioned indirectly in four other combinations. No other methods gained more than one or two mentions.

Planting native plants (14) was mentioned with related BMPs (8) and for displacing invasive plants (11).

Septic systems (6) were mentioned with preventive measures (5) and repair (1). Connections were made to redirecting runoff away from drainfields (2) and water quality (2), but not to fecal coliform (0).

References to the specific BMP for septic inspections (2). References to the **reason for inspections** (7).

Implementation of recommendations (10) was expressed with pride and confidence. The connection to water quality (2), fecal coliform (0)

Not implementing recommendations (2) was expressed with willingness but inability. Mentioning the specific related BMPs (0). **Lack of understanding the goal of the recommendation (12).**

Barriers to implementation were physical limitations (9) and need for information/assistance (6). Secondary barriers were cost (4), time (4), and resistance to change (4).

Follow-up was a common and important request throughout the survey. Help needed to implement recommendations were for information and education (6), follow-up (4), and money (4).

Specific help the landowner remembered receiving during the site visit to implement recommendations: Information (8), technical assistance (3) and access to low cost plants (3).

No specific help received (5). Specific references to BMPs regarding help received: septic system (2), plants to absorb and filter (4).

Native plants (16) was the only incentive chosen. No one chose the pooper scooper, but two were given to landowners for a Homeowner's Association and a community beach. No one needed the tarp to cover manure.

Plants were planted (18), but some died (2). Plants died before planting (1).

Native plants were good incentives (8).

Also a good incentive: Funding for assistance (3) with planting (1), in general (1), and with septics (1) "but it probably wouldn't be worth it since it is so expensive".

Suggestions for increasing interest or implementation in the future:

- Useless if no follow-up or completion.
- People are motivated more by wanting to improve their properties rather than water quality.
- Timing is difficult with people at work on weekdays.
- Septic coupons or discounts (2).
- Letter followed by a phone call – "people don't want anyone on their property".
- Advertising or advice on social media, flyer in paper to raise awareness.
- Stenciling street drains "as reminder that stormwater can carry contaminants to marine water".
- Add a "blurb" about how upland properties and marine waters are connected, and how "uplanders" can help.
- Participation is discouraged when some get away with something while others are being conscientious – it's alienating. Need to enforce environmental laws evenly to gain confidence of people.

- Focus on invasive plants: solutions for maintaining and potentially beautifying stormwater ditches.
- Educational materials about native plants.
- Examples of neighbors' successes is encouraging.
- Community "connectors" (such as Alderbrook) could provide meeting place or incentive.
- Use KMAS radio/website to get information out.

Recommendations

The following recommendations are provided for follow-up or future work.

- **Allow preparation time** for assembling resource materials. Site visits that occur at the time of door knocking are effective in gaining the interest of landowners, however returning to the site for follow-up with more specific information is most effective.

- **Help with planting is needed.** Many site visit recipients cannot physically implement the recommendations for buffer planting. Money is an issue for hiring professionals. A strategy could be developed with other organizations that provide service within the education system such as Americorps or high school students who are required to do community service. Including follow-up and timing elements in the strategy will most efficiently utilize manpower and establish plantings. There is also the additional educational opportunity to the service provider in implementing the recommended BMPs.

- **On-going Follow-up is critical.** Develop a mechanism or protocol for follow-up to support landowners with tools and information, as well as technical assistance. Without on-going outreach and designated staff, landowners become discouraged and are less likely to complete a recommended practice. Audience research found that landowners requested information and continuing education. It is recommended that follow-up include an additional site visit.

- **Develop a strategy and materials for upland landowners.** Provide educational materials to educate landowners on tributaries or those who live in the uplands. A common theme for landowners is that distance means they have no impact. Include conveyances such as ditches in this education. Create a resource sheet with services available that can be edited to pertain to an individual landowner's property.

- **Post visit follow-up is valuable to develop an ongoing relationship with the owner or resident**. After the visit, staff obtained email addresses and sent a written summary of recommendations, researched information that they were unable to provide on the spot, and provided contacts and links for more information and support.

- **Provide a role for the Conservation District**, either within a separate grant that allows follow-up or within the Outreach and Education grant:

    - The project's field work should begin sooner (April or May) to allow scheduling site visits and follow-up throughout the summer. Provide time and budget for continuing follow-up by WSU Extension and the Conservation District.

- Some drainage issues were too complex for the scope of this project, and were referred to the Conservation District. Future outreach and education projects in these areas should work with local stormwater agencies to develop a strong stormwater component.
- Conduct site visits in pairs. The most effective use of time in the site visit, and which generated the most positive responses, was having two Clean Water Advisors conduct the site visit, preferably WSU Extension and Conservation District staff. This provided expertise as well as backup if other field staff are unavailable, and may reduce the need for follow-up. During these site visits, one representative from WSU Extension and another from the Conservation District felt strongly that sessions would not have been as successful had they gone out by themselves. Property owners benefitted from the range of expertise, from septic system maintenance to planting. Several who went out alone said it was hard to represent the interests of another agency and felt that property owners received "half of what they needed."

– **Promote the Conservation District's plant sale**. Be sure to recommend the Conservation District's Native Plant Sale. Acquire the schedule and plant options early so education around appropriate plants can be provided for the specific site. This sale increases the opportunity for landowners to obtain a larger quantity of plants at an affordable price. Additionally, plants are picked up in late winter, which is a good time to get new plants successfully established.

– **Review lessons learned**. Several of the "lessons learned" found in the 2015 Focused Watershed Outreach and Model Stewardship Final Report are directly applicable to providing site visits to landowners. Key highlights include:

  - For this type of outreach, mailing did not seem to be an effective way to garner interest in the program even when multiple contacts by mail were attempted. The number of site visits derived from door knocking provided a significantly improved response rate compared to the mailings, however, some staff observed that visits that occurred spontaneously were less successful than the visits that were scheduled in advance due to lack of ability to prepare for the individual site.

  - The initial mailing using a standard letter format with WSU Extension heading and return address was more effective than either of the two subsequent postcard mailings. However, the larger educational mailing packet and envelope seemed to garner greater notice than the standard letter envelope the initial mailing used. Multiple mailings increased landowner participation in site visits.

  - People were most enthusiastic when they had a problem and perceived that you could help them solve it. Choose a BMP that you can help people enact and install. Some BMPs are expensive (e.g. installing manure compost bins) while others, like ivy pulling, are hard for some property owners to do themselves. A project of this nature should include follow-up assistance to help property owners act on the outreach provided. Consider developing a volunteer component for follow-up maintenance like weeding or summer-watering until plants are established.

  - Strategies are important in steering the conversation to the target BMPs. Property owners signed up for a variety of reasons, often not related to the target BMPs, so staff developed a

variety of ways to steer the conversation toward the target BMPs. These included making observations while touring the property, looking for clues about property owner interests and making the connection to best practices, and sharing personal stories that put them on the same level with property owners.

- Provide a combination of educational materials including single topic fact sheets and longer booklets. While the booklets were too long for people to read on the spot, they were well received and several staff used them at the end of each site visit to point to the pages that related to their recommendations.

Appendix 1: Interview Questions

2016 HCPIC Outreach and Education

Site Visit Follow-Up Survey of 2015 Site Visit Recipients

- Interviews will be conducted with the 24 homeowners that participated in a site visit during the Model Stewardship grant work in Hood Canal 6.
- Interviews will be done by phone, but we may return to the site to offer more assistance if requested.

1. Date of original site visit (from our records)

2. What is your preferred method of contact to offer a site visit?
    a. Letter in mail
    b. Door knocking
    c. Other?

3. What actions/changes were recommended to you for your property? (Potential here to compare what they remember with what we recorded.)

4. Have you been able to implement any of the recommended changes on your property?

5. What barriers have prevented implementation of the recommended changes?

6. What would help you implement those changes now or in the future?

7. Was there any specific help you received that was necessary to implement the changes?

8. What incentive did you receive for the site visit?

9. Have you used your incentive?

10. Do you have recommendations for other types of incentives that could be offered in the future?

11. Do you need additional help to implement the recommendations?

12. We plan to do some more outreach in this area, do you have any suggestions on how we can best gain the interest some of your neighbors.

Appendix 2: Grouped Interview Responses

1. **Date and time of original site visit?**

   Between March and June, inclusive. Mondays through Fridays, usually between 10am and 4pm.

2. **What is your preferred method of contact to offer a site visit?**

   (8) Letter in mail
   (1) Door knocking
   Other:
   (1) Email preferred but otherwise Letter
   (1) Phone call
   (1) Letter followed by phone call
   (2) Letter followed by email
   (2) None - one respondent had a negative response and one felt he didn't have an impact

3. **What actions/changes were recommended to you for your property?**
   (Potential here to compare what they remember with what we recorded)

   (14) References to planting native plants.
   Related BMPs mentioned
   (4) To absorb and direct runoff (prevent erosion)
   (1) To filter runoff
   (2) To direct runoff away from septic system
   (1) To help riparian area below
   (11) Remove invasive plants and replace with native plants

   (6) References to septic system.
   Related BMPs mentioned
   (2) Avoid impacts (runoff, drainfield area, tree roots)
   (2) Maintenance
   (0) Pumping
   (1) Inspection
   (1) Repair (add risers)

   References to other recommendations:
   (2) Redirect surface water runoff
   (1) Each: yard waste disposal, bulkhead softening, bulkhead planting to absorb water, bulkhead repair

   Connections made to
   (2) Water quality (to help riparian area, filter runoff)
   (0) Fecal coliform

References to BMPs selected for 2015:

Specific references:	**Reflecting the concept or goal:**
(2) Inspect septic system and repair when needed	(7)
(0) Pick up, bag and dispose of dog waste in garbage	(0)
(6) Install vegetation to absorb and filter water	(14) planting/native plants

4. **Have you been able to implement any of the recommended changes on your property?**
   (10)Yes (expressed pride and confidence)
   (2) No (expressed willingness but inability)
   (6) Some - overlaps with "yes" and "no" ("yes but", or "no but")

   Connections made to:
   (2) water quality
   (0) fecal coliform

   References to BMPs selected for 2015:

Specific references:	**Reflecting the concept or goal:**
(0) Inspect septic system and repair when needed	(2)
(0) Pick up, bag and dispose of dog waste in garbage	(0)
(0) Install vegetation to absorb and filter water	(12) planting/native plants

5. **What barriers have prevented implementation of the recommended changes?**
   (4) Cost
   (4) Time
   (9) Physical limitations
   (6) Information needed
   (4) Resistance (likes the look of the invasive plants, limited options for dumping yard waste)
   (3) None

6. **What would help you implement those changes now or in the future?**
   (4) Money
   (2) Physical help
   (6) Information, Education
   (3) Nothing
   (4) Follow-up

7. **Was there any specific help you received that was necessary to implement the changes?**
   (6) No
   (5) Yes
      (3) Access to low cost plants
      (1) WSU weed removal
      (8) Information
      (3) Technical assistance

References to BMPs selected for 2015:
(2) Onsite Sewage System
(0) Pet waste
(4) Plants to absorb and filter

8. **What incentive did you receive for the site visit?**
   (16) Native plants
   (0) Pooper Scoopers
   (0) Tarps for Manure (there were no livestock properties in the Mason County target areas)

9. **Have you used your incentive?**
   (18) Yes
      (15) Planted
      (2) Planted but died
   (1) No
      (1) Died before it was planted

10. **Do you have recommendations for other types of incentives that could be offered in the future?**
   (8) No – satisfied with plants
   (2) Doesn't care, can't think of anything else
   (6) Suggestions
      (3) Funding for assistance
         (1) Septic – "would have to be worth it"
         (1) Planting
         (1) General
      (1) WSU Extension class
      (1) Follow-up visit (to advise, answer questions)
      (1) Mason Bee houses

11. **Do you need additional help to implement the recommendations?**
   (8) No
   (8) Yes
      (5) Information/Follow-up visit
      (3) Help planting
      (1) Funding for assistance

12. **We plan to do some more outreach in this area, do you have any suggestions on how we can best gain the interest some of your neighbors.**
   (Responses recorded as they were spoken)

   S1 Thinks it's useless and a waste of time if not followed with action or project completed
   S2 Not really. "You all" already met with a few neighbors so feel WSU/CD did do what "you" could; Not sure that Water Quality is what motivated people. It was motivating to them because Mr.

Anderson worked in Water Quality; She felt that people were motivated because they want to improve their properties in a natural way.

S3 No - timing is difficult with people at work, not very approachable - esp. weekdays

S4 septic coupons or discounts

S5 No - just the septic coupon/discount

S6 not really. People don't really want to have anyone on their property. Probably a letter is best then follow-up with a phone call

S7 advertising or advice on social media. Maybe a promotional flyer in the paper to raise awareness like that done by the Journal (a bright orange flyer was in paper with a one-day offer for several free issues)

S8 A very good reminder to people is the stenciling of street drains and culverts (esp. the ones that fish use) to remind them that stormwater can carry contaminants to marine shoreline

S9 none relating to WSU project (suggested mandatory impromptu OSS inspections)

S10 Asked a neighbor if they'd received the letter. The neighbor said yes, but since they live far uphill, it didn't apply. Mrs. Parks thought that adding a little blurb about how upland and marine waters are connected, or how uplanders can help, would be helpful

S11 Need the confidence of the people by enforcing the environmental laws - when people see that some can get away with something and others won't because they are being conscientious, it alienates and discourages them from participating

S12 Flyer in people's mailbox to let them know about the benefits of the site visit and access to native plants.

S13 Invasives may be more of an issue to focus on, a solution for how to maintain & potentially beautify the stormwater ditches; neighbors were encouraged when they saw the property owner making such progress on knotweed removal; sludge dumping on web hill is a huge problem for local residents and conflicts with the water quality messages (60 trucks per day at one point) especially irking because of the enforcement on residents to protect water quality and septic maintenance

S14 Word of mouth is a good way to get other property owners to get involved; educational materials were a great help; getting native plants after getting the educational material about native plants

S15 An into letter - does not remember receiving a letter in Seattle at home address; the offer of an incentive for a site visit is good.

S16 The Alderbrook Resort is a kind of community connector since Union does not have a community meeting place for info & meetings; perhaps some kind of incentive from them - to provide a meeting place or access to an event (e.g. they have auctions); could possibly hold a meeting there to introduce info to community (of project site visits); KMAS does a lot of info distribution so would be a good way to get the info out

Hood Canal Coordinating Council

Hood Canal Regional Pollution Identification and Correction Program

Phase II Outreach and Education: Audience Research Report

March 2017

Authors and Contact Information

Bob Simmons, simmons@wsu.edu
WSU Jefferson County Extension
380 Jefferson St.
Port Townsend, WA 98368
(360) 379-5610

Darcy McNamara, WSU Extension
Erica Bates, WA Dept. of Ecology (formerly with WSU Extension)
Wendy Mathews, Active Consulting

Research conducted and report written by: Washington State University Extension

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This report and the final project report will be available on the Hood Canal Coordinating Council website.

Executive Summary

Audience research was conducted to better understand how to effectively reach landowners in the Hoodsport and Union areas of Hood Canal prior to conducting outreach efforts. A total of 15 people participated in the audience research, including five from Hoodsport and 10 from Union. Interviews were conducted primarily by phone.

Findings show that most people are interested in having a site visit to their property to assess potential pollution sources and solutions, once they understood what a site visit entailed. Most people were concerned about runoff issues and some wanted information on buffers and planting. Those who indicated that they did not want a site visit felt that it was not needed in their situation. Scheduling seemed to be a concern amongst landowners.

Most participants said they had heard of fecal coliform pollution in Hood Canal, and all but one had heard some recommendations about what homeowners could do to help improve water quality. Most participants knew that septic system maintenance was a key recommendation and many had also heard about the need to pick up pet waste and dispose of it properly. Participants felt most motivated to have a site assessment due to concerns about potential detrimental health effects and water quality.

Participants wanted to ensure that the site visits would be conducted by qualified individuals and that regulatory agencies would not receive the findings. Washington State University Mason County Extension was identified as the most trusted, with the Mason Conservation District as second. Several comments were made that they would not want regulatory agencies to provide a site visit.

The most popular incentives for participating in a site visit were a $200 rebate for having a septic system professionally inspected and maintained and a selection of free native plants appropriate for the Hood Canal region. Participants felt that letters or phone calls to homeowners would be the most conducive way to reach people. The least popular methods were by door hanger and door knocking.

Keys recommendations for future outreach include using a variety of methods including letters and post cards that provide links to in-depth information and invite people to call for a site visit, followed by door knocking as needed. Focusing on helping a landowner solve *their* issue is key, thus, asking people up front if they have any specific concerns will aid this. Site visits need to be confidential, voluntary, educational, and free of regulatory consequences, offering new information such as how to solve issues of stormwater runoff on their property and improve water quality at the same time.

Scheduling the site visit must be made easy. The value of incentives should be balanced; high enough to be motivating, but not a waste of tax dollars. When discussing BMPs: septic system maintenance was a more approachable subject when put in terms of property value and health. Discussions about pet waste are aided when pet owners are given credit for knowing what the BMP is, and keeping the mood light.

More work is needed to develop improved messaging about impacts to water quality for non-shoreline landowners, part-time residents, those with on-site sewage systems (OSS) far from water, smaller dogs, and run off.

Background

One of the early steps of the Hood Canal Regional Pollution Identification and Correction (HCRPIC) Outreach and Education Project was to conduct audience research to help design an outreach plan and strategies. This Outreach and Education Project builds off of work done in 2015 by Washington State University Extension and the Washington State Conservation Commission (Joy et. al., 2015). Although audience research was conducted as a part of the 2015 project, it was only conducted in the project areas in Kitsap and Jefferson counties. Therefore, audience research was conducted as a part of the current project with residents in Union and Hoodsport.

Methodology

Participants for the 2016 audience research project were recruited through a targeted mailing to more than 300 property owners in Hoodsport and Union. These property owners were a subset of the group identified for contact in the 2015 project (Joy et. al., 2015) who had not responded to previous attempts via direct mailing or door knocking, and who had not had a site visit. All participants in the interview were offered a $10 gift certificate to a local business, either the Hoodsport Coffee Company or the Union Country Store.

The original goal was to have 10 property owners participate in an interview. We anticipated a challenge to meet our goal since the people contacted were non-respondents from the 2015 project (Joy et. al., 2015). However, we exceeded our goal, receiving 29 responses, and had to limit participation to fifteen property owners to stay within this project's budget. To randomize the selection of participants, each step to schedule and conduct an interview was recorded in the order in which contact was made: responses to the letter, calls to schedule, responses to calls, successful interviews. After the first 10 interviews, respondents were informed that no more gift certificates were available. After the 15 interviews were conducted, most of the remaining 14 were informed that the interviews had concluded.

In-depth telephone interviews were conducted with 15 people who own property within 250 feet of the marine shoreline or its upland tributaries. Participants were asked a series of open-ended questions. During the call, they were also sent an email with various program ideas and options to which they were asked to react and rank in order of preference. Three people were willing to give their email addresses for this purpose; the rest preferred to listen while the interviewer read the information. The interview script was adapted from the script developed and used during the 2015 project, by Heidi Keller Consulting (Joy et. al., 2015).

Findings and Analysis

A total of fifteen people participated in the audience research including five from Hoodsport and 10 from Union. Interviews were conducted by phone, with one conducted in person. The interview solicitation letter and script for the interviews are found in Appendices 1 and 2. Responses are grouped by topic as follows.

Interest in a site visit: Learning more about what a site visit involved convinced 50% of the audience who identified as "Somewhat Likely" to participate, to change their minds to "Very Likely".

Of the 15 participants, eight identified as “Somewhat Likely” to be interested in a site visit when asked early on in the interview. After learning more about the site visits and the concerns to be addressed, four who were “Somewhat Likely” changed their minds to be “Very Likely” to participate. Those who identified as “Very Likely” (4) and “Not at all Likely” (3) remained unchanged.

Influences on participation: Concerns about runoff had the greatest influence on participation. Words and subjects that influenced the likelihood of participating in a site visit primarily regarded “runoff” (8); “buffers” (3) and “plantings” (3) were associated with runoff. Other words specifically mentioned were “scheduling” (2) and “confidential" (2).

Reasons for not participating: The most cited reason for not participating in a site visit was that they felt it was not needed. Six of the seven participants who continued to be hesitant or were “Not Likely” said the site visit was “not needed” and would be a waste of time. Properties were assumed to have no issues or their conditions would have minor or no impact if:

- Residency was part-time
- Property was upland
- On-site Sewage Systems (OSS) were maintained or “far” from the Hood Canal
- Dogs were small or upland
- Runoff appeared to travel within a ditch or other conveyance

The most-cited concern about agreeing to a site visit was scheduling. There were nine part-time residents and five full time residents on Hood Canal in the survey. One participant had been both part-time and full- time for more than 20 years. While four of the participants suggested that timing was a factor (ability to make an appointment (2) and the amount of time it would take (2)), only two of the four were part- time residents.

Some respondents were willing to have a site visit but would like more details, such as how to prepare for a site visit, what types of things the Clean Water Advisor would look for, and examples of recommendations that might be made. One asked about the availability of OSS records.

Awareness of fecal coliform pollution in Hood Canal: When asked without cues, all of the participants said they’d heard of fecal coliform pollution in Hood Canal and all but one had heard some recommendations about what homeowners could do to help improve water quality.

Recognition of Best Management Practices (BMPs): After reading or listening to a water quality status summary for Hood Canal, and the specific recommendations to homeowners, all said they had previously heard the recommendations from other sources. Five respondents simply said “yes,” they had heard of them and 10 voluntarily mentioned specific recommendations. Of those, the most common response was related to maintaining septic systems (9), followed by picking up pet waste (4), and managing runoff (4).

Sources of information: Where people got their information was varied and came from many sources including:

- PUD/water district (5)
- Unknown (4)
- Shellfish company (3)
- Newspaper (3)

- Neighbors (3)
- TV, if shellfish harvesting conditions were dangerous (2)

Organizations mentioned: Those organization mentioned without prompting were Mason County Public Health, Kitsap, "DOH", Hood Canal Coordinating Council, WSU, and WRIA; also mentioned were Do Some Good for the Hood (an earlier educational campaign) and Gold Coast Shellfish Co. websites, homeowner associations, event booths and pamphlets.

Reaction to pet waste recommendation: In response to the recommendation that pet owners pick up dog waste and dispose of it in the garbage, the majority of participants (13) agreed that it was an important recommendation and expect pet owners to do so. One said "I don't know," one found it hard to believe that pet waste is really an issue, and one didn't think it was an issue with a small dog more than 100 feet from surface water.

Motivators and barriers for a site visit: Participants were provided with a list of potential reasons to agree to a site visit including economic reasons, health reasons, concerns about nearby waters, and receiving free, confidential, and site-specific recommendations. Many of the participants were happy with all of the statements, while some highlighted a few that were particularly motivating:

- Public health (7)
- Concerns about water quality (5)
- Free site-specific and confidential recommendations (2)
- Economic reasons (2)

Participants were also asked if any of the statements were more of a deterrent to participating in a site visit. While none of the statements were considered a deterrent, statements regarding site visits raised most of the interviewees' questions. Their concerns included: who would conduct the site visits, whether or not they're qualified and knowledgeable, and who would receive the findings (i.e. regulators).

The most motivating reasons for a site visit were concerns about water quality (5 "most" to 1 "least"), and health (7 "most" to 4 "least"). Economic reasons and receiving site-specific recommendations were both balanced between "most" and "least" motivating (2 "most" to 3 "least"). One person was not motivated by any statements related to pet waste because the feeling was that people already pick up the waste, and one felt that pets were getting the "brunt of the questions." Two participants were concerned about how much money was being spent on the project and were not comfortable with the use of grants or tax money for this type of project.

Interviewees were asked which specific words had the greatest impact on their responses. Only three of the participants slightly objected to the words: "site visit", "pet waste", and "financial incentive". "Confidential" was the most impactful word during the survey and was mentioned by five respondents in response to this question. Other words liked by individuals included "customized", "site-specific", "clean", "fecal matter", "poop", and "health". One participant suggested the use of more positive words and statements would have a greater impact, such as "working together", and highlighting the successes of "neighbors" in the community.

Common themes included:

- The impact of a septic system's condition on the property's market value was more motivating than its effect on ongoing personal finances, the local economy or best practices for water quality.
- Some found confidential recommendations to be most important in case a problem was discovered.
- Health reasons would be especially important in an area where residents like to eat the local shellfish. Personal health experiences as well as complaints were expressed during the survey, primarily regarding illness from eating contaminated shellfish, and that some in the community were able to continue practices "known" to pollute.
- Large-scale sewage disposal, livestock operations, and failing septic systems were concerns.

Trusted organizations: Participants were asked if they had suggestions for organizations they would trust to conduct a site visit on their properties. The nine suggestions favored educational organizations over regulatory entities. Participants were then offered a list of eight organizations from which to choose one or more as most likely to be welcomed onto their properties to provide site visits and consultation. Washington State University Mason County Extension (8) and WSU Shore Stewards (8) were identified as the most trusted. Although not all the participants were familiar with the Mason Conservation District, it was the 2nd most popular option (4). Other organizations selected from the list were Tribes (3) and septic professionals (2). Three respondents said they would allow any organization on the list to conduct a site visit.

Several comments were made identifying organizations that would not be trusted to provide a site visit: "no government" (i.e. regulatory entities), no Tribes (2) due to their perceived agendas, and no septic professionals (1) due to possible profit motives.

Concerns were also raised about ensuring the person conducting the site visit was qualified and had identification and credentials.

Preferred incentives: Participants were asked to select incentives that would make them more likely or least likely to agree to a site visit. Two of the most popular incentives for participating in a site visit were monetary rebates and coupons for professional septic system inspection and maintenance. These results indicate that financial assistance for OSS maintenance was the most preferred incentive to agree to a site visit. The responses rank as follows:

- $200 rebate for OSS inspection and maintenance (6)
- Selection of free plants native to Hood Canal (6)
- Coupon for a discount on septic inspection and pumping (5)
- Assistance applying for a low interest septic repair loan (5). One participant commented that help applying for a loan wouldn't interest anyone whose septic was working.
- Septic leak - dye testing kit (5)
- Pet waste station (4). One participant commented that a pet waste station might encourage people to walk a beach when they might not otherwise, so it would be best if placed in frequented spots. Similarly, one commented that pet waste stations are good because of all the Hood Canal visitors, and three commented on specific locations where pet waste stations were needed: fire easements, parking lots of popular dog walking beaches, and "uphill locations."

Participants were asked about the incentives that would be of less interest to encourage them to agree to a site visit. The least popular incentive options were all related to pets. The complete list of least popular incentive options are ranked below (**least** popular at top):

- Dog kerchief (6)
- Poop scoop bucket (4)
- Clip on pet waste bag container (4)
- Certification as a Shore Steward, including a Shore Stewards yard sign (4)
- Septic leak testing kit (4)
- Pet waste station (3)
- Dog poop scoop shovel (3)
- Selection of Hood Canal native plants (3)

There were some notable comments of interest to the overall idea of incentives. Five participants said that there were none in which they would be 'uninterested'. Two participants stated that the incentive didn't matter and wouldn't affect their decision to participate in a site visit. One expressed concern that the incentive not cost too much to provide, and one said that a $200 coupon for inspection and maintenance would be a "drop in the bucket towards the thousands of dollars of bills". One participant observed that she did not know what some of the incentives were, specifically the septic leak testing kit and Shore Stewards. Another suggested that pet waste stations and/or poop scoops might be of use for visitors of home owner or neighborhood associations. Addressing pet waste, one comment was that it "wouldn't make a difference to Hood Canal".

Recommended method of contact: Interviewees were asked about their preferred method of being contacted. The most popular suggestion was to contact local property owners by letter to offer site visits (9). The ranked responses for preferred mode of contact include:

- Letter to offer site visits (9)
- Phone call to offer site visits (7)
- Door hanger (6)
- Door knocking (5); the 2015 project found that door knocking was the most effective method resulting in property owners agreeing to a site visit.
- Postcards (4); according to one respondent, "It wouldn't give enough information" (i.e. not enough detail to convince a homeowner to allow someone to visit the property).

Several suggested email though it was generally understood to be the most difficult to execute. Overall comments regarding preferred method of contact included:

- Part time owners would not be present
- Phone calls are screened
- Mailings are overwhelming

Participant profile: Participants were asked what best described their practices for septic system maintenance and repairs. Of the 15 respondents, 11 had their septic systems inspected in the last three years. Three said that they weren't sure but probably *not* in the last three years. No one said that their septic system had not been inspected in the last 3 years. One declined to answer.

When asked whether they had followed through with making the recommended repairs, 10 said "yes". Two said that no, they had not made all the repairs. One commented that it depended on the recommendation and whether it was really necessary or affordable (there was no further clarification of

the response). Three people said that no repairs were recommended. One participant did not know, and one declined to answer.

The third profile question regarded annual income, according to a range:

- $25,000 to just under $50,000 (3)
- $50,000 to just under $75,000 (1)
- $75,000 to just under $100,000 (2)
- $100,000 or more (4)

Recommendations

Recommendations to achieve the goal of conducting site visits to discuss water quality issues and provide guidance on landscaping choices, septic system maintenance, drainage issues, and mud and waste management in the Hood Canal area include:

Initial contact. This research produced and reinforced a set of basics to apply to outreach, whether by written materials, phone calling or in-person. There is very little time to make the case for a site visit, so saying what is both important and motivating, as well as addressing resistance, is a challenge. Hood Canal populations around Hoodsport and Union have been hearing the messaging for years now. Getting landowner attention with many of these issues is harder, but offering to help a landowner solve *their* issue, is well received. It is recommended to combine outreach tools:

- Use letters and post cards to introduce the idea of a site visit, and the option to call to schedule
- Use the same letters to offer links to more in-depth information that addresses their concerns (such as the http://shorestewards.wsu.edu website)
- Follow with door knocking (even though it was not favored, it was the most cost-efficient and effective method in the 2015 project)

The offer of a site visit needs to be educational in nature and free of regulatory consequences for the landowner. It should focus on what they have not heard much about: how to solve issues of stormwater runoff on their property and improve water quality at the same time.

The following is an example of language to use that meets the initial challenge of engaging the landowner:

Objective	**Example**
Provide a clear and concise introduction	”Hello, I’m *name* with *organization/agency*.”
State the purpose and the reason	”Our goal is to improve water quality and protect public health.”
Focus on key motivational words	“We’re offering free and confidential site-specific recommendations to help landowners solve issues on their property.”
Example of a common concern	”Are you concerned about stormwater runoff?”
Example of solution	“Buffer plantings can filter out contaminants and prevent erosion.”

Incentives: Incentives need to provide high enough value to motivate, yet not be seen as a waste of tax dollars. A $200 rebate was clearly a preferred incentive, however some people felt this to be an excessive use of tax dollars. A low cost option that was well received was a 4-pack of native plants which serves as a nice reward and as an example of a solution to erosion.

Scheduling: Once catching their interest, scheduling must be made easy. The landowners do not want to waste their time – they want to know that they can participate when it's convenient, that it won't take too long, and that they will hear sound advice. There must be ready information and ready resources. There is a strong advantage to being ready with answers, but if an issue is identified that requires more expertise, then providing resources that can help is just as important to credibility.

Messaging: Most people in this audience had heard about the connection of septic systems and pet waste to water quality and health, but seemed less aware of what else homeowners could do to help. Reinforcing the need for septic system maintenance and pet waste management along with specific information on what they should be doing, along with additional information on other BMPs is our recommended strategy.

Septic system maintenance (inspection) was a more approachable subject when seen in terms of property value. Whether to prevent having an expensive fix or to increase the home selling price, protecting an investment is a good way to open the subject.

Pet waste discussions are sensitive and can be easier if the landowner is given credit for knowing what is supposed to be done. Only a few in the audience felt that pet waste was not likely to impact water quality. A lighter approach, using words such as "poop" and tying the family's health to what comes in on Spot's feet.

Specific outreach message improvements needed for landowners who do not recognize their impact. Property owners generally assumed they would have minor or no impact if their:

- Residency was part-time
- Property was upland
- On-site sewage systems (OSS) were maintained or "far" from the canal
- Dogs were small or upland
- Runoff appeared to travel within a ditch or other conveyance

References

Joy, Shana, R. Simmons & M. Brincka. (2015). *Focused Watershed Outreach and Shore Stewards - Joint Final Report*. 45 pp. Puget Sound Partnership. Tacoma, WA.

Appendix #1: Interview Solicitation Letter

WASHINGTON STATE UNIVERSITY EXTENSION

May 2016

To: Owners of property on or near Hood Canal, local streams, and surrounding watersheds

From: Robert Simmons, Olympic Region Water Resources Specialist
Washington State University Extension

Subject: Sign up for homeowner interviews

I am writing to ask you to participate in a 25-minute, confidential phone interview about your property on or near the waters of Hood Canal and nearby watersheds. You will receive a $10 gift certificate to a local business for your time.

Washington State University Extension is working with a coalition of local organizations to improve water quality and stormwater management in your area. We want to hear your thoughts, ideas, and opinions on landscaping, septic system maintenance, drainage, and mud/waste management.

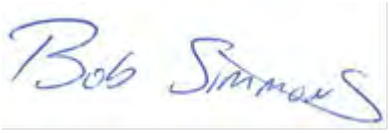
Your opinions are very important to us. To schedule an interview please call or email our contractor:

Wendy Mathews
wendy.odm@gmail.com
360-463-6966

Your comments will be confidential and your name will never appear in documents related to this project or any other.

Hood Canal waters are a precious resource and are important to the economy, recreation, and culture of our communities. By signing up for a telephone interview you can help us to make our outreach and education programs meet the specific needs of your community.

Sincerely,



Bob Simmons
Olympic Region Water Resources Specialist

Appendix #2: Interview Instrument

Hood Canal Pollution Identification and Correction
Outreach and Education Project 2016
WSU Mason County Extension

Audience Research Property Owner Questionnaire

KEY FOR DATA ENTRY
In this document, choices of responses are numbered and letters highlighted for ease of data entry into the spreadsheet only. They were not conveyed to the participant.

Property Owner Audience Research Guide

Introduction:

Thank you for making time to talk with me today. I want to start by assuring you that everything you say will be confidential. I am taking notes, but your name will not appear in any reports and nothing you say can be identified with you.

PURPOSE: WSU Extension and their local partners want to improve their outreach and education services to homeowners in your area. They want to make sure that you have the information and support you need to manage your storm water, septic system, landscaping, and waste and mud management issues. The purpose of these interviews is to make sure that their services are helpful and something that people like you want and need. Your candid and honest answers are very important. Again, this conversation is strictly confidential and your individual responses will never be shared with any regulatory agency.

This interview should take about 25 minutes.

First, I'd like to know more specifically where you live (for out of area property owners: the location of your property) and how long you have lived there (owned this property).

(Prompts) Do you have a specific name you call this area?

Do you have a dog?

IF YES: Which of the following best describes you- you pick up your dog's waste and put it in the garbage…..

Every time

Most of the time

Some of the time

I don't pick up my dog's waste and put it in the garbage

Do you have any livestock on your property?

IF NEEDED: This would include farm type animals such as horses, goats, chickens, and llamas, etc. but not companion pets such as dogs or cats.

How many?

As mentioned in the letter, WSU Extension and their local partners in Mason County provide advice to homeowners on septic system, landscaping, and stormwater issues.

First let me ask if you have specific questions along those lines.

One of the things that WSU Extension and their local partners are working on is preventing household waste from draining into area lakes, streams, and bays. They would like to meet with homeowners like you and provide recommendations specific to your property.

How likely would you be to agree to have a clean water advisor visit your property and work with you on a customized drainage plan?

Very likely (If yes, ask if they have any questions)

Somewhat likely

Prompt: What concerns/questions do you have? What would you need to know before agreeing to this?

Not at all

Prompt: What concerns do you have?

Section 1: Unaided awareness of facts and recommendations

One of the reasons we are reaching out to you is that high levels of fecal coliform have caused closures and restrictions on shellfish harvesting in some areas of Hood Canal. Your property is within what is called the Hood Canal 6 shellfish growing area. The area adjacent to the Hoodsport shoreline is prohibited for shellfish harvest. A new area of restricted commercial shellfish is near Big Bend Creek and the Alderbrook Resort dock. This is a conditionally approved area with the area near the Alderbrook dock closed May 1st- September 30th. The Big Bend Creek area is closed based on rainfall if there is 0.75 inches of rain or greater within 24 hours.

IF NEEDED: Define fecal coliform pollution:

Fecal coliform is a bacteria found in human and animal waste. When it is found in water it shows that the water is contaminated with fecal matter. Contaminated water can cause diseases such as gastroenteritis, ear infections, typhoid, dysentery, and hepatitis A. When fecal pollution levels reach a certain point, shellfish areas are downgraded or closed.

Have you heard anything about fecal pollution in Hood Canal?

Have you heard any recommendations about what homeowners can do to prevent fecal pollution?

I'd like to take a minute to review some facts about water quality in Hood Canal and area lakes and streams. I'd like you to open the email that I just sent you and read along with me.

Email Section 1: Water Quality Problems in Hood Canal

Fecal coliform levels in Hood Canal have fluctuated in recent years. Hood Canal is fragile and susceptible to pollution. Recently, some drainages have shown elevated levels of fecal coliform. Fecal coliform levels occasionally exceed the levels required for harvest and human consumption of shellfish, and have resulted in closures and restrictions to recreational and commercial shellfish gathering.

Through studies and analysis it has been found that sources of fecal coliform in Hood Canal include:

- Human waste coming from broken septic systems, and
- Domestic animals, primarily dogs and livestock

There are a number of ways that property owners can prevent human and domestic animal waste from entering nearby waters, including:

1. Have your septic system professionally inspected at least every 3 years, and make repairs as needed
2. Pick up, bag, and dispose of dog waste in the garbage
3. Dispose of cat waste in the garbage
4. Manage water runoff and wet areas
5. Install plantings to absorb and filter water

Have you heard any of this before? Where have you heard this?

Do you have any questions, or is any of this unclear?

How about the recommendation regarding dog poop? What is your reaction to that recommendation?

Section 2: Site Visits

Washington State University Extension wants to work with homeowners to identify and fix sources of fecal pollution. They would like to conduct site visits with homeowners that live within 250' of marine shorelines and freshwater tributaries. While on site they would identify sources of fecal pollution and provide a customized plan to help prevent water pollution.

I'd like you to look at Section 2 in that email I sent you. Some of the recommendations could include:

Email Section 2: Potential Site-Specific Recommendations

- The proper collection and disposal of pet and livestock waste
- Drainage plans

- Recommended plantings for buffer zones along your property and the shoreline
- Recommendations regarding septic maintenance, including do-it-yourself maintenance and the availability of low interest loans for septic repair or replacement. And how to get the most life from your septic system investment.

IF THEY WERE HESITANT EARLIER: You mentioned earlier that you were hesitant to have someone visit your property. Now that you know more about what a site visit would involve, does that influence you?

Are there particular words or messages that do/would help change your mind?

(Prompt) What piques your interest? Makes you more likely to participate?

Still hesitant or unlikely:

I'd like to hear why.

Want more information

(Prompt) What questions do you have? Things you would need to know before agreeing to a site visit?

Section 3: Motivators

Now I want you to look at that area in my email that is labeled Section 3. This information about fecal pollution is meant to give you and your neighbors some reasons why you would want to have a free site visit from a clean water advisor. Take a few minutes to read through this and I want you to identify the section that most motivates you to have a site visit. And while you're at it, identify the section that you find the least motivating- things that just don't appeal to you or maybe even rub you the wrong way.

I'll give you a few minutes to read through these and you tell me when you're done.

Email Section 3. What is the best reason for having a site visit?

1. **Economic reasons**
   1. If my septic system fails it will lower the value of my property and can prevent the sale of my home if I ever decide to sell.
   2. Regular septic maintenance extends the life of the system and saves money in the long run by avoiding more costly repairs.
   3. Our local economy will suffer and jobs that depend on shellfish harvesting and water recreation will be lost if the waters are too polluted.
   4. Learning about financial incentives to help me implement recommended practices on my property.

2. **Health reasons**
   1. If my septic system fails it can make my family, pets, and even my neighbors sick.
   2. Pet waste bacteria and parasites survive for long periods of time. When people walk across my yard they bring bacteria from pet waste into my house.
   3. Bacteria from pet waste can make me and my family sick.

3. **Concerns about nearby waters**
    1 Local bays could be closed to collecting shellfish, swimming and other water sports if pollution here worsens.
    2 Dog poop left in the yard and along roads and paths flows directly into local streams and bays.
    3 Detectable levels of animal waste have been measured in Hood Canal area waters.
    4 Fecal pollution has resulted in closures and restrictions to recreational and commercial shellfish gathering in Hood Canal.
    5 I want to do my part to improve and protect Hood Canal area waters.

4. **Getting free, confidential, site-specific recommendations**
    1 A site visit will result in recommendations that will be customized specifically to my property.
    2 Recommendations from the site visit will be strictly confidential, and will not be shared with any outside people or agencies.
    3 Education and recommendations for things like stormwater runoff, waste management, and planting for buffer zones.

Let's start with the section that you found most motivating.

> Prompt: Are there any words or statements that you particularly liked? That really grabbed you?

Okay, how about the section or statements that you found least motivating – that just don't grab you or even rub you the wrong way.

> Prompt: Are there certain words that stand out? If it were worded differently would that make a difference?

Section 4: Incentives

We know that your time is valuable and it's hard to squeeze in more appointments, so the sponsors are considering offering some incentives – things that would encourage people to agree to a site visit.

Look now at Section 4, titled "Incentives." These are things that they are considering offering to homeowners, and I want to find out which of these would make you more likely to agree to have a visit.

Go ahead and mark those that you like the best – things that would make you want to schedule a visit. Then I want you to tell me the ones that you just would not be interested in.

Email Section 4: Incentives for having a site visit

1 Coupon for a discount on septic inspection and pumping
2 Help applying for low interest septic repair or replacement loans
3 Tank risers installed that make it easier to inspect your septic system
4 Kit for testing for septic leaks
5 Up to $200 rebate for having your septic system professionally inspected and maintained

6 Green Cleaning Kit- items that help extend the life of your septic system, such as Zip-it drain cleaners, sink screens that keep food from going down the drain
7 A selection of native plants appropriate for the Hood Canal region
8 Certification as a Shore Steward (includes personalized assistance, newsletter, and yard sign)
9 Shovel to scoop dog poop
10 Clip on pet waste bag container
11 Poop scoop bucket
12 Pet waste station bag dispenser installed in my neighborhood
13 Dog kerchief that says "I poop, you pick it up" or "Dogs for clean water", or "My owner picks up after me"

Section 5: Agencies and Spokespeople

Are there organizations that come to mind that you would trust more than others to come onto your property for this purpose?

Take a look at Section 5 in the email. These are some of the groups that are interested in providing site visits and consultation. I'd like you to tell me which of these organizations (*or other if they mentioned any)* you would be most likely to invite onto your property to for a site visit and customized plan.

Email Section 5:
1 WSU County Extension
2 WSU Shore Stewards
3 Mason Conservation District
4 Mason County Public Health
5 State Department of Health
6 State Department of Ecology
7 Local Tribes
8 Septic professionals
9 Other?

Section 6: Communication Methods

This service will only be available to people living within 250 feet of the marine shoreline or the upland tributaries. We want to know the best way to contact people like you to let you know about this program.

Here are some ideas. I'd like to know the one that you like best. (Read aloud)

1 Phone call
2 Postcard
3 Personal letter to my home
4 Knock on my door and discuss it with me
5 Doorknob hanger with program information and contact information
6 Neighborhood or homeowner association

Which do you think is best? Are there any that you don't like?

Do you have any other suggestions?
Any suggestions about specific words or information that should be included?

Participant Profile

Before we end this call, I'd like to ask a few more questions. Again, your answers are voluntary and will be kept strictly confidential.

Which of the following best describes your practices toward septic maintenance…

1 Your septic system has been inspected in the last 3 years
2 Your septic system has not been inspected in the last 3 years, or
3 You are not sure when it was last inspected but probably not in the last 3 years
4 Refused - DO NOT READ

Have you followed through with the recommended repairs based on that inspection?

1 Yes on all recommended repairs
2 No, not on all of the recommended repairs
3 There were no recommendations for repairs
4 Don't know
5 Refused - DO NOT READ

What range best describes your annual income? Would you say...

1 Under $25,000
2 25,000 to just under 50,000
3 50,000 to just under 75,000
4 75,000 to just under 100,000
5 Or 100,000 or more
6 Don't know - DO NOT READ
7 Refused - DO NOT READ

Conclusion

Before we go, are there any other thoughts you have or words of advice for the sponsors?
Thank you.

Hood Canal Coordinating Council

Hood Canal Regional Pollution Identification and Correction Program

Phase II Outreach and Education – 2016 Site Visit Report

March 2017

Authors and Contact Information

Bob Simmons, simmons@wsu.edu
WSU Jefferson County Extension
380 Jefferson St.
Port Townsend, WA 98368
(360) 379-5610

Darcy McNamara, WSU Jefferson County Extension
Erica Bates, WA Dept. of Ecology (formerly with WSU Extension)
Wendy Mathews, Active Consulting

Research conducted and report written by: Washington State University Extension

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This report and the final project report will be available on the Hood Canal Coordinating Council website at www.hccc.wa.gov.

Introduction

This educational outreach project was initiated to work directly with landowners to reduce fecal coliform and associated contaminants in the Hoodsport, Union and Tahuya areas of Hood Canal. The project was part of the overall Hood Canal Regional Pollution Identification and Correction Program (HCRPIC) and built upon work conducted as part of the Focused Watershed Outreach and Model Stewardship Project that was conducted by Washington State University Extension and the Washington State Conservation Commission between 2014 and 2015. HCRPIC coordinators participated in the 2014-2015 project to develop similar social marketing outreach projects and to produce robust results for both projects despite short timelines by utilizing the information developed and lessons learned.

These projects were implemented to promote selected Best Management Practices (BMPs) for improving water quality. The BMPs were:

- Inspect septic systems (as recommended by the appropriate local county agency) and complete repairs as needed
- Pick up, bag, and dispose of dog (and cat) waste in the garbage
- Install vegetation to absorb and filter water
- Collect, contain and cover livestock waste

The 2014-2015 project targeted priority areas within 250 feet of freshwater and marine shorelines in Burley Lagoon, Rocky Bay, Vaughn Bay, Hoodsport and Union. Audience research was conducted to understand target audience barriers, benefits, and motivators for agreeing to a water quality advisor site visit, and to get audience reactions to various ways of describing and communicating about the pilot stewardship project (Simmons, et. al., 2017a).

Throughout 2015, landowners were offered site visits through letters, postcards, an event booth, and door knocking to help solve contaminant and runoff issues on their properties. Site visits were shown to be an effective way of conveying best practices. Success was measured by increased knowledge of the BMPs. Door knocking resulted in more site visits than other means of contact, as reported in the *Focused Watershed Outreach and Shore Stewards Joint Final Report* (Joy, et.al., 2015).

The HCRPIC outreach project builds on earlier work by focusing on landowners in Hoodsport and Union who did not respond to contact methods used in 2015 outreach efforts. In addition, the North Shore area of Tahuya was included. The purpose of this outreach project was to gather audience research information to design and implement effective outreach methods and to encourage adoption of BMPs by landowners in Hoodsport, Union, and the North Shore area of Tahuya. This phase of the project occurred in 2016 and was funded by a grant from the Washington Department of Health through the U.S. Environmental Protection Agency's National Estuary Program.

Background

In an earlier project, WSU Mason County Extension and the Mason Conservation District offered site visits to landowners in the Hood Canal Shellfish Growing Area #6 during the summer of 2015. Within Hood Canal #6, the population centers of Hoodsport and Union were selected, focusing on properties within 250 feet of Hood Canal and its tributaries for outreach. Letters were sent to invite landowners to call and schedule a site visit. Landowners who did not respond to the letters were then approached by door knocking: 371 residences were door knocked from mid-March through June 2015. Of those that

were home at the time, 22% agreed to have a site visit, which represented 35 parcels. Site visits began and ended with a survey to measure the change in landowner knowledge of the BMPs.

At the end of the first phase of the project, phone interviews with 24 of the site visit recipients were conducted to get feedback on their experience. Responses were generally positive and provided a qualitative profile of a successful site visit. Notable lessons included: the length of some site visits were too long, too much information at one time, the most effective site visits were conducted by two staff members – one from WSU Mason County Extension and one from the Mason Conservation District, and the handouts were helpful. Although septic systems were discussed thoroughly, recipients did not remember "fecal coliform," but did have a good grasp of "pollution" sources.

Building on the 2015 project, this outreach approach was planned again for 2016 with the incorporation of lessons learned from the past surveys and staff input, as well as additional audience research. This data was used to improve communication techniques and continue to implement and improve outreach with the landowners that did not respond in 2016.

Methodology

In preparation for outreach efforts in the summer of 2016, WSU Extension carefully reviewed the Focused Watershed Outreach and Model Stewardship Project methodology and results from 2015, as well as conducted two new phone interview surveys to gather feedback from landowners. The first survey solicited feedback from a sample of the landowners who had a site visit in 2015. Sixteen landowners participated in interviews that were designed to gain information about their experiences with their site visit, what they remembered of the BMPs, whether they'd applied what they had learned, and the barriers to implementation. The results of these interviews are reported in the *Hood Canal Regional Pollution Identification and Correction: Outreach and Education Project 2016 – Supplemental Evaluation of 2015 Site Visits* (Simmons, et. al., 2017b). The other survey was conducted with landowners who did not participate in the 2015 project. The survey took place in the Hoodsport and Union target areas to find out how landowners would like to be contacted, their current knowledge of pollutant sources, their sources of information for water quality BMPs, and their likelihood of accepting the offer of a site visit. The findings from these interviews are found in the *Hood Canal Regional Pollution Identification and Correction Audience Research Report* (Simmons, et. al., 2017a).

Combined with lessons learned during the 2015 project reported in *Focused Watershed Outreach and Shore Stewards Joint Final Report* (Joy, et.al., 2015), landowner feedback was taken into consideration when planning and implementing 2016 outreach efforts. Although both surveys found that door knocking was not favored as a method of contact, results from 2015 showed it to be the most successful method when compared to survey favorites: letters, phone calls and post cards. Native plants were again selected to offer as incentives to participate in the site visits based on staff's 2015 experience and feedback from site visit recipients.

Aside from monetary and physical assistance, site visit recipients said that more information and follow-up would help them implement the recommended BMPs.

The 2015 outreach materials were also reviewed and adaptations were made based on audience research. This included a more comprehensive written summary of recommendations to leave with the landowner that included a resource list for each recommendation with the website and phone numbers of relevant supporting technical assistance organizations (See example in Appendix 1).

A newsletter for Hoodsport was created (Appendix 2), and a "Sorry we missed you" card (Appendix 3) for Union and North Shore. These communication materials were designed to be left at residences where no one answered the door, or to be left for the landowner if they were not present (if a renter or visitor answered the door). The newsletter contained an update on Hoodsport water quality conditions; and both the newsletter and the postcard gave a brief description of the outreach project and contact information to request a site visit.

The landowners selected to receive door knocking were those in Hoodsport and Union who did not respond to any contact methods used in 2015 outreach. In addition, the North Shore area of Tahuya was targeted for door knocking. The Hoodsport and Union areas included both shoreline and upland properties on or within 250 feet of Hood Canal shorelines or its tributaries. Only North Shore properties on the shoreline of Hood Canal were included, primarily due to the topography of the area.

After filtering out non-residential and undeveloped properties using the Mason County Assessor's on-line database, 464 addresses were identified for door knocking.

Door knocking to invite landowners to participate in site visits was scheduled for July and August to reach holiday populations later in the summer. Site visits were completed by August 18, 2016. Landowners who agreed to a site visit were advised on three important BMPs selected from the 2015 project:

- Inspect septic systems, as recommended by the appropriate local county agency, and complete repairs as needed
- Pick up, bag, and dispose of dog waste in the garbage
- Install vegetation to absorb and filter water

A fourth BMP from 2015 to "collect, contain and cover livestock waste" was dropped due to few landowners with livestock in the area.

Since the audience research showed stormwater was a large concern, recommendations were developed and offered to solve stormwater issues such as erosion, wet areas, slope stability, and negative impacts on onsite sewage systems on landowners' properties. During the site visit, water quality improvement were shown to be connected to stormwater, pet waste, and septic management, and emphasis placed on how landowners could help reduce fecal coliform and other pollution entering Hood Canal and its tributaries. Landowner packets, containing pertinent educational information and resources, were provided (Appendix 4).

Surveys were conducted during each site visit to measure the landowners' change in awareness of the BMPs (Appendix 5). The surveys were based on those used in the 2015 project. Survey questions regarding livestock were not included as there were no farms identified in the target areas.

Findings and Analysis

Combined Target Areas Results

Of the 464 residences identified for door knocking, 402 were viable addresses and 119 (30%) residents answered the door and were offered a site visit. Thirty-four (29%) of them agreed to a site visit and 19 (56%) of the site visits were completed.

Overall, 30% of residents answered the door with a high of 43% in the Hoodsport Upland area and a low of 20% in the Hoodsport Shoreline area (Table 1). Although the Hoodsport Shoreline had the lowest number of residents answering the door they had the highest percentage of interest in a site visit (67%). Among the remaining areas, an average of 31% were interested in a site visit. The Hoodsport and Union Upland residents had the highest rates of completing site visits (75% of those interested), and the Union Shoreline had the lowest follow through (33%). The highest percentage of completed site visits based on total doors knocked were Union Upland and North Shore (6%).

Table 1 - Comparison of site visit results across all areas

Area	Total properties in area	Doors knocked on	Answered door - heard offer	Interested in site visit	Completed site visit (% of those expressing interest)	Potential Interested but haven't scheduled visit	% of completed site visits based on total doors knocked on	% of all those interested completed site visit
All areas combined	**542**	**402**	**119 (30%)**	**34 (29%)**	**19 (56%)**	**15**	**2%**	**8%**
Hoodsport All	157	137	42 (31%)	14 (33%)	7 (50%)	7	5%	10%
Hoodsport Shoreline	88	74	15 (20%)	10 (67%)	4 (40%)	6	5%	14%
Hoodsport Upland	69	63	27 (43%)	4 (15%)	3 (75%)	1	5%	6%
Union All	201	138	40 (29%)	7 (18%)	4 (57%)	3	3%	5%
Union Shoreline	121	88	24 (27%)	3 (13%)	1 (33%)	2	1%	3%
Union Upland	80	50	16 (32%)	4 (25%)	3 (75%)	1	6%	8%
North Shore	184	127	37 (29%)	13 (35%)	8 (62%)	5	6%	10%

In addition to completed site visits, the focus BMPs were conveyed by other means and were labelled "potential" site visits (15). Opportunities arose for the BMPs to be discussed when:

1. The owner said 'no' to a site visit (8), but:
   - Proceeded to discuss the property's issues to the extent that the BMPs were casually discussed (uncounted), or
   - Proceeded to discuss the property's issues to the extent that, in effect, a site visit occurred but no survey was conducted (i.e. an "unofficial" site visit (8)).
2. The owner said 'yes', he/she was interested in a site visit (15 potential), and
   - Called to schedule a site visit (committed (9)), or
   - Could not foresee a time when they would be available (uncommitted (6))

If all the potentially interested residents completed site visits the completion rates could be as high as 14% in Hoodsport Shoreline with an average completion rate of 8%.

Attempts to contact landowners were made at all 464 properties. Attempts were not made at 62 properties because they were undeveloped or were otherwise inaccessible (such as a locked driveway gate). Newsletters (Hoodsport Water Quality Update) and "Sorry we missed you" cards were left at 283 residences where no one answered. Information was left with non-owners such as visitors or renters,

and at a locked gate if it was not visible from the road. The newsletters and cards were designed to get people to call and sign up for a site visit. These materials are available in Appendices 2, 3, and 5.

A total of 137 Hoodsport Water Quality Update newsletters were distributed as follows:

- 95 to Hoodsport residences where the owner was not home/unavailable.
- 42 were also given to homeowners that were home (including those interested and not interested in a site visit).

A total of 188 "Sorry we missed you" cards were distributed to Union (98) and North Shore residences (90) where the owner was not home or unavailable.

Hoodsport Target Area Results

The Hoodsport Target Area included properties on the shoreline from Finch Creek Road to the south end of Potlatch Road. Upland areas were on drainages above this segment of the shoreline, as far west as Suncrest Drive off Lake Cushman Road.

There were 144 properties in this area that had not responded to contacts made in the 2015 project (Joy, et. al., 2015), or were non-residential or undeveloped. Of those, there were 95 residences where the owner was not home, and seven that were undeveloped properties or inaccessible at the time of door knocking. Site visits were offered to 42 landowners, 28 of whom were not interested. Fourteen landowners expressed an interest in a site visit, but only seven agreed to walk their property with the WSU Clean Water Advisor; four landowners completed the pre- and post- site visit surveys. Some landowners did not complete the post-survey because they preferred to have the follow-up site visit before forming their opinions.

In both the shoreline and upland areas of Hoodsport, 31% of the residents answered the door, 33% were interested in a site visit, and 50% of those completed a site visit (Table 1).

Hoodsport Shoreline

While only 22% of the residents in the Hoodsport Shoreline area were home and answered the door in this area, 67% agreed to a site visit and 40% of them completed the site visit (Table 1).

Of the 81 Hoodsport shoreline properties door-knocked, 59 owners were not home and seven properties were either undeveloped or inaccessible. Three landowners completed site visits, and one completed a partial site visit because she could not be scheduled for the follow-up visit with the Mason Conservation District engineer. Two landowners completed survey forms.

Two landowners (one representing two properties) expressed an interest in a site visit and said they'd call to schedule (potential site visit). One landowner said she'd call after Labor Day, and one said she'd call after speaking with her husband about scheduling. Neither called to schedule a site visit.

Three other landowners said they'd be interested in a site visit, but responded "not now." Another landowner said she was not interested in a site visit, but walked the property in order to ask about what to plant on a slope that receives a lot of runoff. During these conversations, the target BMPs were discussed and pertinent information sheets were provided.

Hoodsport Uplands

In the Hoodsport Uplands area, 43% residents answered the door and 15% agreed to a site visit with 75% of those completing a site visit (Table 1).

Site visits were offered to 27 landowners who answered the door; 23 said they were not interested in a site visit. Three landowners agreed to a site visit, two at the time of door knocking and one scheduled for later. All three completed a walk around their properties to point out areas of concern. One survey form was completed and two preferred to wait until after the follow-up.

A fourth landowner was designated "potential site visit" because the property is a hobby farm; the landowner said he would be interested in having the Small Farms specialist from the Mason Conservation District help find solutions, but was not sure he'd make the call.

Three other landowners who declined a site visit continued to discuss their properties. One pointed out some erosion, but also listened to information about the potential fecal coliform contamination that may be entering her property from the two goats pastured upslope. One landowner lived on the edge of a very steep drop-off to a grassed slope and a seasonal pond and discussed securing his slope, pruning rather than topping his trees for a view, and his dog's contribution to fecal coliform. The third landowner was not able to understand the conversation regarding her onsite sewage system.

Union Target Area Results

The Union Target Area included shoreline properties from just east of the Olympic Vista community to just west of McReavy Road at SR 106. The Alderbrook Resort lies within this area. Upland areas on drainages to Hood Canal included the more densely populated neighborhoods on and off of McReavy, Dalby, Country Club, and Olympic Vista roads.

Of the 201 properties in the Union target area, 42 non-residential or undeveloped properties were removed from the list, leaving 159 non-respondents to 2015 outreach efforts. Upon door knocking, 21 properties were found to be non-residential or undeveloped, and the owner was not home at 98 residences. Forty landowners answered their doors, 33 were not interested in a site visit, and seven expressed an interest in a site visit. Four landowners completed site visits, two chose to conduct the site visit upon door knocking, one scheduled a site visit during door knocking, and one called to schedule a site visit in response to a "sorry we missed you" card. Three landowners completed survey forms, and one preferred to fill out the form after follow-up.

In the Union area, 29% of the residents answered the door, 18% were interested in a site visit and 57% of those completed a site visit (Table 1).

Union Shoreline

In the Union Shoreline area, 27% of the residents answered the door, 13% were interested in a site visit and 33% of those completed a site visit (Table 1).

Of the 103 Union shoreline properties door knocked, 64 owners were not home and 15 properties were either undeveloped or inaccessible. Of the 24 that were home, three landowners expressed an interest in a site visit. One landowner completed a site visit and the pre- and post-survey. The second landowner had responded to the Audience Research letter and had said in an email that she would like to have a site visit. However, she was not one of the first 15 respondents and her request was not noticed until later.

The third landowner did a partial walk through of the upland side of his shoreline property. One of the BMPs discussed was the family's management of a significant drainage that had been diverted at a 90 degree angle to flow along the upslope end of his property. This results in very wet land below the diversion and the drainfield is located where it is susceptible to groundwater flooding. The owner said he'd be interested in a complete site visit and would call to schedule one, but did not.

Two other landowners were interested but did not complete site visits. However all three proceeded to walk their properties discussing the BMPs. Two of those said they would call for a site visit but did not. These two parcels had significant issues.

One landowner was concerned about SR 106 crumbling along the beach side of the road. She pointed out a small but year-round drainage that passed very near her house. The quality of this water (from which she withdrew drinking water) was discussed, and she listened to the benefits of planting a buffer to filter and absorb contaminants. She understood that her septic system was in a very small space with only a ditch between it and the highway, but when she was advised to have an inspection in addition to pumping, she said she was careful enough that it was not a problem. This landowner said that she would agree to a site visit if her neighbor would. The neighbor subsequently declined a site visit because she felt her property had no issues.

Union Uplands

In the Union Uplands area, 32% of the residents answered the door, 25% were interested in a site visit and 75% of those completed a site visit (Table 1).

Of 56 Union Upland properties door knocked, 34 owners were not home and six properties were either undeveloped or inaccessible. Sixteen landowners were home; 12 said they were not interested in a site visit. Three of the landowners who said they were interested lived in the Olympic Vista community near the top of a very steep and considerably deep drainage ravine. Two completed a site visit. One agreed to a site visit at the time of door knocking, one scheduled a date upon door knocking, and the third called to schedule in response to a "sorry we missed you" card. Two site visit recipients completed pre- and post-surveys and one preferred to wait until after follow-up.

The fourth interested landowner said he'd call after a family event, but did not. This landowner also had significant issues on his property. He listened briefly to information about the risk of removing and topping trees on a steep slope, but was convinced he was doing the right thing and said he had been trying to convince his neighbors to do the same.

North Shore Target Area Results

The North Shore Target Area included approximately five miles of densely populated shoreline properties with very steep slopes parallel to the shoreline on the upland side of North Shore Road. Almost all the slopes above this stretch of road are naturally vegetated, in many places draining to larger creeks and streams, and to culverts that discharge to the canal. The rest of the drainages collect into ditches at the toe along the road and empty to the canal through periodic culverts.

Around the outlet of the Tahuya River, smaller creeks from higher elevations feed into larger streams and pass through neighborhood communities grouped into clusters. Although some upland development has occurred, recent activity has included both commercial and private property clearing, leading to increased flows and flooding of lowland properties.

The North Shore target area was not part of the 2015 outreach and education project. There were 184 properties, of which 23 were designated non-residential or undeveloped according to the Mason County Assessor's online database. Upon door knocking attempts at 161 properties, 34 were found to be undeveloped, or inaccessible mainly due to locked driveway gates. No owner was home or available at 90 residences. Of 37 owners who answered the door, 24 said they were not interested in a site visit.

Thirteen landowners expressed interest in a site visit. Seven landowners completed a site visit at the time of door knocking, and one called to schedule. Of the eight site visits, five completed pre- and post-surveys, and three completed only the pre-survey. The reason for not completing the post-survey was to await follow-up, and one did not want to take the time.

In the Northshore area, 29% of the residents answered the door, 35% were interested in a site visit and 62% of those completed a site visit (Table 1).

Five additional landowners were labelled "potential" when they expressed an interest and said they would call, but did not schedule a site visit. Because of erosion conditions that were severe but not immediately dangerous, two of the five landowners were encouraged to call a Mason Conservation District engineer whether or not they pursued a site visit, and a third was encouraged to call soon to schedule a site assessment with the Shore Friendly Mason Program with Mason Conservation District.

There were many opportunities to discuss BMPs during these interactions. Three such opportunities arose when the landowners did not want a site visit, but ended up walking the property, discussing all the BMPs, but not completing a pre- and post-site visit survey (i.e. an "unofficial" site visit). One of the three was very concerned about flooding in a creek below, extensive logging on private land upslope, and the risk to their home.

Many landowners encountered had similar concerns, citing private property logging, development and other diversions upslope. When flooding was too severe to fall under the scope of this project, landowners were encouraged to contact Mason County's Community Development or Public Works departments for more information. Most landowners had minor flooding over North Shore Road during heavy rains, and many had driveways that collected and channeled runoff onto their properties. Landowners not interested in a site visit were given information on planting buffers, directing runoff away from septic systems, and pet waste management to prevent fecal coliform and other pollution from entering their properties or Hood Canal.

Observations Regarding Site Visits

Site visits were generally successful in conveying the selected BMPs to landowners. Site visits conducted at a pre-scheduled time were the most thorough and most likely to lead to implementation. However, site visits conducted at the time of door knocking were more likely to result in drawing attention to conditions that could be addressed using the BMPs. In addition, casual conversations often led to the conveyance of one or more BMPs, especially due to the pervasive runoff experienced by shoreline properties.

Pet Waste
One of the most remarkable observations was the widespread knowledge of pet waste management. Virtually all landowners who were asked about the correct method for handling pet waste, not only knew what to do, but most also used the phrasing found in educational materials (i.e. pick up, bag and throw it into the garbage). One gentleman said he wasn't sure, but after being told, jokingly said he knew what he was supposed to do but wanted to hear it from the WSU representative. There was almost no pushback by shoreline landowners who expressed a concern with water quality, but some upland landowners were skeptical of the impact pet waste could have on nearby drainages or the canal.

Onsite Sewage Systems
Landowners along the shoreline in Hoodsport and Union were well aware that their septic systems had the greatest potential for contributing to fecal coliform pollution. Behavior consistently indicated a weariness, but sometimes pride, in knowing that pumping regularly was a fundamental management practice. Very few used the term "inspected," and most landowners felt that they were doing the necessary maintenance. Three landowners on the shoreline along Potlatch Road, knew a lot about their septic systems' features, location and care of the drainfield area, and regular inspections – only one had a commercially harvested shellfish beach.

Nothing left to do
A majority of shoreline properties were "built out," and landowners were left feeling that there was little else they could do. However, discussions around directing runoff away from their septic systems were well received. When asked if they knew where their septic system was, people tended to point out their septic tanks or said their drainfield was "somewhere around here." When the drainfield appeared to be under pavement or otherwise used for parking, discussions about water conservation were pursued. One gentleman said he'd advised his sister to get a port-o-let when she had parties – and she did.

Planting buffers to absorb and filter runoff
Planting buffers was the least well-known subject in regard to reducing contaminants, but more well-known along the shoreline. The largest obstacle was either the lack of room on the property, or the large volume of stormwater escaping ditches, culverts or coming from under the roads (mostly in Hoodsport and North Shore). Plantings seemed most needed for erosion control. Responses ran the spectrum from too small a problem to worry about, to too much volume to be managed by plantings.

Recommendations for future outreach

The same WSU Extension contractor conducted door knocking and site visits in both the 2015 and 2016 projects. Although the sample size of site visited properties is small, the results of the door knocking approach were very positive. Recommendations and lessons learned from the 2015 project, including the 2016 interviews of 2015 site visited landowners, and 2016 the Audience Research surveys, were taken into account during the 2016 door knocking and site visits. These lessons include:

Conduct site visits with two Clean Water Advisors: The original recommendation was for one WSU Extension and one Conservation District staff member to collaboratively conduct the site visits. However, implementation may better be achieved by door knocking and site visits conducted by two WSU Extension staff members, with a designated follow-up role for the Conservation District (CD) where necessary.

Develop a targeted outreach program for stormwater issues: The 2016 project site visits found that almost all of the North Shore and many Hoodsport sites involved significant stormwater concerns including significant flow from steep uplands that required more detailed and expert advice and could not be addressed by the site visit as described in the scope of work. Upland development and timber clearing will likely result in more stormwater problems. Future outreach and education projects in these areas should work with local stormwater agencies to develop a strong stormwater component. A drainage workshop could be developed by training small contractors and landscapers and then following up with residential workshops and making available a list of the trained contractors.

Follow-up as soon as possible: Follow-up should be done as soon as possible after the site visit, in order to keep the information fresh in the landowner's mind. This may also be a good opportunity to finish the post-site visit survey (if the landowner is home), to drop off plants or other incentives that may have been offered, and to reinforce BMP messaging.

Identify an issue *then* connect it with fecal coliform pollution: The mention of fecal coliform in the initial offer of a site visit has little effect on what the landowner remembers about the goal of the site visit. Fecal coliform and its specific importance to water quality and human health in shellfish growing areas needs to be repeated. However, experience with landowners showed increased receptivity when an issue was identified and *then* connected with fecal coliform pollution, rather than conducting the site visit for the purpose of identifying sources of this pollution.

Expand pet waste messaging: Most dog owners were knowledgeable in pet waste management and agreed it was the right thing to do. For those landowners, messaging could include passing-it-on to guests, family, and neighbors. Visitors who bring dogs along may not have knowledge of the BMP for pet waste, or consider a brief visit as unlikely to matter. Upland pet owners also need a better understanding that pet waste from their property could affect Hood Canal. For the landowner, in addition to adding fecal contamination to waterways, this also increases the chances of dog poop being tracked into the house on people's and pet's feet.

Develop specific messaging for upland property owners: Specific educational materials should be developed (or provided) for upland landowners. Most who lived in the uplands on drainages to Hood Canal did not think they impacted the canal or even the water quality of the drainage when the property was not on the bank of the waterway. However, stormwater issues were still a concern for some upland properties and the site visit was still useful.

Schedule site visit at time of door knocking: The landowners who were interested in a site visit and said they would call to schedule one, did not call. The letter sent in 2015 inviting landowners to schedule a site visit, and the letter sent in 2016 to request Audience Research participants, may have provided a 'heads up' about the project making door knocking less of a surprise in Hoodsport and Union. Although North Shore residents responded very well to site visit offers upon door knocking, they did not make calls to schedule either.

The option could be offered by the Clean Water Advisor doing the door knocking to offer to schedule the future site visit. A calendar could be shared by a smart phone in the field and the office, and the door knocker could be better prepared to address specific issues raised by the landowner. This might also provide an opportunity to ask a Conservation District to attend the site visit (with the owner's permission). If possible, offer an incentive for scheduling "on-the-spot."

Improve methods for Post-Site Visit Surveys: The pre-site visit survey is relatively easy to conduct, but there was more reluctance on the part of the landowners to complete the post-site visit survey. Reluctance seemed affected by the limitations of the site visit without follow-up, and not having enough

time to absorb the information. Perhaps the post-site visit survey could be completed online, via email, or snail mail (providing a stamped/addressed envelope would help). This could be more effective as a tool to measure the change in BMP awareness, but also might rely too much on landowner motivation. Consider an additional incentive for completing the survey.

Pursue Potential Site Visits: There were quite a few landowners who said they were interested in a site visit, but they either did not call to schedule one, did not have time "now," or would think about it. In the future, landowners who seem interested and who agree, could be re-contacted by door knocking, email, letter or phone call (most likely method). Follow-up contact could be made during the current project or at the beginning of the next project.

Engage the resident in a long term advisory program: There is a need to engage shoreline residents in a long term strategy to keep them up to date on water quality issues as well as remind them about BMPs and link them to more information. The WSU Shore Stewards program is one such program that provides a bi-monthly newsletter that keeps people up to date on current issues, interesting shoreline topics and upcoming local events relevant to shoreline residents.

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Appendix 1 – Landowner Summary Report

Example of letter provided to landowners after site visit.

LANDOWNER NAME – address

>Insert Aerial photo – Residence on Hood Canal shoreline with natural beach

>Insert Aerial photo of property – Prior to new home, septic, and landscaping changes

THANK YOU FOR ALLOWING WSU MASON COUNTY EXTENSION to conduct a 2016 Site Visit with you on your property at >*address*< to help you manage surface water runoff (stormwater) that causes you problems such as erosion and periodic wet areas.

Runoff greatly affects water quality by carrying contaminants and soil/silt to nearby ditches, culverts, streams and to Hood Canal. We hope to recommend solutions that work for your specific property as well as for Hood Canal, by applying these Best Management Practices for improving water quality:

- Inspection of septic systems as recommended by the appropriate local county agency and completing repairs as needed
- Pick up, bag and dispose of dog waste in the garbage
- Install vegetation to absorb and filter water

The following are issues identified when I walked with you around your property, and recommendations for addressing them. Resources for the recommendations are listed at the end of this document.

- **YOUR PROPERTY is served by an Onsite Sewage System (OSS)**. The drainfield (the disposal component of the system) is located approximately 180 ft. upland from the septic tanks. A 1986 septic system installation shows its drainfield approximately 125 ft upland of the old house.

Your septic system is designed to protect ground and surface water from fecal pollution. The 2010 septic tank and pump chamber are nearer the house and have risers to seal out surface water runoff as well as an effluent filter to remove additional particulate matter from the liquid before being pumped to the drainfield. These features make it easier to ensure the proper function of the OSS. You also have a reserve area set aside for a replacement drainfield if ever needed. The reserve area is farther upland and may be located where you store your boat.

RECOMMENDATION 1: ***Locate the drainfield and reserve areas to ensure they are not compacted due to parking of boats or cars, or by other activities.***

Drainfields require air and some water in order to treat the harmful bacteria and pathogens found in human waste. Avoid compacting the soil in the drainfield *and* reserve areas.

The reserve may be near the bottom of the rise on which you park your boat(s). Newer septic requirements ensure that the disposal components are far enough away from the toe of the slope to avoid being impacted by stormwater runoff. However, observe surface water flow during heavy rains to ensure runoff is directed away from this area.

It was not clear to me how near the 1986 septic drainfield was to the newer one. It would be useful to know the location, or to at least be aware of its presence, to avoid confusion during future land use changes.

- **YOU HAVE A WONDERFUL DOG and you know how to dispose of dog waste.** Of all the sources of fecal coliform pollution, dog waste is the most likely to go unaddressed. Some people just don't know, some just don't believe and some just find it to be too much trouble.

RECOMMENDATION 2: ***Share this information with visitors***. Having a home on the waterfront is so appealing for gatherings of friends and family. It may be uncomfortable or be unwelcome, but if you get the chance, pass on the information about the impact of fecal coliform from dog waste on the canal and the simple solution: pick up, bag and put it in the trash. It's not fun, but it's not so hard, and it will help improve water quality for you, your family, friends, *and* pets.

- **YOUR HOOD CANAL WATERFRONT HAS A NATURAL BEACH WITH NATIVE PLANTS.** A natural beach allows a dynamic equilibrium to occur, where changes over time are both expected and desired. Beneficial processes cause beaches to grow, diminish and grow again creating a diverse habitat that supports a healthy, complex ecosystem. In addition, any vegetation between homeowner activity and Hood Canal will filter additional contaminants and help prevent erosion.

Photo by Amy Bartow, NRCS Corvallis Plant Materials Center, 2009

While walking along your beachfront, you asked about some of the plants there. The multi-branched semi-woody plant with yellow flowers is called Puget Sound Gumweed (*Grindelia integrifolia*) and is a native plant common to Hood Canal. A fact sheet is included in your site visit packet.

RECOMMENDATION 3: ***Become familiar with your waterfront plant community and coastal processes.*** Learn more about native and non-native shoreline plants, how a buffer of native vegetation can improve water quality, and how to preserve and protect your natural shoreline as well as your home.

The Mason Conservation District has programs that benefit homeowners with stretches of natural shoreline like yours and your neighbors'. The Shore Friendly Mason Program can provide free, non-regulatory technical assistance, information and resources to support your efforts to balance shoreline and homeowner choices. Contact Karin Strelioff, (360) 427-9436 ext 122, and *Call soon to get on the calendar for a free site assessment*.

You may want to develop some plant identification skills for information and for fun. For an at-a-glance picture gallery of native shoreline plants, see the Mason Conservation District website or contact an Environmental Specialist for help with identification.

Use the Washington State Noxious Weed Board's on-line tool to identify whether your beach plants should be removed. For proper removal and disposal of noxious weeds, call WSU Mason County Extension Noxious Weed Control program coordinator.

- **PLANTS FOR A SMALL ROCKY AREA near the septic tanks**. You wanted low maintenance, attractive plants that were not too tall and could handle the full sun as well as periodic stormwater pooling.

RECOMMENDATION 4: ***Check out the options for salt-tolerant native groundcovers, grasses, sedges and wildflowers.*** Some suggestions that fit the location and your preferences are: Sea Thrift, Broad-leaved Stonecrop, Coastal Lupine, Silverweed, and several grasses including Tufted Hairgrass.

There are plenty of cultivars (cultivated by selective breeding) that you might like, but be sure to check whether they are appropriate for our Hood Canal shoreline!

- **YOUR PROPERTY has a large grassed area, but also has native and non-native plants along the property lines.** The invasive plants on the northern property line closest to the house are not very extensive, however as you approach >*name of road*< invasives are integrated into the shrubby hedge. Himalayan blackberry, English Ivy, Yellow Archangel and other common noxious weeds invade the whole neighborhood.

RECOMMENDATION 5: ***Remove the invasive shrubs nearest the house entirely by mechanical methods, and get technical advice about managing the rest.***

Noxious weeds do not stay put – they spread rapidly and displace native and other plantings, destroy habitat, increase erosion, and disrupt septic drainfield function. Remove all that you can before they take over and then manage the rest. Continue monitoring to avoid being suddenly overwhelmed.

Planting natives at the same time can help crowd out the invaders and because they have adapted to this region, they require less maintenance. Native plants can also be used as an attractive screen between yours and neighboring properties, absorbing and filtering stormwater as well. Some great options are red-flowering currant, tall Oregon grape, Nootka and other roses, and huckleberry. See the Native Plants for Marine Shorelines fact sheet in your packet for more ideas.

RESOURCES FOR MORE INFORMATION:

Washington State University's Mason County Extension (360) 427-9670 ext. 680
http://extension.wsu.edu/mason/

The "Guide for Shoreline Living" (in your site visit packet) is a booklet of info and references for stewards of the Pacific Northwest's "Salish Sea" (including Hood Canal) and its tributaries.

http://shorestewards.cw.wsu.edu/ => FAQ to learn about becoming a Shore Steward

Mason Conservation District (360) 427-9436
https://www.masoncd.org
Free and non-regulatory programs and technical assistance for shoreline homeowners, the yearly native plant sale, and a great resource for helping landowners responsibly and efficiently manage their land and associated natural resources.

RECOMMENDATION 1:

Mason County Public Health Dept. (360) 427-9670 ext. 400
www.co.mason.wa.us
If you are unsure exactly where your drainfield and reserve (or the old drainfield) are located, call to see if your Mason County Onsite Sewage Specialist can help. You can also find a maintenance schedule for your septic (a pressure system), Do's and Don'ts and other helpful information on the website.

Septic systems: => Public Health => Environmental Health => Onsite Sewage Systems

Records and mapping tool: => Property/Parcel information (Your parcel# is 42223-50-00145). Click on Mapsifter to "Check if Land Records are Available" or "View Map".

WSU Shore Stewards' topical newsletters
http://shorestewards.cw.wsu.edu/ => News => Archived Newsletters

2014 - Landscaping Septic System Drainfields and Mounds – Issue 98

RECOMMENDATION 2:

Washington State University's Mason County Extension (360) 427-9670 x680
http://extension.wsu.edu/mason/
There are a couple of dog waste information sheets in your site visit packet, but if you want more to hand out (smile), call the WSU Mason Extension office and ask for Water Resources.

RECOMMENDATIONS 3 and 4:

Mason Conservation District (360) 427-9436
https://www.masoncd.org

Call Karin Strelioff at extension 122 to receive expert advice on the Shore Friendly Mason Program for shoreline homeowners.

See “Waterfront” => Shore Friendly Mason => Marine Shoreline Plants => Groundcovers, Shrubs & Small Trees for the Marine Shoreline.

See “2017 Native Plant Sale” for many of the plants recommended in planting plans.

See “Resources” => Program Resources => Native Plant Resources

WSU Mason County Extension Master Gardeners Program
http://extension.wsu.edu/mason/ => Master Gardener Program and Small Farms
For help identifying plant diseases and lots of other gardening info

RECOMMENDATIONS 3 and 5:
Washington State Noxious Weed Control Board
www.nwcb.wa.gov
=> Noxious Weed List => Identify a Noxious Weed.
=> Noxious Weed List for shopping at a nursery or deciding what’s what in your yard
=> Outreach => Publications => Garden Wise (NW Wa) for alternatives to invasives

Washington State University’s Mason County Extension (360) 427-9670
http://extension.wsu.edu/mason/
Noxious Weed Control Program Coordinator, Pat Grover at ext. 592 for Mason-specific weed problems and removal methods on the shoreline.

Appendix 2 – Hoodsport Water Quality Report

Page 1

Hoodsport Water Quality Update

Summer 2016

Hood Canal 6 Shellfish Growing Area, WA State Dept. of Health

This report is being provided as a part of the Hood Canal Regional Pollution Identification and Correction (PIC) Program. The PIC Program works to protect and restore water quality, particularly to clean up and prevent fecal pollution from human and animal waste that threatens public health and our economy. Funding for the program is provided through a grant from the Washington State Department of Health (DOH) and the Environmental Protection Agency.

Hoodsport is part of the Hood Canal 6 Shellfish Growing Area (Hood Canal 6) (see map) as classified by the DOH. Water quality in marine and freshwater areas is monitored by DOH, Mason County Public Health (MCPH), and the Skokomish Indian Tribe (Tribe).

Commercial shellfish harvest is currently prohibited in the area directly adjacent to Hoodsport due to historic concerns about failing onsite septic systems in the area. DOH staff have been evaluating this area due to a request to open the area for commercial shellfish harvest. In 2014-2015, DOH evaluated shoreline and upland conditions throughout Hood Canal 6. DOH staff surveyed for potential sources of pollution from drainage areas, roads, onsite sewage systems, agricultural activities, and other activities with the potential to harm water quality. Water quality monitoring in the Hoodsport area during this time period included thirty sites over one mile of shoreline, with each site monitored between one to twelve times. Of the Hoodsport sites, 63% met the water quality standard for fecal bacteria.

The western shoreline of Hood Canal 6 has approximately 205 total acres of shellfish beds, with the Prohibited area by Hoodsport making up 65.6 acres. Efforts to improve water quality in these areas have the potential to benefit commercial and recreational shellfish harvest, and to protect human health and enjoyment of the natural resources in the area.

For more information visit: http://hccc.wa.gov/content/pollution-identification-correction

Hood Canal Snapshot

- HC is a glacier-carved basin that is more than 60 miles long.
- The average width is 1.5 miles and the mean depth is 177 feet.
- HC provides habitat for a variety of wildlife including shellfish, finfish, and invertebrates but 80% of the animal species are too small to see with the naked eye.
- There are over 12 rivers in the HC watershed including the Skokomish River, Duckabush River, Hamma Hamma River, and Dosewallips River.

Water Quality Success Stories

Long-time residents of the Hoodsport area are aware that the issue of water quality and pollution correction has come up many times in recent history. This project will attempt to build on previous successes to maintain improvements already achieved and address new concerns.

Previous water quality assessments include a Hood Canal Identification and Correction Project conducted by Mason County Public Health (MCPH) between July 2005-August 2008. This project included monitoring for fecal coliform bacteria and at sites with high fecal coliform results they also analyzed nutrient inputs.

The project was conducted through a shoreline survey in which staff walked the exposed tidelands and collected samples of water from discharges along the shoreline which were then analyzed for fecal coliform. High results triggered confirmation sampling and if those results also had high levels of fecal coliform this triggered a sanitary survey. A sanitary survey involves surveying the onsite septic system components on a property and performing dye tests to see if the system is failing.

Sampling of the shoreline near Hoodsport showed elevated fecal coliform levels at 10% of the sites compared to elevated levels found at only 7% of the total sites sampled around Hood Canal. A total of 29 properties throughout Hood Canal were identified for further investigation with some receiving sanitary surveys and dye testing. Eight properties had identified septic system failures and five of those had repairs completed by the end of the project in 2008. Since then, two of the remaining sites have had septic systems repaired or replaced and MCPH is still working to investigate one in the Hoodsport area.

In addition to identifying and addressing failing septic systems, MCPH staff conducted 14 public meetings and workshops related to fecal coliform and nutrient pollution, onsite septic system maintenance and operation, and other actions to protect water quality throughout Hood Canal. MCPH also adopted a new online data management system for septic system records that allows them to send out maintenance reminders to homeowners for whom maintenance reports have not been received as required.

You Can Help Protect Water Quality

Free Educational Site Visit

There are many ways for homeowners to address water quality concerns through the ways you manage your property. Washington State University Extension is offering free site visits from clean water advisors. They can offer specific recommendations for your property including:

- Landscaping with native plants to add beauty to your yard, create a buffer along the shoreline or stream, or minimize erosion problems.
- Methods for managing drainage and wet areas.
- Recommendation for septic maintenance, including do-it-yourself maintenance.

The recommendations you receive will be strictly voluntary and will not be shared with any regulatory agency. However, upon request our clean water advisors can connect you with other experts who may provide additional assistance.

Site visit participants will receive a free gift of native plants for your property!

To learn more or schedule an educational site visit contact us by August 19th at:

Erica Bates
WSU Mason County Extension
erica.bates@wsu.edu
(360) 427-9670 ext. 682

Onsite Septic Systems


Photo by Toni Droscher

Onsite septic systems can significantly contribute to reduced water quality if they are not properly maintained and serviced. Fecal coliform bacteria from septic systems or pet and livestock waste have been correlated with the presence of viruses or other pathogens that can affect human health.

All septic systems are required to undergo routine inspection and maintenance. The frequency and approved service providers depends on the type of system. As of 2015, none of the septic system types on the west shore of Hood Canal has more than a 50% compliance rate with operation and maintenance requirements.

Much of the development in this area is over 50 years old and many onsite septic systems have no as-built records. At least one third of the shoreline septic systems in the area also have a drainfield within 100 feet of surface water. These issues all have the potential to impact water quality and can be prevented with proper inspection and maintenance.

For more information on how to protect your investment in your septic system and water quality, contact Mason County Public Health or visit the website at: http://www.co.mason.wa.us/health/environmental/onsite/index.php.
If you need financial assistance to repair or replace your septic system, Mason County has partnered with Craft3. Craft3 is a non-profit that offers clean water loans to help property owners with their septic systems. The loans can cover up to 100% of the costs of designing, permitting, installing, and maintaining the septic system. More information is available at www.craft3.org and 1 (888) 231-2170.

For more information on Hood Canal, water quality, and homeowner practices visit:

WSU Mason County Extension: http://extension.wsu.edu/mason/

Mason County Public Health: http://www.co.mason.wa.us/health/

Hood Canal Coordinating Council: http://hccc.wa.gov/

Animal Waste

Manure composting facility. Photo from Mason Conservation District.

Pet and livestock waste contains fecal coliform and other bacteria that can get carried into nearby water by stormwater runoff. These disease causing organisms can be transmitted to people, pets, and wildlife. Fecal coliform, bacteria, salmonella, roundworms, and giardia can remain in your yard for weeks or months if not cleaned up.

Landfills are designed to safely handle pet waste but yards and septic systems are not. To keep harmful bacteria out of the water and out of your house scoop dog poop, bag it, and put it in the trash. Livestock owners can address manure issues by storing it in a covered area, composting it, and removing excess from the property.

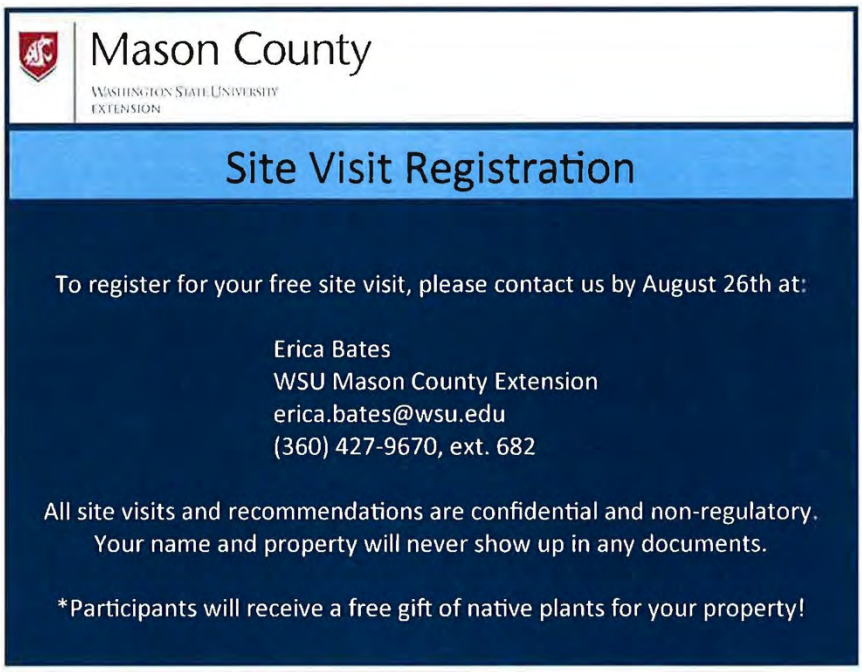
For help managing livestock manure contact the Mason Conservation District at 360-427-9436.

Washington State Department of Health | Mason County Washington State University Extension | Mason County Public Health

This product has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement PC-00J32601 to Washington Department of Health. The contents of this document do no necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. In collaboration with Hood Canal Coordinating Council.

Appendix 3 – "Sorry We Missed You" Postcard

Left at doors where no one was home.



Appendix 4 – Handouts for Landowners

EDUCATIONAL MATERIALS included in Landowner Site Visit Packet – Available under separate cover.

Mason County Public Health, Onsite Sewage System Program

- OSS Maintenance Schedule
- OSS Maintenance Requirements
- Septic Care Do's and Don'ts
- Inspecting Your Septic Tank (adapted from Thurston County)

WSU Extension

- Shore Stewards "Guide to Shoreline Living" booklet
- Shore Stewards Program and sign up information
- Pruning for Views
- OSS Key Points to Remember
- Landscaping Your Drainfield
- Dog Waste – Why Should I Care?
- Weed Alerts for Himalayan Blackberry and English Ivy

Mason Conservation District

- Marine Shoreline Planting Plan
- Shady Moist Planting Plan
- Sunny Dry Planting Plan
- Existing Tree Care and Views

USDA Natural Resources Conservation Service

- Plant Fact Sheet: Puget Sound Gumweed

Noxious Weed Control Board

- Bees and Noxious Weed Control
- Noxious Weed Disposal
- "Noxious Weeds That Harm Washington State" Western WA Field Guide booklet

Sound Native Plants

Plants for Steep Slope and Erosion

Craft3

Brochure on Clean Water Loans

Appendix 5: Site Visit Survey

Site Visit Survey- Questions for the beginning and during site visit

For Official Use: Parcel Number _____

Where is the property located?

- ❍ Union
- ❍ Hoodsport
- ❍ Northshore

How would you classify the property?

- ❍ Marine Shoreline
- ❍ Within 250' of Marine Shoreline
- ❍ Upland Freshwater Shoreline
- ❍ Upland within 250' of Freshwater Shoreline

Why did you agree to participate in a site visit?

How many dogs are located on the property?

___Very small (under 8 lbs.)
___Small (9-22 lbs.)
___Medium (23-55 lbs.)
___Large (56-100 lbs.)
___Giant (100+ lbs)

What is your current level of knowledge (1-5) of the following shoreline/landowner management practices?

	Very Limited – 1	Limited – 2	Fair – 3	Good – 4	Very Good – 5
Maintaining your septic system	❍	❍	❍	❍	❍
Managing your pet waste	❍	❍	❍	❍	❍
Buffer plantings between your property and the water	❍	❍	❍	❍	❍

How often do you get your septic system professionally inspected?

- ❍ Once a year
- ❍ Every 3 years
- ❍ Every 5 years
- ❍ Every 10 years
- ❍ More than10 years
- ❍ I don't know or can't remember
- ❍ I inspect it myself
- ❍ Other_____

What would you do if the inspection found that repairs are needed on your septic system?

- ❍ Fix it right away
- ❍ Seek financial assistance to repair system
- ❍ I would not fix it
- ❍ Contact Mason County Public Health for assistance
- ❍ Replace the entire septic system
- ❍ Other_____

How often do you do the following pet waste management practices?

	Never	Once a Month	Once a Week	2-3 Times a Week	Daily	Not applicable/No pets
Place in trash	❍	❍	❍	❍	❍	❍
Compost/bury	❍	❍	❍	❍	❍	❍
Place waste in toilet	❍	❍	❍	❍	❍	❍
Leave in yard	❍	❍	❍	❍	❍	❍
Other	❍	❍	❍	❍	❍	❍

Do you have a buffer of plants between your yard and the water?

- ❍ Buffer of native vegetation between my yard and the water
- ❍ Buffer of vegetation (not necessarily all native) between my yard and the water
- ❍ No buffer present

Survey questions for the end of the site visit:

Would you recommend an educational site visit to other property owners?

❍ Yes
❍ No

How has your knowledge changed due to the information and recommendations received during your site visit?

	Knowledge has decreased	Knowledge is about the same	Knowledge has slightly increased	Knowledge has significantly increased	Not applicable
Overall knowledge about water quality impacts due to homeowners activities	❍	❍	❍	❍	❍
Understanding of septic system maintenance recommendations	❍	❍	❍	❍	❍
Understanding of suggested pet waste disposal methods	❍	❍	❍	❍	❍
Understanding of plant buffers and how they affect water quality	❍	❍	❍	❍	❍

What is the likelihood that you will do the following behaviors in the future?

	Much less likely	Less likely	Neutral	Likely	Much more likely	Not applicable
Have your septic system professionally inspected at least every 1-3 years, and make repairs as needed	❍	❍	❍	❍	❍	❍
Pick up, bag and dispose of dog waste in garbage on a regular basis	❍	❍	❍	❍	❍	❍
Install plantings to absorb and filter water	❍	❍	❍	❍	❍	❍

Why do you plan on implementing one or more of the noted behaviors from above? Check all that apply.

- ❍ I am concerned about the health of nearby waters
- ❍ I am concerned about the environment as a whole
- ❍ I am concerned about the health of myself, my family, or my pets
- ❍ It is the right thing to do
- ❍ Other _____

If you do not plan on implementing one or more of the recommendations from above please check all the reasons that apply.

- ❍ It will cost too much
- ❍ I don't want to have consequences from a regulatory agency
- ❍ I don't think my changes on my property will make a difference
- ❍ I will do what I think is best for my property
- ❍ I don't have time
- ❍ Other _____

Are you interested in becoming a WSU Shore Steward?

- ❍ Yes
- ❍ No, why? _____

What other topics or issues would you like to receive information about?

Would you be interested in participating in a quick phone survey in the near future about your experience today? If so, please provide name (if desired), phone number, and the best time to contact you.

Hood Canal Regional Pollution Identification & Correction Program

PHASE II HIGHLIGHTS

The Hood Canal Regional Pollution Identification and Correction (PIC) Program is a cooperative effort to identify and correct fecal pollution sources on Hood Canal shorelines to improve water quality, protect clean beaches and increase harvestable shellfish beds.

The PIC program has fostered and strengthened working relationships between its partners: Jefferson, Kitsap and Mason counties, the Port Gamble S'Klallam and the Skokomish Tribes, WSU Extension and local conservation districts, as well as the Washington State Department of Health (DOH) Shellfish Program. **This valuable working partnership has resulted in joint field work, new ways of sharing information and collaborative problem solving.**

Implementation of the regional PIC program was launched in 2014 with four components:

- Prioritized shoreline monitoring and hotspot investigations across Hood Canal
- Residential parcel surveys to assess on-site septic systems' (OSS) status in prioritized areas
- A study of potential nutrient sources from on-site septic systems and seepage pits
- Audience research to understand attitudes about water quality, followed by outreach to landowners

HOOD CANAL REGIONAL PIC PROGRAM ACCOMPLISHMENTS

SHORELINE FIELD WORK

The regional team partnered with DOH staff to identify and prioritize areas where field work had the most likelihood of improving water quality. Through field surveys the PIC team identified, investigated and documented pollution "hotspots," then worked with landowners to address the problems. The Port Gamble S'Klallam and Skokomish Tribes' natural resource departments conducted research and tested investigative tools that may be more effective in some areas than traditional PIC techniques.

PIC TEAM MEMBER INSPECTING DRAINPIPE

RESULTS HIGHLIGHTS:

- **More than 66 miles** of Hood Canal shoreline were surveyed by the regional PIC team in both wet and dry seasons
- **778 landowners were consulted**, and their septic systems and drainfields inspected for sewage leaks
- **76 failing on-site septic systems were identified**, many of which were discharging pollution into Hood Canal
- **67 on-site septic systems have been voluntarily repaired** or replaced and are no longer polluting Hood Canal
- **25 on-site septic systems have repairs in progress**

AGENCY	SHORELINE SURVEYS	PARCEL SURVEYS	OSS FAILURES	OSS REPAIRS
Jefferson County Public Health^	25.5 miles	353	46	42
Kitsap Public Health District*	25.9 miles	282	14	14
Mason County Public Health	13.1 miles	143	16	11
Port Gamble S'Klallam Tribe	1.6 miles	0	0	0
TOTAL	**66.1 miles**	**778**	**76**	**67**

^Jefferson County Public Health conducted field work under multiple funding sources
**Kitsap Public Health District conducted field work under separate funding*

PROGRAM ACCOMPLISHMENTS *(CONTINUED)*

AUDIENCE RESEARCH & OUTREACH EFFORTS

In preparation for outreach efforts, WSU Extension conducted audience research in the Hood Canal region to learn how best to communicate with landowners about water quality issues, as well as what has worked in past efforts that resulted in landowners implementing recommended actions. Survey results showed that most participants implemented at least some of the recommendations. Primary barriers included physical limitations, cost and need for more information. The research results were taken into consideration when planning and implementing 2016 outreach efforts.

In 2016, WSU staff went door-to-door to 464 residences in the Hoodsport, Union and North Shore areas to offer a water quality site assessment of their property. **Of the 119 people who were at home, nearly a third agreed to an assessment.** The assessments provided residents with septic system, stormwater runoff, shoreline vegetation, and pet waste management recommendations specific to their property.

Additionally, OSS maintenance vouchers were offered to targeted neighborhoods in Mason County as an incentive to offset costs of OSS pumping or riser installation. **Forty-four properties utilized the vouchers, of which 18 had no current OSS maintenance records.**

GREEN DYE IS USED TO REVEAL A FAILING SEPTIC SYSTEM

PILOT NUTRIENT STUDY FINDINGS

The PIC team worked with the University of Washington's Puget Sound Institute to develop and conduct pilot studies to further knowledge about bacterial and nutrient pollution sources from seepage-pits. Six seepage-pit sites in Mason County were evaluated. The study found that the **seepage pits were not significantly greater sources of bacteria or nutrients to the shoreline compared to on-site septic systems**. More research is needed to make conclusive recommendations regarding the continued use of seepage pits in Hood Canal.

THE NEXT PHASE

Phase III of the PIC program is funded for April 2017-March 2019, and will utilize lessons learned to address newly prioritized Hood Canal shoreline areas. Phase III will also incorporate ambient fresh water monitoring. The PIC Program hopes to transition over time to a sustainable local and regional funding model for this important work.

Visit hccc.wa.gov
and learn more at OurHoodCanal.org

This project has been funded wholly or in part by the United States Environmental Protection Agency under Assistance Agreements PC-00J32601 to Washington Department of Health. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Produced by: WASHINGTON STATE UNIVERSITY EXTENSION

HCRPIC Phase II Highlights is available for download on the HCCC website library: www.hccc.wa.gov/resources.

Pollution, Identification and Correction Program

Photo credit: Karleigh Gomez; Hans Daubenberger extracting water sample at Duckabush River flow wire below Collins Campground.

Final Report

2017

CFDA # 66.123 Puget Sound Action Agenda: Technical Investigations and Implementation Assistance Program DOH Contract N20718WDOH and Ecology Pathogens Prevention, Reduction, and Control PIC Programs Port Gamble Bay/Hood Canal PIC Program

Acknowledgements

This Pollution Identification and Correction (PIC) Program document was developed by staff of the Port Gamble S'Klallam Tribe (PGST).

PGST PIC Program was made possible through funding from the Washington State Department of Health (WDOH) and the United States Environmental Protection Agency (USEPA) National Estuary Program (NEP), with significant coordination with Washington State Department of Ecology (Ecology).

Photo Credit: Devon Hayes, PGST reservation shellfish opening during sampling event on June 19, 2015

Contents

Photo Credit: Courtney Ewing, Aurora Robles digging clams for the Port Gamble S'Klallam Early Childhood Program Yearly Celebration Clam Bake.

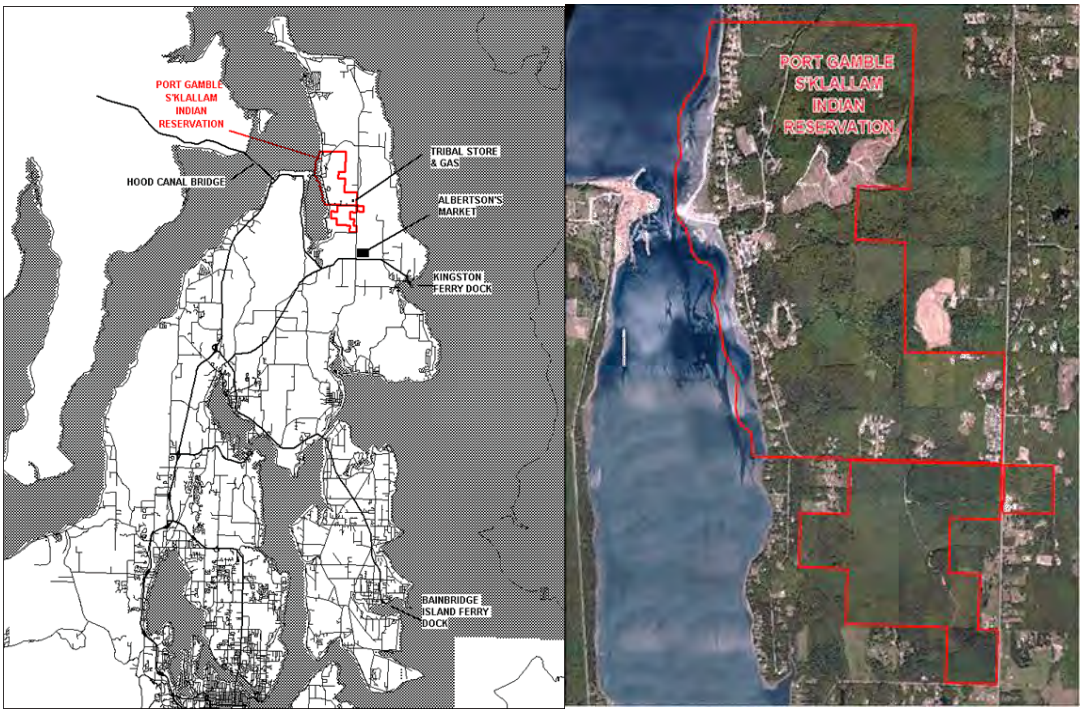
Acronyms and Abbreviations

autosampler	Hach Sigma SD 900 Portable Sampler
cfu	colony forming units
CDX	Central Data Exchange
EC	*Escherichia coli* bacteria
E. coli	*Escherichia coli* bacteria
Ecology	Washington State Department of Ecology
FC	fecal coliform bacteria
FEATS	Financial and Ecosystem Accounting Tracking System
GIS	Geographic Information System software
GMV	geometric mean value
GPS	Global Positioning System
HCCC	Hood Canal Coordinating Council
HCRPIC	Hood Canal Regional Pollution Identification and Control Program
KPHD	Kitsap Public Health District
MCPH	Mason County Public Health
NPDES	National Pollution Discharge Elimination System (permitting program)
NTR	National Toxics Rule
OSS	onsite sewage system
PGST	Port Gamble S'Klallam Tribe
PIC	Pollution Identification and Correction
PSAMP	Puget Sound Assessment and Monitoring Program
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard Operating Procedure
STORET	USEPA Storage and Retrieval database
TMDL	total maximum daily value
TOD	time of day
Tribe	Port Gamble S'Klallam Tribe
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOH	Washington Department of Health
WRIA	Water Resources Inventory Area
WSTMP	Washington State Toxics Monitoring Program
YSI	Yellow Springs Instruments

1 Introduction

The Port Gamble S'Klallam Tribe's reservation is home to more than 1,200 tribal members. Located near the northern end of the Kitsap Peninsula (Figure 1), the reservation lands rise from Admiralty Inlet and Port Gamble Bay. The reservation is mostly forested, contains approximately 2.5 miles of marine shoreline, and receives approximately 20 inches of rain per year. Port Gamble Bay is one of the largest and most productive marine areas open for commercial and recreational shellfish harvest in Kitsap County (see WA DOH shellfish harvest area classification map https://fortress.wa.gov/doh/eh/maps/biotoxin/biotoxin.html).

Figure 1. Overview maps of the Kitsap Peninsula and the PGST Reservation



Shellfish and other aquatic organisms along streams and shorelines within the PGST Usual and Accustomed Areas (U&A, Appendix A) have been negatively affected by nutrient and fecal pollution from failing onsite sewage systems (OSS) and other sources. Closure of shellfish beds due to fecal pollution, in particular, has prompted PGST and local governments to develop and implement marine and freshwater monitoring programs.

Pollution Identification and Control (PIC) programs in the Hood Canal region monitor marine and fresh water bodies, mainly for fecal coliform (FC) and/or *Escherichia coli* (EC) bacteria. Some of these programs also measure nutrient concentrations and ancillary environmental parameters such as temperature, salinity, specific conductance, pH, turbidity, and dissolved oxygen.

PGST is a member of the Hood Canal Coordinating Council (HCCC), whose mission is to protect and enhance the environmental and economic health of the Hood Canal and to support the Puget Sound

Action Agenda (PSP, 2014). The HCCC more recently developed the Hood Canal Regional Pollution, Identification and Control Program (HCRPIC) to monitor water quality. PGST serves on the HCRPIC Pilot Guidance Group to provide oversight, guidance and structure for consistent procedures and technical assistance for the HCRPIC program (Banigan, 2015).

Photo Credit: Katy Davis, Hans Daubenberger taking water sample at the marine sample stations outside the Duckabush River Estuary.

PGST's main role in the HCRPIC program is to research data gaps identified at HCRPIC meetings and during discussions of data submitted by its members. To do this, the PGST developed its own Pollution, Identification, and Correction program. This report describes PIC-related activities that have occurred at freshwater sites, both upland and near marine shorelines, within the reservation and throughout the Hood Canal including Water Resource Inventory Areas (WRIAs) 14-17. The study area and its surroundings are U&A harvest areas of the Port Gamble S'Klallam Tribe protected by the Point-No-Point Treaty of 1855.

Recent HCCC meetings and discussions about data shared by its members, identified issues that needed to be addressed by literature reviews or conducting "gap" analyses related to identifying sources of *E. coli* or fecal coliform bacteria.

This report and appendices describe PGST's PIC program development including wet and dry season sampling, literature reviews, a microbial source tracking (MST) study, and a temporal sampling investigation.

2 Regulatory Criteria Standards

Non-tribal lands

Washington State delegates the responsibility for identifying and correcting nonpoint pollution to local governments (KPHD, 2014a/b). The regulatory authorities in the Hood Canal region include Jefferson County Public Health (JCPH), Kitsap Public Health District (KPHD), and Mason County Public Health and Human Services (MCPH). These jurisdictions are given flexibility to implement water quality protection programs, e.g., PIC programs, using different tools. For example, these regulatory authorities may choose to measure EC, FC and/or nutrients as indicators of fecal pollution. FC is still a common analysis, but federal guidance suggests EC (a species of FC bacteria specific to humans and other warm-blooded animals) and enterococci are better indicators of health risk from water contact (USEPA, 2012).

Staff from local governments compared PIC monitoring results to current Washington State water quality standards to determine appropriate response actions. HCRPIC guidance and regional agreements

state that Hood Canal drainages with FC exceeding 200 colony forming units (cfu) per 100 milliliters (mL) or EC exceeding 100 cfu/100 mL, must be sampled at least two additional times for confirmation. The Geometric Mean Value (GMV) of the three (or more) sample results is then calculated. If the GMV for FC exceeds 500 cfu/100mL or 320 cfu/100mL for EC, further investigation is required.

PGST Tribal Lands

The Port Gamble S'Klallam Tribe is responsible for identifying and correcting nonpoint pollution on tribal lands. To this end, PGST collects and analyzes water samples from the reservation for EC concentrations. Collection and analysis methods are comparable to those used by other Hood Canal Regional PIC programs (Banigan, 2015). PGST staff compared its EC results to Tribal Water Quality Standards adopted to afford stringent levels of protection within the reservation (PGST, 2002):

Photo Credit: Courtney Ewing, Therron Sullivan digs cockles at Point Julia for Port Gamble S'Klallam Early Childhood Program's Yearly Celebration Clam Bake.

Waters designated for recreational and cultural use shall not contain concentrations of EC bacteria exceeding a 30-day GMV of 126 cfu / 100 mL (based on a minimum of 5 samples).

Water designated for shellfish and crustacean spawning, rearing, and harvesting shall not contain FC levels exceeding a GMV of 14 cfu / 100 mL and no more than 10 percent of the samples used to calculate the GMV shall contain 43 cfu / 100 mL.

Project Administration and Management

PGST Natural Resources staff was primarily responsible for managing and implementing the PGST PIC program. PGST prepared and submitted necessary documentation for planning and reporting, submitted semi-annual reports to the USEPA Puget Sound Financial and Ecosystem Tracking System (FEATS), and facilitated data reporting to USEPA's STOrage and RETrieval (STORET) website through the tribe's network node.

PGST administrated the PIC Program on the reservation and worked closely with Kitsap County Public Health District (KPHD) to plan and conduct Shoreline Surveys in the wet and dry seasons, as well as respond to elevated bacteria levels. PGST coordinated contracts with Spectra Laboratories – Kitsap, LLC for sample analysis and an environmental contractor for assistance with sampling and other program needs.

PGST led planning for regional gap studies based on available pollution trend analyses. PGST worked with county staff to prioritize sample locations for the temporal investigation, MST study, and the optical brightener and tryptophan evaluation.

3 Project Descriptions

The Port Gamble S'Klallam Tribe (PGST) has traditionally harvested shellfish for commercial, subsistence, and ceremonial purposes within areas that are currently prohibited and unclassified for harvest by State and Federal programs. PGST developed coordinated strategies to improve local PIC programs' ability to effectively protect shellfish beds within the tribal U&A harvest areas in Port Gamble Bay and the northern Hood Canal region. The following actions are the result of this undertaking.

Shoreline Surveys

PGST PIC Program conducted wet and dry season shoreline surveys on the PGST reservation in 2015. The wet season survey was conducted on February 24 and the dry season survey on September 25. KPHD was a critical partner for the shoreline surveys and provided valuable support to PGST personnel and contractors throughout the planning, field work, laboratory coordination, sample results review. PGST reservation shoreline survey results filled a lingering data gap in water quality records and allowed KPHD to assess and account for all shorelines in Kitsap County.

The wet season shoreline survey results led to one hotspot confirmation. PGST coordinated with KPHD on response. KPHD and PGST staff led a home visit and dye test in April 2015. The results of this dye test were negative, meaning the source of pollution remained unconfirmed, and subsequent monitoring results showed that water quality improved. Dry season shoreline survey bacteria results yielded no hotspot confirmation and required no investigation (See Appendix B).

A second hotspot investigation was initiated in response to a sewer overflow on the PGST reservation sewer system. PGST determined the source of the spill to be near Bud Purser Lane and began sampling streams in the vicinity. PGST worked with KPHD to confirm the hotspot and began a dye testing strategy for the neighborhood. As part of this ongoing investigation, PGST deployed charcoal filters in the impacted stream to test background conditions. After this, PGST deployed new charcoal filters and conducted dye tests in the lowest elevation houses. After the first dye test period, new charcoal filters were deployed and dye tests conducted on a new set of houses at the next higher elevation in the neighborhood. PGST then continued weekly sampling and coordinated with US Health and Human Services (USHHS). PGST closed the associated beach to shellfish harvest to protect tribal members until water quality improves sufficiently. As of March 2017, correcting this pollution source on the reservation is an ongoing effort.

Photo Credit: Devon Hayes, Due to elevated levels of FC and EC detected in Bud Purser Lane stream this popular shellfish harvest location was forced to close.

MST Literature Review and Study

To date, water quality monitoring and management practices have relied heavily on fecal indicator bacteria (FIB), including *Escherichia coli* and *Enterococcus,* which have low pathogenic potential but abundant presence in sewage and feces. FIB are therefore suggestive of pathogen presence. However, conventional indicators cannot discern between human and animal sources because FIB are present in the feces of most mammals and birds. It is important to distinguish between human and animal derived fecal pollution because of the heightened health risks associated with human sewage and the different remediation strategies for mitigating contamination from sewage versus surface runoff carrying animal waste. PGST conducted a literature review of published methods which have been used to identify microbial sources (see Appendix C). This resulted in the development of a DNA-based microbial source tracking study utilizing PCR and high throughput sequencing. Results of the microbial source tracking study are expected to be available Spring 2017.

Temporal Investigation

PGST coordinated sample collection of EC over a 24-hour period, to test for temporal variation in sample results. PGST collected water samples using a Hach Sigma SD 900 Portable Sampler (autosampler) which collected one sample per hour during the 24-hour sampling periods. Variability in results between samples was enough to warrant a second test, to determine the range of variability between split and replicate samples. A second collection period was coordinated with personnel collecting samples by hand four times a day over 72 hours.

Temporal studies were conducted on the PGST Reservation, and in Jefferson County at Irondale Creek and the Duckabush River. A time of day study was planned at Lofall Creek in Kitsap County during the wet season of 2015-2016 however was eventually canceled after excessive rainfall. Results showed that EC levels did vary significantly with time of day, beyond the variability found between split and replicate samples.

PGST recommends that future projects looking to utilize an autosampler should consider a model which can be easily dismantled and autoclaved. Additionally, unless the autosampler is going to be deployed regularly at a set location with proper infrastructure to house the equipment, using personnel to collect samples by hand is likely the more practical approach. For detailed methods and results of the temporal investigation, see Appendix D.

Tryptophan and Optical Brighteners

PGST used a Turner Designs Cyclops 7 Submersible Fluorometer with tryptophan and optical brightener sensors to determine if *in situ* measurements of tryptophan and optical brighteners are a useful proxy for identifying EC hotspots. Results showed no correlation between optical brighteners and EC at the three temporal investigation sites where the fluorometer was deployed. At one of the three sites, there was a weak correlation between EC and tryptophan (See Appendix D).

Implementation Summary

Table 1: Number of samples analyzed at each survey site

Shellfish Growing Area & County	Site	PGST Shoreline Survey	24-Hour EC Sampling	72-Hour EC Sampling	DNA	Total EC and FC
Port Gamble Bay, Kitsap	PGST Reservation	70	17	99	1	120
Port Townsend, Jefferson	Irondale Creek	-	14	-	1	16
Hood Canal 2, Kitsap	Lofall Creek	-	-	-	2	14
Hood Canal 3, Jefferson	Dosewallips River	-	-	-	8	14
Hood Canal 3 Jefferson	Duckabush River	-	-	104	12	122
Totals		70	31	203	24	286

4 Education and Outreach

Attending Puget Sound PIC workshops and regional meetings was valuable to PGST Natural Resources personnel to understand the broad program opportunities and educational options available. PGST maintained records of meeting agendas and notes in the Tribe's project files. With the understanding gained from these networking opportunities, PGST was able to consider the best ways to reach its audience.

PGST identified two priority audiences, tribal members, and regional policy-makers. To engage with these audiences, PGST developed its own outreach materials. This encouraged PGST to increase its field documentation, associated training and photographs of relevant field activities in U&A areas with actual PGST tribal members and personnel. PGST prepared outreach materials for social media, such as the PGST website and Facebook page. The materials are PowerPoint slides that stand alone to introduce PGST PIC priorities. Additionally, PGST created two PowerPoint presentations that are tailored to the tribal members and policy-makers.

PGST and KPHD conducted outreach and education with property owners and onlookers during field sampling events. Natural Resources Department staff offered presentations to college and grade school students on the reservation. The newly strengthened relationship with KPHD provided excellent networking opportunities for engaging with local policy-makers.

5 References

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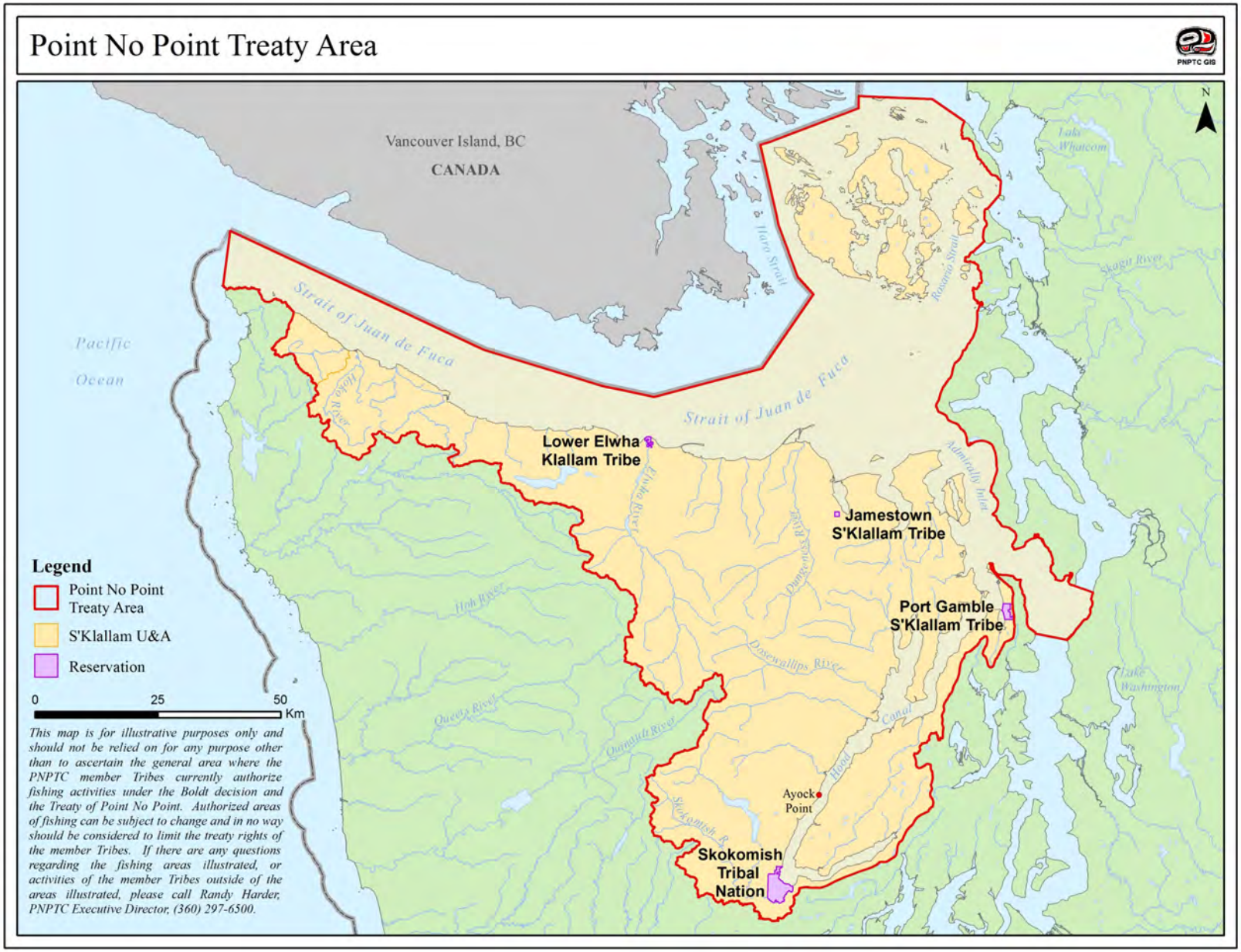
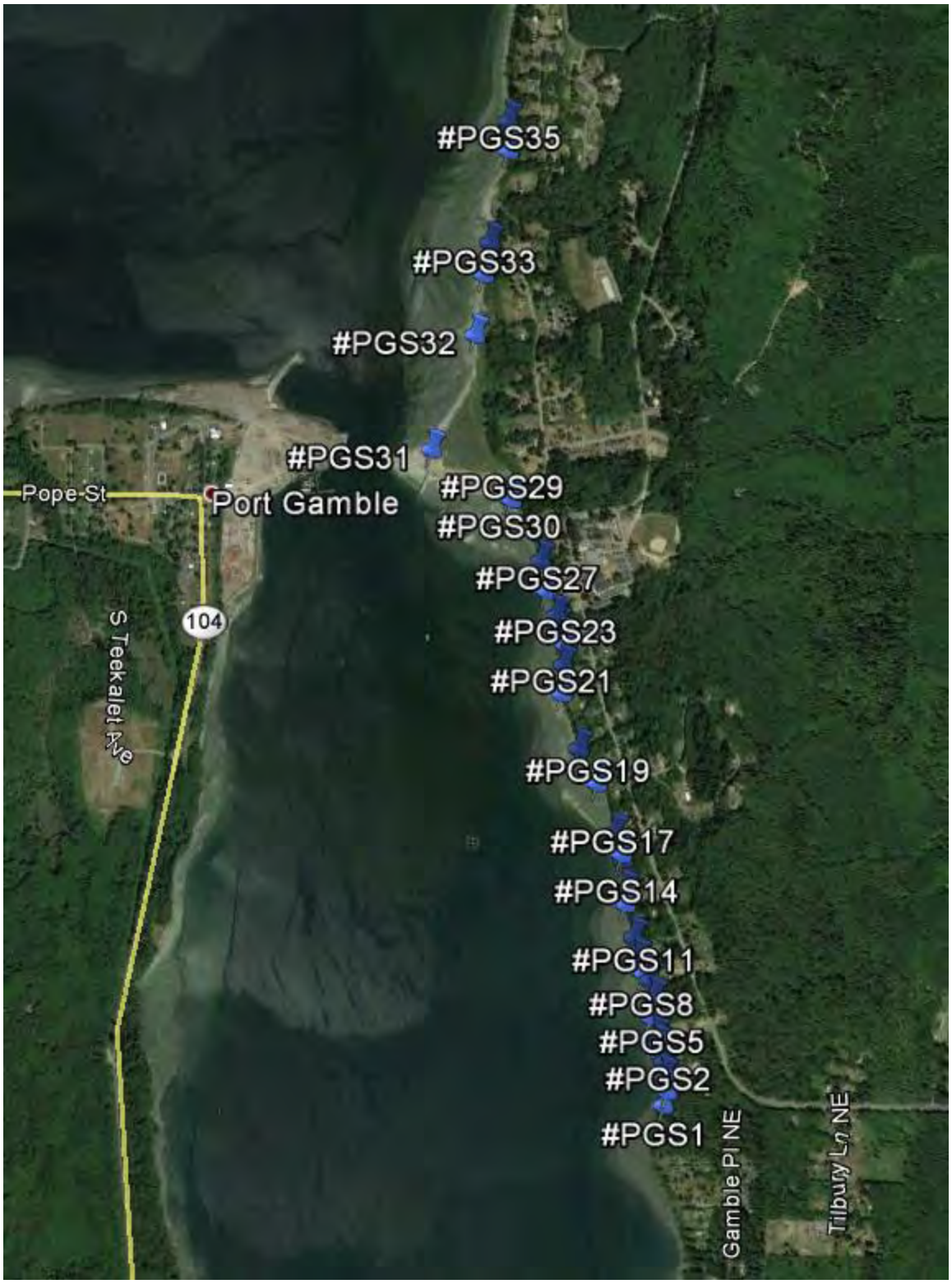

Point No Point Treaty Area
PNPTC GIS
N
Vancouver Island, BC
CANADA
Pacific
Ocean
Strait of Juan de Fuca
Strait of Juan de Fuca
Haro Strait
Rosario Strait
Lake Whatcom
Skagit River
Lower Elwha
Klallam Tribe
Jamestown
S'Klallam Tribe
Port Gamble
S'Klallam Tribe
Admiralty Inlet
Dungeness River
Elwha River
Hoko River
Hoh River
Dosewallips River
Queets River
Quinault River
Hood Canal
Lake Washington
Ayock
Point
Skokomish
Tribal
Nation
Legend
Point No Point
Treaty Area
S'Klallam U&A
Reservation
0
25
50
Km
This map is for illustrative purposes only and should not be relied on for any purpose other than to ascertain the general area where the PNPTC member Tribes currently authorize fishing activities under the Boldt decision and the Treaty of Point No Point. Authorized areas of fishing can be subject to change and in no way should be considered to limit the treaty rights of the member Tribes. If there are any questions regarding the fishing areas illustrated, or activities of the member Tribes outside of the areas illustrated, please call Randy Harder, PNPTC Executive Director, (360) 297-6500.

Appendix B. Shorelines Surveys

Shoreline Monitoring Results and Rainfall Data

Duplicates Displayed (Use Ctrl-Shift-D to toggle)

Station	Date	Time	Rainfall totals			E.coli	Notes	Lat	Long
(units)			*inches*	*inches*	*inches*	*0ml*			
(Standard)			*24hr*	*48hr*	*72 hr*	*126.0*			
#PGS1	02/24/2015	11:56				1.0	Seep under clay bank, blackberries /	47.83886	-122.56671
#PGS1	09/25/2015	08:33				9.5	Seep under clay bank, blackberries /	47.83886	-122.56671
#PGS10	02/24/2015	12:46				11.0	Flow over alder roots off bank /	47.84202	-122.56722
#PGS10	02/24/2015	12:46				3.1	Flow over alder roots off bank /	47.84202	-122.56722
#PGS11	02/24/2015	12:51				1.0	Flow over clay bank, downed tree /	47.84221	-122.56745
#PGS11	09/25/2015	09:01				6.1	Flow over clay bank, downed tree /	47.84221	-122.56745
#PGS12	02/24/2015	12:56				64.4	Bank flow near tire /	47.84257	-122.56768
#PGS12	09/25/2015	09:09				12.0	Bank flow near tire /	47.84257	-122.56768
#PGS13	02/24/2015	13:05				4.1	Small stream, root ball. /	47.84310	-122.56783
#PGS13	09/25/2015	09:16				2.0	Small stream, root ball. /	47.84310	-122.56783
#PGS14	02/24/2015	13:14				0.5	Bank seep, alders above /	47.84395	-122.56814
#PGS15	02/24/2015	13:20				14.5	Flow over clay bank, algae /	47.84428	-122.56817
#PGS15	09/25/2015	09:30				31.3	Flow over clay bank, algae /	47.84428	-122.56817
#PGS16	02/24/2015	13:27				2.0	Composite (2)-Flow under alders & flow to west /	47.84506	-122.56823
#PGS16	09/25/2015	09:34				21.6	Composite (2)-Flow under alders & flow to west /	47.84506	-122.56823
#PGS17	02/24/2015	13:33				4.1	Flow down clay bank, cars above /	47.84520	-122.56827
#PGS17	09/25/2015	09:41				1.0	Flow down clay bank, cars above /	47.84520	-122.56827
#PGS18	02/24/2015	13:40				26.2	Flow under blackberries, black flex /	47.84572	-122.56856
#PGS19	02/24/2015	13:50				4.1	Small creek, downed trees /	47.84699	-122.56920
#PGS19	09/25/2015	09:56				10.8	Small creek, downed trees /	47.84699	-122.56920
#PGS19	09/25/2015	09:56				13.2	Small creek, downed trees /	47.84699	-122.56920
#PGS2	02/24/2015	12:03				2.0	Seep under clay bank, blue tarp above /	47.83921	-122.56658
#PGS20	02/24/2015	13:57				27.5	Small creek, stairs to west /	47.84787	-122.56989
#PGS21	02/24/2015	14:07				2.0	Small creek, flows east to west /	47.84926	-122.57054
#PGS21	09/25/2015	10:06				7.2	Small creek, flows east to west /	47.84926	-122.57054
#PGS22	02/24/2015	14:13				52.0	Flow under large, downed alder /	47.84998	-122.57047
#PGS22	09/25/2015	10:14				21.1	Flow under large, downed alder /	47.84998	-122.57047
#PGS23	02/24/2015	14:18				2.0	Seep from bank, alders /	47.85051	-122.57041
#PGS23	09/25/2015	10:21				3.0	Seep from bank, alders /	47.85051	-122.57041
#PGS24	02/24/2015	14:22				461.1	Bank flow under blackberries /	47.85069	-122.57050
#PGS24	03/26/2015	13:13				410.6	Bank flow under blackberries / 1st Confirmations	47.85069	-122.57050
#PGS24	03/26/2015	13:25				686.8	Bank flow under blackberries / 2nd Confirmation	47.85069	-122.57050
#PGS24	04/21/2015	13:11				4.1	Bank flow under blackberries /	47.85069	-122.57050
#PGS24	09/25/2015	10:26				48.9	Bank flow under blackberries /	47.85069	-122.57050
#PGS25	02/24/2015	14:27				2.0	Bank flow, blackberries, lots of wood /	47.85098	-122.57069
#PGS25	09/25/2015	10:31				5.2	Bank flow, blackberries, lots of wood /	47.85098	-122.57069
#PGS26	02/24/2015	14:30				9.6	Bank flow, trees above /	47.85123	-122.57074
#PGS26	09/25/2015	10:35				114.5	Bank flow, trees above /	47.85123	-122.57074
#PGS27	02/24/2015	14:39				74.8	Small flow next to large tree /	47.85123	-122.57074
#PGS27	09/25/2015	10:39				9.6	Small flow next to large tree /	47.85123	-122.57074
#PGS28	02/24/2015	14:42				7.4	Composite (2 flows)-Either side of cedar /	47.85261	-122.57131
#PGS28	09/25/2015	10:44				3.1	Composite (2 flows)-Either side of cedar /	47.85261	-122.57131
#PGS29	02/24/2015	14:49				2.0	Little Boston Creek /	47.85416	-122.57242
#PGS29	02/24/2015	14:49				5.2	Little Boston Creek /	47.85416	-122.57242
#PGS29	09/25/2015	10:50				34.1	Little Boston Creek /	47.85416	-122.57242
#PGS29	09/25/2015	10:50				59.1	Little Boston Creek /	47.85416	-122.57242
#PGS3	02/24/2015	12:12				3.1	Small flow near roots /	47.83959	-122.56668
#PGS30	02/24/2015	14:50				6.3	Composite-2 white PVC pipes /	47.85421	-122.57253
#PGS31	02/24/2015	15:00				1.0	Small creek at bridge /	47.85543	-122.57543
#PGS31	09/25/2015	11:02				2420.0	Small creek at bridge /	47.85543	-122.57543
#PGS32	02/24/2015	15:09				4.0	Wetland drain-salinity 35 / Salinity-35-Ran as marine water	47.85833	-122.57380
#PGS33	02/24/2015	15:14				4.0	Wetland drain-blue A-frame-salinity 21 / Salinity-21-Ran as marine water	47.85985	-122.57347
#PGS33	09/25/2015	11:15				10.0	Wetland drain-blue A-frame-salinity 21 /	47.85985	-122.57347
#PGS34	02/24/2015	15:18				1.0	Small creek, flowing north to south along beach /	47.86066	-122.57322
#PGS34	09/25/2015	11:21				7.3	Small creek, flowing north to south along beach /	47.86066	-122.57322
#PGS35	02/24/2015	15:24				0.5	Flow parallel to beach, cedars /	47.86298	-122.57254
#PGS35	09/25/2015	11:30				2.0	Flow parallel to beach, cedars /	47.86298	-122.57254
#PGS36	02/24/2015	15:27				0.5	Seep under alders /	47.86372	-122.57255
#PGS36	09/25/2015	11:36				9.7	Seep under alders /	47.86372	-122.57255
#PGS4	02/24/2015	12:18				3.1	Small seep, big stump, alders /	47.83996	-122.56669
#PGS5	02/24/2015	12:23				45.9	Small seep, roots, concrete blocks /	47.84015	-122.56680
#PGS6	02/24/2015	12:27				9.7	Hill flow & flow to west, either side of tree /	47.84038	-122.56692
#PGS7	02/24/2015	12:33				150.0	Large flow under blackberries /	47.84061	-122.56700
#PGS8	02/24/2015	12:38				3.1	Flow down bank, reeds, horsetail /	47.84109	-122.56719
#PGS9	02/24/2015	12:42				12.1	Middle Creek /	47.84157	-122.56708
#PGS9	09/25/2015	08:50				57.3	Middle Creek /	47.84157	-122.56708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#PGS14
#PGS11
#PGS8
#PGS5
#PGS2
#PGS1
Pope St
Port Gamble
104
S Teekalet Ave
Gamble Pl NE
Tilbury Ln NE

Station: #PGS1-N47.83886° W122.56671°

Description: Seep under clay bank, blackberries

Date	EC/100 ml	Sample type
2/24/2015	1	Routine

Station: #PGS2-N47.83921° W122.56658°

Description: Seep under clay bank, blue tarp above

Date	EC/100 ml	Sample type
2/24/2015	2	Routine

Station: #PGS3-N47.83959° W122.56668°

Description: Small flow near roots

Date	EC/100 ml	Sample type
2/24/2015	3.1	Routine

Station: #PGS4-N47.83996° W122.56669°

Description: Small seep, big stump, alders

Date	EC/100 ml	Sample type
2/24/2015	3.1	Routine

Station: #PGS5-N47.84015° W122.56680°

Description: Small seep, roots, concrete blocks

Date	EC/100 ml	Sample type
2/24/2015	45.9	Routine

Station: #PGS6-N47.84038° W122.56692°

Description:

Date	EC/100 ml	Sample type
2/24/2015	9.7	Routine

Station: #PGS7-N47.84061° W122.56700°

Description: Large flow under blackberries

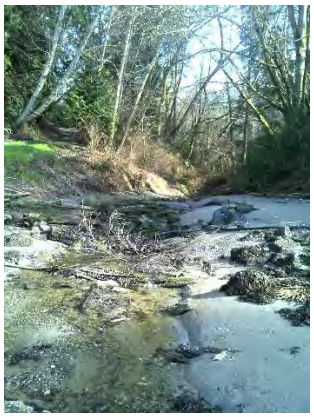
Date	EC/100 ml	Sample type
2/24/2015	150	Routine

Station: #PGS8-N47.84109° W122.56719°

Description: Flow down bank, reeds, horsetail

Date	EC/100 ml	Sample type
2/24/2015	3.1	Routine

Station: #PGS9-N47.84157° W122.56708°



Description: Middle Creek

Date	EC/100 ml	Sample type
2/24/2015	12.1	Routine

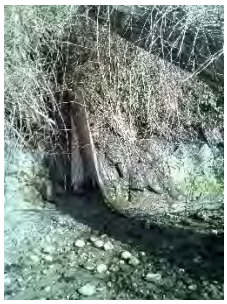
Station: #PGS10-N47.84202° W122.56722°

NO PHOTO

Description: Flow over alder roots off bank

Date	EC/100 ml	Sample type
2/24/2015	11/3.1	Routine

Station: #PGS11-N47.84221° W122.56745°



Description: Flow over clay bank, downed tree

Date	EC/100 ml	Sample type
2/24/2015	1	Routine

Station: #PGS12-N47.84257° W122.56768°

Description: Bank flow near tire

Date	EC/100 ml	Sample type
2/24/2015	64.4	Routine

Station: #PGS13-N47.84310° W122.56783°

Description: Small stream, root ball

Date	EC/100 ml	Sample type
2/24/2015	4.1	Routine

Station: #PGS14-N47.84395° W122.56814°

Description: Bank seep, alders above

Date	EC/100 ml	Sample type
2/24/2015	<1	Routine

Station: #PGS15-N47.84428° W122.56817°

Description: Flow over clay bank, algae

Date	EC/100 ml	Sample type
2/24/2015	14.5	Routine

Station: #PGS16-N47.84506° W122.56823°

Description: Composite (2)-flow under alders & flow to west

Date	EC/100 ml	Sample type
2/24/2015	2	Routine

Station: #PGS17-N47.84520° W122.56827°

Description: Flow down clay bank, cars above

Date	EC/100 ml	Sample type
2/24/2015	4.1	Routine

Station: #PGS18-N47.84572° W122.56856°

NO PHOTO

Description: Flow under blackberries, black flex

Date	EC/100 ml	Sample type
2/24/2015	26.2	Routine

Station: #PGS19-N47.84699° W122.56920°

Description: Small creek, downed trees

Date	EC/100 ml	Sample type
2/24/2015	4.1	Routine

Station: #PGS20-N47.84787° W122.56989°

Description: Small creek, stairs to west

Date	EC/100 ml	Sample type
2/24/2015	27.5	Routine

Station: #PGS21-N47.84926° W122.57054°

Description: Small creek, flows east to west

Date	EC/100 ml	Sample type
2/24/2015	2	Routine

Station: #PGS22-N47.84998° W122.57047°

Description: Flow under large, downed cedar

Date	EC/100 ml	Sample type
2/24/2015	52	Routine

Station: #PGS23-N47.85051° W122.57041°

Description: Seep from bank, alders

Date	EC/100 ml	Sample type
2/24/2015	2	Routine

Station: #PGS24-N47.85069° W122.57050°

Description: Bank flow under blackberries

Date	EC/100 ml	Sample type
2/24/2015	461.1	Routine
3/26/2015	410.6	Confirmation
3/26/2015	686.8	Confirmation

Station: #PGS25-N47.85098° W122.57069°

Description: Bank flow, blackberries, lots of wood

Date	EC/100 ml	Sample type
2/24/2015	2	Routine

Station: #PGS26-N47.85123° W122.57074°

Description: Bank flow, trees above

Date	EC/100 ml	Sample type
2/24/2015	9.6	Routine

Station: #PGS27-N47.85123° W122.57074°

Description: Small flow next to large tree

Date	EC/100 ml	Sample type
2/24/2015	74.8	Routine

Station: #PGS28-N47.85261° W122.57131°

Description: Composite-2 flows-either side of cedar

Date	EC/100 ml	Sample type
2/24/2015	7.4	Routine

Station: #PGS29-N47.85416° W122.57242°

Description: Little Boston Creek

Date	EC/100 ml	Sample type
2/24/2015	2/5.2	Routine

Station: #PGS30-N47.85421° W122.57253°

Description: Composite 2 white PVC pipes

Date	EC/100 ml	Sample type
2/24/2015	6.3	Routine

Station: #PGS31-N47.85543° W122.57543°

Description: Small creek at bridge

Date	EC/100 ml	Sample type
2/24/2015	1	Routine

Station: #PGS32-N47.85833° W122.57380°

Description: Wetland drain-salinity 35

Date	EC/100 ml	Sample type
2/24/2015	<10	Routine

Station: #PGS33-N47.85985° W122.57347°

Description: Wet land drain-blue A-frame-salinity 21

Date	EC/100 ml	Sample type
2/24/2015	<10	Routine

Station: #PGS34-N47.86066° W122.57322°

Description: Small creek, flowing north to south along beach

Date	EC/100 ml	Sample type
2/24/2015	1	Routine

Station: #PGS35-N47.86298° W122.57254°

Description: Flow parallel to beach, cedars

Date	EC/100 ml	Sample type
2/24/2015	<1	Routine

Station: #PGS36-N47.86372° W122.57255°

Description: Seep under alders

Date	EC/100 ml	Sample type
2/24/2015	<1	Routine

2015 E.Coli Bacteria (EC) Hotspot at Station: #PGS24-N47.85069° W122.57050°

Date	EC/100 ml	Sample type
2/24/2015	461.1	Routine
3/26/2015	410.6	Confirmation
3/26/2015	686.8	Confirmation

Description: Bank flow under blackberries (looking east)

EC counts at or above100 EC/100 mL are resampled two times to confirm. A geometric mean value (GMV) of the three sample results over 320 EC/100mL leads to investigation.

GMV calculated by the Kitsap County database for PGS24 is 506. Sampling, photo, and GPS coordinates by Kitsap Public Health District: Kim Jones; Accompanied by Devon Hayes for PGST; EC Results by Twiss Analytical Laboratory, Poulsbo, WA, according to Hood Canal Regional PIC guidance.

Next Steps: Contact adjacent property owner(s) with information and obtain permission to access stream area and yard, Contact PGST Utilities for map of septic connections,

By 4/24/15: Sample site for EC and investigate area with Kitsap Public Health to identify potential fecal pollution sources including animal waste, septic system, or other.

4/27-29: Kitsap and PGST review lab results, determine if indoor dye test is needed, and plan next steps. “Dry Season” shoreline survey will occur before the end of Oct.

2016 *E. coli* Bacteria (EC) Hotspot at Station: #PGS19- N47.84699° W122.56920°

PIC Station 19 Stream Data

Date	EC/100 mL	Sample Type
2/24/15	4.1	Shoreline Survey
8/17/16	**218**	Stream-Response, >100EC/100mL
8/22/16	**1,483**	Stream-Confirmation 1/2, >100EC/100mL
9/7/16	**3,255**	Stream-Confirmation 2/2, >100EC/100mL
9/13/16 **Data Review**	**1,017**	**Stream-Geometric Mean Value** >320 EC/100mL = Investigation

Next: Request Utilities and Septic Map, Request access permission as needed, Sample upstream for EC within dry season, Inspect connections, Map Hotspot area with 200-foot buffer, Decide on coordination with KPH and dye testing needs.

References:

2015 Shoreline Survey by Kitsap Public Health, and Devon Hayes for PGST

2016 Sampling by PGST Natural Resources (SP, HD)

EC Results by SPECTRA Lab, Poulsbo, WA

Hood Canal Regional PIC Guidance: http://www.hccc.wa.gov/sites/default/files/resources/downloads/HCR_PIC_Program_Guidance_3-10-14_Final.pdf

Appendix C. Review of Methods and Markers for Microbial Source Tracking

Introduction

Fecal material containing pathogenic viruses, bacteria, and protozoa creates a public health risk in contaminated environmental water. Sources of fecal pollution in a watershed can be both point and non-point, from diverse human, agricultural and wildlife origins. The ability to track the fate and transport of fecal pollution and distinguish between sources is particularly important for mitigating and managing water quality and waterborne diseases. At present, monitoring for all waterborne pathogens is unrealistic due to the diversity present in sewage and the broad range of costly or challenging methods used to collect and identify pathogenic organisms in environmental samples.

To date, water quality monitoring and management practices have relied heavily on fecal indicator bacteria (FIB), including *Escherichia coli* and *Enterococcus,* which have low pathogenic potential but abundant presence in sewage and feces. FIB are therefore suggestive of pathogen presence. Studies have shown, however, that pathogen presence does not always co-vary strongly and consistently with FIB concentrations since the ecology and fate of FIB outside a host can vary widely (Anderson et al. 2005, Harwood et al. 2005, Colford et al. 2007, McQuaig et al. 2009). FIB can be native or adapted to stream, estuary, and bay habitats and some are shown to persist or even grow in association with aquatic sediments, aquatic vegetation, and terrestrial soils (Whitman et al. 2003, Ishii et al. 2006, Badgley et al. 2011). Furthermore, conventional indicators cannot discern between human and animal sources because FIB are present in the feces of most mammals and birds (Harwood et al., 1999; Souza et al., 1999; Leclerc et al., 2001). It is important to distinguish between human and animal derived fecal pollution because of the heightened health risks associated with human sewage and the different remediation strategies for mitigating contamination from sewage versus surface runoff carrying animal waste. As our knowledge of zoonotic disease potential increases, the need to identify specific sources of animal waste in contaminated water bodies also intensifies.

Despite the limitations of FIB methods, they continue to be broadly used because they offer fast, easy, inexpensive detection. Alternative indicators for waterborne fecal pollution also exist, including viruses, caffeine, and optical brighteners, and molecular markers (Noble et al. 2003, Buerge et al. 2003, Dixon et al. 2005; Glassmeyer et al. 2005, Hagedorn and Weisberg 2009). Using molecular markers to target DNA sequences from host-associated microorganisms or sequences derived directly from the

host offers an analytical approach with unprecedented specificity, sensitivity, and quantitative capacity. Differences in gut conditions such as temperature, diet, and type of digestive system shape the intestinal microbiota and select for microbial communities unique to their respective human or animal host (Sekelja et al. 2011, Shanks et al. 2011). Microbial source tracking (MST) relies on bacterial taxa or genetic markers that occur preferentially or exclusively in the intestinal system of a target host population and are excreted in high abundance through the host feces (Field and Samadpour, 2007). Ideally, MST markers are also directly correlated with public health risks and provide quantitative data for determining total daily maximum loads (TDML) of pollution in water bodies in accordance with state regulations and the federal Clean Water Act (US EPA CWA 303(d)). Advances in next-generation sequencing technologies and microbiome research have resulted in comprehensive inventories of microbial communities associated with a wide range of hosts and environments allowing rapid development and application of targeted genetic markers for microbial source tracking (MST) (Robinson et al. 2010, Lozupone et al. 2012, Quast et al. 2013, McLellan and Eren, 2014).

Overview of Methods

Techniques for MST can be generally divided into two categories, library-dependent and library-independent, with a focus on genetic or phenotypic traits. Phenotypic analyses measure expressed traits of microorganisms whereas genotypic methods detect a specific gene sequence or evaluate genetic polymorphisms (differences) in DNA.

Library-Dependent

Library-dependent techniques require a cultivation step to generate the library of known bacterial isolates from water sources and fecal samples, to which unknown bacterial isolates from environmental samples can be compared. The library of isolate bacteria is characterized by an identifying attribute such as genetic signature, antibiotic resistance or carbon source utilization (Hagedorn et al. 1999, Moore et al. 2005). Phenotypic analyses like antibiotic resistance and carbon source utilization assume that selective pressure alters the antibiotic resistance or metabolic profile of fecal bacteria from different animals and humans because they are likely exposed to different types of antibiotics or organic substrates. Therefore, antibiotic resistance or carbon utilization profiles of easily cultured FIB bacteria from known fecal samples can be used to classify unidentified environmental isolates based on profile similarity. Genotypic library-dependent analyses generally discriminate between *E. coli* or *Enterococcus spp*. based on the assumption that these organisms are uniquely adapted to their known host environment therefore differ genetically from other strains found in other host species.

Ribotyping and Pulsed Field Gel Electrophoresis (PFGE) are commonly used library-dependent genetic techniques (Carson et al. 2001, Stoeckel et al. 2004). Both methods use restriction enzymes to cut bacterial DNA into fragments that are separated by size and visualized as unique banding patterns, or fingerprints, that can be compared to a library of characterized DNA from known fecal bacteria. PFGE digests whole genomic DNA of bacterial isolates and visualizes large DNA fragments on a specialized gel. Ribotyping is based on differences in the genomic sequences within 16S ribosomal ribonucleic acid (rRNA) gene, a gene that is universally present in bacterial genomes and contains hyper-variable regions that are widely used for taxonomic classification of bacterial communities (Chakravorty et al. 2007).

In a comparison of phenotypic and genotypic library-dependent techniques using blind samples containing one to three of five possible fecal sources (human, dog, cattle, seagull, or sewage) all methods could correctly identify the dominant source in most samples (Harwood et al. 2003, Myoda et al. 2003). Overall, the genotypic library-based techniques performed better than the phenotypic techniques (Stoeckel and Harwood, 2007, Sargeant et al. 2011). While the phenotypic methods had high false positive rates (i.e. a source was identified when it was not actually present) the genotypic analyses showed variable sensitivity (Myoda et al. 2003). Issues with all methods were attributed to the statistical tests used to match patterns from blind sample isolates with the host library database and the limited representativeness of libraries (Stoeckel and Harwood, 2007, Sargeant et al. 2011). In order to establish a comprehensive library, observational knowledge of potential sources of fecal contamination is required and many representative fecal samples from target organisms across all geographic sites of interest must be collected. In general, the accuracy of with which environmental samples are classified into fecal source categories varies widely with library size and representativeness (Stoeckel and Harwood, 2007). The need to develop large site-specific libraries (>1000 isolates), that are both time and labor intensive, has decreased interest in using library-dependent approaches (Johnson et al. 2004, Santo Domingo et al. 2011).

Library-Independent

In contrast, library-independent techniques do not require the development of a source library database. These techniques rely on a species-specific genotype or characteristic detected within a mixed environmental sample. Nucleic acid replication via polymerase chain reaction (PCR) is an important genetic tool in library-independent approaches that can be applied to both laboratory-cultivated bacteria and DNA sequences obtained directly from environmental samples. PCR facilitates rapid, preferential amplification of specific nucleotide sequences from a mixture of non-target sequences. As a result, PCR allows detection and examination of gene targets that are strong indicators of fecal source DNA and only requires a small amount of starting

material from cultured bacterial cells or environmental DNA. PCR protocols that detect the presence or absence of a gene sequence are referred to as end-point PCR.

In one of the first library-independent studies, Bernhard and Field demonstrated the use of end-point PCR of the 16S rRNA gene of human-associated *Bacteroidales* to detect human fecal contamination (Bernhard and Field, 2000). This method served as a precursor for many other library-independent gene-specific PCR analyses (reviewed in Harwood et al. 2013). A common end-point PCR method for identifying human fecal pollution not based on the 16S rRNA gene, uses a culture step to enrich for target *Enterococcus faecium* cells and then amplifies and detects the enterococcal surface protein (esp) gene (Scott et al. 2005, Ahmed et al. 2008). Both methods have been shown to be highly sensitive and specific (>90%) (Ahmed et al. 2009, Boehm et al. 2013, Harwood et al. 2013) although additional studies have detected some level of *E. faecium* and human-associated *Bacteroidales* in the feces of animals (Kildare et al. 2007, Whitman et al. 2007; Layton et al., 2009; Boehm et al. 2013). In addition to human-associated microbial gene targets, many PCR methods have been developed to detect common animal sources including dogs, pigs, cows, poultry, gulls and other wild birds. These, and other gene-specific PCR targets discussed below, are adequate to determine the source of fecal microbial pollution in the environment, however, they cannot be used to quantify the amount the fecal pollution and evaluate associated public health risks.

Recently, quantitative real-time PCR (qPCR) assays which allow for more rapid detection of markers, as well as determination of their relative concentrations, have been developed (Dick and Field 2004, Seurinck et al. 2005). qPCR works much like end-point PCR but the accumulation of PCR products is quantified with each reaction cycle using a fluorescence detector. The strength of the fluorescent signal indicates the relative amount of a specific target DNA sequence in a sample (Walker, 2002) and thus can be used in TMDL analysis and subsequent management decisions. In many studies of human and animal-associated gene targets, qPCR methods have been found to more precisely correlate with pathogen presence compared to end-point PCR or other MST methods (Savichtcheva et al. 2007; Walters et al. 2009; Harwood et al. 2013). It should be noted that correlations between MST markers and pathogens have not been found in all studies yet the general conclusion in the field is that *Bacteroidales* markers have a comparable or better ability to predict pathogens compared with conventional FIB methods (Fremaux et al. 2009; Schriewer, et al. 2010).

Oligotyping is a recently introduced computational method that allows the identification of closely related but distinct bacterial strains that would normally be classified as one taxonomic unit. Variations within a single bacterial taxa can result in differential distribution patterns between geographically distinct host populations that can then be used to identify a source population. Eren and colleagues (2015) identified host-specific oligotypes of the bacterial taxon *Blautia* that occurred exclusively in fecal

samples of humans, swine, cows, deer or chickens. Oligotyping has also been used to distinguish between members of the taxon *Helicobacter* found in the gut and feces of wild and domestic animals including seabirds, marine mammals, and dogs (Oxley and McKay 2005).

Whole-community analysis based on bacterial 16S rRNA gene sequencing of fecal and environmental microbial communities demonstrate evidence of host patterns in entire bacterial assemblages. Early studies using whole bacterial communities demonstrated that the native microbial communities in water are changed by the addition of fecal contamination from bovine or equine sources (Cho and Kim 2000, Simpson et al., 2004). More recently, Newton and colleagues (2013) used community sequencing of bacterial 16S rRNA gene to describe three sewer infrastructure-associated bacterial genera and five fecal-associated bacterial families that served as signatures of sewer and fecal contamination in urban rivers and lakes. Other studies have found that microbial communities from the same fecal origin were highly similar and could be used to determine the dominant sources of fecal contamination in water samples (Lee et al. 2011, Cao et al. 2013).

Microarray technology provides high-throughput comprehensive screening of whole microbial communities or targeted MST markers. Microarray platforms contain thousands of short gene sequences for classes of markers specific to indicator organisms, pathogens, and source identifiers that hybridize with PCR products or whole genomic DNA in samples. Multiple microarrays have been designed and used to specifically detect waterborne bacterial pathogens (Miller et al. 2008, Gomes et al. 2015). Specifically for MST applications, the Phylochip microarray for 16S rRNA bacterial community analysis was modified by Dubinsky and colleagues (2016) to detect and distinguish fecal bacteria from humans, birds, ruminants, horses, pigs and dogs. Also, Li and colleagues (2015) developed a custom microarray targeting waterborne viral, bacterial, and protozoan pathogens, well-studied fecal indicator bacteria and markers, antibiotic resistance genes, as well as universal bacterial probes for whole community characterization. While microarray tests can be used to rapidly screen for multiple sources of fecal contamination and identify human health risks, they do not provide quantitative information about the identified sources that may be critical for environmental monitoring applications.

Microbial Targets

Recent MST research has focused on fecal anaerobe markers because of the unlikelihood that these organisms will successfully grow and reproduce outside their host. They are either specifically adapted to or selected for by the host gut, and consequently will be more tightly associated with fecal pathogen presence in the environment. Fecal anaerobes of the taxonomic order *Bacteroidales* have received the

majority of MST research effort (Bernhard and Field, 2000, and reviewed in Harwood et al. 2013); other potential indicators include members of *Clostridiales* and direct pathogen detection.

Bacteriodes

Selected for its high concentrations in feces and tendency to coevolve with its host, the Bacteroides-Prevotella taxon was one of the first targets of library-independent detection based on the HF183 end-point PCR of the 16S rRNA gene (Bernhard and Field, 2000). *Bacteroidales* are gram-negative, obligate anaerobes that occur in human and animal feces at concentrations from 10^9 to 10^{11} cells · g^{-1} and at concentrations of 10^9 cells · $100ml^{-1}$ in sewage (Holdeman et al. 1976, Wexler 2007) compared to traditional FIB that exist at orders of magnitude lower concentrations (10^6 to 10^7 CFU · $100ml^{-1}$ in sewage) (Harwood et al. 2005, Converse et al. 2009). Many studies have confirmed the high sensitivity and general specificity of HF183 and related *Bacteroides* markers for human and animal targets (Kildare et al., 2007, Harwood et al. 2013, Boehm et al. 2013).

Clostridiales

Obligate anaerobes of the phylum Firmicutes, members of the *Clostridiales* are commonly found in the gut of humans and animals. Within this group of organisms, MST focus has been on *Lachnospiraceae*, one of the most abundant groups of faecal bacteria in sewage (McLellan et al. 2013). A strong correlation was observed between between *Lachnospiraceae* and adenovirus, indicating a link between these markers and human pathogen presence (Newton et al. 2011). Members of *Clostridiales* have also been found in high abundance in avian and marine mammal hosts and feces and subsequently been developed as MST markers for these organisms (Oxley and McKay 2005, Green et al. 2012, Koskey et al. 2014).

Pathogens

Direct detection of pathogens in watersheds is beneficial for assessing public health risk. The Centers for Disease Control and Prevention (CDC) has found fecal pathogens shiga-toxin producing *E. coli, Shigella, Salmonella,* and *Campylobacter* as the dominant sources of fecal-associated waterborne disease (Lee et al. 2002). Among the fecal coliform bacteria strains of shiga-toxin *producing E. coli* O157:H7 and the pathogen *Shigella sonnei* both cause a range of intestinal illnesses. The *E. coli* O157 serotype and other pathogenic *E. coli* can be identified by the PCR detection of specific shiga-toxin genes and surface proteins (Maurer 1999, Osek 2003, Duris et al. 2009). Certain *E. coli* toxin genes can also distinguish between cattle and swine fecal pollution presence (Duris et al. 2011). Campylobacter is another leading cause of bacterial gastroenteritis in developed regions. Wild birds and poultry are recognized as sources

of the Campylobacter taxa, *C. jejuni, C. coli* and *C. lari*, frequently implicated in human illness (Butzler 2004). Campylobacter qPCR markers can discern between pathogenic and non-pathogenic strains and have been used to inform public health risk assessment from gull fecal pollution (Lu et al 2011). The issue with direct detection is pathogen strains are normally found in low densities in environmental water, and a cultivation step is required to increase the sensitivity of the assays (Duris et al. 2011).

Non-Bacterial Targets

Viruses

Monitoring for human viruses has been suggested as an alternate approach to assess human health risks in environmental waters. Viruses are generally highly host-specific and do not multiply in the environment or readily degrade under environmental stressors, such as UV irradiance and water treatment processes, unlike traditional FIBs. However, pathogenic viruses usually infect a small percentage of any given population, making them relatively rare targets (and thus more difficult to detect) (Pina et al. 1998). Certain non-pathogenic human viruses have a wider distribution in human populations than pathogenic viruses and their stable nature makes them ideal indicators of other viral pathogens, such as noroviruses and hepatitis A viruses, persistent in the environment (McQuaig et al. 2009). The human adenovirus (HAdV) and human polyomavirus (HPyV) are promising as human fecal indicators, as they are frequently excreted in the feces or urine of humans both with and without clinical symptoms and they are commonly detected in urban wastewater (Bofill-Mas et al., 2001). Certain adenoviruses exist that are specific to livestock as well providing distinction between human or animal-derived fecal pollution (Rusinol et al. 2014). Studies have demonstrated HPyV targets to be 100% specific, showing no cross-reactivity to animal fecal samples (Harwood et al. 2009, McQuaig et al. 2009, Ballesete et. al. 2010)

Archaea

Archaeal methanogens are commonly associated with the oral, vaginal, and intestinal mucosa of mammals (Belay et al. 1998, Belay et al. 1990, Miller et al. 1982, Miller et al. 1986). *Methanobrevibacter ruminantium* and *M. smithii* have been tested for possibilities as ruminant and human markers, respectively (Ufnar et al. 2006, Ufnar et al. 2007). *M. smithii* a methanogenic archaeon found exclusively and abundantly in the human gut and human fecal samples (Lin and Miller 1998, Dridi et al., 2009). Likewise, *M. ruminantium* is specific to the rumen of domesticated animals (Smith and Hungate 1958). The nifH gene is targeted in archaeal indicators because it is a predominantly methanogen-specific gene with sequence differences that can be used to discriminate between methanogen groups. The *M. ruminantium* nifH assay is shown to be successful at detecting cattle, sheep, and goat feces and contamination by agricultural lagoon

waste in environmental water samples (Ufnar et al. 2007). The *M. smithii* marker has high sensitivity against human sewage pollution especially in coastal waters but did show some cross-reactivity with bird feces (Ufnar et al. 2006, Johnston et al. 2010).

Direct source detection

The first fecal source tracking method based on a eukaryotic genetic marker was the end-point PCR assay targeting the human mitochondrial DNA (mtDNA) NADH dehydrogenase subunit (Martellini et al., 2005). mtDNA was proposed as a marker based upon the premise that it should be abundant in feces and especially host-specific. Other studies have used qPCR probes to target human, bovine, ovine and swine mtDNA for use as indicators in source tracking studies of shellfish harvesting areas (Baker-Austin et al. 2010). Developments in biodiversity monitoring using environmental DNA (eDNA), genetic material obtained directly from environmental samples from any organism, have also found application in fecal source tracking. Utilization and contamination of waterbodies by various wildlife, human, and domesticated animals can be detected through eDNA markers (Thomsen and Willerslev 2015).

Evaluation of Source Tracking Methods

Any satisfactory MST method must comply with a set of performance criteria (Stoeckel and Harwood, 2007). Some performance criteria are universally applicable while others depend on the objectives of a particular study (Santo Domingo et al. 2007). The key universal criteria are described here.

Sensitivity

The sensitivity of a MST method is defined by the percentage of true positive results detected. Sensitivity indicates the robustness of an assay provided that targets are present at or above detection levels. Samples spiked with fecal material or other known contaminated samples are used to directly test the number of positive controls correctly identified as positive by the assay. Physical or chemical properties of the water matrix or sample type may impair the sensitivity of certain methods (Siefring et al. 2008).

Specificity

The specificity of a MST marker is represented by the rate of false positive results or the percentage of negative results correctly ascribed to samples known to lack the host target in question (Stoeckel and Harwood, 2007). A highly-specific MST marker should not cross-react with unintended targets and accurately identify only target source species. It is desirable that a marker is tested against as many nontarget

fecal samples as possible to better constrain limitations of method specificity (Harwood and Stoeckel, 2011)

Stability

The stability criteria dictates that changes in environmental or biological conditions due to seasonal or regional differences should not affect the presence of MST targets in host feces. A stable marker does not vary in frequency or concentration over time at the population level, has consistent detection across all geographic regions of the host range, and exhibits predictable rates decay in all habitats and water matrices (Sargeant et al. 2011).

Challenges for stream, river, and estuarine systems

Understanding eDNA detection rates in lotic systems is critical for inclusion of eDNA analysis as a reliable survey method in fecal source tracking. The concentration of DNA in rivers and streams depends on dynamics between eDNA released into the water, downstream transport and losses to the system through physical, chemical and biological processes. The contribution and rate of production of eDNA by various organisms has been the focus of only a few studies (Pilliod et al. 2014, Thomsen et al. 2012, Klymus et al. 2015) and is likely influenced by the size, sex, health, and density of members in a population. Difficulty measuring the transport and residence time of eDNA in riverine systems also poses challenges to describing the geographic origin of eDNA and making spatial interference about the source organism(s). A study by Deiner and Altermatt (2014) observed movement of eDNA five to ten kilometers downstream of the source population within a 24hr sampling period, indicating that eDNA can persist over relatively large distances in a river system. It has been shown, however, that eDNA concentrations are generally localized and do not appear to accumulate downstream (Deiner and Altermatt 2014, Pilliod et al. 2013, Laramie et al. 2015). Dilution and removal processes such as settling and degradation, likely reduce the amount of detectable eDNA over time and as it travels downstream thereby limiting accumulation (Dejean et al. 2011, Jane et al. 2014).

Recommendations

In a review and critique of MST methods, the Washington State Department of Ecology highlighted the lack of standardized, validated, promulgated, and U.S. Environmental Protection Agency approved molecular MST methods. Sargeant and colleagues (2011) proposed the following quality assurance sampling for substantiation of results: 1) Field samples duplicated for reproducibility information; 2) Preliminary testing of source feces from the study area to confirm the source-specific MST indicator or marker is present; 3) Samples spiked with fecal material from each potential source per study as positive controls; 4) Samples from presumably uncontaminated sites as

field negative controls. The use of multiple MST techniques in parallel, was also recommended to overcome the experimental nature of fecal source tracking methods and to produce acceptable levels of accuracy, reproducibility, and investigation of numerous potential source types. Furthermore, library-independent methods are recommended over library-dependent methods because they typically have a lower cost and provide much faster results (Sargeant et al. 2011).

The Toolbox Approach

Because rivers, streams and estuaries can have considerable temporal and spatial variability in microbial water quality from a multitude of human and animal-derived sources, a monitoring strategy that captures data about all potential sources is optimal. No one marker has all the requisite performance qualities for identifying and quantifying the source and magnitude of fecal pollution in water. Thus, a toolbox approach using a suite of techniques and molecular markers, producing multiple lines of evidence, is considered important to effective microbial source tracking (Harwood et al. 2013).

Monitoring, mitigation, and management of fecal pollution can be costly to coastal communities, which depend on uncontaminated water bodies for tourism, recreation, and fisheries (Rabinovici et al. 2004). Most public advisories and closures in recreation areas and shellfisheries are posted without specific knowledge of the type and source of fecal contamination (NRDC, 2006). A better understanding and implementation of MST will facilitate targeted remediation, enhance protection of public health, and minimize economic costs associated with fecal pollution in water systems.

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Appendix D. Temporal Studies, Tryptophan, and Optical Brighteners

PGST coordinated sample collection of EC over a 24-hour period, to test if there are advantages to sampling at certain times of day. PGST collected water samples using a Hach Sigma SD 900 Portable Sampler (autosampler) which collected one sample per hour during the 24-hour sampling periods. Variability in results between samples was enough to warrant a second test, to determine the range of variability between split and replicate samples. A second collection period was coordinated with personnel collecting samples by hand four times a day over 72 hours.

Temporal studies were conducted on the PGST Reservation, and in Jefferson County at Irondale Creek and the Duckabush River. A temporal study was planned at Lofall Creek in Kitsap County during the wet season of 2015-2016 however was eventually canceled after excessive rainfall. Results showed that EC levels did vary significantly temporally, beyond the variability found between split and replicate samples.

PGST recommends that future projects looking to utilize an autosampler should consider a model which can be easily dismantled and autoclaved. Additionally, unless the autosampler is going to be deployed regularly at a set location with proper infrastructure to house the equipment, using personnel to collect samples by hand is likely the more practical approach.

Additionally, PGST used a Turner Designs Cyclops 7 Submersible Fluorometer with tryptophan and optical brightener sensors to determine if *in situ* measurements of tryptophan and optical brighteners are a useful proxy for identifying EC hotspots. Results showed no correlation between optical brighteners and EC at the three time of day study sites where the fluorometer was deployed. At one of the three sites, there was a weak correlation between EC and tryptophan.

24-Hour Sampling- Preliminary Temporal Study

Photo Credit: Devon Hayes, Hans Daubenberger deploying autosampler and optical brightener probe at Irondale Creek.

24-hour sampling was conducted between April 21 and 22nd 2015 on the PGST Reservation at Shoreline Survey Station PGS 24, which was a confirmed hotspot from the wet season survey. 24-hour sampling was also conducted in Jefferson County at the Irondale Creek PIC monitoring station PH028 between August 26 and 27th 2015.

PGST staff used a programmable Hach Sigma SD 900 Portable Sampler (autosampler), set up with a (24) 575mL Bottle Kit for automated sampling. The autosampler was programmed to automatically collect discrete water samples at preset or fixed-interval times over no more than a 24-hour period. These containers were cleaned and decontaminated between 24-hour sampling events. At the end of the 24-hour test, PGST personnel transferred water samples into 110 milliliter bottles

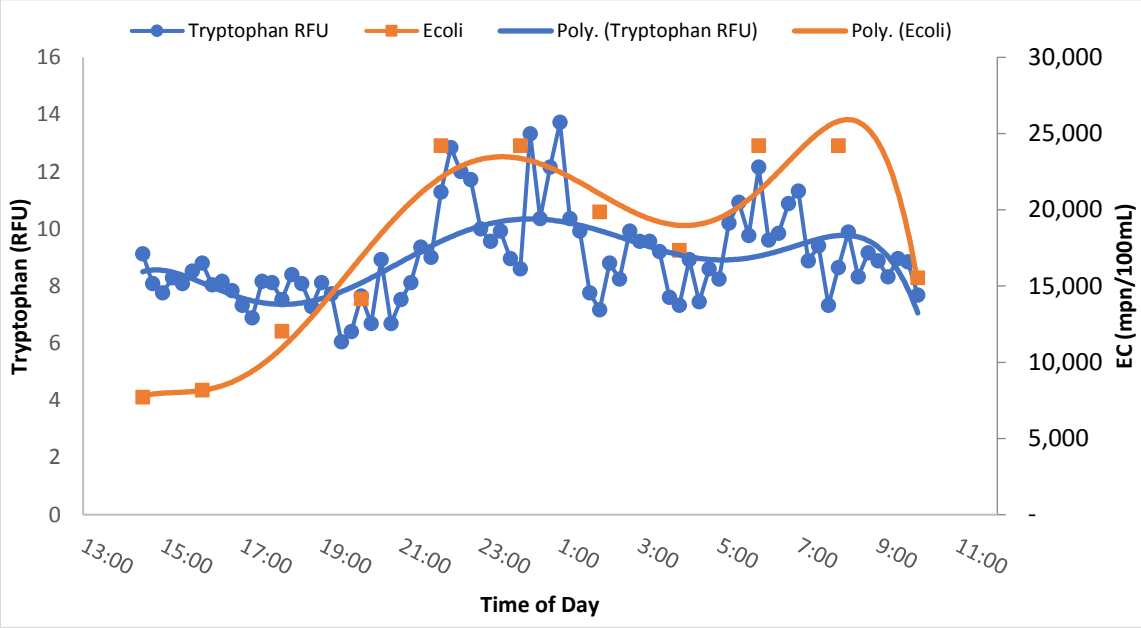
and immediately delivered them to the laboratory for analysis. Two to three blind split replicates were also delivered to the lab to examine variation. PGST staff programmed the autosampler to pump water through the tubing between samples to prevent bacteria growth and potential bias in analytical results.

PGST also collected discrete grab samples at the beginning before installing the autosampler and the end of the sampling period. This was to ensure samples were representative of the stream conditions at the time period and not potentially contaminated by bacteria from previous collection events, or otherwise influenced by the holding time or sampling system.

Results from the Reservation ranged between 1.0 and 248.1 mpn/100mL. The standard deviation was 63.7 and the coefficient of variation was 2.08, showing that results were disperse between samples taken at different times of day at this site. Irondale Creek yielded higher EC levels with a lower variation. Results ranged between 7701 and 24196 mpn/100mL with a standard deviation of 5750.1 and a coefficient of variation of 0.33.

During the 24hr sampling period of Irondale Creek, a Turner Designs Cyclops 7 Submersible Fluorometer was also deployed, to sample tryptophan and optical brightener levels at 15 minute intervals. Results showed a minor correlation between EC levels and tryptophan (r = 0.2453, Figure 1), but much less association with optical brighteners (r = 0.1662).

Figure 1. Tryptophan and EC levels at Irondale Creek



72-Hour Sampling

This sampling design was intended to determine variation between different temporal samples and single events (collected within 20 minutes). Greater variation between single event samples than the variation amongst different temporal samples would suggest there is no benefit to implementing temporal sampling, however if variation between single event samples is

significantly less than variation between temporal samples, then temporal sampling may improve hotspot identification.

72-hour sampling was conducted on the PGST Reservation upstream of Shoreline Survey station PGS 19, near Bud Purser Lane. The other 72-hour test location was at the Duckabush River tributary (also known as Pierce Creek) next to the Brinnon Volunteer Fire Station (42). The PGST Environmental Contractor (Devon Hayes) collected the water samples by hand during the 72hr test according to standard operating procedures for collection and handling EC samples.

Methods

Collection events took place at 8am, 12pm, 3pm, and 8pm on Oct. 31st-Nov. 2nd at the PGST Reservation site and on Nov. 14th-16th at the Duckabush River. Two 100 mL and three 50 mL samples were collected from the stream within 30 seconds of one another. Next, the first 100 mL sample was gently agitated and 50 mL was poured into the sixth sample bottle to produce a split replicate. This process was repeated for the second 100 mL sample to create a second split replicate, for a total of seven samples to be delivered to the lab.

At 3pm, three additional replicates were collected and held overnight, to determine whether longer holding time affected results of sample analysis. Field blank samples consisting of distilled water were submitted blind to the laboratory at a rate of one per sample batch. Salinity analysis was conducted on Duckabush River samples to test for effects of high tide on the site. Sampling on the PGST Reservation was located in a stream well above the high tide line and therefore did not require salinity analysis.

Samples were delivered to the laboratory immediately following collection at 8am, 12pm, and 3pm, excepting the three additional field replicates collected at 3pm. 8pm samples were submitted to the laboratory immediately following the 8am sample collection, with the 8am samples and the select replicates from 3pm the day before.

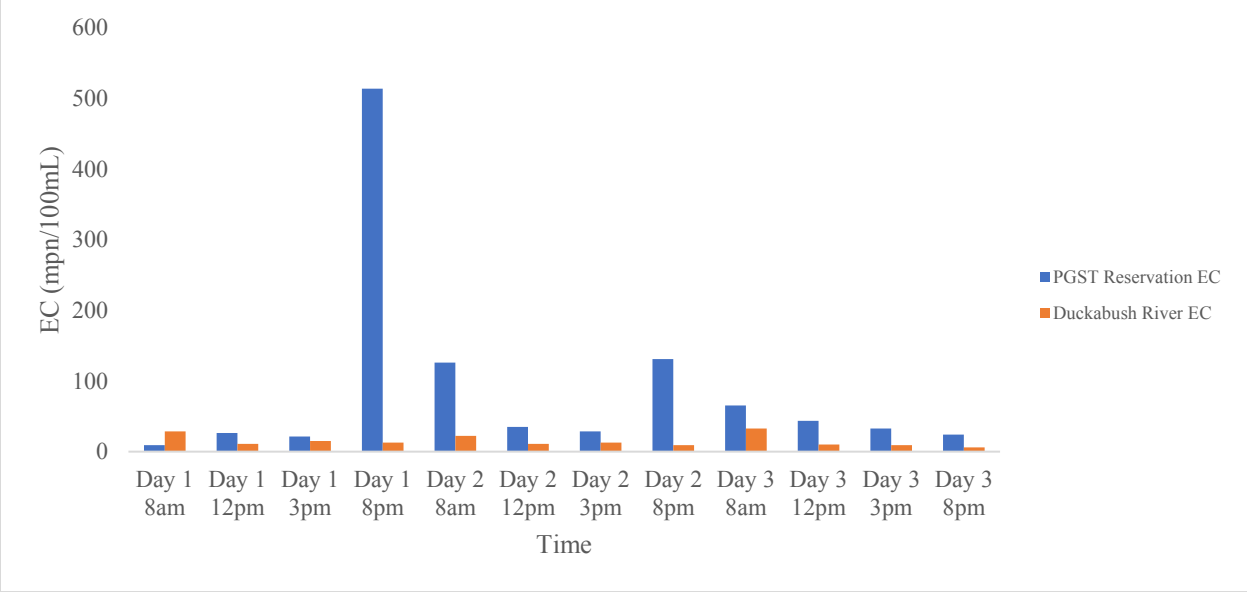
The Turner Designs Cyclops 7 Submersible Fluorometer was deployed at the PGST Reservation site just downstream of the EC sampling location on Oct. 30th and retrieved on Nov. 3rd. The fluorometer was deployed at the Duckabush River just after the 12pm measurement on Nov. 14th, and retrieved on Nov 18th. Optical brighteners and amino acid tryptophan measurements were set to be taken every 15min. The values recorded 15min before, during, and 15min after the EC sampling event times were averaged to give corresponding tryptophan and optical brightener values.

Results

A total of 99 water samples were collected over 72hrs for PGST Reservation EC analysis, including 6 blanks of distilled water. The first 7 samples were collected at the shoreline, and the rest upstream primarily for safe access, and a more controlled environment that adequately represented site conditions. Analytical results for EC ranged between less than 10 mpn/100mL to 783 mpn/100mL, which was detected at 8pm on 10/31/16 (Figure 2).

For the Duckabush River 72-hour test, 104 water samples were collected for EC analysis, including 12 distilled water blanks. 10 water samples were analyzed for salinity after the sample station was found inundated by king tides. EC results ranged from less than 10 mpn/100mL to 63 mpn/100mL, which was detected at 3pm on the third day (Figure 2).

Figure 2. Results of 72-hr E. coli test. Results of primary samples (n = 5 for each sampling event, no splits or blanks included) were averaged for each sampling event.



In the Duckabush River, E. coli values were highest at 8:00am on each of the three days sampled. At 8:00pm on October 31st, E. coli values at Bud Purser were approximately 4x higher than results from any other sampling event at that site during the 3 days studied. EC values varied significantly with time of day, in both systems, for each day sampled (Table 1). Samples did not vary notably within a single sampling event, however variance did increase as EC values increased.

Table 1. P-values for analysis of variance between EC sampling events (TOD) for Bud Purser and Duckabush (Single Factor Anova). *indicates a significant result

Bud Purser		Duckabush	
Date	P-value	Date	P-value
31-Oct	3.38E-15*	14-Nov	0.012226*
1-Nov	1.3E-05*	15-Nov	0.046141*
2-Nov	0.008859*	16-Nov	0.000164*

Split samples were not significantly different from their counterparts in either system (BP p = 0.8178, DB p = 0.7489, Anova: Two-Factor without Replication). Holding samples on ice for 6-17.5hrs before delivering them to the lab did not significantly alter results (BP p = 0.8025, DB p = 0.4770 Anova: Two-Factor without Replication).

At both sites Tryptophan and Optical Brightener values varied significantly between days (Tryptophan: DB p = 0.036616, BP p = 5.13E-07, Optical Brighteners: DB p = 4.62E-09, BP p =1.63E-15). Time of day had varied results (Tables 2 and 3).

Table 2. P-values for analysis of variance between Tryptophan sampling events for Bud Purser and Duckabush (Single Factor Anova, except 14-Nov which was a t-Test paired two sample for means). *indicates a significant result

Bud Purser		Duckabush	
Date	P-value	Date	P-value
31-Oct	5.87E-10*	14-Nov	0.97613
1-Nov	0.081139	15-Nov	0.065428
2-Nov	0.074953	16-Nov	0.177793

Table 3. P-values for analysis of variance between Optical Brighteners sampling events for Bud Purser and Duckabush (Single Factor Anova, except 14-Nov which was a t-Test paired two sample for means). *indicates a significant result

Bud Purser		Duckabush	
Date	P-value	Date	P-value
31-Oct	0.026521*	14-Nov	0.076448
1-Nov	0.001722*	15-Nov	1.01E-05*
2-Nov	0.349408	16-Nov	4.13E-07*

Despite the variability, both Tryptophan, and Optical Brighteners were significantly higher in Bud Purser than in the Duckabush River ($p = 4.49E-05$, $p = 1.38E-27$ respectively). Optical brighteners were highest at Bud Purser on Nov 1st, and Tryptophan was highest on October 31st (Figure 3, Figure 4). There was no correlation between Tryptophan or Optical Brightener values and E. coli levels, suggesting that neither can serve as a sufficient proxy for EC at the two sites tested.

Figure 3. Results of the 72-hr optical brighteners data collection. Values are an average of results collected within a 30-min time window of corresponding EC sampling event times (n=3 for each sampling event).

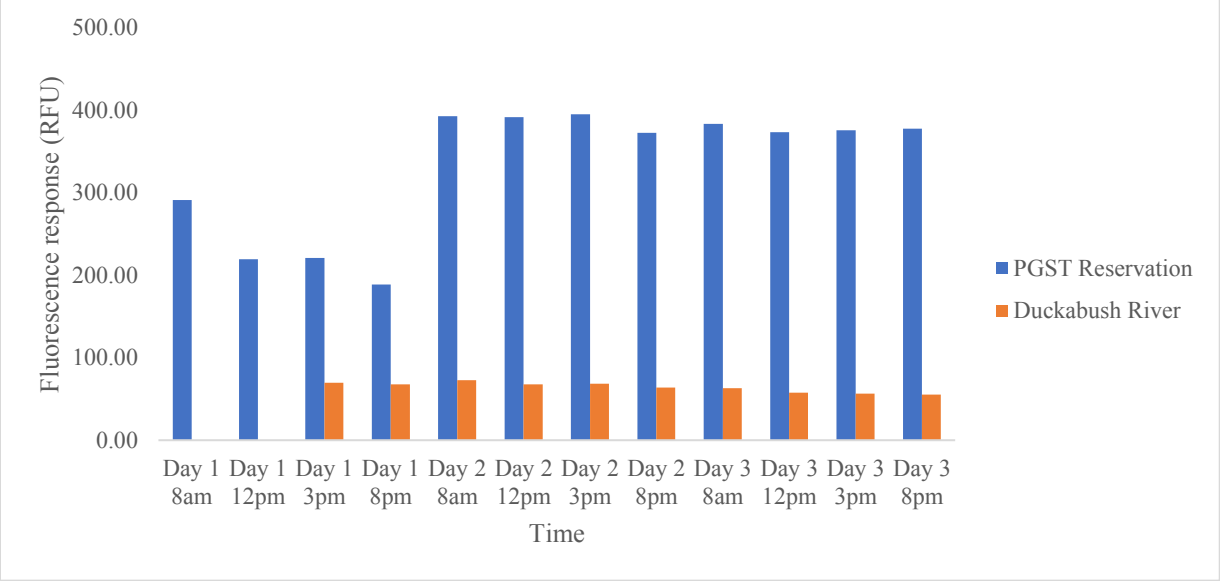
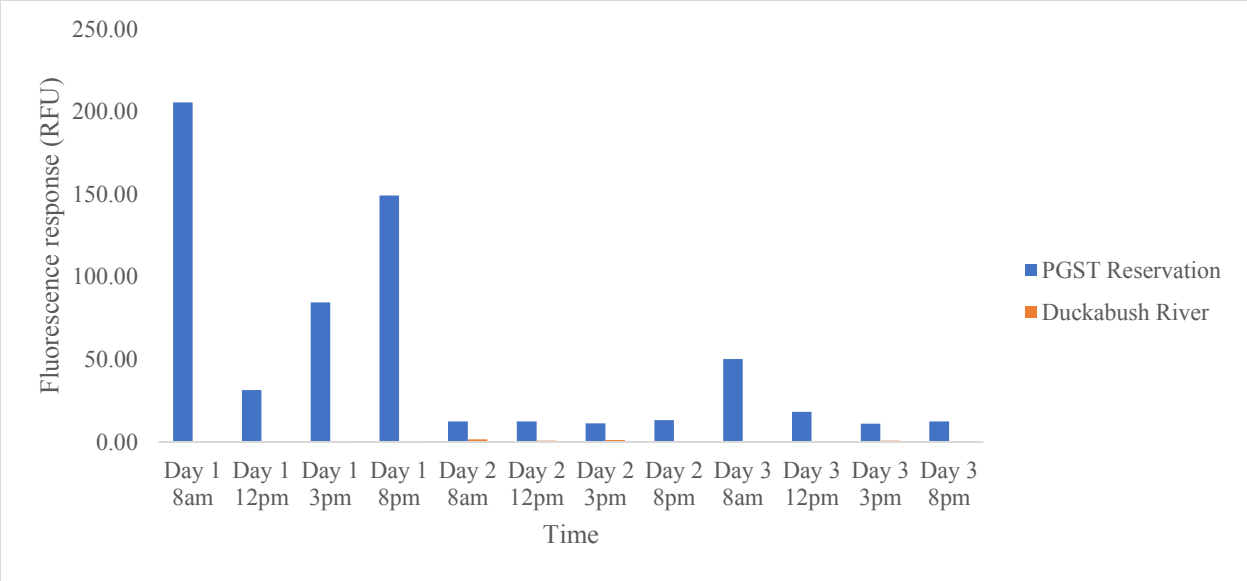


Figure 4. Results of the 72-hr tryptophan data collection. Values are an average of results collected within a 30-min time window of corresponding EC sampling event times (n = 3 for each sampling event).



Recommendations

Temporal sampling[1] in important shellfish harvest and recreational areas would likely reduce human exposure to fecal contamination.

Temporal sampling is valuable for increasing the probability of correctly identifying hotspots and reducing the risk to human health through exposure to fecal bacteria.

The temporal investigation results showed that variation was low between samples taken within a sampling event[2], but samples taken at different times of day produced results above and below threshold criteria for hotspot identification.

In situ tryptophan and optical brightener sampling is unlikely to be a good proxy for EC contamination. Tryptophan and optical brighteners may provide evidence of anthropogenic fecal contamination.

To evaluate the usefulness of tryptophan and optical brighteners for determining anthropogenic fecal contributions, an informative follow-up study could include the analysis of diluted samples from waste treatment facilities relative to environmental samples from systems with varying fecal concentrations.

[1] Temporal sampling in this report refers to collecting a minimum of 4 samples 3hrs apart over a 12hr interval.
[2] A sampling event in this study refers to a set of samples taken within 30 seconds of one another collectively representing one particular time of day.