Hood Canal Coordinating Council

Hood Canal Regional Pollution Identification and Correction Program – Phase II

Evaluation of Nutrient Loading from Seepage Pits in Hood Canal

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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 onsite 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 2). 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 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 3. 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 4 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

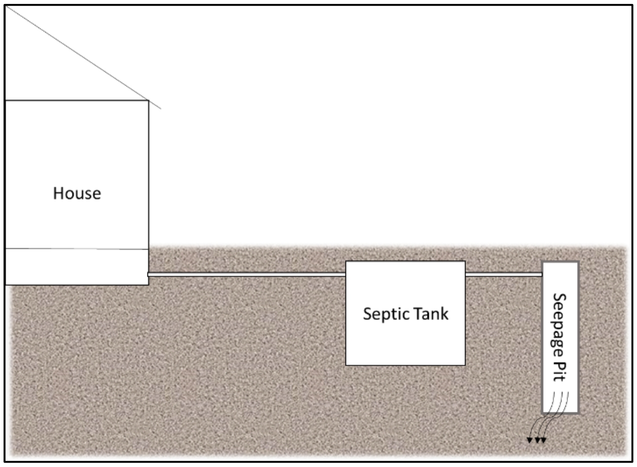

Figure 1. Generalized schematic of septic system with seepage pit.

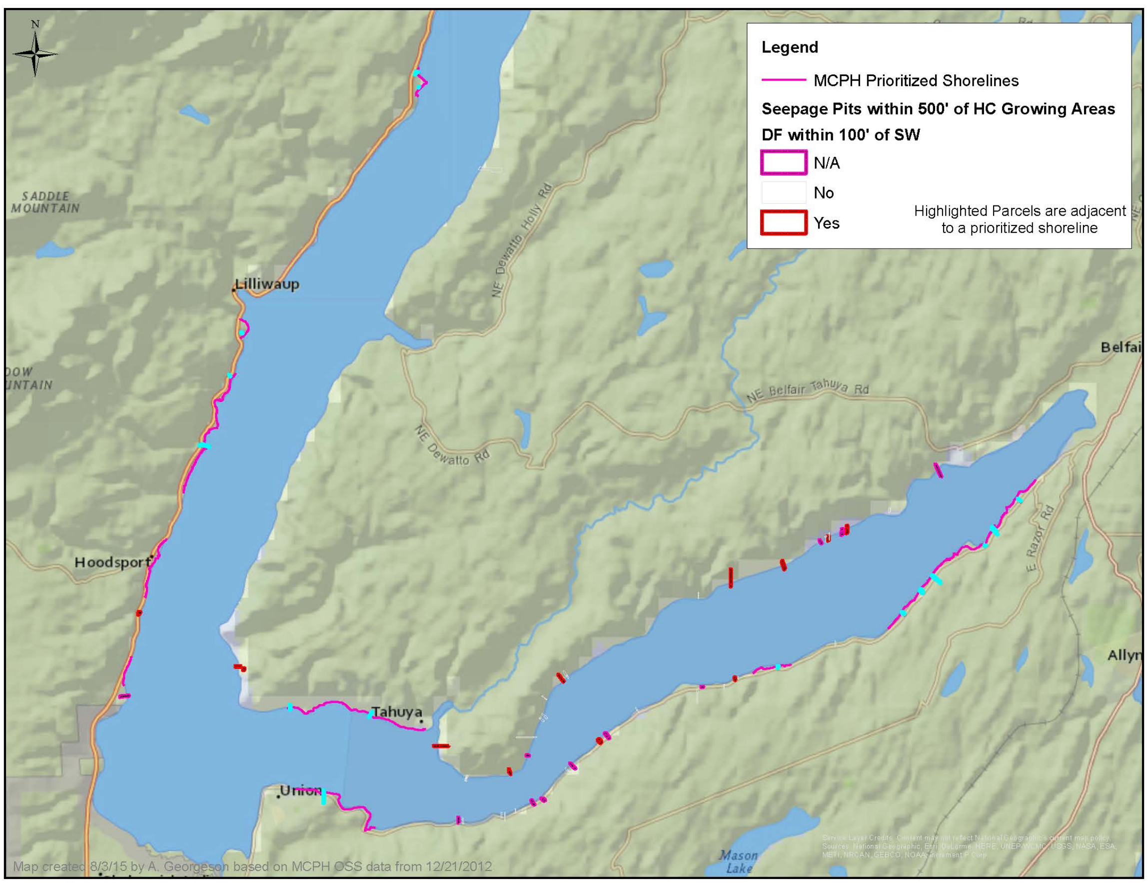

Figure 2. Approximate locations of household seepage pit systems in Mason County located within 100 ft. of the Hood Canal shoreline. Map produced by Washington State Department of Health

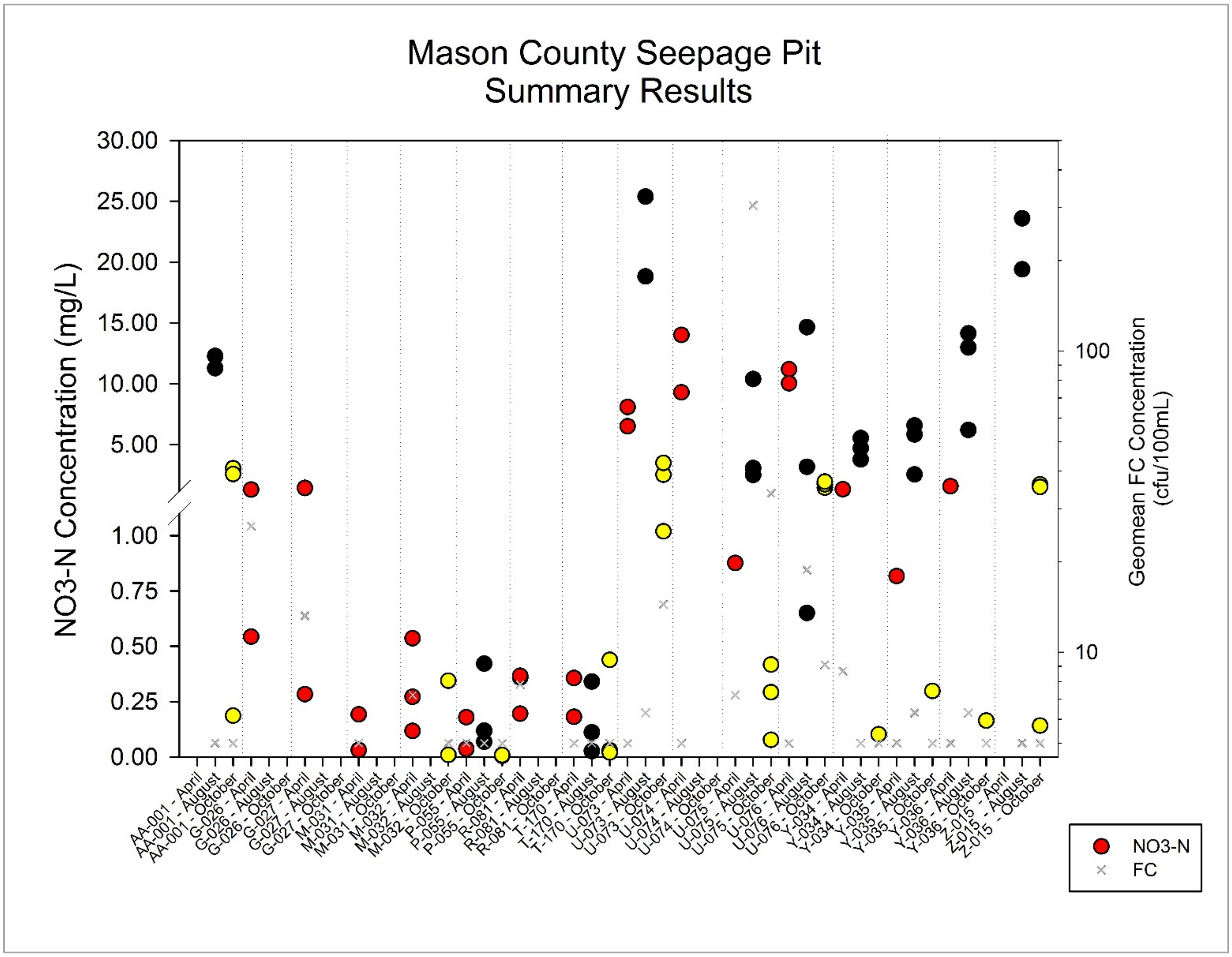

Figure 3. Summary of sampling results by site and sampling month. Analytical results for chloride (Table 4) indicate that several of the sampling sites were influenced by marine water and are likely not indicative of local groundwater conditions. These sites include: AA-001, G-026, G-027, U-073, U-074, and Y-034.

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

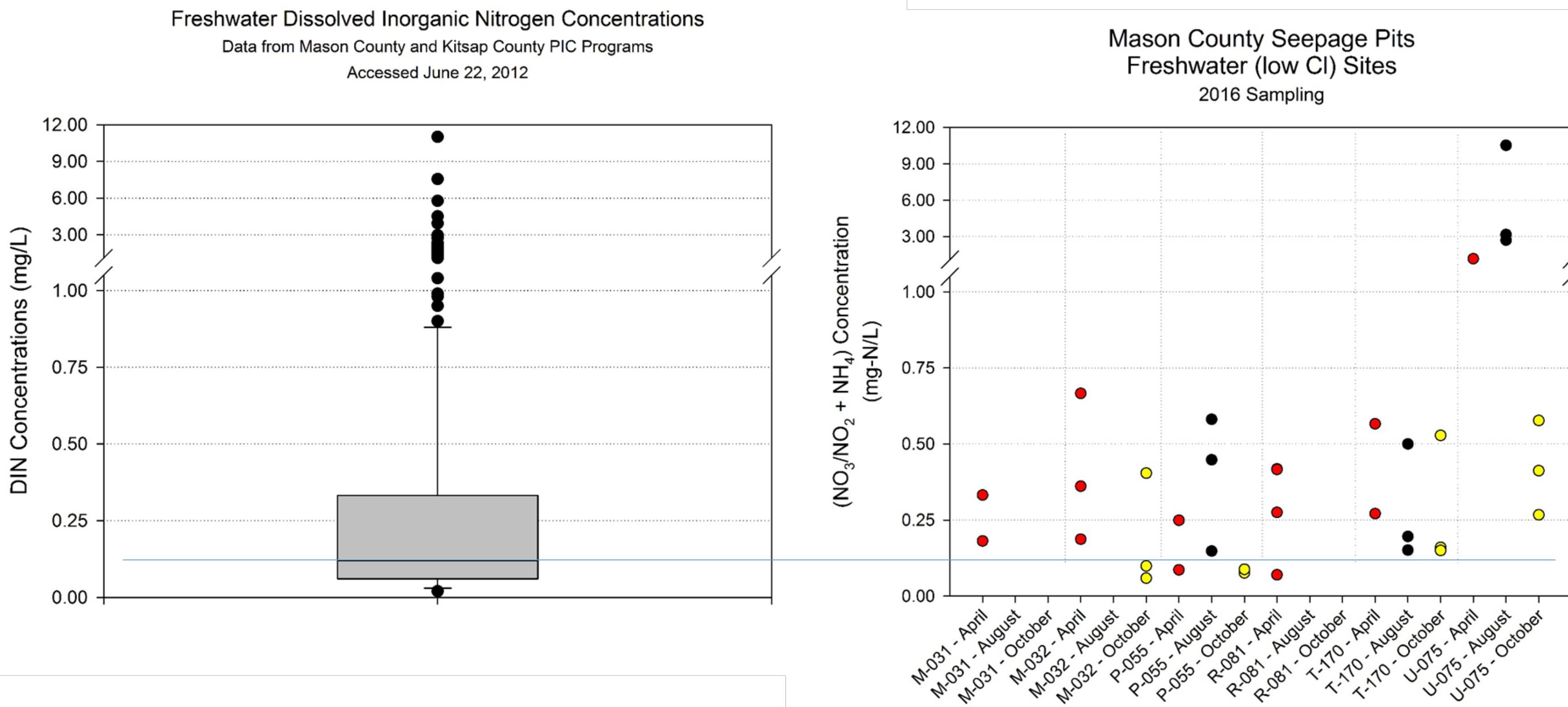

Figure 4. Comparison of Dissolved Inorganic Nitrogen (DIN) concentrations for data from sites associated with seepage pits (right pane) compared to a reference distribution from samples collected from the Hood Canal between 2007-2011 (n=560; left pane). All data was screened to exclude samples with probable 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.

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
			Sample Date												
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
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

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	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
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

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	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