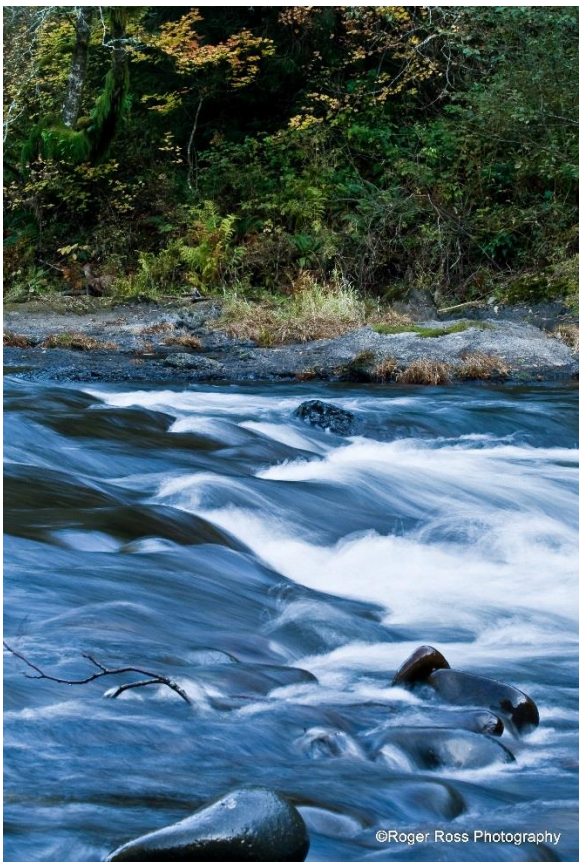
Tillamook Estuaries Partnership
Volunteer Water Quality Monitoring Program

Bacteria Status and Trends Analysis

September 5th, 2018



Prepared by York Johnson, TEP Water Quality Coordinator

Background

E. coli, enterococcus, and fecal coliform bacteria concentrations in many streams, bays, and beaches in the north coast of Oregon are at levels that exceed the State standards for recreational contact and shellfish harvest. These waterbodies usually occur lower in the watersheds and are associated with urban and agricultural landscapes. DEQ has subsequently developed three Total Maximum Daily Loads (TMDLs) in the north coast of Oregon: the North Coast Subbasins, Tillamook Bay Watershed, and Nestucca Bay Watershed to address this problem.

The Tillamook Estuaries Partnership began monitoring *E. coli* bacteria in the Tillamook Bay Watershed in 1997, as part of its Volunteer Water Quality Monitoring Program (VWQMP) to evaluate bacteria levels in the rivers and streams. The data collected by TEP were used in the development of the aforementioned Tillamook Bay TMDL, 2001. The program expanded to include most of the major rivers and streams and all five estuaries by 2013. The ongoing monitoring effort includes 74 sites throughout Tillamook County. Data have been used by DEQ to determine the status and trends of bacteria concentrations in relation to water quality. The most recent analysis took place in spring of 2017 and will be discussed later in the document.

Volunteer Water Quality Monitoring Program Description

TEP uses citizen scientist volunteers to collect water sample at established monitoring locations throughout Tillamook County. Approximately 8 volunteers collect water samples for TEP twice a month on a year-round basis. The Tillamook County Creamery Association (TCCA) collects samples from the 6 sites on the Wilson River on a monthly basis and provides the results to TEP. VQWMP water samples are brought to the TEP office where they are processed and analyzed for bacteria using IDEXX equipment and methods. The TCCA processes and analyzes samples internally and provide *E. coli* bacteria concentrations to TEP.

Sample results are recorded by TEP staff and entered into an online database. Recent results are available to the public through an interactive map on TEP's website. Every two years TEP compiles, formats, and rates all data per DEQ protocols for accuracy. (The VWQMP data generally rate as "A" quality). The bacteria data are forwarded to DEQ, which compares the most recent two years of data to the appropriate State water quality standards to determine the status of the streams, sloughs, and bays. DEQ also performs regression analysis for each site to determine if statistically significant changes (trends) in bacteria concentrations are present. TEP and DEQ use this information to inform partners and the general public about water quality changes in the coastal area.

Sampling Design and Monitoring Protocols

TEP worked closely with DEQ to develop the sampling design for this program. Sampling locations were selected to correspond with DEQ's 303(d) listed reaches, monitoring locations identified in the TMDLs, and sites that encompass all estuaries in TEP's study area. The sampling locations were chosen based on two essential requirements: (1) locations must be within water quality limited streams or their tributaries identified in the TMDL and (2) each site is publicly accessible. Whenever possible an additional location was included beyond the upper boundary of the water quality limited reach in order to verify that the listed reach was truly representative of the elevated bacteria concentrations. All sampling sites are located at road bridges, boat ramps, or other areas that are open to the public. Long-

term access to these monitoring locations is critical to the success of this effort because data need to be collected over an extended time period.

TEP monitoring follows DEQ protocols for field sample collection. Samples are collected in sealed 120ml sterile bottles supplied by IDEXX or similar provider. Each sample bottle is labeled with a waterproof mark on the cap and bottle. Both the cap and bottle have the name of the sampling location and time of collection. This information is required for each sample bottle including duplicate sample bottles.

Samples are collected in one of two ways: hand grab from shore or sampling bucket. The hand grab method requires volunteers to wade into the water and walk upstream and fill the bottle while facing upstream. Samples are collected between the surface and one foot below the surface. Samples are then placed in a cooler with ice for transport to the TEP office.

The sampling bucket method is used to lower the sample bottles from bridges or stream banks at overly steep, confined, or overgrown portions of the river. A bucket with an attached rope containing the sample bottle is used for sampling in these areas. Samples are taken from the upstream site of the bridges and in midstream. Samples are collected by lowering the sample bottle to at least one foot below the surface. The sample is then placed in a cooler for transport and analysis.

One duplicate sample is collected at a single rotating location per sampling event. Duplicate samples are collected to measure precision between samples and rate the quality of the data from the samples. Duplicate samples are collected in separate containers directly after or at the same time as the original sample. The bottle is marked with the letters FD for Field Duplicate.

In addition to the protocols outlined above, TEP has documented all quality control and quality assurance procedures for this effort in a DEQ approved Quality Assurance Project Plan (QAPP) entitled Volunteer Water Quality Monitoring Program QAPP June 12, 2002. The QAPP was updated by TEP and approved by the EPA National Estuary Program in 2012.

Oregon Water Quality Standards for Bacteria

The State of Oregon has established three (3) water quality standards for bacteria to be protective for recreational use and shellfish consumption. Each of these standards monitor a different bacteria species: *E. coli* for freshwater recreation, enterococcus for coastal recreation, and fecal coliform for shellfish. TEP only collects bacteria data for recreational use in freshwater and coastal use. These standards have two criteria that need to be met to protect users from unacceptable risk to exposure to pathogens in polluted water. The first is a limit for a single sample and the second is a geometric mean (an average) of a minimum of 5 samples collected within a 90 day period. The standards are listed below:

Freshwater contact recreation:
A 90-day geometric mean of 126 *E. coli* organisms per 100 mL
No single sample may exceed 406 *E. coli* organisms per 100 mL

Coastal water contact recreation:
A 90-day geometric mean of 35 enterococcus organisms per 100 mL
Not more than ten percent of the samples may exceed 130 organisms per 100 mL

Water Quality Status and Trend Analysis

Water Quality Status

TEP provides all bacteria data collected through this effort to DEQ for a status and trend analysis. DEQ utilizes "R", a free programing language and software environment, to compare bacteria results to State bacteria standards for *E. coli* and enterococcus. These standards are protective for recreational use in freshwater and estuary waters, respectively. The status of a site is determined biennially by comparing the last two, most current, years of data to the State standard and determining the percent of samples that exceed both criteria for recreational use. This analysis first began in 2006 and has continued with the most recent analysis in 2016 including data from January 2015 through March of 2017 (Table 1). DEQ's bacteria water quality status assessment for all Tillamook sites is provided in Appendix A.

Table 1. Examples of bacteria data comparison to State water quality standards (Jan 2015-Mar 2017)

Sites are classified based on percent exceedances during the past two years: less than 6% (green) generally meets criteria; between 6% and 30% (orange) have seasonal exceedances; greater than 30% (red) consistently exceed criteria

ID	Station_Description	Samples	Exceeded	Percent	Sample Stats
N6	Anderson Creek at North Fork Road	92	1	1%	1 Single, 0 geomean
TR1	Trask River at Cedar Creek	130	2	2%	1 Single, 1 geomean
WR3	Hughey Creek at Hwy 6	55	1	2%	1 Single, 0 geomean
NE1	Nestucca at Woods	134	5	4%	2 Single, 3 geomean
Mi2	Mill Creek at Brickyard	105	9	9%	4 Single, 5 geomean
LN1	Little Nestucca at 101Boat Ramp	134	11	8%	3 Single, 8 geomean
NF10	North Fork Nehalem River	91	11	12%	3 Single, 8 geomean
NE8	Three Rivers at Hebo Bridge	134	23	17%	3 Single, 20 geomean
TL2	Tillamook River at Bewley Creek Rd	143	55	38%	4 Single, 51 geomean
N3	Gallagher Slough at HWY 101	91	36	40%	13 Single, 23 geomean
C3	Hoquarten Slough at Hwy 101	103	45	44%	14 Single, 31 geomean
TR6	Holden Creek at Tillamook River Rd	121	88	73%	22 Single, 66 geomean

Water Quality Trends

Once the status of a site is determined, DEQ uses "R" to conduct a Seasonal Kendall regression analyses on the entire bacteria concentration dataset available for each individual site (Figure 1). The data available for an individual site range from 1997 for sites on the Wilson River to as recently as 2013 for sites on the Sand Lake Estuary (Appendix B). The confidence interval for the trend analysis increases with the number of years of data included in the analysis. Generally, DEQ requires at least 8 years of

data to have the highest confidence in the results.

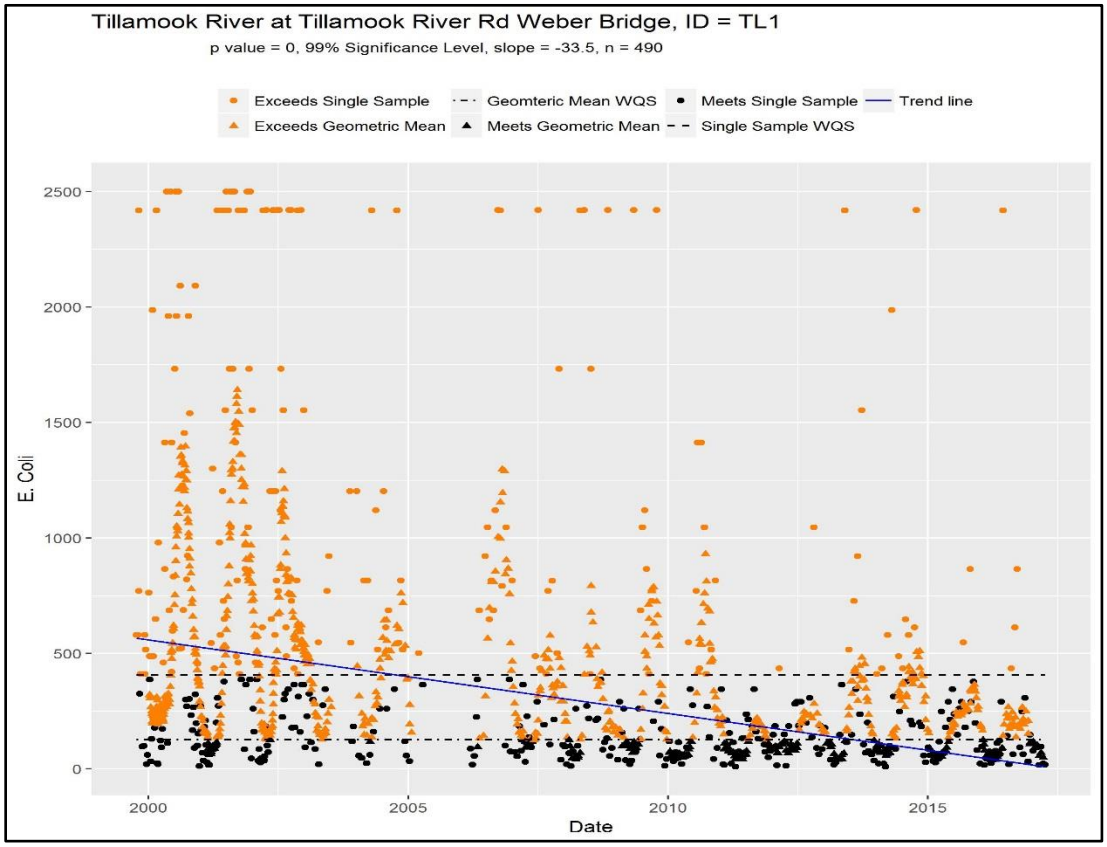


Figure 1. Seasonal Kendall analysis of bacteria concentration trends at Weber Bridge, Tillamook River (2000 – 2017)

Negative slope (-33.5) with 99% significance level indicates a statistically significant decrease in bacteria concentration, which means water quality is improving.

The Seasonal Kendall regression calculates slope, which indicates the change in bacteria concentration over time: a negative (positive) slope means the bacteria concentrations are decreasing (increasing) and water quality is improving (declining). Statistically significant bacteria trends (≥80% significance level) are represented by downward pointing (↓) and upward pointing (↑) arrows in an infographic to communicate results of the analysis (Figure 2). If the slope is less than 2 counts in either direction for a give site, the bacterial concentration is consider steady and is represented with a horizontal line (−). Season Kendall regression results by site are provided in Appendix C.

Results:

Tillamook and Netarts Bay Watersheds

In general, the Wilson and Kilchis rivers have been meeting recreational standards since 2005 and 2009, respectively. Dougherty Slough began meeting water quality standards in 2015. The Tillamook River, while not meeting standards, continues to improve at all monitoring locations. Mill Creek is not meeting standards but bacteria levels are no longer increasing as in past analyses. Hoquarton Slough bacteria levels are higher than the recreational use standards but water quality is improving as of the 2016 analysis. Tillamook Bay is not meeting standards at two of the three monitoring locations but does show improvement at the upper- most monitoring site. The bacteria levels in Netarts Bay are generally meeting standards at the site closest to the mouth of the estuaries, but not higher up in the estuaries. However, the sites are influenced by near shore activities and may not be representative of water quality in the center of the bay where oyster production occurs. ODA has a regular monitoring effort in Netarts Bay associated with commercial oyster production.

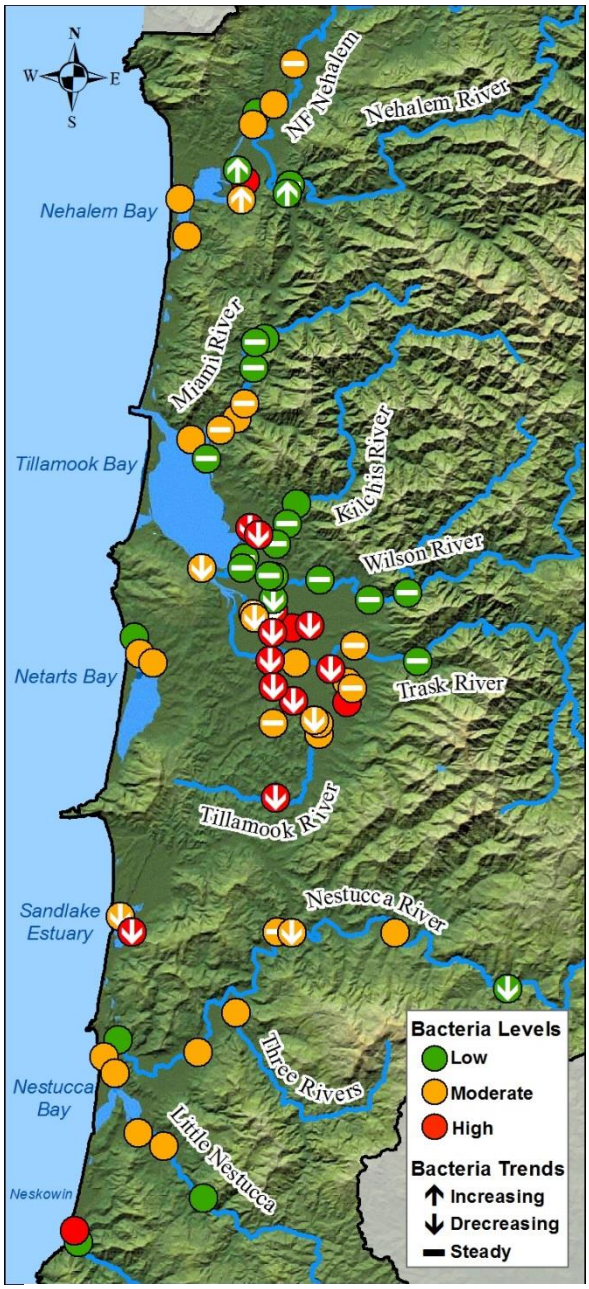


Figure 2. Bacteria levels and trends throughout Tillamook County.

Nehalem Bay Watershed

The Nehalem River has been meeting water quality standards since 2010. However, two of the sites are showing moderate increases in bacteria concentrations. Some of the smaller tributaries to the Nehalem River have levels of bacteria above the standards. Gallagher Slough has the most consistently high bacteria levels. The Nehalem Bay is not meeting water quality standards for recreational use at any of the monitoring locations with seasonal exceedances present.

Nestucca, Neskowin, and Sand Lake

The Nestucca River watershed was added to the VWQMP in 2012. As a result, less data are available making it challenging to establish trends. Generally, the lower reaches of the Nestucca River and the Little Nestucca River are not meeting the recreational use standard. However, further upstream monitoring sites are meeting standards, with a trend present at the uppermost site on the Nestucca

River. Sand Lake Estuary is not meeting water quality standards; however, both monitoring sites are showing improvements in water quality. Less than eight years of data are available for this estuary; therefore, the trend result has lower confidence. Hawk Creek is not meeting standards and continues to experience elevated levels of bacteria in the late summer, early fall months. Based on results of TEP monitoring data, Neskowin Beach has been added to the Oregon Health Authority Beach Monitoring Program. The beach has had two beach advisories in the past three years.

While monitoring shows that improvements are being made in many of the watersheds as it relates to the State's recreational standards for bacteria, opportunities for improvement exist. Using VWQMP results, TEP identifies and prioritizes degraded areas and works with partners to target lowering bacteria levels in waterways that are not meeting standards.

Monitoring Objectives

As described in TEP's VWQMP grant, the first objective of the project was to acquire data at the appropriate scale and frequency in order to determine if water quality standards are being met or exceeded. TEP has identified the status of water quality related to bacteria at all of its monitoring locations. TEP and partners are currently monitoring 74 sites; 26 sites (35%) are generally meeting water quality standards; 33 sites (45%) have seasonal exceedances and are a concern for water quality; and 15 sites (20%) are consistently exceeding standards and show poor water quality.

The second objective of the project was to provide a continuous long-term dataset to allow DEQ to determine if statistically significant changes are occurring throughout the watersheds. TEP has included the dataset as part of this compliance report. Of the 74 monitoring sites, 45 sites (61%) have statistically significant trends. Among the 45 sites with significant trends, 21 sites (46%) show decreasing bacteria concentrations trends with corresponding improvements in water quality; 21 sites (46%) indicate a steady bacteria concentrations and water quality, and the remaining 3 sites (6%) show increasing bacteria concentrations though two of these sites currently meet water quality standards.

Finally, the specific hypothesis that TEP and partners are attempting to test is that restoration projects are improving water quality as it relates to bacteria concentration at the monitoring network scale. While bacteria related water quality still needs improvement, overall progress has been documented through TEP's VWQMP and DEQ's water quality analysis.

Next Steps: inform future actions

TEP's VWQMP continues to be implemented through the collection of 74 water quality samples twice a month on a year-round basis. The information generated through the VWQMP will continue to be used by many partners to focus future resources and monitor past efforts. The Oregon Department of Agriculture (ODA) uses this information to inform its North Coast Agriculture Water Quality Management Plan. ODA CAFO program uses this information to understand the effectiveness of the program's work in Tillamook County and to shift resources to areas where water quality problems continue. The Tillamook Soil and Water Conservation District also relies on this information in a similar manner.

DEQ has used this data to craft three SP-12 success stories for the EPA through its 319 grant program which, along with OWEB, has funded several water quality improvement projects in the watersheds. Since January of 2018, the TEP VWQMP data have been used to update a success story about the Wilson River for the Oregon Conservation Effectiveness Partnership (CEP) which includes agency partners such as the Oregon Watershed Enhancement Board (OWEB), the Oregon Department of Environmental Quality (DEQ), Oregon Department of Agriculture (ODA), and the Natural Resources Conservation Service (NRCS). In addition, result of the program, including water quality status and trend information, have been included in the following TEP presentations: ODFW's Restoration and Enhancement Program board meeting, ODA LAC Biennial Meeting, North Coast Water Quality Summit, and the Tillamook Working Lands and Waters Tour.

Appendix A

DEQ Bacteria Water Quality Status Assessment

Station_ID	Station_Description	Total_Observed	Total_Exceed	Percent_Exceed
M5	Miami River at Miami Forest Rd Bridge (Bridge out no samples)	53	0	0%
WR1	Wilson River at Hwy 6 Mills Bridge	54	0	0%
WR5	Wilson River at Solle Smith Rd Bridge	54	0	0%
WR7	Wilson River Milk Hole	54	0	0%
WR6	Wilson River at Hwy 101	55	0	0%
N4	Nehalem River at Foley Road (Roy Creek Campground)	97	0	0%
C4	Dougherty Slough at Hwy 101	101	0	0%
NE9	Nestucca 12 miles up Blaine Rd logging Rd	117	0	0%
M4	Miami River at Stuart Creek Bridge	126	0	0%
LN3	Little Nestucca 4.2 miles up L. Nestucca Rd	127	0	0%
M3	Miami River at road mile 3.0	129	0	0%
K2	Squeedunk Slough at Geinger Farm	140	0	0%
K4	Kilchis River at Alderbrook Rd Bridge	143	0	0%
K5	Kilchis River at Curl Rd Bridge	143	0	0%
K6	Kilchis River at logging road bridge	135	1	1%
NT1	Netarts Bay at Happy Camp	99	1	1%
N6	Anderson Creek at North Fork Road	92	1	1%
TR1	Trask River at Cedar Creek boat launch	130	2	2%
WR3	Hughey Creek at Hwy 6	55	1	2%
WR8	Wilson River at Geinger Farm dock	51	1	2%
TB3	Tillamook Bay at Ghost Hole	69	2	3%
NE1	Nestucca at Woods	134	5	4%
N2	Foley Creek at Lommen Road	98	4	4%
NS1	Neskowin Creek at Watermaster Office	91	4	4%
N0	Nehalem R at HWY 101 (Nehalem Bay Ramp)	101	5	5%
NT2	Netarts Bay access west of Boat Ramp	98	5	5%
NT3	Netarts Bay at Netarts RV Park & Marinia bridge	102	6	6%
TB2	Tillamook Bay at Picket Fence	83	6	7%
TR11	Trask River at Hwy 131 Bridge below STP	124	9	7%
TL10	Tillamook River Upstream of Hwy 101 Rest Area	136	10	7%
TL12	Fawcett Creek at Hwy 101	135	11	8%
LN1	Little Nestucca at 101Boat Ramp	134	11	8%
TB5	Tillamook Bay at Port of Garibaldi Pier	72	6	8%
Mi2	Mill Creek at Brickyard and Mill Crk Rd	105	9	9%
NE7	Nestucca 5 miles up Blaine Rd	130	12	9%
TR2	Trask River at Long Prairie Rd Johnson Bridge	130	12	9%
NB2	Nehalem Bay at Brighton Marina	64	6	9%
TR5	Trask River at Hwy 101	130	15	12%
NF10	North Fork Nehalem River at Mcdonald Road Bridge	91	11	12%
TR7	Trask River at Carnahan Park	130	17	13%
M6	Miami River at Hwy 101	122	20	16%
NE4	West Creek at 101	134	22	16%
M2a	Miami River at Moss Creek Rd Bridge	129	22	17%
NE8	Three Rivers at Hebo Bridge	134	23	17%
NB3	Nehalem Bay at Nehalem Bay State Park	67	12	18%
NB4	Nehalem Bay at Wheeler Ramp	61	11	18%
SL2	Sandlake at Sandlake State Park day use	66	12	18%
TL11	Killiam Creek at Hwy 101 (Sampling discontinued)	132	25	19%
NE10	Nestucca Bay at Pacific Ave bridge	88	17	19%
NF8	North Fork Nehalem River at North Fork Rd	98	20	20%
NE5	Nestucca River at 1st bridge boat ramp (u/s Beaver)	127	26	20%
NE11	Nestucca Bay at Brooten Boat Ramp	96	20	21%
LN2	Little Nestucca 1.3 miles up L. Nestucca Rd	134	28	21%
TL4	Tillamook River downstream of Hwy 101 Rest Stop	138	30	22%
NF1	Coal Creek at North Fork Rd	91	20	22%
NE2	Nestucca at Cloverdale	133	36	27%
Mi1	Mill Creek Trib at Brickyard Rd	92	26	28%
M2	Miami River at road mile 0.5	129	37	29%
TL13	Bewley Creek at Bewley Creek Rd Bridge	137	40	29%
SL1	Sandlake at Whalen Island bridge	77	24	31%
TL0	Tillamook River at Tillamook River Rd Burton Bridge	121	38	31%
K12	Vaughn Creek at Hwy 101	141	53	38%
TL2	Tillamook River at Bewley Creek Rd Bridge	143	55	38%
N3	Gallagher Slough at HWY 101 (Nehalem)	91	36	40%
NS2	Hawk Creek at State Park	91	37	41%
C3	Hoquarten Slough at Hwy 101	103	45	44%
TL1	Tillamook River at Tillamook River Rd Weber Bridge	143	63	44%
TL7	Tillamook River at Yellow Fir Rd Bridge	130	66	51%
K3	Hathaway Slough at Hwy 101 Bridge	142	73	51%
C2	Holden Creek at Evergreen Rd	76	42	55%
TR4	Mill Creek at Long Prairie Rd Bridge	129	73	57%
C1	Holden Creek at Marloff Loop Rd	77	47	61%
Mi3	Mill Creek Trib at Brickyard Rd. beyond Magnolia	82	54	66%
TR6	Holden Creek at Tillamook River Rd	121	88	73%

Appendix B

Tillamook Estuaries Partnerships VWQMP Sites

Site ID	Site Description	Watershed	Latitude	Longitude	Parameters	Period
C1	Holden Creek at Marloff Loop Rd	Trask	45.450960	-123.813972	E. coli	2003 to present
C2	Holden Creek at Evergreen Rd	Trask	45.449305	-123.828459	E. coli	2003 to present
C3	Hoquarten Slough at Hwy 101	Trask	45.459145	-123.844161	E. coli	2003 to present
C4	Dougherty Slough at Hwy 101	Trask	45.465199	-123.844309	E. coli	2003 to present
K12	Vaughn Creek at Hwy 101	Kilchis	45.504802	-123.865413	E. coli	2003 to present
K2	Squeedunk Slough at Geinger Farm	Kilchis	45.487893	-123.868635	E. coli	1999 to present
K3	Hathaway Slough at Hwy 101 Bridge	Kilchis	45.501067	-123.858423	E. coli	1999 to present
K4	Kilchis River at Alderbrook Rd Bridge	Kilchis	45.496165	-123.843841	E. coli	1999 to present
K5	Kilchis River at Curl Rd Bridge	Kilchis	45.508191	-123.835348	E. coli	1999 to present
K6	Kilchis River at logging road bridge	Kilchis	45.519559	-123.828814	E. coli	1999 to present
M2	Miami River at road mile 0.5	Miami	45.566643	-123.879463	E. coli	1999 to present
M2a	Miami River at Moss Creek Rd Bridge	Miami	45.574971	-123.873755	E. coli	1999 to present
M3	Miami River at road mile 3.0	Miami	45.595479	-123.867833	E. coli	1999 to present
M4	Miami River at Stuart Creek Bridge	Miami	45.610248	-123.867288	E. coli	1999 to present
M5	Miami River at Miami Forest Rd Bridge	Miami	45.612597	-123.860016	E. coli	1999 to present
M6	Miami River at Hwy 101	Miami	45.559660	-123.892289	E. coli	1999 to present
Mi1	Mill Creek Trib at Brickyard Rd	Trask	45.419640	-123.782200	E. coli	2003 to present
Mi2	Mill Creek at Brickyard and Mill Crk Rd	Trask	45.416322	-123.777724	E. coli	2003 to present
Mi3	Mill Creek Trib at Brickyard Rd. beyond Magnolia	Trask	45.409566	-123.777777	E. coli	2003 to present
TL0	Tillamook River at Tillamook River Rd Burton Bridge	Tillamook	45.430400	-123.844551	E. coli	1999 to present
TL1	Tillamook River at Tillamook River Rd Weber Bridge	Tillamook	45.415499	-123.841688	E. coli	1999 to present
TL10	Tillamook River Upstream of Hwy 101 Rest Area	Tillamook	45.397014	-123.806031	E. coli	2003 to present
TL11	Killiam Creek at Hwy 101	Tillamook	45.395906	-123.803583	E. coli	2003 to present
TL12	Fawcett Creek at Hwy 101	Tillamook	45.389822	-123.803020	E. coli	2003 to present
TL13	Bewley Creek at Bewley Creek Rd Bridge	Tillamook	45.394628	-123.840133	E. coli	1999 to present
TL2	Tillamook River at Bewley Creek Rd Bridge	Tillamook	45.407905	-123.824543	E. coli	1999 to present
TL4	Tillamook River downstream of Hwy 101 Rest Stop	Tillamook	45.397597	-123.807596	E. coli	1999 to present
TL7	Tillamook River at Yellow Fir Rd Bridge	Tillamook	45.352775	-123.835723	E. coli	1999 to present
TR1	Trask River at Cedar Creek boat launch	Trask	45.433371	-123.726075	E. coli	1999 to present
TR11	Trask River at Hwy 131 Bridge below STP	Trask	45.456255	-123.859767	E. coli	2001 to present
TR2	Trask River at Long Prairie Rd Johnson Bridge	Trask	45.440615	-123.777134	E. coli	1999 to present
TR4	Mill Creek at Long Prairie Rd Bridge	Trask	45.426814	-123.795678	E. coli	1999 to present
TR5	Trask River at Hwy 101	Trask	45.429566	-123.824062	E. coli	1999 to present
TR6	Holden Creek at Tillamook River Rd	Trask	45.446146	-123.844086	E. coli	1999 to present
TR7	Trask River at Carnahan Park	Trask	45.454186	-123.858937	E. coli	2000 to present
N0	Nehalem R at HWY 101 (Nehalem Bay Ramp)	Nehalem	45.709800	-123.889500	E. coli	2009 to present
NF1	Coal Creek at North Fork Rd	Nehalem	45.739700	-123.861200	E. coli	2009 to present
N2	Foley Creek at Lommen Road	Nehalem	45.695300	-123.845600	E. coli	2009 to present
N3	Gallagher Slough at HWY 101 (Nehalem)	Nehalem	45.701200	-123.880400	E. coli	2009 to present
N4	Nehalem River at Foley Road (Roy Creek Campground)	Nehalem	45.700400	-123.842400	E. coli	2009 to present
NF8	North Fork Nehalem River at North Fork Rd	Nehalem	45.768400	-123.843100	E. coli	2009 to present
NF10	North Fork Nehalem River at Mcdonald Road Bridge	Nehalem	45.733300	-123.874400	E. coli	2009 to present
N6	Anderson Creek at North Fork Road	Nehalem	45.740260	-123.873370	E. coli	2010 to present
LN1	Little Nestucca at 101Boat Ramp	Nestucca	45.159814	-123.935251	E. coli	2012 to present
LN2	Little Nestucca 1.3 miles up L. Nestucca Rd	Nestucca	45.152796	-123.913901	E. coli	2012 to present
LN3	Little Nestucca 4.2 miles up L. Nestucca Rd	Nestucca	45.124334	-123.880586	E. coli	2012 to present
NE1	Nestucca at Woods	Nestucca	45.211805	-123.954001	E. coli	2012 to present
NE2	Nestucca at Cloverdale	Nestucca	45.206963	-123.890091	E. coli	2012 to present
NE4	West Creek at 101	Nestucca	45.276766	-123.830525	E. coli	2012 to present
NE5	Nestucca River at 1st bridge boat ramp (u/s Beaver)	Nestucca	45.276500	-123.818200	E. coli	2012 to present
NE7	Nestucca 5 miles up Blaine Rd	Nestucca	45.278858	-123.735721	E. coli	2012 to present
NE8	Three Rivers at Hebo Bridge	Nestucca	45.229900	-123.860900	E. coli	2012 to present
NE9	Nestucca 12 miles up Blaine Rd logging Rd	Nestucca	45.249670	-123.643632	E. coli	2012 to present
NB4	Nehalem Bay at Wheeler Ramp	Nehalem Bay	45.690067	-123.882790	Enterococcus	2011 to present
NB3	Nehalem Bay at Nehalem Bay State Park	Nehalem Bay	45.689490	-123.932490	Enterococcus	2011 to present
NB2	Nehalem Bay at Brighton Marina	Nehalem Bay	45.668750	-123.925800	Enterococcus	2011 to present
TB5	Tillamook Bay at Port of Garibaldi Pier	Tillamook Bay	45.553650	-123.915670	Enterococcus	2011 to present
TB3	Tillamook Bay at Ghost Hole	Tillamook Bay	45.543050	-123.902990	Enterococcus	2011 to present
TB2	Tillamook Bay at Picket Fence	Tillamook Bay	45.481150	-123.903080	Enterococcus	2011 to present
NT1	Netarts Bay at Happy Camp	Netarts	45.4403	-123.954700	Enterococcus	2013 to present
NT2	Netarts Bay access west of Boat Ramp	Netarts	45.43129	-123.949750	Enterococcus	2013 to present
NT3	Netarts Bay at Netarts RV Park & Marinia bridge	Netarts	45.42617	-123.939220	Enterococcus	2013 to present
SL1	Sandlake at Whalen Island bridge	Sandlake	45.27343	-123.946910	Enterococcus	2013 to present
SL2	Sandlake at Sandlake State Park day use	Sandlake	45.28163	-123.956440	Enterococcus	2013 to present
NE10	Nestucca Bay at Pacific Ave bridge	Nestucca Bay	45.20202	-123.964910	Enterococcus	2013 to present
NE11	Nestucca Bay at Brooten Boat Ramp	Nestucca Bay	45.19299	-123.955520	Enterococcus	2013 to present
NS1	Neskowin Creek at Watermaster Office	Neskowin	45.09653	-123.978940	Enterococcus	2013 to present
NS2	Hawk Creek at State Park	Neskowin	45.10289	-123.982690	Enterococcus	2013 to present
Tillamook County Creemery Association Monitoring locations on the Wilson River						
WR1	Wilson River at Hwy 6 Mills Bridge	Wilson	45.471691	-123.736757	E. coli	1997 to present
WR3	Hughey Creek at Hwy 6	Wilson	45.466717	-123.766769	E. coli	1998 to present
WR5	Wilson River at Solle Smith Rd Bridge	Wilson	45.477207	-123.807284	E. coli	1999 to present
WR6	Wilson River at Hwy 101	Wilson	45.477783	-123.844409	E. coli	2000 to present
WR7	Wilson River Milk Hole	Wilson	45.478170	-123.848203	E. coli	2001 to present
WR8	Wilson River at Geinger Farm dock	Wilson	45.481915	-123.870533	E. coli	2002 to present

Appendix C

DEQ Bacteria Water Quality Trend Analysis

Station_ID	Station_Description	Parameter	Lat	Long	Slope	Trends
N4	Nehalem River at Foley Road (Roy Creek Campground)	Ecoli	45.700130	-123.843960	0.77	80% Significance Level
WR3	Hughey Creek at Hwy 6	Ecoli	45.466717	-123.766769	-0.79	80% Significance Level
N2	Foley Creek at Lommen Road	Ecoli	45.695060	-123.846540	5.02	80% Significance Level
N0	Nehalem R at HWY 101 (Nehalem Bay Ramp)	Ecoli	45.707230	-123.887460	2.19	80% Significance Level
M6	Miami River at Hwy 101	Ecoli	45.559660	-123.892289	-0.18	80% Significance Level
C1	Holden Creek at Marloff Loop Rd	Ecoli	45.450960	-123.813972	-12.88	80% Significance Level
K5	Kilchis River at Curl Rd Bridge	Ecoli	45.508191	-123.835348	-0.20	90% Significance Level
M3	Miami River at road mile 3.0	Ecoli	45.595479	-123.867833	-1.28	90% Significance Level
M4	Miami River at Stuart Creek Bridge	Ecoli	45.610248	-123.867288	0.14	90% Significance Level
Mi2	Mill Creek at Brickyard and Mill Crk Rd	Ecoli	45.416322	-123.777724	-0.59	90% Significance Level
TL13	Bewley Creek at Bewley Creek Rd Bridge	Ecoli	45.394628	-123.840133	-1.16	90% Significance Level
WR1	Wilson River at Hwy 6 Mills Bridge	Ecoli	45.471691	-123.736757	0.27	95% Significance Level
TR1	Trask River at Cedar Creek boat launch	Ecoli	45.433371	-123.726075	-0.80	95% Significance Level
TR2	Trask River at Long Prairie Rd Johnson Bridge	Ecoli	45.440615	-123.777134	-1.20	95% Significance Level
M2a	Miami River at Moss Creek Rd Bridge	Ecoli	45.574971	-123.873755	-0.97	95% Significance Level
NF8	North Fork Nehalem River at North Fork Rd	Ecoli	45.768820	-123.844830	1.79	95% Significance Level
C3	Hoquarten Slough at Hwy 101	Ecoli	45.459145	-123.844161	-25.63	95% Significance Level
TR4	Mill Creek at Long Prairie Rd Bridge	Ecoli	45.426814	-123.795678	-9.31	95% Significance Level
C4	Dougherty Slough at Hwy 101	Ecoli	45.465199	-123.844309	-6.00	99% Significance Level
K2	Squeedunk Slough at Geinger Farm	Ecoli	45.487893	-123.868635	-1.82	99% Significance Level
K4	Kilchis River at Alderbrook Rd Bridge	Ecoli	45.496165	-123.843841	-1.67	99% Significance Level
WR5	Wilson River at Solle Smith Rd Bridge	Ecoli	45.477207	-123.807284	-1.38	99% Significance Level
WR6	Wilson River at Hwy 101	Ecoli	45.477783	-123.844409	-1.56	99% Significance Level
WR7	Wilson River Milk Hole	Ecoli	45.478170	-123.848203	-1.68	99% Significance Level
WR8	Wilson River at Geinger Farm dock	Ecoli	45.481915	-123.870533	-1.13	99% Significance Level
TR11	Trask River at Hwy 131 Bridge below STP	Ecoli	45.456255	-123.859767	-3.17	99% Significance Level
TL10	Tillamook River Upstream of Hwy 101 Rest Area	Ecoli	45.397014	-123.806031	-9.18	99% Significance Level
TR7	Trask River at Carnahan Park	Ecoli	45.454186	-123.858937	-3.01	99% Significance Level
TL11	Killiam Creek at Hwy 101 (Sampling discontinued)	Ecoli	45.395906	-123.803583	-4.57	99% Significance Level
TL4	Tillamook River downstream of Hwy 101 Rest Stop	Ecoli	45.397597	-123.807596	-9.90	99% Significance Level
TL0	Tillamook River at Tillamook River Rd Burton Bridge	Ecoli	45.430400	-123.844551	-10.14	99% Significance Level
K12	Vaughn Creek at Hwy 101	Ecoli	45.504802	-123.865413	-19.38	99% Significance Level
TL2	Tillamook River at Bewley Creek Rd Bridge	Ecoli	45.407905	-123.824543	-43.22	99% Significance Level
TL1	Tillamook River at Tillamook River Rd Weber Bridge	Ecoli	45.415499	-123.841688	-33.50	99% Significance Level
TL7	Tillamook River at Yellow Fir Rd Bridge	Ecoli	45.352775	-123.835723	-18.03	99% Significance Level
K3	Hathaway Slough at Hwy 101 Bridge	Ecoli	45.501067	-123.858423	-27.17	99% Significance Level
TR6	Holden Creek at Tillamook River Rd	Ecoli	45.446146	-123.844086	-16.14	99% Significance Level
NE4	West Creek at 101	Ecoli	45.276766	-123.830525	-1.78	80% Significance Level 8
TB2	Tillamook Bay at Picket Fence	Entero	45.481150	-123.903080	-5.00	80% Significance Level 8
SL2	Sandlake at Sandlake State Park day use	Entero	45.281630	-123.956440	-4.75	80% Significance Level 8
SL1	Sandlake at Whalen Island bridge	Entero	45.273430	-123.946910	-5.17	80% Significance Level 8
TB3	Tillamook Bay at Ghost Hole	Entero	45.543050	-123.902990	0.00	90% Significance Level 8
NE9	Nestucca 12 miles up Blaine Rd logging Rd	Ecoli	45.249670	-123.643632	-4.68	95% Significance Level 8
NE5	Nestucca River at 1st bridge boat ramp (u/s Beaver)	Ecoli	45.276500	-123.818200	-29.44	95% Significance Level 8
NB4	Nehalem Bay at Wheeler Ramp	Entero	45.690620	-123.882870	2.55	99% Significance Level 8
LN3	Little Nestucca 4.2 miles up L. Nestucca Rd	Ecoli	45.124334	-123.880586	0.64	Not Significant 8
NE1	Nestucca at Woods	Ecoli	45.211805	-123.954001	0.79	Not Significant 8
LN1	Little Nestucca at 101Boat Ramp	Ecoli	45.159814	-123.935251	-4.41	Not Significant 8
NE7	Nestucca 5 miles up Blaine Rd	Ecoli	45.278858	-123.735721	-3.34	Not Significant 8
NE8	Three Rivers at Hebo Bridge	Ecoli	45.229900	-123.860900	0.94	Not Significant 8
LN2	Little Nestucca 1.3 miles up L. Nestucca Rd	Ecoli	45.152796	-123.913901	0.06	Not Significant 8
NE2	Nestucca at Cloverdale	Ecoli	45.206963	-123.890091	-14.36	Not Significant 8
NT1	Netarts Bay at Happy Camp	Entero	45.440300	-123.954700	0.00	Not Significant 8
NT2	Netarts Bay access west of Boat Ramp	Entero	45.431290	-123.949750	1.21	Not Significant 8
NS1	Neskowin Creek at Watermaster Office	Entero	45.096530	-123.978940	1.38	Not Significant 8
NT3	Netarts Bay at Netarts RV Park & Marinia bridge	Entero	45.426170	-123.939220	-4.13	Not Significant 8
TB5	Tillamook Bay at Port of Garibaldi Pier	Entero	45.553650	-123.915670	0.00	Not Significant 8
NB2	Nehalem Bay at Brighton Marina	Entero	45.668750	-123.925800	0.00	Not Significant 8
NB3	Nehalem Bay at Nehalem Bay State Park	Entero	45.689490	-123.932490	1.67	Not Significant 8
NE10	Nestucca Bay at Pacific Ave bridge	Entero	45.202020	-123.964910	-2.63	Not Significant 8
NE11	Nestucca Bay at Brooten Boat Ramp	Entero	45.192990	-123.955520	0.96	Not Significant 8
NS2	Hawk Creek at State Park	Entero	45.102890	-123.982690	-4.17	Not Significant 8
M5	Miami River at Miami Forest Rd Bridge	Ecoli	45.612597	-123.860016	0.06	Not Significant
K6	Kilchis River at logging road bridge	Ecoli	45.519559	-123.828814	0.06	Not Significant
N6	Anderson Creek at North Fork Road	Ecoli	45.740260	-123.873370	1.50	Not Significant
TL12	Fawcett Creek at Hwy 101	Ecoli	45.389822	-123.803020	-0.54	Not Significant
TR5	Trask River at Hwy 101	Ecoli	45.429566	-123.824062	-0.02	Not Significant
NF10	North Fork Nehalem River at Mcdonald Road Bridge	Ecoli	45.733570	-123.876100	-0.99	Not Significant
NF1	Coal Creek at North Fork Rd	Ecoli	45.745410	-123.860170	1.77	Not Significant
Mi1	Mill Creek Trib at Brickyard Rd	Ecoli	45.419640	-123.782200	0.79	Not Significant
M2	Miami River at road mile 0.5	Ecoli	45.566643	-123.879463	-1.21	Not Significant
N3	Gallagher Slough at HWY 101 (Nehalem)	Ecoli	45.701200	-123.880400	6.35	Not Significant
C2	Holden Creek at Evergreen Rd	Ecoli	45.449305	-123.828459	-1.39	Not Significant
Mi3	Mill Creek Trib at Brickyard Rd. beyond Magnolia	Ecoli	45.408530	-123.781970	0.89	Not Significant