PARSONS CREEK WATERSHED
WATER QUALITY REPORT

December 2022

PREPARED FOR

Town of Rye
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Rye, NH 03862

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TRACKING FECAL CONTAMINATION

Current Tools and Challenges

STATEWIDE FECAL CONTAMINATION ISSUE

Surface waters near developed areas are impacted by fecal contamination from polluted stormwater runoff, malfunctioning septic systems, pet, livestock, and wildlife waste, leaky sewer lines, and other aging infrastructure on residential, municipal, and commercial properties. The State of New Hampshire lists over 300 river and estuarine segments as impaired for fecal indicator bacteria (FIB). These impaired waterbodies are particularly concentrated in the populated Seacoast Region. This fecal contamination generates a significant threat to water quality, public health, and the local economy.

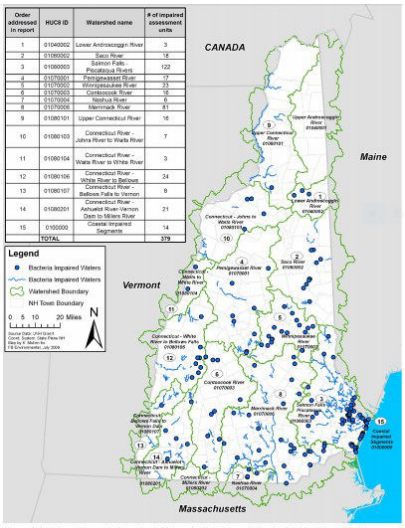
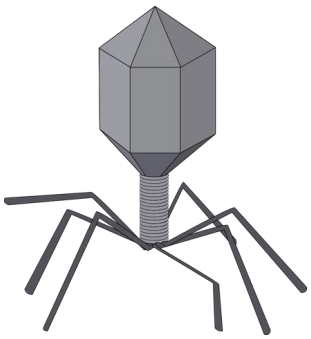


Figure 1-1: Map of Bacteria Impaired Waters in New Hampshire, by HUC 8 Watershed.

TRACKING FECAL SOURCES IS DIFFICULT

Monitoring, tracking, and managing pathogens in fecal matter is extremely difficult, particularly when fecal indicators (e.g., *E.coli,* Enterococci, or fecal coliform) are also highly variable to track and measure. Bacteria and viral pathogens react differently in the natural environment, so that external factors (temperature, sunlight, proliferation, etc.) may influence the concentration of FIB, but not the viral pathogens of interest for protecting public health. In addition, laboratory analysis of FIB can be highly variable due to the biological nature of the bacteria. For instance, laboratory and field duplicates can vary up to 200% or more, particularly at lower concentrations. As such, bacteria results should not be interpreted as absolute numbers, but as a rough estimate of concentration.



To aid with fecal source tracking, other parameters can be used as “co-indicators” to help determine if the source of the bacteria is from human waste. Nutrients (nitrate-nitrite and ortho-phosphate) can indicate the presence of human sewage in extremely high concentrations (>100 ppb for nitrate-nitrite and >1000 ppb for phosphate). If surface waters present elevated FIB counts and extremely high nutrient concentrations, then it is likely that the fecal contamination is from illicit discharges of human waste rather than other sources like stormwater runoff or animal waste.

Designed by L. Diemer, FBE
Graphic credit: OpenClipArt

BEACH MONITORING

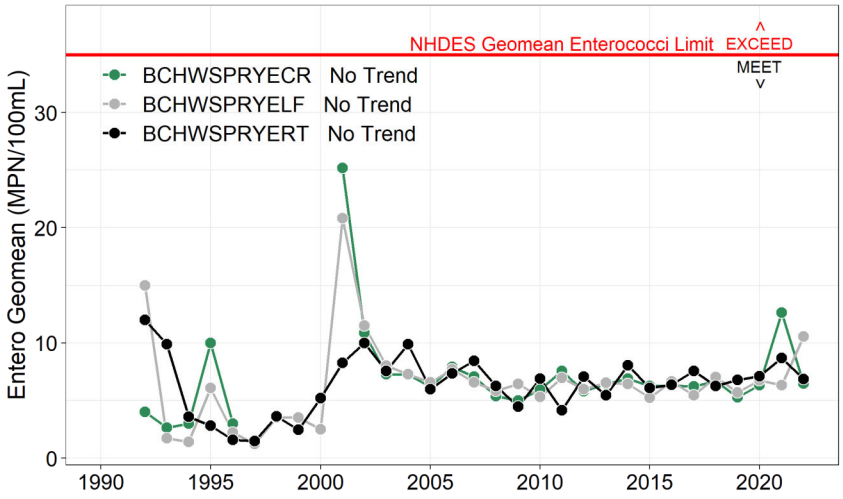
Wallis Sands State Beach and Wallis Beach, Rye, NH

NHDES BEACHES PROGRAM

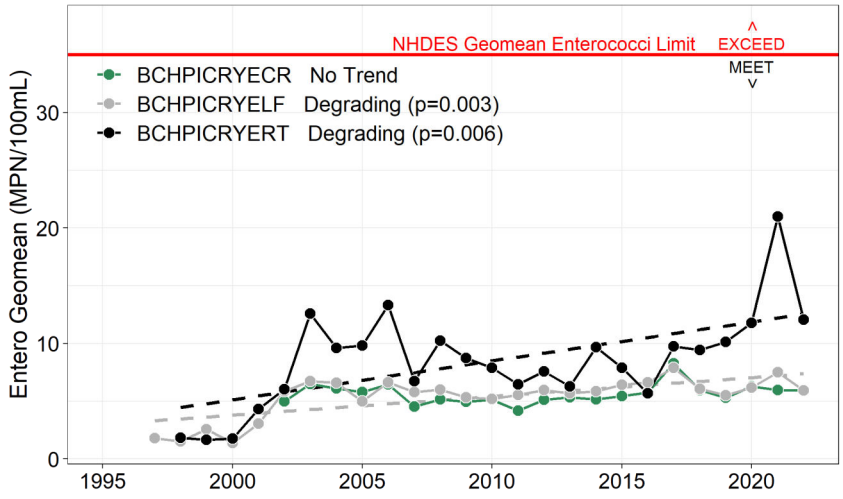
NHDES conducts regular sampling of freshwater and coastal beaches and issues advisories if FIB counts exceed water quality criteria established for the protection of public health. The annual geometric means for the six monitored beach sites were well within acceptable limits for NHDES water quality criteria, but two sites (BCHPICRYELF and BCHPICRYERT) on Wallis Beach showed statistically-significant degrading trends from 1997-2022 and 1998-2022, respectively. Wallis Sands State Beach was issued one advisory in 2022, two advisories in 2021, and one advisory in 2017; Wallis Beach was issued one advisory in 2022, three advisories in 2021, and one advisory in each of the following years: 2020, 2018, 2017, 2014, 2010, 2009, 2008, and 2006. In 2022, FIB counts at Wallis Sands State Beach did not exceed 104 mpn/100mL at any site. At Wallis Beach, FIB counts were elevated one time at BCHPICRYERT (6/15/2022) at a level of 556 mpn/100mL.

Wallis Beach has shown elevated and worsening FIB counts at BCHPICRYERT, the swimmable wading zone near the outlet of Parsons Creek.

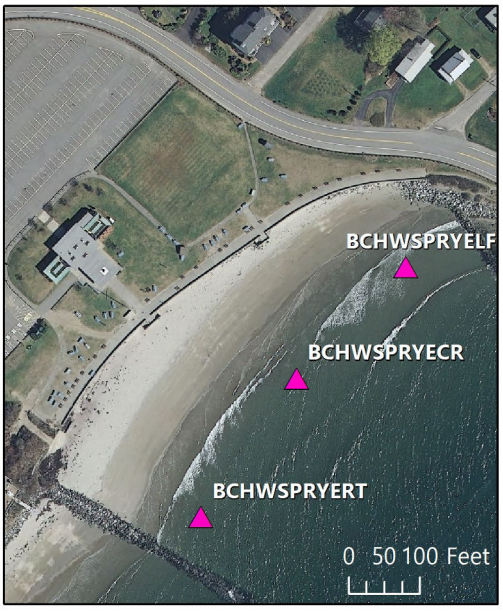
Wallis Sands State Beach Monitoring Sites



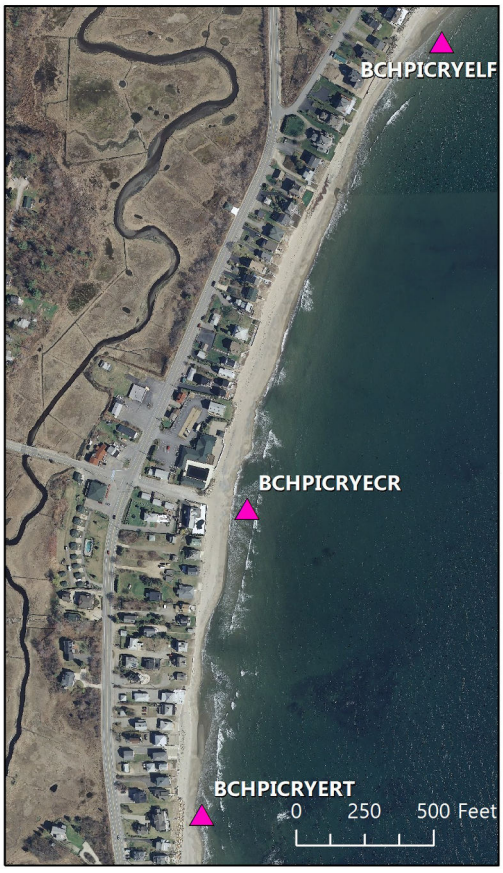
Wallis Beach Monitoring Sites



Wallis Sands State Beach



Wallis Beach

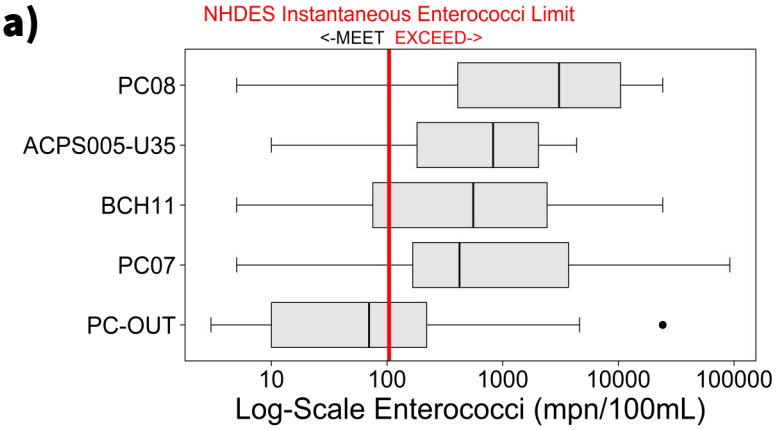


WATERSHED

Parsons Creek, Rye, NH

WATERSHED MONITORING (Bacteria)

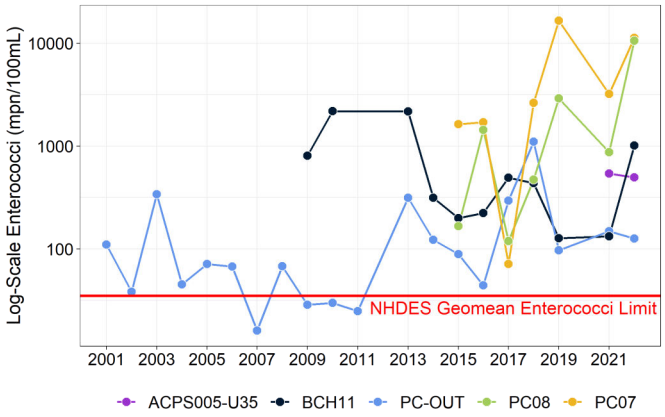
Five sites (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT) within the Parsons Creek watershed were sampled for Enterococci six times at low tide during wet and dry weather conditions from June through September in 2022. These sites have showed historically-elevated levels of Enterococci for multiple years and have been positive for human fecal contamination by either ribotyping or canine detection or both. The Town of Rye has identified several septic systems in failure within the watershed, which may be contributing to elevated levels of Enterococci at these sites.



All data (2001-2022) distribution for the five sites monitored in 2022. Sites ordered from highest to lowest median value.

All sites exceeded the state criterion for geometric mean (35 mpn/100mL) in 2022. All but 4 out of 33 samples (PC-OUT on 6/8/22, 7/5/22, and 7/21/22, and BCH11 on 9/20/22) surpassed the instantaneous state criterion (104 mpn/100mL) in 2022. Duplicate samples were omitted from the data distributions and geometric means for Enterococci. Refer to Appendix A-B for data and Appendix C for methods.

Similar to previous years, FIB counts exceeded state criteria at all five locations in Parsons Creek (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT). FIB counts at PC08, PC07, and BCH11 remain high and were higher than in 2021. FIB counts at PC-OUT may be worsening since around 2011.



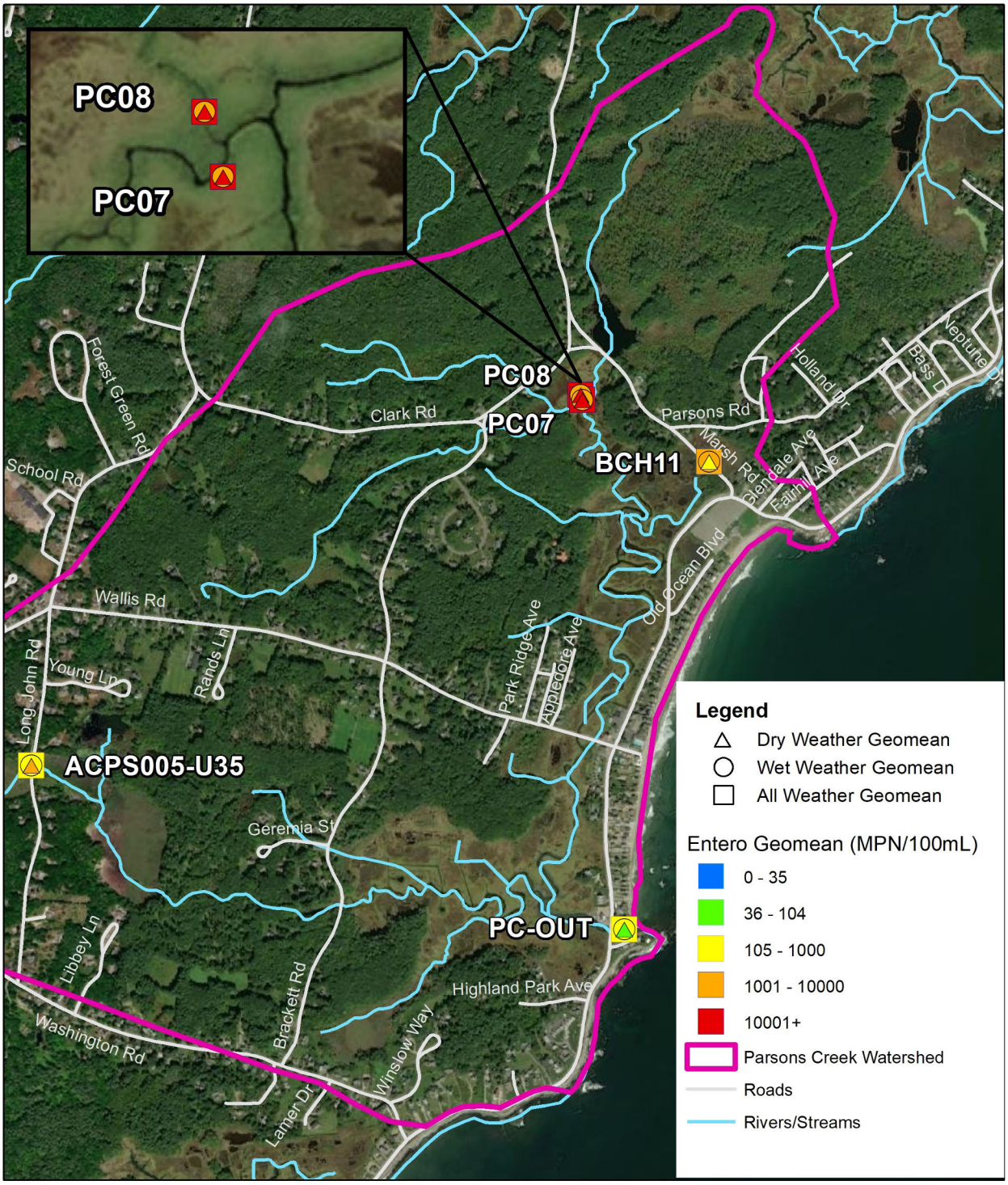
Annual geometric mean from 2001-2022 for the five sites monitored in 2022.

View of site BCH11 on July 5, 2022. Photo Credit: FBE.

View of site ACPS005-U35 on June 8, 2022. Photo Credit: FBE.

WATERSHED MONITORING

Parsons Creek, Rye, NH



2022 Bacteria Results
Parsons Creek, Rye, NH

0 0.5 1 Miles

N

Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES. Projection: NAD 1983 New Hampshire State Plane FIPS 2800. Created by FB Environmental (M. Kosalek), October 2022

WET/DRY WEATHER ANALYSIS

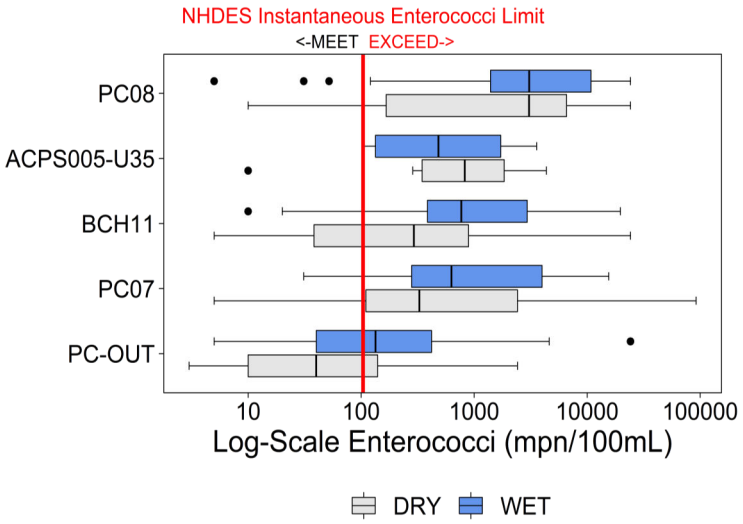
Parsons Creek, Rye, NH

WET/DRY WEATHER ANALYSIS (Bacteria)

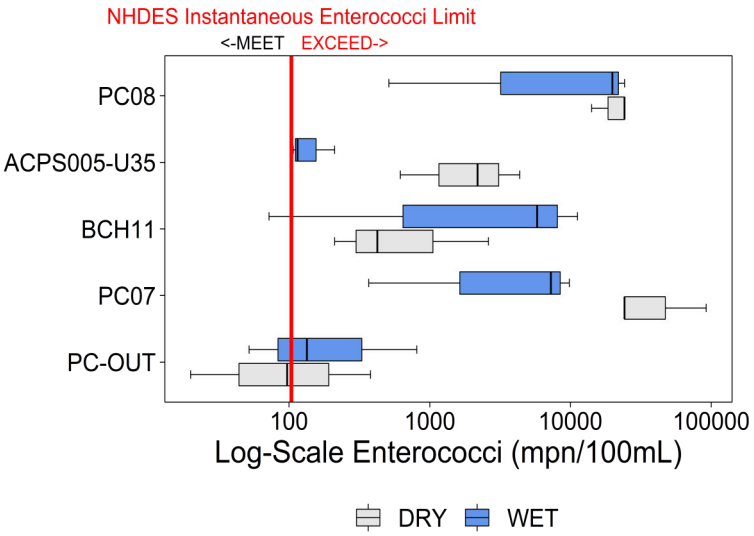
Dry weather in 2022 generated slightly higher counts of FIB in surface waters compared to wet weather for PC07, PC08, and ACPS005-U35, suggesting that groundwater may be a significant source of fecal contamination in that portion of the watershed. For the remaining two sites (BCH11 and PC-OUT), wet weather produced higher FIB, demonstrating that stormwater runoff is also a source of fecal bacteria to Parsons Creek. All sites exceeded the state criterion for the geometric mean of FIB (35 mpn/100mL) during both dry and wet weather.

Historically and in 2022, FIB counts exceeded state criteria during both wet and dry weather, suggesting that both stormwater runoff and groundwater are significant sources of contamination to Parsons Creek. The low-lying topography and high groundwater table in the watershed make leachfields susceptible to malfunction, which is likely the primary source of fecal contamination in the watershed and at the beaches.

PC07 during wet weather on September 6, 2022 (top) and PC-OUT during dry weather on July 5, 2022 (bottom).
Photo Credit: FBE.



All data (2001-2022) distribution for the five sites monitored in 2022 by weather condition (dry and wet).



2022 data distribution for the five sites monitored in 2022 by weather condition (dry and wet).

WATERSHED MONITORING

Parsons Creek, Rye, NH

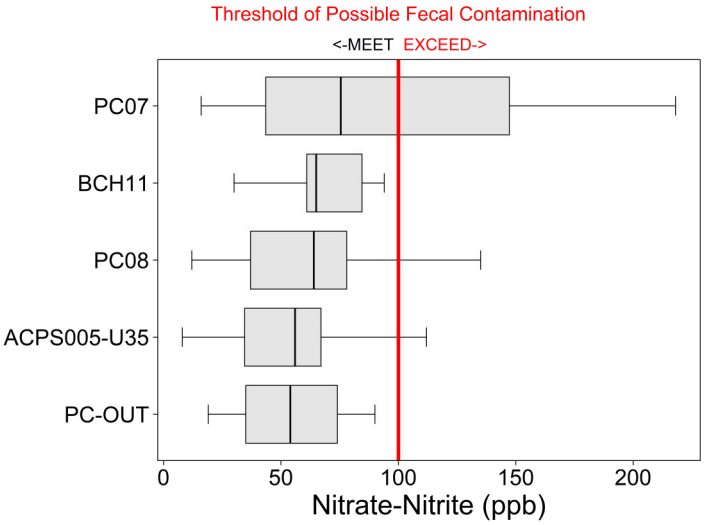
WATERSHED MONITORING (Nutrients)

Five sites (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT) within the Parsons Creek watershed were sampled for nutrient concentrations (nitrate-nitrite and ortho-phosphate) six times at low tide during wet and dry weather conditions from June through September in 2022. These sites have been positive for human fecal contamination by either ribotyping or canine detection or both, and the Town of Rye has identified and remediated several septic systems in failure within the watershed. Extremely high concentrations of nitrate-nitrite or ortho-phosphate would suggest that the dominant source of fecal contamination is from illicit discharges of human waste.

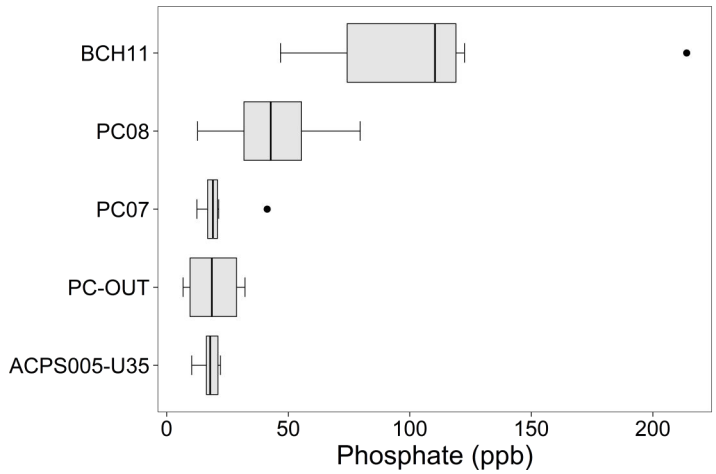
There were no sites that had an average nitrate-nitrite concentration that exceeded the threshold of possible fecal contamination (>100 ppb), however, one site (PC07) had two samples that exceeded the threshold, and two sites (ACPS005-U35 and PC-08) had one sample that exceeded the threshold. For ortho-phosphate, all five sites had concentrations well below the threshold of possible fecal contamination (>1000 ppb). Differences in ortho-phosphate concentrations between the sites are partially explained by oxygen levels, where low oxygen promotes the release of phosphorus from the underlying sediments, potentially causing higher ortho-phosphate concentrations in surface waters. The two sites ((BCH11 and PC08) with the highest ortho-phosphate concentrations consistently had low oxygen concentrations. ACPS005-U35 also had low oxygen but exhibited low ortho-phosphate concentrations as well, demonstrating that factors other than oxygen are also at play. Duplicate samples were included in the data distributions and averages. Refer to Appendices A-B for data and Appendix C for methods.

View of site PC-08 on June 8, 2022 (top) and view of site PC-OUT on July 5, 2022 (bottom).
Photo Credit: FBE.

Average nitrate-nitrite and ortho-phosphate concentrations were below the thresholds of possible fecal contamination for all sites. Although the averages were not exceeded, a few individual samples at sites in the upper watershed (PC07, PC08, and ACPS005-U35) exceeded the threshold for nitrate-nitrite, suggesting that there may be fecal contamination in those areas.



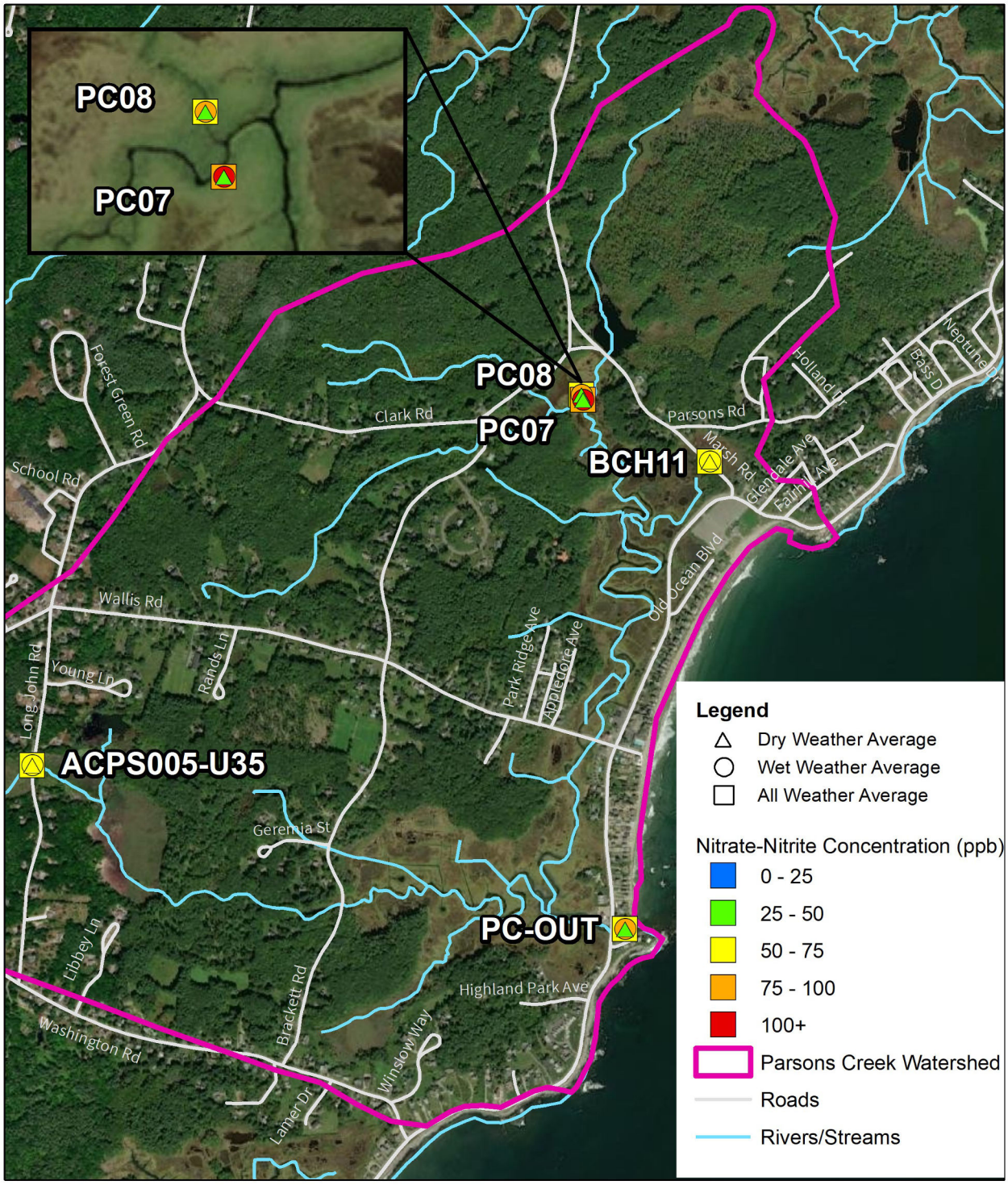
2022 data distribution for nitrate-nitrite. Sites ordered from highest to lowest median value.



2022 data distribution for phosphate. Sites ordered from highest to lowest median value.

WATERSHED MONITORING

Parsons Creek, Rye, NH



2022 Nitrate-Nitrite Results
Parsons Creek, Rye, NH

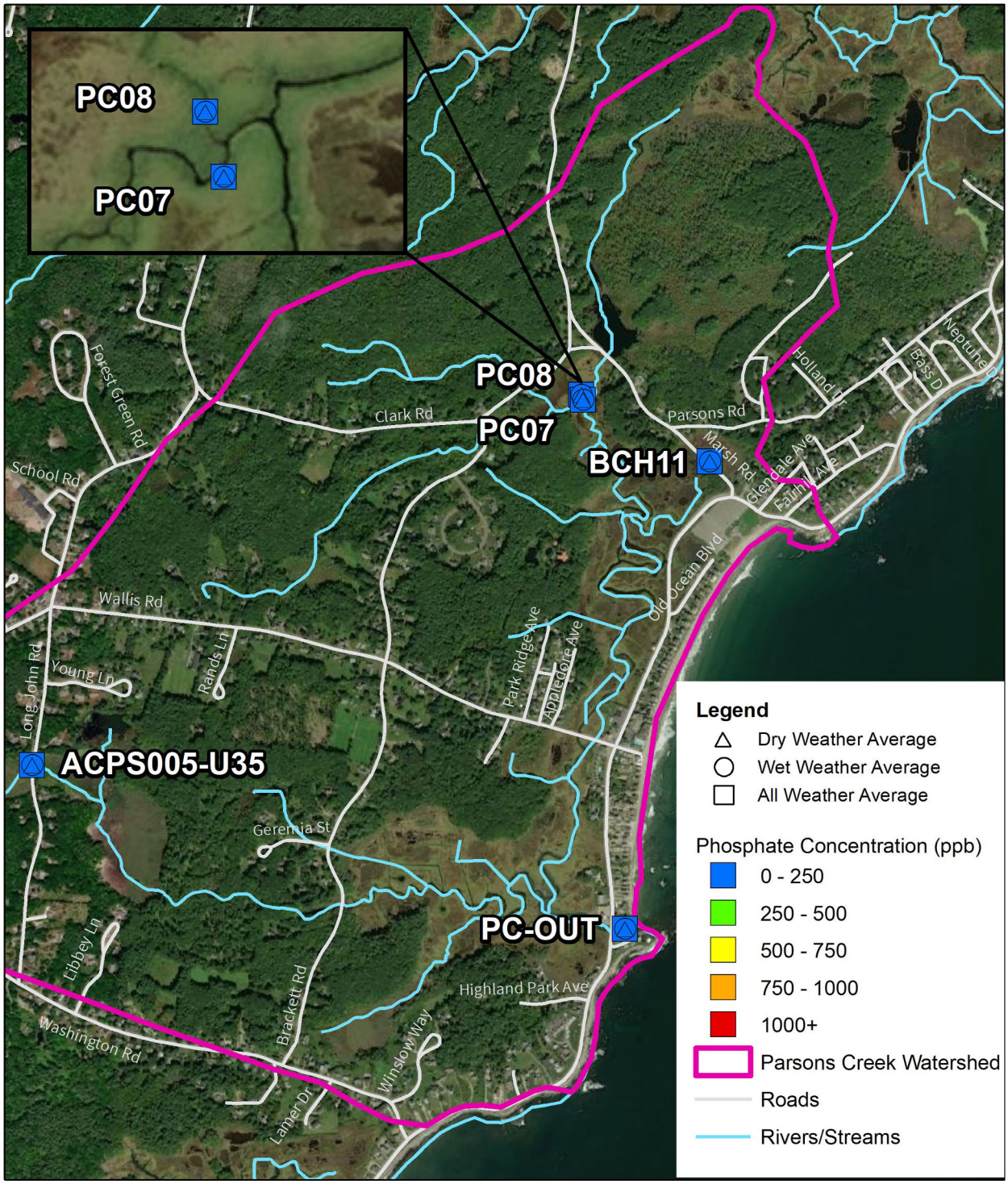
0 0.5 1 Miles

N

Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES. Projection: NAD 1983 New Hampshire State Plane FIPS 2800. Created by FB Environmental (M. Kosalek), October 2022

WATERSHED MONITORING

Parsons Creek, Rye, NH



2022 Phosphate Results
Parsons Creek, Rye, NH

0 0.5 1 Miles

N

Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES. Projection: NAD 1983 New Hampshire State Plane FIPS 2800. Created by FB Environmental (M. Kosalek), October 2022

WET/DRY WEATHER ANALYSIS

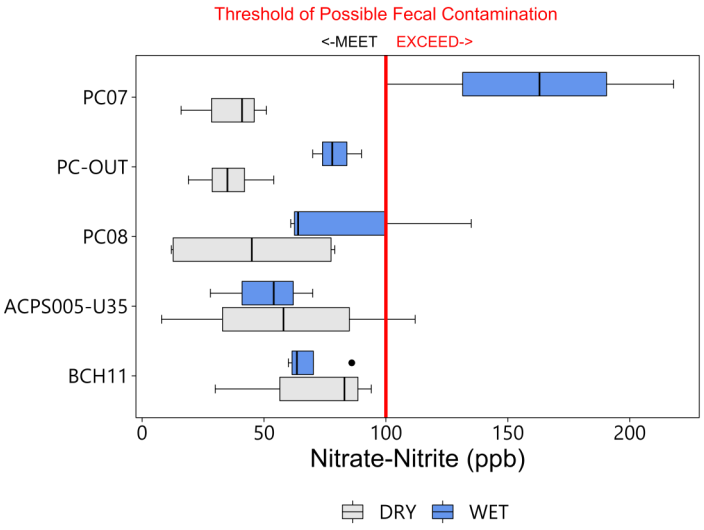
Parsons Creek, Rye, NH

WET/DRY WEATHER ANALYSIS (Nutrients)

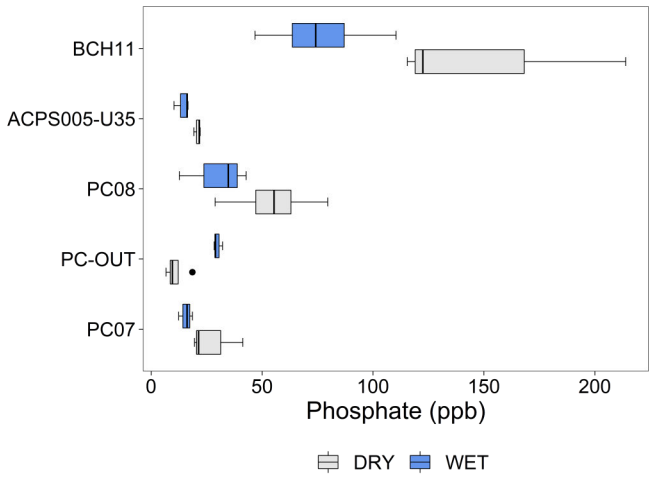
Weather had a significant impact on nutrient concentrations at several of the sites sampled within the Parsons Creek watershed. Nitrate-nitrite concentrations under wet and dry weather conditions were similar at BCH11 and ACPS005-U35 and quite different at PC-07, PC-08, and PC-OUT. The higher nitrate-nitrite values at PC-07, PC-08, and PC-OUT during wet weather suggest that the dominant sources of nitrogen were likely from stormwater. Ortho-phosphate concentrations under wet and dry weather conditions were also quite different at each site. Ortho-phosphate concentrations were higher under dry conditions at BCH11, ACPS005-U35, PC-08, and PC-07, suggesting that groundwater was the primary source of ortho-phosphate. Ortho-phosphate concentrations were higher under wet conditions at PC-OUT, suggesting that overland flow and stormwater runoff were dominant sources of phosphorus.

In general, nutrient input to Parsons Creek comes from both stormwater and groundwater sources, with diverging responses to wet and dry weather conditions at several sites. For most sites, nitrate-nitrite concentrations were higher during wet weather while ortho-phosphate concentrations were higher during dry weather, suggesting that surface runoff is a dominant source of nitrate-nitrite, while groundwater discharge is a dominate source of ortho-phosphate.

BCH11 during wet weather on September 6, 2022.
Photo Credit: FBE.



2022 data distribution for nitrate-nitrite by weather condition (dry and wet).



2022 data distribution for ortho-phosphate by weather condition (dry and wet).

SUMMARY

Snapshot of Results

Overall, the Town of Rye, the NHDES Beaches Program, the NHDES Watershed Assistance Section, the NH Shellfish Program, FB Environmental Associates, the Jackson Laboratory, and Environmental Canine Services have done a considerable amount of work to track sources of fecal contamination in both surface water and groundwater within the Parsons Creek watershed and along the beach. This work has generated a long-term dataset for analysis and interpretation for determining next steps in dealing with this issue. A summary of results is provided below.

Beach Monitoring Results

- ⇒ Both Wallis Sands State Beach and Wallis Beach were issued less advisories in 2022 than in 2021, with each issued only one advisory in 2022.
- ⇒ Two sites on Wallis Beach (BCHPICRYELF and BCHPICRYERT) showed statistically-significant degrading trends over time; and BCHPICRYERT near the outlet of Parsons Creek showed one high FIB count in 2022 that exceeded the threshold at 556 mpn/100mL.
- ⇒ Historical results have shown the critical connection between Parsons Creek water quality and protection of public health at the beach.

Watershed Monitoring Results

- ⇒ In 2022, all sites sampled within the Parsons Creek watershed had FIB counts that exceeded the state criterion for the geometric mean. Historical investigations by human waste tracking canines showed that human fecal contamination is a diffuse problem throughout the watershed due to the area's low-lying topography and high groundwater table that likely intercepts leachfields on a regular basis during storm events and/or spring tides. Even if a high water table is not the issue, sandy soils would allow for fast percolation rates of contaminated leachfield water to groundwater and ultimately surface waters without adequate treatment of pathogens.
- ⇒ Several septic systems near or contributing to the area around these hotspot sites have been found to be malfunctioning and possibly contributing to human fecal contamination in Parsons Creek. The town has and will continue to work with property owners to fix malfunctioning septic systems as they are identified.
- ⇒ Average nitrate-nitrite and ortho-phosphate concentrations in 2022 were below the general guideline for possible fecal contamination at all sites; however, a few sites in the upper watershed (PC07, PC08, and ACPS005-U35) exceeded the criteria for nitrate-nitrite on individual sample dates. Illicit discharge of human waste is possibly a source of fecal contamination at these sites.

Wet/Dry Weather Analysis

- ⇒ Historically and in 2022, FIB counts exceeded state criteria during both wet and dry weather, suggesting that both stormwater runoff and groundwater are significant sources of fecal contamination to Parsons Creek and the beach.
- ⇒ Results showed that nutrients are sourced from both stormwater and groundwater to Parsons Creek with diverging responses to wet and dry weather conditions at several sites. In general, nitrate-nitrate concentrations were higher during wet weather while ortho-phosphate concentration were higher during dry weather, suggesting that surface runoff is a dominant contributor of nitrogen, while groundwater discharge is a dominant contributor of phosphorus. Some common sources of nitrogen to stormwater include lawn fertilizers and impervious surfaces that collect nitrogen deposited from the atmosphere. Common sources of phosphorus to groundwater include septic systems.

NEXT STEPS

Recommendations and Priorities

- **Address groundwater sources of fecal contamination**
  - ⇒ Update the septic system database on a regular basis.
  - ⇒ Continue to enforce the septic system health regulation that requires pump-outs every 3 years.
  - ⇒ Continue evaluation of individual properties for septic system functioning near hotspots.
  - ⇒ Consider incorporating stricter guidelines for septic system replacement or installation to town ordinances.
  - ⇒ Consider a town sewer system to connect homes in low-lying areas along the marsh and beach.
- **Address surface runoff sources of fecal contamination**
  - ⇒ Continue to locate candidate sites for BMP implementation to address stormwater runoff.
  - ⇒ Continue to secure funding that implements these candidate BMP sites.
  - ⇒ Continue to track and monitor existing BMP conditions and fix or improve sites, as necessary.
  - ⇒ Maintain installed pet waste signs.
- **Enhance public outreach program**
  - ⇒ Post and maintain advisories at the beach.
  - ⇒ Continue to distribute educational materials and reports to the public via the town's website.
  - ⇒ Continue to educate homeowners on proper disposal of pet waste and maintenance of septic systems.
  - ⇒ Reinstitute regular meetings of the Parsons Creek Water Quality Committee.
- **Continue monitoring program**
  - ⇒ Continue water quality sampling throughout the Parsons Creek watershed under varying weather conditions to track changes in FIB over time, especially as failing septic systems are replaced.
  - ⇒ Complete a groundwater testing study of the marsh area draining to BCH11.
  - ⇒ Retest the area around the large marsh pool to determine whether the elevated fecal indicator levels are from wildlife or possibly remnant from a failing septic system that was recently replaced on a property draining to the large marsh pool.
  - ⇒ Consider updating the 2011 Parsons Creek Watershed Management Plan.

APPENDIX A

2022 Watershed Monitoring Data

Date	Dry/Wet	Site ID	Water Temp (°C)	DO (ppm)	Specific Conductivity (µS/cm)	Salinity (ppt)	pH	Enterococci (mpn/100mL)	Nitrate-Nitrite (ppb)	Ortho-Phosphate (ppb)
06/08/22	Wet	PC-OUT	17.2	6.04	37,390	23.81	7.33	52	78	32.2
06/08/22	Wet	BCH11	17.4	*0.44*	22,757	13.78	6.50	*5,794*	86	110.4
06/08/22	Wet	PC08	18.8	*4.30*	904	0.45	6.51	*512*	61	34.8
06/08/22	Wet	PC07	17.0	9.71	2,136	1.10	6.96	*368*	100	12.4
06/08/22	Wet	ACPS005-U35	18.1	*0.43*	358	0.17	6.38	*211*	70	16.6
07/05/22	Dry	PC-OUT	18.9	7.55	40,950	26.27	7.81	20	54	6.7
07/05/22	Dry	BCH11	20.6	*0.09*	34,205	21.52	6.55	*211*	94	213.9
07/05/22	Dry	PC08	23.0	*0.78*	35,590	22.46	6.85	*14,126*	77	79.6
07/05/22	Dry	PC07	23.6	*0.09*	32,285	20.16	7.00	*92,080*	41	41.3
07/05/22	Dry	ACPS005-U35	18.8	*0.19*	369	0.18	6.40	*4,360*	58	22.1
07/21/22	Dry	PC-OUT	21.7	7.29	47,147	30.71	7.66	97	38	9.2
07/21/22	Dry	BCH11	22.0	*0.17*	40,353	25.83	6.56	*425*	83	122.5
07/21/22	Dry	PC08	27.6	*4.49*	39,600	25.18	6.71	*>24,196*	79	28.8
07/21/22	Dry	PC07	26.1	19.72	40,683	25.99	6.89	*>24,196*	51	19.5
07/21/22	Dry	ACPS005-U35	18.9	*0.14*	439	0.21	6.39	*2,187*	*112*	21.7
08/18/22	Dry	PC-OUT	19.8	6.56	46,143	30.00	7.75	*379*	19	18.6
08/18/22	Dry	BCH11	20.7	*0.43*	45,122	29.25	6.68	*2,613*	30	115.5
08/18/22	Dry	PC08	21.9	*3.80*	43,863	28.32	6.76	*>24,196*	13	57.5
08/18/22	Dry	PC07	21.8	10.98	43,531	28.09	6.84	*24,196*	16	21.4
08/18/22	Dry	ACPS005-U35	17.6	*0.13*	467	0.23	6.48	*617*	8	19.2
09/06/22	Wet	PC-OUT	17.0	5.71	42,144	27.11	7.44	*809*	70	29.0
09/06/22	Wet	BCH11	20.7	*0.04*	36,076	22.83	6.76	*11,199*	62	79.2
09/06/22	Wet	PC08	18.4	*0.77*	31,123	19.41	6.82	*19,863*	*135*	42.8
09/06/22	Wet	PC07	17.2	6.55	11,155	6.37	7.05	*9,804*	*218*	16.2
09/06/22	Wet	ACPS005-U35	18.0	*0.19*	419	0.20	6.80	*107*	28	16.2
09/20/2022	Wet	PC-OUT	16.6	6.37	46,654	30.35	7.69	*121*	90	28.4
09/20/2022	Wet	BCH11	19.0	*0.15*	39,050	24.92	6.82	*402*	65	46.8
09/20/2022	Wet	PC08	17.4	*3.09*	37,625	23.92	6.92	*8,664*	64	12.7
09/20/2022	Wet	PC07	16.9	6.94	16,390	9.66	7.10	*1,785*	*163*	18.6
09/20/2022	Wet	ACPS005-U35	16.0	*0.10*	395	0.19	6.85	20	54	10.3

Italicized red text indicates exceedance of the state criterion threshold or natural background guideline for individual samples (DO = 5 ppm; Enterococci = 104 mpn/100mL; Nitrate-Nitrite = 100 ppb; Phosphate = 1000 ppb).

APPENDIX B

2022 Watershed Monitoring Data QA/QC

Date	Dry/Wet	Site ID	Rep	Enterococci (mpn/100mL)	Enterococci RPD	Nitrate-Nitrite (ppb)	Nitrate-Nitrite RPD	Ortho-Phosphate (ppb)	Phosphate RPD
7/5/2022	Dry	PC-OUT	1	20	67%	*0.054*	*51%*	6.7	40%
7/5/2022	Dry	PC-OUT	2	10		*0.032*		10.0	
8/18/2022	Dry	PC08	1	>24,196	0%	0.013	8%	57.5	8%
8/18/2022	Dry	PC08	2	>24,196		0.012		53.3	
9/6/2022	Wet	BCH11	1	11,199	0%	0.062	3%	79.2	13%
9/6/2022	Wet	BCH11	2	11,199		0.060		69.2	

Italicized red text indicates nitrate-nitrite and ortho-phosphate samples that were flagged for elevated field duplicates. These values are flagged if the Relative Percent Difference (RPD) is greater than 20%, the Relative Standard Deviation (RSD) is greater than 30%, and the values are greater than five times the detection limit. Since there is only one pair of duplicate samples that were flagged, the data were included as there is no systematic bias present.

APPENDIX C

Summary of Methods

SAMPLING PROTOCOL

Baseline bacteria sampling was performed as documented in the *NHDES Generic Beach Program Quality Assurance Project Plan* dated April 3, 2012, RFA # 06193, Section B2.0. Bacteria samples were collected in labeled whirlpak bags and stored on ice in a cooler for transport to Absolute Resource Associates Laboratory in Portsmouth, NH for analysis of Enterococci. Water samples for nutrients were field filtered using a 0.45 mm Millipore filter and stored on ice in a cooler for transport to the UNH Water Quality Analysis Laboratory for analysis of nitrate-nitrite and ortho -phosphate. Water quality parameters (temperature, dissolved oxygen, specific conductivity, salinity, and pH) were collected in the field using calibrated instruments: YSI ProSolo and Oakton pHTestr® 30. Three duplicate samples were collected and generally fell within the acceptable difference (see Appendix B).

WET/DRY WEATHER CLASSIFICATION

Wet weather was determined as: >0.1" of precipitation in the prior 24 hours; or >0.25" in the prior 48 hours; or >2.0" in the prior 96 hours. Conditions were considered dry weather when precipitation was <0.1" for each day within 72 hours.

STATISTICAL METHODS

A Mann-Kendall trend analysis was performed for beach sites with at least 10 years of data. The Mann-Kendall Trend Test is a non-parametric statistical test that determines if the central value (median) of a dataset has changed over time. A non-parametric test is appropriate here because it does not make assumptions about the normality or variability of the dataset; variation seen year-to-year or within seasons will not influence the results of non-parametric analysis the way that parametric tests can be influenced.

DATA INTERPRETATION – WATER QUALITY STANDARDS

The NHDES Consolidated Assessment Listing Methodology (CALM) describes the process and water quality standards used to assess the state's waters. This information is used to help interpret Parsons Creek water quality results and relate it to state criteria. https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdf