

# IMPAIRED STREAMS MONITORING PLAN

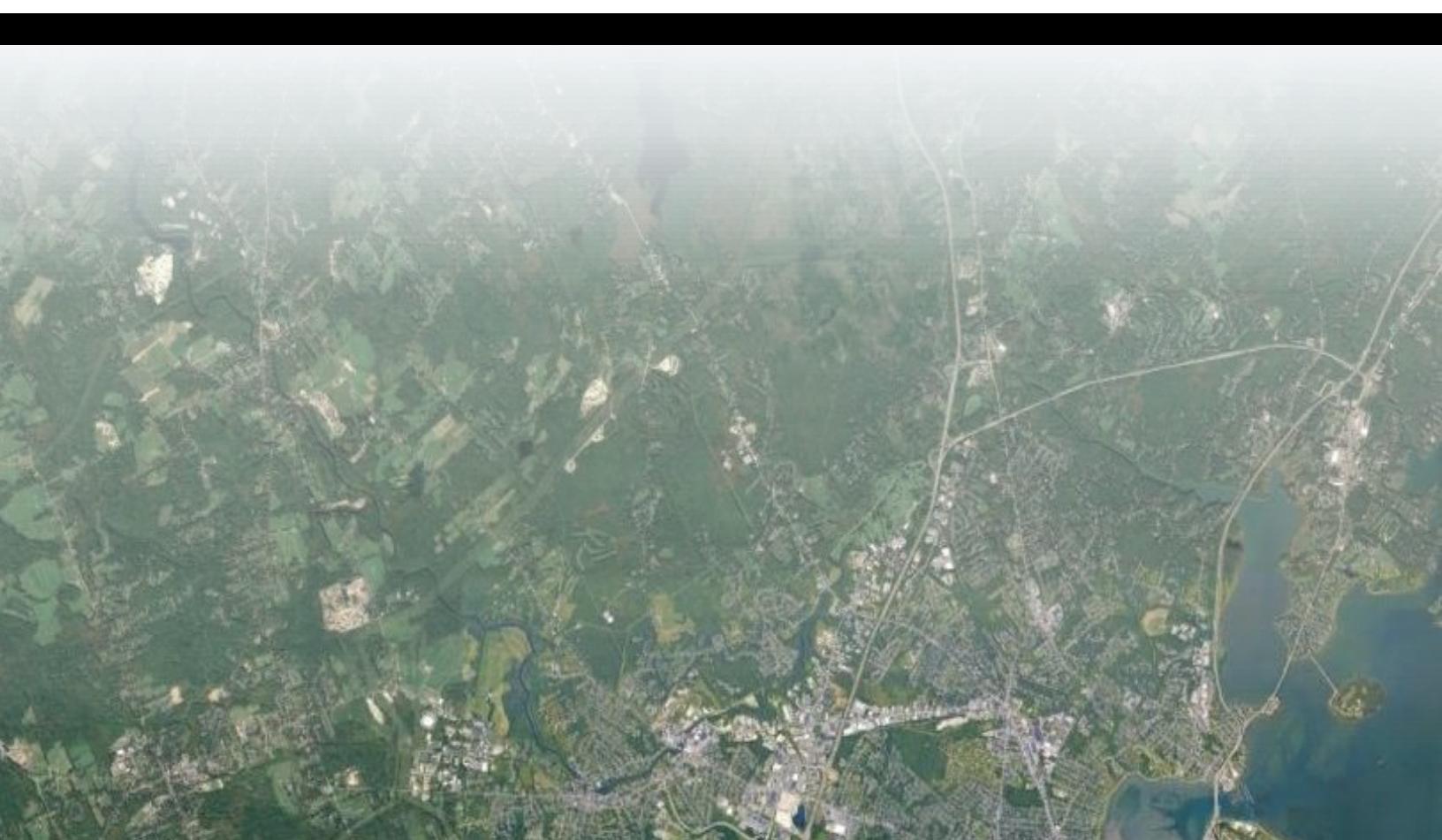
Windham, ME

June 2022

**Prepared by:** FB Environmental



**Prepared for:** The Town of Windham



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**The Pringle Preserve located along Otter Brook. © FBE.**

# Town of Windham

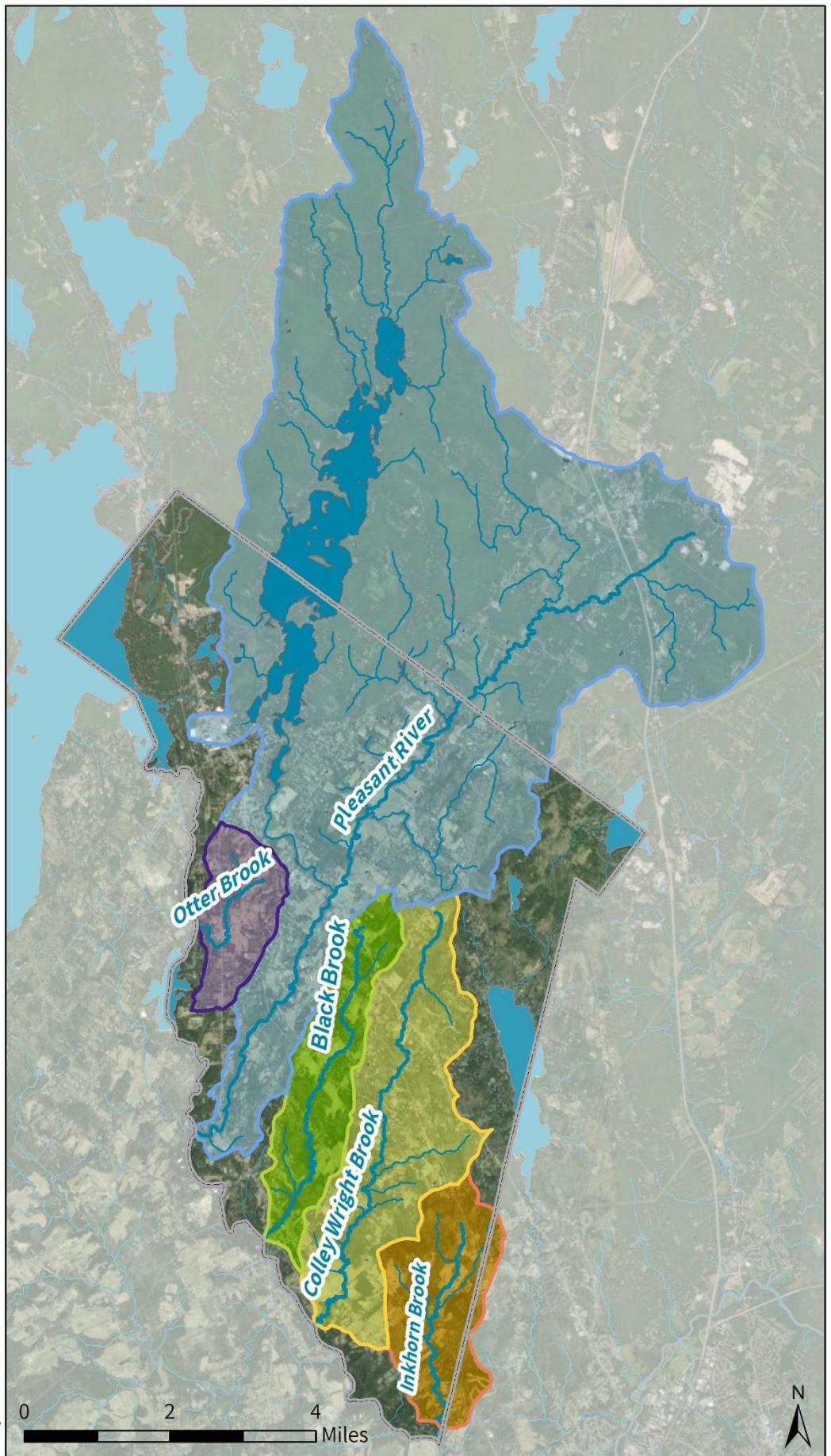
## Impaired Stream Watersheds

### Overview Map

-  Town of Windham
-  Otter Brook Watershed
-  Pleasant River Watershed
-  Black Brook Watershed
-  Colley Wright Brook Watershed
-  Inkhorn Brook Watershed
-  Waterbody
-  Tributary



Data Sources: NHD, ESRI,  
Town of Windham, MEGIS.  
Coordinate System: NAD  
83 UTM Zone 19N  
Map by: FB Environmental  
December 2021



## INTRODUCTION

This report outlines a three-year monitoring plan for five impaired streams in Windham, ME. These include Black Brook, Colley Wright Brook, Inkhorn Brook, Otter Brook, and the Pleasant River (Table 1). The watersheds of Black Brook, Colley Wright Brook, and Otter Brook are entirely within the Town of Windham. The 48.9 sq.mi. Pleasant River watershed stretches into the Towns of Gray and Raymond and the Inkhorn Brook watershed has a small section in Westbrook. All five of these streams were included in the recent release of the *Maine Statewide TMDL for Nonpoint Source Pollution Addendum* in September 2021 as an addendum to the *Maine Statewide Total Maximum Daily Load for Nonpoint Source Pollution*. The cause of listing for all five was low dissolved oxygen. The *2009 Statewide Bacteria TMDL for Maine* includes bacteria impairments for Colley Wright Brook, Inkhorn Brook, Otter Brook, and the Pleasant River. Black Brook was not included in the *2009 Statewide Bacteria TMDL* but is not meeting bacteria standards and will be included as impaired in a future update. An explanation of state and federal attainment standards is detailed in Figure 1.

This plan was produced for the Town to assist with prioritization of water resources and data collection to work towards restoration of these streams and to inform land use regulations in the Town. To aid in the monitoring plan development process, scientists at FB Environmental Associates (FBE) synthesized existing surface water data from previous monitoring efforts into a database and produced individual watershed-scale maps with listed pollutant stressors for each stream (Attachment 1). In the report that follows, we have presented a brief summary of existing water quality data, known stream stressors, and data gaps for each stream and provided recommendations for future monitoring.

**In summary, we recommend that the best use of the 2022 fiscal year remaining funds is to complete one round of targeted wet weather sampling across all streams at regularly monitored sites before June 30, 2022. During this round of sampling, we recommend sampling for *Escherichia coli* (*E. coli*) and co-indicators including total phosphorus (TP), nitrate, ammonia, ortho-phosphate, and optical brighteners. Additionally, we recommend deployment of Maine DEP loggers in 2-3 sites on Black Brook.** The State of Maine uses *E. coli* as the primary indicator bacteria for fecal source tracking, however, several other parameters have been successfully used as “co-indicators” to tracking fecal indicator bacteria and the combination of these parameters can help determine whether the contamination source is likely from humans.

During the remainder of 2022 (after June 30) and in 2023, we recommend pursuing additional continuous monitoring, wet versus dry weather investigative sampling and microbial source tracking sampling depending on available funds. If funds are limited, we recommend prioritizing work targeted on Black Brook and Pleasant River. Additional recommendations for long term and investigative sampling recommendations for each stream is presented in detail.

**Table 1. Five impaired streams in the Town of Windham.**

STREAM	CLASS	WATERSHED AREA	IMPAIRED SEGMENT*	IMPAIRMENT CAUSES
Black Brook	B	3.91 sq.mi.	6.07 mi.	Dissolved Oxygen, <i>E. coli</i> **
Colley Wright Brook	B	7.65 sq.mi.	8.20 mi.	Dissolved Oxygen, <i>E. coli</i>
Inkhorn Brook	B	3.90 sq.mi.	4.32 mi.	Dissolved Oxygen, <i>E. coli</i>
Otter Brook	B	2.14 sq.mi.	2.16 mi.	Dissolved Oxygen, <i>E. coli</i>
Pleasant River	B	48.90 sq.mi.	11.20 mi.	Dissolved Oxygen, <i>E. coli</i>

\*All streams are impaired for their full length, with the exception of Pleasant River which is impaired downstream of its confluence with Thayer Brook. The entirety of Pleasant River within Windham is impaired.

\*\*Included in a future update.

## GOALS

The five impaired streams in Windham are important for the health of the local ecosystem and are also important to critical downstream waters such as the Presumpscot River and eventually, Casco Bay. The goal of this monitoring plan is to outline actions that will help the Town identify causes and sources of current impairments to inform restoration. Investigative water quality monitoring will allow the Town to identify causes that are manageable and those that are natural to the system and therefore, will allow the Town to focus restoration efforts.

## PARTNER ORGANIZATIONS

**The Town of Windham**, “the Town”, is leading and funding the efforts to develop a monitoring program for impaired streams within the Town boundaries. This work is being led by Gretchen Anderson, Environmental and Sustainability Director, and Amanda Lessard, Planning Director.

**Cumberland County Soil & Water Conservation District**, “CCSWCD”, is a local partner organization focused on protecting and conserving soil and water resources as a result of regional land use change. The Town of Windham is within CCSWCD’s service area. Most recently, CCSWCD developed a memorandum for the Town of Windham (dated 01/09/2021) to help the Town prioritize protection and conservation of their water resources. Of the 35 fresh waterbodies within the Town, CCSWCD recommended focusing on the five impaired streams. This work was the precursor to this monitoring plan.

**Presumpscot Regional Land Trust**, “PRLT”, is a regional nonprofit organization that helps communities to conserve, steward, and provide access to local lands and clean water. PRLT serves the Town of Windham, in addition to four other local communities (Gorham, Gray, Standish, and Westbrook). In 2018, PRLT merged with the “Presumpscot River Watch”, and assumed responsibility for collecting baseline data on the Presumpscot River and its tributaries. The Presumpscot River Watch had conducted this work for the previous ten years. PRLT collects data on dissolved oxygen, temperature, and *Escherichia coli* (*E. coli*) bacteria. PRLT has two sites on Colley Brook, five sites on Black Brook, one site on Inkhorn Brook, two sites on Otter Brook, and eight sites on the Pleasant River.

**Casco Bay Estuary Partnership**, “CBEP”, is part of the National Estuary Program. This is a collective of organizations focused on protecting and restoring the 28 estuaries of national significance across the United States. The Casco Bay watershed, the focus of CBEP, includes the Town of Windham and the five impaired streams discussed in this Plan. The CBEP helps to fund the water quality monitoring conducted by PRLT.

**Maine Department of Environmental Protection**, “Maine DEP”, is the regulatory agency responsible for ensuring that Towns are working towards restoration of impaired waterbodies. Maine DEP administers grants to provide funding for restoration efforts (both planning and implementation). Ongoing projects in Windham with the Maine DEP include a Watershed Plan for Black Brook (funded in 2021) and an implementation project on the Pleasant River (funded in 2020). CCSWCD is managing execution of both projects. Maine DEP also organizes the Volunteer River Monitoring Program (VRMP), a network of volunteer groups participating in quality-assured river and stream sampling.

## CLEAN WATER ACT

Section 305(b) of the Clean Water Act requires states to submit an Integrated Report to EPA every even-numbered year to assess the ability of Maine's water resources to meet uses (e.g., drinking water, aquatic life support, fishing or recreation) identified in the Classification of Maine Waters.

## INTEGRATED REPORT

Also known as the 303(b) report and 303(d) list, the integrated report lists impaired waters identified as not meeting one or more of their designated uses. The most recent Integrated Report for Maine is from 2016. A draft 2022 Report has also been released (no report was released in 2018 and 2020). For the purposes of this project, we will use data from the draft 2022 Report.

## TOTAL MAXIMUM DAILY LOADS (TMDLs)

Waters identified as "impaired" in the integrated report require the development of a TMDL. These are summary documents that identify impairments and calculate the total amount of pollutants that a waterbody can receive and still meet water quality standards. They are used to guide restoration.

### What is the Classification of Maine Waters?

This classification system is what establishes water quality goals for waters in the State of Maine and is used to help direct the State in the management of its surface waters. Freshwater rivers are listed under four classes (AA, A, B, C). All five impaired streams in Windham are "Class B" streams indicating that they must be suitable for five designated uses: (1) drinking water supply after treatment, (2) aquatic life use support, (3) fishing/fish consumption, (4) recreation, and (5) navigation/hydropower/agriculture/industrial supply. Each designated use has specific listed criteria for attainment. All five of Windham's impaired streams do not meet attainment for the designated uses of "aquatic life use support" and "recreation" due to low dissolved oxygen and high *E. coli*, respectively.

Class B waters must meet the following specific criteria:

Dissolved oxygen: May not be less than 7 ppm or 75% saturation, whichever is higher between May 15 and September 30. The 7-day mean dissolved oxygen concentration may not be less than 9.5 ppm and the one-day minimum concentration may not be less than 8 ppm in fish spawning areas.

E. coli: May not exceed a geometric mean of 64 CFU/100mL over a 90-day interval or 236 CFU/100mL in more than 10% of the samples in any 90-day interval.

### The Integrated Report lists surface waters under five categories:

Category 1: Attaining all designated uses and water quality standards, and no use is threatened.

Category 2: Attains some of the designated uses; no use is threatened; and insufficient data or no data and information is available to determine if the remaining uses are attained or threatened (with presumption that all uses are attained).

Category 3: Insufficient data and information to determine if designated uses are attained (with presumption that one or more uses may be impaired).

Category 4: Impaired or threatened for one or more designated uses, but does not require development of a TMDL (Total Maximum Daily Load).

Category 5: Waters impaired or threatened for one or more designated uses by a pollutant(s), and a TMDL is required.

### Active TMDLs relevant to the impaired streams in Windham include:

1. 2021 Maine Statewide TMDL for Nonpoint Source Pollution Addendum. *All five impaired streams in Windham were included in this recent Addendum due to not meeting the Class B dissolved oxygen requirements.*
2. 2009 Maine Statewide Bacteria TMDL. *The 2009 statewide bacteria TMDL includes Colley Wright Brook, Inkhorn Brook, Otter Brook, and the Pleasant River. Black Brook is also listed for E. coli but was not included in the 2009 statewide TMDL for bacteria and will be included in a future update.*

All five of these streams have also been identified as a nonpoint source priority, meaning that they are most vulnerable to pollution and the state has identified them as a priority for protection and restoration. This is where the Town becomes involved.

Figure 1. Explanation of the federal and state regulatory layers in place to protect Maine waters.

## STREAM SUMMARIES

The following section contains a brief summary description for each of the five tributaries including recommendations and the justification for these recommendations. Recommendations for all streams are listed in two categories, (1) Long-term Monitoring and (2) Investigative Water Quality Monitoring. The order of the streams listed represents our recommended prioritization for restoration efforts. Black Brook and Pleasant River are included first to leverage existing efforts through ongoing watershed planning (Black Brook) and implementation projects (Pleasant River).

### **BLACK BROOK**

**Class:** B

**Designated use(s) not met:** aquatic life use, recreation

**Listing cause:** dissolved oxygen, *E. coli*

**Sites with ongoing monitoring:** BL010 & RBK05 (River Rd), BL015 & RBK24 (Webb Rd), BL018 & RBK32 (Swett Rd), BL020 & RBK49 (Windham Center Road). (An additional site upstream of the Black Brook Preserve – BL030 – was added in 2021 but will likely be dropped because it was often dry.)

**Organization completing monitoring:** PRLT with support from CBEP and VRMP

**Parameters being measured:** Dissolved oxygen (instantaneous), Temperature, and *E. coli* grab samples

Due to the ongoing development of the Watershed Plan, we recommend prioritizing monitoring at Black Brook over the other four tributaries in 2022 to enhance both efforts. Black Brook is a 6.1-mile-long stream within a 3.91 sq. mi. watershed. It is listed due to low dissolved oxygen and elevated *E. coli*. The watershed is 70% non-developed, 20% agriculture, and 10% developed with four major roads crossing in a northwest to southeast direction (Pope Road, Swett Road, Webb Road, and River Road). The watershed includes the Black Brook Preserve as well as an extensive active hayfield at the Clark Farm and Forest. A sizeable wetland enters the stream between Webb Road and Swett Road.

#### **Recommendations:**

##### *Long-term*

The spatial coverage of monitoring sites on Black Brook is sufficient for baseline monitoring of both dissolved oxygen and *E. coli*/conditions in the stream to track any changes over time. We recommend that PRLT continue to test for both dissolved oxygen and *E. coli* at the ongoing sites with historical data to maintain a long-term record. (Currently only BL010/RBK05 at River Rd has more than five years of data.) We agree with PRLT to drop site BL030 from the monitoring regime because it was often dry upon sampling in 2021 and therefore is not a consistent long-term monitoring site. We recommend that PRLT record the time and day of sample collection as well as record the previous 24, 48, and 72-hr rainfall conditions. Additionally, because the Black Brook watershed is approximately 20% agriculture, we recommend the addition of nutrient sampling to the twice monthly PRLT sampling regime (total phosphorus and nitrate). Runoff from agricultural lands can carry nutrients to the stream channel that fuel excess algae growth. Dissolved oxygen is consumed during the decomposition phase of this algae material.

Maine DEP is considering the addition of a biomonitoring site on Black Brook. There are no current monitoring sites. We recommend that the Town work with Maine DEP to ensure that the selection of a new biomonitoring site in Black Brook is representative of the stream and does not only reflect naturally suppressed dissolved oxygen due to influences from the wetland.

##### *Investigative*

We recommend that the Town focus on investigative monitoring in Black Brook to further identify the causes of impairment for the stream. In 2022, we recommend that the Town sample at the same sites as PRLT (BL010, BL015, BL018, BL020) as well as the addition of two stations at each of the tributary outlets by Meredith Drive and Twoey Drive. Recommended sample parameters include total phosphorus (TP), nitrate, ammonia, ortho-phosphate, and optical brighteners. The State of Maine uses *E. coli* as the primary indicator bacteria for fecal source tracking, however, several

other parameters have been successfully used as “co-indicators” to fecal indicator bacteria; the combination of these parameters can help determine whether the contamination source is likely from humans. Nutrients (nitrate and phosphate) can indicate human sewage if in extremely high concentrations. Ammonia is used in illicit discharge detection screenings and high concentrations can indicate sewage contamination, however not all discharges have high concentrations, so it is best used in combination with other parameters. Orthophosphates provide an estimation of the amount of phosphorus available for algae and plant growth, and as they are often the main constituent in fertilizers used agriculturally and residentially, they can indicate human presence. Optical brighteners are commonly used for wastewater detection. Optical brighteners are not naturally occurring and are typically added to laundry soaps, detergents, cleaning agents, and toilet papers to aid in the brightening of fabrics and/or surfaces. Testing positive for optical brighteners in groundwater, definitively indicates the presence of greywater from leach fields. We also recommend that the Town add sample sites at the outlet of the two tributaries at the end of Meredith Drive and Twoey Drive and sample for *E. coli*. Historical data in the previous five years at site RBK05/BL010 indicates that precipitation within the 48 hours prior to sampling is significantly correlated with bacteria (Attachment 2a). Given this, we recommend the first step in investigative sampling is to target sampling with co-indicators during a precipitation event. Wet weather often mobilizes fecal sources on the landscape and transports them to nearby rivers and streams. Consequently, high fecal indicator bacteria levels during wet weather events can point to fecal sources on the landscape via stormwater runoff. Targeting sampling with co-indicators during wet weather is intended to help identify potential sources of bacteria. We recommend that in future sampling efforts, the Town and PRLT record the previous 24, 48, and 72-hr rainfall conditions during investigative monitoring. In contrast, samples collected during dry weather, or baseflow conditions, indicate the potential impact of groundwater contamination sources (such as from faulty septic systems).

Maine DEP indicated that they have two to three continuous dissolved oxygen loggers that could be used in the Town of Windham. In 2022, we recommend deploying these loggers at Black Brook to support and enhance the Watershed Plan. If available, loggers should be deployed at BL010, BL015, and RBK38. Specifically, we think it is important to isolate the influence of the Swett Road wetland on dissolved oxygen levels in the brook by tracking dissolved oxygen above (RBK38) and below (BL015) its influence. Continuous dissolved oxygen data should be evaluated for diurnal trends to identify elevated productivity in the stream (diurnal dissolved oxygen shifts of more than 2 ppm can indicate elevated productivity). Loggers should be deployed for a full season at these three sites in 2022. If dissolved oxygen levels are sufficient at the most downstream site (BL010), we recommend moving that logger further up in the watershed.

We recommend that the Town conduct a stream walk of Black Brook (already planned through the Watershed Plan Development Project) to identify areas with poor vegetated buffers. Specifically, we recommend walking the buffer along the Christmas Tree Farm below Webb Road and discuss existing land management strategies employed at the farm.

# BLACK BROOK

Windham, Maine

## Natural Resources and Potential Pollutant Sources

-  Town of Windham
  -  Town Boundary
  -  Black Brook Watershed
  -  Sampling Site
  -  Stormwater Outfall
  -  Impaired Tributary Segment
  -  Tributary
  -  Waterbody
  -  Town Property
  -  Conserved Land
  -  Wetland

## Black Brook Snapshot

Impaired segment length: 6.07 mi.  
Watershed size: 3.91 sq. mi.

Watershed size: 3.91 sq. mi.  
Impairment: Dissolved oxygen,  
*E. coli*\*

*E. coli*

Classification: Class B  
Black Book does not meet water quality standards for aquatic life.

### Land Use Composition

Land use comp.

Developed: 10%

Non-developed: 70%

Habitat Assessment (2012)

Minor erosion from stormwater runoff at road crossing was documented

was documented.  
Data from Maine DEP TMDL.  
In-field assessments completed  
2011-2012. TMDL report  
appendix published 2021.  
\*Black Brook was not included in the 2009  
Statewide TMDL but is not meeting  
bacteria standards and will be included  
as proposed in a future update.



Data Sources: Town of Windham,  
Maine DEP, PRLT, WLT, NHD,  
Maine GeoLibrary, ESRI.  
Coordinate System: NAD 83  
UTM Zone 19N  
Map by: FB Environmental,  
January 2022.

**Note:** The currently underway Black Brook Watershed Management Plan will likely provide more detailed pollutant source identification.

Developed areas in the Black Brook watershed composes approximately 10%.

Areas with impervious surfaces in close proximity to the stream may impact water quality.

Agricultural land in the Black Brook watershed is likely the largest source of nonpoint source pollution to Black Brook.

Agricultural land is concentrated in the central portion of the watershed along Swett Road, Town Farm Rd, and Pope Rd, and 10% of Black Brook passes through agricultural land.

Parking & impervious areas.

Logging storage.

Road crossing with minor erosion.

Active hay fields with minimal buffer along Black Brook.

Riparian zone with limited buffer at road crossing.

Active hay fields.

Road crossing with minor erosion.

Active hay fields.

Windham

Black Brook Preserve

BL030

RBK49/BL020

RBK32/BL018

RBK38

RBK24/BL015

RBK05/BL010

Black Brook

Presumpscot River

Windham

0 0.5 1 Miles

Site ID	Years Sampled DO (n)	Years Sampled Temperature (n)	Years Sampled TP (n)	Years Sampled E. coli (n)	Other Key Parameters Sampled
BL030	-	-	-	2021 (4)	-
RBK38	-	-	-	2014-2015 (11)	-
RBK49/BL020	2017-2021 (60)	2017-2020 (30)	-	2017-2020 (76)	Specific Conductance
RBK05/BL010	2011-2021 (84)	2011-2020 (78)	-	2011-2021 (90)	Specific Conductance
					Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity,
RBK24/BL015	2007, 2021 (15)	2007 (6)	2007 (4)	2014-2015, 2021 (22)	TSS
RBK32/BL018	2021 (9)	-	-	2014-2015, 2021 (22)	-

DO = dissolved oxygen; TP = total phosphorus; *E. coli* = *Escherichia coli*. n = total number of samples.

## **PLEASANT RIVER**

**Class:** B

**Designated use(s) not met:** aquatic life use, recreation

**Listing cause:** dissolved oxygen, *E. coli*

**Sites with ongoing monitoring:** PL010 & RPL06 (River Rd), PL020 & RPL29 (Pope Rd), PL030 & RPL37 (Windham Center Rd), PL040 & RPL47 (Route 302), PL043 & RPL68 (Falmouth Rd), PL045 & RPL89 (Gray/Windham Border),

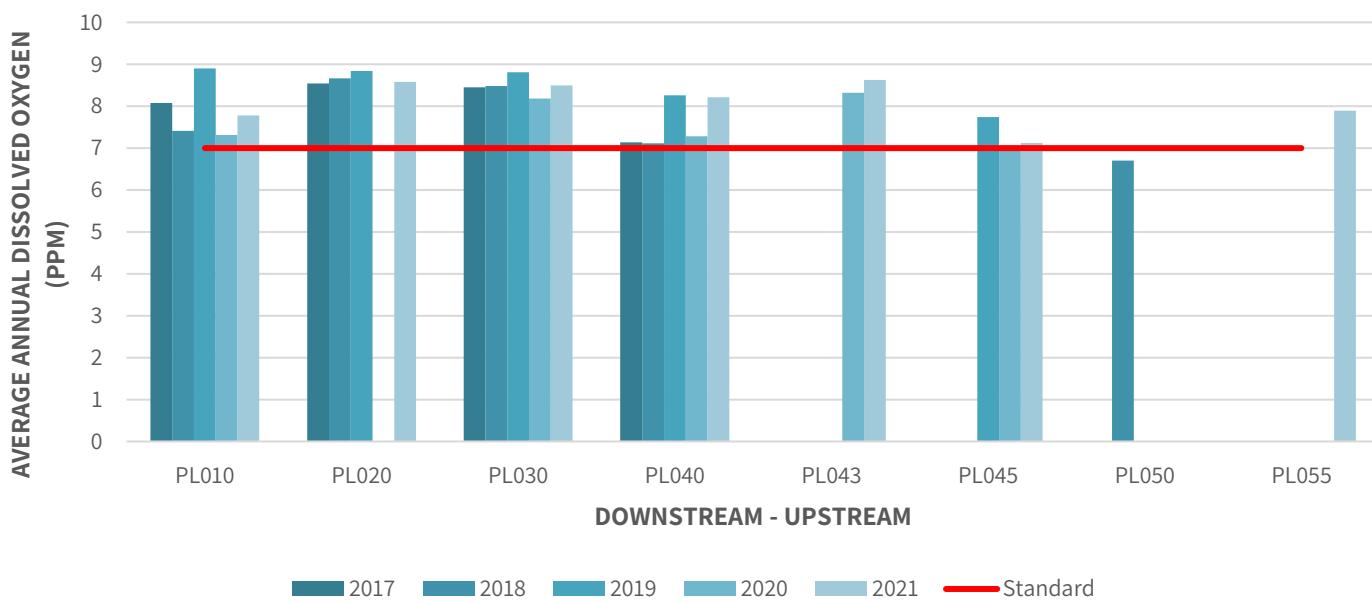
**Pleasant River Tributaries with ongoing monitoring:** DB010 & RPL00 (Ditch Brook - Route 302), BB010 & RPLBK17 (Baker Brook - Blackstrap Rd).

**Organization completing monitoring:** PRLT with support from CBEP and VRMP

**Parameters being measured:** Dissolved oxygen (instantaneous), Temperature, and *E. coli* grab samples.

The Pleasant River is the largest of the five watersheds with a total area of 48.9 square miles. 17.1 square miles of the watershed are in Windham. The Pleasant River has five major tributaries including Thayer Brook, Wiggins Brook/Thayer River, Allen Bog, Baker Brook, and Ditch Brook (drains Collins Pond). The watershed also contains Little Sebago Lake. The watershed is 14% developed and 6% agriculture. Agriculture was listed as one of the main causes of pollution in the watershed and is concentrated along the main river corridor.

The river is listed for a dissolved oxygen impairment due to historical data collected in 2011 or earlier. Periphyton and benthic macroinvertebrate data has demonstrated class B attainment or better. Instantaneous dissolved oxygen readings collected by PRLT demonstrate that the downstream sites have average annual dissolved oxygen concentrations that are just above the state standard while upstream sites suffer from lower average annual DO as well as elevated bacteria levels, however, available data at upstream sites is limited (Figure 2).



**Figure 2. Average annual instantaneous dissolved oxygen for eight sites on the Pleasant River, listed from downstream to upstream (left to right). The state standard for dissolved oxygen in Class B waterbodies is <7 ppm.**

### **Recommendations:**

#### *Long-Term*

The most recent Pleasant River Watershed Based Management Plan expired in 2021, and we recommend the Town of Windham update the plan through a 604(b) watershed planning grant under the Maine Department of Environmental Protection. The watershed-based plan update process should involve consulting with Maine DEP and the other watershed stakeholders (see Partner Organizations section above) and should include identifying the reason for

updating the plan, what was successful in the previous plan and how it could be improved, and how the current water quality status has changed.<sup>1</sup> The specific recommendations for the Pleasant River found below can be used to inform either 1) additional monitoring completed ahead of a watershed planning grant submission, or 2) to inform monitoring to be completed under funding from the watershed planning grant. We recommend the Town of Windham prepare to submit for the 2023 grant application cycle. Proposals are due on an annual schedule in late April.

We recommend PRLT continue to monitor for dissolved oxygen and *E. coli* at the ongoing sites with historical data to maintain a long-term record. Specifically, we also recommend increasing the consistency of monitoring for dissolved oxygen sites PL045, PL050, and PL055, as dissolved oxygen levels fall below the state threshold of 7.0 ppm during recent years at these upstream sites and these sites lack the consistent annual monitoring that the downstream sites (PL010, PL020, PL030, and PL040) have. At a minimum, we recommend sampling consistently at site PL050. Approximately one mile upstream of PL050, Thayer Brook enters Pleasant River. Pleasant River is identified listed as impaired downstream of the confluence of Pleasant River and Thayer Brook.

Given that the upstream reaches of Pleasant River have historically had decreased oxygen levels, we also recommend consistent sampling by PRLT or VRMP for dissolved oxygen at the tributaries that enter Pleasant River in the upstream reaches. Specifically, we suggest sampling on Thayer Brook (which has not been sampled by since 2015 as a volunteer river monitoring program site).

### *Investigative*

We recommend working with DEP to deploy continuous loggers for dissolved oxygen at two locations in 2023 (after the loggers have been deployed in Black Brook during 2022) in the Pleasant River within the Town of Windham. Average annual dissolved oxygen data from the last five years indicates dissolved oxygen levels in the lower reaches of the Pleasant River – downstream of PL043 – have been above the Maine DEP threshold of 7.0 ppm to sustain aquatic life. Additional monitoring for dissolved oxygen with continuous data loggers to assess whether lower sites in Pleasant River meet attainment standards may be able to reduce the length of impaired segment within Windham. We recommend deployment at sites PL010 and PL043.

We also recommend deploying one additional continuous logger in 2023, if available, at one of the locations which have had problems with low dissolved oxygen levels (either site PL045 or PL050) depending on results from the 2022 season.

Given that Pleasant River has also experienced elevated bacteria levels and is listed as impaired for *E. coli*, we recommend the Town perform investigative monitoring in the Pleasant River on the same schedule as Black Brook to be efficient with time and resources. The first component of investigative monitoring we recommend is sampling for co-indicator parameters at the same sites consistently monitoring by PRLT that are within Windham's borders. Based on previous bacteria trends, we recommend prioritizing sites PL010, PL020, PL030, PL040, PL043, and PL045. Co-indicators should include total phosphorus, nitrate, ammonia, ortho-phosphate, and optical brighteners (refer to the Black Brook investigative section for a description of co-indicators). An analysis of rainfall in the previous 24 and 48 hours at site PL010 (the most downstream site) compared to *E. coli* concentrations indicated bacteria levels were significantly correlated with rainfall amount (Attachment 2b). In addition, we recommend in the future, the Town and PRLT record the previous 24, 48, and 72-hr rainfall conditions during investigative monitoring.

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<sup>1</sup> Maine DEP Guidance for updating Maine Watershed Based Plans. 2017. <https://www.maine.gov/dep/water/grants/319-documents/Guidance-for-Updating-Maine-Watershed-based-Plans.pdf>

The third component of investigative monitoring we recommend is for the Town to use microbial source tracking in 2022 or in 2023. Microbial source tracking (MST) is a scientific technique that uses mitochondrial (mtDNA) host-specific markers to determine the source animal of mtDNA found in water samples. Source markers available for testing typically include 1) human, 2) canine, 3) Canada goose, 4) beaver, and 5) bovine, and 6) poultry. We recommend choosing markers based on land use-observations and bacteria monitoring results. For example, if results are primarily elevated during dry weather sampling, we recommend testing for the human marker that is potentially contributing from faulty septic systems. Or, if the surrounding land use is a well-used dog walking location and agriculture, we recommend testing for the canine marker or bovine to inform potential sources of bacteria.

# PLEASANT RIVER

Windham, Maine

## Natural Resources and Potential Pollutant Sources

- Town of Windham
- Town Boundary
- Pleasant River Watershed
- Sampling Site
- Stormwater Outfall
- Impaired Tributary Segment
- Tributary
- Waterbody
- Town Property
- Conserved Land
- Wetland

### Pleasant River Snapshot

Impaired segment length: 11.2 mi.  
Watershed size: 48.9 sq. mi.

Impairment: Dissolved oxygen, E. coli

Classification: Class B

Pleasant River does not meet water quality standards for aquatic life.

#### Land Use Composition

Agriculture: 69%

Developed: 14%

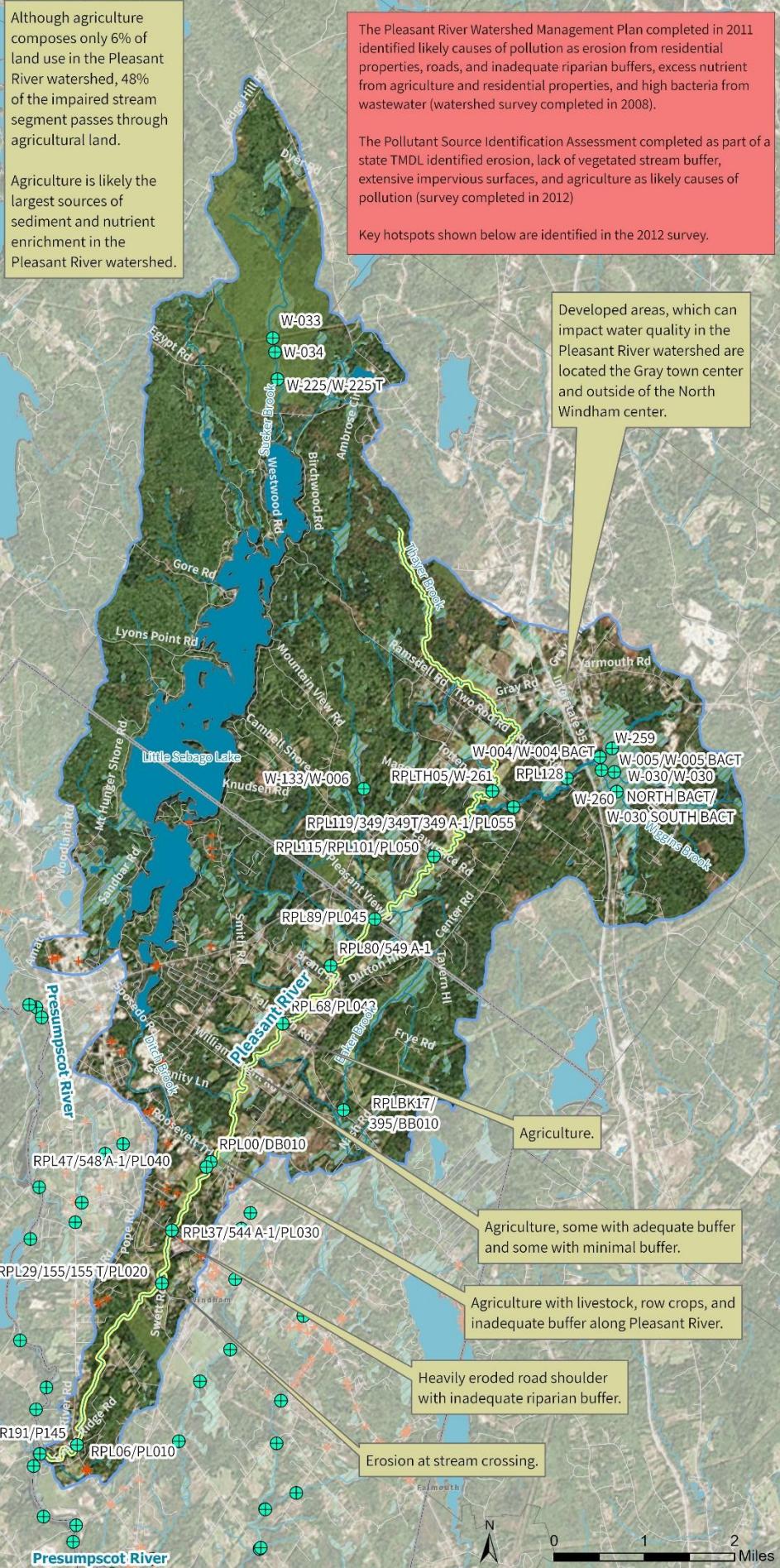
Non-developed: 80%

#### Habitat Assessment (2012)

The habitat assessment in Pleasant River was conducted in a forested portion of the stream with a thick buffer, and results were high, indicating better habitat.

Investigation of potential sources of NPS pollution should focus on "hotspots".

Data from Maine DEP TMDL.  
In-field assessments completed 2011-2012. TMDL report appendix published 2021.



Data Sources: Town of Windham, Maine DEP, PLT, WLT, NHD, Maine GeoLibrary, ESRI.  
Coordinate System: NAD 83  
UTM Zone 19N  
Map by: FB Environmental, January 2022.



## Pleasant River Water Quality Monitoring Sites

Site ID	Years Sampled DO (n)	Years Sampled Temperature (n)	Years Sampled TP (n)	Years Sampled <i>E. coli</i> (n)	Other Key Parameters Sampled
RPL00-VRMP/DB010	2009-2021 (76)	2009-2020 (70)	-	2009-2021 (88)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
RPL06/PL010	2009-2021 (67)	2009-2020 (62)		2009-2021 (72)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
RPL115/RPL101/PL050	2013, 2018 (7)	2013, 2018 (7)	-	2013-2018 (20)	Specific conductance
RPL119/349T/349 A-1/PL055	2005-2020 (11)	1999-2020 (4,332)	1999, 2005, 2010 (4)	2013-2015 (23)	Nitrate, nitrite, pH, specific conductance
RPL29/155/155 T/PL020	1992-2021 (73)	1992-2020 (8,135)	-	2009-2021 (74)	pH, specific conductance
RPL37/544 A-1/PL030	2005-2021 (54)	1999-2020 (50)	1999-2015 (5)	2009-2021 (53)	Nitrate, nitrite, pH, specific conductance
RPL47/548 A-1/PL040	2009-2021 (88)	2009-2021 (85)	2000, 2010, 2015 (3)	2009-2021 (106)	Nitrate, nitrite, pH, specific conductance
RPL68/PL043	2020-2021 (13)	2020 (7)	-	2020-2021 (17)	Specific conductance
RPL80/549 A-1	2013 (1)	1999, 2013 (2)	1999-2000 (2)	2013-2015 (12)	Nitrate, nitrite
RPL89/PL045	2019-2021 (22)	2019-2020 (18)	-	2019-2021 (23)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
RPLBK17/395/BB010	2009-2021 (86)	1999-2020 (82)	-	2009-2021 (84)	Specific conductance
RPLTH05/W-261	2013, 2015 (2)	2013, 2015 (2)	2015 (1)	2013-2014 (6)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W-004/W-004 BACT	1998-2014 (9)	1998-2014 (8)	1998-1999, 2005 (3)	2013-2014 (13)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W-005/W-005 BACT	1998-2014 (9)	1998-2014 (8)	1998-1999, 2005 (3)	2013-2014 (13)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W-030/W-030 NORTH BACT/W-030	2000-2014 (10)	2000-2014 (10)	2000-2009 (4)	2014 (14)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W-133/W-006	1998-1999, 2005 (3)	1998-1999, 2005 (3)	1998-1999, 2005 (3)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W-225/W-225 T	2010 (1)	2010 (13,681)	2010 (1)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W-259	2014 (3)	2014 (3)	-	2014-2015 (13)	pH, specific conductance
W-260	2014 (3)	2014 (3)	-	2014-2015 (13)	pH, specific conductance
RPL128	2013-2014 (6)	2013-2014 (5)	-	2013-2015 (24)	pH, specific conductance
W-033	2000-2001 (2)	2000-2001 (2)	2000-2001 (2)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W-034	2000 (1)	2000 (1)	2000 (1)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance

DO = dissolved oxygen; TP = total phosphorus, E. coli = Escherichia coli. n = total number of samples.

## **COLLEY WRIGHT BROOK**

**Class:** B

**Designated use(s) not met:** aquatic life use, recreation

**Listing cause:** dissolved oxygen, *E. coli*

**Sites with ongoing monitoring:** CW010 & RCW10 (River Rd), CW020 & RCW28 & RCW24 (Montgomery Rd),

**Organization completing monitoring:** PRLT with support from CBEP and VRMP

**Parameters being measured:** Dissolved oxygen (instantaneous), Temperature, and *E. coli* grab samples.

The Colley Wright Brook has a watershed size of approximately 7.65 square miles located entirely in Windham. Colley Wright Brook, flowing generally north to south for 8.20 miles until it enters the Presumpscot River, is listed as impaired for dissolved oxygen and *E. coli*. There are several unnamed tributaries that enter Colley Wright Brook, one of which was sampled in two locations several times between 2013 and 2014, but not since. The watershed is 13% developed and 18% agriculture, with agricultural land in the southern portion of Colley Wright Brook identified as a likely source of pollution.

Colley Wright Brook was listed due to not meeting dissolved oxygen state criteria from 2016-2020, and due to *E. coli* criteria being routinely exceeded between 2013 and 2019.

Due to consistently elevated bacteria levels and low dissolved oxygen levels, we recommend investigative sampling during varying weather conditions in Colley Wright Brook to narrow hotspots and inform future bracket sampling.

### **Recommendations:**

#### *Long-term*

We recommend PRLT continue to monitor for dissolved oxygen and *E. coli* at the ongoing sites with historical data (CW010) and (CW020) to maintain a long-term record. Given that bacteria and dissolved oxygen levels have consistently been not meeting state standards at both of the locations that are consistently sampled (RCW10/CW010 at the River Road crossing, and RCW28/RCW24/CW020 at the Montgomery Rd crossing), we also recommend re-activating one to two of the VRMP sites in the upstream reaches of Colley Wright Brook (RCW50, or RCW63). These sites were last monitoring in 2013-2014, and additional monitoring by VRMP or the establishment of a new PRLT site at these locations may provide additional context on how dissolved oxygen and bacteria levels vary upstream to downstream.

Following completion of both the Black Brook Watershed Management Plan development project and the updated Pleasant River Watershed Management Plan, we recommend following suit for Colley Wright Brook in the 2024 grant cycle. Although the watershed is small, the Maine DEP grants provide substantial footing for identifying stressors and ultimately enacting Best Management Practices that are valuable for any size watershed.

#### *Investigative*

We recommend using co-indicators and wet vs. dry weather sampling to perform further investigation at the same sites as PRLT (CW10, CW020). For co-indicators, we recommend total phosphorus, nitrate, ammonia, ortho-phosphate, and optical brighteners (refer to the prior investigative sections for a description of co-indicators). Historical data in the previous five years at site RCW10/CW010 indicates that precipitation within the 48 hours prior to sampling is significantly correlated with bacteria (Attachment 2c).

# COLLEY WRIGHT BROOK

Windham, Maine

## Natural Resources and Potential Pollutant Sources

- Town of Windham
  - Town Boundary
  - Colley Wright Brook Watershed
  - + Stormwater Outfall
  - Impaired Tributary Segment
  - Tributary
  - Sampling Site
  - Waterbody
  - Town Property\*
  - Conserved Land
  - Wetland
- \*Less than 1 acre of Town property exists in the Colley Wright Brook watershed.

## Colley Wright Brook Snapshot

Impaired segment length: 8.2 mi.  
Watershed size: 7.65 sq. mi.  
Impairment: Dissolved oxygen, E. coli  
Classification: Class B  
Colley Wright Brook does not meet water quality standards for aquatic life.

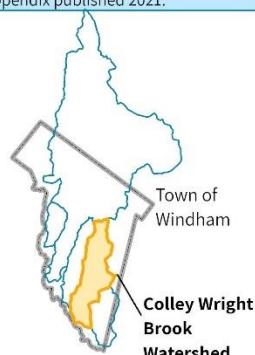
### Land Use Composition

Agriculture: 18%  
Developed: 13%  
Non-developed: 69%

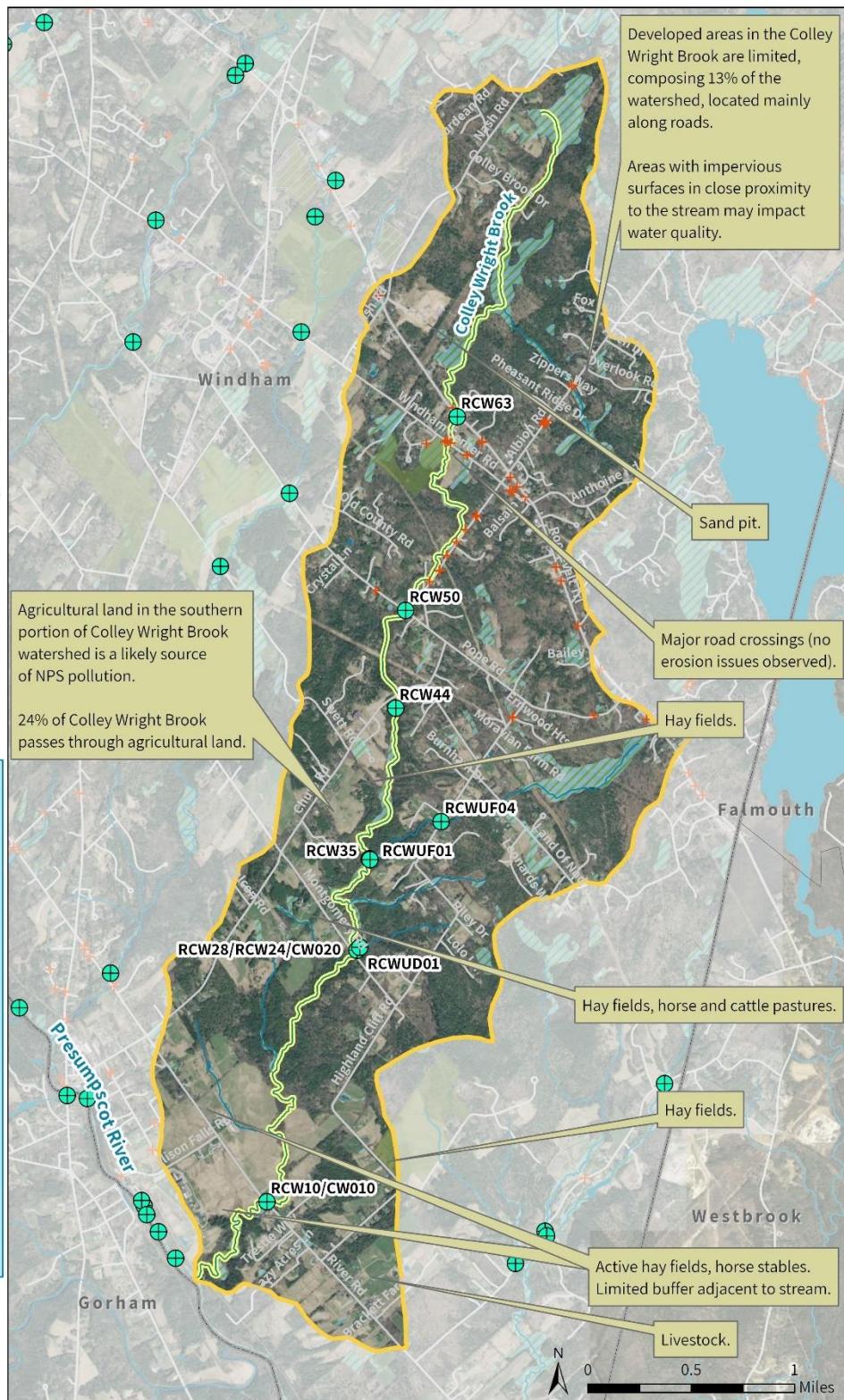
### Habitat Assessment (2012)

Stream conditions documented as turbid with sand and fine sediment deposits in-stream.

Data from Maine DEP TMDL.  
In-field assessments completed 2011-2012. TMDL report appendix published 2021.



Data Sources: Town of Windham, Maine DEP, PRRI, WLI, NHD, Maine GeoLibrary, ESRI.  
Coordinate System: NAD 83  
UTM Zone 19N  
Map by: FB Environmental, January 2022.



Site ID	Years Sampled DO (n)	Years Sampled Temperature (n)	Years Sampled TP (n)	Years Sampled E. coli (n)	Other Key Parameters Sampled
RCW35	2013 (1)	2013 (1)	-	2013 (2)	-
RCW44	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance
RCW50	-	-	-	2014 (1)	-
RCW63	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance
RCWUD01	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance
RCWUF01	2013 (1)	2013 (1)	-	2013 (2)	-
RCWUF04	2013 (3)	2013 (3)	-	2013 (4)	Specific Conductance
RCW10/CW010	2011-2021 (79)	2012-2020 (64)	-	2011-2021 (73)	Specific Conductance
RCW28/RCW24/CW020	(82)	(71)	2007 (5)	2011-2021 (69)	Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity, TSS

DO = dissolved oxygen; TP = total phosphorus; E. coli = Escherichia coli. n = total number of samples.

## **INKHORN BROOK**

**Class:** B

**Designated use(s) not met:** aquatic life use, recreation

**Listing cause:** dissolved oxygen, *E. coli*

**Sites with ongoing monitoring:** RIK05 & IN010 (River Road)

**Organization completing monitoring:** PRLT with support from CBEP and VRMP

**Parameters being measured:** Dissolved oxygen (instantaneous), Temperature, and *E. coli* grab samples.

Inkhorn Brook is the southernmost of the five impaired streams in Windham with the eastern border entering into the Town of Westbrook. The watershed area is 3.9 sq.mi. and the full length of the stream is 4.32 miles. The stream enters the Presumpscot River just downstream of the Sunset Ridge Golf Links off River Road. Only one site, located near the outlet at the crossing on River Road, has been monitored continuously through 2021.

### **Recommendations:**

#### *Long-term*

We recommend PRLT continue to monitor for dissolved oxygen and *E. coli* at the site RIK05/IN010 to maintain a long-term record. Given that bacteria and dissolved oxygen levels have consistently not been meeting state standards at this site, we also recommend re-activating site RIK25/RIK27 to bracket the upper watershed above the influence of Milliken Brook. Previous data collected at this site in 2013 demonstrates that the dissolved oxygen at this site is most often meeting attainment (ranging from 6.62 to 13.7 mg/L with a median of 8.45 mg/L). *E. coli* at this site in 2013 was elevated. We also recommend re-activating site RIKMK01 on Milliken Brook to identify the contribution of that tributary to the impaired status of Inkhorn Brook. Data collected in 2013 indicates dissolved oxygen generally meeting state standards and elevated *E. coli* bacteria.

#### *Investigative*

We recommend using co-indicators and wet vs. dry weather sampling to perform further investigation at the same site as PRLT (IN010) as well as at site RIK25 to understand upstream conditions. For co-indicators, we recommend total phosphorus, nitrate, ammonia, ortho-phosphate, and optical brighteners (refer to the prior investigative sections for a description of co-indicators). We also recommend investigative sampling at RIK27 and RIKMK01 on Milliken Brook for just *E. coli* during the 2023 or 2024 season to bracket bacteria levels around Inkhorn's confluence with Milliken Brook. Historical data in the previous five years at site RIK05/IN010 indicates that precipitation within the 48 hours prior to sampling is significantly and strongly correlated with bacteria (Attachment 2d). During the 2022 season, we recommend sampling for co-indicators on the same schedule as the other streams during wet weather for sampling efficiently. In the future, we recommend the Town and PRLT track and analyze precipitation preceding baseline monitoring events.

# INKHORN BROOK

Windham, Maine

## Natural Resources and Potential Pollutant Sources

- Town of Windham
- Town Boundary
- Inkhorn Brook Watershed
- Sampling Site
- Stormwater Outfall
- Impaired Tributary Segment
- Tributary
- Waterbody
- Town Property
- Conserved Land
- Wetland

### Inkhorn Brook Snapshot

Impaired segment length: 4.32 mi.  
Watershed size: 3.9 sq. mi.  
Impairment: Dissolved oxygen, E. coli  
Classification: Class B  
Inkhorn Brook does not meet water quality standards for aquatic life.

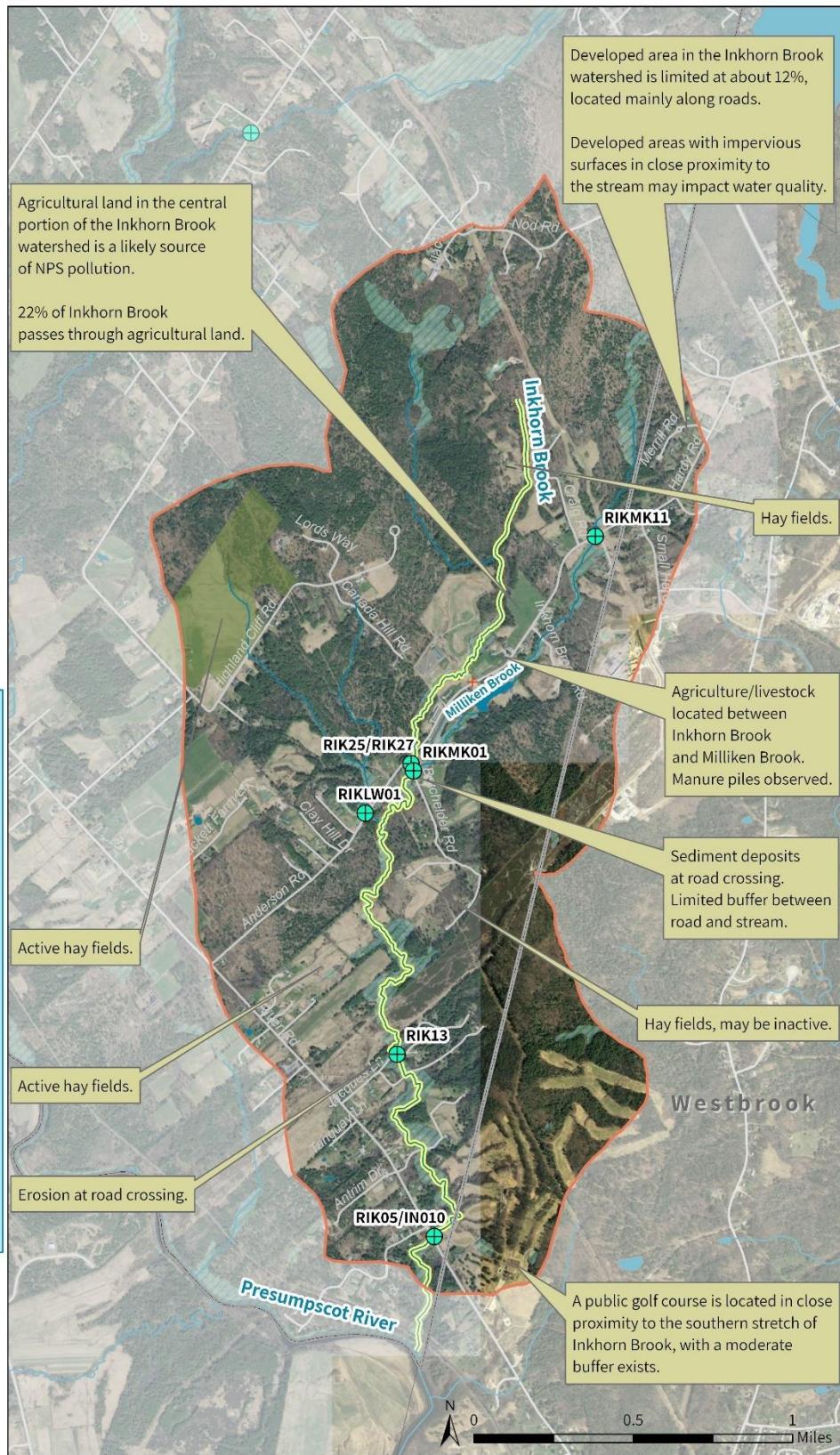
#### Land Use Composition

Agriculture: 16%  
Developed: 12%  
Non-developed: 72%

#### Habitat Assessment (2012)

Stream conditions documented as turbid with significant sand and fine sediment deposits in-stream.

Data from Maine DEP TMDL.  
In-field assessments completed 2011-2012. TMDL report appendix published 2021.



Site ID	Years Sampled DO (n)	Years Sampled Temperature (n)	Years Sampled TP (n)	Years Sampled E. coli (n)	Other Key Parameters Sampled
RIK13	2013 (3)	2013 (3)	-	2013 (5)	Specific Conductance
RIKLW01	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance
RIKMK01	2013 (4)	2013 (4)	-	2014 (6)	Specific Conductance
RIKM11	2013 (4)	2013 (4)	-	2015 (6)	Specific Conductance
RIK05/INO10	2011-2021 (54)	2012-2020 (39)	-	2011-2021 (57)	Specific Conductance
RIK27/RIK25	2007, 2013 (11)	2007, 2013 (11)	2007 (5)	2013 (6)	Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity, TSS

DO = dissolved oxygen; TP = total phosphorus; E. coli = Escherichia coli. n = total number of samples.



Data Sources: Town of Windham, Maine DMR, PRLT, WLT, NHD, Maine GeoLibrary, ESRI.  
Coordinate System: NAD 83 UTM Zone 19N  
Map by: FB Environmental, January 2022.



## **OTTER BROOK**

**Class:** B

**Designated use(s) not met:** aquatic life use, recreation

**Listing cause:** dissolved oxygen, *E. coli*

**Sites with ongoing monitoring:** OB010 & ROT06 (River Rd), OB020 & ROT10, and ROT07 (Windham Center Rd).

**Organization completing monitoring:** PRLT with support from CBEP and VRMP

**Parameters being measured:** Dissolved oxygen (instantaneous), Temperature, and *E. coli* grab samples.

Otter Brook has a watershed size of approximately 2.14 square miles located entirely in Windham; the watershed is the smallest among the impaired stream watersheds within Windham. Otter Brook, approximately 2.1 miles long, is listed as impaired for dissolved oxygen and *E. coli*. There are no mapped tributaries that enter Otter Brook. The watershed is 18% agriculture (41% of the stream flows through agriculture) and 31% of the stream is developed.

Otter Brook was listed due to ongoing dissolved oxygen and *E. coli* data not meeting state criteria from 2013-2019.

### **Recommendations:**

#### *Long-Term*

Otter Brook is a slow flowing stream that winds through wetlands for a large segment of the Brook. Between Pope Road and Windham Center Road (upstream of sites ROT10, ROT07 and OB020) Otter Brook flows through a large emergent wetland complex. Just downstream of Windham Center Road, Otter Brook flows through the Pringle Preserve, a large marsh and wetland complex that also experiences slow flows.

Wetlands can naturally depress dissolved oxygen levels and elevate bacteria due to slow flow and warm waters. In addition, wetlands are excellent habitat for wildlife such as ducks, geese, and beavers, which can contribute fecal bacteria to waterways naturally. Given these land use observations, we suggest the Town perform investigative sampling and PRLT continue long term monitoring at OB010 and OB020 to continue the historical dataset.

#### *Investigative*

As Otter Brook is listed as impaired, future monitoring and investigative work to help guide stream restoration is required.

We recommend investigative sampling to assist with narrowing and tracking the bacteria sources to determine if the bacteria sources may be natural or human caused. First, we recommend using co-indicators and wet vs. dry weather sampling to perform further investigation at the same sites as PRLT (OB010, OB020). For co-indicators, we recommend total phosphorus, nitrate, ammonia, ortho-phosphate, and optical brighteners (refer to the prior investigative sections for a description of co-indicators). Similar to the other five streams, historical data for site ROT06/OB010 over the previous five years indicated bacteria levels are significantly correlated with precipitation amount in the prior 24 and 48 hours (Attachment 2e). During the 2022 season, we recommend sampling for co-indicators on the same schedule as the other streams for sampling efficiency.

Second, we recommend conducting microbial source tracking. Microbial source tracking can be used to determine the source animal of mtDNA found in water samples. Because Otter Brook flows through some extensive wetland areas, including the Pringle Preserve, we think it would be advantageous to isolate whether the bacteria in this stream is from a manageable source (e.g., humans, dogs, livestock) or natural sources (e.g., wildlife, waterfowl). As MST tracking is expensive, we recommend first conducting expanded investigative *E. coli* sampling during the 2023 or 2024 season. There are three stormwater outfalls adjacent to the Windham Center Road and River Road intersection, and we recommend sampling for *E. coli* at the southeastern two outfalls (sampling likely will need to be done during wet weather). Second, we recommend sampling on Otter Brook upstream of the emergent wetlands, potentially with access

off Center Brook Drive or Rocklin Drive via the town-owned Otter Brook Estates municipal land. Following these efforts, we recommend using MST source markers based on these results and any land use observations, such as Canada goose, waterfowl, beaver, and human. Further information on the source of the bacteria will help inform what future restorative actions are appropriate. If funds are limited in the 2022 season, we recommend prioritizing sampling on Black Brook and the Pleasant River and conducting this MST work in 2023.

# OTTER BROOK

Windham, Maine

## Natural Resources and Potential Pollutant Sources

-  Town of Windham
-  Town Boundary
-  Otter Brook Watershed
-  Sampling Site
-  Stormwater Outfall
-  Impaired Tributary Segment
-  Tributary
-  Waterbody
-  Town Property
-  Conserved Land
-  Wetland

### Otter Brook Snapshot

Impaired segment length: 2.16 mi.

Watershed size: 2.14 sq. mi.

Impairment: Dissolved oxygen, E.coli

Classification: Class B

Otter Brook does not meet water quality standards for aquatic life.

### Land Use Composition

Agriculture: 18%

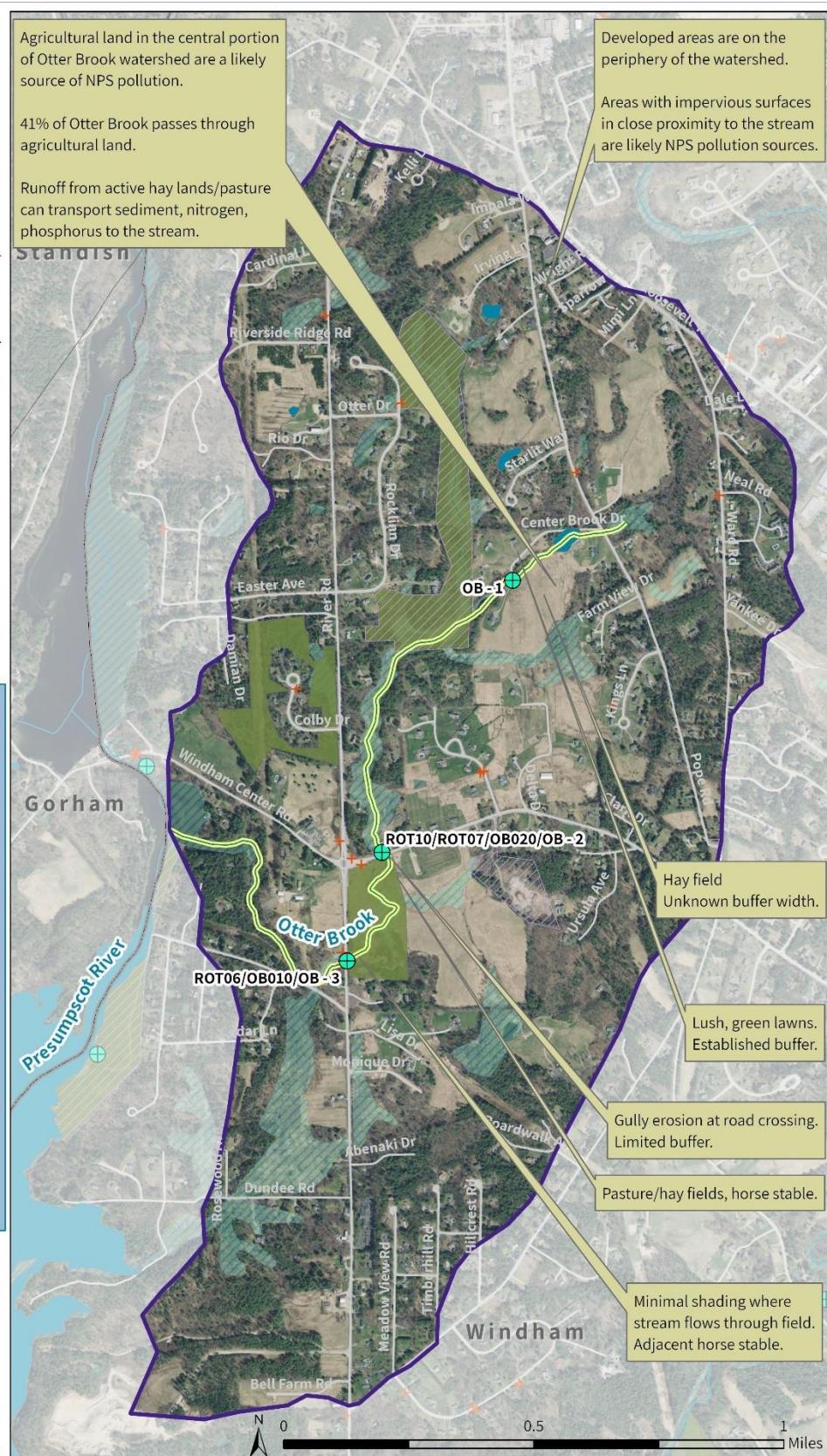
Developed: 31%

Non-developed: 51%

### Habitat Assessment (2012)

Stream conditions documented as slightly turbid with minimal sediment deposits.

Data from Maine DEP TMDL.  
In-field assessments completed 2011-2012. TMDL report appendix published 2021.



Site ID	Years Sampled DO (n)	Years Sampled Temperature (n)	Years Sampled TP (n)	Years Sampled E. coli (n)	Other Key Parameters Sampled
OB - 1	-	-	-	2014-2015 (6)	Total coliform
ROT10/ROT07/OB020/OB - 2	2007, 2013, 2017 (57)	2007, 2013, 2017 (41)	2007 (5)	2017-2020 (60)	Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity, TSS
ROT06/OB010/ OB - 3	2009-2021 (90)	2009-2020 (80)	-	2009-2021	Specific conductance

DO = dissolved oxygen; TP = Total Phosphorus; E. Coli = Escherichia coli. n = total number of samples.



Data Sources: Town of Windham, Maine DEP, PLT, WLT, NHD, Maine GeoLibrary, ESRI.  
Coordinate System: NAD 83  
UTM Zone 19N  
Map by: FB Environmental, January 2022.



## MONITORING RECOMMENDATIONS

We recommend utilizing the remaining allocated budget for the 2022 fiscal year ending on June 30 to complete two sampling events. First, we recommend completing one sampling event during wet weather across all five streams for *E. coli* and co-indicators including total phosphorus, ortho-phosphate, total suspended solids, nitrate, ammonia, and optical brighteners. Sampling sites will include six sites each on Black Brook and Pleasant River and two sites each on Colley Wright Brook, Inkhorn Brook, and Otter Brook. Second, we recommend deploying dissolved oxygen continuous loggers in Black Brook in late-May. We only recommend doing this if Maine DEP commits to lending the Town dissolved oxygen loggers and if the Town is able to fund maintenance for the remaining summer months (July – September). **The total expected cost of monitoring completed prior to June 30, 2022 is \$7,570.**

The remaining action items in table 2 are intended to be completed after June 30, 2022, pending the available funds the Town is able to put towards investigative monitoring. FBE can work with the Town of Windham to adjust the sampling plan depending on available funds for the July 1, 2022 – June 30, 2023 fiscal year. Table 3 includes all long term and investigative monitoring recommendations and estimated costs, where applicable.

**Table 2. Monitoring recommendations for 2022 including expected costs. This monitoring is in addition to the long-term PRLT monitoring funded in-part by CBEP.**

PRIORITY	ACTION ITEM	LOCATION	TIMELINE	ESTIMATED COST
<b>PROPOSED WORK COMPLETED BEFORE JUNE 30 2022 (TOTAL ESTIMATED COST = \$7,570)</b>				
1	Investigative monitoring to bracket sources of <i>E. coli</i> entering all five bacteria-impaired streams. Includes analysis for total phosphorus, ortho-phosphate, total suspended solids, nitrate, <i>E. coli</i> , ammonia, and optical brighteners. Field staff will collect temperature and dissolved oxygen field readings.	Six sites each on Black Brook and Pleasant River; Two sites each on Colley Wright Brook, Inkhorn Brook, and Otter Brook.	One sampling event during wet weather (>0.5" of rain) before June 30 2022.	<b>\$5,070</b> (includes lab fees, labor for one day of sampling, field meter rental)
2	Deployment of 2-3 continuous dissolved oxygen loggers at Black Brook in late-May. Includes labor for deployment and one maintenance event in June (monthly). Loggers provided by MEDEP. Action item is only viable if the Town is able to fund maintenance bi-weekly in July and August. (July and August are the highest productivity month and biofouling because of algae growth can interfere with the sensor if not maintained.)	BL010, BL015, and RBK38.	Deployment in late May, maintenance one time prior to June 30, 2022.	<b>\$2,500</b> (cost for deploying loggers and one maintenance event in June)
<b>PROPOSED WORK COMPLETED AFTER JULY 1 2022 (TOTAL ESTIMATED COST = \$9,250)</b>				
3	Bi-weekly maintenance of continuous dissolved oxygen loggers for July through September.	BL010, BL015, and RBK38.	Bi-weekly, July through September.	<b>\$5,500</b>
4	Logger data QaQc and analysis.	BL010, BL015, and RBK38.	By Dec 2022	<b>\$2,000</b>
5	Microbial source tracking (MST) to be completed on Pleasant River for three source markers (based on land use observations, likely including human and canine). Pleasant River sites are intended to inform future watershed plan update action items and the specific three sites will be	Three sites on Pleasant River (chosen out of PL010, PL020, PL030, PL040, PL043, and PL045).	One sampling event between July – September 2022 (can be delayed to 2023)	<b>\$1,750</b> (includes lab fees, labor for one day of MST sampling, field meter rental)

PRIORITY	ACTION ITEM	LOCATION	TIMELINE	ESTIMATED COST
<b>PROPOSED WORK COMPLETED BEFORE JUNE 30 2022 (TOTAL ESTIMATED COST = \$7,570)</b>				
	chosen based on bacteria levels from prior wet weather sampling events.			

Table 3. Long-term (three-year) action table to assist the Town of Windham with prioritization for monitoring of the five impaired streams in Windham. TP=Total Phosphorus, DO=Dissolved Oxygen, PRLT=Presumpscot Regional Land Trust, DEP=Maine Department of Environmental Protection, CBEP=Casco Bay Estuary Partnership.

STREAM	MONITORING TYPE	ACTION	STATION ID	RESPONSIBLE PARTY	FREQUENCY	TIMEFRAME	ESTIMATED COST TO TOWN
Black Brook	Long-term	Continue to conduct baseline monitoring for dissolved oxygen, temperature, and <i>E. coli</i> . Record date/time and previous 24, 48, and 72-hr rainfall conditions.	BL010, BL015, BL018, and BL020.	PRLT	Twice monthly May through September	Annual/ongoing	NA—funded by PRLT/CBEP
	Long-term	If possible, consider the addition of grab samples for total phosphorus and nitrate to the baseline monitoring program in Black Brook.	BL010, BL015, BL018, and BL020.	PRLT	Twice monthly May through September	Annual/ongoing	Estimated at \$650/yr (lab costs only, included with routine volunteer labor)
	Long-term	Establish long-term biomonitoring site for macroinvertebrates that is representative of the stream (e.g., not directly downstream of a wetland and within representative habitat.)	TBD	Maine DEP	Five-year rotation	Established in 2022	NA—funded by Maine DEP
	Investigative	Collect grab samples for <i>E. coli</i> , TP, nitrate, ammonia, orthophosphate, and optical brighteners. Take field readings for DO and temperature.	BL010, BL015, BL018, and BL020. Two new sites at end of Meredith Drive and Twoey Drive.	Town	One time during wet weather	2022	\$5,070 (lumpsum cost for sampling with four other streams)
	Investigative	Deploy three continuous DO loggers and evaluate diurnal DO levels in stream.	BL010, BL015, and RBK38	Town and Maine DEP	Collect at 15 min intervals, bi-weekly maintenance	June 1–Sept 30 2022	Loggers provided by Maine DEP. Estimated cost of \$10,000 includes deployment, bi-weekly maintenance and data analysis. <sup>2</sup>
	Investigative	Conduct a stream survey to evaluate vegetated buffers and habitat. Specifically evaluate the buffer along the Christmas Tree Farm below Webb Road. Discuss land management strategies with farm.	Impaired length	Maine DEP and CCSWCD (through Planning Grant)	One time	2022	NA—funded by Maine DEP through 604(b) grant

<sup>2</sup> Cost breakdown includes \$2,500 for deployment in May of 2022 and one maintenance event in June. Bi-weekly monitoring for the remainder of the year is estimated at \$5,500. Data Qa/Qc and analysis is estimated at \$2,000.

STREAM	MONITORING TYPE	ACTION	STATION ID	RESPONSIBLE PARTY	FREQUENCY	TIMEFRAME	ESTIMATED COST TO TOWN
Pleasant River	Long-term	Update the 2011 Pleasant River Watershed Based Plan working with Maine DEP and other watershed stakeholders through the Maine DEP 604(b) Watershed Planning Grants. Monitoring in 2022 can be used to inform the submission (and grant funds may be used to continue investigative monitoring). We recommend establishing a nutrient monitoring plan for the Pleasant River as part of this effort.	Impaired length	Town	Submit planning grant application in April 2023.	2023	Planning grants typically range from \$25k- \$40k with 25% match required (\$7k - \$10k cash and in-kind funds).
	Long-term	Continue to conduct baseline sampling for dissolved oxygen and <i>E. coli</i> . Increase consistency of annual monitoring at sites PL045, PL050, and PL055. Record date/time and previous 24, 48, and 72-hour rainfall conditions.	PL010, PL020, PL030, PL040, PL043, PL045	PRLT	Twice monthly May through September	Annual/ongoing	NA – funded by PRLT/CBEP
	Investigative	If Maine DEP has two dissolved oxygen loggers available in 2023, deploy continuous loggers for dissolved oxygen at two locations in the Pleasant River in Windham to assess whether lower sites in Pleasant River meet attainment standards may be able to reduce the length of impaired segment within Windham.	PL010 and PL043	Town and Maine DEP	Collect at 15 min intervals, bi-weekly maintenance	June 1 – Sept 30 2023	Loggers provided by Maine DEP. Estimated costs of \$8,000 - \$10,000 includes deployment bi-weekly maintenance and data analysis.
	Investigative	If Maine DEP has a third dissolved oxygen logger available in 2023, deploy one continuous logger at the locations which have had problems with low dissolved oxygen levels in the Pleasant River.	PL045 or PL050	Maine DEP (out of Town boundary)	Collect at 15 min intervals, bi-weekly maintenance	June 1 – Sept 30 2023	Loggers provided by Maine DEP. \$3,000 includes deployment, bi-weekly maintenance and data analysis (if added to above work)
	Investigative	Collect grab samples for <i>E. coli</i> and co-indicators, including TP, nitrate, ammonia, ortho-phosphate, and optical brighteners. Take field readings for DO and temperature.	PL010, PL020, PL030, PL040, PL043, and PL045	Town	One time during wet weather	2022	Included in Black Brook cost for wet weather co-indicator sampling
	Investigative	Use microbial source tracking for specific source markers such as human, dog, or livestock to inform potential sources of bacteria.	Three sites out of PL010, PL020, PL030, PL040, PL043, and PL045	Town	One sampling event between July – September 2022	2022	\$1,750 (includes lab fees, labor for one day of MST sampling, field meter rental)

STREAM	MONITORING TYPE	ACTION	STATION ID	RESPONSIBLE PARTY	FREQUENCY	TIMEFRAME	ESTIMATED COST TO TOWN
Colley Wright Brook	Long-term	Continue to conduct baseline sampling for dissolved oxygen and <i>E. coli</i> .	CAW010 and CAW020	PRLT	Twice monthly May through September	Annual/ongoing	NA—funded by PRLT/CBEP
	Long-term	Reactivate long-term sampling at two upstream sites for dissolved oxygen and <i>E. coli</i> due to consistent elevated counts of both parameters downstream to assist with bracketing the source and/or listing a segment of the stream that is meeting standards.	RCW50 and RCW63	PRLT	Twice monthly May through September	Starting in 2022 and annual/ongoing thereafter	NA—funded by PRLT/CBEP
	Long-term	Write a Watershed Management Plan with Maine DEP and other watershed stakeholders through the Maine DEP 604(b) Watershed Planning Grants program. Monitoring in 2022 and 2023 can be used to inform the submission (and grant funds may be used to continue investigative monitoring).	Impaired length	Town	Submit planning grant application in April 2024.	2023-2024	Planning grants typically range from \$25k-\$40k with 25% match required (\$7k-\$10k cash and in-kind funds).
	Investigative	Collect grab samples for <i>E. coli</i> and co-indicators, including TP, nitrate, ammonia, ortho-phosphate, and optical brighteners. Take field readings for DO and temperature.	CAW010, CAW020	Town	One time during wet weather	2022	Included in Black Brook cost for wet weather co-indicator sampling
Inkhorn Brook	Long-term	Continue to conduct baseline sampling for dissolved oxygen and <i>E. coli</i> .	IN010	PRLT	Twice monthly May through September	Annual/ongoing	NA—funded by PRLT/CBEP
	Long-term	Reactivate sites RIK25 and/or RIK27, and RIKMK01 on Milliken Brook to gather baseline data for dissolved oxygen and <i>E. coli</i> in the upper watershed.	RIK25 and/or RIK27, and RIKMK01	PRLT/VRMP	Twice monthly May through September	Annual/ongoing	NA—funded by PRLT/CBEP, or by ME DEP through VRMP
	Investigative	Collect grab samples for <i>E. coli</i> and co-indicators, including TP, nitrate, ammonia, ortho-phosphate, and optical brighteners. Take field readings for DO and temperature.	IN010, RIK25	Town	One time during wet weather	2022	Included in Black Brook cost for wet weather co-indicator sampling

STREAM	MONITORING TYPE	ACTION	STATION ID	RESPONSIBLE PARTY	FREQUENCY	TIMELINE	ESTIMATED COST TO TOWN
	Investigative	Collect grab samples for <i>E. coli</i> at RIK27 (above Milliken Brook's inlet) and RIKMK01 on Milliken Brook to bracket bacteria levels around Inkhorn's confluence with Milliken Brook. Estimated cost is to sample in coordination with additional sites at Otter Brook.	RIK27, RIKMK01	Town	Two sampling events during wet weather (>0.5" of rain) between July–September 2022	2023 or 2024	\$2,500–\$3,000 (includes labor, lab fees, and fieldmeter)
Otter Brook	Long-term	Continue to conduct baseline sampling for dissolved oxygen and <i>E. coli</i> .	OB010, OB020	PRLT	Twice monthly May through September	Annual/ongoing	NA—funded by PRLT/CBEP
	Investigative	Collect grab samples for <i>E. coli</i> and co-indicators, including TP, nitrate, ammonia, ortho-phosphate, and optical brighteners. Take field readings for DO and temperature.	OB010, OB020	Town	One time during wet weather	2022	Included in Black Brook cost for wet weather co-indicator sampling
	Investigative	Collect grab samples for <i>E. coli</i> at two stormwater outfalls adjacent to Windham Center Road and one site above the large wetland complex off Windham Center Road (former site OB-1)	Two stormwater outfalls, site off Windham Center Road (OB-1)	Town	Two sampling events during wet weather (>0.5" of rain) between July–September 2022	2023 or 2024	Included in cost to do wet weather events at Inkhorn
	Investigative	Use microbial source tracking for specific source markers such as wildlife vs. human to isolate the possibility of wildlife influence in the large wetland complex.	OB010, OB020, OB-1	Town	One wet weather sampling event (>0.5").	2023 or 2024	\$1,800 (includes lab fees, labor for one day of MST sampling, fieldmeter rental)

<sup>3</sup> Includes expected 3% cost increase over 2022 cost if completed in 2023.

## ATTACHMENT 1. Historical Data Summary

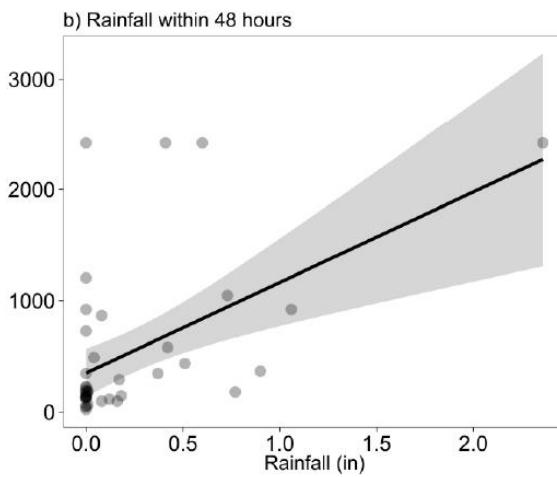
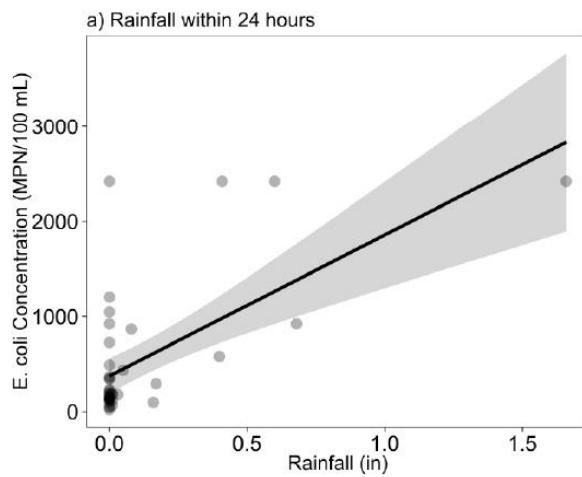
Table A-1. Summary table of all surface water data collected from the five impaired streams in Windham. Data included show the years sampled with a total count in parentheses (n). DO=dissolved oxygen, n=count, TP=total phosphorus, E. coli=Escherichia coli.

Site ID	Years Sampled DO (n)	Years Sampled Temperature (n)	Years Sampled TP (n)	Years Sampled E. coli (n)	Other Key Parameters Sampled
<b>Black Brook</b>					
BL030	-	-	-	2021 (4)	-
RBK38	-	-	-	2014-2015 (11)	-
RBK49/BL020	2017-2021 (60)	2017-2020 (30)	-	2017-2020 (76)	Specific Conductance
RBK05/BL010	2011-2021 (84)	2011-2020 (78)	-	2011-2021 (90)	Specific Conductance
RBK24/BL015	2007, 2021 (15)	2007 (6)	2007 (4)	2014-2015, 2021 (22)	Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity, TSS
RBK32/BL018	2021 (9)	-	-	2014-2015, 2021 (22)	-
<b>Pleasant River</b>					
RPL00/VRMP/DB010	2009-2021 (76)	2009-2020 (70)	-	2009-2021 (88)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
RPL06/PL010	2009-2021 (67)	2009-2020 (62)	-	2009-2021 (72)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
RPL115/RPL101/PL050	2013, 2018 (7)	2013, 2018 (7)	-	2013-2018 (20)	Specific conductance
RPL119/349/349T/349A-1/PL055	2005-2020 (11)	1999-2020 (4,332)	1999, 2005, 2010 (4)	2013-2015 (23)	Nitrate, nitrite, pH, specific conductance
RPL29/155/155T/PL020	1992-2021 (73)	1992-2020 (8,135)	-	2009-2021 (74)	pH, specific conductance
RPL37/544A-1/PL030	2005-2021 (54)	1999-2020 (50)	1999-2015 (5)	2009-2021 (53)	Nitrate, nitrite, pH, specific conductance
RPL47/548A-1/PL040	2009-2021 (88)	2009-2021 (85)	2000, 2010, 2015 (3)	2009-2021 (106)	Nitrate, nitrite, pH, specific conductance
RPL68/PL043	2020-2021 (13)	2020 (7)	-	2020-2021 (17)	Specific conductance
RPL80/549A-1	2013 (1)	1999, 2013 (2)	1999-2000 (2)	2013-2015 (12)	Nitrate, nitrite
RPL89/PL045	2019-2021 (22)	2019-2020 (18)	-	2019-2021 (23)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
RPLBK17/395/BB010	2009-2021 (86)	1999-2020 (82)	-	2009-2021 (84)	Specific conductance
RPLTH05/W-261	2013, 2015 (2)	2013, 2015 (2)	2015 (1)	2013-2014 (6)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W004/W004BACT	1998-2014 (9)	1998-2014 (8)	1998-1999, 2005 (3)	2013-2014 (13)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W005/W005BACT	1998-2014 (9)	1998-2014 (8)	1998-1999, 2005 (3)	2013-2014 (13)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W030/W030NORTHBACT/W030SOUTH	2000-2014 (10)	2000-2014 (10)	2000-2009 (4)	2014 (14)	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W133/W006	1998-1999, 2005 (3)	1998-1999, 2005 (3)	1998-1999, 2005 (3)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W225/W-225T	2010 (1)	2010 (13,681)	2010 (1)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W259	2014 (3)	2014 (3)	-	2014-2015 (13)	pH, specific conductance
W260	2014 (3)	2014 (3)	-	2014-2015 (13)	pH, specific conductance
RPL128	2013-2014 (6)	2013-2014 (5)	-	2013-2015 (24)	pH, specific conductance
W033	2000-2001 (2)	2000-2001 (2)	2000-2001 (2)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
W034	2000 (1)	2000 (1)	2000 (1)	-	Chloride, chlorophyll-a, nitrate, nitrite, pH, specific conductance
<b>Colley Wright Brook</b>					
RWA55	2013 (1)	2013 (1)	-	2013 (2)	-
RWA44	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance
RWA50	-	-	-	2014 (1)	-
RWA63	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance
RWAUD01	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance

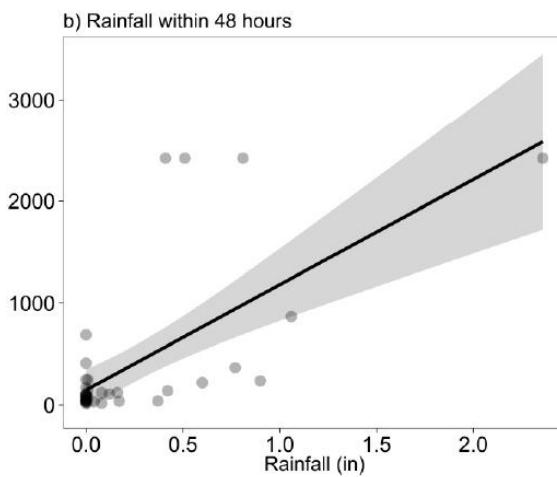
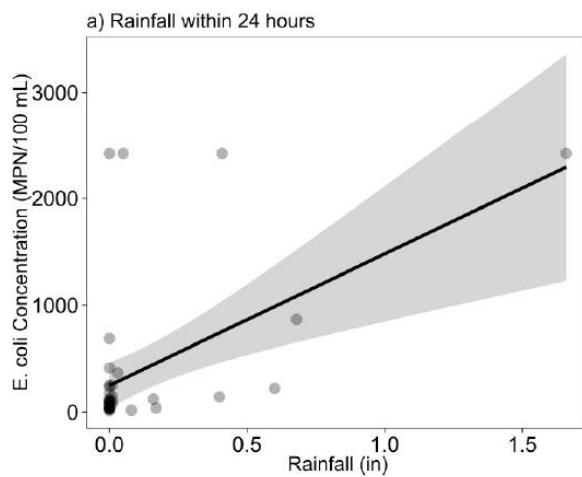
Site ID	Years Sampled DO (n)	Years Sampled Temperature (n)	Years Sampled TP (n)	Years Sampled <i>E. coli</i> (n)	Other Key Parameters Sampled
RCWUF01	2013 (1)	2013 (1)	-	2013 (2)	-
RCWUF04	2013 (3)	2013 (3)	-	2013 (4)	Specific Conductance
RCW10/CAW10	2011-2021 (79)	2012-2020 (64)	-	2011-2021 (73)	Specific Conductance
RCW28/RCW24/CAW20	2007, 2011-2021 (82)	2007, 2011-2020 (71)	2007 (5)	2011-2021 (69)	Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity, TSS
<i>Inkhorn Brook</i>					
RK13	2013 (3)	2013 (3)	-	2013 (5)	Specific Conductance
RK1W01	2013 (4)	2013 (4)	-	2013 (6)	Specific Conductance
RKMK01	2013 (4)	2013 (4)	-	2014 (6)	Specific Conductance
RKMK11	2013 (4)	2013 (4)	-	2015 (6)	Specific Conductance
RK05/IN010	2011-2021 (54)	2012-2020 (39)	-	2011-2021 (57)	Specific Conductance
RK27/RK25	2007, 2013 (11)	2007, 2013 (11)	2007 (5)	2013 (6)	Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity, TSS
<i>Otter Brook</i>					
OB-1	-	-	-	2014-2015 (6)	Total coliform
ROT10/ROT07/OB020/OB-2	2007, 2013, 2017-2021 (57)	2007, 2013, 2017-2020 (41)	2007 (5)	2017-2020 (60)	Chlorophyll a, nitrate/nitrite, pH, specific conductance, turbidity, TSS
ROT06/OB010/OB-3	2009-2021 (90)	2009-2020 (80)	-	2009-2021 (101)	Specific conductance

DO=dissolved oxygen; TP=total phosphorus, E. coli=Escherichia coli. n=total number of samples.

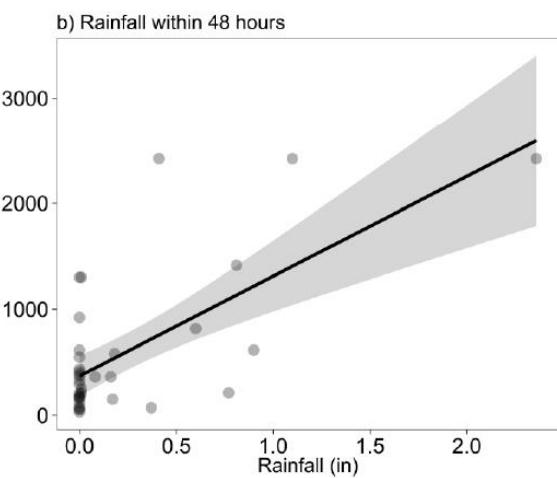
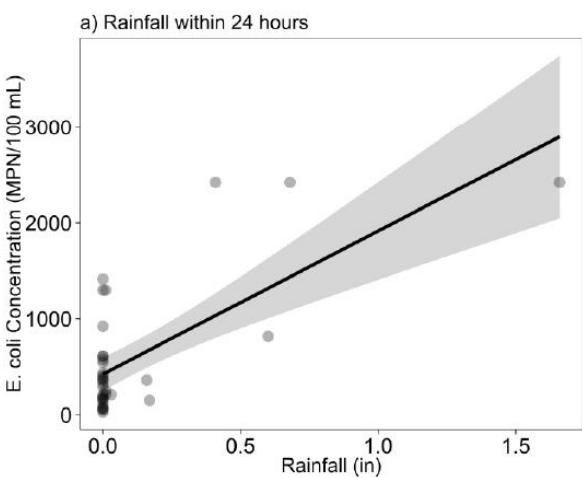
**ATTACHMENT 2.** Precipitation within the 24- and 48-hour periods prior to sampling over the previous five years of sampling. Sites were assessed by “adjacent spatial location” (meaning VRMP sites and PRLT sites in the same sites that are the same road crossing in the EGAD database, but that may have slightly different coordinates).



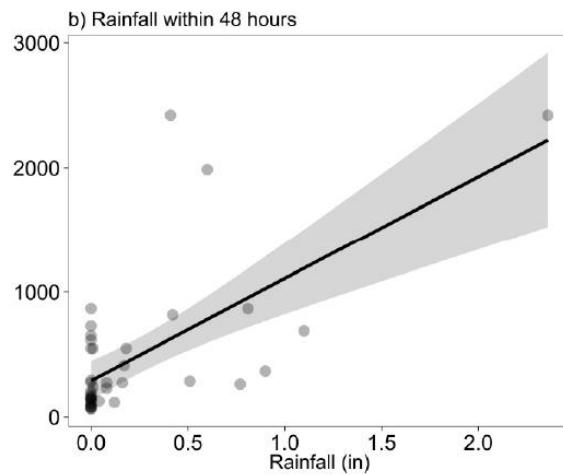
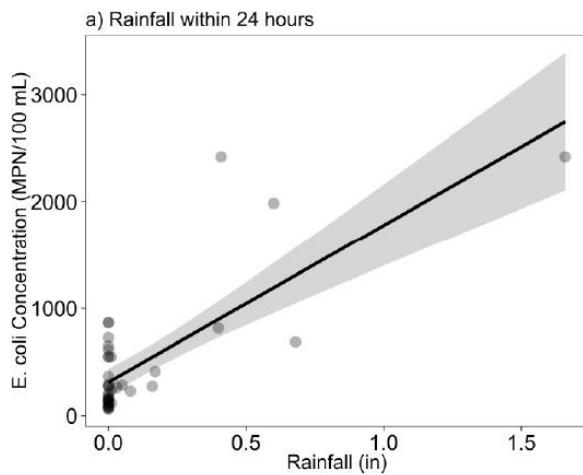
a) Black Brook, site RBK05/BL010



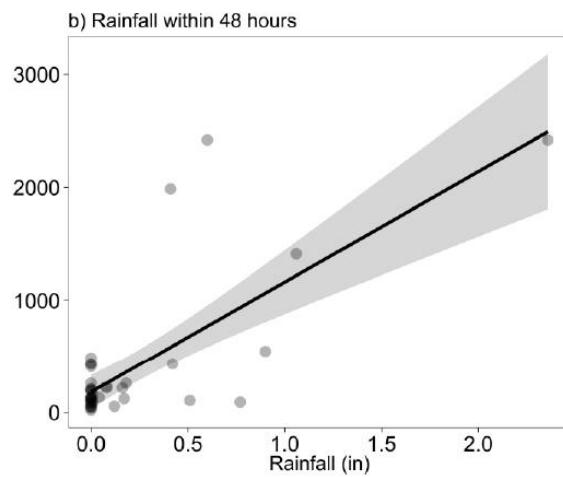
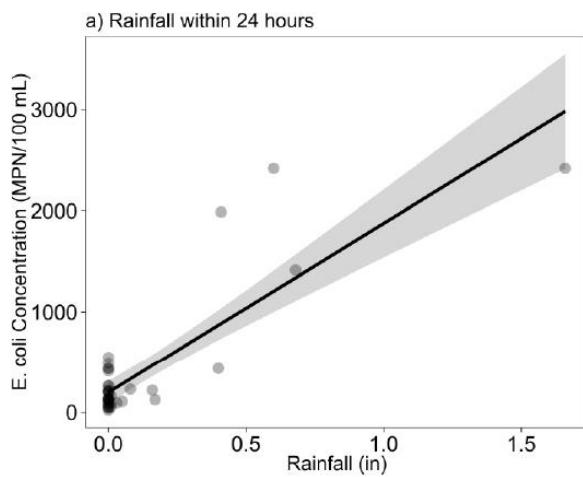
b) Pleasant River, site RPL06/PL010



c) Colley Wright Brook, site RCW10/CW010



d) Inkhorn Brook, site RIK05/IN010



e) Otter Brook, site ROT06/OB010