Pleasant River

WATERSHED DESCRIPTION

This **TMDL** applies to a 11.2 mile section of Pleasant River, located in the towns of Windham and Gray, Maine. The impaired segment of Pleasant River begins at the confluence of Thayer Brook and Upper Pleasant River (attainment) in the northern portion of the watershed just south of Totten Road. Pleasant River flows south crossing Lawrence Road, Gray Road (Route 4), Brand Road, Belanger Avenue, Falmouth Road, William Knight Road, Route 302, Windham Center Road, Pope Road, and River Road before its confluence with the Presumpscot River. The Pleasant River watershed covers an area of 48.9 square miles.

- Pleasant River is on Maine's 303(d) list of Impaired Streams as referenced in the 2016 Integrated Report (Maine DEP, 2018).
- The Pleasant River watershed is predominately non-developed (80.3%). Forested areas (68.4%) within the watershed absorb and filter pollutants helping protect both water quality in the stream and stream channel stability. Wetlands (11%) may also help filter nutrients.
- Non-forested areas within the watershed are predominantly agricultural (5.8%) and developed (13.3%) and are located throughout the watershed.
- Developed areas (13.3%) with impervious surfaces in close proximity to the stream or creating concentrated flow may impact water quality.
- Runoff from agricultural land located throughout the southern portion of the watershed is likely a large source of **nonpoint source (NPS) pollution** to Pleasant River. Runoff from cultivated lands, active hay lands, and pasture can transport sediment, nitrogen, and phosphorus to the stream.

Definitions

- ***Total Maximum Daily Load (TMDL)*** *represents the total amount of pollutants that a waterbody can receive and still meet water quality standards.*
- ***Nonpoint Source Pollution*** *refers to pollution that comes from many diffuse sources across the landscape, and are typically transported by rain or snowmelt runoff.*

Waterbody Facts

Segment ID: ME0106000103_607R12

Town: Windham and Gray, ME

County: Cumberland

Impaired Segment Length: 11.2 miles

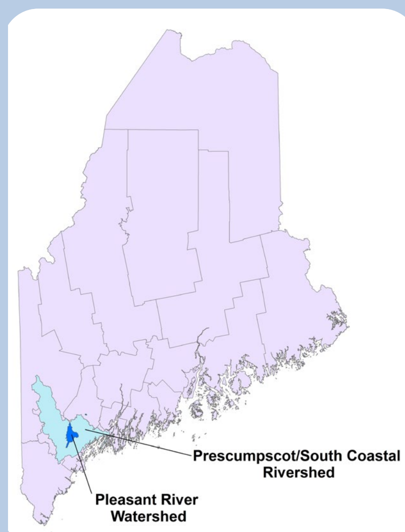
Classification: Class B

Direct Watershed: 48.9 mi^2 (31,309 acres)

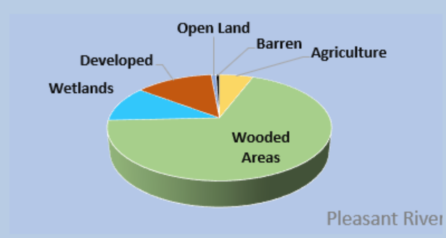
Impairment Listing Cause: Dissolved Oxygen

Watershed Agricultural Land Use: 5.8%

Major Drainage Basin: Presumpscot River



Watershed Land Uses



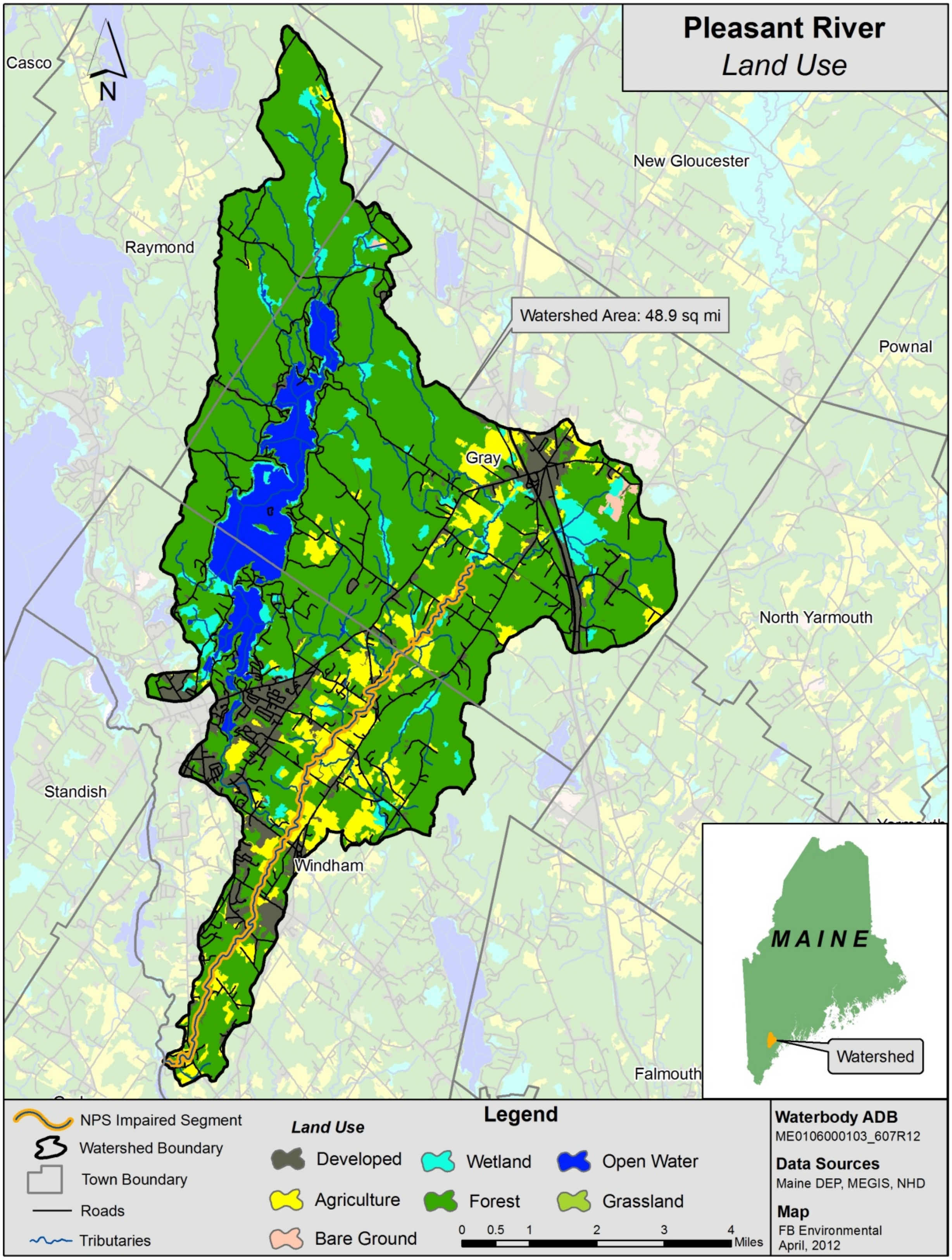


Figure 1: Land Use and Land Cover (from 2011) in the Pleasant River Watershed

WHY IS A TMDL ASSESSMENT NEEDED?

Pleasant River, a Class B freshwater stream, has been assessed by Maine DEP as not meeting water quality standards for the designated use of aquatic life, and placed on the 303(d) list of impaired waters under the Clean Water Act. The Clean Water Act requires that all 303(d)-listed waters undergo a TMDL assessment that describes the impairments and establishes a target to guide the measures needed to restore water quality. The goal is for all waterbodies to comply with state water quality standards.

Pleasant River *near Pope Road crossing, Station 27. Photo: FB Environmental*

Pleasant River watershed is heavily forested as forested lands account for 68.4% of the total area. Developed land (13.3%) is just over two times the area of agricultural land (5.8%) of the watershed. However, 48% of the impaired stream segment length passes through agricultural land (Figure 1). Agriculture, therefore, is still likely to be the largest contributor of sediment and nutrient enrichment to the stream. This is especially evident from farmland on Lotts Drive where a strong smell of manure was documented, 35 cows observed, and heavily-trodden ground on the opposite side of river was observed, indicating a potential cow-crossing. The close proximity of many agricultural lands to the stream further increases the likelihood that nutrients from disturbed soils, manure, and fertilizers will reach the stream.

WATER QUALITY DATA ANALYSIS

Maine DEP uses a variety of data types to measure the ability of a stream to adequately support aquatic life, including; dissolved oxygen, benthic macroinvertebrates, and periphyton (algae). For benthic macroinvertebrates, DEP makes aquatic life use determinations using a statistical model that incorporates 30 variables of data collected from rivers and streams, including the richness and abundance of streambed organisms, to determine the probability of a sample meeting Class A, B, or C conditions. Biologists use the model results and supporting information to determine if samples comply with the numeric aquatic life criteria of the class assigned to the stream or river (Davies and Tsomides, 2002). Maine DEP uses an analogous model to aid in the assessment of algal communities but makes aquatic life use determinations based on narrative standards.

All segments in the watershed have a Class B designation. The aquatic life impairment in Pleasant River is based on dissolved oxygen data collected at station S-544 in 1999, S-548 in 2000, S-549 in 1999-2000, RPL47 in 2009-2011, and RPL06 in 2011. In addition, periphyton data at S-549 in 1999 indicated impairment, although this is not the listing cause. Data from periphyton stations (S-394, S-544, S-548 and S-549) in 2000, 2005, 2010 or 2015 and benthic macroinvertebrate stations (S-155, S-394 and S-548) in 1999, 2005, 2010 or 2020 all indicated class B attainment or better.

TMDL ASSESSMENT APPROACH: NUTRIENT AND SEDIMENT MODELING OF IMPAIRED AND ATTAINMENT STREAMS

NPS pollution is difficult to measure directly, because it comes from many diffuse sources spread across the landscape. For this reason, an online nutrient loading model, *Model My Watershed* (v. 1.32.0), was used to estimate the sources of pollution based on well-established hydrological equations (Stroud Water Research Center 2017). *Model My Watershed* makes use of the GWLF-enhanced model engine. The model incorporates detailed maps of soil, land use, and slope, daily weather and localized weather data (from the period 2009-2020), and direct observations of agriculture and other land uses within the watershed. *Model My Watershed* is derived from its parent MapShed developed by Evans and Corradini (2012). *Model My Watershed* replaced MapShed in 2017-2018.

The nutrient loading estimates for the impaired stream were compared to similar estimates for five non-impaired (attainment) streams of similar watershed land uses across the state. The TMDL for the impaired stream was set as the mean nutrient loading estimate of these attainment stream watersheds, and units of mass per unit watershed area per year (kg/ha/year) were used. The difference in loading estimates between the impaired and attainment watersheds represents the percent reduction in nutrient loading required under this TMDL. The attainment streams and their nutrient and sediment loading estimates and TMDL are presented below in Table 1.

Table 1: Numeric Targets for Pollutant Loading Based on Model My Watershed Outputs (2021) for Attainment Streams

Attainment Streams	Town	Total P Load (kg/ha/yr)	Total N Load (kg/ha/yr)	Sediment Load (kg/ha/yr)
Footman Brook	Exeter	0.17	1.73	35.2
Martin Stream	Fairfield	0.13	2.98	57.9
Moose Brook	Houlton	0.18	1.59	48.5
Upper Kenduskeag Stream	Corinth	0.16	1.72	100.5
Upper Pleasant River	Gray	0.16	4.26	86.5
Total Maximum Daily Load		**0.16**	**2.46**	**65.7**

Rapid Watershed Assessment

Habitat Assessment

A habitat assessment survey was conducted on both the impaired and attainment stream. The assessment approach is based on the *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (Barbour et al. 1999), which integrates various parameters relating to the structure of physical habitat. The habitat assessments include a general description of the site, physical characterization and visual assessment of in-stream and riparian habitat quality.

Based on rapid bioassessment protocols for low gradient streams, Pleasant River received a score of 190 out of a total 200 for quality of habitat. Higher scores indicate better habitat. The range in habitat assessment scores for attainment streams was 155 to 179.

There are several possible explanations for why the habitat assessment score for this watershed is higher than the score of its reference stream. First, the habitat assessment was conducted on a relatively short sample reach (about 100-200 meters for a typical small stream), and was located near the most downstream Maine DEP sample station. For both impaired and attainment streams, the assessment location was usually near a road crossing for ease of access. In the Pleasant River watershed, the downstream sample station was located in a forested portion of the stream with a thick buffer, while not all of the stream flows through forested areas within the watershed.

Figure 2 (right) shows the range of habitat assessment scores for all attainment and impaired streams, as well as for the Pleasant River. These scores show that habitat is not a factor in the impairment of the Pleasant River at the sample location, so it is important to look for other potential sources within the watershed leading to impairment. Consideration should be given to major "hot spots" in the Pleasant River watershed as potential sources of NPS pollution contributing to the water quality impairment.

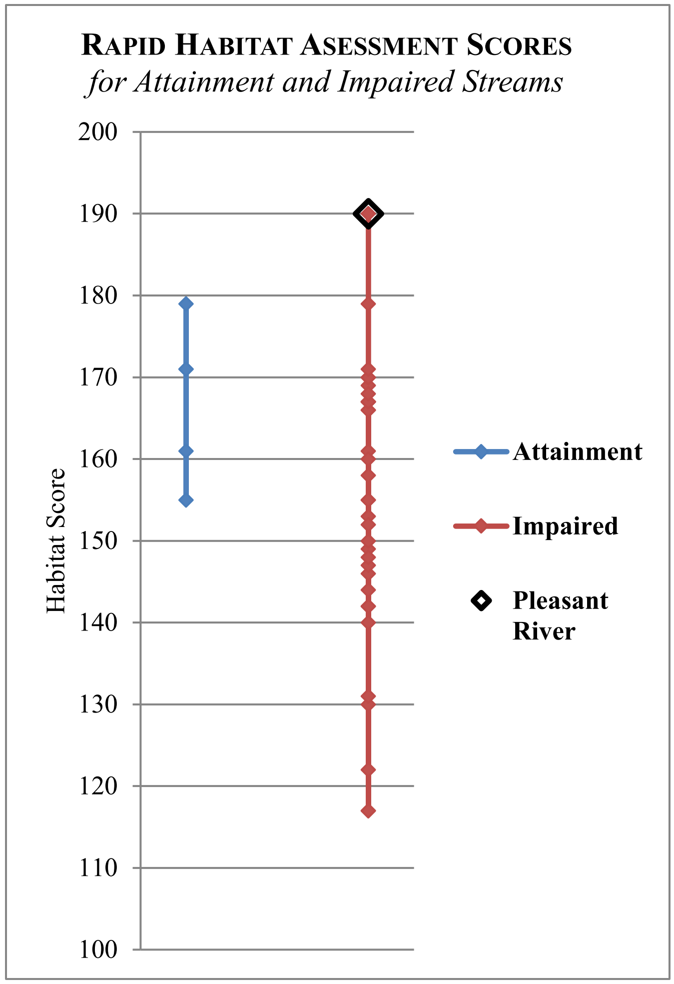


Figure 2: Habitat Assessment Scores for Pleasant River (2012) Compared to Region

Pollution Source Identification

Pollution source identification assessments were conducted for both Pleasant River (impaired) and the attainment streams. The source identification work is based on an abbreviated version of the Center for Watershed Protection's Unified Subwatershed and Site Reconnaissance method (Wright, et al. 2005). The abbreviated method includes both a desktop and field component. The desktop assessment consists of generating and reviewing maps of the watershed boundary, roads, land use and satellite imagery, and then identifying potential NPS pollution locations, such as road crossings, agricultural fields, and large areas of bare soil. When available, multiple sources of satellite imagery were reviewed. Occasionally, the high resolution of the imagery allowed for observations of livestock, row crops, eroding stream banks, sediment laden water, junkyards, and other potential NPS concerns that could affect stream quality. As many potential pollution sources as possible were visited, assessed and documented in the field. Field visits were limited to NPS sites that were visible from roads or a short walk from a roadway. Neighborhoods were assessed for NPS pollution at the whole neighborhood level including streets and storm drains (where applicable). The assessment does not include a scoring component, but does include a detailed summary of findings and a map indicating documented NPS sites throughout the watershed.

The watershed source assessment for the Pleasant River was completed in July 2012. Field observations of erosion, lack of vegetated stream buffer, extensive impervious surfaces, high-density neighborhoods and agricultural activities were documented throughout the watershed (Table 2, Figure 3).

Table 2: Potential Pollution Source ID Assessment (2012) for the Pleasant River Watershed

Potential Source			Notes
ID#	**Location**	**Type**	
1	Falmouth Road	Road Crossing/ Agriculture	• Agricultural fields with row crops, most likely corn, were observed close to the river near the Falmouth Road crossing. • A mowed lawn also exists with minimal buffer to the stream.
3	William Knight Road	Agriculture	• Agricultural fields with row crops were observed near the William Knight Road crossing with adequate buffer. • However, currently inactive fields adjacent to row crops have a very small buffer from the stream.
4	Old Route 202/Lott's Drive	Agriculture	• Active agricultural fields with a strong smell of manure were documented on Lott's Drive on the grounds of Mineral Springs Farm in Windham. • Approximately 30-35 cows were observed on the farm near the river, and have direct access to the river that runs through a grazing area. • This portion of the Pleasant River does not have a buffer, and from aerial photographs, you can see that cows cross the river. Heavily trodden ground and walking trails are visible. • Row crops were also observed within 20 m of the river.
7	Windham Center Road	Road Crossing	• A heavily eroded road shoulder at the Windham Center Road crossing provided evidence of large volumes of runoff at this site. • Riparian buffer is not adequate here as soil travels down slope toward stream.
9	Pope Road	Road Crossing	• Recent road undercutting and erosion was documented at the Pope Road stream crossing. Ditches were vegetated.

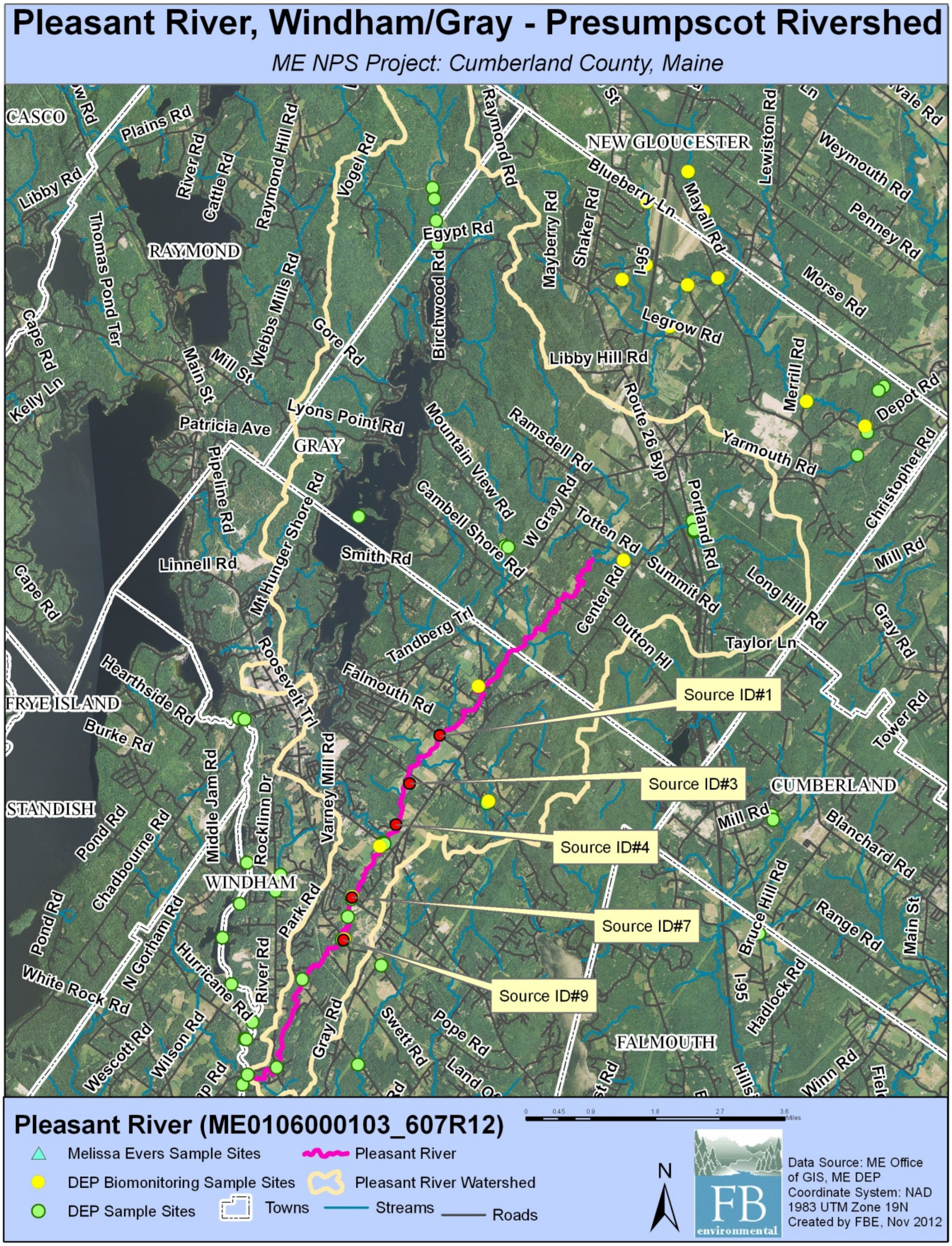


Figure 3: Aerial Photo of Potential Source ID Locations (identified in 2012) in Pleasant River Watershed

NUTRIENT AND SEDIMENT LOADING – *MODEL MY WATERSHED* ANALYSIS

The *Model My Watershed* model was used to estimate stream loading of total phosphorus, total nitrogen, and sediment in Pleasant River watershed. The model estimated nutrient loads over a 12-year period (2009-2020), which was determined by local (Portland Jetport USW00014764) weather data inserted into *Model My Watershed*. This extended period captures a recent but wide range of hydrologic conditions to account for variations in nutrient and sediment loading over time. Loads for the attainment watersheds (five total; Table 1) were computed using the same model with the same recent inputs (i.e., regional weather, 2016 land use and land cover, 2016 wetland extent, and BMPs similar to the impaired watersheds).

Many quality assured and regionally calibrated input parameters are provided with *Model My Watershed*. However, several updates to some of the default parameters were made in this TMDL effort, and namely more recent land use/cover using **MRLC-NLCD 2016** [1], more recent and local weather (precipitation and temperature) data (as described above), and more regional estimates of Best Management Practices (BMPs; see ensuing discussion). Because land use/cover is more recent, the estimated filtration fraction of wetland and open water and the amount of stream buffer in agricultural land should be more accurate. It is also worth noting that improved classification algorithms were employed by MLRC in the NCLD 2016 and these new algorithms were used in the revisions of all previous NLCD versions.

Livestock Estimates

Livestock waste contains nutrients which can cause water quality impairment. The nutrient loading model considers numbers and types of animals. Table 3 (right) provides livestock (numbers of animals) in the watershed based on the USDA National Agricultural Statistics Service (NASS) estimation for 2012. Some of these totals were modified by direct observations made in the watershed in the 2012 survey. To generate watershed-based livestock counts, NASS county-based livestock totals are converted to a per unit area (based on the total area of the county). The unit area amount is then multiplied by the total watershed area to derive a watershed total count (as seen in Table 3).

Table 3: Livestock Estimates in the Pleasant River Watershed

Type	Pleasant River
Dairy Cows	42
Beef Cows	50
Broilers	60
Layers	238
Hogs/Swine	60
Sheep	158
Horses	83
Turkeys	19
Other	--
Total	**710**

The Pleasant River watershed is predominantly forested, but also has substantial mixed agricultural and developed land uses. Large areas of corn fields and hay were documented throughout the watershed, as well as a dairy farm on Old Route 202 (Lotts Drive). At this property, cows have direct access to the Pleasant River near the road crossing. No buffer exists here, exposed banks are heavily trodden by cows, and paths have formed through the river as a result. Row crops are also present within about 20 meters of the river.

[1] MRLC-NLCD 2016 : Multi-Resolution Land Characteristics – National Land Cover Dataset (version 2016) provided by the MRLC Consortium (Jin et al. 2019).

Vegetated Stream Buffer in Agricultural Areas

Table 4: Summary of Vegetated Buffers in Agricultural Areas (2012)

Pleasant River
• Agricultural Land Stream Length = 3.2 mi • Agricultural Land Stream Length with Buffer = 0.5 mi (or 16% of total agricultural land stream length) • Percentage of total stream length flowing through non-buffered agricultural land = 1.72%

Vegetated stream buffers are areas of trees, shrubs, and/or grasses adjacent to streams, lakes, ponds or wetlands which provide nutrient loading attenuation (Evans and Corradini 2012). *Model My Watershed* considers natural vegetated stream buffers within agricultural land areas as providing nutrient load attenuation. A width of approximately 98 feet (30 m) on one side of a stream is required to be considered a streamside buffer per the *Model My Watershed* technical manual (Stroud Water Research Center 2017). Analysis of recent aerial photos was used to estimate the number of agricultural land stream miles with and without vegetative buffers, and these estimates were directly entered into the model.

The Pleasant River is an 11.2 mile-long impaired segment as listed by Maine DEP. As modeled, the total stream miles (including tributaries) within the watershed was calculated as 98.8 miles. Of this total, 3.2 stream miles are located within agricultural areas and 0.5 miles of that area *appear* to have a 98 foot or greater vegetated buffer (Table 4, Figure 4). From a watershed perspective, this equates to 1.7 miles or 1.72% of the total stream length running through agricultural land with less than a 98 foot buffer. By contrast, for attainment stream watersheds, the percentage of total stream miles running through agricultural land without a 75 foot vegetated buffer ranged from 0% to 3.9% with an average of 1.3%. Note, a minimum vegetated buffer width of 75 feet was used in an earlier (2012) effort to produce Figure 4 shown here. Differences in stream length estimates using a 98-foot or 75-foot buffer were practically insignificant.

Home Septic System Loads

Loads for "normally functioning" septic systems are calculated in *Model My Watershed* using an estimate of the average number of persons per acre in "Low-Density Mixed" areas. In these areas, it is assumed that the populations therein are served by septic systems rather than centralized sewage systems. All homes in such areas are assumed to be connected to "normally functioning" systems rather than those that experience "surface breakouts" (surface failures), "short-circuiting" to underlying groundwater (subsurface failures), or have direct conduits to nearby water bodies. Non-functioning systems would be modeled with a higher load contribution to the waterbody.

Best Management Practices (BMPs)

Best management practices (BMPs) are typically instituted to reduce the loading of sediment and nutrients from upland (i.e., non-point) sources. Ideally, information on BMPs for a specific watershed from local and regional sources would improve this component of the water quality model. Maine DEP sought information on BMP use in early 2021 from local, regional, and state agricultural agencies for rural BMPs and from nearby municipalities for urban BMPs. Very little to no information was returned in the solicitation. Hence, estimates for typical New England watersheds were derived from information available from Vermont. An upper limit of BMP use was garnered from watersheds entering the Chesapeake Bay where BMP use is intensive.

Four agricultural BMPs were used in this modeling effort and in the following manner:

- *Cover Crops:* Cover crops are the use annual or perennial crops to protect soil from erosion during time periods between harvesting and planting of the primary crop. The percent of cropland area in a cover crop BMP deployed was estimated at 25% and selected as the low end of the range (25 to 30 percent) expected for cropland in New England. This value was assigned to the five attainment watersheds.
- *Conservation Tillage:* Conservation tillage is any kind of system that leaves at least 30% of the soil surface covered with crop residue after planting. This reduces soil erosion and runoff. This BMP was estimated to occur in 25% of cropland. This value was assigned to the five attainment watersheds.
- *Strip Cropping / Contour Farming:* This BMP involves tilling, planting and harvesting perpendicular to the gradient of a hill or slope using high levels of plant residue to reduce soil erosion from runoff. Both interview sources suggest this practice is minimal to non-existent for New England watersheds. Hence, no BMP of this type was used in this modeling effort. This value was assigned to the five attainment watersheds.
- *Grazing Land Management:* This BMP consists of ensuring adequate vegetation cover on grazed lands to prevent soil erosion from overgrazing or other forms of over-use. This usually employs a rotational grazing system where hays or legumes are planted for feed and livestock is rotated through several fenced pastures. Both interview sources were not aware of this practice being active and is likely minimal for New England watersheds. Hence, no BMP of this type was used in this modeling effort for both impaired and attaining watersheds.

Note that other agricultural and development BMPs likely exist in the watershed but their location and type were not available in a watershed-wide format that is necessary to include in the model. Agricultural BMPs recommended by Maine DEP to reduce sediment and nutrient loads include vegetated buffers, covered manure storage facilities, and stream exclusion fencing. BMPs for developed areas recommended by the Maine DEP include vegetated buffers, stormwater BMPs, and minimization of impervious cover.

Pollutant Load Attenuation by Lakes, Ponds and Wetlands

Depositional environments such as lakes, ponds, and wetlands can attenuate watershed sediment and nutrient loading. This information is entered into the nutrient loading model by a simple percentage of watershed area draining to a lake, pond, or wetland. The Pleasant River watershed is 11.1% wetland and open water, per the 2016 NLCD land use/cover. Little Sebago Lake is located in the northwestern portion of the Pleasant River watershed. It is estimated that 22.2% of land area within the watershed drains to wetlands and open water. The percent of watershed draining to a wetland in the attainment watersheds, based on the 2021 analysis, ranged from 26 to 58 percent, with an average of 40%.

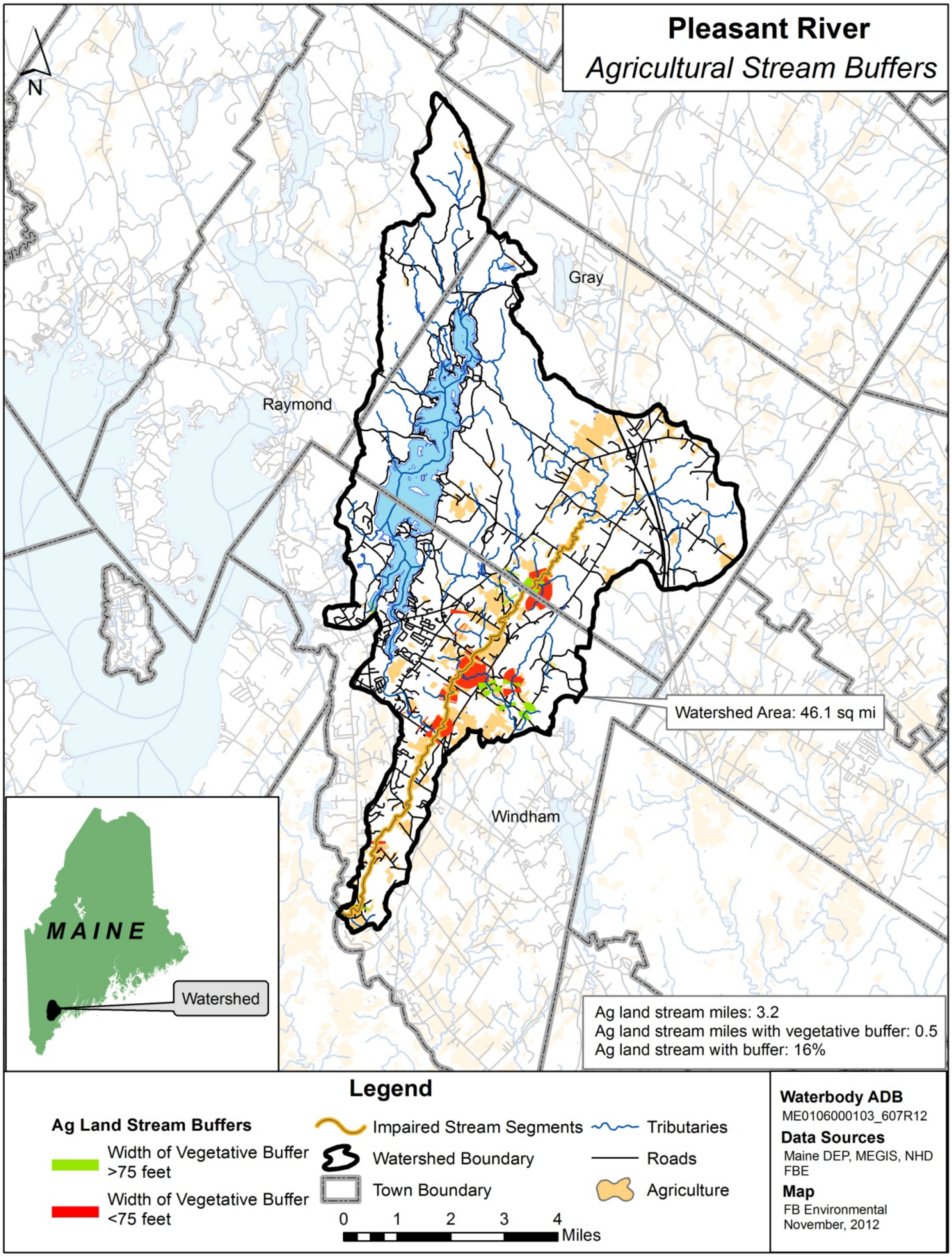


Figure 4: Agricultural Stream Buffers (from 2012) in the Pleasant River Watershed

NUTRIENT AND SEDIMENT MODELING RESULTS

Selected results from the watershed loading model are presented here. The TMDL itself is expressed in units of kilograms per hectare per year. The additional results shown below assist in better understanding the likely sources of pollution. The model results for Pleasant River watershed indicate a very high reduction for sediment and high reductions for both phosphorus and nitrogen are needed to improve water quality. Below, loading for nitrogen, phosphorus and sediment are discussed individually.

There are two categories of loads – sources and pathways. Sources are determined by land use/cover and the overland flow they generate, livestock counts by animal type, and home sewage treatment systems in developed areas. Pathways represent additional loads derived from subsurface flow and streambank erosion. Subsurface loads are calculated using dissolved N and P coefficients for shallow groundwater and are mainly derived from atmospheric inputs. Sediment and nutrient loads produced by eroding streambanks are estimated using an approach developed by Evans et al. (2003). This pathway is comprised of loads originating from five sources, and listed in order of decreasing importance: amount of developed land area, soil erodibility (K-factor), density of livestock, runoff curve number, and topographic slope. For any given model run, the amount of developed land in the watershed is responsible for just over 72% of the total streambank load, whereas soil erodibility and animal density are responsible for 21% and 7% of the total streambank load, respectively.

Sediment

Stream bank erosion contributes almost 96% of the total sediment load in the Pleasant River watershed. Of the remainder, the major source load originates from hay/pasture land (47.1% of total sources) and residential sources (43.8% of the source load).

Note that total loads by mass cannot be directly compared between watershed TMDLs due to differences in watershed area. See section *TMDL: Target Nutrient and Sediment Levels for Pleasant River* below for loading estimates that have been normalized by watershed area.

Table 5: Total Sediment Load by Source

Pleasant River	**Sediment** (1000 kg/year)	**Sediment** (%)
Source Load		
Hay/Pasture	105.5	47.1%
Cropland	10.0	4.5%
Wooded Areas	7.2	3.2%
Wetlands	1.3	0.6%
Open Land	1.9	0.9%
Barren Areas	0.017	0.007%
Low-Density Mixed	19.1	8.5%
Medium-Density Mixed	29.0	12.9%
High-Density Mixed	12.4	5.5%
Low-Density Open Space	37.6	16.8%
Farm Animals	0	0
Septic Systems	0	0
Source Load Total:	**224.0**	**100%**
Pathway Load		
Stream Bank Erosion	5021.8	-
Subsurface Flow	0	-
Total Watershed Mass Load:	**5246**	

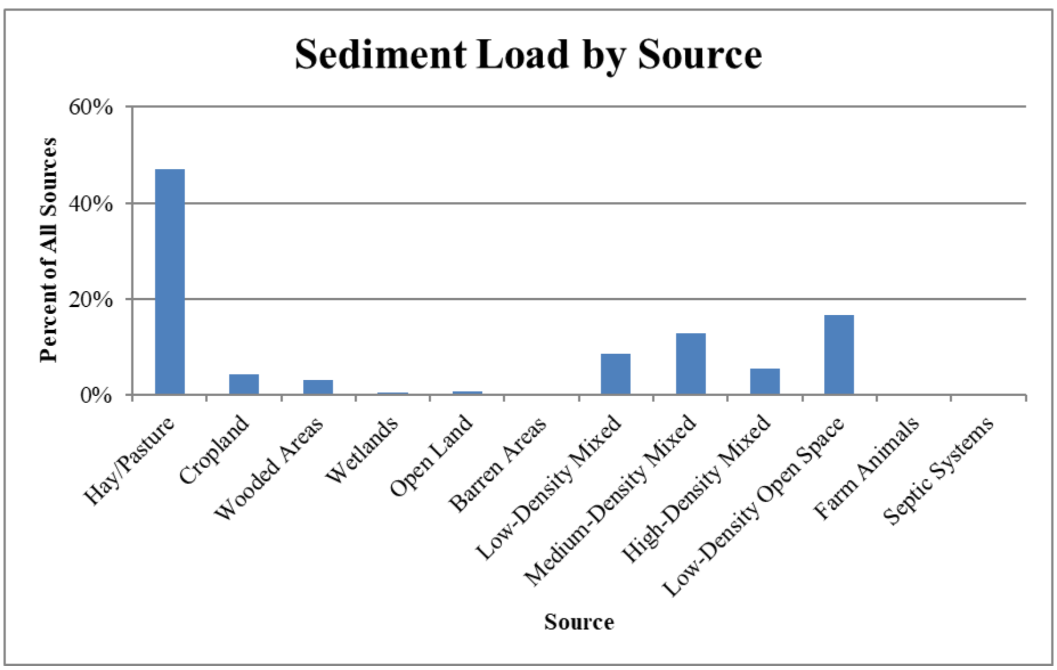


Figure 5: Total Sediment Load by Source in the Pleasant River Watershed

Total Nitrogen

Table 6 and Figure 6 (below) show the estimated total nitrogen load, in terms of mass and percent of total by source, in the Pleasant River watershed. A balanced contribution of load is met by nearly all sources. Hay and pasture lands and farm animals contribute 29.4% and residential areas combined contribute 31%. Wooded and wetland areas contribute a combined 28.7% of the total source load.

Note that total loads by mass cannot be directly compared between watershed TMDLs due to differences in watershed area. See section *TMDL: Target Nutrient and Sediment Levels for Pleasant River* below for loading estimates that have been normalized by watershed area.

Table 6: Total Nitrogen Load by Source

Pleasant River	Total N (kg/year)	Total N (%)
Source Load		
Hay/Pasture	1,573	17.3%
Cropland	219	2.4%
Wooded Areas	1,610	17.7%
Wetlands	996	11.0%
Open Land	191	2.1%
Barren Areas	30	0.3%
Low-Density Mixed	568	6.3%
Medium-Density Mixed	790	8.7%
High-Density Mixed	337	3.7%
Low-Density Open Space	1,118	12.3%
Farm Animals	1,093	12.0%
Septic Systems	552	6.1%
Source Load Total:	**9,076**	**100%**
Pathway Load		
Stream Bank Erosion	5,228	-
Subsurface Flow	22,107	-
Total Watershed Mass Load:	**36,411**	

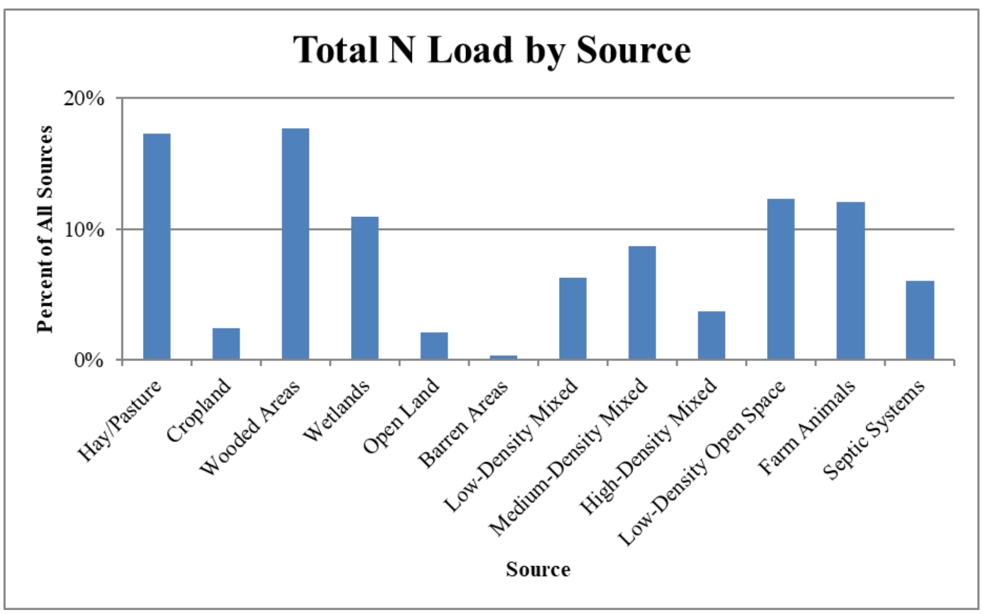


Figure 6: Total Nitrogen Load by Source in the Pleasant River Watershed

Total Phosphorus

Table 7 and Figure 7 (below) show the estimated total phosphorus load in terms of mass and percent of total by source, in the Pleasant River watershed. Hay and pasture lands are the largest source of phosphorus loading contributing 38.6% of the total source load. Residential areas combined contribute 24.2%. Farm animals also contribute considerably at 22.6%.

Note that total loads by mass cannot be directly compared between watershed TMDLs due to differences in watershed area. See section *TMDL: Target Nutrient and Sediment Levels for Pleasant River* below for loading estimates that have been normalized by watershed area.

Table 7: Total Phosphorus Load by Source

Pleasant River	Total P (kg/year)	Total P (%)
Source Load		
Hay/Pasture	454.0	38.6%
Cropland	28.2	2.4%
Wooded Areas	86.3	7.3%
Wetlands	50.9	4.3%
Open Land	5.4	0.5%
Barren Areas	1.0	0.09%
Low-Density Mixed	58.7	5.0%
Medium-Density Mixed	77.2	6.6%
High-Density Mixed	32.9	2.8%
Low-Density Open Space	115.5	9.8%
Farm Animals	265.3	22.6%
Septic Systems	0	0
Source Load Total:	**1,175.4**	**100%**
Pathway Load		
Stream Bank Erosion	1,259.0	-
Subsurface Flow	885.3	-
Total Watershed Mass Load:	**3,320**	

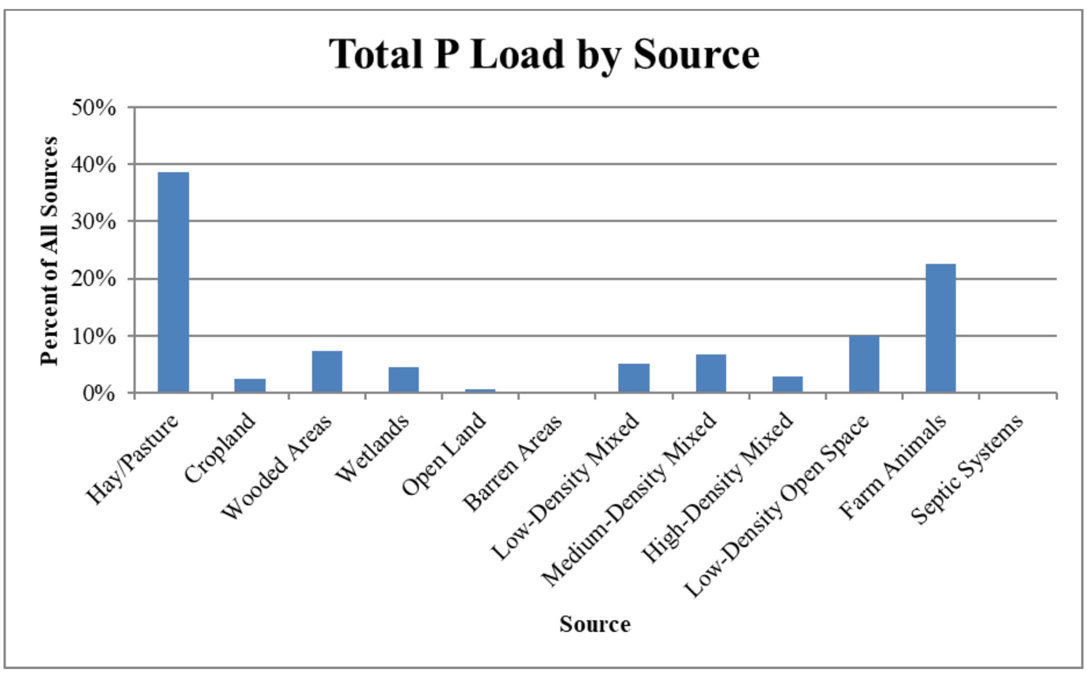


Figure 7: Total Phosphorus Load by Source in the Pleasant River Watershed

TMDL: TARGET NUTRIENT AND SEDIMENT LEVELS FOR PLEASANT RIVER

The existing loads for nutrients and sediments in the impaired segment of Pleasant River are listed in Table 8, along with the TMDL which was calculated from the average loading estimates of five attainment watersheds throughout the state. Table 9 presents a more detailed view of the modeling results and calculations used in Table 8 to define TMDL reductions, and compares the existing nutrient and sediment loads in Pleasant River to TMDL endpoints derived from the attainment waterbodies. An annual time frame provides a mechanism to address the daily and seasonal variability associated with nonpoint source loads.

Table 8: Pleasant River Pollutant Loading Compared to TMDL Targets

Pleasant River			
Pollutant Load	**Existing Load**	**TMDL**	**Reduction Required**
Total Annual Load per Unit Area		Attainment Streams	
Sediment (kg/ha/yr)	443.7	65.72	85.2%
Total N (kg/ha/yr)	3.08	2.46	20.2%
Total P (kg/ha/yr)	0.28	0.16	43.1%

Future Loading

The prescribed reduction in pollutants discussed in this TMDL reflects reduction from estimated existing conditions. Expansion of agricultural and development activities in the watershed have the potential to increase runoff and associated pollutant loads to Pleasant River. To ensure that the TMDL targets are attained, future agricultural and development activities will need to meet the TMDL targets. Between 2012 to 2017 in Cumberland County, the growth in agricultural lands was decreasing, with a 7% decrease in the total number of farms and a 20.2% decrease in total farm area. Average farm size has also declined significantly (13.8%) during this time period. These values are extracted from the most recent (2017) Census of Agriculture (USDA 2017). Human population in Cumberland County increased by 4.8% from 2000 to 2019 (US Census 2020). Future activities and BMPs that achieve TMDL reductions are addressed below.

Next Steps

The use of agricultural and developed area BMP’s can reduce sources of polluted runoff in Pleasant River. It is recommended that municipal officials, landowners, and conservation stakeholders in Windham and Gray work together to develop a watershed management plan to:

- Encourage greater citizen involvement through the development of a watershed coalition to ensure the long term protection of Pleasant River;
- Run a “Hot-Spot Analysis” in *Model My Watershed* to determine sub-watershed locations of higher existing contributions of sediment and nutrients to the outlet of Pleasant River watershed; then focus BMP mitigation in these hot-spot sub-areas of the watershed;
- Address existing nonpoint source problems in the Pleasant River watershed by instituting BMPs where necessary; and

- Prevent future degradation of Pleasant River through the development and/or strengthening of local Nutrient Management Ordinance.

Table 9: Annual Loads by Land Use, Other Sources, and Pathways for Pleasant River Based on Modeling

Pleasant River				
	Area (ha)	**Sediment** (1000 kg/yr)	**Total N** (kg/yr)	**Total P** (kg/yr)
Land Uses				
Hay/Pasture	658	105.5	1,573	454.0
Cropland	30	10.0	219	28.2
Wooded Areas	8,093	7.2	1,610	86.3
Wetlands	1,302	1.3	996	50.9
Open Land	100	1.9	191	5.4
Barren Areas	67	0.017	30	1.0
Low-Density Mixed	453	19.1	568	58.7
Medium-Density Mixed	155	29.0	790	77.2
High-Density Mixed	66	12.4	337	32.9
Low-Density Open Space	899	37.6	1,118	115.5
Total Area	11,823			
Other Sources				
Farm Animals		0.0	1,093	265.3
Septic Systems		0.0	552	0.0
Pathway Load				
Stream Bank Erosion		5021.8	5,228	1,259.0
Subsurface Flow		0.0	22,107	885.3
Total Annual Load		5,246	36,411	3,320
Total Annual Load per Unit Area		0.444	3.08	0.28
		1000 kg/ha/yr	kg/ha/yr	kg/ha/yr

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