DRAFT TMDL SUMMARY

Colley Wright Brook

WATERSHED DESCRIPTION

This **TMDL** applies to a 8.16 mile section of Colley Wright Brook, located in the Town of Windham, Maine. The impaired segment of Colley Wright Brook begins in the northern portion of the watershed, flows south through forest until crossing Route 302, then passes through agriculture. The stream continues through woods bordered by residential development, crossing Brick Hill Road, Pope Road, and Chute Road. The stream then enters into more dense agriculture, crossing Montgomery Road and River Road before meeting the Presumpscot River. The Colley Wright Brook watershed covers an area of 7.65 square miles.

- Runoff from a horse farm located on River Road is likely the largest source of **nonpoint source (NPS) pollution** to Colley Wright Brook. Runoff from cultivated lands, active hay lands, and pasture can transport nitrogen and phosphorus to the nearest section of the stream.
- The Colley Wright Brook watershed is predominately non-developed (89.3%). Forested areas (64.1%) within the watershed absorb and filter pollutants helping protect both water quality in the stream and stream channel stability. Wetlands (2%) may also help filter nutrients.
- Non-forested areas within the watershed are predominantly agricultural (23.53%) and are located in the southern portion of the watershed.
- Developed areas (9.7%) with impervious surfaces in close proximity to the steam may impact water quality.
- Colley Wright Brook is on Maine's 303(d) list of Impaired Streams (Maine DEP, 2012).

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_607R03

Town: Windham, ME

County: Cumberland

Impaired Segment Length: 8.16 miles

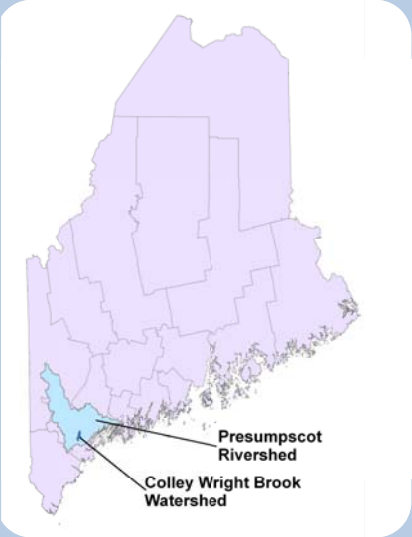
Classification: Class B

Direct Watershed: 7.65 mi^2 (4,896 acres)

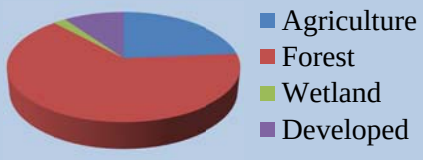
Impairment Listing Cause: Dissolved Oxygen

Watershed Agricultural Land Use: 23.53%

Major Drainage Basin: Presumpscot River



Watershed Land Uses



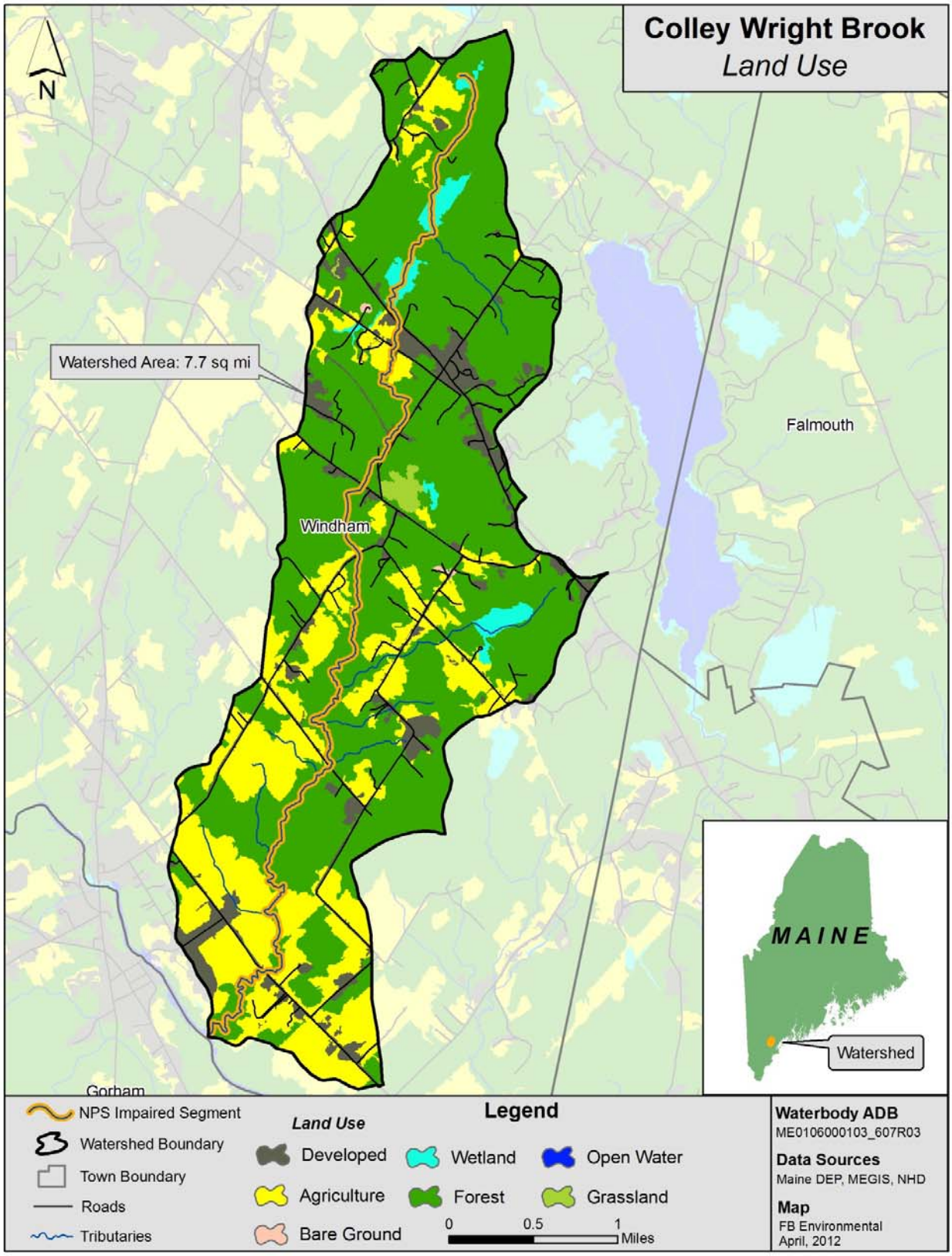


Figure 1: Land Use in the Colley Wright Brook Watershed

WHY IS A TMDL ASSESSMENT NEEDED?

Colley Wright Brook, 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.

Colley Wright Brook *near Station RCW10 – River Road crossing. Photo: FB Environmental*

Agriculture in the Colley Wright Brook watershed makes up about 26% of the total land area. This is more than twice the area of developed land which makes up only 10% of the watershed. 24% of the impaired segment length passes through agricultural areas (Figure 1) making agriculture the likely largest contributor of sediment and nutrient enrichment to the stream. The close proximity of many agricultural lands, including a horse farm on River Road, to the stream further increases the likelihood that nutrients from disturbed soils, manure, and fertilizers will reach the stream.

WATER QUALITY DATA ANALYSIS

There are three types of numeric data by which Maine DEP measures the ability of a stream to adequately support aquatic life, including; dissolved oxygen, benthic macroinvertebrates, and periphyton (algae).The aquatic life impairment in Colley-Wright Brook is based on historic dissolved oxygen data, which includes data collected at stations RCW10 and RCW11 in 2011 and station RCW24 in 2007.

TMDL ASSESSMENT APPROACH: NUTRIENT 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, a nutrient loading model, MapShed, was used to estimate the sources of pollution based on well-established hydrological equations; detailed maps of soil, land use, and slope; many years of daily weather data; and direct observations of agriculture and other land uses within the watershed.

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, nutrient loading estimates, and TMDL are presented below in Table 1.

Table 1: Numeric Targets for Pollutant Loading Based on MapShed Model Outputs for Attainment Streams

Attainment Streams	**Town**	**TP load (kg/ha/yr)**	**TN load (kg/ha/yr)**	**Sediment load (1000 kg/ha/yr)**
Martin Stream	Fairfield	0.14	3.4	0.008
Footman Brook	Exeter	0.33	6.4	0.058
Upper Kenduskeag Stream	Corinth	0.29	5.6	0.047
Upper Pleasant River	Gray	0.22	4.6	0.016
Moose Brook	Houlton	0.25	5.9	0.022
Total Maximum Daily Load		**0.24**	**5.2**	**0.030**

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 and physical characterization and visual assessment of in-stream and riparian habitat quality.

Based on Rapid Bioassessment protocols for low gradient streams, Colley Wright Brook received a score of 152 out of a total 200 for quality of habitat. Higher scores indicate better habitat. The range of habitat assessment scores for attainment streams was 155 to 179.

Habitat assessments were conducted on a relatively short sample reach (about 100-200 meters for a typical small stream) near the most downstream Maine DEP sample station in the watershed. For both impaired and attainment streams, the assessment location was usually near a road crossing for ease of access. In the Colley Wright Brook watershed, the downstream sample station was located at the River Road stream crossing and DEP sample station RCW10. Water was documented as turbid and many sand and fine sediment deposits were observed throughout the reach. An agricultural field was located near the stream reach with a minimal buffer to the east. Trees dominated the surrounding riparian zone of Willow, Alder, Maple and Ash.

Figure 2 (right) shows the range of habitat assessment scores for all attainment and impaired streams, as well as for Colley Wright Brook. Though these scores show that habitat is clearly an issue in the impairment of Colley Wright Brook, it is important to look for other potential sources within the watershed lending to impairment. Consideration should be given to major "hot spots" in the Colley Wright Brook watershed as potential sources of NPS pollution contributing to the water quality impairment.

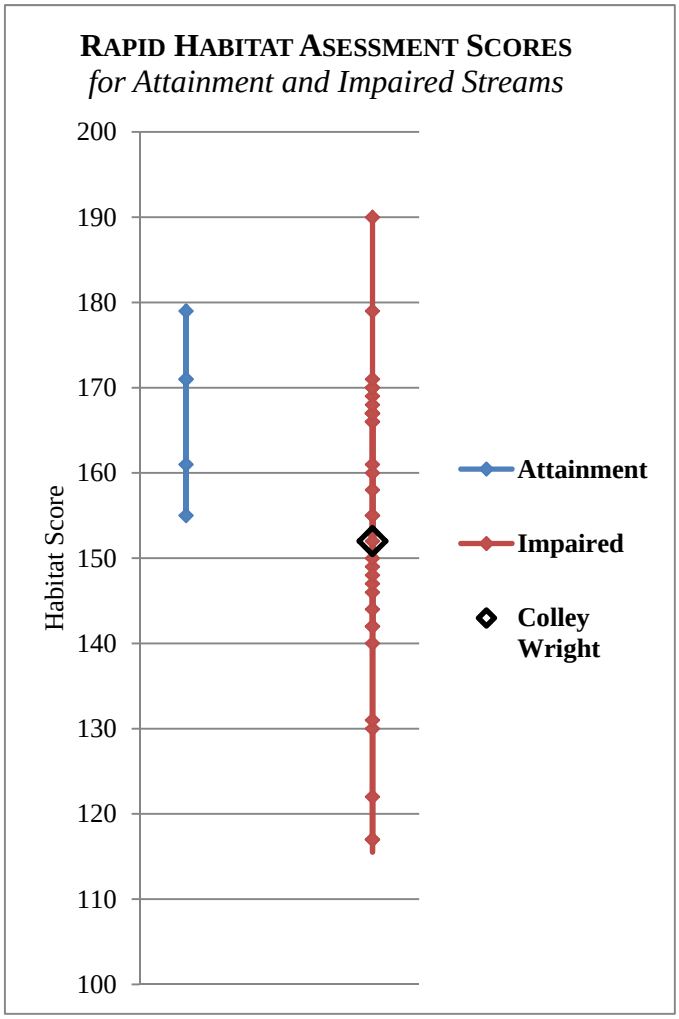


Figure 2: Habitat Assessment Scores

Pollution Source Identification

Pollution source identification assessments were conducted for both Colley Wright Brook (impaired) 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 Colley Wright Brook was completed on July 11, 2012. In-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: Pollution Source ID Assessment for the Colley Wright Brook Watershed

Potential Source			Notes
ID#	**Location**	**Type**	
3	River Road/Chute Road	Agriculture	• Large active hay field.
3b	River Road	Agriculture	• Active hay field.
3c	River Road	Agriculture	• Horse stables; estimated 20 horses observed. • Active hay fields surrounding.
3d	River Road	Agriculture	• Large hay field. • Adjacent to stream with limited buffer.
4	Highland Cliff Road	Agriculture	• Active hay fields.
4b	Highland Cliff Road	Agriculture	• Large active hay field adjacent to stream with small wooded buffer.
6	Montgomery Road/Chute Road	Agriculture	• Cooper's Royal Heritage Farm. • Miniature horse breeder with about 24 horses. • Hay fields and pastures. • Greenhouses and Maple house.
6b	Montgomery Road/Chute Road	Agriculture	• Cooper's Royal Heritage Farm. • Property on Montgomery Road raises Charolais cattle. • About 3 cows estimated.
7	Chute Road	Agriculture	• Hay fields.
10	Highland Cliff Road/Land of Nod Road	Forestry	• Active cutting.
16	Windham Center Road	Road Crossings/ Agriculture	• Multiple Road crossings on major roads. • No erosion issues observed. • Active hay land in immediate surrounding area.
18	Nash Road	Agriculture	• Shaw Brother's Sand Pit.
21	River Road	Agriculture	• Windy Hill Farm. • Cattle, sheep, pigs, chickens, crops, hay. • None observed, information acquired from farm website.

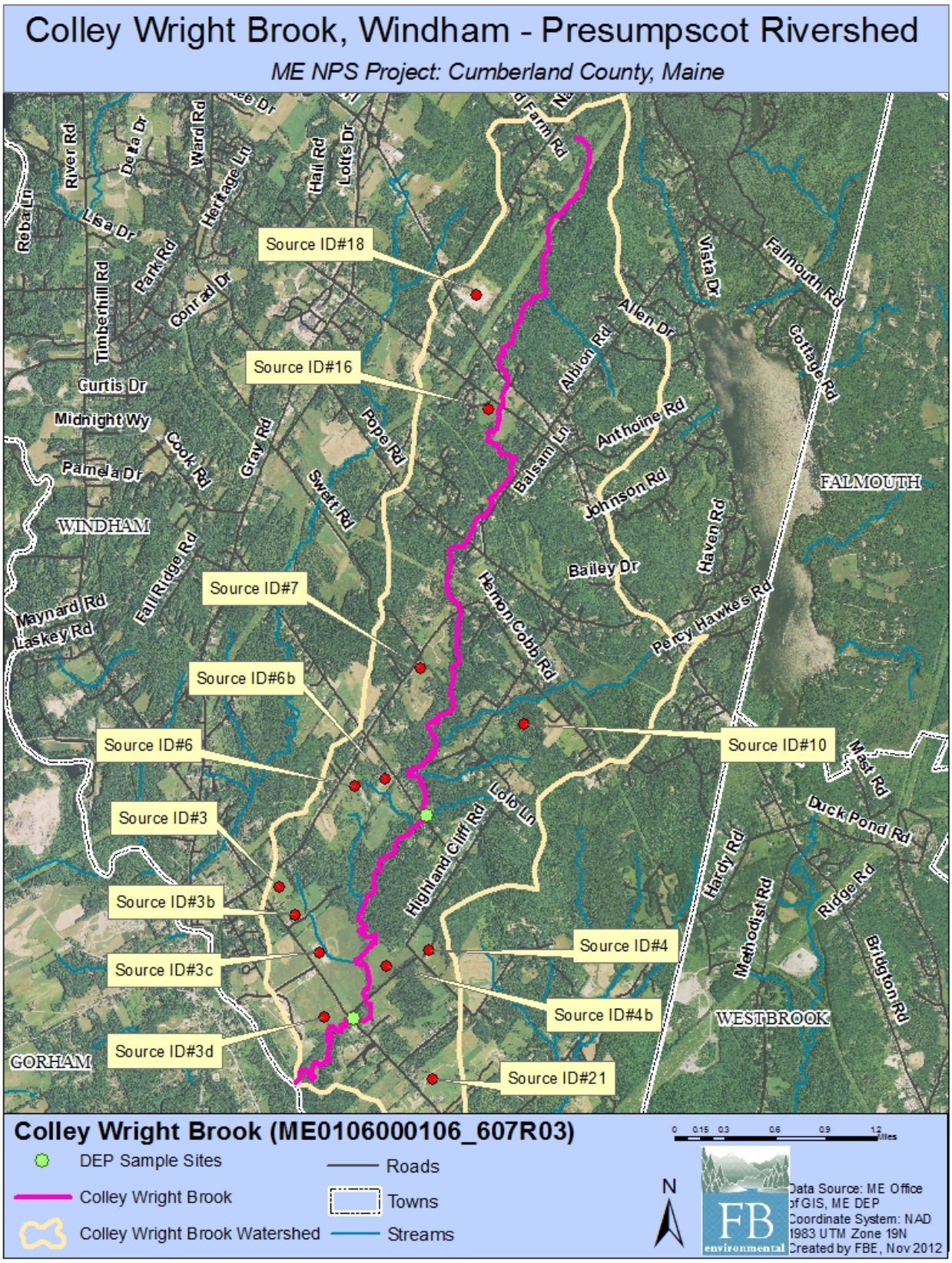


Figure 3: Aerial Photo of Source ID locations in the Colley-Wright Brook Watershed

NUTRIENT LOADING – MAPSHED ANALYSIS

The MapShed model was used to estimate stream loading of sediment, total nitrogen and total phosphorus in Colley Wright Brook (impaired), plus five attainment watersheds throughout the state. The model estimated nutrient loads over a 15-year period (1990-2004), which was determined by the available weather data provided within MapShed. This extended period captures a wide range of hydrologic conditions to account for variations in nutrient and sediment loading over time.

Many quality assured and regionally calibrated input parameters are provided with MapShed. Additional input parameters were manually entered into the model based on desktop research and field observations, as described in the section on Habitat Assessment and Pollution Source Identification. These manually adjusted parameters included estimates of livestock animal units, agricultural stream miles with intact vegetative buffer, Best Management Practices (BMPs), and estimated wetland retention and/or drainage areas.

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 estimates of livestock (numbers of animals) in the watershed, based on direct observations made in the watershed, plus other publicly available data.

Table 3: Livestock Estimates in the Colley Wright Watershed

Type	Colley Wright Brook
Dairy Cows	
Beef Cows	3
Broilers	
Layers	
Hogs/Swine	
Sheep	
Horses	44
Turkeys	
Other	
Total	**47**

The Colley Wright Brook watershed is predominantly forested, with substantial mixed agricultural land uses scattered through watershed, and consisted of large hay fields and some pasture. A miniature horse farm, *Coopers Royal Heritage Farm*, is home to about 24 horses. The same owners also have Charolais cattle; with 3 cows estimated. A horse stable is located on River Road in close proximity to a tributary of Colley Wright Brook. About 20 horses were observed here. A large farm is also Located on River Road just southeast of the sample reach station. *Windy Hill Farm* and farm stand is located to the north and south of River Road. From the farm's website, they raise and sell cattle, pigs, lamb, turkey and chicken along with growing various vegetable crops. It is unknown whether all animals are raised in this location as no livestock or clear signs of pasture were observed during the field visit. No estimates were made for this potential source.

Vegetated Stream Buffer in Agricultural Areas

Vegetated stream buffers are areas of trees, shrubs, and/or grasses adjacent to streams, lakes, ponds or wetlands which provide nutrient loading attenuation (Evans & Corradini, 2012). MapShed considers natural vegetated stream buffers within agricultural areas as providing nutrient load attenuation. The width of buffer strips is not defined within the MapShed manual, and was considered to be 75 feet for this analysis. Geographic Information System (GIS) analysis of recent aerial photos along with field reconnaissance observations were used to estimate the number of agricultural stream miles with and without vegetative buffers, and these estimates were directly entered into the model.

Table 4: Summary of Vegetated Buffers in Agricultural Areas

Colley Wright Brook
• 9.3 stream miles in watershed (includes ephemeral streams) • 1.2 stream miles in agricultural areas • **63%** of agricultural stream miles have a vegetated buffer

Colley Wright Brook is an 8.2 mile-long impaired segment as listed by Maine DEP. As modeled, the total stream miles (including tributaries) within the watershed was calculated as 9.3 miles. Of this total, 1.9 stream miles are located within agricultural areas and 1.2 miles or 63% of the stream shows a 75 foot or greater vegetated buffer (Table 4, Fig. 4). By contrast, agricultural stream miles (as modeled) with a 75 foot vegetated buffer in the attainment stream watersheds ranged from 34% to 92%, with an average of 61%.

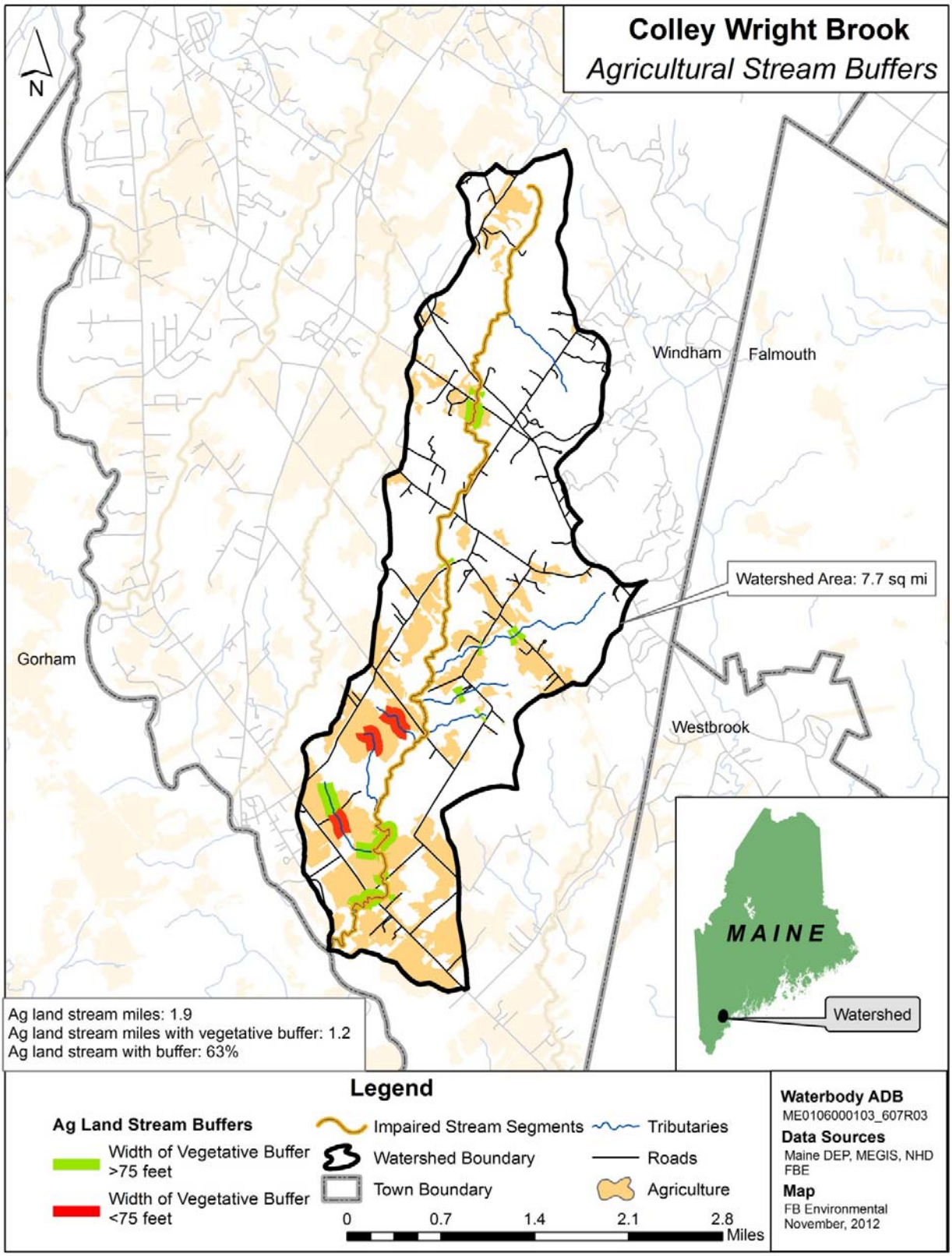


Figure 4: Buffer Agricultural Stream Miles in the Colley Wright Brook Watershed

Best Management Practices (BMPs)

For this modeling effort, four commonly used BMPs were entered based on literature values. These estimates were applied equally to impaired and attainment stream watersheds. More localized data on agricultural practices would improve this component of the model.

- *Cover Crops:* Cover crops are the use of annual or perennial crops to protect soil from erosion during time periods between harvesting and planting of the primary crop. The percent of agricultural acres cover crops used within the model is estimated at 4%. This figure is based on information from the 2007 USDA Census stating that 4.1% of cropland acres is left idle or used for cover crops or soil improvement activity, and not pastured or grazed (USDA, 2007b).
- *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 and is one of the most commonly used BMPs. This BMP was assumed to occur in 42% of agricultural land. This figure is based on a number given by the Conservation Tillage Information Center's 2008 Crop Residue Management Survey stating that 41.5% of U.S. acres are currently in conservation tillage (CTIC, 2000).
- *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. This BMP was assumed to occur in 38% of agricultural lands, based on a study done at the University of Maryland (Lichtenberg, 1996).
- *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. In this TMDL, a figure of 75% of hay and pasture land is assumed to utilize grazing land management. This figure is based on a study by Farm Environmental Management Systems of farming operations in Canada (Rothwell, 2005).

Pollutant Load Attenuation by Lakes, Ponds and Wetlands

Depositional environments such as ponds and wetlands can attenuate watershed sediment loading. This information is entered into the nutrient loading model by a simple percentage of watershed area draining to a pond or a wetland. There are no major wetlands within the Colley Wright Brook watershed, therefore zero percent of the watershed drains to wetlands. Percent of watershed draining to a wetland in the attainment watersheds ranged from 15% to 60%, with an average of 35%.

NUTRIENT MODELING RESULTS

The MapShed model simulates surface runoff using daily weather inputs of rainfall and temperature. Erosion and sediment yields are estimated using monthly erosion calculations and land use/soil composition values for each source area. Below, selected results from the watershed loading model are presented. 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 Colley Wright Brook indicate significant reductions of nutrients and sediment are needed to improve water quality. Below, loading for sediment, nitrogen and phosphorus are discussed individually.

Sediment

Sediment loading in the Colley Wright Brook watershed is mainly derived from agricultural sources with hay/pasture and cropland together accounting for 54% of the total sediment load. Medium density development accounts for 22% of loads and forested lands also contribute 19% of the total load. Total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Colley Wright Brook* (below) for loading estimates that have been normalized by watershed area.

Table 5: Total Sediment Load by Source

Colley Wright Brook	**Sediment (1000kg/year)**	**Sediment (%)**
Source Load		
Hay/Pasture	20.96	33%
Crop land	13.13	21%
Forest	12.36	19%
Wetland	0.19	0%
Disturbed Land	0	0%
Low Density Mixed	3.38	5%
Medium Density Mixed	13.75	22%
High Density Mixed	0.08	0%
Low Density Residential	0	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	0	0%
Septic Systems	0	0%
Source Load Total:	**63.85**	**100%**
Pathway Load		
Stream Banks	21.07	-
Subsurface / Groundwater	0	-
Total Watershed Mass Load:	**84.92**	

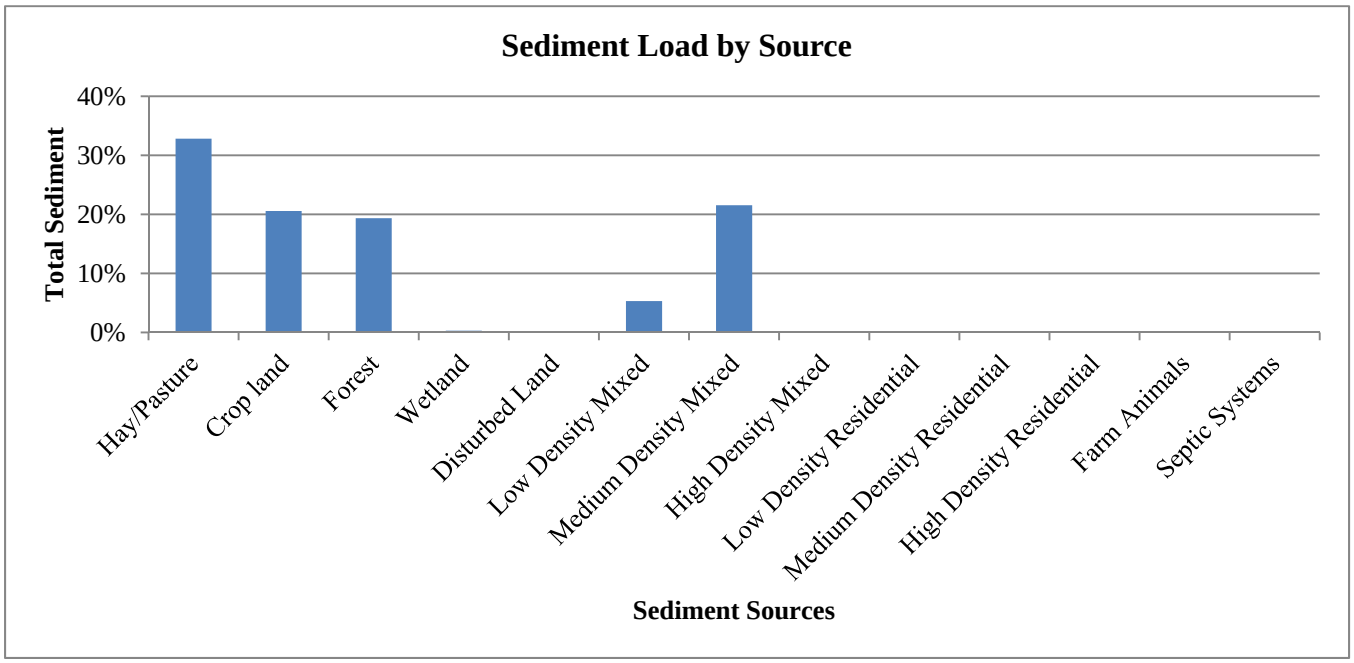


Figure 5: Total Sediment Loads by Source in the Colley Wright Brook Watershed

Total Nitrogen

The largest source of nitrogen loading in the Colley Wright Brook watershed is septic systems which account for 31% of the total load. Table 6 and Figure 6 (below) show estimated total nitrogen loads in terms of mass and percent of total, and by source, in Colley Wright Brook. Hay and pasture and forested lands also contribute a significant amount to the nitrogen load with 21% and 19% of the load, respectively. Total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Colley Wright Brook* (below) for loading estimates that have been normalized by watershed area.

Table 6: Total Nitrogen Loads by Source

Colley Wright Brook	**Total N (kg/year)**	**Total N (%)**
Source Load		
Hay/Pasture	923.6	21%
Crop land	447.8	10%
Forest	823.4	19%
Wetland	45.1	1%
Disturbed Land	0	0%
Low Density Mixed	88.5	2%
Medium Density Mixed	0	0%
High Density Mixed	533.0	12%
Low Density Residential	2.0	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	98.9	2%
Septic Systems	1336.4	31%
Source Load Total:	**4298.5**	**100%**
Pathway Load		
Stream Banks	11.0	-
Subsurface / Groundwater	10339.7	-
Total Watershed Mass Load:	**14649.2**	

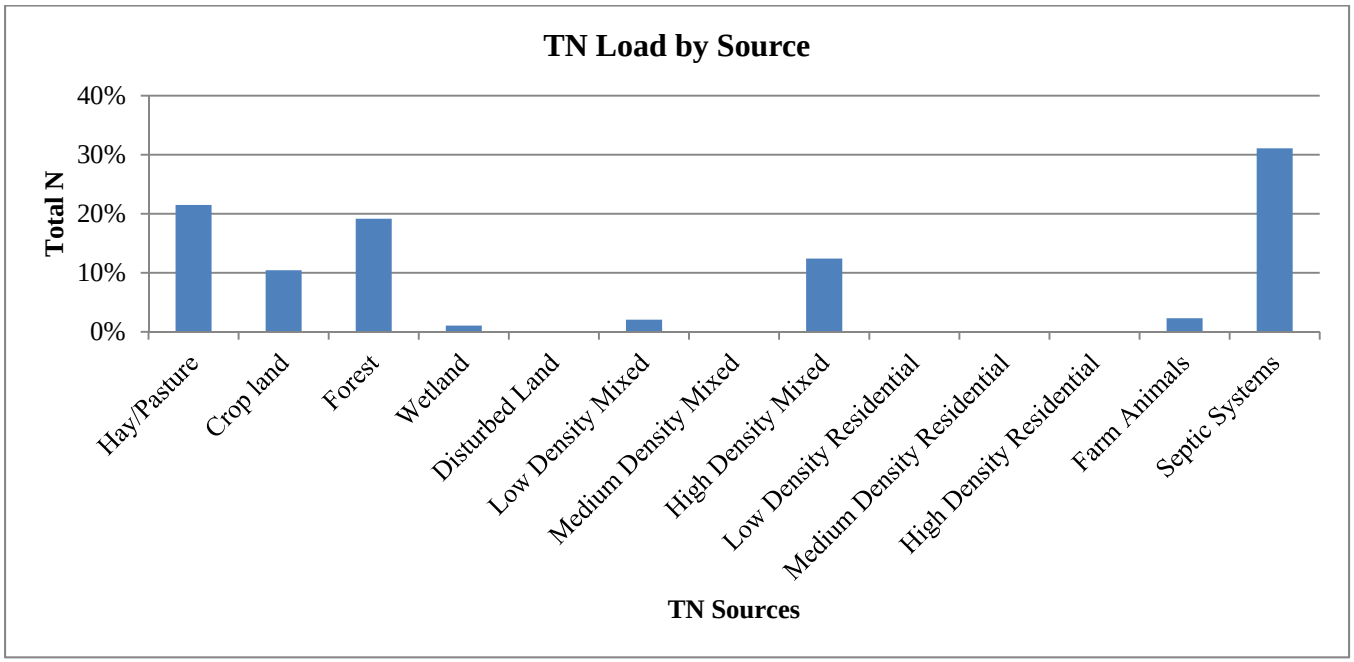


Figure 6: Total Nitrogen Loads by Source in the Colley Wright Brook Watershed

Total Phosphorus

Phosphorus loading within the watershed is mainly attributed to hay and pasture lands which account for 60% of the total load. Phosphorus loads in Colley Wright Brook are presented in Table 7 and Figure 7. Note that total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Colley Wright Brook* below for loading estimates that have been normalized by watershed area.

Table 7: Total Phosphorus Loads by Source

Colley Wright Brook	Total P (kg/year)	Total P (%)
Source Load		
Hay/Pasture	341.8	60%
Crop land	47.8	8%
Forest	50.8	9%
Wetland	2.5	0%
Disturbed Land	0	0%
Low Density Mixed	10.1	2%
Medium Density Mixed	0	0%
High Density Mixed	56.0	10%
Low Density Residential	0.2	0%
Medium Density Residential	0	0%
High Density Residential	0	0%
Farm Animals	24.8	4%
Septic Systems	31.9	6%
Source Load Total:	**565.8**	**100%**
Pathway Load		
Stream Banks	4.0	-
Subsurface / Groundwater	247.8	-
Total Watershed Mass Load:	**817.6**	

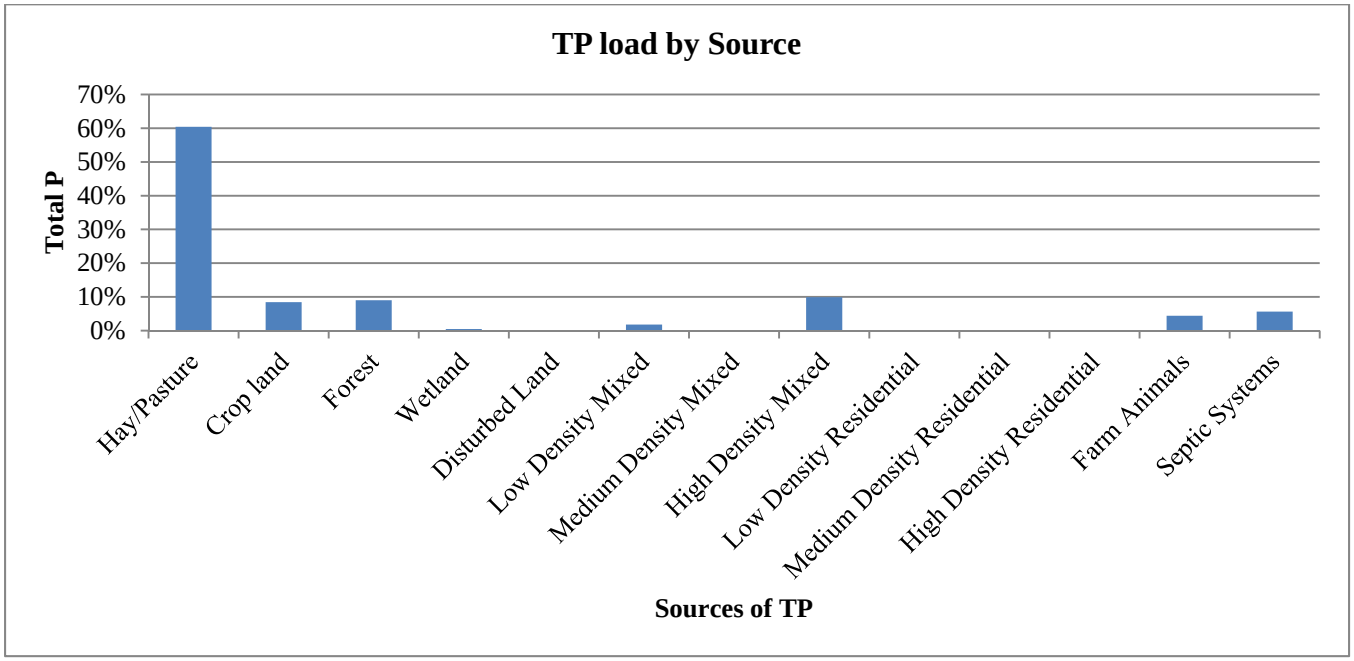


Figure 7: Total Phosphorus Loads by Source in the Colley Wright Brook Watershed

TMDL: TARGET NUTRIENT LEVELS FOR COLLEY WRIGHT BROOK

The existing loads for nutrients and sediments in the impaired segment of Colley Wright Brook 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 Colley Wright Brook 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: TMDL Targets Compared to Colley Wright Brook Pollutant Loading

TMDL POLLUTANT LOADS Annual Loads per Unit Area	**Estimated Loads Colley Wright Brook**	**Total Maximum Daily Load**	**TMDL % REDUCTIONS Colley Wright Brook**
Sediment Load *(1000 kg/ha/year)*	**0.043**	**0.030**	**30%**
Nitrogen Load *(kg/ha/year)*	**7.39**	**5.2**	**30%**
Phosphorus Load *(kg/ha/year)*	**0.41**	**0.24**	**41%**

Future Loading

The prescribed reduction in pollutants discussed in this TMDL reflects reduction from estimated existing conditions. Expansion of agricultural and development activities have the potential to increase runoff and associated pollutant loads to Colley Wright Brook. To ensure that the TMDL targets are attained, future agriculture or development activities will need to meet the TMDL targets. Future growth from population increases is a moderate threat in the Colley Wright Brook watershed because Cumberland County has increasing population trends, with a 3.9% increase between 2000 and 2008 (USM MSAC, 2009). The growth in agricultural lands is also increasing, with a 6% increase in the total number of farms in Cumberland County between 2002 and 2007. However, a decrease of 5% was seen in the land (acres) in farms between 2002 and 2008, and a 10% decrease occurred in the average farm size in this time period as well (USDA, 2007a). 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 Colley Wright Brook. It is recommended that municipal officials, landowners, and conservation stakeholders in Windham 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 Colley Wright Brook;
- Address <u>existing</u> nonpoint source problems in the Colley Wright Brook watershed by instituting BMPs where necessary; and
- Prevent <u>future</u> degradation of Colley Wright Brook through the development and/or strengthening of local Nutrient Management Ordinance.

Table 9: Modeling Results Calculations for Derived Numeric Targets and Reduction Loads for Colley Wright Brook

Colley-Wright Brook				
	Area ha	**Sediment 1000kg/yr**	**TN kg/yr**	**TP kg/yr**
Land Uses				
Hay/Pasture	431	21.0	923.7	341.8
Crop land	47	13.1	447.8	47.8
Forest	1268	12.4	823.4	50.8
Wetland	39	0.2	45.1	2.5
Disturbed Land	0	0.0	0.0	0.0
Low Density Mixed	90	3.4	88.5	10.1
High Density Mixed	104	13.8	533.0	56.0
Low Density Residential	2	0.1	2.0	0.2
Other Sources				
Farm Animals			98.9	24.8
Septic Systems			1336.4	31.9
Pathway Loads				
Stream Banks		21.1	11.0	4.0
Groundwater			10339.7	247.8
Total Annual Load		85 x 1000 kg	14649 kg	818 kg
Total Area	1981 ha			
Total Maximum Daily Load		**0.043 1000kg/ha/year**	**7.39 kg/ha/year**	**0.41 kg/ha/year**

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