



DRAFT TMDL SUMMARY

Stetson Brook

WATERSHED DESCRIPTION

This **TMDL** applies to a 6.82 mile section of Stetson Brook, located in the City of Lewiston. The impaired segment of Stetson Brook begins in the northern portion of the watershed in a predominantly forested area at the outlet of a wetland, and flows south crossing College Road, Lane Road, College Road again, and rail road tracks before entering into another wetland. The stream re-crosses the railroad tracks and enters into mixed agriculture and development, crossing College Street and Hamel Road before entering woods. After crossing Stetson Road and College Street, Stetson Brook flows through a developed area crossing the railroad tracks and Main Street (Route 11), finally flowing into the Androscoggin River just downstream of the dam. The Stetson Brook watershed covers an area of 14.87 square miles. The watershed is located within the City of Lewiston and the town of Greene.

- Runoff from agricultural land located throughout the central portion of the watershed is likely the largest source of **nonpoint source (NPS) pollution** to Stetson Brook. Runoff from cultivated lands, active hay lands, and pasture can transport nitrogen and phosphorus to the nearest section of the stream.
- The Stetson Brook watershed is predominately non-developed (86.6%). Forested areas (68.1%) within the watershed absorb and filter pollutants helping protect both water quality in the stream and stream channel stability. Wetlands (6.3%) may also help filter nutrients.
- Non-forested areas within the watershed are predominantly agricultural (12.1%) and developed (13.4%) and are located throughout the watershed.
- Developed areas (13.4%) with impervious surfaces in close proximity to the steam may impact water quality.
- Stetson 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:

ME0104000208_413R03

City: Lewiston, ME

County: Androscoggin

Impaired Segment Length:

6.82 miles

Classification: Class B

Direct Watershed: 14.87 mi²

(9,517 acres)

Impairment Listing Cause:

Dissolved Oxygen

Watershed Agricultural Land

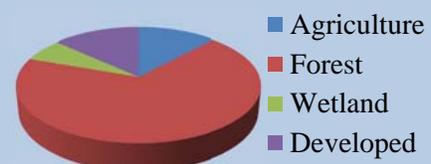
Use: 12.09%

Major Drainage Basin:

Androscoggin



Watershed Land Uses



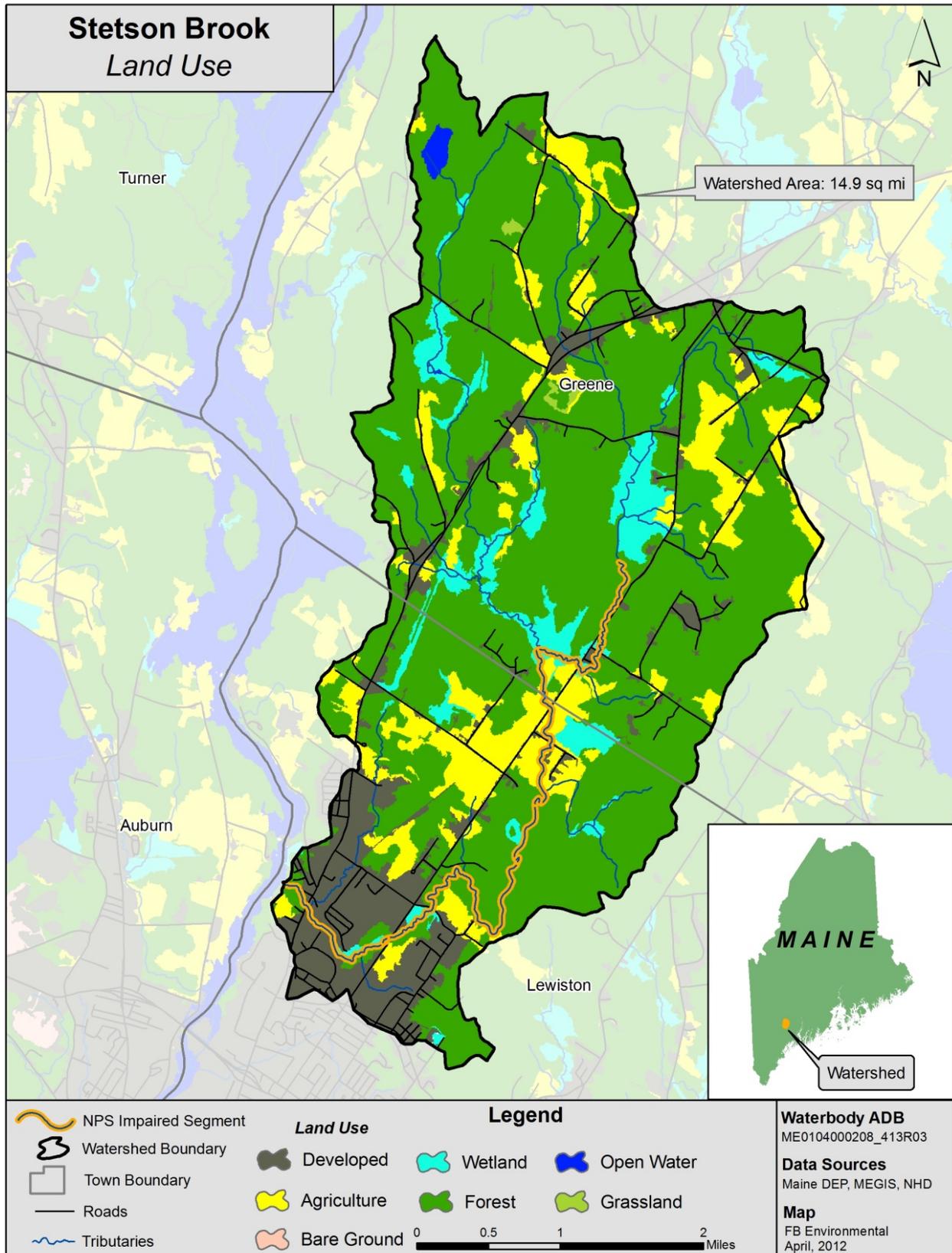


Figure 1: Land Use in the Stetson Brook Watershed

WHY IS A TMDL ASSESSMENT NEEDED?

Stetson 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.

Agricultural land make up about 12% of the Stetson Brook watershed. This is slightly less than the area of developed land which makes up about 13% of the total watershed area. The watershed is heavily forested at 68% of the watershed, however, 39% of the impaired stream segment length passes through agricultural land (Figure 1). Agriculture and development, therefore, are likely to be the largest contributors of sediment and nutrient enrichment to the stream. 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. Eroded stream crossings with washouts and collapsed pavement were fairly common throughout the watershed and may be nonpoint source pollution hotspots.



Stetson Brook downstream of the
Stetson Road crossing – Station 356
Photo: FB Environmental

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). The aquatic life impairment in Stetson Brook is based on historic dissolved oxygen.

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 standards of the class assigned to the stream or river (Davies and Tsomides, 2002). Maine DEP uses an analogous model for periphyton assessment. Macroinvertebrate results from site S-356 in 2008 show attainment of class A. Periphyton results from site S-356 in 2004 and 2008 show attainment of class B.

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 streams. 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 high gradient streams, Stetson Brook received a score of 179 out of a total 200 for quality of habitat. Higher scores indicate better habitat. The range in habitat assessment scores for attainment stream was 155 to 179.

The habitat assessment for Stetson Brook 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 Stetson Brook watershed, the downstream sample station was located in a forested portion of the stream downstream of the Stetson Road crossing. This area was forested with a thick buffer, while the much of the stream and associated tributaries flow near agricultural lands and developed areas with minimal buffers.

Figure 2 (right) shows the range of habitat assessment scores for all attainment and impaired streams, as well as for Stetson Brook. The overlapping attainment and impaired stream scores indicate that factors other than habitat should be considered when addressing the impairments in Stetson Brook. Consideration should be given to major “hot spots” in the Stetson Brook watershed as potential sources of NPS pollution contributing to the water quality impairment.

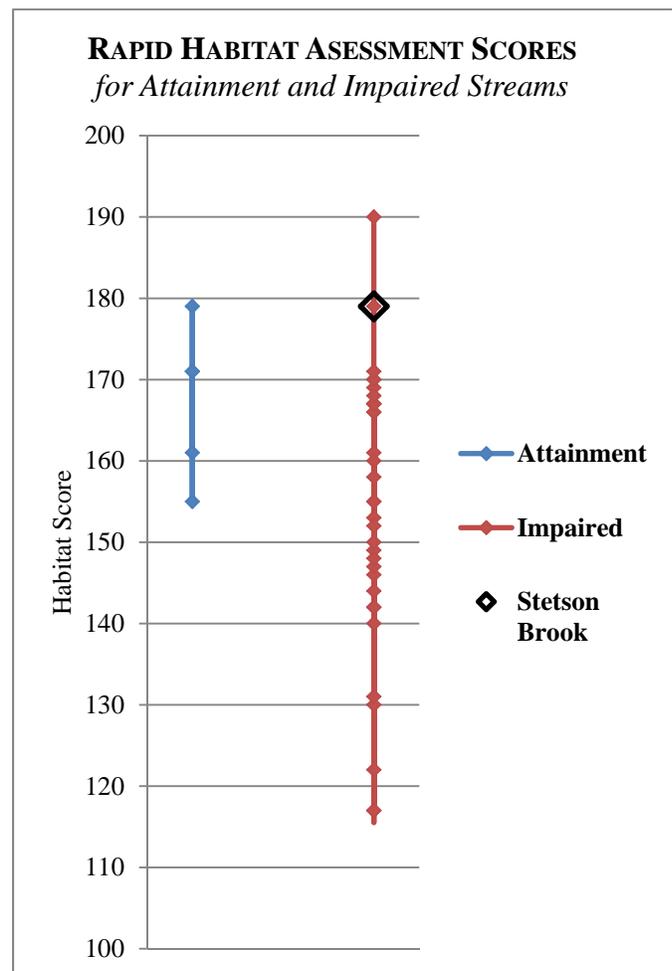


Figure 2: Habitat Assessment Scores

Pollution Source Identification

Pollution source identification assessments were conducted for both Stetson Brook (impaired) and the attainment streams. The source identification work study 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 Stetson Brook was completed on June 28, 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 Stetson Brook Watershed

Potential Source			Notes
ID#	Location	Type	
10	Tekakwitha Drive	Residential	<ul style="list-style-type: none"> • A large lawn mowed within approximately two feet of stream. • Fertilizer use on the lawn is suspected as it is lush and very green. • A small bridge crossing over stream. • Possible thermal and nutrient impacts.
11	Sawyer Road	Road Crossing	<ul style="list-style-type: none"> • Slumping road shoulder is eroding directly into stream.
19	College Road	Road crossing	<ul style="list-style-type: none"> • A small wash out and pavement collapse was observed at an unstable road crossing on College Road.
24	Near College Road crossing	Residential	<ul style="list-style-type: none"> • Maintained lawn with minimal buffer to stream was identified as a potential source near the College Road crossing in Greene.
34	Daggett Hill Road & Route 11	Road Crossing	<ul style="list-style-type: none"> • Crumbling pavement and sand and gravel deposits into stream. excess sediment on road and in ditches.

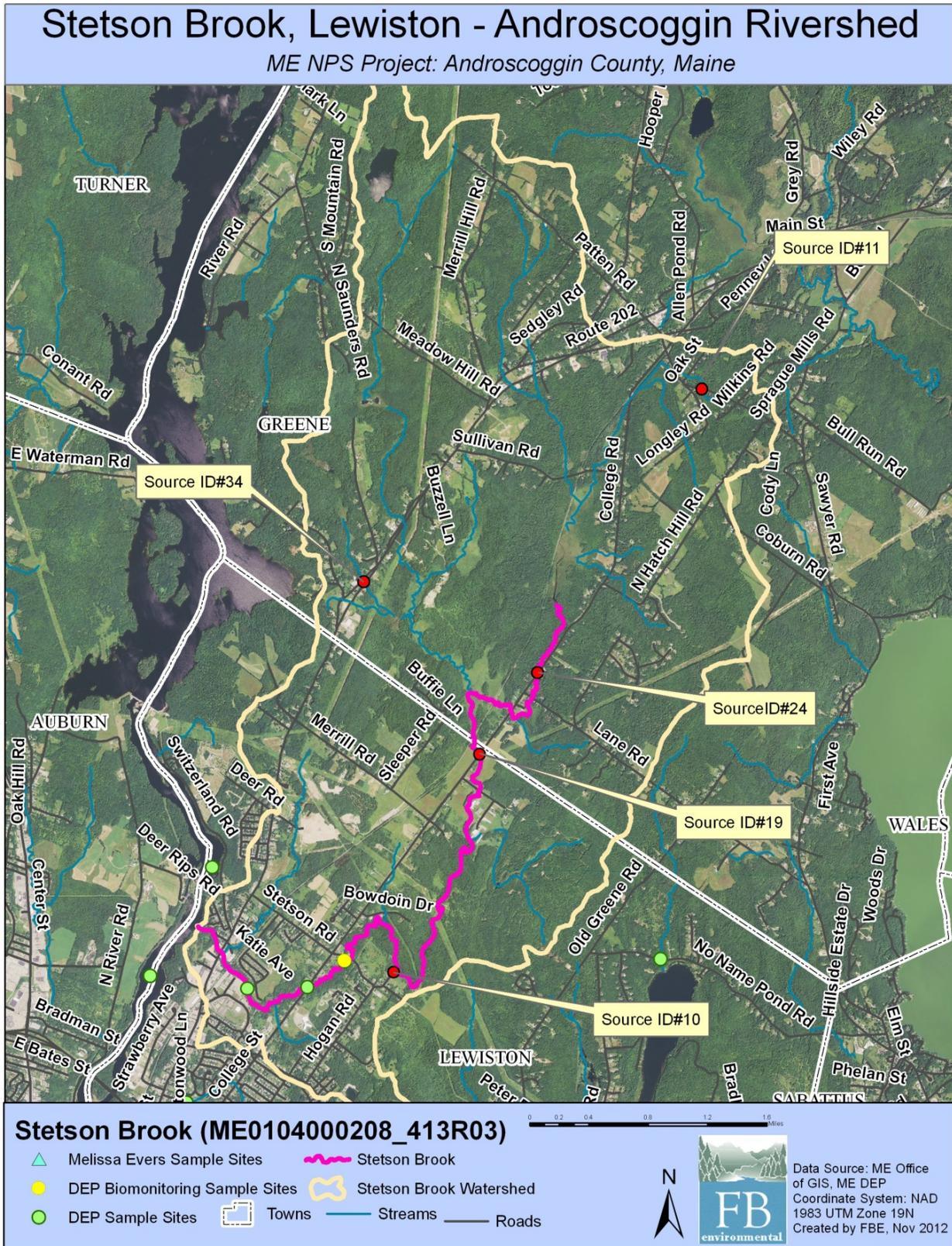


Figure 3: Aerial Photo of Source ID locations in the Stetson Brook Watershed

NUTRIENT LOADING – MAPSHED ANALYSIS

The MapShed model was used to estimate stream loading of sediment, total nitrogen and total phosphorus in Stetson 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) shows that no livestock (numbers of animals) were found in the watershed, based on direct observations made in the watershed, plus other publicly available data.

The Stetson Brook watershed is predominantly forested with a substantial amount of development and agriculture. Agricultural areas are concentrated most in the central and upper portion of the watershed away from the Androscoggin River. Despite the high level of agricultural land use, no livestock was observed within the watershed.

Table 3: Livestock Estimates in Stetson Brook Watershed

Type	Stetson Brook
Dairy Cows	0
Beef Cows	0
Broilers	0
Layers	0
Hogs/Swine	0
Sheep	0
Horses	0
Turkeys	0
Other	0
Total	0

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.

Stetson Brook is a 6.8 mile-long impaired segment as listed by Maine DEP. As modeled, the total stream miles (including tributaries) within the watershed was calculated as 13.7 miles. Of this total, 2.7 stream miles are located within agricultural areas and 1.1 miles or 41% 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%.

Table 4: Summary of Vegetated Buffers in Agricultural Areas

Stetson Brook
<ul style="list-style-type: none"> • 13.7 stream miles in watershed (includes ephemeral streams) • 2.7 stream miles in agricultural areas • 41% of agricultural stream miles have a vegetated buffer

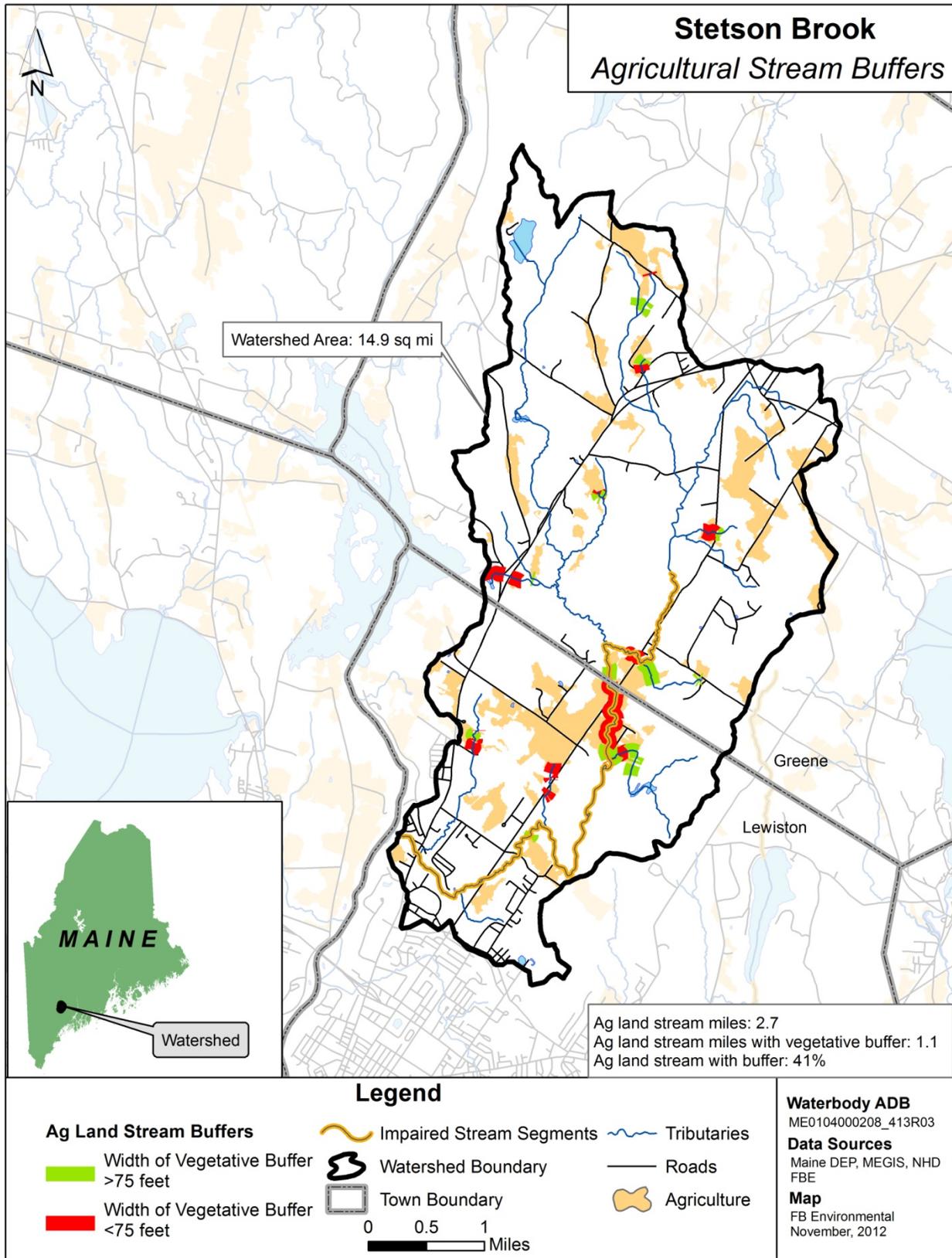


Figure 4: Buffered Agricultural Stream Miles in the Stetson Brook Watershed***Best Management Practices (BMPs)***

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. The Stetson Brook Watershed is 6.3% wetland. A fairly large wetland complex exists at the origin of the impaired segment of Stetson Brook. The major eastern tributaries first drain into this wetland before continuing into Stetson Brook. Smaller wetlands are also found along tributaries in the nor western portion of the watershed. It is estimated that these wetlands drain 15% of land area within the watershed. 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 Stetson Brook indicate no 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 Stetson Brook watershed is mainly derived from development which makes up over 60% of the total sediment load. Agriculture is a secondary source contributing 28% of the load to Stetson Brook (Table 5, Figure 5). Total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Stetson Brook* (below) for loading estimates that have been normalized by watershed area.

Table 5: Total Sediment Load by Source

Stetson Brook	Sediment (1000kg/year)	Sediment (%)
Source Load		
<i>Hay/Pasture</i>	5.86	14%
<i>Crop land</i>	5.59	14%
<i>Forest</i>	4.54	11%
<i>Wetland</i>	0	0%
<i>Disturbed Land</i>	0	0%
<i>Low Density Mixed</i>	7.49	18%
<i>Medium Density Mixed</i>	0	0%
<i>High Density Mixed</i>	17.63	43%
<i>Low Density Residential</i>	0	0%
<i>Medium Density Residential</i>	0	0%
<i>High Density Residential</i>	0	0%
<i>Farm Animals</i>	0	0%
<i>Septic Systems</i>	0	0%
Source Load Total:	41.11	100%
Pathway Load		
<i>Stream Banks</i>	31.10	-
<i>Subsurface / Groundwater</i>	0	-
Total Watershed Mass Load:	72.21	

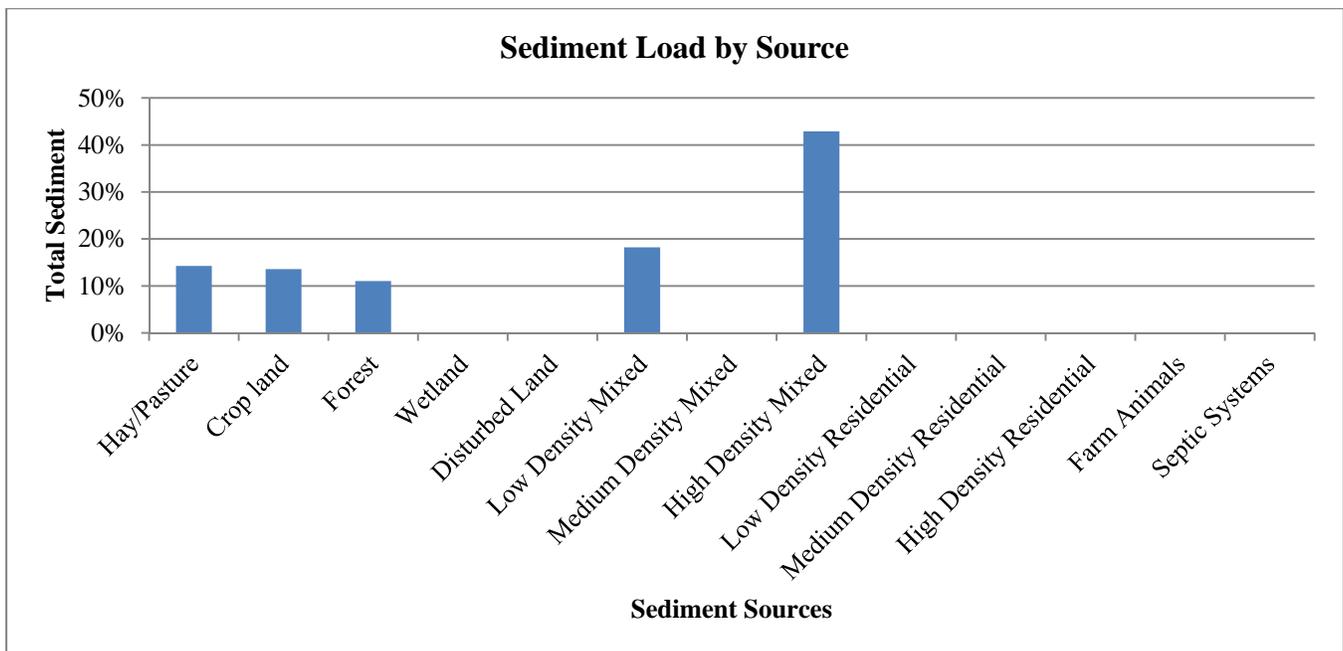


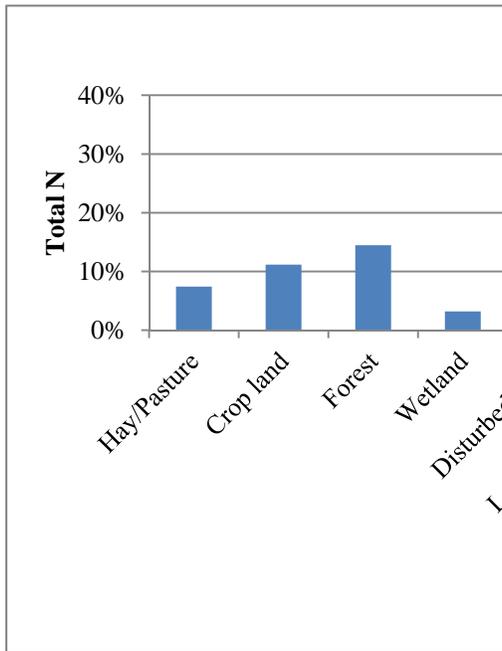
Figure 5: Total Sediment Loads by Source in the Stetson Brook Watershed

Total Nitrogen

Nitrogen loading is attributed mainly to septic systems which contribute 36% of the total load. Development is a secondary source of nitrogen and accounts for 28% of the total nitrogen load in Stetson Brook. Agricultural sources also contribute a significant portion of the load at a combined total of 18%, respectively. Table 6 and Figure 6 (below) shows estimated total nitrogen load in terms of mass and percent of total by source, in Stetson Brook. 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 Stetson Brook* (below) for loading estimates that have been normalized by watershed area.

Table 6: Total Nitrogen Loads by Source

Stetson Brook	Total N (kg/year)	Total N (%)
Source Load		
<i>Hay/Pasture</i>	261.8	7%
<i>Crop land</i>	394.1	11%
<i>Forest</i>	510.2	14%
<i>Wetland</i>	112.8	3%
<i>Disturbed Land</i>	0	0%
<i>Low Density Mixed</i>	226.2	6%
<i>Medium Density Mixed</i>	0	0%
<i>High Density Mixed</i>	769.7	22%
<i>Low Density Residential</i>	0	0%
<i>Medium Density Residential</i>	0	0%
<i>High Density Residential</i>	0	0%
<i>Farm Animals</i>	0	0%
<i>Septic Systems</i>	1252.9	36%
Source Load Total:	3527.7	100%
Pathway Load		
<i>Stream Banks</i>	19.6	-



<i>Subsurface / Groundwater</i>	15854.3	-
Total Watershed Mass Load:	19401.6	

Table 7: Total Phosphorus Loads by Source

Stetson Brook	Total P (kg/year)	Total P (%)
Source Load		
<i>Hay/Pasture</i>	94.9	33%
<i>Crop land</i>	37.7	13%
<i>Forest</i>	29.2	10%
<i>Wetland</i>	5.8	2%
<i>Disturbed Land</i>	0	0%
<i>Low Density Mixed</i>	24.9	9%
<i>Medium Density Mixed</i>	0	0%
<i>High Density Mixed</i>	78.7	27%
<i>Low Density Residential</i>	0	0%
<i>Medium Density Residential</i>	0	0%
<i>High Density Residential</i>	0	0%

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

Total Phosphorus

Phosphorus loading within the watershed is attributed primarily to agriculture. Crop land and hay/pasture combined account for 46% of the total phosphorus load to Stetson Brook. Development is a secondary source contributing 36% of the total load. Phosphorus loads are presented in Table 7 and Figure 7. Total loads by mass cannot be directly compared between watersheds due to differences in watershed area. See section *TMDL: Target Nutrient Levels for Stetson Brook* (below) for loading estimates that have been normalized by watershed area.

<i>Farm Animals</i>	0	0%
<i>Septic Systems</i>	15.3	5%
Source Load Total:	286.3	100%
Pathway Load		
<i>Stream Banks</i>	6.7	-
<i>Subsurface / Groundwater</i>	342.0	-
Total Watershed Mass Load:	635.1	

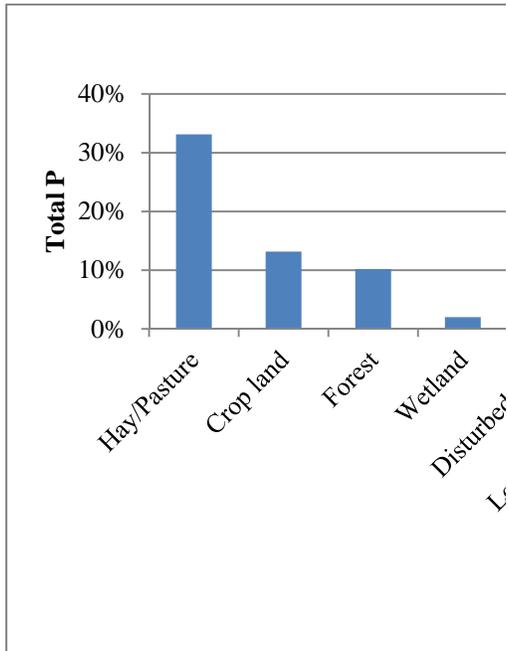


Figure 7: Total Phosphorus Loads by Source in the Stetson Brook Watershed

TMDL: TARGET NUTRIENT LEVELS FOR STETSON BROOK

The existing loads for nutrients and sediments in the impaired segment of Stetson 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 Stetson 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 Stetson Brook Pollutant Loading

TMDL POLLUTANT LOADS Annual Loads per Unit Area	Estimated Loads Stetson Brook	Total Maximum Daily Load	TMDL % REDUCTIONS Stetson Brook
<i>Sediment Load (1000 kg/ha/year)</i>	0.019	0.030	No Reduction Needed
<i>Nitrogen Load (kg/ha/year)</i>	5.01	5.2	No Reduction Needed
<i>Phosphorus Load (kg/ha/year)</i>	0.16	0.24	No Reduction Needed

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 Stetson 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 Stetson Brook watershed because Androscoggin County has increasing population trends, with a 3% increase between 2000 and 2008 (USM MSAC, 2009). The growth in agricultural lands is also increasing, with a 13% increase in the total number of farms in Androscoggin County between 2002 and 2007. However, a decrease of 9% was seen in the land (acres) in farms between 2002 and 2007, and a 19% 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 Stetson Brook. It is recommended that municipal officials, landowners, and conservation stakeholders in Lewiston 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 Stetson Brook;

- Address existing nonpoint source problems in the Stetson Brook watershed by instituting BMPs where necessary; and
- Prevent future degradation of Stetson 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 Stetson Brook

Stetson Brook				
	Area ha	Sediment 1000kg/yr	TN kg/yr	TP kg/yr
Land Uses				
<i>Hay/Pasture</i>	376	5.9	261.8	94.9
<i>Crop land</i>	96	5.6	394.1	37.7
<i>Forest</i>	2634	4.5	510.2	29.2
<i>Wetland</i>	242	0.0	112.8	5.8
<i>Disturbed Land</i>	0	0.0	0.0	0.0
<i>Low Density Mixed</i>	330	7.5	226.2	24.9
<i>High Density Mixed</i>	193	17.6	769.7	78.7
Other Sources				
<i>Farm Animals</i>			0.0	0.0
<i>Septic Systems</i>			1252.9	15.3
Pathway Loads				
<i>Stream Banks</i>		31.1	19.6	6.7
<i>Groundwater</i>			15854.3	342.0
Total Annual Load		72 x 1000 kg	19402 kg	635 kg
Total Area	3871 ha			
Total maximum Daily Load		0.019 1000kg/ha/year	5.01 kg/ha/year	0.16 kg/ha/year

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