Middle River

Watershed Summary

WATERSHED DESCRIPTION AND MAPS

The Middle River watershed covers an area of approximately 10,451 acres in northeastern Connecticut (Figure 1). The watershed is located almost entirely within the Town of Stafford, CT, and a portion extends into Massachusetts.

The Middle River watershed includes two segments, Middle River (Segment 1) (CT-3102-01_01), and Middle River (Segment 2) (CT-3102-02_01), impaired for recreation due to elevated bacteria levels. These segments were assessed by Connecticut Department of Energy and Environmental Protection (CT DEEP) and included in the CT 2010 303(d) list of impaired waterbodies. An excerpt of the Integrated Water Quality Report is included in Table 1 to show the status of some of the other waterbodies in the watershed (CT DEEP, 2010).

Middle River (Segment 2) begins in central Stafford at the outlet to Orcutts Pond just upstream of Orcuttsville Road, flows south before turning southwest then southeast, crosses Stafford Road, West Street, Center Street, and Park Street (Route 140), and ends just downstream of the Route 140 crossing in downtown Stafford. The impaired segment is 3.92 miles long and is located entirely within the Town of Stafford.

Middle River (Segment 1) begins at the downstream terminus of Middle River (Segment 2) approximately 800 feet upstream of the Route 32 crossing in downtown Stafford, flows east to cross Hyde Park Road, Highland Terrace Road, and Route 32, and ends at its confluence with Furnace Brook in downtown Stafford. Middle River (Segment 1) is 0.23 miles long and is located entirely within the Town of Stafford.

Impaired Segment Facts

Impaired Segments, Lengths (miles), and Water Quality Classification:

1. Middle River (Segment 1) (CT3102-01_01); 0.23; B
2. Middle River (Segment 2) (CT3102-02_01); 3.92; A

Town: Stafford

Designated Use Impairments: Recreation

Sub-regional Basin Name and Code: Middle River, 3102

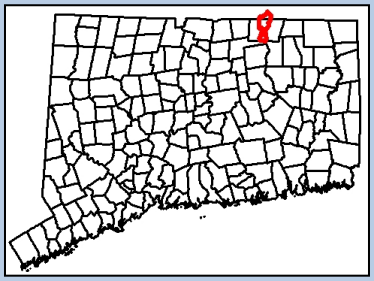
Regional Basin: Willimantic

Major Basin: Thames

Watershed Area (acres): 10,451

MS4 Applicable? No

Figure 1: Watershed location in Connecticut

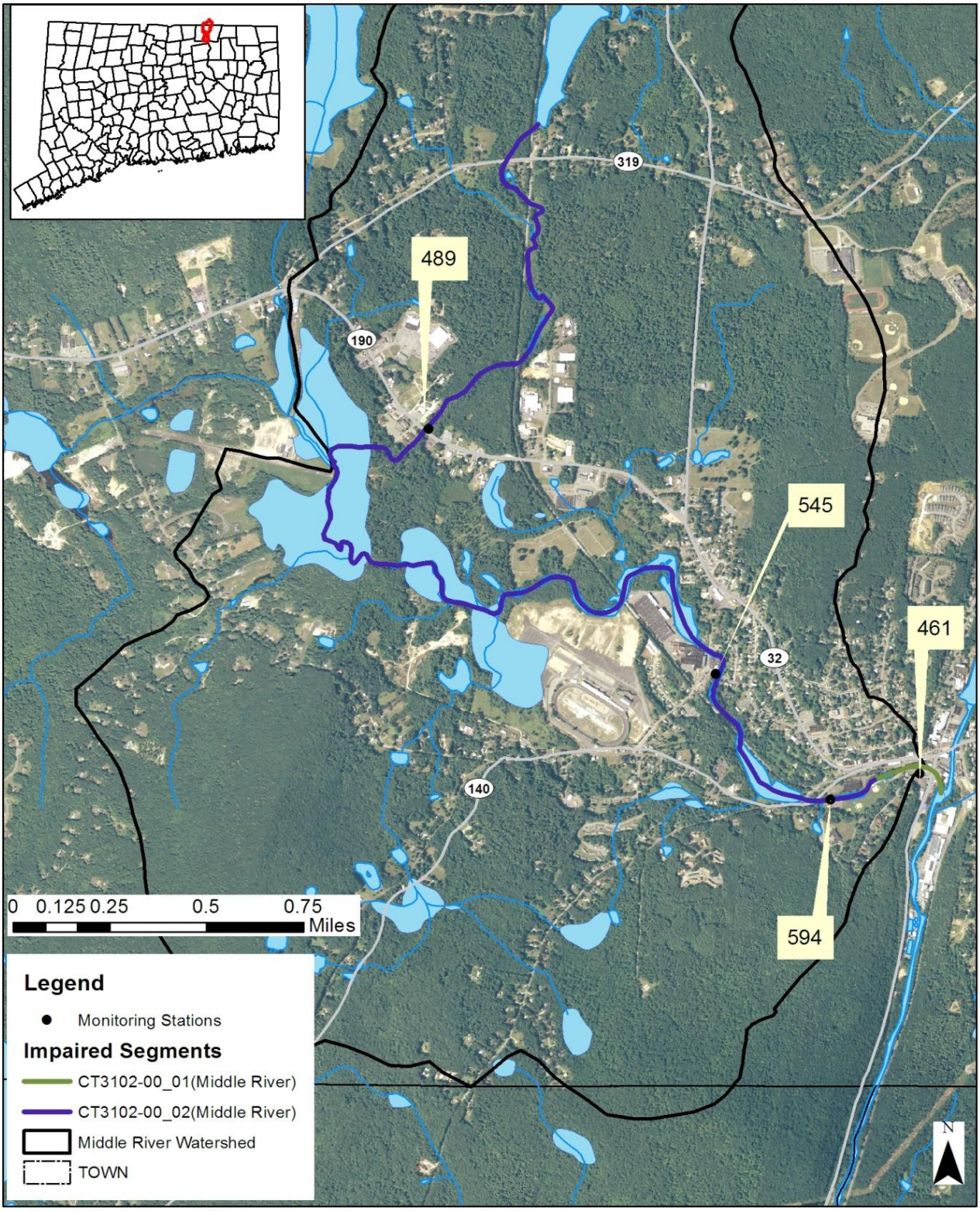


Middle River (Segment 1) has a water quality classification of B. Designated uses include habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. Middle River (Segment 2) has a water quality classification of A. Designated uses include potential drinking water supply, habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. These segments are impaired due to elevated bacteria concentrations, affecting the designated use of recreation. As there are no designated beaches on these segments, the specific recreation impairment is for non-designated swimming and other water contact related activities.

Table 1: Impaired segments and nearby waterbodies from the Connecticut 2010 Integrated Water Quality Report

Waterbody ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation	Fish Consumption
CT3102-00_01	Middle River (Stafford)-01	From mouth at confluence with Furnace Brook (above Willimantic River), US to 800Ft US of Route 32 crossing, Stafford Springs center.	0.23	FULL	NOT	FULL
CT3102-00_02	Middle River (Stafford)-02	From 800Ft US of Route 32 crossing, Stafford Springs center, US to Orcutts Pond dam outlet (just US of Orcutville Road (Route319) crossing), Stafford.	3.92	FULL	NOT	FULL
Shaded cells indicate impaired segment addressed in this TMDL **FULL = Designated Use Fully Supported** **NOT = Designated Use Not Supported** **U = Unassessed**						

Figure 2: GIS map featuring general information of the Middle River watershed at the sub-regional level



Land Use

Existing land use can affect the water quality of waterbodies within a watershed (USEPA, 2011c). Natural processes, such as soil infiltration of stormwater and plant uptake of water and nutrients, can occur in undeveloped portions of the watershed. As impervious surfaces (such as rooftops, roads, and sidewalks) increase within the watershed landscape from commercial, residential, and industrial development, the amount of stormwater runoff to waterbodies also increases. These waterbodies are negatively affected as increased pollutants from failing and insufficient septic systems, oil and grease from automobiles, and sediment from construction activities become entrained in this runoff. Agricultural land use activities, such as fertilizer application and manure from livestock, can also increase pollutants in nearby waterbodies (USEPA, 2011c).

As shown in Figures 3 and 4, the Middle River watershed consists of 71% forest, 16% urban area, 8% water, and 5% agriculture. The area surrounding Middle River (Segment 1) is dominated by urban land uses. Middle River (Segment 2) is surrounded by a mix of forested and urban land uses, particularly in the downstream portions where impervious surfaces are greatest.

Figure 3: Land use within the Middle River watershed

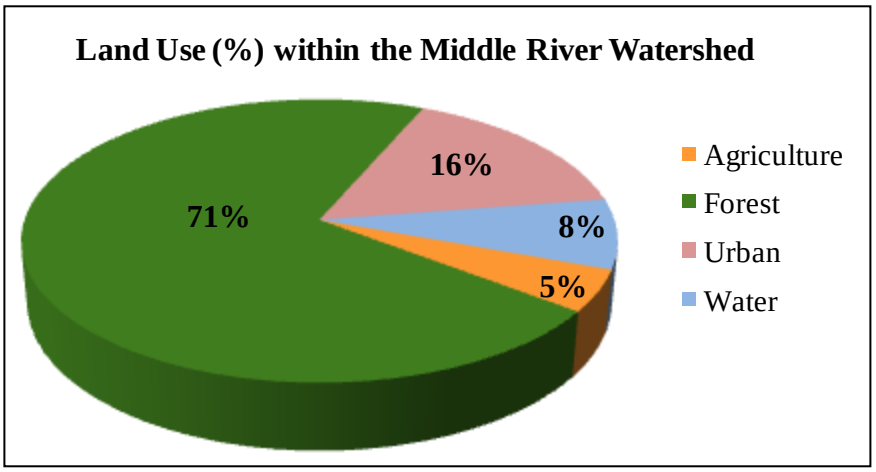
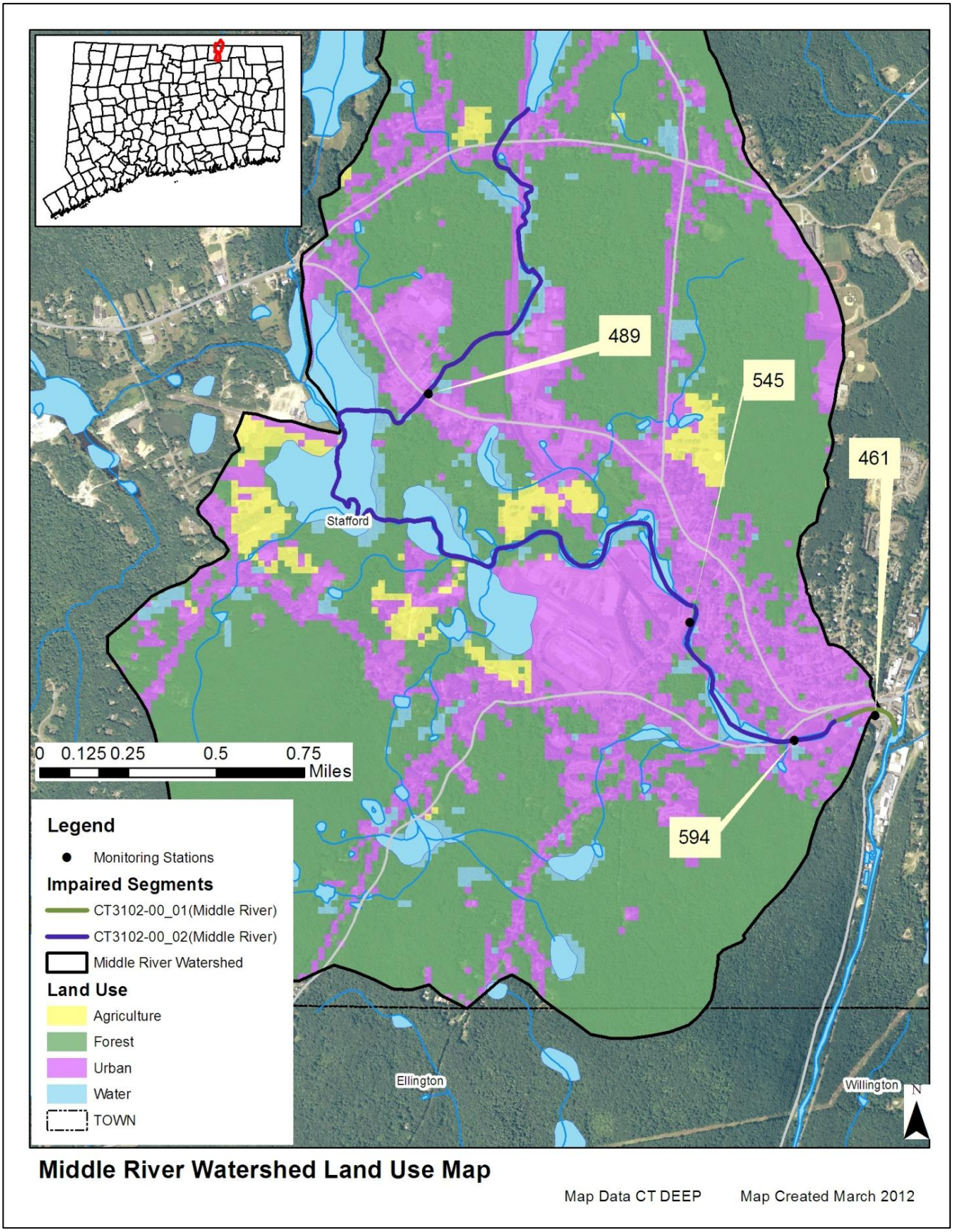


Figure 4: GIS map featuring land use for the Middle River watershed at the sub-regional level



WHY IS A TMDL NEEDED?

E. coli is the indicator bacteria used for comparison with the CT State criteria in the CT Water Quality Standards (WQS) (CTDEEP, 2011). All data results are from CT DEEP, USGS, Bureau of Aquaculture, or volunteer monitoring efforts at stations located on the impaired segments.

Table 2: Sampling station location description for impaired segments in the Middle River watershed

Waterbody ID	Station	Station Description	Municipality	Latitude	Longitude
CT3102-00_01	461	Route 32 bridge	Stafford	41.9524889	-72.3038972
CT3102-00_02	594	At upstream entrance of American Sleeve Bearing	Stafford	41.9518863	-72.3083649
	545	Upstream of West Street intersection	Stafford	41.95675	-72.3140833
	489	Downstream of Route 190	Stafford	41.9659333	-72.3277528

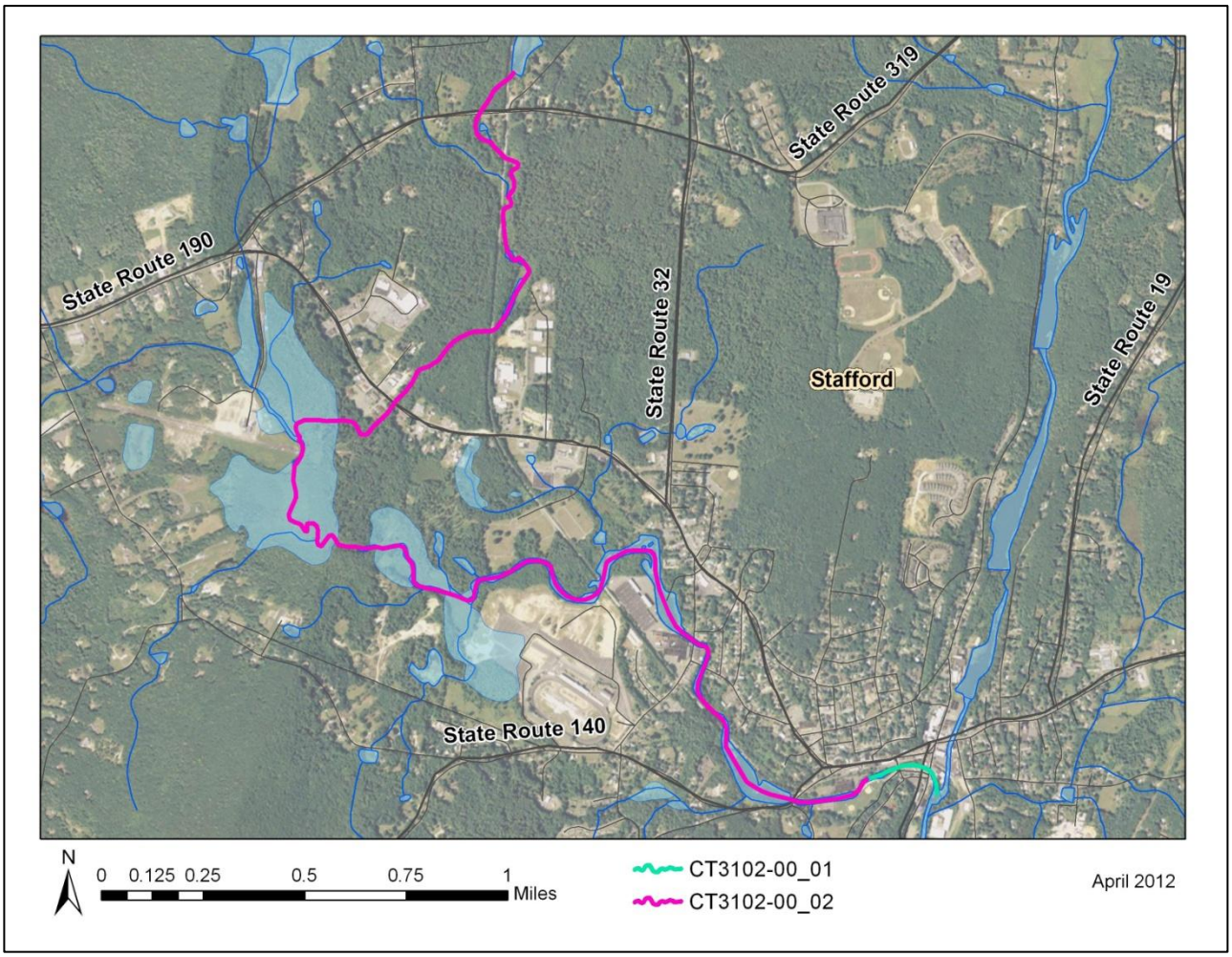
Middle River (Segment 1) (CT3102-01_01) is a Class B freshwater river (Figure 5). Its applicable designated uses are habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Middle River (Segment 2) (CT3102-02_01) is a Class A freshwater river. Its applicable designated uses are potential drinking water supply, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Water quality analyses were conducted using data from one sampling location on Middle River (Segment 1) (Station 461), and three sampling locations on Middle River (Segment 2) (Stations 594, 545, and 489) (Table 2).

Water quality criteria for *E. coli*, along with bacteria sampling results from 1999-2004 and 2010, are presented in Table 8 for Middle River (Segment 1). Single sample values at Station 461 on Middle River (Segment 1) exceeded the WQS for *E. coli* at least once in 2002 and 2010. Annual geometric means were calculated for Station 461 and exceeded the WQS for *E. coli* in 2010. Water quality criteria for *E. coli*, along with bacteria sampling results from 1999-2001 and 2010, are presented in Table 9 for Middle River (Segment 2). Single sample values exceeded the WQS for *E. coli* at Station 545 in 2010. Annual geometric means were calculated for Station 545 and exceeded the WQS for *E. coli* in 2010. All other stations did not exceed the WQS for *E. coli* for geometric mean or single sample values.

To aid in identifying possible bacteria sources, the geometric mean was also calculated for each station for wet-weather and dry-weather sampling days (Tables 8 and 9). Geometric means at Station 461 on Middle River (Segment 1) exceeded the WQS for *E. coli* during both wet and dry-weather. Geometric means during wet-weather could not be calculated for Stations 594 or 489 on Middle River (Segment 2) due to a lack of wet-weather data, and none of these stations exceeded the WQS for *E. coli* during dry-weather. The geometric mean at Station 545 on Middle River (Segment 2) exceeded the WQS for *E. coli* during wet-weather.

Due to the elevated bacteria measurements presented in Tables 8 and 9, these impaired segments did not meet CT's bacteria WQS, were identified as impaired, and were placed on the CT List of Waterbodies Not Meeting Water Quality Standards, also known as the CT 303(d) Impaired Waters List. The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes the impairments and identifies the measures needed to restore water quality. The goal is for all waterbodies to comply with State WQS.

Figure 5: Aerial map of the Middle River



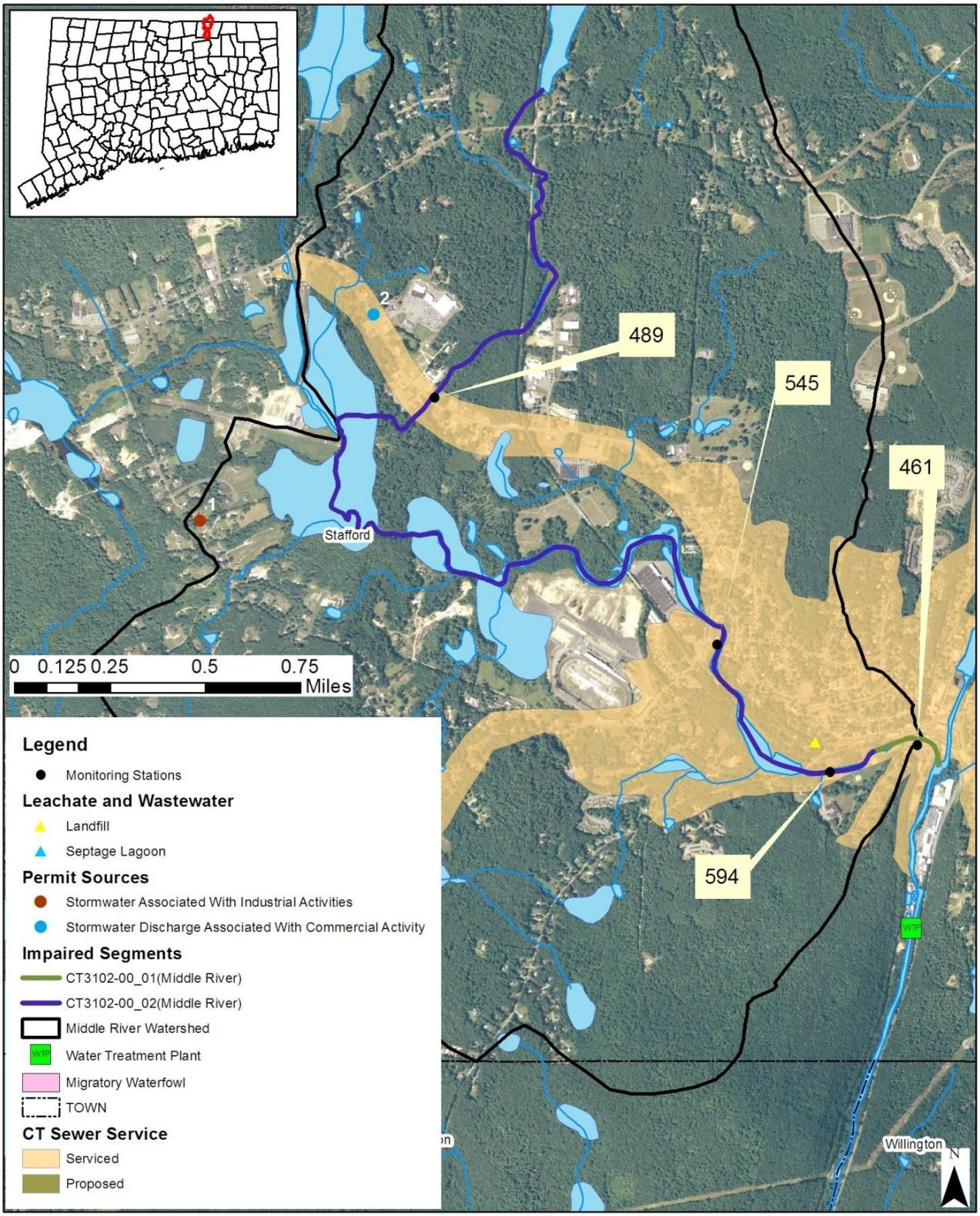
POTENTIAL BACTERIA SOURCES

Potential sources of indicator bacteria in a watershed include point and non-point sources, such as stormwater runoff, agriculture, sanitary sewer overflows (collection system failures), illicit discharges, and inappropriate discharges to the waterbody. Potential sources that have been tentatively identified in the Furnace Brook watershed based on land use (Figures 3 and 4) and a collection of local information for each of the waterbodies is presented in Table 3 and Figure 6. However, the list of potential sources is general in nature and should not be considered comprehensive. There may be other sources not listed here that contribute to the observed water quality impairment in the study segments. Further monitoring and investigation will confirm listed sources and discover additional sources. Some segments in this watershed are currently listed as unassessed by CT DEEP procedures. This does not suggest that there are no potential issues on these segments, but indicates a lack of current data to evaluate the segments as part of the assessment process. For some segments, there are data from permitted sources, and CT DEEP recommends that any elevated concentrations found from those permitted sources be addressed through voluntary reduction measures. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement these TMDLs.

Table 3: Potential bacteria sources in the Middle River watershed

Impaired Segment	Permit Source	Illicit Discharge	CSO/SSO Issue	Failing Septic System	Agricultural Activity	Stormwater Runoff	Nuisance Wildlife/Pets	Other
Middle River CT3102-00_01	**x**	**x**				**x**	**x**	
Middle River CT3102-00_02	**x**	**x**		**x**		**x**	**x**	

Figure 6: Potential sources in the Middle River watershed at the sub-regional level



Middle River Watershed Potential Sources Map

Map Data CT DEEP Map Created March 2012

The potential sources map for the impaired basin was developed after thorough analysis of available data sets. If information is not displayed in the map, then no sources were discovered during the analysis. The following is the list of potential sources that were evaluated: problems with migratory waterfowl, golf course locations, reservoirs, proposed and existing sewer service, cattle farms, poultry farms, permitted sources of bacteria loading (surface water discharge, MS4 permit, industrial stormwater, commercial stormwater, groundwater permits, and construction related stormwater), and leachate and discharge sources (agricultural waste, CSOs, failing septic systems, landfills, large septic tank leach fields, septage lagoons, sewage treatment plants, and water treatment or filter backwash).

Point Sources

Permitted sources within the watershed that could potentially contribute to the bacteria loading are identified in Table 4. This table includes permit types that may or may not be present in the impaired watershed. A list of active permits in the watershed is included in Table 5. Additional investigation and monitoring could reveal the presence of additional discharges in the watershed. Available effluent data from each of these permitted categories found within the watershed are compared to the CT State WQS for the appropriate receiving waterbody use and type. When available, bacteria data results from these permitted sources are listed in Table 6.

Table 4: General categories list of other permitted discharges

Permit Code	Permit Description Type	Number in watershed
CT	Surface Water Discharges	0
GPL	Discharge of Swimming Pool Wastewater	0
GSC	Stormwater Discharge Associated with Commercial Activity	1
GSI	Stormwater Associated with Industrial Activity	1
GSM	Part B Municipal Stormwater MS4	0
GSN	Stormwater Registration – Construction	0
LF	Groundwater Permit (Landfill)	0
UI	Underground Injection	0

Permitted Sources

As shown in Table 5, there are two permitted discharges in the Middle River watershed. Bacteria data from 2001-2003 from one of these industrial permitted facilities are included in Table 6. This data cannot be compared to the water quality standard as there is no recreation standard for fecal coliform. The Warren Corp (GSI001115) had a relatively low reading of 10 colonies/100 mL in 2001.

Since the MS4 permits are not targeted to a specific location, but the geographic area of the regulated municipality, there is no one accurate location on the map to display the location of these permits. One dot will be displayed at the geographic center of the municipality as a reference point. Sometimes this location falls outside of the targeted watershed and therefore the MS4 permit will not be displayed in the Potential Sources Map. Using the municipal border as a guideline will show which areas of an affected watershed are covered by an MS4 permit.

Table 5: Permitted facilities within the Middle River watershed

Town	Client	Permit ID	Permit Type	Site Name	Address	Map #
Stafford Springs	Trustees of The Big Y Trust	GSC000383	Stormwater Discharge Associated With Commercial Activity	Big Y Foods	87 West Stafford Road	2
Stafford Springs	CT DOT	GSI000063	Stormwater Associated With Industrial Activities	Stafford Salt Storage	Cooper Lane	1

Table 6: Industrial permits in the Middle River watershed and available fecal coliform data (colonies/100 mL). The results cannot be compared to the water quality standard as there is no recreation standard for fecal coliform.

Town	Location	Permit Number	Receiving Water	Sample Location	Sample Date	Result
Stafford	The Warren Corp.	GSI001115	Middle River	003-Reed Building	07/17/01	10

Municipal Stormwater Permitted Sources

Per the EPA Phase II Stormwater rule all municipal storm sewer systems (MS4s) operators located within US Census Bureau Urbanized Areas (UAs) must be covered under MS4 permits regulated by the appropriate State agency. There is an EPA waiver process that municipalities can apply for to not participate in the MS4 program. In Connecticut, EPA has granted such waivers to 19 municipalities. All participating municipalities within UAs in Connecticut are currently regulated under MS4 permits by CT DEEP staff in the MS4 program.

The US Census Bureau defines a UA as a densely settled area that has a census population of at least 50,000. A UA generally consists of a geographic core of block groups or blocks that exceeds the 50,000 people threshold and has a population density of at least 1,000 people per square mile. The UA will also include adjacent block groups and blocks with at least 500 people per square mile. A UA consists of all or part of one or more incorporated places and/or census designated places, and may include additional territory outside of any place. (67 FR 11663)

For the 2000 Census a new geographic entity was created to supplement the UA blocks of land. This created a block known as an Urban Cluster (UC) and is slightly different than the UA. The definition of a UC is a densely settled area that has a census population of 2,500 to 49,999. A UC generally consists of a geographic core of block groups or blocks that have a population density of at least 1,000 people per square mile, and adjacent block groups and blocks with at least 500 people per square mile. A UC consists of all or part of one or more incorporated places and/or census designated places; such a place(s) together with adjacent territory; or territory outside of any place. The major difference is the total population cap of 49,999 people for a UC compared to >50,000 people for a UA. (67 FR 11663)

While it is possible that CT DEEP will be expanding the reach of the MS4 program to include UC municipalities in the near future they are not currently under the permit. However, the GIS layers used to create the MS4 maps in this Statewide TMDL did include both UA and UC blocks. This factor creates some municipalities that appear to be within an MS4 program that are not currently regulated through an MS4 permit. This oversight can explain a municipality that is at least partially shaded grey in the maps and there are no active MS4 reporting materials or information included in the appropriate appendix. While these areas are not technically in the MS4 permit program, they are still considered urban by the

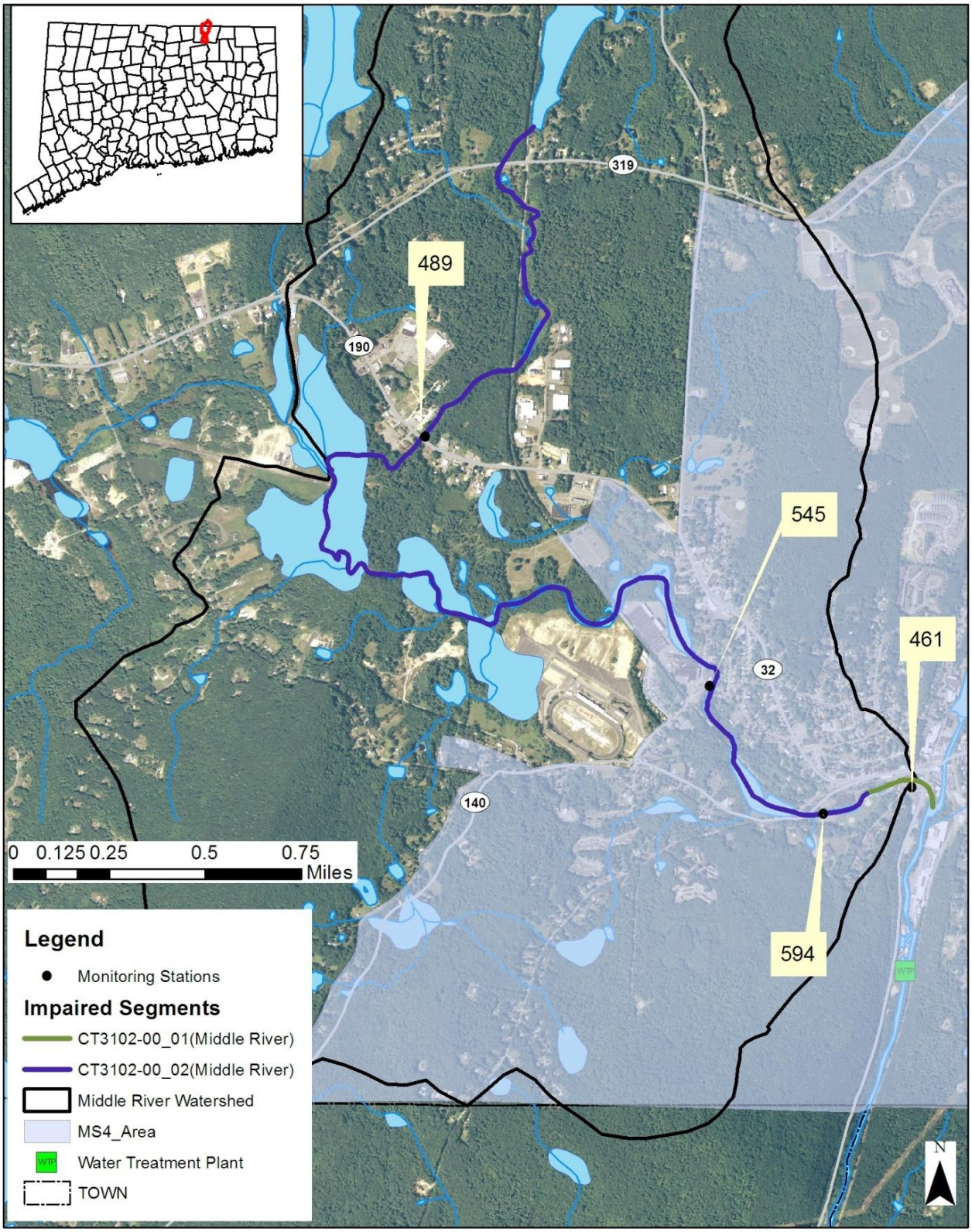
cluster definition above and are likely to contribute similar stormwater discharges to affected waterbodies covered in this TMDL.

As previously noted, EPA can grant a waiver to a municipality to preclude their inclusion in the MS4 permit program. One reason a waiver could be granted is a municipality with a total population less than 1000 people, even if the municipality was located in a UA. There are 19 municipalities in Connecticut that have received waivers, this list is: Andover, Bozrah, Canterbury, Coventry, East Hampton, Franklin, Haddam, Killingworth, Litchfield, Lyme, New Hartford, Plainfield, Preston, Salem, Sherman, Sprague, Stafford, Washington, and Stafford. There will be no MS4 reporting documents from these towns even if they are displayed in an MS4 area in the maps of this document.

The list of US Census UCs is defined by geographic regions and is named for those regions, not necessarily by following municipal borders. In Connecticut the list of UCs includes blocks in the following Census Bureau regions: Colchester, Danielson, Lake Pocotopaug, Plainfield, Stafford, Storrs, Torrington, Willimantic, Winsted, and the border area with Westerly, RI (67 FR 11663). Any MS4 maps showing these municipalities may show grey areas that are not currently regulated by the CT DEEP MS4 permit program.

The impaired segments of the Middle River watershed are located in the Town of Stafford. As mentioned above, the Town of Stafford is one of 19 municipalities in Connecticut that received a waiver for MS4 General Permit compliance requirements (Figure 7). Information regarding stormwater management and the MS4 General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4 permit) can be obtained on CTDEEP's website (http://www.ct.gov/dep/cwp/view.asp?a=2721&q=325702&depNav_GID=1654).

Figure 7: MS4 areas of the Middle River watershed



Middle River Watershed MS4 Map

Map Created March 2012 Map Data CT DEEP

Non-point Sources

Non-point source pollution (NPS) comes from many diffuse sources and is more difficult to identify and control. NPS pollution is often associated with land-use practices. Examples of NPS that can contribute bacteria to surface waters include insufficient septic systems, pet and wildlife waste, agriculture, and contact recreation (swimming or wading). Potential sources of NPS within the Middle River watershed are described below.

Insufficient Septic Systems and Illicit Discharges

As shown in Figure 6, there are residential and commercial areas around Middle River (Segment 2), particularly in the upstream forested portions, that do not have access to a sanitary sewer and instead rely on onsite wastewater treatment systems, such as septic systems. Insufficient or failing septic systems can be significant sources of bacteria by allowing raw waste to reach surface waters. In Connecticut, local health directors or health districts are responsible for keeping track of any reported insufficient or failing septic systems in a specific municipality. The Town of Stafford has its own Health Department (http://www.staffordct.org/health.php).

The entire area surrounding Middle River (Segment 1) and multiple areas adjacent to Middle River (Segment 2) are serviced by sanitary sewer. Sewer system leaks and other illicit discharges or connections may be contributing bacteria to nearby surface waters. Water quality data taken at Station 461 on Middle River (Segment 1) were consistently high, especially during dry weather, which suggests that illicit discharges may be a source of bacteria to the Middle River (Tables 8 and 9).

Wildlife and Domestic Animal Waste

Wildlife and domestic animals within the Middle River watershed represent a potential source of bacteria. With the construction of roads and drainage systems, these wastes may no longer be retained on the landscape, but instead may be conveyed via stormwater to the nearest surface water. These physical land alterations can exacerbate the impact of natural sources on water quality (USEPA, 2001).

Geese and other waterfowl are known to congregate in open areas including recreational fields, golf courses, and agricultural crop fields. There are recreational fields adjacent to the Middle River at the downstream terminus of Middle River (Segment 2) and upstream portion of Middle River (Segment 1) off Hyde Park Road in Stafford. In addition to creating a nuisance, large numbers of geese can also create unsanitary conditions on the grassed areas and cause water quality problems due to bacterial contamination associated with their droppings. Large populations of geese can also lead to habitat destruction as a result of overgrazing on wetland and riparian plants.

As hotspots for dog and horse owners, residential development surrounds portions of the impaired segments throughout Stafford (Figure 4). When not properly disposed, waste from domestic animals such as dogs and horses can enter surface waters directly or through stormwater infrastructure.

Stormwater Runoff from Developed Areas

Approximately 16% of the watershed is considered urban, and some of that area is concentrated around the impaired segments in the Town of Stafford (Figure 4). Urban areas are often characterized by impervious cover, or surface areas such as roofs and roads that force water to run off land surfaces rather than infiltrate the soil. Studies have shown a link between increasing impervious cover and degrading water quality conditions in a watershed (CWP, 2003). In one study, researchers correlated the amount of fecal coliform to the percent of impervious cover in a watershed (Mallin *et al*., 2000).

As shown in Figure 8, approximately 86% of the Middle River watershed is characterized by 0-6% impervious cover in the upstream forested area around Middle River (Segment 2), 12% is characterized by 7-11% impervious cover near the downstream portion of Middle River (Segment 2), and 2% is characterized by greater than 16% impervious cover around Middle River (Segment 1) (Figure 9). While impervious surfaces are not prevalent in the watershed as a whole, there are areas near the impaired segments with impervious surfaces, including buildings, parking lots, and roads along West Street, West Stafford Road, and Middle River Drive. The Stafford Motor Speedway is located near Middle River (Segment 2) off Stafford Springs Motor Speedway Access Road. Water quality data taken at Stations 461 and 545 were consistently high, especially during wet-weather, which suggests that stormwater runoff may be a source of bacteria to the Middle River (Tables 8 and 9).

Figure 8: Range of impervious cover (%) in the Middle River watershed

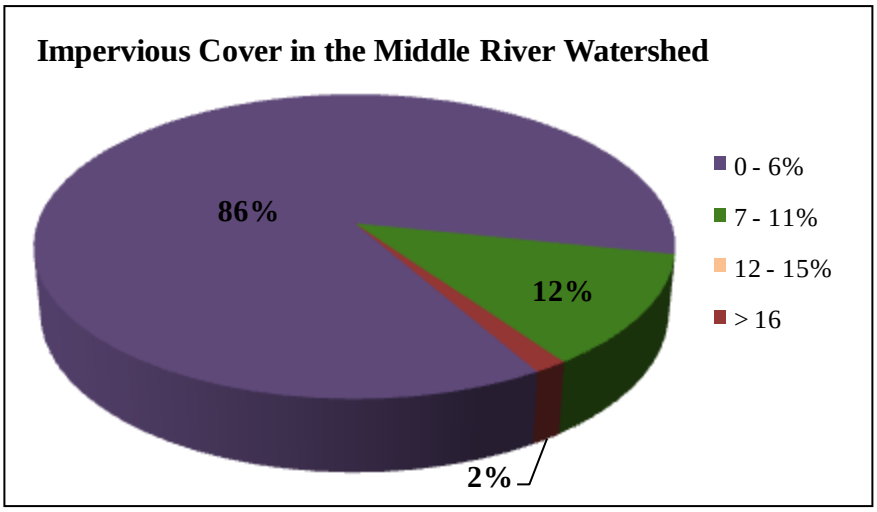
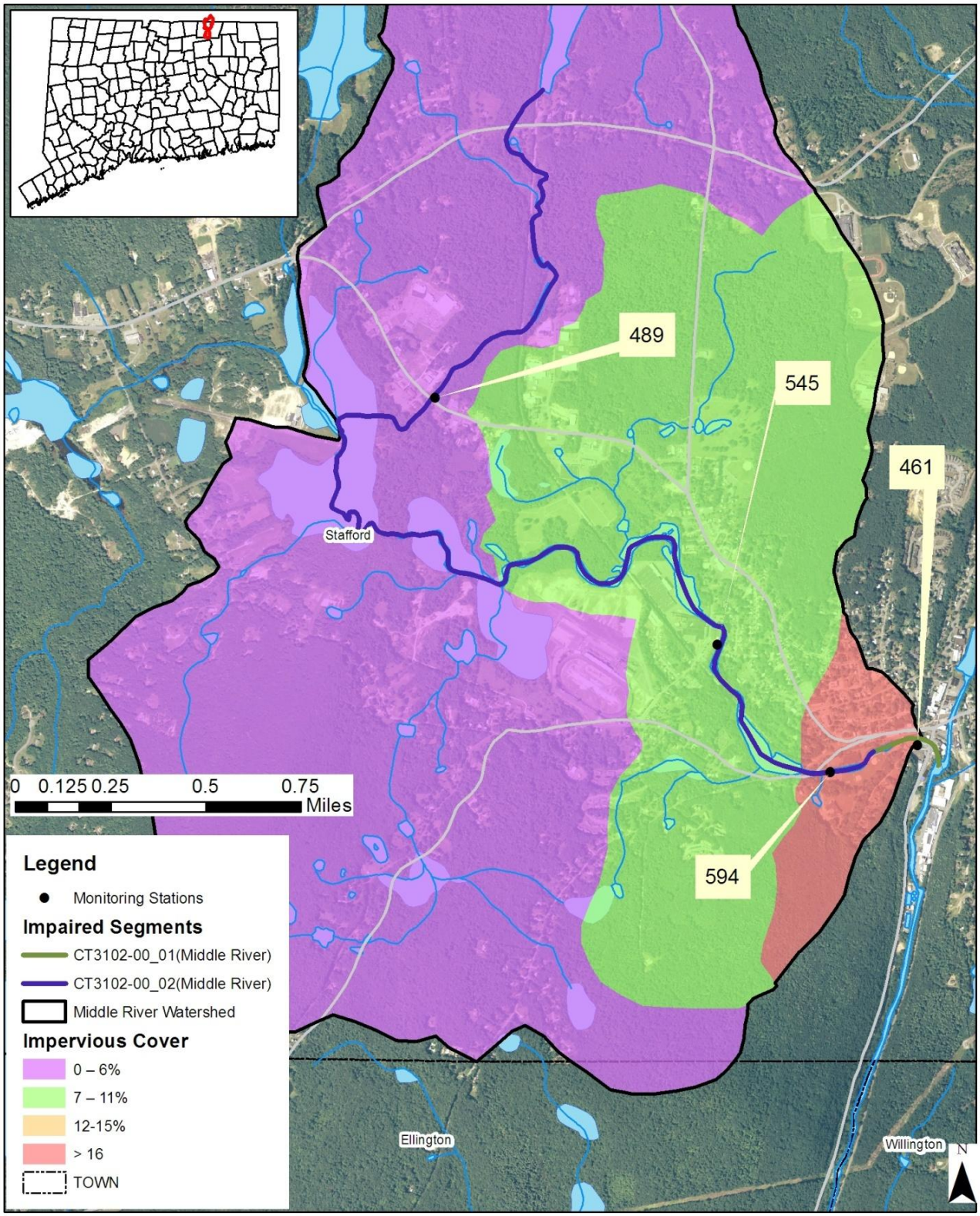


Figure 9: Impervious cover (%) for the Middle River sub-regional watershed



Middle River Watershed Impervious Cover Map

Map Data CT DEEP Map Created March 2012

Agricultural Activities

Agricultural operations are an important economic activity and landscape feature in many areas of the State. Runoff from agricultural fields may contain pollutants such as bacteria and nutrients (USEPA, 2011a). This runoff can include pollutants from farm practices such as storing manure, allowing livestock to wade in nearby waterbodies, applying fertilizer, and reducing the width of vegetated buffer along the shoreline. Agricultural land use makes up 5% of the Middle River watershed, and there are no major agricultural areas in close proximity to the impaired segments (Figure 4).

Additional Sources

A landfill was identified in Figure 6 near the downstream portion the Middle River (Segment 2) and may be a potential source of bacterial contamination. There may be other sources not listed here or identified in Figure 6 that contribute to the observed water quality impairment in the Middle River watershed. Further monitoring and investigation will confirm the listed sources and discover additional ones. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement this TMDL.

Land Use/Landscape

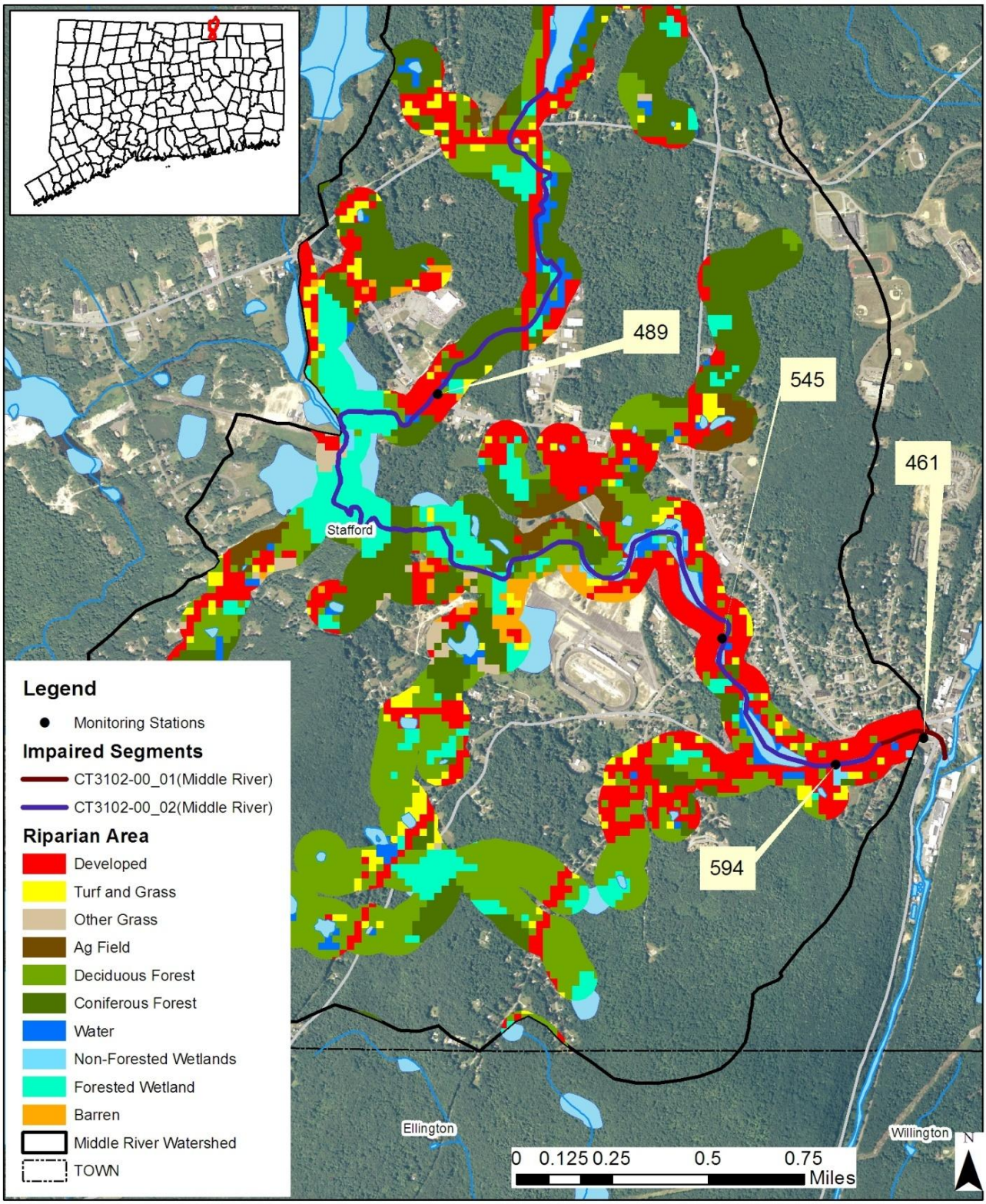
Riparian Buffer Zones

The riparian buffer zone is the area of land located immediately adjacent to streams, lakes, or other surface waters. The boundary of the riparian zone and the adjoining uplands is gradual and not always well-defined. However, riparian zones differ from uplands because of high levels of soil moisture, frequent flooding, and the unique assemblage of plant and animal communities found there. Through the interaction of their soils, hydrology, and vegetation, natural riparian areas influence water quality as contaminants are taken up into plant tissues, adsorbed onto soil particles, or modified by soil organisms. Any change to the natural riparian buffer zone can reduce the effectiveness of the natural buffer and has the potential to contribute to water quality impairment (USEPA, 2011b).

The CLEAR program at UCONN has created streamside buffer layers for the entire State of Connecticut (http://clear.uconn.edu/), which have been used in this TMDL. Analyzing this information can reveal potential sources and implementation opportunities at a localized level. The land use directly adjacent to a waterbody can have direct impacts on water quality from surface runoff sources.

The riparian zone for Middle River (Segment 1) consists almost entirely of developed land. The riparian zone for Middle River (Segment 2) is characterized primarily by developed land use in the southern half and forested areas in the northern half (Figure 10). Developed areas within the riparian zone likely contribute pollutants such as bacteria to the waterbody since the natural riparian buffer cannot treat stormwater runoff from impervious surfaces.

Figure 10: Riparian buffer zone information for the Middle River watershed



Middle River Watershed Riparian Area Map

UCONN CLEAR: http://clear.uconn.edu/ Map Data CT DEEP Map Created March 2012

RECOMMENDED NEXT STEPS

Future mitigative activities are necessary to ensure the long-term protection of the Middle River watershed and have been prioritized below.

1) Implement a program to evaluate the sanitary sewer system.

The majority of residents and businesses surrounding Middle River (Segments 1 and 2), particularly in the downstream portion of the watershed, rely on a municipal sewer system (Figure 6). It is important for the municipalities to develop a program to evaluate its sanitary sewer and reduce leaks and overflows. This program should include periodic inspections of the sewer line.

2) Develop a system to monitor septic systems.

Many residents within Stafford near Middle River (Segment 2) rely on onsite wastewater systems, such as septic systems. If not already in place, Stafford should establish a program to ensure that existing septic systems are properly operated and maintained, and create an inventory of existing septic systems through mandatory inspections. Inspections help encourage proper maintenance and identify failed and sub-standard systems. Policies that govern the eventual replacement of sub-standard systems within a reasonable timeframe can be adopted. The municipalities should also develop a program to assist citizens with the replacement and repair of older and failing systems.

3) Evaluate municipal education and outreach programs regarding animal waste.

Any education and outreach programs in the Middle River watershed should highlight the importance of not feeding waterfowl and wildlife, managing horse and livestock waste, and picking up after dogs and other pets. Municipalities and residents can take measures to minimize waterfowl-related impacts such as allowing tall, coarse vegetation to grow in the riparian areas of the Five Mile River that are frequented by waterfowl. Waterfowl, especially grazers like geese, prefer easy access to water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese and encourage migration. In addition, any educational program should emphasize that feeding waterfowl, such as ducks, geese, and swans, may contribute to water quality impairments in the Middle River and can harm human health and the environment. Animal wastes should be disposed of away from any waterbody or storm drain system. BMPs effective at reducing the impact of animal waste on water quality include installing signage, providing pet waste receptacles in high-use areas, enacting ordinances requiring the clean-up of pet waste, and targeting educational and outreach programs in problem areas.

4) Identify areas along the developed portions of the Middle River to implement Best Management Practices (BMPs) to control stormwater runoff.

As noted previously, 16% of the Middle River watershed is considered urban. As such, stormwater runoff is likely contributing bacteria to the impaired segments. To identify areas that are contributing bacteria to the impaired segments, Stafford should continue to conduct wet-weather sampling and prioritize sampling stations with high bacteria concentrations for BMP installation (Table 6). To treat stormwater runoff, Stafford should identify areas along the impaired segments to install BMPs that encourage stormwater to infiltrate the ground before entering the waterbodies. These BMPs would disconnect impervious areas and reduce pollutant loads to the river. More detailed information and BMP recommendations can be found in the core TMDL document.

5) Continue monitoring of permitted sources.

As shown in Figure 6, there are multiple permitted discharges within the Middle River watershed near the impaired segments. Further monitoring will provide information essential to better locate, understand, and reduce pollution sources. If any current monitoring is not done with appropriate bacterial indicator based on the receiving water, then a recommended change during the next permit reissuance is to include the appropriate indicator species. If facility monitoring indicates elevated bacteria, then implementation of permit required, and voluntary measures to identify and reduce sources of bacterial contamination at the facility are an additional recommendation. Regular monitoring should be established for all permitted sources to ensure compliance with permit requirements and to determine if current requirements are adequate or if additional measures are necessary for water quality protection.

Section 6(k) of the MS4 General Permit requires a municipality to modify their Stormwater Management Plan to implement the TMDL within four months of TMDL approval by EPA if stormwater within the municipality contributes pollutant(s) in excess of the allocation established by the TMDL. For discharges to impaired waterbodies, the municipality must assess and modify the six minimum measures of its plan, if necessary, to meet TMDL standards. Particular focus should be placed on the following plan components: public education, illicit discharge detection and elimination, stormwater structures cleaning, and the repair, upgrade, or retrofit of storm sewer structures. The goal of these modifications is to establish a program that improves water quality consistent with TMDL requirements. Modifications to the Stormwater Management Plan in response to TMDL development should be submitted to the Stormwater Program of DEEP for review and approval.

Table 7 details the appropriate bacteria criteria for use as waste load allocations established by this TMDL for use as water quality targets by permittees as permits are renewed and updated, within the Middle River Watershed.

For any municipality subject to an MS4 permit and affected by a TMDL, the permit requires a modification of the SMP to include BMPs that address the included impairment. In the case of bacteria related impairments municipal BMPs could include: implementation or improvement to existing nuisance wildlife programs, septic system monitoring programs, any additional measures that can be added to the required illicit discharge detection and elimination (IDDE) programs, and increased street sweeping above basic permit requirements. Any non-MS4 municipalities can implement these same types of initiatives in effort to reduce bacteria source loading to impaired waterways.

Any facilities that discharge non-MS4 regulated stormwater should update their Pollution Prevention Plan to reflect BMPs that can reduce bacteria loading to the receiving waterway. These BMPs could include nuisance wildlife control programs and any installations that increase surface infiltration to reduce overall stormwater volumes. Facilities that are regulated under the Commercial Activities Stormwater Permit should report any updates to their SMP in their summary documentation submitted to DEEP.

Table 7. Bacteria (e.coli) TMDLs, WLAs, and LAs for Recreational Use

		Instantaneous *E. coli* (#/100mL)						Geometric Mean *E. coli* (#/100mL)	
Class	**Bacteria Source**	**WLA[6]**			**LA[6]**			**WLA[6]**	**LA[6]**
	Recreational Use	**1**	**2**	**3**	**1**	**2**	**3**	**All**	**All**
A	Non-Stormwater NPDES	0	0	0				0	
	CSOs	0	0	0				0	
	SSOs	0	0	0				0	
	Illicit sewer connection	0	0	0				0	
	Leaking sewer lines	0	0	0				0	
	Stormwater (MS4s)	235[7]	410[7]	576[7]				126[7]	
	Stormwater (non-MS4)				235[7]	410[7]	576[7]		126[7]
	Wildlife direct discharge				235[7]	410[7]	576[7]		126[7]
	Human or domestic animal direct discharge[5]				235	410	576		126
B[4]	Non-Stormwater NPDES	235	410	576				126	
	CSOs	235	410	576				126	
	SSOs	0	0	0				0	
	Illicit sewer connection	0	0	0				0	
	Leaking sewer lines	0	0	0				0	
	Stormwater (MS4s)	235[7]	410[7]	576[7]				126[7]	
	Stormwater (non-MS4)				235[7]	410[7]	576[7]		126[7]
	Wildlife direct discharge				235[7]	410[7]	576[7]		126[7]
	Human or domestic animal direct discharge[5]				235	410	576		126

(1) **Designated Swimming.** Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protections and the Department of Public Health. May 1989. Revised April 2003 and updated December 2008.

(2) **Non-Designated Swimming.** Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.

(3) **All Other Recreational Uses.**

(4) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23. (Class B surface waters located north of Interstate Highway I-95 and downstream of a sewage treatment plant providing seasonal disinfection May 1 through October 1, as authorized by the Commissioner.)

(5) Human direct discharge = swimmers

(6) Unless otherwise required by statute or regulation, compliance with this TMDL will be based on ambient concentrations and not end-of-pipe bacteria concentrations

(7) Replace numeric value with “natural levels” if only source is naturally occurring wildlife. Natural is defined as the biological, chemical and physical conditions and communities that occur within the environment which are unaffected or minimally affected by human influences (CT DEEP 2011a). Sections 2.2.2 and 6.2.7 of this Core Document deal with BMPs and delineating type of wildlife inputs.

BACTERIA DATA AND PERCENT REDUCTIONS TO MEET THE TMDL

Table 8: Middle River (Segment 1) Bacteria Data

Waterbody ID: CT3102-00_01

Characteristics: Freshwater, Class B, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **86%**

Single Sample: **96%**

Data: 1999-2004 and 2010 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from Station 461 on Middle River (Segment 1) with annual geometric means calculated

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
461	Route 32 bridge	10/13/1999	170	dry	94
461	Route 32 bridge	11/29/1999	52	dry	
461	Route 32 bridge	2/9/2000	10	dry	109
461	Route 32 bridge	5/16/2000	160	dry	
461	Route 32 bridge	8/28/2000	340	dry	
461	Route 32 bridge	10/3/2000	260	dry	
461	Route 32 bridge	3/19/2001	10	dry	24
461	Route 32 bridge	5/1/2001	10	dry	
461	Route 32 bridge	7/23/2001	63	dry	
461	Route 32 bridge	10/17/2001	52	dry	
461	Route 32 bridge	6/13/2002	330	wet	120
461	Route 32 bridge	10/10/2002	530	dry	
461	Route 32 bridge	10/23/2002	10	dry	
461	Route 32 bridge	10/2/2003	86	dry	NA

Single sample *E. coli* (colonies/100 mL) data from Station 461 on Middle River (Segment 1) with annual geometric means calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
461	Route 32 bridge	5/12/2004	20	dry	NA
461	Route 32 bridge	4/27/2010	110	wet	**928* (86%)**
461	Route 32 bridge	5/5/2010	130	dry	
461	Route 32 bridge	5/11/2010	110	dry	
461	Route 32 bridge	5/18/2010	98	wet	
461	Route 32 bridge	5/25/2010	250	dry	
461	Route 32 bridge	6/1/2010	230	wet	
461	Route 32 bridge	6/8/2010	430	dry	
461	Route 32 bridge	6/15/2010	440	dry	
461	Route 32 bridge	6/22/2010	380	wet	
461	Route 32 bridge	6/29/2010	810	dry	
461	Route 32 bridge	7/6/2010	1500	dry	
461	Route 32 bridge	7/13/2010	1100	wet	
461	Route 32 bridge	7/20/2010	2900	dry	
461	Route 32 bridge	7/27/2010	2000	dry	
461	Route 32 bridge	8/3/2010	2000	dry	
461	Route 32 bridge	8/10/2010	5800	dry	
461	Route 32 bridge	8/17/2010	**9800* (96%)**	dry	
461	Route 32 bridge	8/24/2010	960	dry	
461	Route 32 bridge	8/31/2010	5800	dry	
461	Route 32 bridge	9/7/2010	4600	dry	
461	Route 32 bridge	9/14/2010	1900	dry	
461	Route 32 bridge	9/21/2010	1600	dry	
461	Route 32 bridge	9/28/2010	4100	wet	

Shaded cells indicate an exceedance of water quality criteria

†Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather geometric mean values for Station 461 on Middle River (Segment 1)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
461	Route 32 bridge	1999-2004, 2010	7	31	323	391	309

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Hartford Bradley International Airport, CT.

Table 9: Middle River (Segment 2) Bacteria Data

Waterbody ID: CT3102-00_02

Characteristics: Freshwater, Class A, Potential Drinking Water Source, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **13%**

Single Sample: **68%**

Data: 1999-2001 and 2010 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Middle River (Segment 2) with annual geometric means calculated

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
594	At upstream entrance of American Sleeve Bearing	10/3/2000	41	dry	NA
594	At upstream entrance of American Sleeve Bearing	3/19/2001	10	dry	18
594	At upstream entrance of American Sleeve Bearing	5/1/2001	20	dry	
594	At upstream entrance of American Sleeve Bearing	7/23/2001	31	dry	
545	Upstream of West Street intersection	5/16/2000	110	dry	110
545	Upstream of West Street intersection	8/28/2000	110	dry	
545	Upstream of West Street intersection	3/19/2001	10	dry	13
545	Upstream of West Street intersection	5/1/2001	10	dry	
545	Upstream of West Street intersection	7/23/2001	20	dry	

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Middle River (Segment 2) with annual geometric means calculated (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
545	Upstream of West Street intersection	4/27/2010	160	wet	**145* (13%)**
545	Upstream of West Street intersection	5/5/2010	230	dry	
545	Upstream of West Street intersection	5/11/2010	31	dry	
545	Upstream of West Street intersection	5/18/2010	52	wet	
545	Upstream of West Street intersection	5/25/2010	41	dry	
545	Upstream of West Street intersection	6/1/2010	160	wet	
545	Upstream of West Street intersection	6/8/2010	380	dry	
545	Upstream of West Street intersection	6/15/2010	380	dry	
545	Upstream of West Street intersection	6/22/2010	**1300* (68%)**	wet	
545	Upstream of West Street intersection	6/29/2010	41	dry	
545	Upstream of West Street intersection	7/6/2010	140	dry	
545	Upstream of West Street intersection	7/13/2010	95	wet	
545	Upstream of West Street intersection	7/20/2010	140	dry	
545	Upstream of West Street intersection	7/27/2010	220	dry	
545	Upstream of West Street intersection	8/3/2010	41	dry	
545	Upstream of West Street intersection	8/10/2010	41	dry	
545	Upstream of West Street intersection	8/17/2010	200	dry	
545	Upstream of West Street intersection	8/24/2010	440	dry	
545	Upstream of West Street intersection	8/31/2010	200	dry	
545	Upstream of West Street intersection	9/7/2010	340	dry	
545	Upstream of West Street intersection	9/14/2010	290	dry	
545	Upstream of West Street intersection	9/21/2010	74	dry	
545	Upstream of West Street intersection	9/28/2010	200	wet	
489	Downstream of Route 190	10/13/1999	31	dry	40
489	Downstream of Route 190	11/29/1999	52	dry	
489	Downstream of Route 190	2/9/2000	10	dry	17
489	Downstream of Route 190	5/16/2000	10	dry	
489	Downstream of Route 190	8/28/2000	52	dry	
489	Downstream of Route 190	3/19/2001	10	dry	13
489	Downstream of Route 190	5/1/2001	10	dry	
489	Downstream of Route 190	7/23/2001	20	dry	

Shaded cells indicate an exceedance of water quality criteria

†Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather geometric mean values for all monitoring stations on Middle River (Segment 2)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
594	At upstream entrance of American Sleeve Bearing	2000-2001	0	4	22	NA	22
545	Upstream of West Street intersection	2000-2001, 2010	6	22	110	179	96
489	Downstream of Route 190	1999-2001	0	8	19	NA	19

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Hartford Bradley International Airport, CT.

REFERENCES

Costa, Joe (2011). Calculating Geometric Means. Buzzards Bay National Estuary Program. **Online**: http://www.buzzardsbay.org/geomean.htm

CTDEEP (2010). State of Connecticut Integrated Water Quality Report. **Online:** http://www.ct.gov/dep/lib/dep/water/water_quality_management/305b/ctiwqr10final.pdf

CTDEEP (2011). State of Connecticut Water Quality Standards. **Online:** http://www.ct.gov/dep/lib/dep/water/water_quality_standards/wqs_final_adopted_2_25_11.pdf

CWP (2003). Impacts of Impervious Cover on Aquatic Systems. Center for Watershed Protection. **Online**: http://clear.uconn.edu/projects/tmdl/library/papers/Schueler_2003.pdf

Federal Register 67 (March 15, 2002) 11663-11670. Urban Area Criteria for Census 2000

Mallin, M.A., K.E. Williams, E.C. Escham, R.P. Lowe (2000). Effect of Human Development on Bacteriological Water Quality in Coastal Wetlands. Ecological Applications 10: 1047-1056.

USEPA (2001). Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water. **Online**: http://www.epa.gov/safewater/sourcewater/pubs/fs_swpp_petwaste.pdf.

USEPA (2011a). Managing Nonpoint Source Pollution from Agriculture. **Online:** http://water.epa.gov/polwaste/nps/outreach/point6.cfm

USEPA (2011b). Riparian Zone and River Restoration. **Online:** http://epa.gov/ada/eco/riparian.html

USEPA (2011c). Land Use Impacts on Water. Online: http://epa.gov/greenkit/toolwq.htm