VERMONT
ENVIRONMENTAL CONSERVATION

Middlebury River

Watershed Description

This bacteria TMDL summary applies to a 2 mile reach of the Middlebury River (VT03-12), a 18.6-mile long river located southeast of Lake Champlain (Figure 1). A tributary of Otter Creek, the Middlebury River is formed by the confluence of three main branches originating in the Green Mountain National Forest (ACRWC, 2009). The Middlebury flows westerly out of the Green Mountains and into the Champlain Valley where large areas of land are in agricultural use. The Middlebury River watershed covers 62.8 square miles, primarily in the towns of Ripton, Middlebury and Salisbury. Overall, land use in the watershed is 85% forested, 13% agricultural, 1% developed, and 1% wetland, as shown in Figure 2 (based on 2006 Land Cover Analysis by NOAA-CSC). The watershed is home to an estimated 2,326 residents (MRWP, 2001).

In the Green Mountains, the Middlebury River is relatively steep, dropping from 2,400 feet at its headwaters to 500 feet at the outlet of Middlebury Gorge 12.9 miles downstream (at rivermile 5.7) (ACRWC, 2009). Middlebury Gorge is situated near the most upstream sampling station (indicated by a white dot) in Figure 1. From Middlebury Gorge, the terrain flattens out and the river flows past East Middlebury village. Figure 3 provides a more detailed aerial view of the Middlebury River in the downstream reaches with sampling stations indicated.

In the valley reach, the Middlebury River receives Halnon Brook flowing northerly through Salisbury. Sampling station MIR2 (Figure 3) is located near the mouth of Halnon Brook. The sampling stations utilize rivermiles, distances upstream of the mouth of the river, in their title. For example "MIR2" is situated 2 miles from the mouth of the Middlebury River. Figure 3 also provides two boxes outlining highlighted areas and Figures 4 and 5 provide close-up views of those two highlighted areas.

Waterbody Facts (VT03-12)

- **Towns:** Ripton, Middlebury, Salisbury, and portions of others.
- **Impaired Segment Location:** from mouth upstream 2 miles
- **Impaired Segment Length:** 2 miles
- **Classification:** Class B
- **Watershed Area:** 62.8 square miles
- **Planning Basin:** 3-Otter Creek

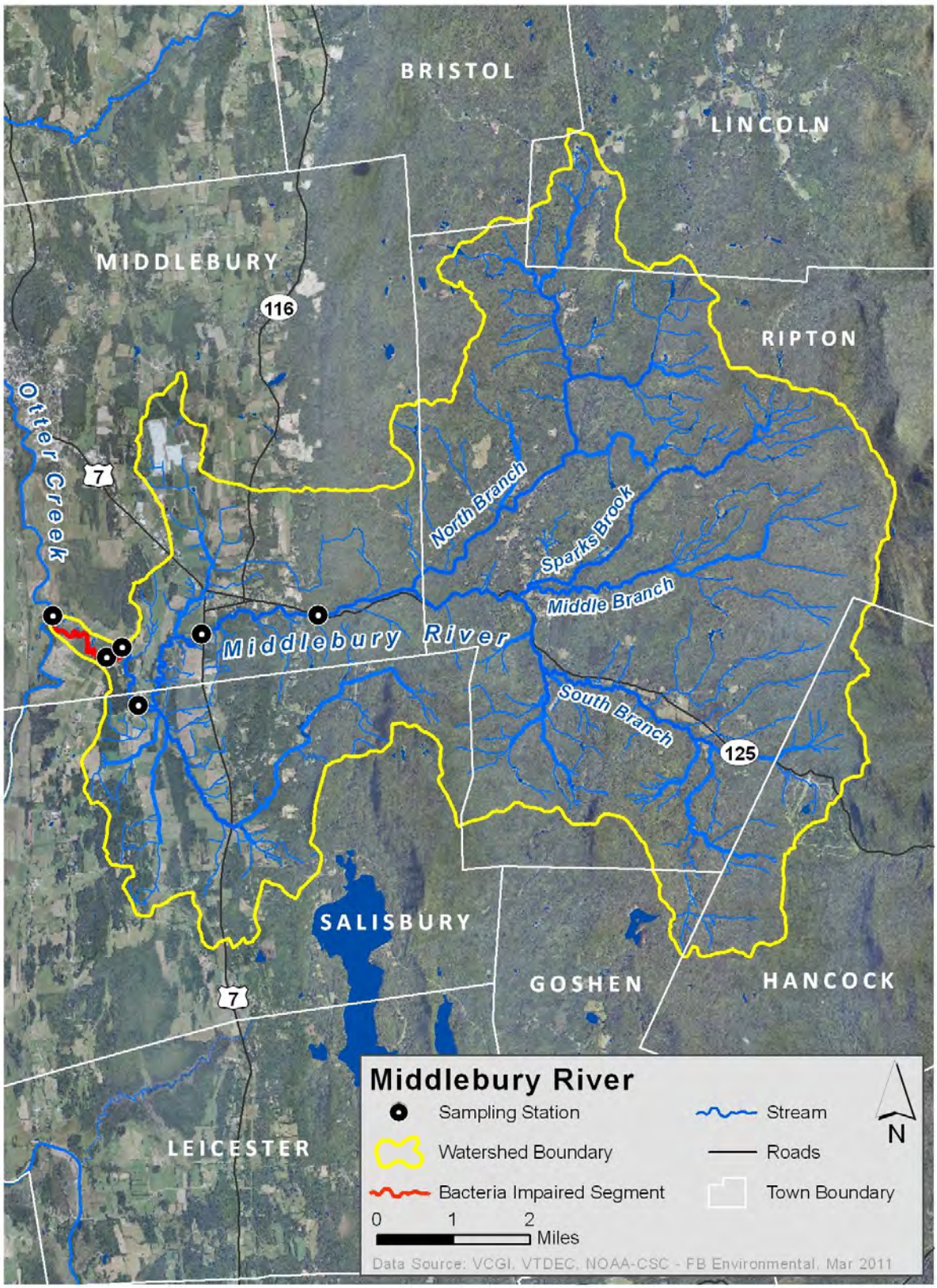

Figure 1: ***Map of the Middlebury River watershed with impaired segment and sampling stations indicated.***

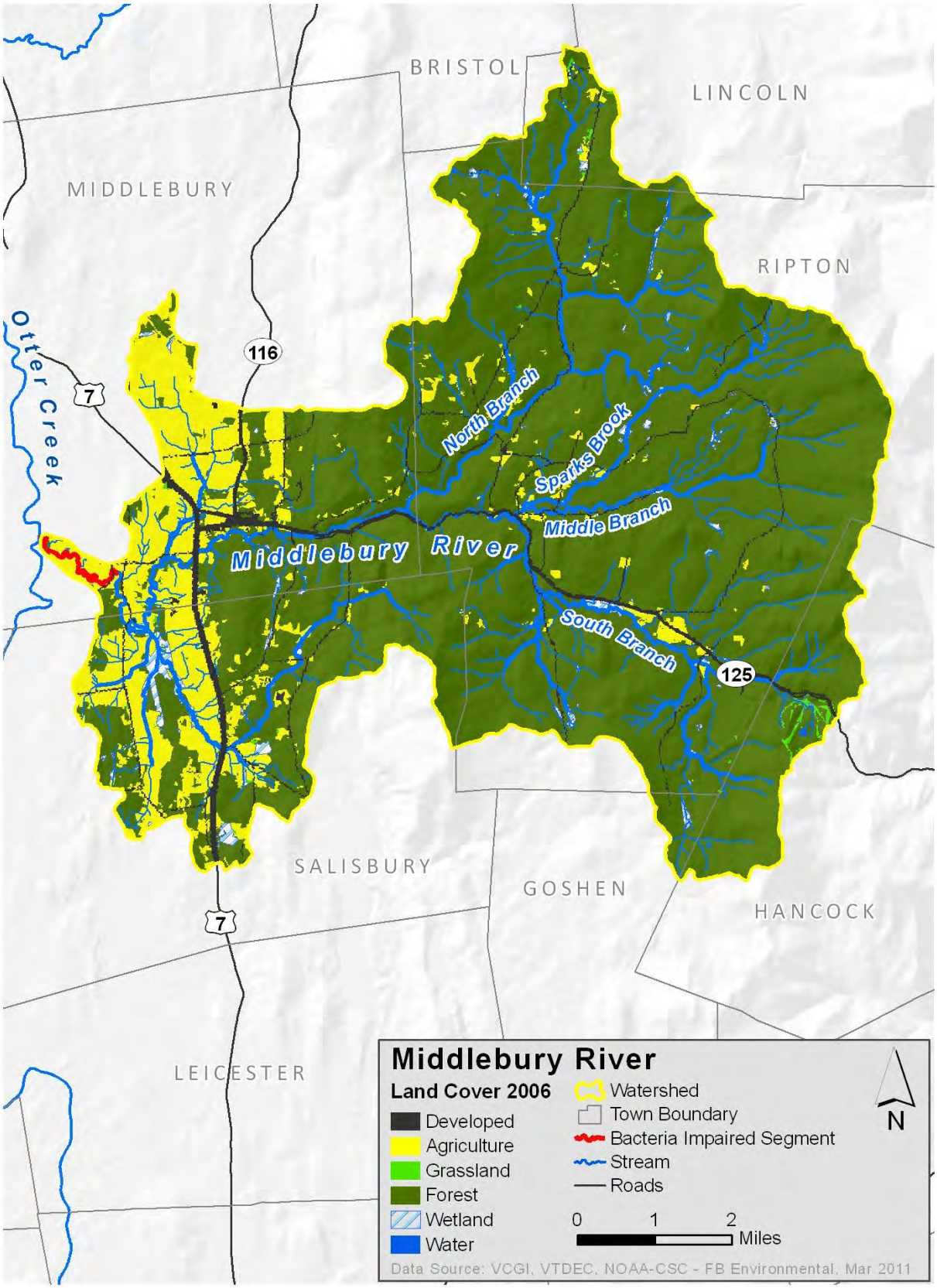

Figure 2: ***Map of the Middlebury River watershed with impaired segment and land cover indicated.***

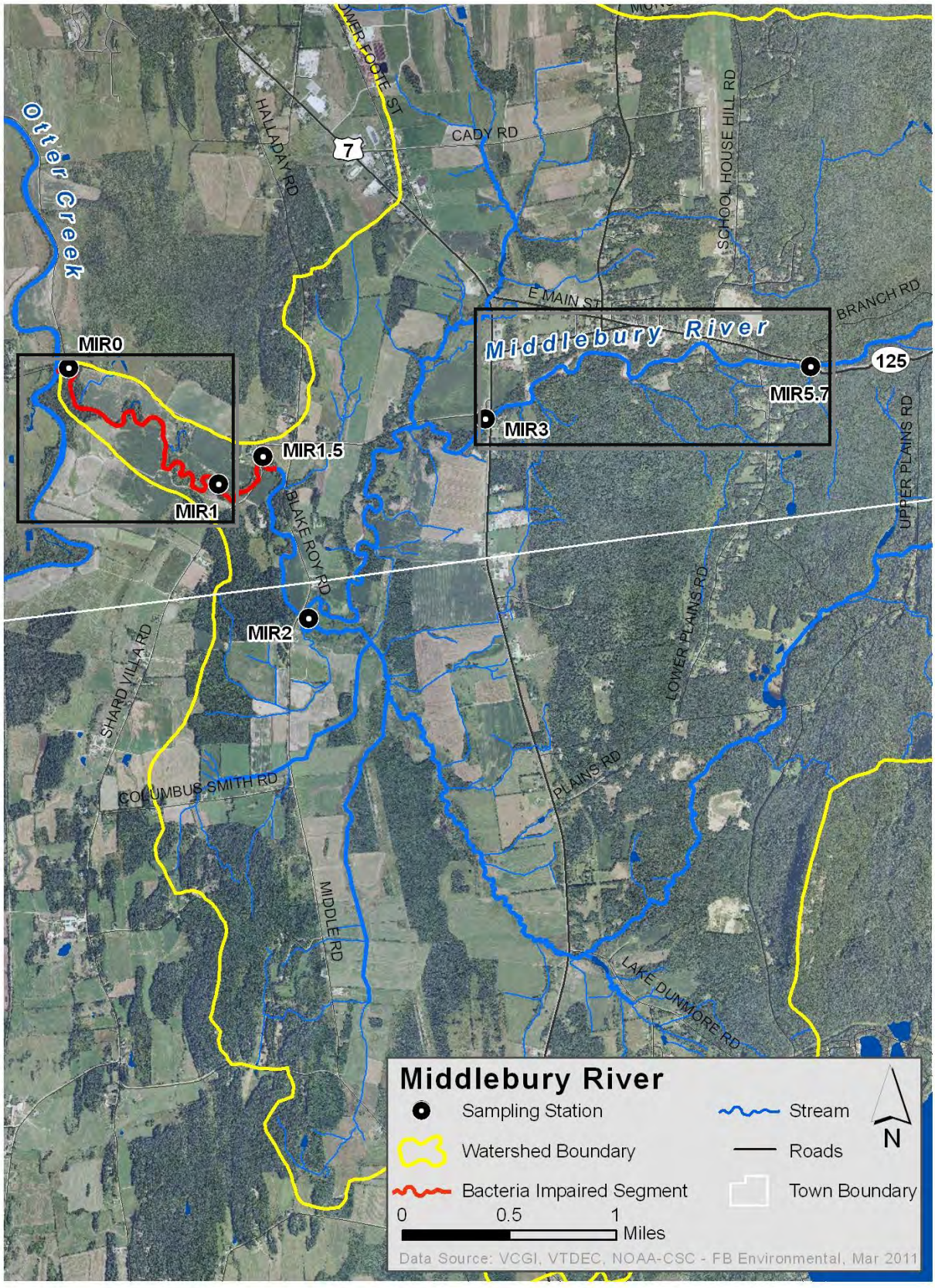

Figure 3: ***Map of downstream reaches of the Middlebury River with impaired segment and sampling locations indicated. Inset areas correspond to Figures 4 and 5 below.***

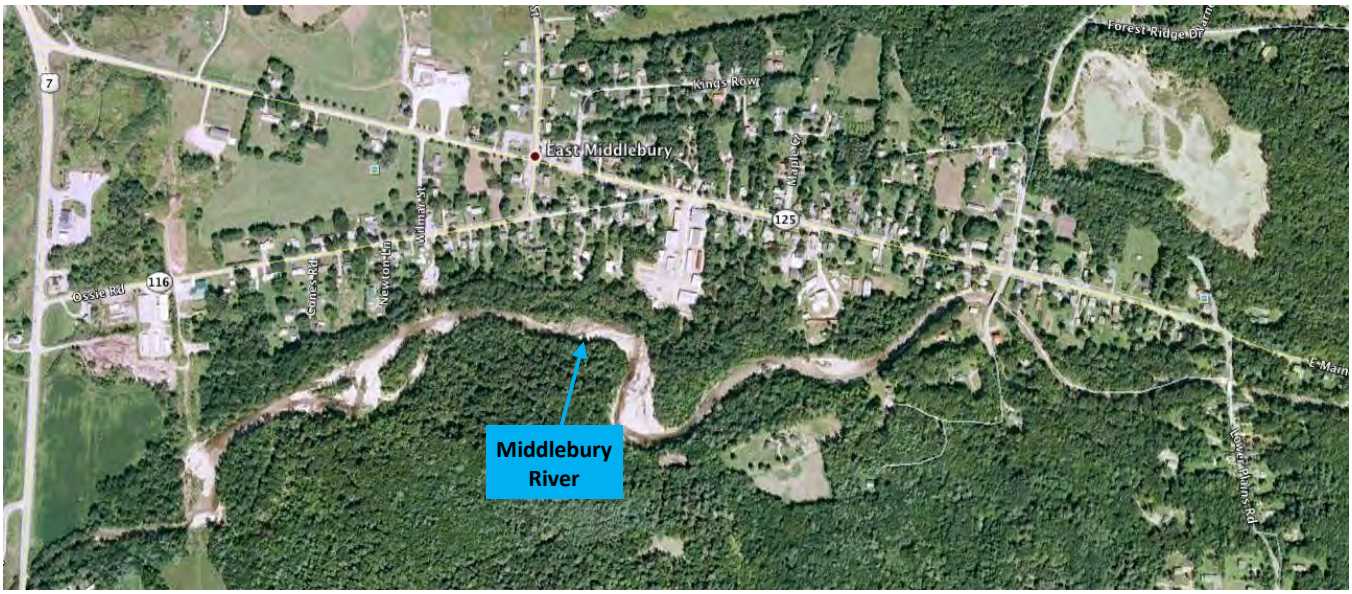

Figure 4: ***Aerial view of the Middlebury River from the Middlebury Gorge to Route 7 (RM 5.7 to 3.0) in East Middlebury.***

Figure 4 shows the reach from approximately rivermile 5.7 to rivermile 3.0 along the village of East Middlebury. The Middlebury River Corridor Planning project investigated the geomorphology of the river and found that the main erosion hazards were due to human built encroachments in the river corridor associated with development in natural deposition areas. These erosion hazard areas are primarily located in the village of East Middlebury (shown in Figure 4), the village of Ripton and along Route 125 between them (MALT, 2009). Erosional and depositional areas along the riverbank are visible in Figure 4. High eroding embankments subject to collapse are reportedly located upstream of Middlebury Gorge (ACRWC, 2009).

From East Middlebury village, the Middlebury River flows through the Champlain Valley flatlands and into Otter Creek. This reach is in large-scale agricultural land use and typically has narrow riparian buffers. Figure 5 provides an aerial view of a reach of the Middlebury River including the confluence with Otter Creek. The Middlebury meanders through croplands and pasture with narrow riparian buffers. The Middlebury River joins Otter Creek (in the upper left corner of Figure 5), another bacteria impaired waterbody, and Otter Creek flows on northward eventually flowing into Lake Champlain.

Why is a TMDL needed?

The Middlebury River is a Class B, cold water fishery with designated uses including swimming, fishing and boating (VTDEC, 2008a). The Addison County River Water Collaborative has been collecting samples from the Middlebury River for analysis of *E.coli* since 1993 (ACRWC, 2009). Each summer, samples are collected from the sampling stations shown in Figure 3. Bacteria data from downstream sampling locations MIR0, MIR1, and MIR1.5 have consistently exceeded Vermont's water quality criteria for *E.coli* bacteria. Table 1 below provides bacteria data collected in these downstream sampling locations from 2000 to 2007. Table 1 provides the water quality criteria for *E.coli* bacteria along with the

individual sampling event bacteria results and geometric mean concentration statistics for each sampling season. The water quality criteria are exceeded in nearly every sampling event and seasonal mean.

Due to the elevated bacteria measurements presented in Table 1, the Middlebury River from the mouth upstream for 2 miles did not meet Vermont's water quality standards, was identified as impaired and was placed on the 303(d) list (VTDEC, 2008b). The 303(d) listing states that use of the Middlebury River for contact recreation (i.e., swimming) is impaired. 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 water quality standards.

Figure 5: ***Aerial view of the Middlebury River and confluence with Otter Creek.***

Potential Bacteria Sources

Previous investigations have concluded that failing on-site septic systems and agricultural runoff washing manure and other wastes into the river are the primary sources of bacteria to the Middlebury River (MRWP 2001). Residents throughout the watershed use on-site septic systems. Relatively older home and businesses situated near the river are suspected of having failing septic systems that may result in discharge of fecal bacteria to the river. The watershed also has ten farming operations, including one large farming operation (LFO) in the area. Livestock at these operations total 2,267 animal units, primarily situated in the valley near the river (MRWP, 2001).

On-site septic systems in the village of East Middlebury and in the Painter Hills Development to the east of the village have been identified as potential sources of fecal bacteria, but failing septic systems have not been documented (MRWP, 2001). The combination of relatively old septic systems and a relatively high water table with clay soils increases the probability of septic systems failing.

Agricultural activities including livestock maintenance and manure applications to croplands adjacent to the river likely result in fecal bacteria contributions. Several on-site improvement projects were conducted in the 1990s to reduce pollutant runoff from farms to the river. The Natural Resources Conservation Service, the Consolidated Farm Services Agency, USEPA, and other agencies provided technical assistance and partial funding to support these projects. Improvement projects included fencing cattle out of the stream, constructing manure storage facilities, and improving barnyard maintenance. Positive results from these projects were observed in the form of reduced bacteria concentration measurements in the years immediately following implementation of these improvements on two farms (MRWP, 2001). It appears likely, however, that agricultural runoff of fecal bacteria continues to be a problem in the watershed due to the presence of narrow riparian buffers and adjacent large-scale farming activities.

Recommended Next Steps

The Addison County River Watch Collaborative (ACRWC) is currently developing and implementing an education and outreach program for several rivers including the Middlebury (VTDEC, 2010). In addition, the Middlebury River Corridor Planning Group is conducting a series of long-term restoration projects focused on riparian corridor assessment and restoration. Planned restoration activities include buffer planting, removal of agricultural land from production within the riparian corridor, and land conservation (VTDEC, 2010).

Additional bacteria data collection may be beneficial to support identification of sources of potentially harmful bacteria in the Middlebury River watershed. For example, sampling upstream and downstream of potential on-site septic and agricultural sources (a practice known as “bracket sampling”) may be beneficial for identifying and quantifying sources. Sampling activities focused on capturing bacteria data under different weather conditions (e.g., wet and dry) may also be beneficial in support of source identification. Field reconnaissance surveys focused on stream buffers, stormwater runoff, other source identification may also be beneficial.

Previous investigations (MRWP, 2001; LNRP, 2008; ACRWC, 2009; VTDEC, 2010) have recommended the following actions to support water quality goals in the Middlebury River:

- On-Site Septic System Management – Conduct a sanitary survey of domestic wastewater, work with Vermont environmental enforcement officers and local health officials to identify and replace failing systems.
- Agricultural - Work with the USDA, NRCS and other agencies to assess the extent of agricultural waste application and potentially reduce applications through improved nutrient management planning. Evaluate riparian buffer and identify opportunities to remove areas near the river from production.
- Land Use Protection - Preserve undeveloped portions of the watershed and institute controls on development near the Middlebury River.
- Riparian Corridor – Continue riparian corridor projects and seek to enhance buffer through a combination of buffer plantings, land conservation, and improved agricultural practices. Protect and restore flood and sediment attenuation areas, including the alluvial fan area in East Middlebury, development at the confluence of the Middle and South branches in Ripton, and roads, particularly Route 125, adjacent to the river. Focusing restoration resources in these areas as a priority for minimizing erosion hazards in the long term (LNRP, 2008).

Several of the steps outlined above are ongoing and should be continued and enhanced to focus on the goals of bacteria TMDL implementation. If implemented these actions will provide a strong basis toward the goal of mitigating bacteria sources and meeting water quality standards in the Middlebury River.

Bacteria Data

Vermont's current criteria for bacteria are more conservative than those recommended by EPA. For Class B waters, VTDEC currently utilizes an E. coli single sample criterion of 77 organisms/100ml. Although, Vermont is in the process of revising their bacteria WQS to better align with the National Recommended Water Quality Criteria (NRWQC) of a geometric mean of 126 organisms/100ml, and a single sample of 235 organisms/100ml. Therefore, in Table 1 below, bacteria data were compared to both the current VTWQS and the NRWQC for informational purposes.

Middlebury River, from mouth upstream 2 miles

***WB ID*:** VT03-12

Characteristics: Class B

Impairment: *E. coli* (organisms/100mL)

Current Water Quality Criteria for E. coli:

Single sample: 77 organisms/100 mL

NRWQC for E. coli::

Single sample: 235 organisms/100 mL

Geometric mean: 126 organisms/100 mL

Percent Reduction to meet TMDL (Current):

Single Sample: **97%**

Percent Reduction to meet NRWQC:

Single sample: **90%**

Geometric mean: **68%**

Data: 2000-2007, Addison County River Water Collaborative

Table 1: *E.coli* (organisms/100 mL) Data for Middlebury River (2000-2007) and Geometric Mean (organisms/100mL) for each Station based on Calendar Year.

Station Name	Station Location	Date	Result	Geometric Mean**
MIR1.5	Shard Villa Rd. Bridge	8/22/2007	152	
MIR1.5	Shard Villa Rd. Bridge	8/8/2007	461	
MIR1.5	Shard Villa Rd. Bridge	7/25/2007	84	334
MIR1.5	Shard Villa Rd. Bridge	7/11/2007	2420	
MIR1.5	Shard Villa Rd. Bridge	6/27/2007	291	
MIR1.5	Shard Villa Rd. Bridge	8/23/2006	190	
MIR1.5	Shard Villa Rd. Bridge	8/2/2006	228	
MIR1.5	Shard Villa Rd. Bridge	7/19/2006	345	193
MIR1.5	Shard Villa Rd. Bridge	7/5/2006	120	
MIR1.5	Shard Villa Rd. Bridge	6/21/2006	150	
MIR1.5	Shard Villa Rd. Bridge	8/17/2005	687	
MIR1.5	Shard Villa Rd. Bridge	8/3/2005	291	
MIR1.5	Shard Villa Rd. Bridge	7/20/2005	179	311
MIR1.5	Shard Villa Rd. Bridge	7/6/2005	411	
MIR1.5	Shard Villa Rd. Bridge	6/22/2005	199	
MIR1.5	Shard Villa Rd. Bridge	8/18/2004	96	
MIR1.5	Shard Villa Rd. Bridge	8/4/2004	160	
MIR1.5	Shard Villa Rd. Bridge	7/21/2004	161	171
MIR1.5	Shard Villa Rd. Bridge	7/7/2004	228	
MIR1.5	Shard Villa Rd. Bridge	6/23/2004	261	

*Shaded cells indicate single sample and geometric mean used to calculate percent reduction.

**Only geometric mean values calculated with 5 data points or more are used to determine percent reduction.

Table 1: *E.coli* (organisms/100 mL) Data for Middlebury River (2000-2007) and Geometric Mean (organisms/100mL) for each Station based on Calendar Year (continued).

Station Name	Station Location	Date	Result	Geometric Mean**
MIR1.5	Shard Villa Rd. Bridge	8/6/2003	2420	595
MIR1.5	Shard Villa Rd. Bridge	7/23/2003	517	
MIR1.5	Shard Villa Rd. Bridge	7/9/2003	345	
MIR1.5	Shard Villa Rd. Bridge	6/25/2003	291	
MIR1.5	Shard Villa Rd. Bridge	8/7/2002	299	252
MIR1.5	Shard Villa Rd. Bridge	7/27/2002	326	
MIR1.5	Shard Villa Rd. Bridge	7/10/2002	308	
MIR1.5	Shard Villa Rd. Bridge	6/29/2002	135	
MIR1.5	Shard Villa Rd. Bridge	8/11/2001	461	301
MIR1.5	Shard Villa Rd. Bridge	7/25/2001	461	
MIR1.5	Shard Villa Rd. Bridge	7/14/2001	140	
MIR1.5	Shard Villa Rd. Bridge	6/27/2001	276	
MIR1.5	Shard Villa Rd. Bridge	8/12/2000	1730	267
MIR1.5	Shard Villa Rd. Bridge	7/26/2000	165	
MIR1.5	Shard Villa Rd. Bridge	7/15/2000	201	
MIR1.5	Shard Villa Rd. Bridge	6/28/2000	89	
MIR1	Goodrich Farm Pasture	8/18/2004	109	163
MIR1	Goodrich Farm Pasture	8/4/2004	120	
MIR1	Goodrich Farm Pasture	7/21/2004	152	
MIR1	Goodrich Farm Pasture	7/7/2004	261	
MIR1	Goodrich Farm Pasture	6/23/2004	219	
MIR1	Goodrich Farm Pasture	8/6/2003	2420	417
MIR1	Goodrich Farm Pasture	7/23/2003	210	
MIR1	Goodrich Farm Pasture	7/9/2003	299	
MIR1	Goodrich Farm Pasture	6/25/2003	199	
MIR1	Goodrich Farm Pasture	8/7/2002	345	259
MIR1	Goodrich Farm Pasture	7/27/2002	317	
MIR1	Goodrich Farm Pasture	7/10/2002	238	
MIR1	Goodrich Farm Pasture	6/29/2002	172	
MIR1	Goodrich Farm Pasture	8/11/2001	326	305
MIR1	Goodrich Farm Pasture	7/25/2001	548	
MIR1	Goodrich Farm Pasture	7/14/2001	133	
MIR1	Goodrich Farm Pasture	6/27/2001	365	

*Shaded cells indicate single sample and geometric mean used to calculate percent reduction.

**Only geometric mean values calculated with 5 data points or more are used to determine percent reduction.

Table 1: *E.coli* (organisms/100 mL) Data for Middlebury River (2000-2007) and Geometric Mean (organisms/100mL) for each Station based on Calendar Year (continued).

Station Name	Station Location	Date	Result	Geometric Mean**
MIR1	Goodrich Farm Pasture	8/12/2000	2420	603
MIR1	Goodrich Farm Pasture	7/26/2000	137	
MIR1	Goodrich Farm Pasture	7/15/2000	1990	
MIR1	Goodrich Farm Pasture	6/28/2000	201	
MIR0	Mouth of Midd. River	8/22/2007	272	394
MIR0	Mouth of Midd. River	8/8/2007	411	
MIR0	Mouth of Midd. River	7/25/2007	96	
MIR0	Mouth of Midd. River	7/11/2007	2420	
MIR0	Mouth of Midd. River	6/27/2007	365	
MIR0	Mouth of Midd. River	8/23/2006	365	229
MIR0	Mouth of Midd. River	8/2/2006	579	
MIR0	Mouth of Midd. River	7/19/2006	138	
MIR0	Mouth of Midd. River	7/5/2006	56	
MIR0	Mouth of Midd. River	6/21/2006	387	
MIR0	Mouth of Midd. River	8/17/2005	649	377
MIR0	Mouth of Midd. River	8/3/2005	411	
MIR0	Mouth of Midd. River	7/20/2005	308	
MIR0	Mouth of Midd. River	7/6/2005	613	
MIR0	Mouth of Midd. River	6/22/2005	152	
MIR0	Mouth of Midd. River	8/18/2004	148	235
MIR0	Mouth of Midd. River	8/4/2004	115	
MIR0	Mouth of Midd. River	7/7/2004	411	
MIR0	Mouth of Midd. River	6/23/2004	435	
MIR0	Mouth of Midd. River	8/6/2003	2420	543
MIR0	Mouth of Midd. River	7/23/2003	649	
MIR0	Mouth of Midd. River	7/9/2003	276	
MIR0	Mouth of Midd. River	6/25/2003	201	
MIR0	Mouth of Midd. River	8/7/2002	214	222
MIR0	Mouth of Midd. River	7/27/2002	261	
MIR0	Mouth of Midd. River	7/10/2002	236	
MIR0	Mouth of Midd. River	6/29/2002	184	
MIR0	Mouth of Midd. River	8/11/2001	770	709
MIR0	Mouth of Midd. River	7/25/2001	866	
MIR0	Mouth of Midd. River	7/14/2001	411	
MIR0	Mouth of Midd. River	6/27/2001	921	
MIR0	Mouth of Midd. River	8/12/2000	2420	302
MIR0	Mouth of Midd. River	7/26/2000	118	
MIR0	Mouth of Midd. River	7/15/2000	201	
MIR0	Mouth of Midd. River	6/28/2000	145	

*Shaded cells indicate single sample and geometric mean used to calculate percent reduction.

**Only geometric mean values calculated with 5 data points or more are used to determine percent reduction.

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