



**Water Quality Report for the Silvermine River  
May - August 2015**

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Stream bank erosion at Site SM3.7 (Zone B) in the Silvermine River

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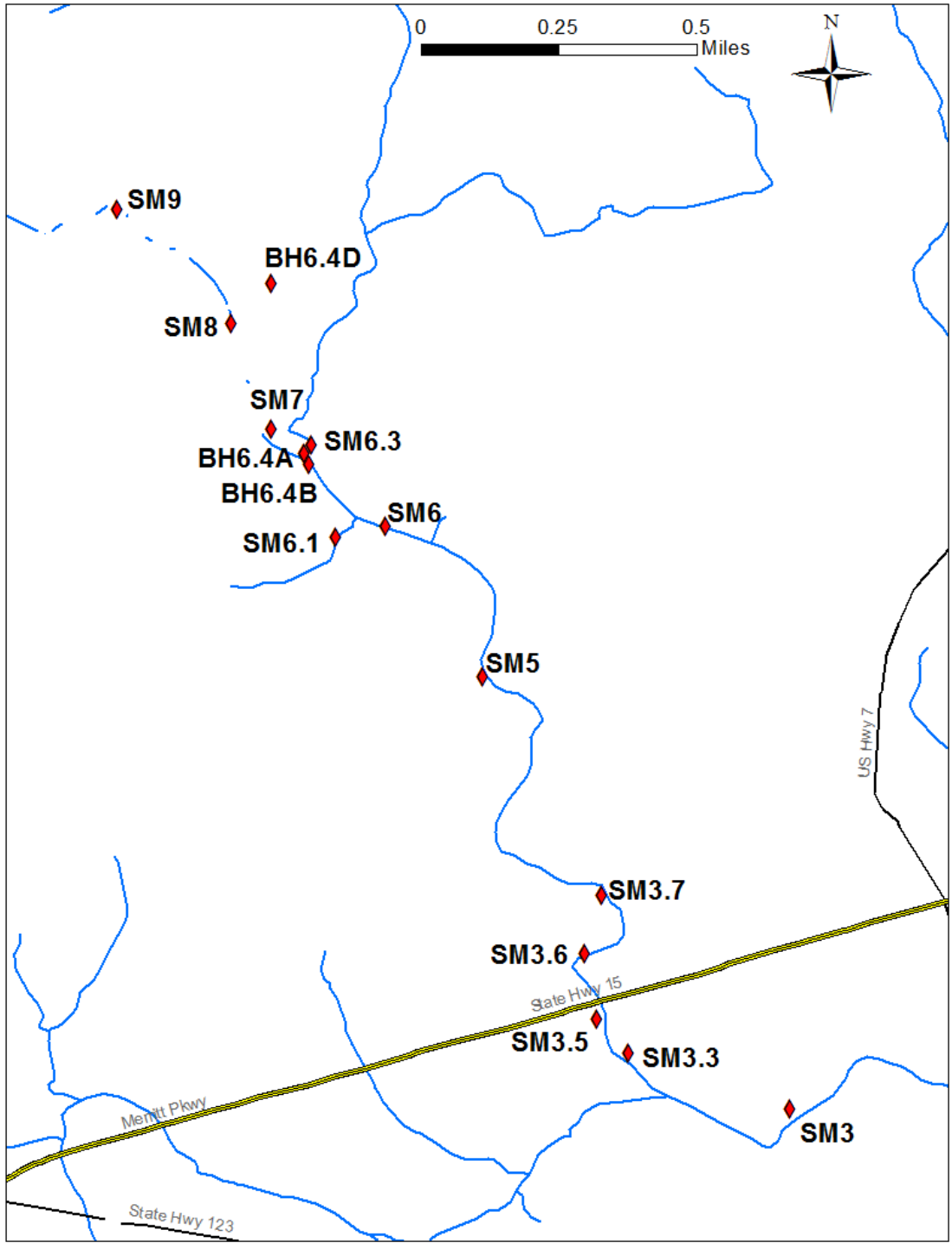
**Introduction:**

The mission of Harbor Watch is to provide the people of Connecticut with the data, knowledge, and field expertise necessary to safeguard our waterways, educate our communities about watershed issues, and train volunteers and student interns through hands-on research. Harbor Watch has conducted monitoring of rivers and streams in Norwalk, Connecticut for the past 29 years. Here, we present a study of indicator bacteria and physical parameters at multiple sites in the Silvermine River (Figure 1). The objective of this water quality monitoring was to assist in the location of sources of bacterial, *Escherichia coli* (*E. coli*), pollution from point and non-point sources.

**Research Zones of the Silvermine River**

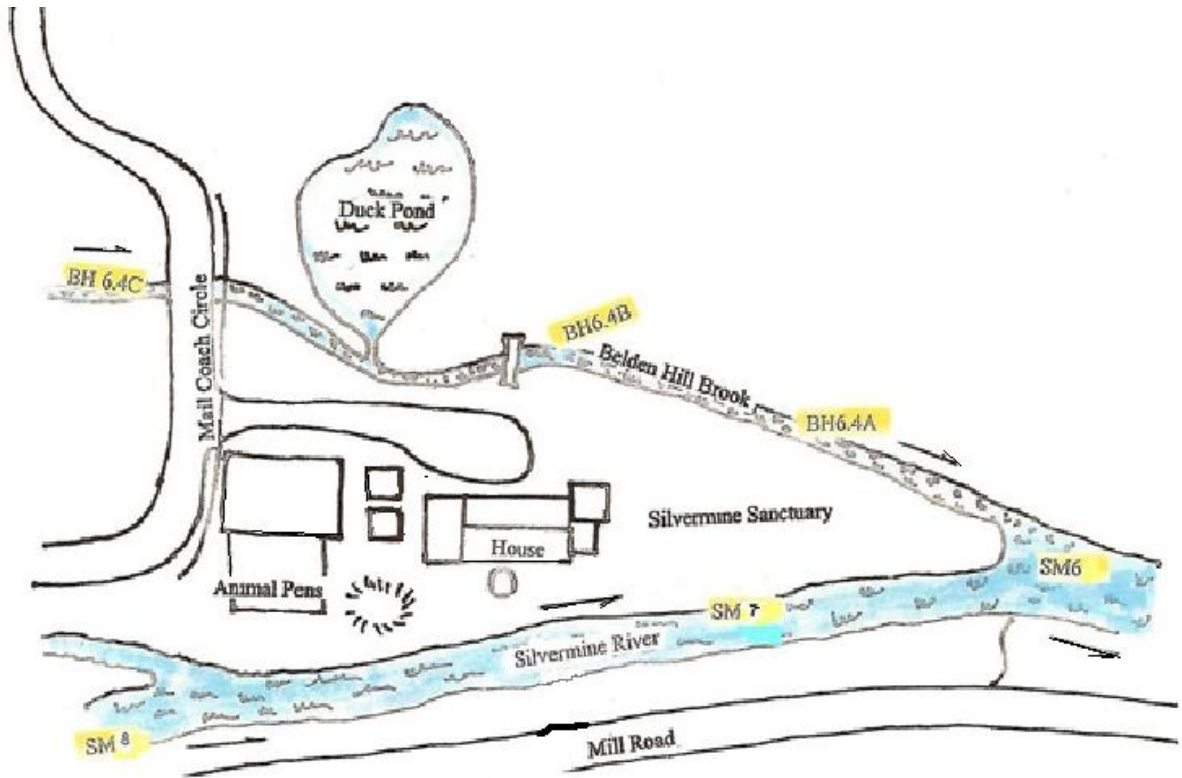
During the summer of 2015, testing in the Silvermine River Watershed focused on two areas referred to as Zone A and Zone B (Figure 1). Zone A monitoring sites (Table A1, Appendix A) encompassed the watershed area from Borglum Road to the former Silvermine Tavern at Perry Avenue. This section of the Silvermine River and Belden Hill Brook has been monitored by Harbor Watch for 8 years to determine the effect of runoff from a large hobby farm on the water quality in that area. The farm property, situated between two water bodies, has the potential for a large impact on water quality resulting from the presence of the farm animals. The Silvermine River and Belden Hill Brook form a confluence at the southern end of the farm property (Figure 2). In recent years, water quality has slowly improved as farm animals (including two llamas) were relocated and in 2011 the original farm owners moved away, along with the rest of the farm animals. The new property owners have shown little interest in boarding farm animals on the property. This change of ownership has proved to be very beneficial to water quality of Belden Hill Brook. Additionally the closing of the Silvermine Tavern Restaurant has also resulted in improvement of the water quality in the vicinity of SM6.

Zone B monitoring sites (Table A2, Appendix A) are located in an area of the watershed starting at the Silvermine elementary school property, which borders the river and flows south to James Street (Figure 2). Zone B was first explored in detail by the 2008 Norwalk Mayor's Water Quality Committee interns because of elevated *E. coli* bacteria counts found at site SM3 (Figure 2). In addition, new sites were established in the slower moving ponds that characterize the Silvermine River in that section south of the Merritt Parkway Bridge downstream (south) to James Street (Figure 2).



**Figure 1.** Map of the Silvermine River showing six testing sites (SM9, SM8, SM7, SM6.3, SM6.1, and SM6) from Borglum Road South to the Perry Avenue Bridge, and three sites (BH6.4D, BH6.4B, and BH6.4A) on Belden Hill Brook) in Zone A, and showing six sites (SM5, SM3.7, SM3.6, SM3.5, SM3.3, and SM3) from the Silvermine Elementary School to James Street in Zone B.





**Figure 2.** Map of three monitoring sites on the Silvermine River and two sites on Belden Hill Brook around the margin of the Silvermine Sanctuary property. Monitoring site BH6.4D is located upstream of Site BH6.4C on Musket Ridge Road.

**Methods:**

Testing protocols in the Harbor Watch EPA approved Quality Assurance Project Plan (QAPP #10160, approved 9/16/2010) for the Norwalk River were used to monitor water quality in the Silvermine River. Conductivity (QAPP Appendix A3.8) and dissolved oxygen (QAPP Appendix A3.3) are measured *in situ* with YSI field meters, and general observations, time, water temperature, and air temperature were also recorded at each site, (QAPP Appendix A5.1). Water samples were also collected at each site (QAPP Appendix A1.1) and transported to the Harbor Watch laboratory at Earthplace, where they were analyzed using the membrane filtration method (Standard Methods, 21<sup>st</sup> edition, 9222D and 922G) for indicator bacteria (fecal coliform and *E. coli* bacteria) levels.

*E. coli* bacteria levels were evaluated using criteria published in the CT DEEP Surface Water Quality Standards, 10/10/13. The CT DEEP *E. coli* criterion for Class AA, A, and B water is established at three levels (Table 1). The water quality of the Silvermine River was evaluated against the “all other recreational uses” section: failure was indicated by a bacteria geometric mean exceeding 126 CFUs/100mL or greater than 10% of samples exceeding a single sample maximum (SSM) of 576 CFUs/100mL.

**Table 1.** CT DEEP criterion for *E. coli* bacteria levels as applied to recreational use effective 2/25/11, CFU denotes Colony Forming Unit

Designated Use Recreation	Class	Indicator	Criteria
Designated Swimming	AA, A, B	<i>Escherichia coli</i> ( <i>E. coli</i> )	Geometric Mean less than 126/100 CFU;*Single Sample Maximum 235/100
Non-designated Swimming	AA, A, B	<i>Escherichia coli</i> ( <i>E. coli</i> )	Geometric Mean less than 126/100 CFU; Single Sample Maximum 410/100
All Other Recreational Uses	AA, A, B	<i>Escherichia coli</i> ( <i>E. coli</i> )	Geometric Mean less than 126/100 CFU; Single Sample Maximum 576/100

### Results and Discussion, Zone A:

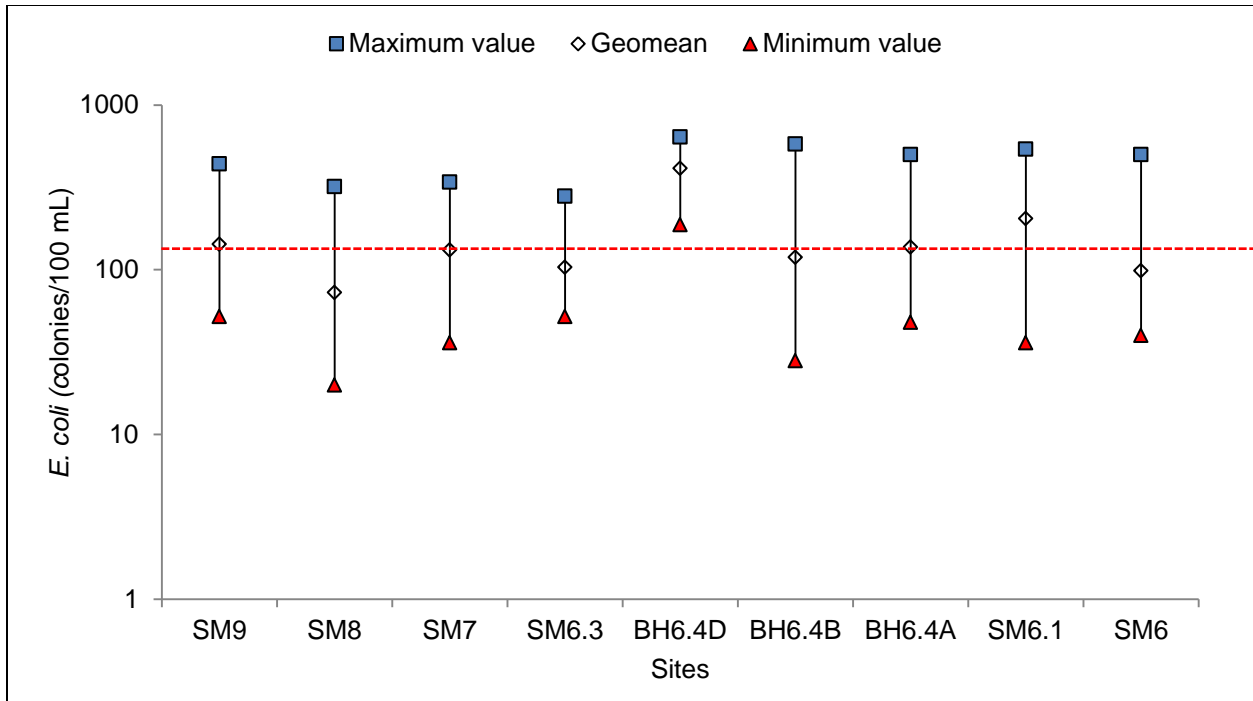
Four sites in Zone A exceeded the CT DEEP geometric mean criterion (SM9, SM7, BH6.4D, BH6.4A, and SM6.1), but only two sites (BH6.4B and BH6.4D) failed the CT DEEP Single Sample Maximum (SSM) criterion (Figure 3 and Table 2). Bacteria levels were high at all Zone A sites on June 2, 2015, which was most likely due to a significant rainfall event (2.95 inches) and the resulting runoff increasing bacteria in the water prior to the sample collection.

Dissolved oxygen concentrations were at healthy levels at all sites in Zone A and met the CT DEEP minimum criterion of 5 mg/L (Figure 4). There is riparian vegetation present along the Silvermine in this zone, which helps to shade the waterway from direct sunlight and the water moves over several rocky riffle areas; both help to maintain high dissolved oxygen concentrations in the water.

Observed conductivity values were fairly similar in Zone A (Figure 4). Mean conductivity values ranged from a maximum of 332  $\mu$ S at site SM6.1 to a minimum of 267  $\mu$ S at site BH6.4A. The widest conductivity range (107  $\mu$ S) was observed at site BH6.4B, and the narrowest conductivity range (37  $\mu$ S) was observed at site BH6.4A (Table 3). The mean conductivity for Zone A was 285  $\mu$ S (standard deviation = 20.2).

Rainfall during the monitoring period averaged 3.42 inches per month. June had the highest rainfall total at 5.67 inches of rain and August had the lowest rainfall total of 2.49 inches (Figure 6). Although low precipitation amounts reduced the flow and height of the Silvermine River in Zone A, dissolved oxygen concentrations remained high, and conductivity ranges at most site sites did not fluctuate much.

As monitoring commenced in May and proceeded into the summer, water temperatures increased from the beginning of the monitoring period until the end as expected (Figure 7). Site SM6.3 exhibited the highest water temperature (23.2 °C) at the end of the monitoring period, and the lowest temperatures at sites BH6.4A and BH6.4B (13.3 °C) at the beginning of the monitoring period. The mean water temperature for Zone A was 18.75 °C, (standard deviation = 0.52)

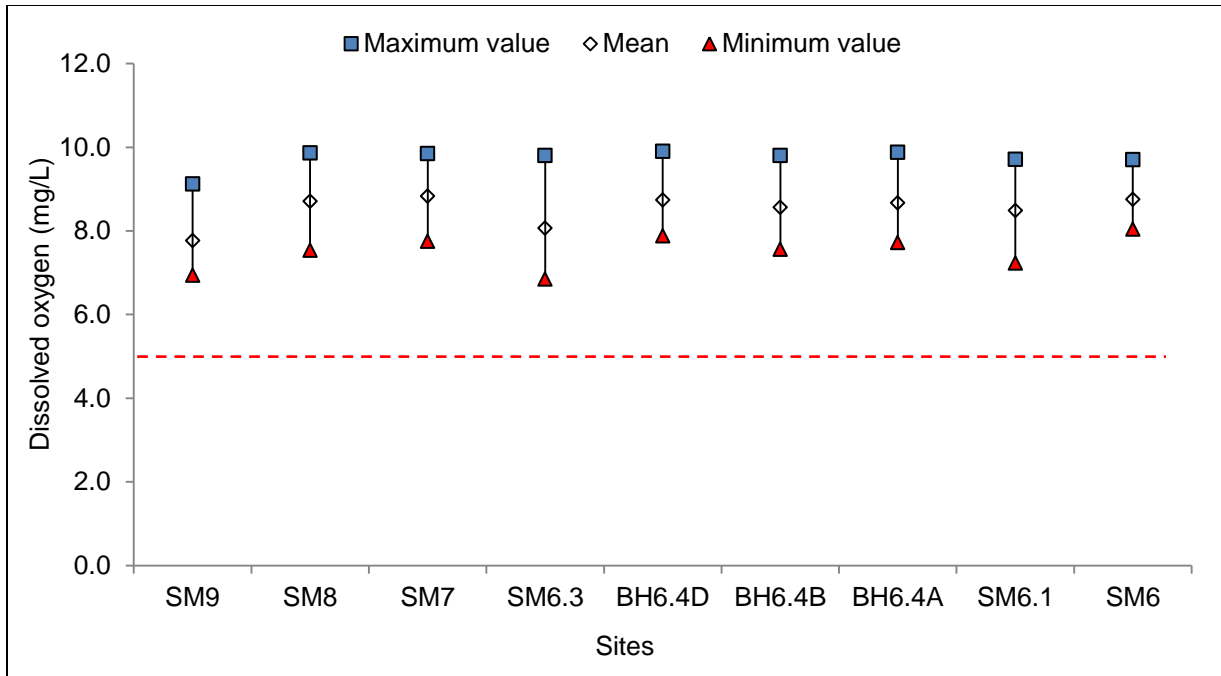


**Figure 3.** Maximum values, geometric means, and minimum values for *E. coli* bacteria concentrations at six monitoring sites in the Silvermine River and three sites in Belden Hill Brook in Zone A from May to August 2015, dotted red line denotes the CT DEEP geometric mean criterion (126 CFU/100 mL) for a Class B river.

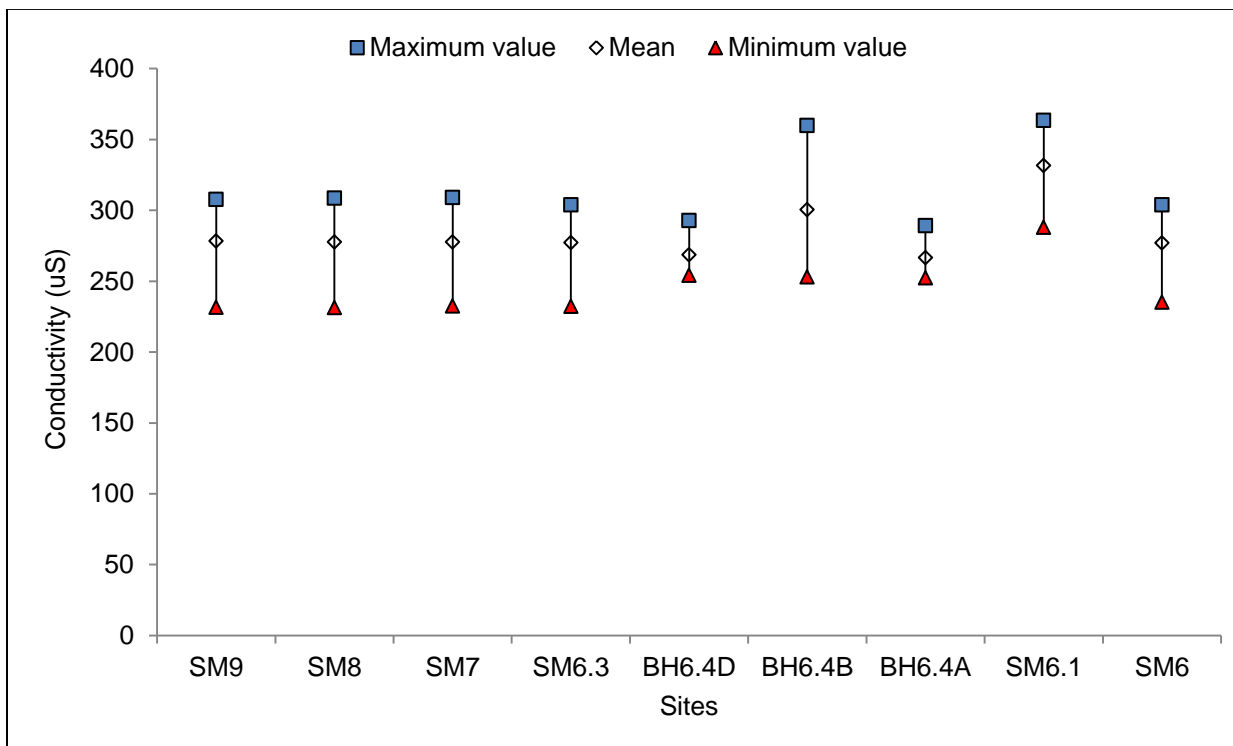
**Table 2.** *E. coli* bacteria concentrations, geometric means, % frequency exceeding 576 CFU/100mL and rainfall amounts at six monitoring sites in the Silvermine River, and three sites in Belden Hill Brook in Zone A from May to August 2015

	6/2/2015	7/6/2015	8/4/2015	Geomean	% Frequency exceeding 576 CFU/100mL
SM9	440	128	52	<b>143</b>	0%
SM8	320	60	20	<b>73</b>	0%
SM7	340	36	188	<b>132</b>	0%
SM6.3	280	76	52	<b>103</b>	0%
BH6.4D	580	640	188	<b>412</b>	67%
BH6.4B	580	28	104	<b>119</b>	33%
BH6.4A	500	48	108	<b>137</b>	0%
SM6.1	440	36	540	<b>205</b>	0%
SM6	500	48	40	<b>99</b>	0%
Rain (in)	2.95	0.68	0.51		
Days Prior	0 <sup>+3</sup>	5	5		





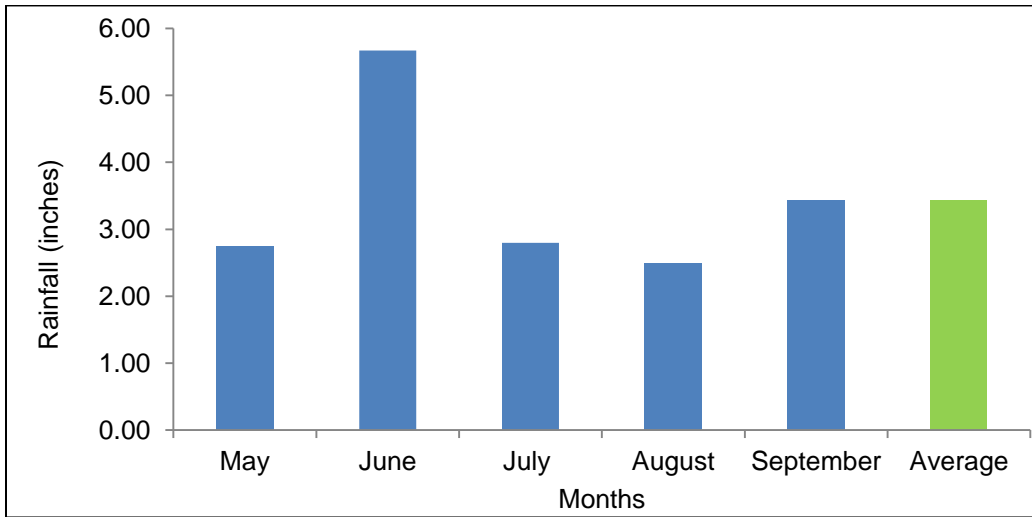
**Figure 4.** Maximum values, means, and minimum values for dissolved oxygen at six monitoring sites in Zone A of the Silvermine River and three sites in Belden Hill Brook from May to August 2015, the dotted red line denotes the CT DEEP minimum value (5 mg/L) for a Class B river.



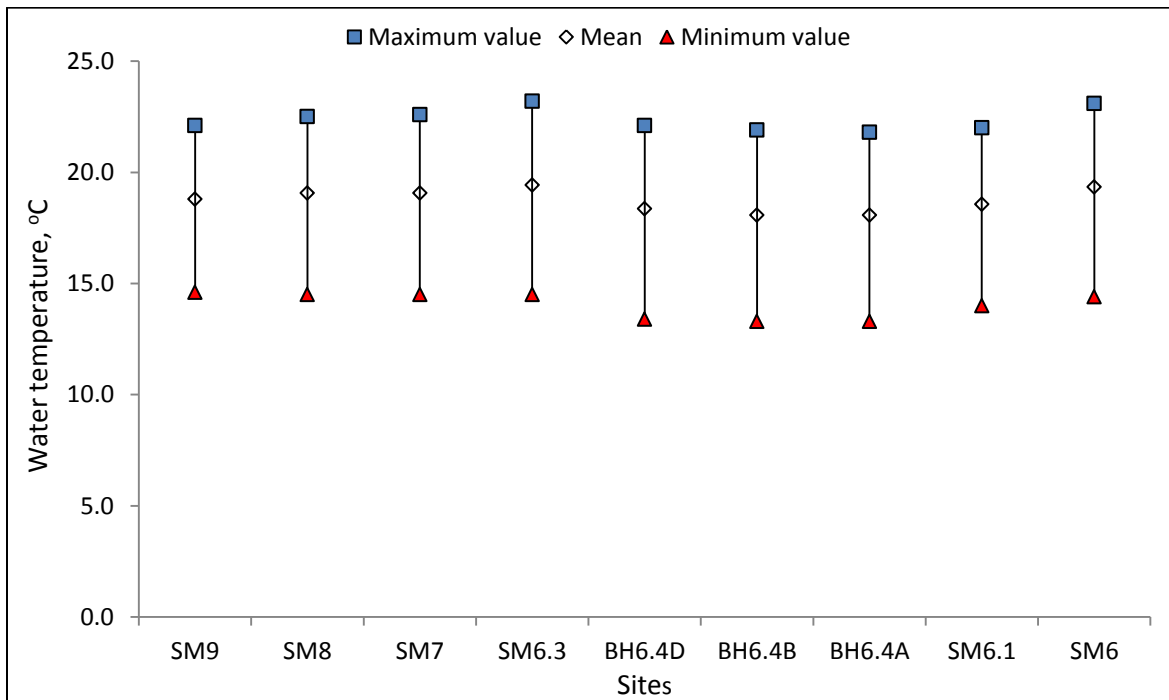
**Figure 5.** Maximum values, means, and minimum values for conductivity at six monitoring sites in Zone A of the Silvermine River and three sites in Belden Hill Brook from May to August 2015.

**Table 3.** Maximum value, means, minimum values and ranges for conductivity at six monitoring sites in Zone A of the Silvermine River and three sites on Belden Hill Brook from May through August 2015

	SM9	SM8	SM7	SM6.3	BH6.4D	BH6.4B	BH6.4A	SM6.1	SM6
Maximum value	308	309	309	304	293	360	289	364	304
Mean	278	278	278	277	269	301	267	332	277
Minimum value	232	231	232	232	254	253	252	288	235
Range	76	77	77	72	39	107	37	76	69



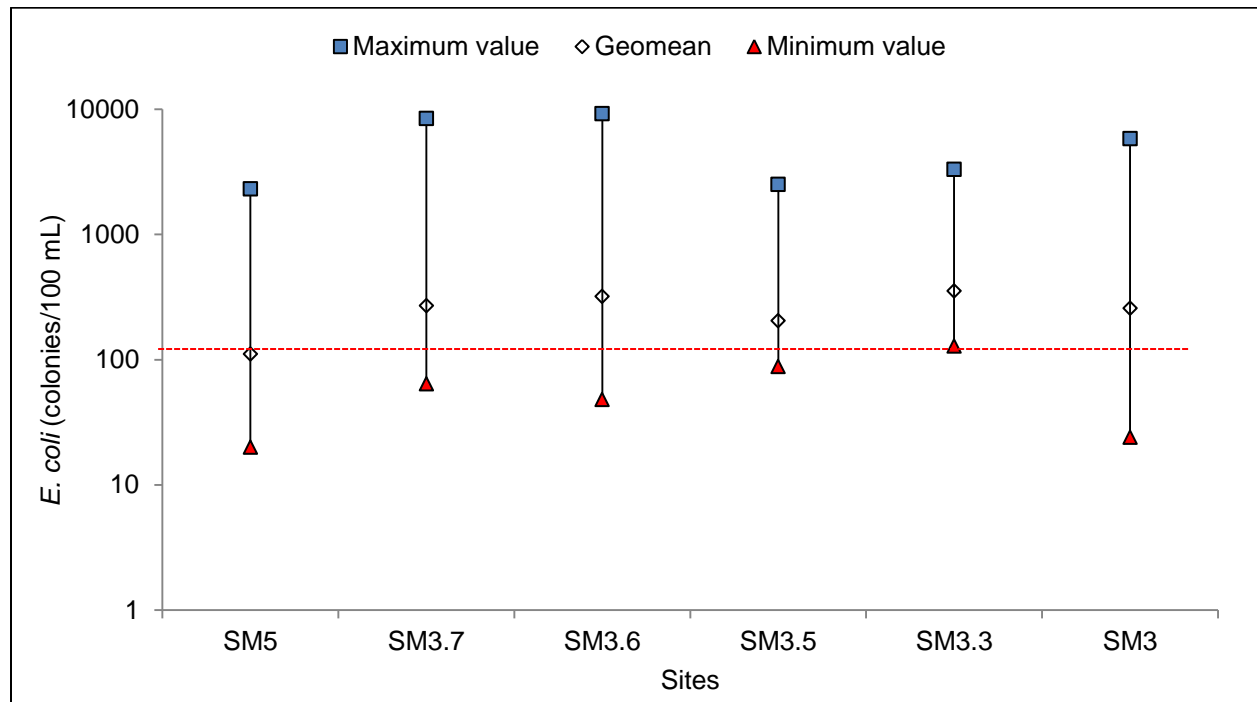
**Figure 6.** Monthly rainfall amounts and average rainfall and normal average rainfall for monitoring the period from May to August 2015.



**Figure 7.** Water temperatures at six monitoring sites of the Silvermine River and three sites on Belden Hill Brook in Zone A from May through August 2015.

### Results and Discussion, Zone B:

Five of the six monitoring sites (SM3.7, SM3.6, SM3.5, SM3.3 and SM3) in Zone failed the CT DEEP geometric mean criterion of  $< 126$  CFU/100 mL (Figure 8 and Table 4). Only site SM5 did not fail this criterion during the testing period. All sites exceeded the SSM criterion (576 CFU/100 mL) at a frequency of more than 10% (Table 4). The higher bacteria levels in Zone B may indicate that bacteria may be entering the water through septic system failures and increased infiltration during high volume rainfall events. One such event occurred on sampling day, August 11, 2015, when over two inches of rainfall fell prior to sample collection. All of the monitoring sites in Zone B on this day exhibited elevated counts. Land use in Zone B can be considered suburban and residential, however, there are more impervious surfaces in this area than in Zone A. Impervious surfaces transport contaminants more quickly into receiving waters during rainfall events, which can result in elevated bacteria levels. The density of houses is also higher in Zone B, and many property owners have manicured lawns (rather than natural vegetative buffers) in close proximity to the river. Streambank erosion, such as that observed at site SM3.3, can contribute to increased runoff of contaminants into the river. More investigation will be needed to pinpoint possible sources of this contamination.

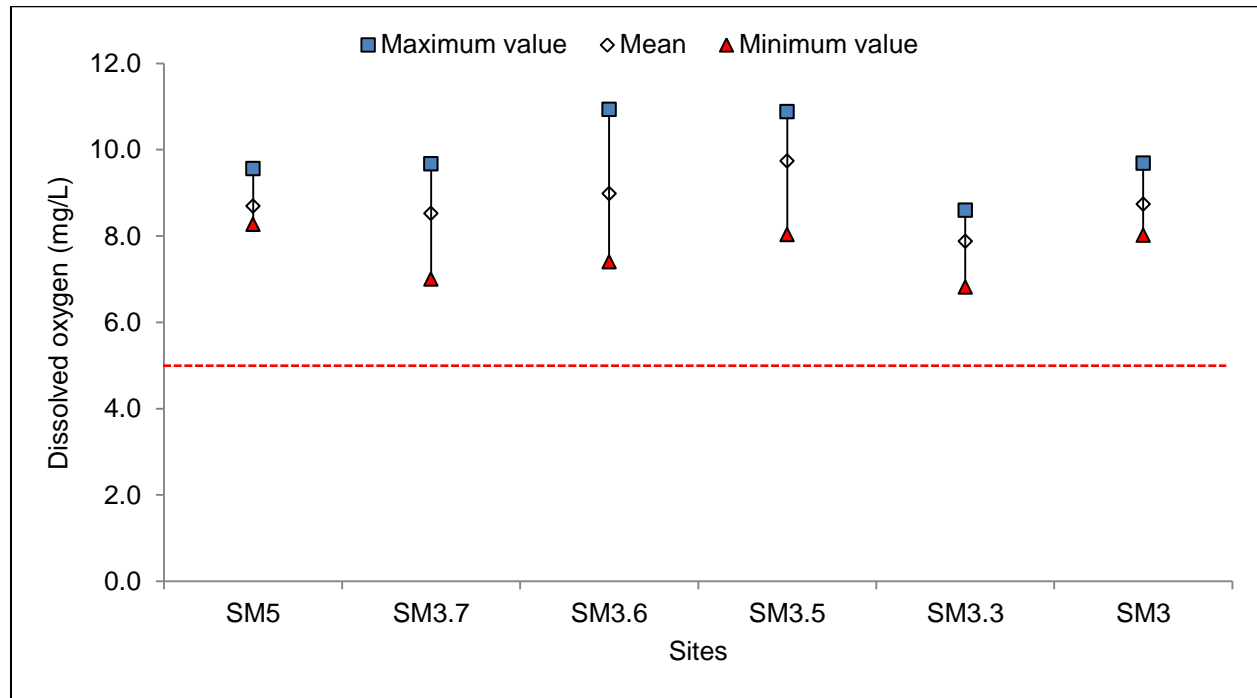


**Figure 8.** Maximum values, geometric means, and minimum values for *E. coli* at six monitoring sites in Zone B of the Silvermine River from May to August 2015, dotted red line denotes the CT DEEP geometric mean criterion for a Class B river.

The observed dissolved oxygen mean values at all sites in Zone B met the CT DEEP criterion of  $\geq 5$  mg/L for dissolved oxygen (Figure 9). Like sites in Zone A, all sites in this area had no individual dissolved oxygen readings that were below 5 mg/L and levels remained healthy throughout the entire monitoring period. The riparian canopy in Zone B is fairly extensive, which helps to provide shade for the water and to keep it out of warming effects of direct sunlight.

**Table 4.** *E. coli* bacteria concentrations, geometric means, % frequency exceeding 576 CFU/100mL, and rainfall amounts at six monitoring sites in Zone B of the Silvermine River from May to August 2015

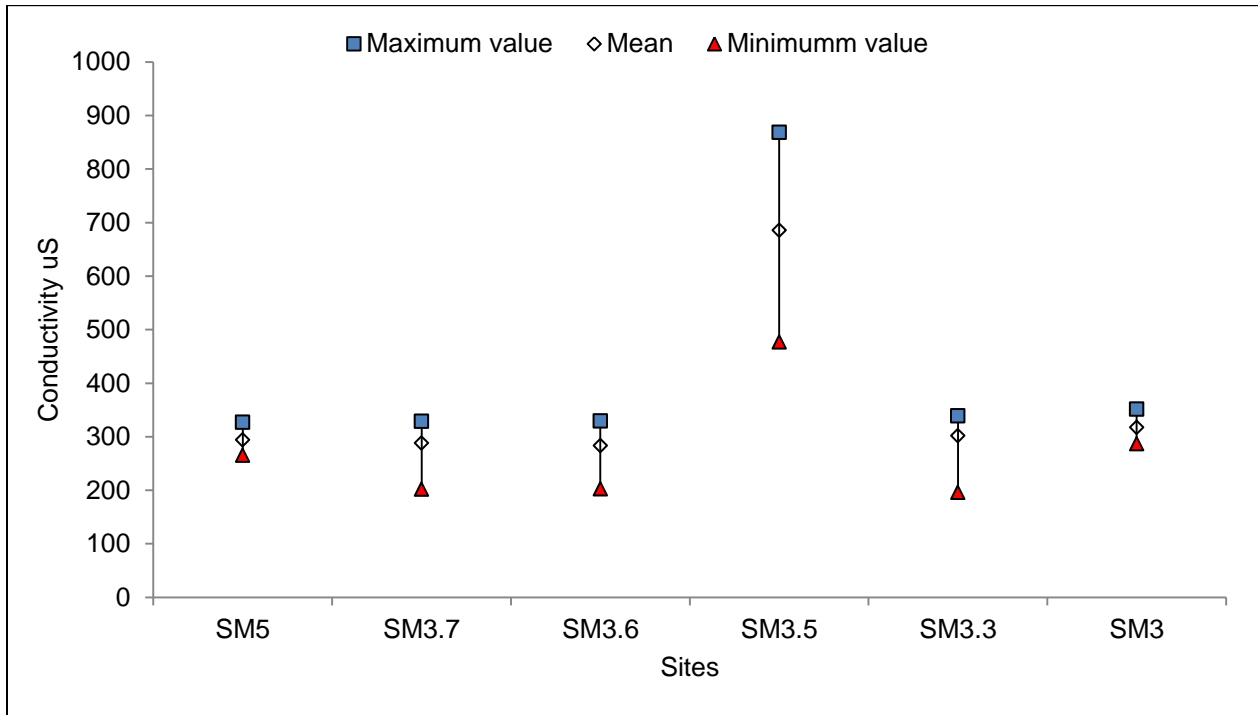
	6/9/2015	6/23/2015	6/30/2015	7/15/2015	7/27/2015	8/11/2015	8/25/2015	<b>Geomean</b>	% Frequency exceeding 576 CFU/100mL
SM5		92	208	104	20	2300	20	<b>111</b>	17%
SM3.7	64	80	132	200	350	8400	256	<b>269</b>	29%
SM3.6	48	720	140	176	300	9200	144	<b>319</b>	29%
SM3.5	200	248	96	88	130	2500	108	<b>204</b>	14%
SM3.3	132	560	128	280	3300	n/a	224	<b>354</b>	29%
SM3	164	380	500	172	100	5800	24	<b>257</b>	14%
Rain (in)	0.16	1.39	1.49	0.6	0.17	2.11	0.34		
Days Prior	1	1 <sup>+4</sup>	3 <sup>+2</sup>	1	0	0	4		



**Figure 9.** Maximum values, means, and minimum values for dissolved oxygen at six monitoring sites in Zone B of the Silvermine River from May to August 2015, the dotted red line denotes the CT DEEP minimum value for a Class B river.

Average conductivity in Zone B ranged from 869  $\mu\text{S}$  at site SM3.5 to 196  $\mu\text{S}$  at SM3.3. The widest conductivity range was observed at site SM3.5 (392  $\mu\text{S}$ ), and the narrowest range was observed at SM5 with a range of 65  $\mu\text{S}$  (Figure 10, Table 5). The mean conductivity for Zone B was 362  $\mu\text{S}$  (standard deviation 159.13), however, if site SM3.5 is removed the mean calculation the conductivity mean (297  $\mu\text{S}$ , Standard deviation = 13.22) closely resembles that of Zone A. Further investigation around site SM3.5 may be necessary to discover the reason for higher conductivity values and ranges at this site. Low

precipitation in July and August certainly contributed to the low flow rate and volume in the river and may have contributed to higher conductivity values observed at site SM3.5

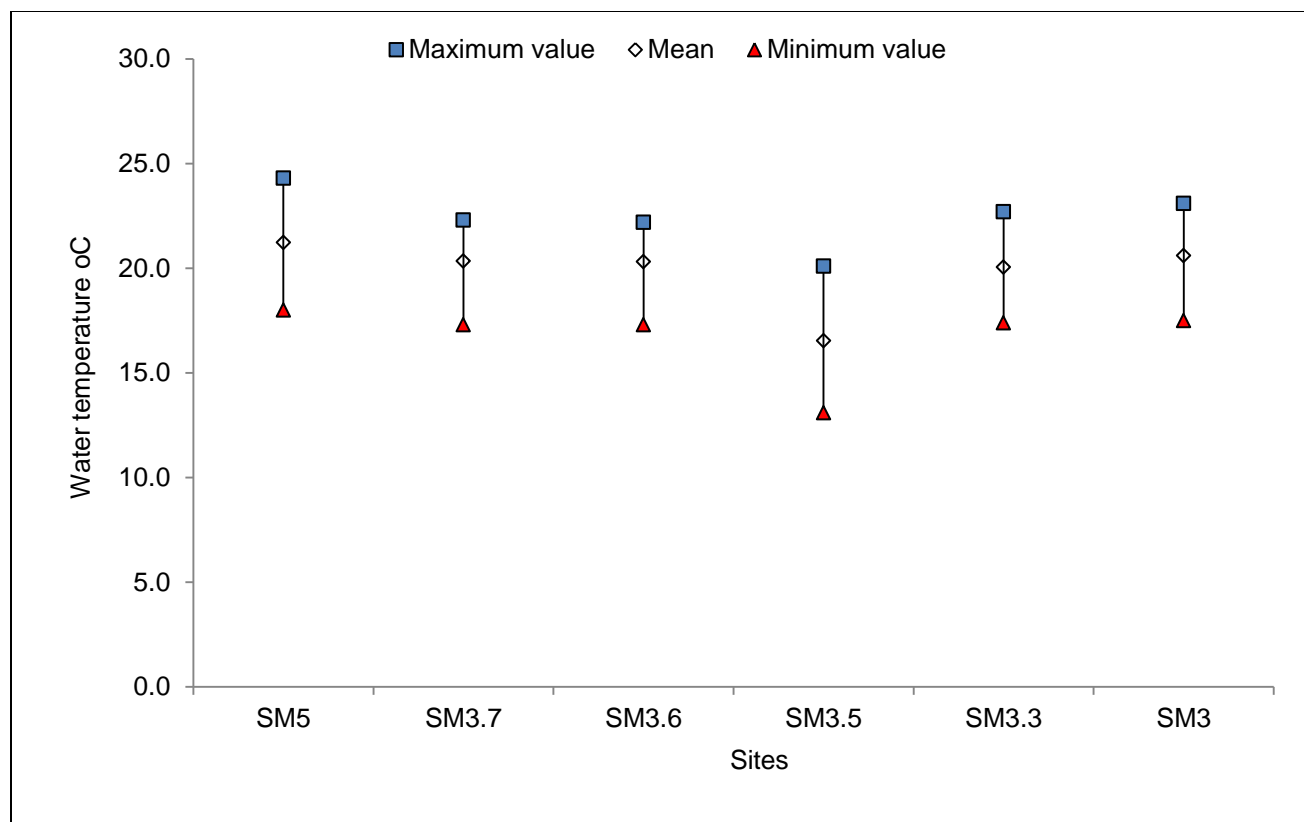


**Figure 10.** Maximum values, means, and minimum values for conductivity at six monitoring sites in Zone B in the Silvermine River from May to August 2015.

**Table 5.** Maximum values means, minimum, values, and ranges for conductivity at six sites in Zone B of the Silvermine River from May to August 2015

	SM5	SM3.7	SM3.6	SM3.5	SM3.3	SM3
Maximum value	327	329	330	869	339	352
Mean	294	288	284	686	302	317
Minimum value	265	202	203	477	196	287
Range	62	127	127	392	143	65

Water temperatures trended upward for Zone B, as expected, as monitoring progressed from the beginning to the end of the period (Figure 11). Site SM3.5 had lower water temperatures during this study, and the other sites had water temperatures that were fairly similar (Figure 11). The mean water temperature for Zone B was 19.8 °C (standard deviation = 2.5).



**Figure 11.** Water temperatures at six monitoring sites in Zone B of the Silvermine River from May to August 2015.

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## Appendix

**Table A1.** Site numbers, descriptions and GPS coordinates for six monitoring sites on Silvermine River and three sites on Belden Hill Brook

Site No.	Site Description	GPS Coordinates
SM9	Borglum Road Bridge	Latitude: N 41° 09' 35.0'' Longitude: W 73° 27' 09.8''
SM8	Silvermine Ave next to Red Barn	Latitude: N 41° 09' 24.2'' Longitude: W 073° 26' 59.0''
SM7	Silvermine Ave	Latitude: N 41° 09' 14.2'' Longitude: W 073° 26' 55.2''
BH6.4D	Musket Ridge Road	Latitude: N 41° 09' 28.0'' Longitude: W 073° 26' 55.2''
BH6.4B	#11 Mail Coach Drive downstream from the former Silvermine Sanctuary, upstream of BH6.4A	Latitude: N 41° 09' 12.7'' Longitude: W 073° 26' 51.4''
BH6.4A	#11 Mail Coach Drive downstream from Silvermine Sanctuary, near confluence with Silvermine River	Latitude: N 41° 09' 11.9'' Longitude: W 073° 26' 52.1''
SM6.3	Confluence of Belden Hill Brook and the Silvermine River	Latitude: N 41° 09' 10.8'' Longitude: W 073° 26' 51.6''
SM6.1	Side stream next to Silvermine Tavern	Latitude: N 41° 09' 03.9'' Longitude: W 073° 26' 49.1''
SM6	Perry Avenue Bridge	Latitude: N 41° 09' 05.0'' Longitude: W 073° 26' 44.4''

**Table A2.** Site numbers, descriptions and GPS coordinates for six monitoring sites in Zone B of the Silvermine River

Site No.	Site Description	GPS coordinates
SM5	Silvermine Elementary School	Latitude: N 41° 08' 50.7'' Longitude: W 073° 26' 35.2''
SM3.7	#184 Silvermine Avenue north of the Merritt Parkway overpass	Latitude: N 41° 08' 21.4'' Longitude: W 073° 26' 27.2''
SM3.6	#184 Silvermine Avenue, north of the Merritt Parkway overpass	Latitude: N 41° 08' 18.4'' Longitude: W 073° 26' 23.8''
SM3.5	Just south of the Merritt Parkway overpass	Latitude: N 41° 08' 18.8'' Longitude: W 073° 26' 26.5''
SM3.3	Bridge at the CT DMR facility	Latitude: N 41° 08' 15.0'' Longitude: W 073° 26' 21.4''
SM3	James Street	Latitude: N 41° 08' 09.8'' Longitude: W 073° 26' 6.1''

## **Acknowledgements**

Two college students, Perri Sheinbaum (Oberlin University) and Amelia Romero (Bucknell University) were hired to be interns for the Norwalk Health Department and Norwalk Shellfish Commission for the 2015 summer season. In addition to their primary responsibility of monitoring indicator bacteria levels at the various bathing beach in Norwalk for the Health Department, they were also assigned to work with Harbor Watch to assist on its investigations on the health of the Silvermine and Norwalk River Watersheds. Harbor Watch wishes to thank the Norwalk Shellfish Commission and the Norwalk Health Department under the direction of the Mayor's Water Quality Committee for providing funding and manpower for Harbor Watch to conduct this monitoring. Our thanks especially go to Tom Cloister, Norwalk Health Department, for his help in coordinating the summer internships for Harbor Watch. We also thank Perri Sheinbaum and Amelia Romero for their assistance in collecting field data and analyzing bacteria samples for this study.