A Summary of Biological Monitoring Results from the Kingdom Wind Project in Lowell, Vermont
Vermont Department of Environmental Conservation
Biomonitoring and Aquatic Studies Section
February 3, 2017

Introduction
Fish and macroinvertebrate communities were monitored annually in and around the Green Mountain Power (GMP) wind project in Lowell, Vermont in fulfillment of condition G included in the 401 Certification 33 USC 1341, dated August 19, 2011. This report presents biological data generated from the monitoring effort. Water chemistry, temperature, and physical habitat stream geomorphic data can be accessed in annual reports and is summarized in: Kingdom Community Wind Project prepared for Green Mountain Power Corporation by VHB consulting, South Burlington, Vermont and Bear Creek Environmental LLC, Montpelier, Vermont on May 6, 2016.

The permittee’s representative assessed communities from eight test streams and a single adjacent off-site control stream before and during construction and operational phases of the project. Data from 2010 (for macroinvertebrates) and 2011 (for macroinvertebrates and fish) served as temporal controls. A spatial control site on Truland Brook (WQM 105) was selected to represent trends in the biological communities unrelated to project activities.

The fish community was monitored at six test sites on five streams that received runoff from project. Macroinvertebrate communities were sampled at 11 test sites from eight streams with eight of the sites being sampled in 2010 as well.

Comparison of Biological Results to Spatial and Temporal Controls
An unusually stressful hydrological year occurred in 2011, beginning with a rapid snowmelt exacerbated by intense precipitation on April 26 which caused high discharges and flooding. Later in August, Tropical Storm Irene again drove discharges up dramatically. These two events caused the scouring of biotic communities in the study streams as well as many streams across the state. The 2011 biological samples were collected only three to four weeks after TS Irene. Minimum annual fish density values over the five monitored years were observed in 2011 at four of the seven sites assessed. Young-of-the-year (YOY) Brook Trout numbers were the lowest in 2011 of all years monitored at all but one site. Because of this stressful water year, the fish communities of 2011 were less reflective of the true “average” condition at the study sites. Fewer stream sites showed depressed numbers of macroinvertebrates, however, as only four of the eleven sites registered their lowest density of the six years monitored. As a result, macroinvertebrate samples collected during 2011 represented a more acceptable temporal pre-construction control than it did for fish populations.

General Results and Conclusion
Data was collected and analyzed using established biological methods in accordance with the Vermont Water Quality Standards (WQS) Appendix G. All data was evaluated by DEC aquatic biologists and assessments of ecological health made that correspond to three levels of water classes: A1 (excellent), B1 (very good) and B2 (good). All waters included in the study are classified as B2.
Both macroinvertebrate and fish communities demonstrated annual variations in density - a common phenomenon in small higher gradient streams - which were likely related to the number and severity of annual high precipitation and snow melt driven discharge events. For most sites this variation resulted in shifting assessments through the period without respect to pre-post construction timing. The exception to this was the East Branch of the Missisquoi River site (WQM 103), which scored the same assessment level all five years for both fish and macroinvertebrate communities (Table 1).

All sites except McCleary Brook supported a combination of typical cold headwater fish species: Brook Trout, Blacknose Dace, and less frequently, Slimy Sculpin and Creek Chub (Table 2). The McCleary Brook site contained only Brook Trout, which is common for small, cold, headwater streams. Most sites supported low densities of fish throughout the period. The exception was the upper East Branch of the Missisquoi River (WQM103) which supported high numbers of Brook Trout throughout the five years. Cold water index of biotic integrity (CWIBI) scores generally exceeded Class B2 criteria (Table 3). Brook trout population estimates are presented in Table 4.

Population densities of macroinvertebrates in the study streams were relatively low and variable as would be expected in small, lightly-buffered, coldwater drainages. This was illustrated by a prevalence of high percent model affinity values, which depict the taxonomic similarity to the expected assemblage in unimpaired streams of this type.

In summary, the six years of biological evaluations for fish and macroinvertebrate populations in streams draining the project area failed to show any significant impacts that could be attributed to the project construction or operation.

**Site Summaries for Fish and Macroinvertebrates**

**Truland Brook RM 0.7 (WQM105 - spatial control)** - All five annual fish community assessments were poor due to very low Brook Trout densities as well as total densities (Tables 1-5). The highest densities, while still comparatively low, were observed in 2015 for total and Brook Trout first electrofishing pass numbers/100 meters² and YOY population estimates. If any 5-year trend was to be discerned in using Truland Brook as a reference, it was slightly upward through the five-year period with the fish CWIBI values ranging from 12 out of 45 (poor) in 2011 to 21 (poor) in 2015. Macroinvertebrate assessments barely achieved Class B2 criteria in 2011 and 2013, and ranged from very good-good to excellent-very good for 2012, 2014 and 2015 (Table 5).

**McCleary Brook RM 2.0 (WQM15)** - With the exception of 2011, this Brook Trout-only stream met Class B2 WQS annually by supporting modest densities comprised of three size classes: YOY, <6 inches and 6-10 inches. During the first three years of macroinvertebrate monitoring (including the two pre-construction years) this reach was found to be “fair or good-fair” due to very low density, low richness and EPT, and a slightly elevated sample proportion of Oligochaeta (worms). In the period of 2013-2015, the percent of Oligochaeta dropped into the reference range and assessments increased to very good-good, excellent and very good-good respectively (Table 6).

**Shalney Branch 1.3 (WQM17)** - Slimy Sculpins (an intolerant species) accompanied Brook Trout in this community resulting in a perfect CWIBI score of 45 out of 45 (excellent) in 2013, 2014 and 2015 and a very good score in 2012. The 2011 fish community sample was rated poor due to very low density. The macroinvertebrate community showed very good-good to Excellent assessments throughout the period without regard for pre-post project construction (Table 7).
Rogers Branch 1.0 (WQM12) - Only macroinvertebrates were monitored at this location. Assessments ranged from “very-good to excellent” for all years except 2011 when low density dictated a rating of “good”. No trend in assessment ratings was observed (Table 8).

“Lower” East Branch Missisquoi River 1.7 (WQM16) - Fish were not monitored at this site. This is the lowest sampled reach on the East Branch, and the only reach that was evaluated for macroinvertebrates using the “Medium High Gradient” (MHG) model criteria. The assessments for the two pre-construction years were good in 2010 and fair-good in 2011 (low density). In 2012 the density returned to a good rating as did the overall assessment. Assessments were very good to good for 2013 and 2014 and very good for 2015 (Table 9).

“Middle” East Branch of the Missisquoi 3.0 (WQM9) - This site is located on the valley floor, winding through agricultural land where bank erosion and scant riparian vegetation may have contributed to consistently low fish CWIBI scores of between 27 and 30 (fair to good). High numbers of the tolerant Blacknose Dace were responsible for depressing the CWIBI at this site. Macroinvertebrate density was low during the 2010 and 2011 temporal controls and for 2012 and 2013. Community assessments however, were good to very good for those years. With density improving in 2014 and 2015, assessments were “excellent-very good” for both years (Table 10).

“Upper” East Branch Missisquoi River 5.4 (WQM103) - Biological integrity of both communities was remarkably consistent throughout the study period, exceeding Class B2 WQS for aquatic biota. Fish CWIBI scores were consistently in the very good range throughout the study with CWIBI values ranging from 36-38. Very high Brook Trout density was also recorded during the last four years. Macroinvertebrate community integrity consistently rated in the very good-good range for all five years sampled (Table 11).

Ace Brook Sites. Both Ace Brook RM 0.6 and RM 0.7 sites are located in a low gradient alluvial fan produced by an abrupt transition from a high gradient reach to a relatively flat area downstream on the valley floor. The channels in both Ace Brook sites were over-widened and over 50% of banks showed an unstable condition. The unforeseen result of this was a sporadically changing physical habitat that placed stress on the aquatic biota. Under this dynamic habitat condition aquatic communities are prevented from becoming fully established and exhibiting population metrics of a healthy community. Additional stresses may have been present on the community from an increased sediment transport load that could have originated from a large, intensively logged area upstream. This effect coupled with the impact from the shifting channel location combined to influence the biological integrity of the fish and macroinvertebrate populations and are unrelated to GMP project construction.

Ace Brook 0.7 (WQM 101) - Both Ace Brook sites contained a greater proportion of eurythermal and tolerant species (Blacknose Dace and Creek Chub) than would be expected in an unimpaired population from a stream of this size and elevation. Except for 2015, fish densities were low throughout the period. The CWIBI ranged from 18 - 30 meeting the Class B2 criterion only once, with a good assessment in 2013. Macroinvertebrates showed a steady decline over the five monitored years with a very good-good assessment in 2011 eventually falling to fair in 2014 and 2015 (Table 16). Very low community density and moderately low richness and EPT taxa accounted for the lower assessments (Table 12).

Ace Brook 0.6 (WQM1) - Density of the Brook Trout at these two sites was lower than expected, resulting in poor fish community assessments during 2011, 2012, 2013, and 2014. The 2015 assessment unexpectedly rose to very good. The presence of water quality sensitive
macroinvertebrate taxa indicated a lack of enrichment nutrient stress or sediment stress at this site. The observed low densities might have been due to a moderate level of embeddedness, a moderate silt index, and a temporally mobile channel. Annual assessments varied more at this site than any other in the study ranging from fair to excellent throughout the period (Table 13).

**East Branch Missisquoi River, Tributary 8, 0.2 (WQM5)** - Fish were not monitored at this site. Macroinvertebrate community evaluations were excellent-very good and very good in the two pre-construction years and very good-good to excellent thereafter. Although the post-construction years 2013 and 2014 recorded the lowest assessments (very good to good), the 2015 sample rose to very good (Table 14).

**East Branch Missisquoi River, Tributary 10, 0.1 (WQM8)** - Fish were not monitored at this site. With the exception of 2012, when the macroinvertebrate community was rated as fair due to very low density, macroinvertebrate assessments ranged from very good-good to excellent-very good before and after project construction. In 2015, 8 of the 10 dominant taxa were considered water quality sensitive and the assessment was very good (Table 15).
Table 1. Biological Assessments of macroinvertebrate and fish assemblages. Shaded areas represent study controls in the form of a temporal, 1-2 years of pre-construction samples and a spatial control - Truland Brook. “Fair” and “poor” assessments represent non-compliance with Class B2 Water Quality Standards for aquatic biota. Sites are identified by the project site prefix “WQM...” followed by the two-digit river mile from the mouth which is located after the stream name.

<table>
<thead>
<tr>
<th>WQM</th>
<th>Truland Brook 0.7 (Control)</th>
<th>Pre-Construction</th>
<th>Construction and Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2010</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>Macro.</td>
<td>Macro.</td>
<td>Fish</td>
</tr>
<tr>
<td>WQM 105 Truland Brook 0.7 (Control)</td>
<td>Good-fair</td>
<td>Poor</td>
<td>Very good -good</td>
</tr>
<tr>
<td></td>
<td>Fair</td>
<td>Good-fair</td>
<td>Did not meet B2</td>
</tr>
<tr>
<td>WQM 15 Shalney Branch 1.3 Black River</td>
<td>Excellent</td>
<td>Very good</td>
<td>Poor</td>
</tr>
<tr>
<td>WQM 12 Rogers Branch 1.0 Black River</td>
<td>Excellent</td>
<td>Good</td>
<td>-</td>
</tr>
<tr>
<td>WQM 103 Upper East Br. Missisquoi R. 5.4</td>
<td>-</td>
<td>Very good -good</td>
<td>Very good -good</td>
</tr>
<tr>
<td>WQM 9 Lower East Br. Missisquoi R. 3.0</td>
<td>Very good</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>WQM 16 Lowest East Br. Missisquoi R.1.7</td>
<td>Good</td>
<td>Good-fair</td>
<td>-</td>
</tr>
<tr>
<td>WQM 5 East Br. Missisquoi Trib. 8 0.2</td>
<td>Excellent-very good</td>
<td>Very good</td>
<td>Excellent</td>
</tr>
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<td>WQM 8 East Br. Missisquoi Trib.10 0.1</td>
<td>Excellent-very good</td>
<td>Very good -good</td>
<td>Fair</td>
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<td>WQM 1 Ace Brook 0.6</td>
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<td>Excellent</td>
<td>Poor</td>
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<tr>
<td>WQM 101 Ace Brook 0.7</td>
<td>-</td>
<td>Very good -good</td>
<td>Poor</td>
</tr>
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</table>
Table 2. Fish Cold Water Index of Biotic Integrity (CWIBI) scores and associated assessments. Shaded area represents pre-construction and control stream. IBI Scores range from 9 (poor) to 45 (excellent). Scores over 29 meet Class B2 WQS for aquatic biota. Assessments in red fail to meet Class B Water Quality Standards.

<table>
<thead>
<tr>
<th>Site Code</th>
<th>Site Name</th>
<th>Fish Species</th>
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<th>2012</th>
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<th>2014</th>
<th>2015</th>
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<td>WQM105</td>
<td>Truland Brook</td>
<td>Brook Trout</td>
<td>12 Poor</td>
<td>18 Poor</td>
<td>18 Poor</td>
<td>18 Poor</td>
<td>21 Poor</td>
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<td></td>
<td>RM 0.7</td>
<td>Blacknose Dace</td>
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<td>2.9</td>
<td>0.4</td>
<td>0.4</td>
<td>1.3</td>
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<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
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<td>3.9</td>
<td>1.9</td>
<td>1.2</td>
<td>4.4</td>
</tr>
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<td>WQM17</td>
<td>McCleary Brook</td>
<td>Brook Trout</td>
<td>Poor-Did not meet B2 WQS</td>
<td>Meets Class B2 WQS</td>
<td>Meets Class B2 WQS</td>
<td>Meets Class B2 WQS</td>
<td>Meets Class B2 WQS</td>
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<td>RM 2.0*</td>
<td>Blacknose Dace</td>
<td><strong>Total</strong></td>
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<td></td>
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<tr>
<td>WQM15</td>
<td>Shalney Branch – Black River</td>
<td>Brook Trout</td>
<td>21 Poor</td>
<td>45 Very Good</td>
<td>45 Excellent</td>
<td>45 Excellent</td>
<td>45 Excellent</td>
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<td>WQM103</td>
<td>Upper East Branch Missisquoi River</td>
<td>Brook Trout</td>
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<td>36 Very Good</td>
<td>36 Very Good</td>
<td>38 Very Good</td>
<td>38 Very Good</td>
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<td>Blacknose Dace</td>
<td><strong>Total</strong></td>
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<td></td>
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<td>WQM9</td>
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<td>30 Good</td>
<td>27 Fair</td>
<td>30 Good</td>
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<tr>
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<td>Brook Trout</td>
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<td>24 Poor</td>
<td>24 Poor</td>
<td>21 Poor</td>
<td>36 Very Good</td>
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<td>WQM101</td>
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<td>30 Good</td>
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<td>27 Fair</td>
</tr>
<tr>
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<td>Blacknose Dace</td>
<td><strong>Total</strong></td>
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</tbody>
</table>

* Only a single fish species collected—no IBI could be calculated

Table 3. One-pass density values for Brook Trout and all species total. Also listed is species collected other than Brook Trout. Shaded areas represent spatial and temporal controls.

<table>
<thead>
<tr>
<th>Site Code</th>
<th>Site Name</th>
<th>Species 1</th>
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<th>2012</th>
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<th>2014</th>
<th>2015</th>
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<tbody>
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<td>Brook Trout</td>
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<td>1.0</td>
<td>1.5</td>
<td>0.8</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>RM 0.7</td>
<td>Blacknose Dace</td>
<td>0.9</td>
<td>2.9</td>
<td>0.4</td>
<td>0.4</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td>2.1</td>
<td>3.9</td>
<td>1.9</td>
<td>1.2</td>
<td>4.4</td>
</tr>
<tr>
<td>WQM17</td>
<td>McCleary Brook</td>
<td>Brook Trout</td>
<td>0.4</td>
<td>8.5</td>
<td>4.2</td>
<td>8.1</td>
<td>9.8</td>
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<tr>
<td></td>
<td>RM 2.0</td>
<td>Blacknose Dace</td>
<td><strong>Total</strong></td>
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<td>WQM15</td>
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<td>Brook Trout</td>
<td>0.9</td>
<td>4.9</td>
<td>7.6</td>
<td>7.4</td>
<td>24.1</td>
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<tr>
<td></td>
<td>RM 1.3</td>
<td>Slimy Scullin</td>
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<td>2.5</td>
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<td>6.1</td>
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<td>30.2</td>
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<td>17.2</td>
<td>20.8</td>
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<td>60.7</td>
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<tr>
<td></td>
<td>RM 3.0</td>
<td>Blacknose Dace</td>
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<td>100.5</td>
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<td>0.7</td>
<td>4.8</td>
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<td>17.7</td>
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<td>3.6</td>
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<td>11.0</td>
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Table 4. Brook Trout population estimates in #s/mile (in bold) by size class. 95% confidence intervals appear below estimates. When no confidence interval appears, the interval is 0. YOY=young of the year. Shaded areas represent temporal and spatial study controls.

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<tr>
<th>Site</th>
<th>2011</th>
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<th>2014</th>
<th>2015</th>
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<td>157</td>
<td>167</td>
<td>101</td>
<td>151</td>
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<td>90</td>
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<td>13</td>
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<td>RM 2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>248</td>
<td>216</td>
<td>451</td>
<td>263</td>
</tr>
<tr>
<td>YOY</td>
<td>42</td>
<td>191</td>
<td>98</td>
<td>314</td>
<td>22</td>
</tr>
<tr>
<td>&lt;6 inches</td>
<td>0</td>
<td>57</td>
<td>20</td>
<td>98</td>
<td>215</td>
</tr>
<tr>
<td>6-10 inches</td>
<td>0</td>
<td>0</td>
<td>98</td>
<td>39</td>
<td>27</td>
</tr>
<tr>
<td><strong>WQM15 Shalney Branch-Black River RM 1.3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>354</td>
<td>766</td>
<td>613</td>
<td>1241</td>
</tr>
<tr>
<td>YOY</td>
<td>78</td>
<td>92</td>
<td>465</td>
<td>143</td>
<td>941</td>
</tr>
<tr>
<td>&lt;6 inches</td>
<td>39</td>
<td>223</td>
<td>163</td>
<td>404</td>
<td>176</td>
</tr>
<tr>
<td>6-10 inches</td>
<td>0</td>
<td>39</td>
<td>25</td>
<td>65</td>
<td>12</td>
</tr>
<tr>
<td><strong>WQM103- Upper East Branch Missisquoi R. RM 5.4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1033</td>
<td>2,053</td>
<td>1,222</td>
<td>2,044</td>
<td>2,923</td>
</tr>
<tr>
<td>YOY</td>
<td>441</td>
<td>1,414</td>
<td>754</td>
<td>1296</td>
<td>2,496</td>
</tr>
<tr>
<td>&lt;6 inches</td>
<td>441</td>
<td>468</td>
<td>400</td>
<td>549</td>
<td>289</td>
</tr>
<tr>
<td>6-10 inches</td>
<td>151</td>
<td>171</td>
<td>57</td>
<td>199</td>
<td>139</td>
</tr>
<tr>
<td><strong>WQM9 Lower East Branch Missisquoi River RM 3.0</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>733</td>
<td>559</td>
<td>No second pass made</td>
<td>No second pass made</td>
<td>533</td>
</tr>
<tr>
<td>YOY</td>
<td>76</td>
<td>424</td>
<td>300-724</td>
<td>388</td>
<td>365-449</td>
</tr>
<tr>
<td>&lt;6 inches</td>
<td>609</td>
<td>114</td>
<td>114-137</td>
<td>118</td>
<td>118-135</td>
</tr>
<tr>
<td>6-10 inches</td>
<td>48</td>
<td>21</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 5. Macroinvertebrate community summary metrics for the Truland Brook control site. Shaded areas represent spatial and temporal study controls.

<table>
<thead>
<tr>
<th>Location: WQM105 Truland Brook RM 0.7 (Spatial Control)</th>
<th>Bio Site ID: 429304000007</th>
<th>Town: Lowell</th>
<th>Type: SHG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Density</td>
<td>Richness</td>
<td>EPT Richness</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
<td>-----------</td>
<td>---------------</td>
</tr>
<tr>
<td>2011</td>
<td>282</td>
<td>31.0</td>
<td>23.0</td>
</tr>
<tr>
<td>2012</td>
<td>357</td>
<td>28.0</td>
<td>23.0</td>
</tr>
<tr>
<td>2013</td>
<td>363</td>
<td>27.0</td>
<td>22.5</td>
</tr>
<tr>
<td>2014</td>
<td>905</td>
<td>39.0</td>
<td>27.5</td>
</tr>
<tr>
<td>2015</td>
<td>458</td>
<td>31.5</td>
<td>23.5</td>
</tr>
<tr>
<td><strong>Class B2 WQS</strong></td>
<td>350</td>
<td>≥ 28</td>
<td>≥ 17</td>
</tr>
</tbody>
</table>

### Table 6. Macroinvertebrate community summary metrics for the McCleary Branch- Missisquoi River RM 2.0.

<table>
<thead>
<tr>
<th>Location:WQM15 McCleary Branch Missisquoi R. RM 2.0</th>
<th>Bio Site ID: 3922000000020</th>
<th>Town: Lowell</th>
<th>Type: SHG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Density</td>
<td>Richness</td>
<td>EPT Richness</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
<td>-----------</td>
<td>---------------</td>
</tr>
<tr>
<td>2010</td>
<td>132</td>
<td>27.5</td>
<td>17.5</td>
</tr>
<tr>
<td>2011</td>
<td>273</td>
<td>29.5</td>
<td>23.5</td>
</tr>
<tr>
<td>2012</td>
<td>271</td>
<td>32.5</td>
<td>25.5</td>
</tr>
<tr>
<td>2013</td>
<td>368</td>
<td>35.0</td>
<td>22.0</td>
</tr>
<tr>
<td>2014</td>
<td>606</td>
<td>38.5</td>
<td>25.5</td>
</tr>
<tr>
<td>2015</td>
<td>332</td>
<td>38.0</td>
<td>25.0</td>
</tr>
<tr>
<td><strong>Class B2 WQS</strong></td>
<td>≥ 300</td>
<td>≥ 27</td>
<td>≥ 16</td>
</tr>
</tbody>
</table>
Table 7. Macroinvertebrate community summary metrics for the Shalney Branch - Missisquoi River RM 1.3.

<table>
<thead>
<tr>
<th>Date</th>
<th>Density</th>
<th>Richness</th>
<th>EPT Richness</th>
<th>PMA-Order</th>
<th>Biotic Index</th>
<th>Oligo.</th>
<th>EPT/EPT + Chiro</th>
<th>PPCS-Function</th>
<th>Community Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>576</td>
<td>40.0</td>
<td>27.0</td>
<td>69.7</td>
<td>2.13</td>
<td>1.17</td>
<td>0.98</td>
<td>0.59</td>
<td>Excellent</td>
</tr>
<tr>
<td>2011</td>
<td>443</td>
<td>28.0</td>
<td>21.0</td>
<td>70.8</td>
<td>2.26</td>
<td>0.12</td>
<td>0.98</td>
<td>0.46</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2012</td>
<td>417</td>
<td>31.0</td>
<td>23.0</td>
<td>77.1</td>
<td>1.71</td>
<td>0.00</td>
<td>0.99</td>
<td>0.60</td>
<td>Very good</td>
</tr>
<tr>
<td>2013</td>
<td>592</td>
<td>32.5</td>
<td>23.5</td>
<td>80.7</td>
<td>1.44</td>
<td>0.16</td>
<td>0.98</td>
<td>0.58</td>
<td>Very good</td>
</tr>
<tr>
<td>2014</td>
<td>1268</td>
<td>37.5</td>
<td>24.5</td>
<td>76.9</td>
<td>1.77</td>
<td>0.00</td>
<td>0.95</td>
<td>0.65</td>
<td>Excellent</td>
</tr>
<tr>
<td>2015</td>
<td>686</td>
<td>39.5</td>
<td>29.0</td>
<td>71.2</td>
<td>1.62</td>
<td>0.00</td>
<td>0.96</td>
<td>0.49</td>
<td>Exc.-V. good</td>
</tr>
</tbody>
</table>

**Class B2 WQS**

≥ 300 ≥ 27 ≥ 16 ≥ 45 ≤ 4.5 ≤ 12 ≥ 0.45 ≥ 0.4 (Good)

Table 8. Macroinvertebrate community summary metrics for Rogers Branch - Missisquoi River RM 1.0.

<table>
<thead>
<tr>
<th>Date</th>
<th>Density</th>
<th>Richness</th>
<th>EPT Richness</th>
<th>PMA-Order</th>
<th>Biotic Index</th>
<th>Oligo.</th>
<th>EPT/EPT + Chiro</th>
<th>PPCS-Function</th>
<th>Community Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>461</td>
<td>36.5</td>
<td>25.5</td>
<td>68.8</td>
<td>2.12</td>
<td>0.32</td>
<td>0.96</td>
<td>0.58</td>
<td>Excellent</td>
</tr>
<tr>
<td>2011</td>
<td>324</td>
<td>31.5</td>
<td>23.0</td>
<td>65.0</td>
<td>3.02</td>
<td>1.87</td>
<td>0.97</td>
<td>0.45</td>
<td>Good</td>
</tr>
<tr>
<td>2012</td>
<td>433</td>
<td>33.5</td>
<td>25.5</td>
<td>71.1</td>
<td>2.12</td>
<td>0.44</td>
<td>0.97</td>
<td>0.59</td>
<td>Very good</td>
</tr>
<tr>
<td>2013</td>
<td>373</td>
<td>37.5</td>
<td>24.5</td>
<td>85.2</td>
<td>1.90</td>
<td>0.72</td>
<td>0.88</td>
<td>0.58</td>
<td>Exc.-V. good</td>
</tr>
<tr>
<td>2014</td>
<td>917</td>
<td>38.5</td>
<td>24.0</td>
<td>77.7</td>
<td>1.40</td>
<td>3.41</td>
<td>0.94</td>
<td>0.63</td>
<td>Very good</td>
</tr>
<tr>
<td>2015</td>
<td>586</td>
<td>35.5</td>
<td>23.0</td>
<td>68.6</td>
<td>1.67</td>
<td>0.16</td>
<td>0.83</td>
<td>0.43</td>
<td>Exc.-V. good</td>
</tr>
</tbody>
</table>

**Class B2 WQS**

≥ 300 ≥ 27 ≥ 16 ≥ 45 ≤ 4.5 ≤ 12 ≥ 0.45 ≥ 0.4 (Good)

Table 9. Macroinvertebrate community summary metrics for the East Branch - Missisquoi River RM 1.7.

<table>
<thead>
<tr>
<th>Date</th>
<th>Density</th>
<th>Richness</th>
<th>EPT Richness</th>
<th>PMA-Order</th>
<th>Biotic Index</th>
<th>Oligo.</th>
<th>EPT/EPT + Chiro</th>
<th>PPCS-Function</th>
<th>Community Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>520</td>
<td>35.5</td>
<td>22.0</td>
<td>64.2</td>
<td>1.78</td>
<td>1.74</td>
<td>0.98</td>
<td>0.52</td>
<td>Very Good</td>
</tr>
<tr>
<td>2011</td>
<td>278</td>
<td>36.5</td>
<td>23.5</td>
<td>69.1</td>
<td>2.38</td>
<td>5.56</td>
<td>0.92</td>
<td>0.53</td>
<td>Good-Fair</td>
</tr>
<tr>
<td>2012</td>
<td>340</td>
<td>41.0</td>
<td>24.5</td>
<td>74.6</td>
<td>2.31</td>
<td>1.19</td>
<td>0.84</td>
<td>0.42</td>
<td>Good</td>
</tr>
<tr>
<td>2013</td>
<td>348</td>
<td>40.0</td>
<td>25.5</td>
<td>72.7</td>
<td>2.18</td>
<td>1.24</td>
<td>0.96</td>
<td>0.57</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2014</td>
<td>636</td>
<td>36.0</td>
<td>23.5</td>
<td>79.0</td>
<td>1.83</td>
<td>1.81</td>
<td>0.94</td>
<td>0.54</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2015</td>
<td>1070</td>
<td>39.5</td>
<td>28.0</td>
<td>71.3</td>
<td>2.82</td>
<td>0.14</td>
<td>0.97</td>
<td>0.69</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

**Class B2 WQS**

≥ 300 ≥ 27 ≥ 16 ≥ 45 ≤ 4.5 ≤ 12 ≥ 0.45 ≥ 0.4 (Good)
Table 10. Macroinvertebrate community summary metrics for the East Branch - Missisquoi River RM 3.0.

<table>
<thead>
<tr>
<th>Location: WQM9 East Branch Missisquoi River RM 3.0</th>
<th>Bio Site ID: 429300000030</th>
<th>Town: Lowell</th>
<th>Type: SHG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Density</td>
<td>Richness</td>
<td>EPT Richness</td>
</tr>
<tr>
<td>2010</td>
<td>391</td>
<td>30.5</td>
<td>23.0</td>
</tr>
<tr>
<td>2011</td>
<td>332</td>
<td>34.5</td>
<td>24.0</td>
</tr>
<tr>
<td>2012</td>
<td>395</td>
<td>34.0</td>
<td>21.5</td>
</tr>
<tr>
<td>2013</td>
<td>336</td>
<td>32.0</td>
<td>22.0</td>
</tr>
<tr>
<td>2014</td>
<td>1234</td>
<td>33.0</td>
<td>22.0</td>
</tr>
<tr>
<td>2015</td>
<td>688</td>
<td>31.5</td>
<td>22.0</td>
</tr>
</tbody>
</table>

**Class B2 WQS**

<table>
<thead>
<tr>
<th>Location: WQM103 East Branch Missisquoi River RM 5.4</th>
<th>Bio Site ID: 429300000054</th>
<th>Town: Lowell</th>
<th>Type: SHG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Density</td>
<td>Richness</td>
<td>EPT Richness</td>
</tr>
<tr>
<td>2011</td>
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<td>23.0</td>
</tr>
<tr>
<td>2012</td>
<td>351</td>
<td>33.5</td>
<td>22.0</td>
</tr>
<tr>
<td>2013</td>
<td>397</td>
<td>29.5</td>
<td>20.0</td>
</tr>
<tr>
<td>2014</td>
<td>397</td>
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</tr>
<tr>
<td>2015</td>
<td>395</td>
<td>35.0</td>
<td>24.0</td>
</tr>
</tbody>
</table>

**Class B2 WQS**

<table>
<thead>
<tr>
<th>Location: WQM101 Ace Brook RM 0.7</th>
<th>Bio Site ID: 429306000007</th>
<th>Town: Lowell</th>
<th>Type: SHG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Density</td>
<td>Richness</td>
<td>EPT Richness</td>
</tr>
<tr>
<td>2011</td>
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<td>20.0</td>
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<td>2012</td>
<td>324</td>
<td>29.5</td>
<td>20.5</td>
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<tr>
<td>2013</td>
<td>277</td>
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<tr>
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</tr>
<tr>
<td>2015</td>
<td>192</td>
<td>32.0</td>
<td>18.0</td>
</tr>
</tbody>
</table>

**Class B2 WQS**
Table 13. Macroinvertebrate community metrics for Ace Brook Rm 0.6.

<table>
<thead>
<tr>
<th>Date</th>
<th>Density</th>
<th>Richness</th>
<th>EPT Richness</th>
<th>PMA-Order</th>
<th>Biotic Index</th>
<th>Oligo.</th>
<th>EPT/EPT + Chiro</th>
<th>PPCS-Function</th>
<th>Community Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>338</td>
<td>32.5</td>
<td>22.5</td>
<td>75.6</td>
<td>1.10</td>
<td>0.30</td>
<td>0.93</td>
<td>0.66</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2011</td>
<td>888</td>
<td>39.0</td>
<td>30.0</td>
<td>70.5</td>
<td>1.55</td>
<td>1.69</td>
<td>0.96</td>
<td>0.56</td>
<td>Excellent</td>
</tr>
<tr>
<td>2012</td>
<td>391</td>
<td>31.5</td>
<td>22.5</td>
<td>75.5</td>
<td>1.24</td>
<td>0.17</td>
<td>0.90</td>
<td>0.52</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2013</td>
<td>235</td>
<td>30.0</td>
<td>19.5</td>
<td>73.8</td>
<td>1.77</td>
<td>0.37</td>
<td>0.87</td>
<td>0.61</td>
<td>Fair</td>
</tr>
<tr>
<td>2014</td>
<td>627</td>
<td>34.0</td>
<td>21.0</td>
<td>77.1</td>
<td>1.65</td>
<td>0.97</td>
<td>0.92</td>
<td>0.58</td>
<td>Ex.-V. good</td>
</tr>
<tr>
<td>2015</td>
<td>359</td>
<td>37.5</td>
<td>21.5</td>
<td>75.1</td>
<td>1.86</td>
<td>0.49</td>
<td>0.77</td>
<td>0.62</td>
<td>V. good-Good</td>
</tr>
</tbody>
</table>

Class B2 WQS ≥ 300 ≥ 27 ≥ 16 ≥ 45 ≤ 4.5 ≤ 12 ≥ 0.45 ≥ 0.4 (Good)

Table 14. Macroinvertebrate community summary metrics for East Branch Missisquoi River - Tributary 8 RM 0.2

<table>
<thead>
<tr>
<th>Date</th>
<th>Density</th>
<th>Richness</th>
<th>EPT Richness</th>
<th>PMA-Order</th>
<th>Biotic Index</th>
<th>Oligo.</th>
<th>EPT/EPT + Chiro</th>
<th>PPCS-Function</th>
<th>Community Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>459</td>
<td>35.5</td>
<td>23.0</td>
<td>74.1</td>
<td>1.57</td>
<td>3.55</td>
<td>0.87</td>
<td>0.65</td>
<td>Exc.-V. Good</td>
</tr>
<tr>
<td>2011</td>
<td>390</td>
<td>35.0</td>
<td>25.0</td>
<td>81.6</td>
<td>1.56</td>
<td>1.43</td>
<td>0.87</td>
<td>0.56</td>
<td>Very Good</td>
</tr>
<tr>
<td>2012</td>
<td>660</td>
<td>30.5</td>
<td>21.0</td>
<td>74.9</td>
<td>1.88</td>
<td>0.48</td>
<td>0.74</td>
<td>0.49</td>
<td>Excellent</td>
</tr>
<tr>
<td>2013</td>
<td>334</td>
<td>32.5</td>
<td>22.0</td>
<td>75.2</td>
<td>1.51</td>
<td>4.04</td>
<td>0.89</td>
<td>0.53</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2014</td>
<td>361</td>
<td>33.5</td>
<td>20.5</td>
<td>84.9</td>
<td>1.67</td>
<td>3.57</td>
<td>0.83</td>
<td>0.60</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2015</td>
<td>411</td>
<td>38.5</td>
<td>25.0</td>
<td>83.7</td>
<td>1.73</td>
<td>0.81</td>
<td>0.88</td>
<td>0.66</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

Class B2 WQS ≥ 300 ≥ 27 ≥ 16 ≥ 45 ≤ 4.5 ≤ 12 ≥ 0.45 ≥ 0.4 (Good)

Table 15. Macroinvertebrate community summary metrics for the East Branch Missisquoi River- Tributary 10 RM 0.1

<table>
<thead>
<tr>
<th>Date</th>
<th>Density</th>
<th>Richness</th>
<th>EPT Richness</th>
<th>PMA-Order</th>
<th>Biotic Index</th>
<th>Oligo.</th>
<th>EPT/EPT + Chiro</th>
<th>PPCS-Function</th>
<th>Community Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>468</td>
<td>32.5</td>
<td>23.5</td>
<td>76.7</td>
<td>1.43</td>
<td>0.43</td>
<td>0.89</td>
<td>0.53</td>
<td>Exc-V. good</td>
</tr>
<tr>
<td>2011</td>
<td>358</td>
<td>33.0</td>
<td>24.0</td>
<td>74.2</td>
<td>1.62</td>
<td>0.96</td>
<td>0.96</td>
<td>0.52</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2012</td>
<td>182</td>
<td>28.5</td>
<td>20.5</td>
<td>89.7</td>
<td>1.59</td>
<td>0.81</td>
<td>0.91</td>
<td>0.62</td>
<td>Fair</td>
</tr>
<tr>
<td>2013</td>
<td>396</td>
<td>33.0</td>
<td>22.0</td>
<td>73.9</td>
<td>1.16</td>
<td>1.07</td>
<td>0.95</td>
<td>0.50</td>
<td>Very good</td>
</tr>
<tr>
<td>2014</td>
<td>315</td>
<td>34.0</td>
<td>24.0</td>
<td>67.1</td>
<td>1.50</td>
<td>0.00</td>
<td>0.92</td>
<td>0.52</td>
<td>V. good-Good</td>
</tr>
<tr>
<td>2015</td>
<td>372</td>
<td>35.0</td>
<td>24.0</td>
<td>71.3</td>
<td>1.40</td>
<td>0.82</td>
<td>0.89</td>
<td>0.56</td>
<td>Very good</td>
</tr>
<tr>
<td>Class B2 WQS</td>
<td>≥ 300</td>
<td>≥ 27</td>
<td>≥ 16</td>
<td>≥ 45</td>
<td>≤ 4.5</td>
<td>≤ 12</td>
<td>≥ 0.45</td>
<td>≥ 0.4</td>
<td>(Good)</td>
</tr>
<tr>
<td>-------------</td>
<td>-------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>-------</td>
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</tbody>
</table>