SUMMARY REPORT

Water Quality and Stream Invertebrate Assessments

for the Millstone River, Nanaimo, BC,

2008-2015

Report prepared by:

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Based on annual projects conducted by:

Students of Vancouver Island University RMOT 306 (Environmental Monitoring)

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1. Background

Vancouver Island University (VIU) has conducted yearly water quality and stream invertebrate assessments on the Millstone River, BC, since 2008. These projects have been undertaken by 3rd year undergraduate students attending the Environmental Monitoring (RMOT 306) course at Vancouver Island University (VIU), offered as part of the Bachelor of Natural Resources Protection. Students worked under the supervision of the course instructors, Dr. Eric Demers and Dr. John Morgan (Vancouver Island University).

This report summarizes water quality and stream invertebrate results for the Millstone River for the 8-year period between 2008 and 2015. This report was compiled by Dr. Eric Demers based on yearly student group reports. Some of the data presented here have been summarized in previous annual reports (see VIU 2009, 2010, 2011, 2012).

Logistical support and funding for analytical processing of water samples was provided by Fisheries and Oceans Canada (DFO). ALS Laboratory (Burnaby, BC) provided reduced rates on their analytical services for these projects.

VIU students contributed approximately 1,000 student-hours to these projects, including site visits, project proposal, field sampling, laboratory analyses, and oral and written presentations. Dr. Eric Demers and Dr. John Morgan contributed approximately 100 hours for project management and report compilation.

2. Introduction

The Millstone River watershed encompasses an area of approximately 93 km^2, comprised of 26 km of streams, 16 tributaries and 8 lakes. The primary drainage network in the watershed consists of Benson Creek, Brannen Lake and the Millstone River. Benson Creek originates west of Mount Benson at Lucid Lake (elevation: 619 m), and flows in a northerly direction for approximately 12 km into Brannen Lake (elevation: 78 m). The Millstone River flows from Brannen Lake in a southeasterly direction for approximately 14 km to the Strait of Georgia at the Nanaimo Harbour.

During summer 2007, an 800-metre long side channel was constructed along the lower Millstone River in Bowen Park by the Nanaimo Fish and Game Protective Association, in partnership with Fisheries and Oceans Canada (DFO) and the City of Nanaimo. The side channel was built to provide anadromous salmonids with new spawning and juvenile rearing habitat, and access to the watershed above the Deadman Falls barrier in Bowen Park. Additional habitat restorations were conducted by DFO during 2008 and 2009 to provide summer flow augmentation to the Millstone River and side channel.

This report summarizes water quality and stream invertebrate results for the Millstone River for the 8-year period between 2008 and 2015. Yearly assessments were conducted each fall, during similar time periods between late October and mid-November. Specific objectives for these yearly studies of the Millstone River included:

- obtain field measurements of water quality at 5 sampling stations during two sampling events (late October; mid-November);
- obtain water samples from each sampling station during two sampling events (late October; mid-November) for detailed laboratory analyses; and,
- collect stream invertebrate samples at 3-5 sampling stations during one sampling event (late October) for analysis at Vancouver Island University.

3. Methods

3.1. Study Site

Yearly assessments were conducted on Benson Creek and the Millstone River located in the City of Nanaimo, BC (Figure 1).

3.1.1. Sampling Stations

Five stations were established on Benson Creek and the Millstone River, and these stations were used consistently from 2008 to 2015 (Tables 1 and 2; Figure 1). The location of each station was chosen to provide adequate coverage for the length of the Millstone River. Stations were numbered from upstream to downstream (Station 1 on Benson Creek; Stations 2-5 on the Millstone River). All stations were easily accessed via foot paths or road crossings. Station 1 was located on Benson Creek at a crossing on Biggs Road. Stations 2 and 3 were located on the Millstone River at crossings on Biggs Road and Durnin Road, respectively. Station 4 was located along the side channel in Bowen Park, just downstream of the Duck Pond. Station 5 was located in Barsby Park, approximately 175 m upstream of the Millstone River estuary. All stations consisted of shallow and gentle riffle sections.

Table 1. Description of the sampling stations used for water quality and stream invertebrate assessments on the Millstone River during 2008-2015. Station 1 was located on Benson Creek. All northing and easting coordinates were obtained from Google Earth®, and are based on zone 10U.

Station	UTM Coordinates		General Location
	Easting	Northing	
1	422738	5450707	Benson Creek, Biggs Road crossing
2	423341	5450828	Millstone River, Biggs Road crossing
3	426304	5448953	Millstone River, Durnin Road crossing
4	430233	5447304	Side channel, downstream of Duck Pond
5	430941	5447091	Barsby Park, 170 m upstream from estuary

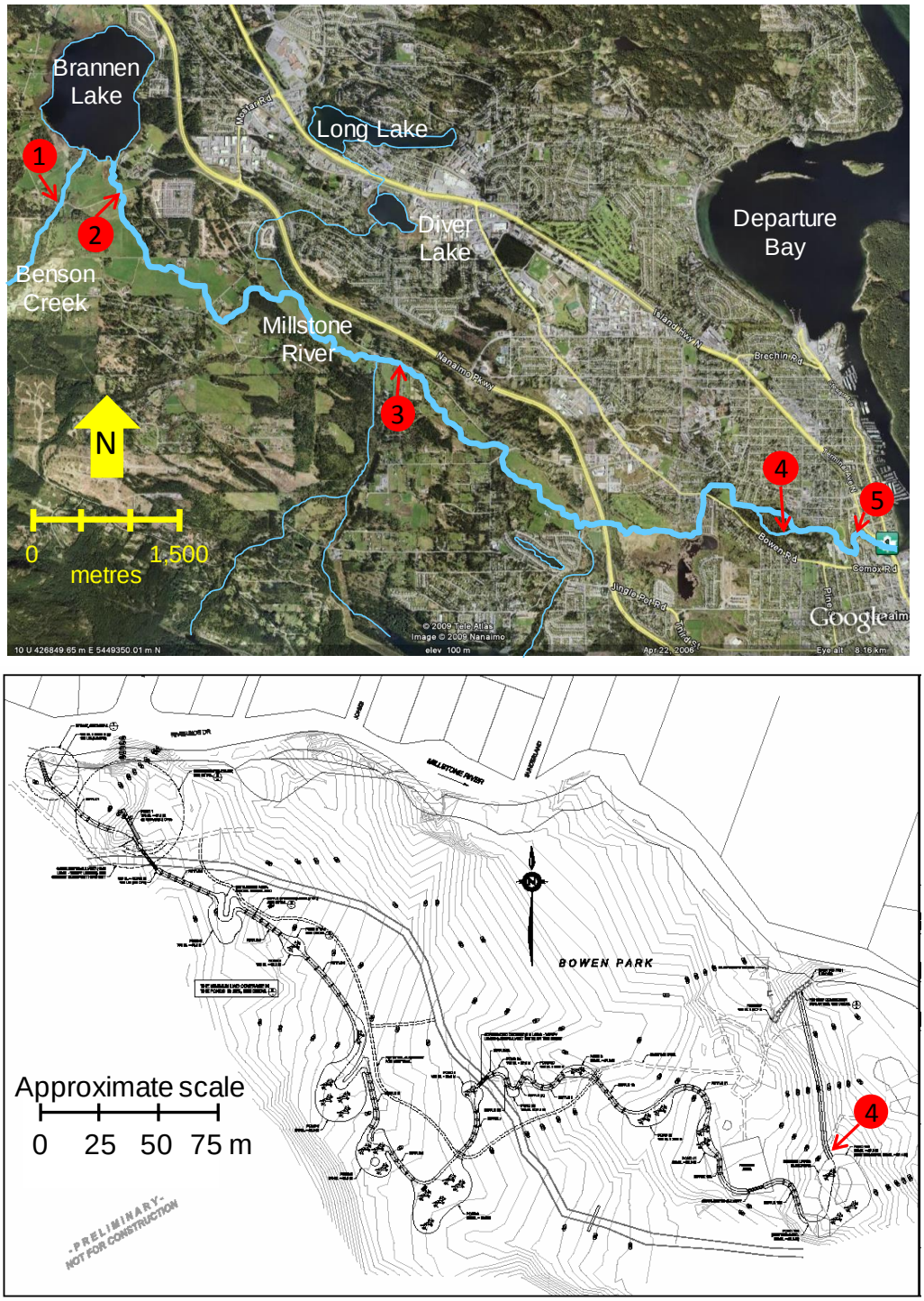

Figure 1. (A) Approximate location of the sampling stations used for water quality and stream invertebrate assessments on the Millstone River, during 2008-2015. Station 1 was located on Benson Creek. This map was obtained from Google Earth. (B) Approximate location of sampling station no. 4 along the Millstone River Side Channel. This map was obtained from Fisheries and Oceans Canada. Table 1 provides details of the specific location of each station. Table 2 details the sampling activities conducted at each station. Map scales are approximated.

3.1.2. Sampling Schedule

Field sampling was conducted twice each fall during 2008 to 2015. The first sampling event was conducted during late October or early November (date range: 26 October to 3 November; median date: 30 October). The second sampling event was conducted during mid-November (date range: 16-25 November; median date: 20 November). The first sampling event was usually representative of lower flow conditions, although this varied in some years due to weather conditions. For simplicity, in this report, the first and second sampling events are referred to as the "late October" and "mid-November" sampling events, respectively.

Each year, samples were collected for water quality analyses, microbiology and stream invertebrate assessment. Table 2 lists the specific activities conducted at each station during each sampling event. Microbiology and stream invertebrate assessments were only completed during the late October sampling event.

Table 2. Water quality and stream invertebrate sampling activities conducted at each station on the Millstone River, during 2008-2015. The symbols "A" or "B" indicate whether samples / measurements were taken during the late October or mid-November sampling events, respectively. ALS Lab analyses, microbiology and stream invertebrates were not conducted at the same stations each year (see parentheses).

Station	Water Quality				Stream Invertebrates
	Field Measurements	VIU Analyses	ALS Lab Analyses	Microbiology	
1	A, B	A, B	A, B (All except 2010)	A (All years)	A (All except 2010)
2	A, B	A, B	A, B (All years)	A (All years)	A (All years)
3	A, B	A, B	A, B (2008-2010)	A (All except 2012)	A (2008-2010)
4	A, B	A, B	A, B (All years)	A (All years)	A (All years)
5	A, B	A, B	A, B (2008-2010)	A (All except 2012)	A (2008-2009)

3.2. Water Quality

3.2.1. Field Measurements

Water quality sampling was conducted during both sampling events each year (late October and mid-November). At each sampling station, field measurements of water temperature (to the nearest 0.1^{o}C) and dissolved oxygen (to the nearest 0.1 mg/L) were obtained with an YSI 556 MPS

or Oxyguard Handy Polaris electronic probe. The electronic probe was placed directly in the channel water.

3.2.2. Water Sampling

During each sampling event, two sets of water samples were collected for laboratory analyses: one set was transported for analysis at Vancouver Island University (VIU), and another set was shipped for analysis by ALS Laboratory, in Burnaby, BC.

Water samples for analysis at VIU were collected from all stations (Table 2). At each station, a clean pre-labelled 500-ml plastic bottle was rinsed 3 times and then used to collect a water sample (Table 3). Samples were obtained while standing on the stream bank or within the stream channel by immersing the containers just below the water surface while facing upstream. Care was taken not to disturb the bottom sediments. All water samples were kept in a cooler and stored at approximately 4^{o}C. Laboratory analyses were conducted at VIU within 72 hours of sampling.

Samples for analysis by ALS Laboratory were collected from 3-5 stations during both sampling events, and the actual stations used varied between years (Table 2). At each station, water samples were collected in three clean laboratory-supplied and pre-labelled sample containers (Table 3). All samples were obtained while standing on the stream bank or within the stream channel by directly immersing the containers just below the water surface while facing upstream. Care was taken not to disturb the bottom sediments. Samples for analysis of nutrients and total metals were preserved with laboratory-supplied sulphuric acid and nitric acid, respectively. Bottles with preservatives were inversed five times for adequate mixing. All water samples were stored in a cooler on site, and shipped with ice packs within 72 hours for laboratory analyses at ALS Laboratory.

Table 3. Sampling containers and preservatives used for water quality samples taken at the Millstone River, during 2008-2015. All containers and preservatives for analysis by ALS Laboratory were provided by ALS Laboratory, Burnaby, BC.

Analytical Parameters	Container	Preservative	Analysed by
Total alkalinity, turbidity	500 ml plastic	None	VIU
Conductivity, pH, total hardness	1 L plastic	None	ALS Laboratory
Nutrients	250 ml amber glass	Sulphuric acid	ALS Laboratory
Total metals	250 ml plastic	Nitric acid	ALS Laboratory

3.2.3. VIU Laboratory Analyses

Water samples transported to Vancouver Island University were analysed for total alkalinity and turbidity. Total alkalinity (as $CaCO_3$) was measured to the nearest 0.1 mg/L using the HACH AL-DT digital titration method. Total alkalinity was not measured in 2013. Turbidity was measured to the nearest 0.01 NTU (Nephelometric Turbidity Units) using a HACH 2100 Potable Turbidimeter. Turbidity was not measured in 2008.

3.2.4. ALS Laboratory Analyses

Water samples submitted for external analyses were processed as per ALS Laboratory standard analytical procedures. The analytes were: conductivity, pH, total hardness, nutrients (ammonia, nitrite, nitrate, orthophosphate and total phosphorus), and total metals (31 metals). Total phosphorus was not measured in 2008.

3.2.5. Quality Assurance / Quality Control

Throughout this study, measures were taken to ensure that potential contamination of water samples was minimized. This included using only clean and rinsed containers, preserving samples as prescribed by the analytical laboratory, and storing samples in well-labelled containers.

3.2.6. Data Analyses – Comparison with Applicable Guidelines

Water quality results were compared with the applicable provincial water quality guidelines for the protection of aquatic life. The BC Water Quality Guidelines are the maximum allowable concentration (for potential acute effects). All guidelines were obtained from the BC Ministry of Environment, Water Protection Division (http://www.env.gov.bc.ca/wat/wq/).

It is important to note that for some metal parameters, analytical detection limits were above applicable guidelines. These included aluminum, antimony, arsenic, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, thallium and vanadium. For these metals, measured values reported to be below method detection limits cannot be assumed to be below the applicable guidelines.

3.3. Microbiology

3.3.1. Field Sampling

Water samples for total and fecal coliform enumeration were collected from all sampling stations during the first sampling event in late October (Table 2), except in 2012 when samples were collected from stations 1, 2 and 4. At each station, a sterile pre-labelled 120-ml Whirl-Pak® bag was used to collect a 100-ml water sample by directly immersing the bag by hand just below the water surface while facing upstream. All samples were stored in a cooler with ice packs and transported within 72 hours to Vancouver Island University for laboratory analysis.

3.3.2. Laboratory Analyses

In the laboratory, water samples were tested for total coliform and fecal coliform (*Escherichia coli* or *E. coli*) using the m-coliBlue24 membrane filtration method (Millipore Corporation). A 25-ml volume of sample water was filtered through a 47-µm membrane filter (marked with 3-mm gridlines) using a vacuum pump. The filtration apparatus was then rinsed with approximately 5 ml of sterile water. Each membrane filter was then transferred to a Petri plate containing an absorbent pad saturated with m-ColiBlue24 broth. All membrane filters were incubated at 37°C for 20 hours (until bacterial colonies were clearly visible).

Upon completion of the incubation period, membrane filters were then examined for bacterial colonies under a dissection microscope. A red or blue colony represents a total coliform "positive" result. A blue colony specifically represents fecal coliform, while a red colony represents non-fecal coliform. All colonies present on a membrane filter were counted and expressed as CFU (colony forming units) per 100-ml of sample water.

3.4. Stream Invertebrates

3.4.1. Sampling Stations

Stream invertebrate samples were collected during the first sampling event in late October (Table 1; Figure 1). Samples were taken each year from stations 2 and 4, from station 1 during all years except 2010, from station 3 in 2008-2010, and from station 5 in 2008-2009. The sampling stations were selected based on hydrological characteristics, apparent substrate uniformity, space available for replicate samples, safety, and site access. At the time of sampling, each station typically consisted of shallow riffles (water depth ~10-25 cm), with water velocity of 0.5-1.0 m/s, and primarily sand and gravel substrate.

3.4.2. Invertebrate Sampling

At each station, three replicate samples (triplicates) were obtained using a Hess sampler and procedures as per the Pacific Streamkeepers (Taccogna and Munro 1995). Each site was approached by walking from downstream. The cylindrical, 34-cm diameter Hess sampler was hand-pressed into the substrate to isolate a circular 0.09-m^2 sampling area. All stones and debris 5 cm or larger within the sampling area were held under water in front of the collecting net and rubbed gently by hand to dislodge invertebrates. Cleaned stones and debris were then placed downstream of the sampling area. The streambed was then gently agitated to a depth of 5 cm to loosen any remaining invertebrates. The content of the collecting net was then transferred in a 125-ml plastic sample jar. The net was carefully inspected to ensure all contents were transferred into the sample jar. Samples were stored in a cooler and transported to Vancouver Island University, where laboratory analyses were completed within 72 hours of sampling.

3.4.3. VIU Laboratory Analyses

Laboratory procedures and identification also followed the Pacific Streamkeepers procedures (Taccogna and Munro 1995). The triplicate samples from each station were combined into a single composite sample per station. The contents of all invertebrate sample jars from a station were poured into a shallow white tray. Invertebrates were sorted into apparent taxonomic groups. Identification to the appropriate taxonomic level (as prescribed by the Pacific Streamkeepers procedures) was confirmed using a dissection microscope. The number of invertebrates and the number of distinguishable subgroups within each broad taxonomic group were recorded on a Pacific Streamkeeper Invertebrate Survey Field Data Sheet. From these records, various useful metrics were calculated for each station, including: total density (number per m^2), total number of taxonomic groups, predominant taxonomic group, Pollution Tolerance Index, EPT (Ephemeroptera-Plecoptera-Trichoptera) Index, EPT to Total Ratio Index, Predominant Taxon Ratio Index, and overall Site Assessment Rating.

4. Results

River discharge can significantly affect water quality results through the differential transport of dissolved and suspended solids. Figure 2 shows that, during most years, discharge in the Millstone River was near the median levels expected at the time of sampling. Exceptions included high discharge levels during the late October sampling events in 2009, 2010 and 2014, and during the mid-November sampling events in 2009 and 2012.

It is important to note that water flow into the Millstone River side channel (station 4) is controlled by an intake weir and, therefore, fluctuations in discharge rate are more restricted than for the mainstem of the Millstone River. However, water flow variations in the river can affect inflowing water quality in the side channel.

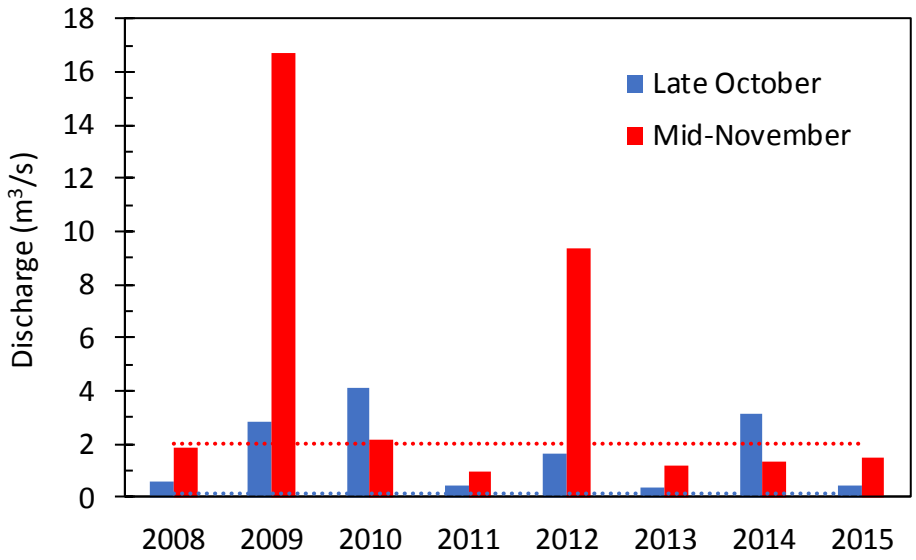

Figure 2. Discharge (m^3/s) measurements for the mainstem Millstone River at the time of sampling during 2008-2015. The bars display the discharge level on the same dates for the late October (blue) and mid-November (red) sampling events, respectively. The dashed lines display the 36-year median discharge (1979-2015) on 30 October (blue) and 20 November (red), respectively. Hydrometric data retrieved from Environment Canada, Water Survey for station 08HB032 (https://wateroffice.ec.gc.ca/).

4.1. Water Quality

In this section, time series for each water quality parameter are presented and described for the 8-year period between 2008 and 2015. Spatial trends among sampling stations are also shown and described where they existed, although some parameters did not exhibit any spatial trend. All water quality data are available in Appendix A (Tables A.1 to A.8).

4.1.1. Water temperature

Water temperature varied between years due to variation in ambient air temperature (Figure 3), although water temperature fluctuations were more pronounced during the mid-November sampling events. Average water temperature ranged from 7.9 to 11.5°C during late October and from 3.6 to 8.7°C during mid-November.

Water temperature was always lowest at Benson Creek (station 1) compared to other stations along the Millstone River (not shown), as expected since this station receives water from higher elevation within the watershed. Water temperature was highest at station 2, just downstream of Brannen Lake, and decreased by an average of 1.6°C with distance downstream to station 5. The slightly warmer water from Brannen Lake reflects the stored heat still present in the lake's surface water during the fall.

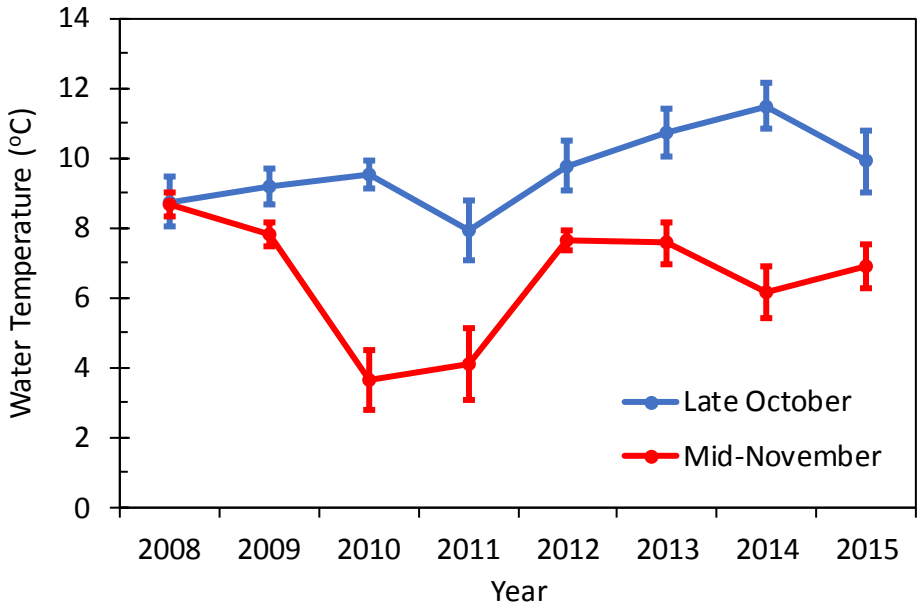

Figure 3. Water temperature (°C) measured during two sampling events in 2008-2015 in the Millstone River. Points show average temperature from five sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

4.1.2. Dissolved oxygen

Dissolved oxygen concentrations varied between years due to variation in water temperature (Figure 4), and fluctuations were more pronounced during the mid-November sampling events as would be expected since the largest temperature variations were also observed then. Dissolved oxygen levels ranged from 9.8 to 12.2 mg/L during late October and from 10.1 to 14.5 mg/L during mid-November.

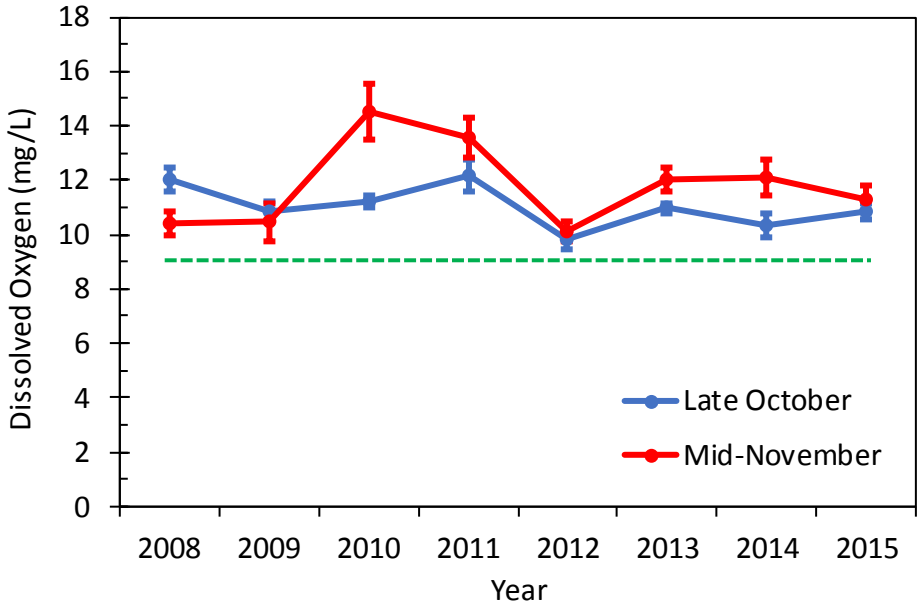

Figure 4. Dissolved oxygen concentrations (mg/L) measured during two sampling events in 2008-2015 in the Millstone River. Points show average concentrations from five sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. The green dashed line represents the minimum guideline of 9.0 mg/L for early fish life stages. Error bars represent ±1 standard error.

On average, dissolved oxygen concentrations varied by 1.7-2.5 mg/L between stations (not shown). Dissolved oxygen levels at each station reflected variation in water temperature, with the highest levels observed at the coolest station (station 1, Benson Creek) and the lowest levels observed at the warmest station (station 2).

Dissolved oxygen levels were always above the minimum guideline of 9.0 mg/L for early fish life stages (RISC 1998) (Figure 4). Overall, dissolved oxygen concentrations were always >85% saturation.

4.1.3. Conductivity

Conductivity was generally higher during late October than during mid-November (Figure 5). Overall, average conductivity ranged from 74 to 109 µS/cm during late October and from 54 to 98 µS/cm during mid-November. Conductivity decreased by an average of 10 µS/cm within station between late October and mid-November as expected due to the dilution effect from increased discharge.

Conductivity increased by an average of 60 µS/cm with distance downstream between station 1 and station 5 (Figure 6). The highest conductivity levels were observed at station 4 (along the side channel), especially during late October. These high levels corresponded with periods of low discharge within the channel.

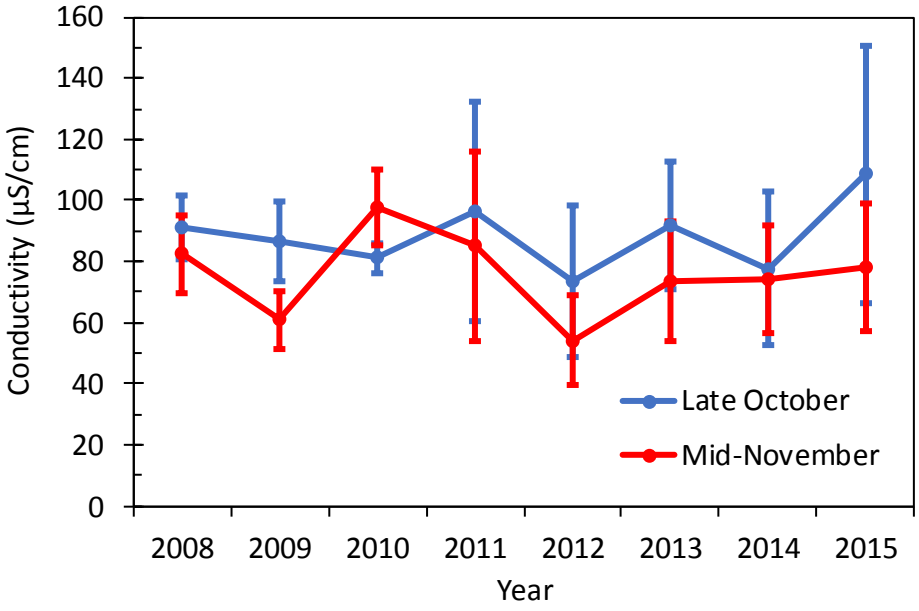

Figure 5. Conductivity (µS/cm) measured during two sampling events in 2008-2015 in the Millstone River. Points show average conductivity from 3-4 sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

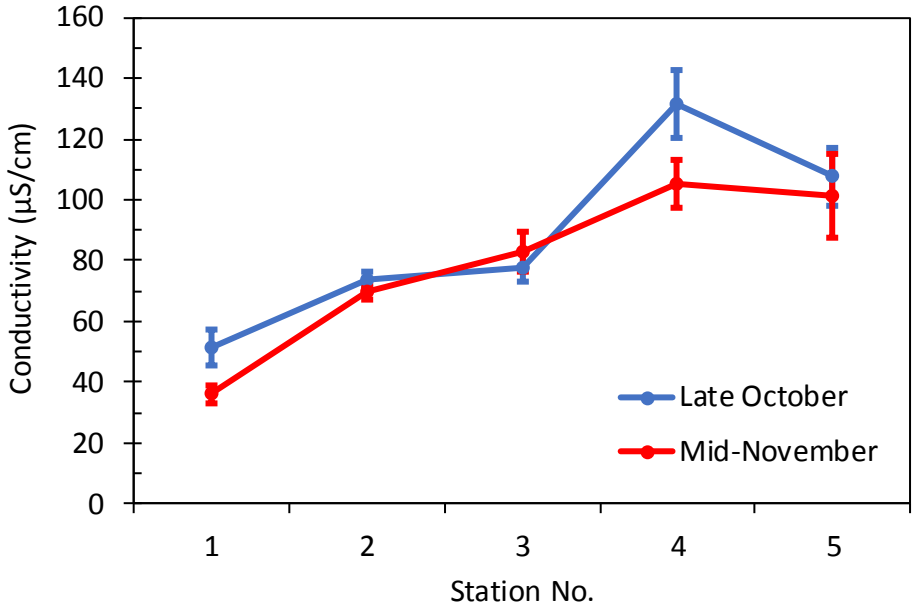

Figure 6. Conductivity (µS/cm) measured at five stations during two sampling events in the Millstone River. Points show average concentrations between 2008 and 2015. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

Overall, there was a negative correlation between average conductivity and river discharge (r = -0.68; df = 14; P = 0.008) (Figure 7). Conductivity was highest in late October during years of lower discharge in 2008, 2011, 2013 and 2015. In contrast, high discharge levels in mid-November 2009 and 2012 were associated with lower conductivity from the dilution effect.

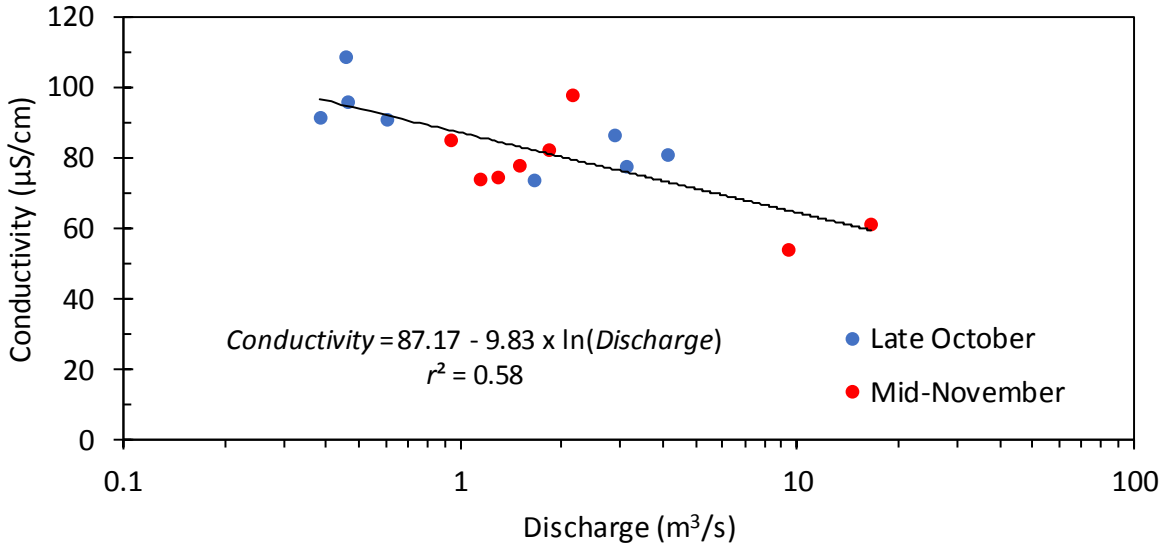

Figure 7. Relationship between average conductivity (µS/cm) and discharge (m^3/s) measured in the Millstone River during two sampling events in 2008-2015. Sampling events were conducted in late October (blue) and mid-November (red) each year.

During most years, low discharge levels in early fall are typically associated with higher concentrations of dissolved ions and higher conductivity. The onset of rainy weather in November often results in a brief pulse in conductivity as dissolved and suspended materials from the watershed are mobilized in the flowing water initially. This is typically followed by a reduction in conductivity resulting from the dilution effect of increased discharge.

4.1.4. pH

Average pH levels were near neutral throughout this study (Figure 8), and averaged 7.5 during both sampling events. There was no clear temporal trend in pH, although there was a weak negative correlation between pH and discharge (r = -0.57; df = 14; P = 0.03) (not shown).

pH increased by an average of 0.2 pH units with distance downstream between station 1 and station 5 (not shown). Like conductivity, the highest pH levels were observed at station 4 (along the side channel), especially during late October.

Overall, pH levels were well within the aquatic life criteria of 6.5-9.0 (RISC 1998).

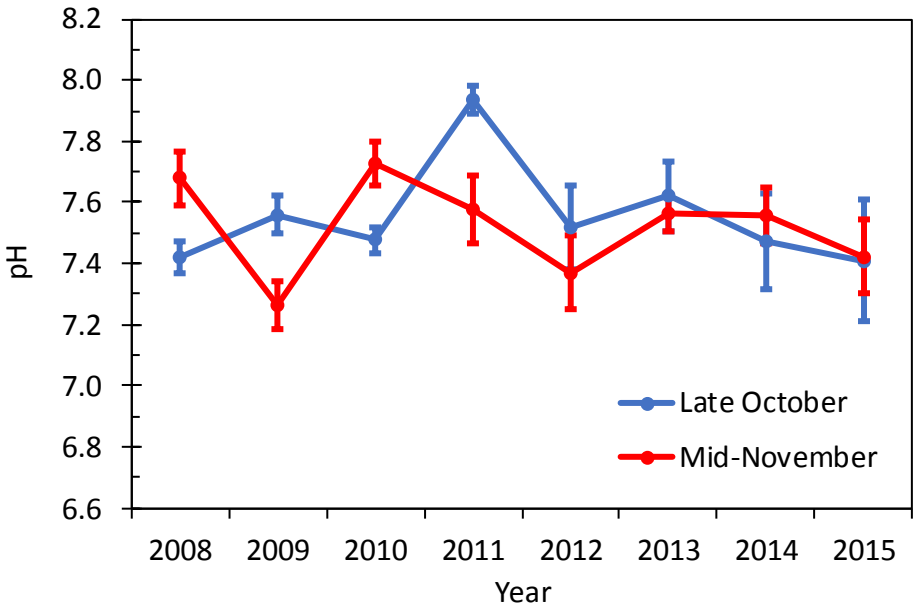

Figure 8. Water pH measured during two sampling events in 2008-2015 in the Millstone River. Points show average pH from 3-5 sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

4.1.5. Total alkalinity

Total alkalinity ranged from 20 to 32 mg/L as $CaCO_3$ during late October and from 17 to 31 mg/L as $CaCO_3$ during mid-November (Figure 9). There was no clear temporal trend in alkalinity. Alkalinity increased by an average of 18 mg/L as $CaCO_3$ with distance downstream between station 1 and station 5 (Figure 10). Like conductivity and pH, the highest alkalinity levels were observed at station 4 (along the side channel).

Overall, alkalinity levels were within the ranges for "low" (>20 mg/L as $CaCO_3$) sensitivity to acidification (RISC 1998). Alkalinity levels at station 1 (Benson Creek) were consistently within the range for "moderate" (10-20 mg/L as $CaCO_3$) sensitivity to acidification.

4.1.6. Hardness

Hardness ranged from 28 to 38 mg/L as $CaCO_3$ during late October and from 21 to 33 mg/L as $CaCO_3$ during mid-November (Figure 11). Hardness decreased by an average of 5 mg/L as $CaCO_3$ between the late October and mid-November sampling events. Hardness increased by an average of 17 mg/L as $CaCO_3$ with distance downstream between station 1 and station 5 (Figure 12). Like conductivity, pH and alkalinity, the highest harness levels were observed at station 4 (along the side channel).

Overall, hardness levels were consistently below 60 mg/L as $CaCO_3$, indicating "soft water" as defined by RISC (1998).

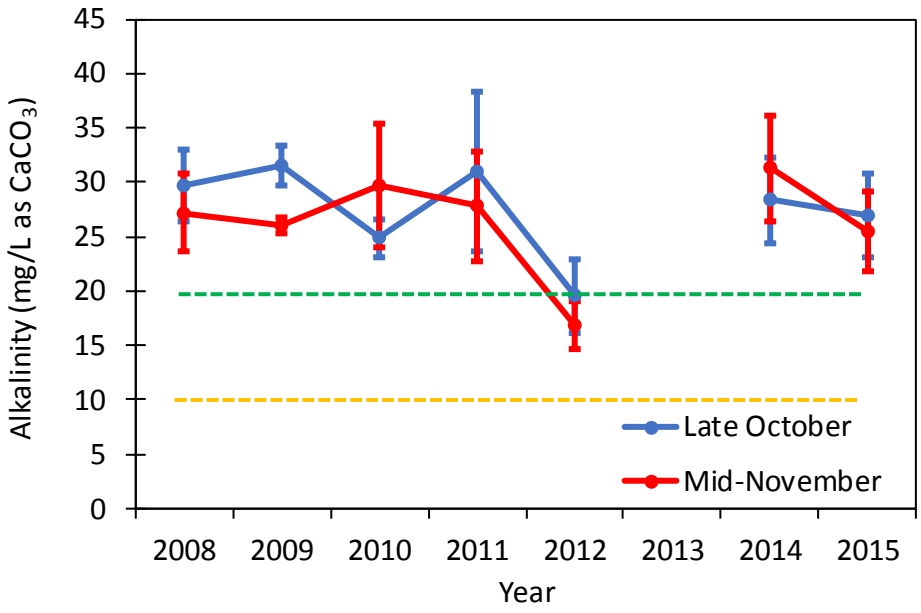

Figure 9. Total alkalinity (mg/L as $CaCO_3$) measured during two sampling events in 2008-2015 (except 2013) in the Millstone River. Points show average alkalinity from 5 sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. The green and orange dashed lines represent the maximum levels for high (10 mg/L) and moderate (20 mg/L) acid sensitivity. Error bars represent ±1 standard error.

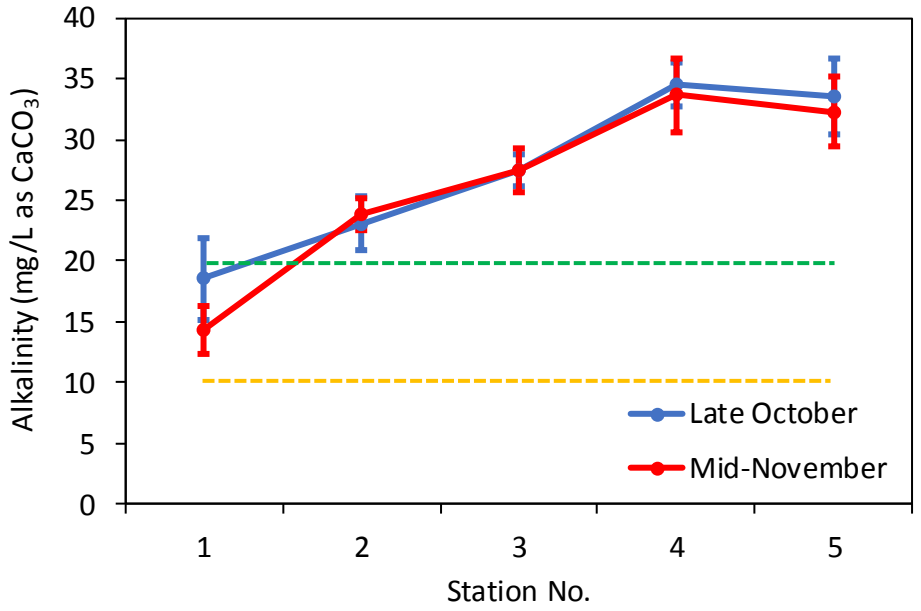

Figure 10. Total alkalinity (mg/L as $CaCO_3$) measured at five stations during two sampling events in the Millstone River. Points show average concentrations between 2008 and 2015 (except 2013). Sampling events were conducted in late October (blue) and mid-November (red) each year. The green and orange dashed lines represent the maximum levels for high (10 mg/L) and moderate (20 mg/L) acid sensitivity. Error bars represent ±1 standard error.

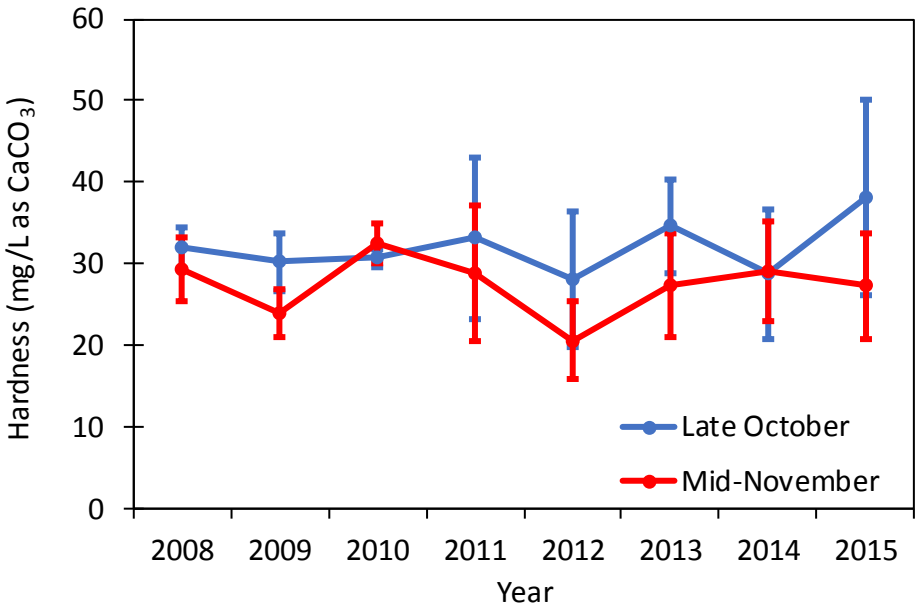

Figure 11. Hardness (mg/L as $CaCO_3$) measured during two sampling events in 2008-2015 in the Millstone River. Points show average hardness from 3-5 sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

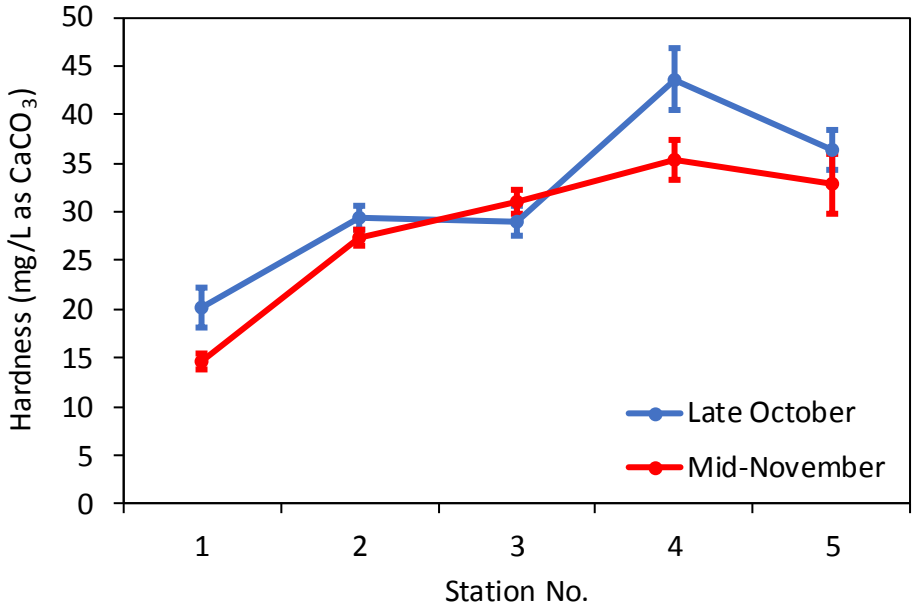

Figure 12. Hardness (mg/L as $CaCO_3$) measured at five stations during two sampling events in the Millstone River. Points show average concentrations between 2008 and 2015. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

There were significant positive relationships between conductivity, alkalinity and hardness (see Appendix B, Figure B.1). These correlations were expected since each of these parameters represent measures of dissolved ions.

4.1.7. Turbidity

Turbidity levels were highly variable between 2009 and 2015, and did not show any clear temporal trend (Figure 13). Overall, turbidity ranged from 1.2 to 6.5 NTU during late October and from 0.8 to 6.6 NTU during mid-November. The higher turbidity levels in late October 2010 and 2014 coincided with high discharge events during those years (see Figure 2). Elevated turbidity is often associated with high discharge, where shear stress increases and causes the mobilization of suspended solids. Turbidity levels in mid-November were not as closely associated with river discharge.

Turbidity increased with distance downstream, especially during late October (Figure 14). High turbidity and variation at station 5 during late October resulted from elevated turbidity results in 2010 and 2014 (9.0 and 14.7 NTU, respectively). These results were associated with high discharge events (Figure 2). As mentioned above, the onset of rainy weather in the fall often results in a brief pulse in suspended materials from the watershed, which may have coincided with these sampling events.

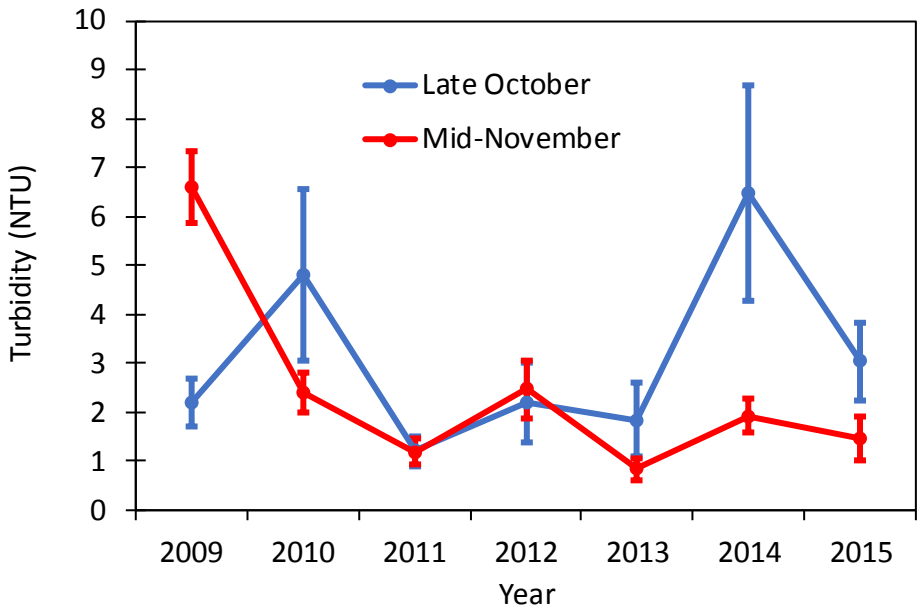

Figure 13. Turbidity levels (NTU) measured during two sampling events in 2009-2015 in the Millstone River. Points show average turbidity from 5 sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error. No results are available for 2008.

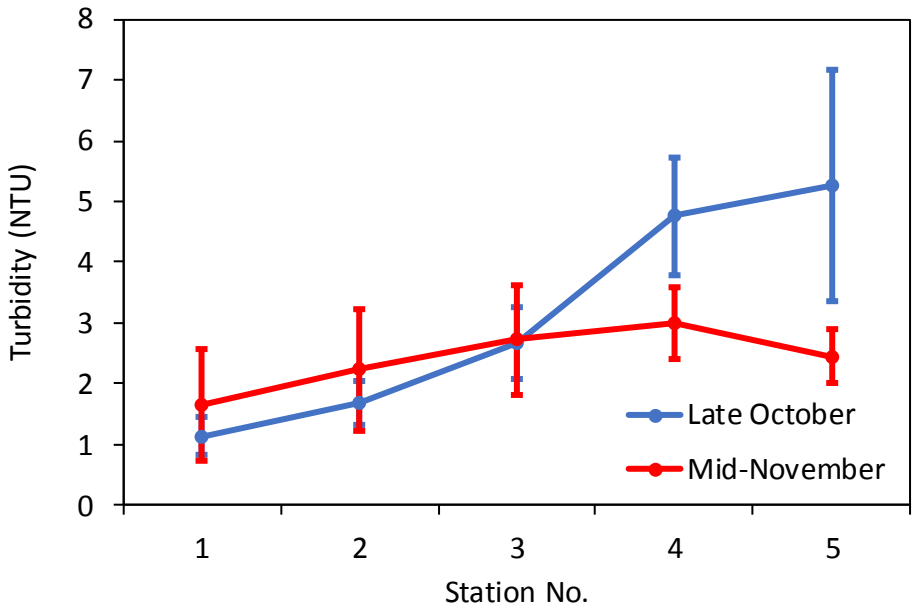

Figure 14. Turbidity levels (NTU) measured at five stations during two sampling events in the Millstone River. Points show average levels between 2009 and 2015. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error. No results are available for 2008.

4.1.8. Nitrate

Nitrate concentrations generally increased between the late October and mid-November sampling events each year (Figure 15), except in 2014 and 2015. From 2008 to 2013, nitrate levels ranged from 0.02 to 0.20 mg/L during late October, but higher levels were observed during 2014 and 2015 (0.39 and 0.71 mg/L, respectively). Nitrate levels were less variable during mid-November and ranged from 0.11 to 0.21 mg/L.

The higher levels and variation for late October 2014 and 2015 resulted from elevated nitrate results at stations 1 and 5 (Figure 16). Similar trends were observed in independent samples analyzed at the VIU laboratory (not shown). Therefore, these results appear to be correct, although causes for these higher results remain unknown. The elevated nitrate results regularly observed at station 1 (Benson Creek) are unexpected since this station receives water from a mostly forested watershed. However, potential sources of nitrate may exist in this area, including rock quarry activities (which may involve rock blasting with nitrate-based explosives) and the application of biosolids.

Nitrate is the main form of combined nitrogen found in natural waters and it is the primary form of nitrogen used by plants as a nutrient to stimulate growth. Excessive amounts of nitrogen may result in excessive aquatic plant growth. Continued monitoring of nitrate levels is warranted to determine long-term conditions within the watershed.

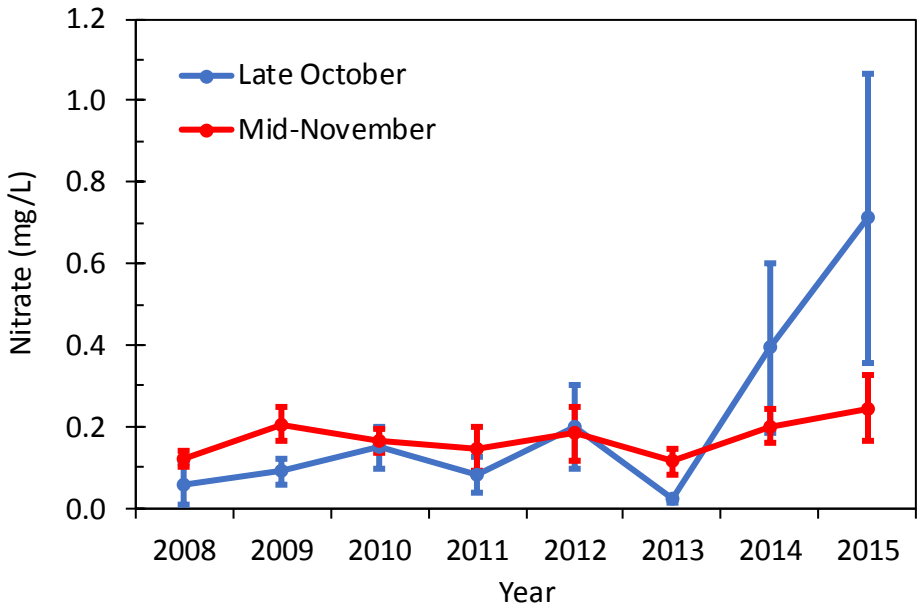

Figure 15. Nitrate concentrations (mg/L) measured during two sampling events in 2008-2015 in the Millstone River. Points show average concentrations from 3-5 sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

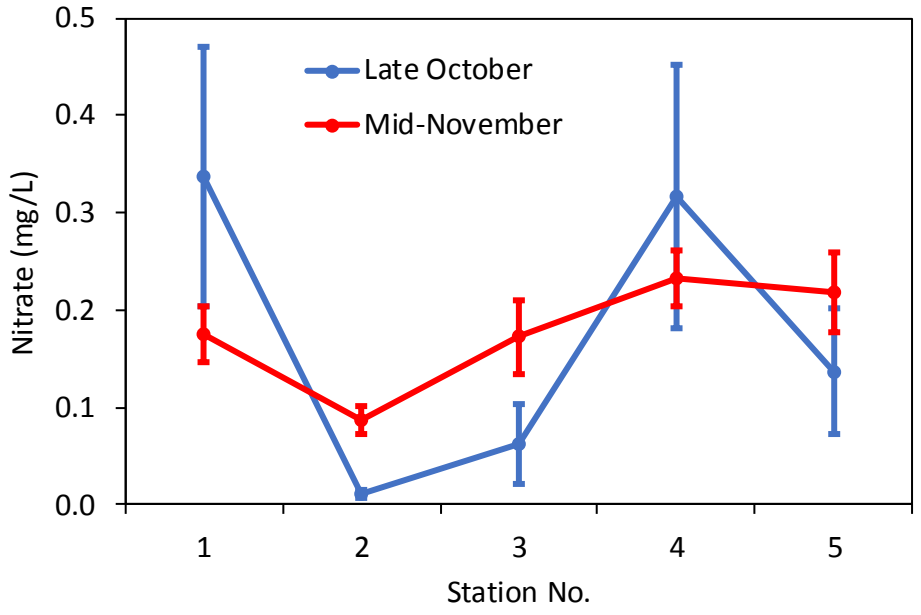

Figure 16. Nitrate concentrations (mg/L) measured at five stations during two sampling events in the Millstone River. Points show average levels between 2008 and 2015. Sampling events were conducted in late October (blue) and mid-November (red) each year. Error bars represent ±1 standard error.

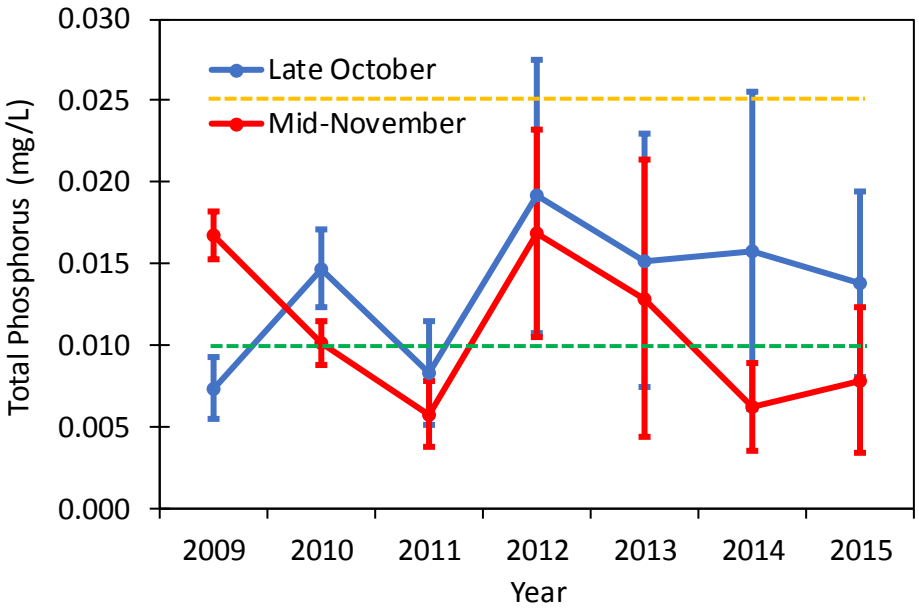

Figure 17. Total phosphorus concentrations (mg/L) measured during two sampling events in 2009-2015 in the Millstone River. Points show average concentrations from 3-5 sampling stations. Sampling events were conducted in late October (blue) and mid-November (red) each year. The green dashed line represents the division between "oligotrophic" water (<0.010 mg/L) and "mesotrophic" water (0.010-0.025 mg/L). Error bars represent ±1 standard error. No results are available for 2008.

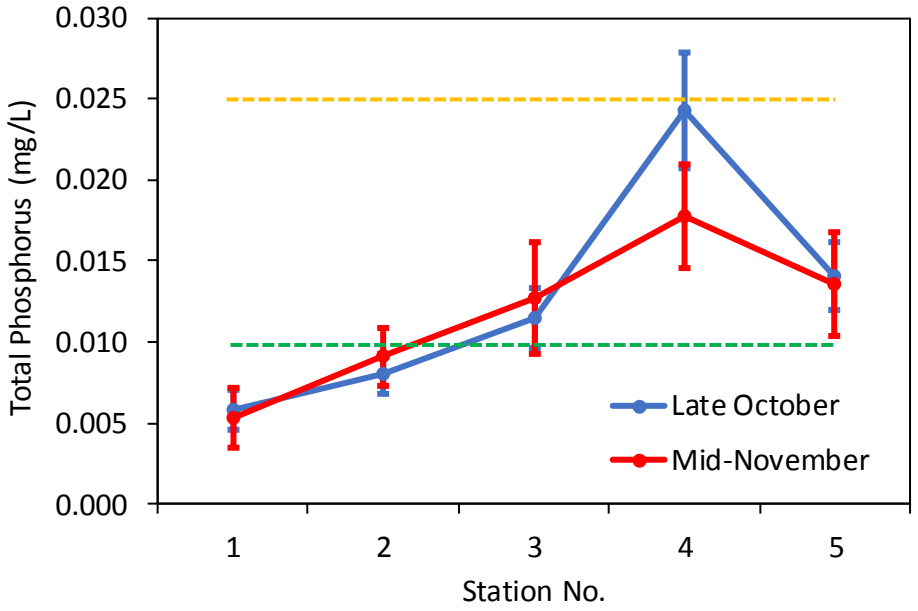

Figure 18. Total phosphorus concentrations (mg/L) measured at five stations during two sampling events in the Millstone River. Points show average levels between 2009 and 2015. Sampling events were conducted in late October (blue) and mid-November (red) each year. The green dashed line represents the division between "oligotrophic" water (<0.010 mg/L) and "mesotrophic" water (0.010-0.025 mg/L). Error bars represent ±1 standard error.

4.1.9. Total phosphorus

Total phosphorus concentrations were highly variable between years (Figure 17), and generally decreased between the late October (average: 0.013 mg/L) and mid-November (average: 0.011 mg/L) sampling events. Overall, total phosphorus levels ranged from 0.007 to 0.019 mg/L during late October and from 0.006 to 0.017 mg/L during mid-November.

Total phosphorus concentrations increased by an average of 0.008 mg/L with distance downstream between station 1 and station 5 (Figure 18). The highest total phosphorus levels were observed at station 4 (along the side channel), especially during late October (average: 0.024 mg/L). Potential source of phosphorus in the side channel could include the activity of and eventual decay of spawning salmon, and elevated ecosystem productivity resulting from generally lower flow conditions.

Overall, total phosphorus levels were within the ranges for "oligotrophic" water (>0.010 mg/L) to "mesotrophic" water (0.010-0.025 mg/L) (RISC 1998).

4.1.10. Total metals

With the exception of aluminum and iron, all metals were below applicable water quality guidelines or below minimum detection limits. Total aluminum concentrations exceeded the applicable guideline for aquatic life (maximum concentration: 0.1 mg/L) during 7 out of the 8 years of this study (Table 4). The highest aluminum concentrations were most often recorded at station 5 (side channel). It is important to note that the aluminum levels measured were only slightly above the water quality guideline, and aluminum is not considered a serious threat to aquatic life, except in areas of acidic inputs.

Table 4. Maximum concentrations of aluminum (mg/L) measured during two sampling events in 2008-2015 in the Millstone River. The water quality guideline of aluminum for aquatic life is 0.10 mg/L. Note that measured levels below method detection limit (<0.20 mg/L) cannot be assumed to be below the guideline.

Year	Late October	Mid-November
2008	0.22	0.24
2009	<0.20	0.36
2010	0.39	<0.20
2011	<0.20	0.27
2012	0.45	0.60
2013	<0.20	<0.20
2014	0.72	<0.20
2015	0.23	0.23

Total iron concentration exceeded the applicable guideline for aquatic life (maximum concentration: 1 mg/L) once during late October 2014 (1.16 mg/L).

Total metal analyses measure the combined amount of metals dissolved in water and bound to particles. In general, dissolved metals are more bio-available (hence toxicologically available) than metals that are bound to particles. It is unclear whether the observed elevated aluminum levels represented dissolved metals or metals bound to suspended particles.

4.2. Microbiology

Total coliform levels fluctuated between years, with levels ranging from 196 CFU / 100 ml (in 2012) to 1,225 CFU / 100 ml (in 2015) (Figure 19). Fecal coliforms were always present and levels ranged from 56 to 202 CFU / 100 ml. The proportion of total coliform made up of fecal coliform ranged from 8 to 43%. There was no apparent temporal trend in coliform levels.

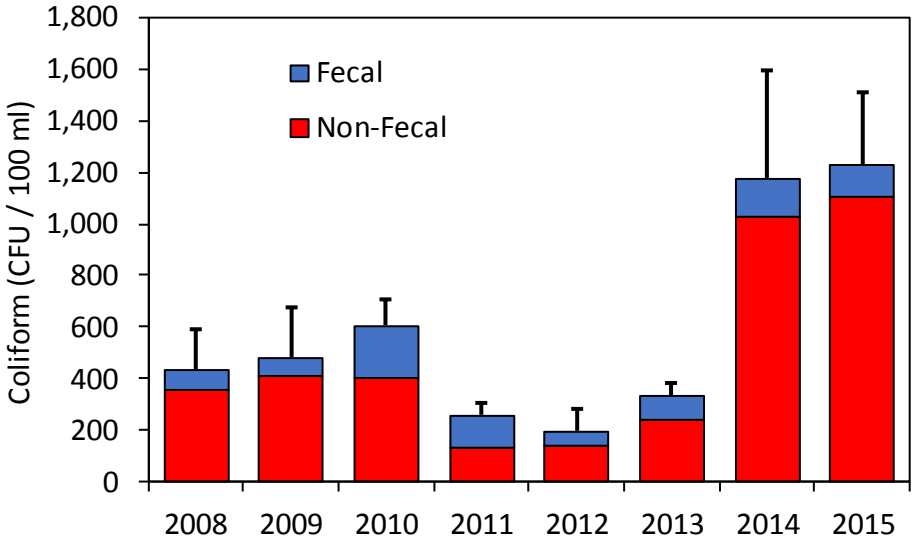

Figure 19. Fecal (blue) and non-fecal (red) coliform levels (colony forming unit; CFU / 100 ml) measured during late October in 2008-2015 in the Millstone River. Bars show average coliform levels from 3-5 sampling stations. Error bars represent ±1 standard error of total coliform (the sum of fecal and non-fecal coliforms).

Total and fecal coliform levels generally increased with distance downstream (Figure 20). Total coliform levels increased by 156% between station 1 (304 CFU / 100 ml) and station 5 (779 CFU / 100 ml). The proportion of total coliform made up of fecal coliforms was highest in the side channel (station 4: 35%). The increase in coliform levels downstream coincided with an increase in turbidity (Figure 14). Increased turbidity reflects elevated levels of suspended solids, which are typically correlated with coliform levels as the solids provide substrate for bacteria to proliferate. Potential sources of total coliform may include spawning salmon in the river and side channel, while fecal coliforms may come from warm-blooded animals (e.g., waterfowl, beavers, dogs).

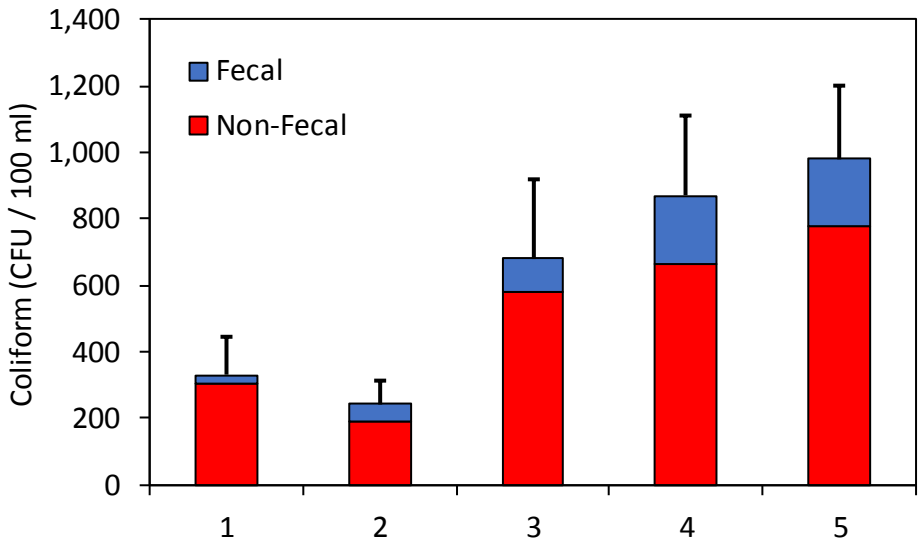

Figure 20. Fecal (blue) and non-fecal (red) coliforms (colony forming unit; CFU / 100 ml) measured at five stations during two sampling events in the Millstone River. Bars show average coliform levels between 2008 and 2015. Error bars represent ±1 standard error of total coliform (the sum of fecal and non-fecal coliforms).

4.3. Stream Invertebrates

Stream invertebrate densities fluctuated between years, with average levels ranging from 111 animals / m^2 (in 2015) to 1,743 animals / m^2 (in 2012) (Figure 21). Overall, the proportion of stream invertebrates made up of "pollution sensitive" taxa (category 1) ranged from 12 to 65%. Pollution sensitive taxa include mayflies, caddisflies and stoneflies, which are indicators of good water quality.

Stream invertebrate densities fluctuated between stations, with the highest levels (1,361 animals / m^2) observed at station 4 (side channel) (Figure 22). The high animal density recorded in the side channel suggests that this habitat has remained relatively productive since its construction in 2007.

Site assessment ratings ranged from 1.8 to 2.8 (out of 4.0), with an overall average of 2.3 from 2008 to 2015 (Figure 23). This average rating suggests that "marginal" to "acceptable" conditions existed for community abundance and diversity of stream invertebrates during most years. The highest average site assessment rating (2.6) was recorded at station 4 (side channel). There was no apparent temporal or spatial trend in animal density or site assessment rating, or correlation with water quality parameters. All Invertebrate Survey Field Data Sheets are included in Appendix C (Tables C.1 to C.8).

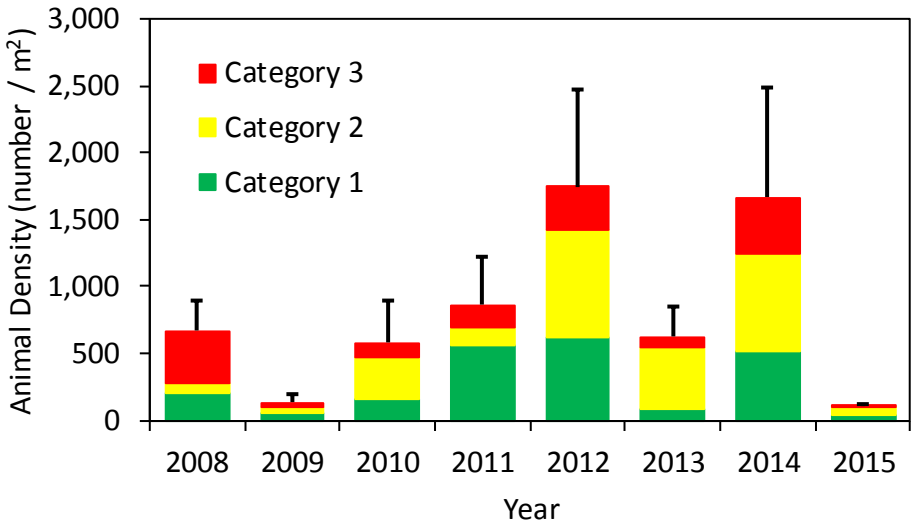

Figure 21. Density of stream invertebrates (number of animals / m^2) measured during late October in 2008-2015 in the Millstone River. Bars represent average densities from 3-5 sampling stations. Colours represent "pollution sensitive" taxa (green; category 1), "somewhat pollution tolerant" taxa (yellow; category 2), and "pollution tolerant" taxa (red; category 3). Error bars represent ±1 standard error of total animal density.

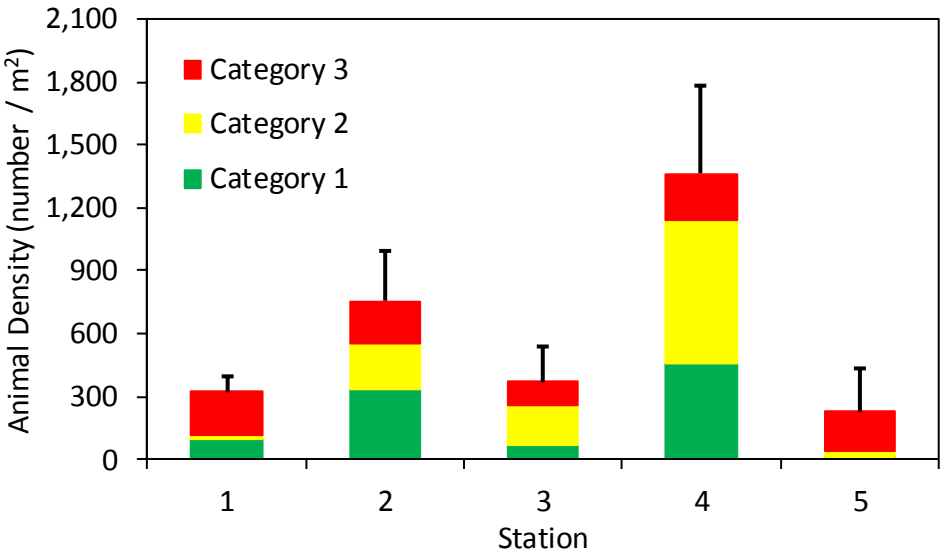

Figure 22. Density of stream invertebrates (number of animals / m^2) measured at five stations during late October in the Millstone River. Bars represent average densities between 2008 and 2015. Colours represent "pollution sensitive" taxa (green; category 1), "somewhat pollution tolerant" taxa (yellow; category 2), and "pollution tolerant" taxa (red; category 3). Error bars represent ±1 standard error of total animal density.

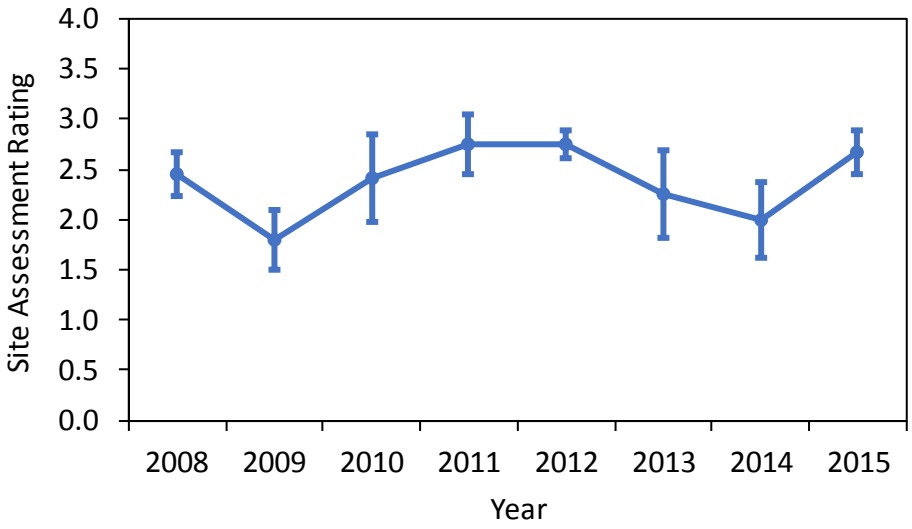

Figure 23. Site assessment ratings (range: 1 = "poor", 2 = "marginal", 3 = "acceptable", 4 = "Good") for the stream invertebrates communities assessed during late October in 2008-2015 in the Millstone River. Points show average ratings from 3-5 sampling stations. Error bars represent ±1 standard error of site assessment ratings.

5. Conclusions

Results from this 8-year environmental monitoring program suggest that water quality has remained consistently "acceptable" for the Millstone River. No serious deficiency in water quality parameters were observed as part of this monitoring project between 2008 and 2015. With only a few exceptions, all water quality parameters were well within the BC water quality guidelines.

Some results warrant continued monitoring of the Millstone River. These include: (1) elevated nitrate levels in Benson Creek, (2) consistently elevated coliform levels, and (3) aluminum concentrations above BC water quality guidelines. It should be noted that none of these results are suggestive of adverse or deteriorating water quality. Continued monitoring at the same time of year and location, and using consistent methodologies will provide a long-term time series, which will be helpful to detect changes in environmental quality.

6. Acknowledgements

This long-term monitoring project would not have been possible without continued interest and support from Fisheries and Oceans Canada. We would like to acknowledge Margaret Wright (Fisheries and Oceans Canada) for continued support in facilitating this and other monitoring projects.

Long-term monitoring was conducted by students attending the Environmental Monitoring (RMOT 306) course at Vancouver Island University. Students conducted all tasks related to site

visits, project proposal, field sampling, laboratory analyses, and oral and written presentations. The following students conducted the yearly monitoring projects:

- 2008: B. Brooks, M. Fuller, L. Isaac, J. Patterson, B. Simmons, and L. Sobie
- 2009: A. Goeppel, N. Hamilton, A. Kennedy, F. Raffaelli, J. Sellars, and S. Vickers
- 2010: D. Clark, A. Hile, and C. McCulloch
- 2011: D. McNeill, C. Smith, and C. White
- 2012: J. Hopps, S. Johnson, J. McIndoe, and J. Paquin
- 2013: E. Badgero, S. Cappus, N. Hepp, and K. Robinson
- 2014: N. Bacheldor, S. Isaak, I. Kearns, and C. Miller
- 2015: A. Horsfield, A. Simpson, L. Sunduk, and H. Stark

The Resource Management and Protection (RMAP) and Biology Departments at Vancouver Island University provided some laboratory supplies, equipment, vehicle and covered fuel expenses. The Regional District of Nanaimo and Fisheries and Oceans Canada provided funding for analytical processing of water samples. ALS Laboratory provided reduced rates on some of their analytical services for this project and other projects conducted as part of the Environmental Monitoring course. We would also like to acknowledge Amber Springer (ALS Laboratory) for continued support of these monitoring projects.

7. References

RISC. 1998. Guidelines for Interpreting Water Quality Data. Resources Information Standards Committee, Victoria, BC.

Taccogna, G., and K. Munro (eds). 1995. The Streamkeepers Handbook: a Practical Guide to Stream and Wetland Care. Salmonid Enhancement Program, Dept. Fisheries and Oceans, Vancouver, BC.

Vancouver Island University (VIU: B. Brooks, M. Fuller, L. Isaac, J. Patterson, B. Simmons, L. Sobie, and E. Demers). 2009. Water Quality and Stream Invertebrate Assessment for the Millstone River, Nanaimo, BC (Fall 2008). Data Report.

Vancouver Island University (VIU: A. Goeppel, N. Hamilton, A. Kennedy, F. Raffaelli, J. Sellars, S. Vickers, and E. Demers). 2010. Water Quality and Stream Invertebrate Assessment for the Millstone River, Nanaimo, BC (Fall 2009). Data Report.

Vancouver Island University (VIU: D. Clark, A. Hile, C. McCulloch, and E. Demers). 2011. Water Quality and Stream Invertebrate Assessment for the Millstone River, Nanaimo, BC (Fall 2010). Data Report.

Vancouver Island University (VIU: D. McNeill, C. Smith, C. White, and E. Demers). 2012. Water Quality and Stream Invertebrate Assessment for the Millstone River, Nanaimo, BC (Fall 2011). Data Report.

8. Appendix A

Table A.1. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2008. All values are expressed in mg/L unless specified otherwise.

Parameters	27 October 2008					17 November 2008				
	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (°C)	6.2	10.6	9.0	8.9	9.0	7.3	9.0	8.8	9.1	9.1
Dissolved Oxygen	13.1	11.0	11.1	12.5	12.4	11.1	9.5	9.2	11.0	11.2
Conductivity (µS/cm)	65.4	72.6	87.1	116	115	38.4	71.4	90.2	106	106
pH (pH units)	7.49	7.26	7.33	7.48	7.54	7.37	7.62	7.74	7.82	7.85
Alkalinity	22.0	23.4	28.9	38.8	35.6	16	24	27	34	35
Hardness, Total	25.0	27.6	32.1	37.4	37.7	15.0	27.0	32.9	35.9	35.7
Nutrients										
Bromide (Br)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chloride (Cl)	2.63	5.05	6.0	10.1	10.1	1.52	4.49	6.06	8.36	8.31
Fluoride (F)	<0.020	<0.020	<0.020	0.022	0.021	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (as N)	0.262	<0.0050	0.0055	0.0138	0.0108	0.145	0.052	0.112	0.144	0.147
Nitrite (as N)	<0.0010	<0.0010	<0.0010	<0.0010	0.0014	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulfate (SO_4)	6.23	4.53	5.23	5.81	5.85	2.68	4.28	5.15	5.61	5.62
Coliforms										
Non-fecal (CFU/100 ml)	92	64	444	605	565					
Fecal (CFU/100 ml)	4	4	28	188	180					
% fecal	4.2	5.7	5.9	23.7	24.2					

(Continued on next page)

Table A.1. (Continued)

Parameters	27 October 2008					17 November 2008				
	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	<0.20	<0.20	<0.20	0.22	<0.20	<0.20	<0.20	<0.20	0.24	<0.20
Antimony (Sb)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic (As)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Barium (Ba)	<0.010	<0.010	<0.010	0.016	<0.010	<0.010	<0.010	<0.010	0.016	<0.010
Berylium (Be)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Boron (B)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium (Ca)	6.96	7.37	8.7	10.3	10.5	4.18	7.23	9.01	9.97	10.00
Chromium (Cr)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt (Co)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Copper (Cu)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron (Fe)	<0.030	0.094	0.152	0.383	0.188	<0.030	0.104	0.18	0.392	0.266
Lead (Pb)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium (Li)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Magnesium (Mg)	1.86	2.23	2.53	2.81	2.8	1.11	2.17	2.53	2.66	2.60
Manganese (Mn)	<0.0050	0.0173	0.0101	0.0325	0.012	<0.0050	0.0171	0.0169	0.0363	0.0238
Molybdenum (Mo)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel (Ni)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphorus (P)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon (Si)	3.63	2.72	2.93	3.04	2.87	3.44	3.04	3.33	3.66	3.49
Silver (Ag)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium (Na)	2.8	3.6	4.7	7.8	7.9	<2.0	3.6	5.2	7.1	7.0
Strontium (Sr)	0.0252	0.0266	0.0517	0.0665	0.066	0.0166	0.0285	0.071	0.0689	0.0693
Thallium (Tl)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tin (Sn)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium (Ti)	<0.010	<0.010	<0.010	0.013	<0.010	<0.010	<0.010	<0.010	0.013	<0.010
Vanadium (V)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc (Zn)	<0.0050	<0.0050	<0.0050	0.0098	<0.0050	<0.0050	<0.0050	<0.0050	0.0073	<0.0050

Table A.2. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2009. All values are expressed in mg/L unless specified otherwise.

Parameters	2 November 2009					25 November 2009				
	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (ºC)	7.6	10.6	9.8	9.2	8.8	7.4	8.9	8.3	7.2	7.3
Dissolved Oxygen	11.7	9.5	11.2	10.8	11.0	11.2	7.8	10.4	11.3	11.6
Conductivity (µS/cm)	35.5	82.8	84.4	118	119	25.5	57.9	70.2	76.0	75.3
pH (pH units)	7.22	7.45	7.48	7.69	7.73	7.49	7.32	7.32	7.05	7.14
Alkalinity	37	29	27	32	33	26	27	28	25	24
Hardness, Total	13.5	29.7	31.0	38.8	38.9	12.6	24.0	28.6	27.2	26.8
Turbidity (NTU)	2.0	2.0	4.0	2.0	1.0	7.0	8.0	8.0	6.0	4.0
Nutrients										
Ammonia	<0.020	<0.020	<0.020	<0.020	<0.020	0.023	0.023	0.048	0.047	0.177
Nitrate	0.349	0.030	0.055	0.156	0.176	0.059	0.162	0.243	0.274	0.292
Nitrite	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Orthophosphate	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0023	0.0037	0.0038	0.0035
Total Phosphorus	0.0086	0.0538	0.0082	0.0102	0.0115	0.0112	0.0179	0.0170	0.0201	0.0175
Coliforms										
Non-fecal (CFU/100 ml)	30	131	272	575	1049					
Fecal (CFU/100 ml)	30	30	101	96	91					
% fecal	50.0	18.6	27.1	14.3	8.0					

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Table A.2. (Continued)

Parameters	2 November 2009					25 November 2009				
	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	<0.20	<0.20	<0.20	<0.20	<0.20	0.22	0.28	0.36	0.28	0.31
Antimony (Sb)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic (As)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Barium (Ba)	<0.010	<0.010	<0.010	0.011	0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Berylium (Be)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Boron (B)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium (Ca)	3.69	7.82	8.23	10.8	10.8	3.46	6.52	7.96	7.61	7.47
Chromium (Cr)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cobalt (Co)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Copper (Cu)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron (Fe)	0.091	0.162	0.176	0.208	0.219	0.262	0.527	0.553	0.434	0.516
Lead (Pb)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium (Li)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Magnesium (Mg)	1.03	2.48	2.54	2.89	2.89	0.96	1.87	2.12	2.00	1.98
Manganese (Mn)	<0.0050	0.0166	0.0134	0.0229	0.0189	<0.0050	0.0220	0.0183	0.0209	0.0166
Molybdenum (Mo)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel (Ni)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phosphorus (P)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Selenium (Se)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon (Si)	3.25	2.76	2.90	3.16	3.16	3.35	3.72	3.85	3.75	3.67
Silver (Ag)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium (Na)	<2.0	4.5	4.6	8.3	8.4	<2.0	3.5	5.5	5.8	5.6
Strontium (Sr)	0.0141	0.0305	0.0322	0.0792	0.0796	0.0140	0.0266	0.0549	0.0504	0.0513
Thallium (Tl)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tin (Sn)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium (Ti)	<0.010	<0.010	<0.010	<0.010	<0.010	0.012	0.014	0.017	0.014	0.018
Vanadium (V)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc (Zn)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table A.3. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2010. All values are expressed in mg/L unless specified otherwise.

	3 November 2010					24 November 2010				
Parameters	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (ºC)	8.2	9.4	10.3	9.7	9.9	2.5	6.4	4.1	3.0	2.1
Dissolved Oxygen	11.9	11.4	10.8	11.3	10.8	15.1	16.0	13.4	11.1	16.8
Conductivity (µS/cm)	89.0	90.2	75.8	70.0		122	112	88.8	67.8	
pH (pH units)	7.56	7.54	7.42	7.39		7.83	7.83	7.72	7.53	
Alkalinity	23	21	24	32	25	14	22	30	47	35
Hardness, Total	32.5	32.4	28.2	29.5		36.0	36.2	31.6	26.2	
Turbidity (NTU)	1.0	2.0	3.0	9.0	9.0	1.0	3.0	2.0	3.0	3.0
Nutrients										
Ammonia	<0.0050	0.0073	0.0055	<0.0050	<0.0050	0.0117	0.0110	0.0131	0.0227	
Nitrate	0.223	0.218	0.142	0.0098	0.223	0.214	0.201	0.162	0.080	
Nitrite	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Orthophosphate	<0.0010	0.0018	<0.0010	<0.0010	<0.0010	0.0011	0.0011	<0.0010	<0.0010	
Total Phosphorus	0.0167	0.0198	0.0137	0.0085	0.0167	0.0096	0.0084	0.0085	0.0141	
Coliforms										
Non-fecal (CFU/100 ml)	524	160	404	328	604					
Fecal (CFU/100 ml)	80	80	160	444	244					
% fecal	13.2	33.3	28.4	57.5	28.8					

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Table A.3. (Continued)

	3 November 2010					24 November 2010				
Parameters	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	0.37	0.39	0.26	<0.20		<0.20	<0.20	<0.20	<0.20	
Antimony (Sb)	<0.20	<0.20	<0.20	<0.20		<0.20	<0.20	<0.20	<0.20	
Arsenic (As)	<0.20	<0.20	<0.20	<0.20		<0.20	<0.20	<0.20	<0.20	
Barium (Ba)	0.011	0.013	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
Berylium (Be)	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050	<0.0050	<0.0050	
Bismuth (Bi)	<0.20	<0.20	<0.20	<0.20		<0.20	<0.20	<0.20	<0.20	
Boron (B)	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	
Cadmium (Cd)	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
Calcium (Ca)	9.01	9.00	7.73	7.93		10.2	10.2	8.85	7.16	
Chromium (Cr)	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
Cobalt (Co)	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
Copper (Cu)	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
Iron (Fe)	0.629	0.529	0.399	0.129		0.301	0.290	0.271	0.405	
Lead (Pb)	<0.050	<0.050	<0.050	<0.050		<0.050	<0.050	<0.050	<0.050	
Lithium (Li)	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
Magnesium (Mg)	2.43	2.41	2.17	2.36		2.57	2.60	2.32	2.03	
Manganese (Mn)	0.0405	0.0426	0.0251	0.0145		0.0203	0.0204	0.0246	0.0743	
Molybdenum (Mo)	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030	<0.030	<0.030	
Nickel (Ni)	<0.050	<0.050	<0.050	<0.050		<0.050	<0.050	<0.050	<0.050	
Phosphorus (P)	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	
Potassium (K)	<2.0	<2.0	<2.0	<2.0		<2.0	<2.0	<2.0	<2.0	
Selenium (Se)	<0.20	<0.20	<0.20	<0.20		<0.20	<0.20	<0.20	<0.20	
Silicon (Si)	3.97	3.84	3.48	3.28		3.90	3.94	3.79	3.76	
Silver (Ag)	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	
Sodium (Na)	5.9	6.0	4.1	3.2		9.6	8.2	5.0	3.0	
Strontium (Sr)	0.0585	0.0596	0.0508	0.0311		0.0738	0.0744	0.0729	0.0287	
Thallium (Tl)	<0.20	<0.20	<0.20	<0.20		<0.20	<0.20	<0.20	<0.20	
Tin (Sn)	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030	<0.030	<0.030	
Titanium (Ti)	0.023	0.018	0.016	<0.010		<0.010	<0.010	<0.010	<0.010	
Vanadium (V)	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030	<0.030	<0.030	
Zinc (Zn)	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050	<0.0050	<0.0050	

Table A.4. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2011. All values are expressed in mg/L unless specified otherwise.

	29 October 2011					20 November 2011				
Parameters	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (ºC)	6.2	10.2	7.9	7.6	7.7	1.8	6.8	4.1	3.9	4.0
Dissolved Oxygen	13.2	10.2	11.5	12.8	13.2	14.9	10.7	13.4	14.3	14.5
Conductivity (µS/cm)	48.1	75.0		166		38.7	72.3		144	
pH (pH units)	7.89	7.89		8.03		7.45	7.49		7.80	
Alkalinity	12	17	32	44	50	11	24	28	38	38
Hardness, Total	18.8	28.6		52.2		15.0	27.8		43.8	
Turbidity (NTU)	0.2	0.8	1.5	2.0	1.6	0.2	1.2	1.7	1.5	1.2
Nutrients										
Ammonia	<0.0050	0.0070		0.0059		<0.0050	0.0109		0.0063	
Nitrate	0.151	<0.0050		0.0895		0.223	0.043		0.169	
Nitrite	0.0048	<0.0010		<0.0010		<0.0010	<0.0010		<0.0010	
Orthophosphate	<0.0010	<0.0010		0.0015		<0.0010	<0.0010		<0.0010	
Total Phosphorus	0.0029	0.0082		0.0138		<0.0020	0.0066		0.0087	
Coliforms										
Non-fecal (CFU/100 ml)	112	188	108	136	108					
Fecal (CFU/100 ml)	0	64	116	260	204					
% fecal	0.0	25.4	51.8	65.7	65.4					

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Table A.4. (Continued)

	29 October 2011					20 November 2011				
Parameters	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	<0.20	<0.20		<0.20		<0.20	0.27		<0.20	
Antimony (Sb)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Arsenic (As)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Barium (Ba)	<0.010	<0.010		0.018		<0.010	<0.010		0.014	
Berylium (Be)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	
Bismuth (Bi)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Boron (B)	<0.10	<0.10		<0.10		<0.10	<0.10		<0.10	
Cadmium (Cd)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Calcium (Ca)	5.26	7.69		15.1		4.18	7.49		12.5	
Chromium (Cr)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Cobalt (Co)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Copper (Cu)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Iron (Fe)	<0.030	0.208		0.384		<0.030	0.669		0.236	
Lead (Pb)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Lithium (Li)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Magnesium (Mg)	1.37	2.29		3.49		1.11	2.22		3.08	
Manganese (Mn)	<0.0050	0.0238		0.0171		<0.0050	0.106		0.0111	
Molybdenum (Mo)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Nickel (Ni)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Phosphorus (P)	<0.30	<0.30		<0.30		<0.30	<0.30		<0.30	
Potassium (K)	<2.0	<2.0		<2.0		<2.0	<2.0		<2.0	
Selenium (Se)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Silicon (Si)	3.71	2.57		3.25		3.52	3.56		3.86	
Silver (Ag)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Sodium (Na)	2.1	3.4		12.2		<2.0	3.4		12.6	
Strontium (Sr)	0.0198	0.0289		0.125		0.0161	0.0297		0.0840	
Thallium (Tl)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Tin (Sn)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Titanium (Ti)	<0.010	<0.010		<0.010		<0.010	0.015		<0.010	
Vanadium (V)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Zinc (Zn)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	

Table A.5. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2012. All values are expressed in mg/L unless specified otherwise.

	29 October 2012					19 November 2012				
Parameters	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (ºC)	7.9	11.2	9.8	9.8	10.2	6.8	8.2	7.8	7.7	7.8
Dissolved Oxygen	10.5	8.9	9.3	10.2	10.0	10.6	8.7	10.2	10.7	10.5
Conductivity (µS/cm)	32.2	71.2		118		25.5	62.2		74.7	
pH (pH units)	7.25	7.59		7.71		7.13	7.47		7.51	
Alkalinity	10	14	22	29	23	9	17	18	22	19
Hardness, Total	13.1	29.7		41.4		11.0	24.8		26.0	
Turbidity (NTU)	0.5	0.6	1.8	3.7	4.5	1.5	0.9	2.5	3.9	3.6
Nutrients										
Ammonia	<0.0050	<0.0050		0.0066		<0.0050	0.0057		0.0078	
Nitrate	0.369	0.009		0.220		0.148	0.091		0.308	
Nitrite	<0.0010	<0.0010		0.0015		<0.0010	<0.0010		<0.0010	
Orthophosphate	<0.0010	<0.0010		0.0019		<0.0010	0.0011		0.0036	
Total Phosphorus	0.0076	0.0143		0.0355		0.0119	0.0092		0.0294	
Coliforms										
Non-fecal (CFU/100 ml)	280	8		132						
Fecal (CFU/100 ml)	32	20		116						
% fecal	10.3	71.4		46.8						

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Table A.5. (Continued)

	29 October 2012					19 November 2012				
Parameters	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	<0.20	<0.20		0.45		0.45	<0.20		0.60	
Antimony (Sb)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Arsenic (As)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Barium (Ba)	<0.010	<0.010		0.020		<0.010	<0.010		0.014	
Berylium (Be)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	
Bismuth (Bi)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Boron (B)	<0.10	<0.10		<0.10		<0.10	<0.10		<0.10	
Cadmium (Cd)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Calcium (Ca)	3.62	7.90		11.7		2.97	6.70		7.14	
Chromium (Cr)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Cobalt (Co)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Copper (Cu)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Iron (Fe)	0.069	0.072		0.731		0.474	0.149		0.787	
Lead (Pb)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Lithium (Li)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Magnesium (Mg)	0.99	2.43		2.95		0.87	1.95		1.99	
Manganese (Mn)	<0.0050	0.0109		0.0640		0.0088	0.0189		0.0439	
Molybdenum (Mo)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Nickel (Ni)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Phosphorus (P)	<0.30	<0.30		<0.30		<0.30	<0.30		<0.30	
Potassium (K)	<2.0	<2.0		<2.0		<2.0	<2.0		<2.0	
Selenium (Se)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Silicon (Si)	3.07	2.95		3.59		3.41	3.22		4.00	
Silver (Ag)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Sodium (Na)	<2.0	3.7		9.0		<2.0	2.9		5.3	
Strontium (Sr)	0.0145	0.0316		0.0886		0.0117	0.0263		0.0433	
Thallium (Tl)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Tin (Sn)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Titanium (Ti)	<0.010	<0.010		0.025		0.023	<0.010		0.031	
Vanadium (V)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Zinc (Zn)	<0.0050	<0.0050		0.0052		<0.0050	<0.0050		<0.0050	

Table A.6. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2013. All values are expressed in mg/L unless specified otherwise.

	27 October 2013					17 November 2013				
Parameters	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (ºC)	9.2	12.5	11.0	10.3	10.6	5.9	8.8	7.9	7.6	7.6
Dissolved Oxygen	11.2	11.0	10.4	10.8	11.5	12.8	10.5	11.8	12.3	12.7
Conductivity (µS/cm)	68.1	74.5		133		40.8	71.4		109	40.8
pH (pH units)	7.43	7.61		7.82		7.61	7.45		7.64	7.61
Alkalinity										
Hardness, Total	27.4	30.2		46.1		16.1	28.2		38.0	16.1
Turbidity (NTU)	0.5	1.7	0.9	4.8	1.4	0.2	0.6	1.1	1.3	1.0
Nutrients										
Ammonia	<0.0050	<0.0050		0.0249		<0.0050	0.0057		0.0382	
Nitrate	0.0359	<0.0050		0.0224		0.153	0.052		0.140	
Nitrite	<0.0010	<0.0010		<0.0010		<0.0010	<0.0010		0.0016	
Total Nitrogen	0.134	0.220		0.280		0.216	0.215		0.380	
Orthophosphate	<0.0010	<0.0010		0.0013		<0.0010	0.0010		0.0036	
Total Phosphorus	0.0050	0.0101		0.0305		0.0022	0.0068		0.0296	
Coliforms										
Non-fecal (CFU/100 ml)	228	404	220	132	220					
Fecal (CFU/100 ml)	28	116	60	124	132					
% fecal	10.9	22.3	21.4	48.4	37.5					

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Table A.6. (Continued)

	27 October 2013					17 November 2013				
Parameters	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Antimony (Sb)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Arsenic (As)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Barium (Ba)	<0.010	<0.010		0.015		<0.010	<0.010		0.012	
Berylium (Be)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	
Bismuth (Bi)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Boron (B)	<0.10	<0.10		<0.10		<0.10	<0.10		<0.10	
Cadmium (Cd)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Calcium (Ca)	7.61	8.04		13.0		4.49	7.59		10.6	
Chromium (Cr)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Cobalt (Co)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Copper (Cu)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Iron (Fe)	0.037	0.210		0.442		<0.030	0.120		0.369	
Lead (Pb)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Lithium (Li)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Magnesium (Mg)	2.04	2.47		3.33		1.18	2.24		2.78	
Manganese (Mn)	<0.0050	0.0197		0.0313		<0.0050	0.0192		0.0211	
Molybdenum (Mo)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Nickel (Ni)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Phosphorus (P)	<0.30	<0.30		<0.30		<0.30	<0.30		<0.30	
Potassium (K)	<2.0	<2.0		<2.0		<2.0	<2.0		<2.0	
Selenium (Se)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Silicon (Si)	4.30	3.25		3.57		3.55	3.29		3.78	
Silver (Ag)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Sodium (Na)	3.1	3.8		9.9		<2.0	3.4		7.4	
Strontium (Sr)	0.0281	0.0284		0.0954		0.0176	0.0288		0.0737	
Thallium (Tl)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Tin (Sn)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Titanium (Ti)	<0.010	<0.010		0.015		<0.010	<0.010		0.013	
Vanadium (V)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Zinc (Zn)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	

Table A.7. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2014. All values are expressed in mg/L unless specified otherwise.

	26 October 2014					16 November 2014				
Parameters	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (ºC)	9.7	12.6	12.3	11.4	11.4	5.4	8.3	6.4	5.6	5.1
Dissolved Oxygen	11.3	9.0	9.8	10.6	11.0	13.1	9.6	11.7	12.9	13.1
Conductivity (µS/cm)	33.0	81.3		119	33.0	44.3	72.4		106	
pH (pH units)	7.16	7.60		7.66	7.16	7.42	7.52		7.73	
Alkalinity	13	29	30	34	36	14	28	34	38	42
Hardness, Total	13.7	31.9		40.5	13.7	18.3	29.1		39.5	
Turbidity (NTU)	2.1	3.5	5.3	6.7	14.7	1.4	1.1	2.5	2.9	1.7
Nutrients										
Ammonia	<0.0050	<0.0050		0.0168		<0.0050	0.0055		0.0076	
Nitrate	0.446	0.0118		0.726		0.188	0.134		0.279	
Nitrite	<0.0010	<0.0010		0.0031		<0.0010	<0.0010		0.0012	
Total Nitrogen	0.588	0.215		1.05		0.276	0.323		0.464	
Orthophosphate	<0.0010	<0.0010		0.0073		<0.0010	<0.0010		0.0029	
Total Phosphorus	0.0058	0.0063		0.0353		<0.0020	0.0053		0.0113	
Coliforms										
Non-fecal (CFU/100 ml)	196	56	1856	1534	1493					
Fecal (CFU/100 ml)	8	64	184	236	260					
% fecal	3.9	53.3	9.0	13.3	14.8					

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Table A.7. (Continued)

	26 October 2014					16 November 2014				
Parameters	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	<0.20	<0.20		0.72		<0.20	<0.20		<0.20	
Antimony (Sb)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Arsenic (As)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Barium (Ba)	<0.010	<0.010		0.021		<0.010	<0.010		0.010	
Berylium (Be)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	
Bismuth (Bi)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Boron (B)	<0.10	<0.10		<0.10		<0.10	<0.10		<0.10	
Cadmium (Cd)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Calcium (Ca)	3.78	8.50		11.4		5.15	7.96		11.1	
Chromium (Cr)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Cobalt (Co)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Copper (Cu)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Iron (Fe)	0.142	0.118		1.16		<0.030	0.173		0.326	
Lead (Pb)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Lithium (Li)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Magnesium (Mg)	1.03	2.59		2.91		1.33	2.25		2.84	
Manganese (Mn)	<0.0050	0.0123		0.0963		<0.0050	0.0226		0.0224	
Molybdenum (Mo)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Nickel (Ni)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Phosphorus (P)	<0.30	<0.30		<0.30		<0.30	<0.30		<0.30	
Potassium (K)	<2.0	<2.0		<2.0		<2.0	<2.0		<2.0	
Selenium (Se)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Silicon (Si)	3.69	2.61		4.59		3.79	3.35		3.92	
Silver (Ag)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Sodium (Na)	<2.0	4.0		8.8		<2.0	3.6		7.3	
Strontium (Sr)	0.0129	0.0297		0.0671		0.0199	0.0310		0.0771	
Thallium (Tl)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Tin (Sn)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Titanium (Ti)	<0.010	<0.010		0.038		<0.010	<0.010		<0.010	
Vanadium (V)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Zinc (Zn)	<0.0050	<0.0050		0.0075		<0.0050	<0.0050		<0.0050	

Table A.8. Water quality results for water samples taken from 5 stations at the Millstone River during fall 2015. All values are expressed in mg/L unless specified otherwise.

	2 November 2015					23 November 2015				
Parameters	1	2	3	4	5	1	2	3	4	5
General / Physical										
Water Temperature (ºC)	8.2	12.4	9.9	9.6	9.4	5.1	7.9	7.3	7.1	7.1
Dissolved Oxygen	11.5	10.0	10.2	11.1	11.3	12.1	9.6	11.0	11.8	12.1
Conductivity (µS/cm)	50.3	85.6		190		40.2	80.8		113	
pH (pH units)	7.02	7.54		7.67		7.20	7.45		7.62	
Alkalinity	12	28	30	33	32	11	26	28	31	32
Hardness, Total	19.3	34.6		60.4		14.5	31.1		36.2	
Turbidity (NTU)	1.7	1.2	2.4	5.2	4.7	0.2	0.9	1.2	2.3	2.7
Nutrients										
Ammonia	<0.0050	<0.0050		0.0236		<0.0050	0.0075		0.0195	
Nitrate	1.05	<0.0050		1.08		0.311	0.0813		0.345	
Nitrite	<0.0010	<0.0010		0.0063		<0.0010	<0.0010		0.0013	
Total Nitrogen	1.39	0.199		1.52		0.402	0.271		0.563	
Orthophosphate	0.0011	<0.0010		0.0080		<0.0010	<0.0010		0.0029	
Total Phosphorus	0.0112	0.0054		0.0246		0.0027	0.0041		0.0167	
Coliforms										
Non-fecal (CFU/100 ml)	969	525	767	1856	1412					
Fecal (CFU/100 ml)	28	28	36	200	304					
% fecal	2.8	5.1	4.5	9.7	17.7					

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Table A.8. (Continued)

	2 November 2015					23 November 2015				
Parameters	1	2	3	4	5	1	2	3	4	5
Total Metals										
Aluminum (Al)	<0.20	<0.20		0.23		<0.20	<0.20		0.23	
Antimony (Sb)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Arsenic (As)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Barium (Ba)	<0.010	<0.010		0.021		<0.010	<0.010		0.011	
Berylium (Be)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	
Bismuth (Bi)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Boron (B)	<0.10	<0.10		<0.10		<0.10	<0.10		<0.10	
Cadmium (Cd)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Calcium (Ca)	5.40	9.31		17.6		4.06	8.39		10.1	
Chromium (Cr)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Cobalt (Co)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Copper (Cu)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Iron (Fe)	0.067	0.090		0.462		<0.030	0.165		0.385	
Lead (Pb)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Lithium (Li)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Magnesium (Mg)	1.41	2.76		4.00		1.07	2.46		2.67	
Manganese (Mn)	<0.0050	0.0090		0.0305		<0.0050	0.0262		0.0245	
Molybdenum (Mo)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Nickel (Ni)	<0.050	<0.050		<0.050		<0.050	<0.050		<0.050	
Phosphorus (P)	<0.30	<0.30		<0.30		<0.30	<0.30		<0.30	
Potassium (K)	<2.0	<2.0		<2.0		<2.0	<2.0		<2.0	
Selenium (Se)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Silicon (Si)	3.77	2.83		4.05		3.54	3.25		3.72	
Silver (Ag)	<0.010	<0.010		<0.010		<0.010	<0.010		<0.010	
Sodium (Na)	2.2	3.9		13.2		<2.0	3.6		7.4	
Strontium (Sr)	0.0213	0.0359		0.121		0.0161	0.0331		0.0658	
Thallium (Tl)	<0.20	<0.20		<0.20		<0.20	<0.20		<0.20	
Tin (Sn)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Titanium (Ti)	<0.010	<0.010		0.016		<0.010	<0.010		0.014	
Vanadium (V)	<0.030	<0.030		<0.030		<0.030	<0.030		<0.030	
Zinc (Zn)	<0.0050	<0.0050		<0.0050		<0.0050	<0.0050		<0.0050	

9. Appendix B

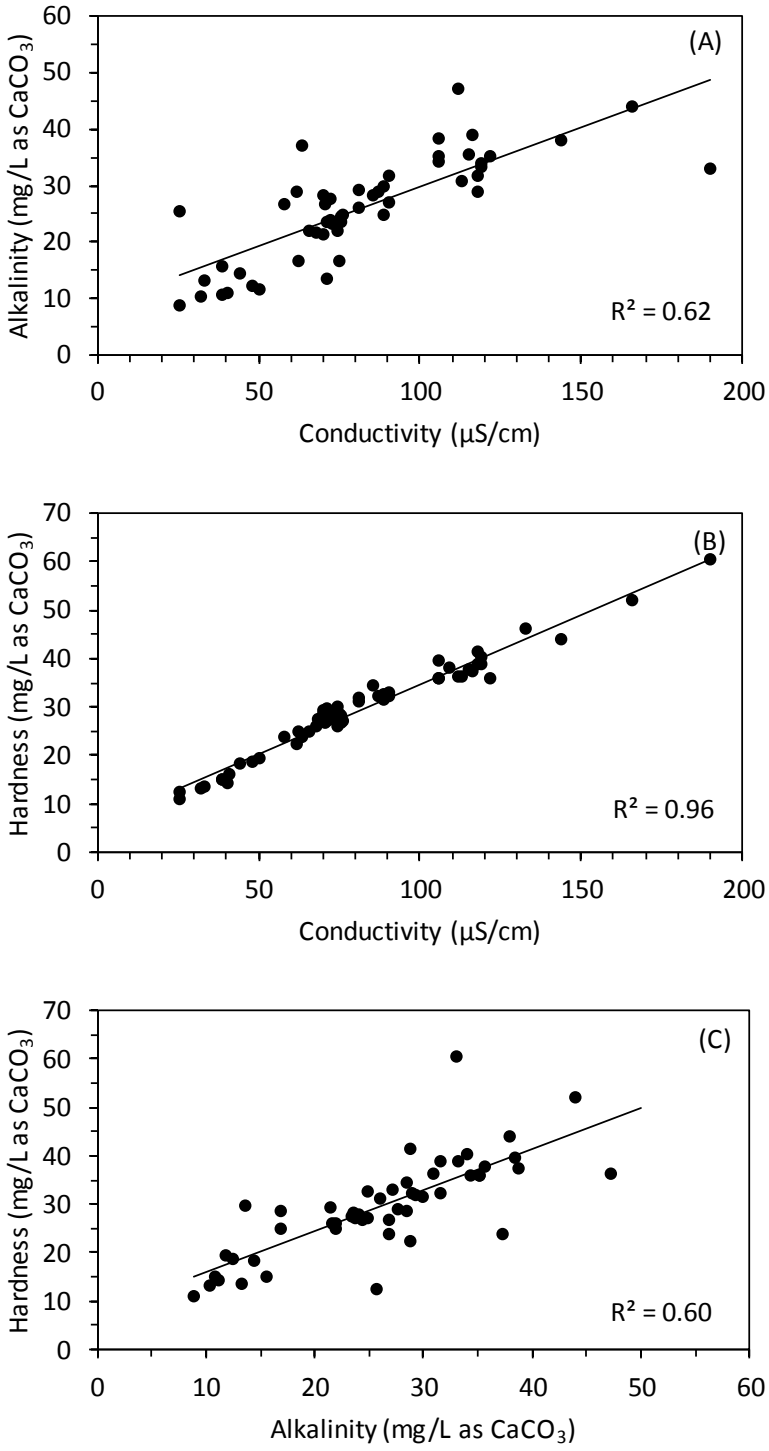

Figure B.1. Linear relationships between (A) alkalinity and conductivity, (B) hardness and conductivity, and (C) harness and alkalinity measured at five stations in the Millstone River during two sampling events in 2008-2015.

10. Appendix C

Table C.1. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 1-5 on the Millstone River during 2008.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Benson Creek		Date: 28 October 2008
Station Name: **Station 1**		Flow status: Low
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	12	2
	Mayfly Nymph (EPT)	8	1
	Stonefly Nymph (EPT)	10	1
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		30	4
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	2	1
	Cranefly Larva	2	1
Somewhat Pollution Tolerant	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	2	1
	Watersnipe Larva		
Sub-Total		6	3
Category 3	Aquatic Worm (oligochaete)	53	2
	Blackfly Larva		
	Leech		
Pollution Tolerant	Midge Larva (chironomid)	1	1
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite	2	1
Sub-Total		56	4
TOTAL		92	11

Table C.1. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 92

DENSITY: Invertebrate density per square metre:

92 ÷ 0.27 = 341

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 3 + 4 = 22

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

2 + 1 + 1 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.75	0.25-0.50	0-0.25

(EPT1 + EPT2 + EPT3) / CT

(12 + 8 + 10) / 92 = 0.33

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 11

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
0-0.40	0.40-0.60	0.60-0.80	0.80-1.0

Col. C for S3 / CT

53 / 92 = 0.58

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
2.50

Table C.1. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date: 28 October 2008
Station Name:	**Station 2**		Flow status: Low
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	174	2
	Mayfly Nymph (EPT)	1	1
	Stonefly Nymph (EPT)	2	1
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		177	4
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	17	2
	Cranefly Larva	1	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	2	1
	Watersnipe Larva		
Sub-Total		20	4
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	227	2
	Blackfly Larva		
	Leech	2	2
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		229	4
TOTAL		426	12

Table C.1. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 426

DENSITY: Invertebrate density per square metre:

426 ÷ 0.27 = 1578

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 4 + 4 = 24

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

2 + 1 + 1 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.75	0.25-0.50	0-0.25

(EPT1 + EPT2 + EPT3) / CT

(174 + 1 + 2) / 426 = 0.42

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
0-0.40	0.40-0.60	0.60-0.80	0.80-1.0

Col. C for S3 / CT

227 / 426 = 0.53

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
2.75

Table C.1. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Millstone River		Date: 28 October 2008
Station Name: **Station 3**		Flow status: Low
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	8	2
	Mayfly Nymph (EPT)	30	3
	Stonefly Nymph (EPT)	2	1
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		40	6
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	2	1
	Cranefly Larva	4	2
	Crayfish	1	1
	Damselfly Larva	1	1
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	23	2
	Watersnipe Larva		
Sub-Total		31	7
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	81	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	2	1
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		83	3
TOTAL		154	16

Table C.1. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 154

DENSITY: Invertebrate density per square metre:

154 ÷ 0.27 = 570

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 6 + 2 x 7 + 3 = 35

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

2 + 3 + 1 = 6

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.75	0.25-0.50	0-0.25

(EPT1 + EPT2 + EPT3) / CT

(8 + 30 + 2) / 154 = 0.26

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 16

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
0-0.40	0.40-0.60	0.60-0.80	0.80-1.0

Col. C for S3 / CT

81 / 154 = 0.53

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	3
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
3.00

Table C.1. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date: 27 October 2008
Station Name:	**Station 4**		Flow status: Low
Sampler Used: Surber	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 Pollution Intolerant	Caddisfly Larva (EPT)		
	Mayfly Nymph (EPT)	2	1
	Stonefly Nymph (EPT)	12	3
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		14	4
Category 2 Somewhat Pollution Tolerant	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	27	1
	Watersnipe Larva		
Sub-Total		27	1
Category 3 Pollution Tolerant	Aquatic Worm (oligochaete)	27	3
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	46	3
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		73	6
TOTAL		114	11

Table C.1. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 114

DENSITY: Invertebrate density per square metre:

114 ÷ 0.27 = 422

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Midge Larva (chironomid)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 1 + 6 = 20

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

0 + 1 + 3 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.75	0.25-0.50	0-0.25

(EPT1 + EPT2 + EPT3) / CT

(0 + 2 + 12) / 114 = 0.12

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 11

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
0-0.40	0.40-0.60	0.60-0.80	0.80-1.0

Col. C for S3 / CT

46 / 114 = 0.40

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	3

Average Rating
2.25

Table C.1. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date: 27 October 2008
Station Name:	**Station 5**		Flow status: Low
Sampler Used: Surber	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)		
	Mayfly Nymph (EPT)	1	1
	Stonefly Nymph (EPT)	3	2
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		4	3
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	1	1
	Cranefly Larva		
	Crayfish		
	Damselfly Larva	1	1
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	13	2
	Watersnipe Larva		
Sub-Total		15	4
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	95	3
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	1	1
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite	1	1
Sub-Total		97	5
TOTAL		116	12

Table C.1. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 116

DENSITY: Invertebrate density per square metre:

116 ÷ 0.27 = 430

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 3 + 2 x 4 + 5 = 22

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

0 + 1 + 2 = 3

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.75	0.25-0.50	0-0.25

(EPT1 + EPT2 + EPT3) / CT

(0 + 1 + 3) / 116 = 0.03

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
0-0.40	0.40-0.60	0.60-0.80	0.80-1.0

Col. C for S3 / CT

95 / 116 = 0.82

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	1

Average Rating
1.75

Table C.2. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 1-5 on the Millstone River during 2009.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Benson Creek		Date: 2 November 2009
Station Name: **Station 1**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	4	2
	Mayfly Nymph (EPT)	7	1
	Stonefly Nymph (EPT)	11	1
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		22	4
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)		
	Watersnipe Larva		
Sub-Total		0	0
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	23	2
	Blackfly Larva	1	1
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		24	3
TOTAL		46	7

Table C.2. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 46

DENSITY: Invertebrate density per square metre:

46 ÷ 0.27 = 170

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 0 + 3 = 15

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

2 + 1 + 1 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(4 + 7 + 11) / 46 = 0.48

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 7

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

23 / 46 = 0.50

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	2
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
2.25

Table C.2. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date: 2 November 2009
Station Name:	**Station 2**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)		
	Mayfly Nymph (EPT)	3	1
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		3	1
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	7	2
	Watersnipe Larva		
Sub-Total		7	2
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	3	3
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		3	3
TOTAL		13	6

Table C.2. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 13

DENSITY: Invertebrate density per square metre:

13 ÷ 0.27 = 48

PREDOMINANT TAXON:
Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 1 + 2 x 2 + 3 = 10

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

0 + 1 + 0 = 1

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(0 + 3 + 0) / 13 = 0.23

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 6

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

7 / 13 = 0.54

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	1
EPT Index	1
EPT To Total Ratio	1
Predominant Taxon Ratio	3

Average Rating
1.50

Table C.2. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Millstone River		Date: 2 November 2009
Station Name: **Station 3**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 Pollution Intolerant	Caddisfly Larva (EPT)		
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)	2	1
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		2	1
Category 2 Somewhat Pollution Tolerant	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	9	1
	Watersnipe Larva		
Sub-Total		9	1
Category 3 Pollution Tolerant	Aquatic Worm (oligochaete)	1	1
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		1	1
TOTAL		12	3

Table C.2. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 12

DENSITY: Invertebrate density per square metre:

12 ÷ 0.27 = 44

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 1 + 2 x 1 + 1 = 6

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

0 + 0 + 1 = 1

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(0 + 0 + 2) / 12 = 0.17

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 3

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

9 / 12 = 0.75

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	1
EPT Index	1
EPT To Total Ratio	1
Predominant Taxon Ratio	2

Average Rating
1.25

Table C.2. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date:	4 November 2009
Station Name:	**Station 4**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Surber	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	7	1
	Mayfly Nymph (EPT)	38	2
	Stonefly Nymph (EPT)	4	1
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		49	4
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
Somewhat Pollution Tolerant	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	32	2
	Watersnipe Larva		
Sub-Total		32	2
Category 3	Aquatic Worm (oligochaete)	12	2
	Blackfly Larva		
	Leech		
Pollution Tolerant	Midge Larva (chironomid)	7	2
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		19	4
TOTAL		100	10

Table C.2. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 100

DENSITY: Invertebrate density per square metre:

100 ÷ 0.27 = 370

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Mayfly Nymph (EPT)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 2 + 4 = 20

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

1 + 2 + 1 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(7 + 38 + 4) / 100 = 0.49

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 10

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

38 / 100 = 0.38

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	4

Average Rating
2.75

Table C.2. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date:	4 November 2009
Station Name:	**Station 5**		Flow status:	Moderate
Sampler Used: Surber	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2		

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)		
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		0	0
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)		
	Watersnipe Larva		
Sub-Total		0	0
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	2	1
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite	4	1
Sub-Total		6	2
TOTAL		6	2

Table C.2. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 6

DENSITY: Invertebrate density per square metre:

6 ÷ 0.27 = 22

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Water Mite

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 0 + 2 x 0 + 2 = 2

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

0 + 0 + 0 = 0

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(0 + 0 + 0) / 6 = 0.00

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 2

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

4 / 6 = 0.67

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	1
EPT Index	1
EPT To Total Ratio	1
Predominant Taxon Ratio	2

Average Rating
1.25

Table C.3. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 2-4 on the Millstone River during 2010.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date:	3 November 2010
Station Name:	**Station 2**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	1	1
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)	1	1
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		2	2
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva	6	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	3	1
	Watersnipe Larva		
Sub-Total		9	2
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	4	1
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite	2	1
Sub-Total		6	2
TOTAL		17	6

Table C.3. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 17

DENSITY: Invertebrate density per square metre:

17 ÷ 0.27 = 63

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Cranefly Larva

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 2 + 2 x 2 + 2 = 12

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

1 + 0 + 1 = 2

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(1 + 0 + 1) / 17 = 0.12

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 6

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

6 / 17 = 0.35

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	2
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	4

Average Rating
2.25

Table C.3. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date:	3 November 2010
Station Name:	**Station 3**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)		
	Mayfly Nymph (EPT)	5	2
	Stonefly Nymph (EPT)	4	2
	Dobsonfly (hellgrammite)	1	1
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		10	5
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish	1	1
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	117	1
	Watersnipe Larva		
Sub-Total		118	2
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	5	1
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		5	1
TOTAL		133	8

Table C.3. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 133

DENSITY: Invertebrate density per square metre:

133 ÷ 0.27 = 493

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 5 + 2 x 1 + 1 = 20

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

0 + 2 + 2 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(0 + 5 + 4) / 133 = 0.07

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 8

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

117 / 133 = 0.88

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	1

Average Rating
1.75

Table C.3. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date: 3 November 2010
Station Name:	**Station 4**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	3	1
	Mayfly Nymph (EPT)	94	3
	Stonefly Nymph (EPT)	18	2
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		115	6
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva	2	1
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	3	1
	Cranefly Larva		
	Crayfish	1	1
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	122	2
	Watersnipe Larva		
Sub-Total		128	5
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	73	1
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		73	1
TOTAL		316	12

Table C.3. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 316

DENSITY: Invertebrate density per square metre:

316 ÷ 0.27 = 1170

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	22-17	16-11	<11

3 x D1 + 2 x D2 + D3

3 x 6 + 2 x 5 + 1 = 29

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

1 + 3 + 2 = 6

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(3 + 94 + 18) / 316 = 0.36

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

122 / 316 = 0.39

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	3
EPT To Total Ratio	2
Predominant Taxon Ratio	4

Average Rating
3.25

Table C.4. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 1, 2 and 4 on the Millstone River during 2011.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Benson Creek		Date: 29 October 2011
Station Name: **Station 1**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	5	2
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)	32	3
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		37	5
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	11	1
	Watersnipe Larva		
Sub-Total		11	1
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	34	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		34	2
TOTAL		82	8

Table C.4. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 82

DENSITY: Invertebrate density per square metre:

82 ÷ 0.27 = 304

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 5 + 2 x 1 + 2 = 19

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

2 + 0 + 3 = 5

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(5 + 0 + 32) / 82 = 0.45

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 8

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

34 / 82 = 0.41

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	3
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
2.75

Table C.4. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date:	29 October 2011
Station Name:	**Station 2**		Flow status:	Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2		

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	127	2
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)	1	1
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		128	3
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	32	1
	Watersnipe Larva		
Sub-Total		32	1
Category 3	Aquatic Worm (oligochaete)	42	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	1	1
Pollution Tolerant	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		43	3
TOTAL		203	7

Table C.4. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 203

DENSITY: Invertebrate density per square metre:

203 ÷ 0.27 = 752

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Caddisfly Larva (EPT)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 3 + 2 x 1 + 3 = 14

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

2 + 0 + 0 = 2

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(127 + 0 + 0) / 203 = 0.63

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 7

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

127 / 203 = 0.63

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	2
EPT Index	2
EPT To Total Ratio	3
Predominant Taxon Ratio	2

Average Rating
2.25

Table C.4. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone River		Date: 29 October 2011
Station Name:	**Station 4**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	114	2
	Mayfly Nymph (EPT)	169	2
	Stonefly Nymph (EPT)	7	2
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		290	6
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	3	1
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	62	1
	Watersnipe Larva		
Sub-Total		65	2
Category 3	Aquatic Worm (oligochaete)	57	2
	Blackfly Larva		
	Leech	1	1
	Midge Larva (chironomid)		
	Planarian (flatworm)		
Pollution Tolerant	Pouch and Pond Snails	1	1
	True Bug Adult		
	Water Mite		
Sub-Total		59	4
TOTAL		414	12

Table C.4. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 414

DENSITY: Invertebrate density per square metre:

414 ÷ 0.27 = 1533

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Mayfly Nymph (EPT)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 6 + 2 x 2 + 4 = 26

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

2 + 2 + 2 = 6

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(114 + 169 + 7) / 414 = 0.70

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

169 / 414 = 0.41

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	3
EPT To Total Ratio	3
Predominant Taxon Ratio	3

Average Rating
3.25

Table C.5. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 1, 2 and 4 on the Millstone River during 2012.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Millstone		Date: 29 October 2012
Station Name: **Station 1**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	9	1
	Mayfly Nymph (EPT)	8	1
	Stonefly Nymph (EPT)	22	2
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny	1	1
Sub-Total		40	5
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	4	1
	Cranefly Larva	2	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva	1	1
	Fishfly Larva		
	Scud (amphipod)	2	1
	Watersnipe Larva		
Sub-Total		9	4
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	63	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult	1	1
	Water Mite	2	1
Sub-Total		66	4
TOTAL		115	13

Table C.5. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 115

DENSITY: Invertebrate density per square metre:

115 ÷ 0.27 = 426

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 5 + 2 x 4 + 4 = 27

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

1 + 1 + 2 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(9 + 8 + 22) / 115 = 0.34

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 13

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

63 / 115 = 0.55

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
2.75

Table C.5. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date:	29 October 2012
Station Name:	**Station 2**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	343	4
	Mayfly Nymph (EPT)	1	1
	Stonefly Nymph (EPT)	3	2
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		347	7
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	78	1
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva	5	1
	Fishfly Larva		
	Scud (amphipod)	19	1
	Watersnipe Larva		
Sub-Total		102	3
Category 3	Aquatic Worm (oligochaete)	42	1
	Blackfly Larva		
	Leech	2	1
	Midge Larva (chironomid)	3	2
Pollution Tolerant	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		47	4
TOTAL		496	14

Table C.5. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 496

DENSITY: Invertebrate density per square metre:

496 ÷ 0.27 = 1837

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Caddisfly Larva (EPT)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 7 + 2 x 3 + 4 = 31

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

4 + 1 + 2 = 7

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(343 + 1 + 3) / 496 = 0.70

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 14

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

343 / 496 = 0.69

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	3
EPT To Total Ratio	3
Predominant Taxon Ratio	2

Average Rating
3.00

Table C.5. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date:	29 October 2012
Station Name:	**Station 4**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	37	2
	Mayfly Nymph (EPT)	61	2
	Stonefly Nymph (EPT)	12	2
	Dobsonfly (hellgrammite)	8	1
Pollution Intolerant	Gilled Snail	2	1
	Riffle Beetle		
	Water Penny		
Sub-Total		120	8
Category 2	Alderfly Larva	1	1
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	7	1
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva	1	1
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	526	2
	Watersnipe Larva		
Sub-Total		535	5
Category 3	Aquatic Worm (oligochaete)	97	5
	Blackfly Larva	3	1
	Leech	4	1
	Midge Larva (chironomid)	38	4
	Planarian (flatworm)		
Pollution Tolerant	Pouch and Pond Snails	4	1
	True Bug Adult		
	Water Mite		
Sub-Total		146	12
TOTAL		801	25

Table C.5. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 801

DENSITY: Invertebrate density per square metre:

801 ÷ 0.27 = 2967

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 8 + 2 x 5 + 12 = 46

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

2 + 2 + 2 = 6

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(37 + 61 + 12) / 801 = 0.14

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 25

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

526 / 801 = 0.66

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	3
EPT To Total Ratio	1
Predominant Taxon Ratio	2

Average Rating
2.50

Table C.6. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 1, 3 and 4 on the Millstone River during 2013.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date:	27 October 2013
Station Name:	**Station 1**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	1	1
	Mayfly Nymph (EPT)	4	2
	Stonefly Nymph (EPT)	25	2
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		30	5
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva	2	1
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	2	1
	Watersnipe Larva		
Sub-Total		4	2
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	23	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	2	1
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite	2	2
Sub-Total		27	5
TOTAL		61	12

Table C.6. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 61

DENSITY: Invertebrate density per square metre:

61 ÷ 0.27 = 226

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Stonefly Nymph (EPT)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 5 + 2 x 2 + 5 = 24

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

1 + 2 + 2 = 5

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(1 + 4 + 25) / 61 = 0.49

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

25 / 61 = 0.41

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	3
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
3.00

Table C.6. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date:	27 October 2013
Station Name:	**Station 2**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	28	3
	Mayfly Nymph (EPT)	1	1
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		29	4
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva	1	1
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel	12	1
	Cranefly Larva		
	Crayfish	2	1
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	114	3
	Watersnipe Larva		
Sub-Total		129	6
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	10	1
	Blackfly Larva		
	Leech	1	1
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails	1	1
	True Bug Adult		
	Water Mite		
Sub-Total		12	3
TOTAL		170	13

Table C.6. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 170

DENSITY: Invertebrate density per square metre:

170 ÷ 0.27 = 630

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 6 + 3 = 27

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

3 + 1 + 0 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(28 + 1 + 0) / 170 = 0.17

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 13

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

114 / 170 = 0.67

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	2

Average Rating
2.25

Table C.6. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date: 27 October 2013
Station Name:	**Station 4**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)		
	Mayfly Nymph (EPT)	3	1
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		3	1
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	251	6
	Watersnipe Larva		
Sub-Total		251	6
Category 3	Aquatic Worm (oligochaete)	13	2
	Blackfly Larva		
	Leech	6	1
	Midge Larva (chironomid)		
	Planarian (flatworm)		
Pollution Tolerant	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		19	3
TOTAL		273	10

Table C.6. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 273

DENSITY: Invertebrate density per square metre:

273 ÷ 0.27 = 1011

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 1 + 2 x 6 + 3 = 18

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

0 + 1 + 0 = 1

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(0 + 3 + 0) / 273 = 0.01

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 10

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

251 / 273 = 0.92

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	1
EPT To Total Ratio	1
Predominant Taxon Ratio	1

Average Rating
1.50

Table C.7. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 1, 2 and 4 on the Millstone River during 2014.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date:	28 October 2014
Station Name:	**Station 1**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	1	1
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)	6	1
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		7	2
Category 2	Alderfly Larva		
	Aquatic Beetle		
	Aquatic Sowbug	1	1
	Clam, Mussel		
	Cranefly Larva	5	2
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)		
	Watersnipe Larva		
Sub-Total		6	3
Category 3	Aquatic Worm (oligochaete)	170	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	2	1
Pollution Tolerant	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite	1	1
Sub-Total		173	4
TOTAL		186	9

Table C.7. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 186

DENSITY: Invertebrate density per square metre:

186 ÷ 0.27 = 689

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Aquatic Worm (oligochaete)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 2 + 2 x 3 + 4 = 16

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

1 + 0 + 1 = 2

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(1 + 0 + 6) / 186 = 0.04

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 9

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

_170_ / 186 = 0.91

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	2
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	1

Average Rating
1.50

Table C.7. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date:	28 October 2014
Station Name:	**Station 2**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	13	2
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		13	2
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva	1	1
	Aquatic Beetle		
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	170	1
	Watersnipe Larva		
Sub-Total		171	2
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	83	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		83	2
TOTAL		267	6

Table C.7. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 267

DENSITY: Invertebrate density per square metre:

267 ÷ 0.27 = 989

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 2 + 2 x 2 + 2 = 12

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

2 + 0 + 0 = 2

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(13 + 0 + 0) / 267 = 0.05

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 6

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

170 / 267 = 0.64

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	2
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	2

Average Rating
1.75

Table C.7. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date:	28 October 2014
Station Name:	**Station 4**		Flow status:	Moderate
Sampler Used:	Number of replicates	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates		
Hess	3	0.09 x 3 =	0.27	m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1 **Pollution Intolerant**	Caddisfly Larva (EPT)	22	2
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)	370	2
	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		392	4
Category 2 **Somewhat Pollution Tolerant**	Alderfly Larva	1	1
	Aquatic Beetle		
	Aquatic Sowbug	3	1
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	413	1
	Watersnipe Larva		
Sub-Total		417	3
Category 3 **Pollution Tolerant**	Aquatic Worm (oligochaete)	70	2
	Blackfly Larva		
	Leech	2	2
	Midge Larva (chironomid)	11	1
	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		83	5
TOTAL		892	12

Table C.7. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 892

DENSITY: Invertebrate density per square metre:

892 ÷ 0.27 = 3304

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 3 + 5 = 23

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

2 + 0 + 2 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(22 + 0 + 370) / 892 = 0.44

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

413 / 892 = 0.46

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	3

Average Rating
2.75

Table C.8. Invertebrate Survey Field Data Sheet completed for triplicate stream invertebrate samples collected at Stations 1, 2 and 4 on the Millstone River during 2015.

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name: Millstone		Date: 4 November 2015
Station Name: **Station 1**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	3	1
	Mayfly Nymph (EPT)	2	1
	Stonefly Nymph (EPT)	6	2
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		11	4
Category 2	Alderfly Larva		
	Aquatic Beetle	2	1
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva	1	1
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	8	1
	Watersnipe Larva		
Sub-Total		11	3
Category 3	Aquatic Worm (oligochaete)	4	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
Pollution Tolerant	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		4	2
TOTAL		26	9

Table C.8. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 26

DENSITY: Invertebrate density per square metre:

26 ÷ 0.27 = 96

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 4 + 2 x 3 + 2 = 20

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

1 + 1 + 2 = 4

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(3 + 2 + 6) / 26 = 0.42

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 9

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

8 / 26 = 0.31

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	2
EPT To Total Ratio	2
Predominant Taxon Ratio	4

Average Rating
2.75

Table C.8. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date: 4 November 2015
Station Name:	**Station 2**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	20	3
	Mayfly Nymph (EPT)		
	Stonefly Nymph (EPT)		
	Dobsonfly (hellgrammite)		
Pollution Intolerant	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		20	3
Category 2	Alderfly Larva		
	Aquatic Beetle	1	1
	Aquatic Sowbug		
	Clam, Mussel	3	2
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	7	3
	Watersnipe Larva		
Sub-Total		11	6
Category 3	Aquatic Worm (oligochaete)	2	1
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)	2	2
	Planarian (flatworm)		
Pollution Tolerant	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		4	3
TOTAL		35	12

Table C.8. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 35

DENSITY: Invertebrate density per square metre:

35 ÷ 0.27 = 130

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Caddisfly Larva (EPT)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 3 + 2 x 6 + 3 = 24

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-4	0-1

EPT4 + EPT5 + EPT6

3 + 0 + 0 = 3

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(20 + 0 + 0) / 35 = 0.57

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 12

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

20 / 35 = 0.57

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	4
EPT Index	2
EPT To Total Ratio	3
Predominant Taxon Ratio	3

Average Rating
3.00

Table C.8. (Continued)

INVERTEBRATE SURVEY FIELD DATA SHEET (Page 1 of 2)

Stream Name:	Millstone		Date: 4 November 2015
Station Name:	**Station 4**		Flow status: Moderate
Sampler Used: Hess	Number of replicates 3	Total area sampled (Hess, Surber = 0.09 m^2) x no. replicates 0.09 x 3 = 0.27 m^2	

Column A Pollution Tolerance	Column B Common Name	Column C Number Counted	Column D Number of Taxa
Category 1	Caddisfly Larva (EPT)	1	1
	Mayfly Nymph (EPT)	3	1
	Stonefly Nymph (EPT)	1	1
Pollution Intolerant	Dobsonfly (hellgrammite)		
	Gilled Snail		
	Riffle Beetle		
	Water Penny		
Sub-Total		5	3
Category 2	Alderfly Larva		
	Aquatic Beetle	7	2
	Aquatic Sowbug		
	Clam, Mussel		
	Cranefly Larva		
	Crayfish		
Somewhat Pollution Tolerant	Damselfly Larva		
	Dragonfly Larva		
	Fishfly Larva		
	Scud (amphipod)	15	2
	Watersnipe Larva		
Sub-Total		22	4
Category 3	Aquatic Worm (oligochaete)	2	2
	Blackfly Larva		
	Leech		
	Midge Larva (chironomid)		
Pollution Tolerant	Planarian (flatworm)		
	Pouch and Pond Snails		
	True Bug Adult		
	Water Mite		
Sub-Total		2	2
TOTAL		29	9

Table C.8. (Continued)

INVERTEBRATE SURVEY INTERPRETATION SHEET (Page 2 of 2)

SECTION 1 - ABUNDANCE AND DENSITY

ABUNDANCE: Total number of organisms from cell **CT**: 29

DENSITY: Invertebrate density per square metre:

29 ÷ 0.27 = 107

PREDOMINANT TAXON:

Invertebrate group with the highest number counted (Col. C): Scud (amphipod)

SECTION 2 - WATER QUALITY ASSESSMENTS

POLLUTION TOLERANCE INDEX: Sub-total number of taxa found in each tolerance category.

Good	Accpetable	Marginal	Poor
>22	17-22	11-16	<11

3 x D1 + 2 x D2 + D3

3 x 3 + 2 x 4 + 2 = 19

EPT INDEX: Total number of EPT taxa.

Good	Accpetable	Marginal	Poor
>8	5-8	2-5	0-1

EPT4 + EPT5 + EPT6

1 + 1 + 1 = 3

EPT TO TOTAL RATIO INDEX: Total number of EPT organisms divided by the total number of organisms.

Good	Accpetable	Marginal	Poor
0.75-1.0	0.50-0.74	0.25-0.49	<0.25

(EPT1 + EPT2 + EPT3) / CT

(1 + 3 + 1) / 29 = 0.17

SECTION 3 - DIVERSITY

TOTAL NUMBER OF TAXA: Total number of taxa from cell **DT**: 9

PREDOMINANT TAXON RATIO INDEX: Number of invertebrate in the **predominant taxon** (S3) divided by CT.

Good	Accpetable	Marginal	Poor
<0.40	0.40-0.59	0.60-0.79	0.80-1.0

Col. C for S3 / CT

15 / 29 = 0.52

SECTION 4 - OVERALL SITE ASSESSMENT RATING

SITE ASSESSMENT RATING: Assign a rating of 1-4 to each index (S4, S5, S6, S8), then calculate the average.

Assessment Rating	
Good	4
Accpetable	3
Marginal	2
Poor	1

Assessment	Rating
Pollution Tolerance Index	3
EPT Index	2
EPT To Total Ratio	1
Predominant Taxon Ratio	3

Average Rating
2.25