Aquatic Habitat and Benthic Macroinvertebrate Monitoring Of Three Streams within the Town of Lindsay (2010-2014)

June 2015

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EXECUTIVE SUMMARY

Fleming College and Kawartha Conservation conduct an annual training exercise on three streams within the Town of Lindsay (Jennings Creek, Albert Street Ditch, and Sucker Creek) to monitor important aspects of stream health such as aquatic habitat and aquatic life. Results indicate that these small-to-medium sized streams support a diverse range of aquatic habitat conditions and aquatic life. However, all streams are likely degraded to a certain degree because they all exhibit characteristics typically associated with impaired streams within urban environments, such as: tolerant taxa dominating benthic macroinvertebrate community composition, low Biotic Index grades, and high levels of phosphorus. Now that baseline conditions have been confirmed (i.e., the range of aquatic habitat and aquatic life we expect to encounter), data collected through future training and monitoring activities can be used to track changes in the aquatic health of these three streams.

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INTRODUCTION

Since 2010, Fleming College students enrolled in the Environmental Technology program are field-trained by program faculty and technical staff from Kawartha Conservation in the use of various stream monitoring techniques. This annual training opportunity provides hands-on experience for students to learn practical approaches for monitoring important aspects of streams such as aquatic habitat (e.g., water chemistry, water flow, substrate, etc.) and resident aquatic life (e.g., benthic macroinvertebrates). Training is conducted every year in late spring or early summer on three streams draining into the Scugog River within the Town of Lindsay. The purpose of this report is to provide a brief summary of monitoring results, with the intention of providing background information on the existing hydrological and ecological status of Lindsay streams. Further, these results will serve to provide baseline conditions against which future field-training results can be compared.

METHODS

Study Area

Training is conducted on three sites, all of which are located near the outlets of three streams within the Town of Lindsay: Jennings Creek, Albert Street Ditch, and Sucker Creek (Figure 1). Jennings Creek is located in the north end of town, has a drainage area of 15.2 km^2, and a catchment comprised of agricultural and urban lands. The sample site is located along the rail trail. Albert Street Ditch is located in the south end of town, has a drainage area of 2.3 km^2, and a catchment comprised of mainly urban lands. The sample site is located adjacent to Memorial Park. Sucker Creek is located in the south end of town, has a drainage area of 11.3 km^2, and a catchment comprised of mainly agricultural lands. The sample site is located immediately downstream of the Lindsay Golf and Country Club.

Data Collection: Aquatic Habitat

Aquatic habitat conditions are assessed at each site through sampling for water chemistry, water quantity, and physical habitat characteristics. Water chemistry data are collected according to procedures used by the Provincial Water Quality Monitoring Network (Conservation Ontario and Ontario Ministry of the Environment, 2003), by submerging a multi-metre probe to measure standard chemical parametres such as water temperature, dissolved oxygen, pH, and conductivity, as well as through taking a grab sample and submitting it to an accredited laboratory for analyses of nutrients such as total phosphorus and nitrate. Water quantity data are collected according to procedures used by Water Survey of Canada (Environment Canada, 1981), by transecting the site into panels and measuring flow volume with the use of a digital flow metre. The remaining aquatic habitat data are collected

Albert Street Ditch
(June 4, 2014)

Jennings Creek
(June 1, 2011)

Sucker Creek
(June 27, 2013)

Figure 1: Locations of training sites in Lindsay, and representative site photos.

according to procedures outlined in the Ontario Benthos Biomonitoring Network (Ontario Ministry of the Environment, 2007), which includes documenting substrate, aquatic macrophytes, algae, and riparian vegetation conditions. Aquatic habitat data analyzed in this report are provided in Appendix A.

Data Collection: Aquatic Life

Resident aquatic life are assessed by collected benthic macroinvertebrates according to procedures outlined in the Ontario Benthos Biomonitoring Network protocol. Specimens are collected in nets through "kicking" the substrate at three locations (ideally two riffles, and one pool) along a single stream meander within the sampling site. The collections are preserved in rubbing alcohol for later analysis which occurs in a laboratory setting with the aid of a microscope. Specimens are identified to a 27-group taxonomic level of detail as listed in the protocol. Benthic macroinvertebrate data analyzed in this report are provided in Appendix B.

Data Analyses

The streams have been monitored on an annual basis beginning in 2010, however due to the emphasis on training, not all data were formally collected every year. Only those years where aquatic habitat conditions and resident aquatic life were recorded are presented in this report. These data include four years on Jennings Creek (2010, 2012, 2013, and 2014), three years on Albert Street Ditch (2010, 2012, and 2014), and three years on Sucker Creek (2010, 2012, and 2014). The following aquatic habitat characteristics are summarized as average values: wetted width, maximum depth, bottom substrate, hydraulic head, water volume, water temperature, dissolved oxygen, and total phosphorus. In terms of resident aquatic life, benthic macroinvertebrate data are summarized as average, maximum, and minimum values in terms of biodiversity (unique taxa), community composition (common taxa), presence of sensitive species (Mayflies, Stoneflies, and Caddisflies), and a Biotic Index (a weighted index based on taxa's tolerance to organic pollution), a modified version of which is used in Watershed Report Cards by Conservation Authorities (Conservation Ontario, 2011).

RESULTS

Jennings Creek

Aquatic habitat data for Jennings Creek are summarized in Table 1. The stream at this site is the largest and deepest of the three, having an average wetted width of 4.6 m and an average maximum depth of 0.26 m. It also has the coarsest bottom substrate (cobble and gravel), fastest flow (average hydraulic head of 17 mm), largest quantity of flow (average flowing volume of 77.1 L/s), and highest dissolved oxygen (average concentration of 10.4 mg/L). The average total phosphorus concentration is 49 ug/L, which is the lowest value of all three streams.

The top five most-common benthic macroinvertebrate taxa, in terms of average relative abundance, include: Midges, Aquatic Sowbugs, Scuds, Caddisflies, and Beetles (Figure 2). These taxa comprise 91.3% of the total abundance found at the site. All other taxa found comprise 8.7% of the sample, and include: Mites, Mayflies, Misc. True Flies, True Bugs, Dragonflies, Craneflies, Blackflies, Alderflies, Aquatic Moths, Clams, Mosquitoes, Crayfish, Stoneflies, Damselflies, Snails, and Horse/Deerflies. The maximum number of unique taxa recorded at this site is 17, which is the highest of the three streams sampled (Figure 3). The average composition of sensitive taxa is 10.9%, which is the highest of all streams (Figure 3). Sensitive taxa were found within the creek during every sampling year. The calculated index of biotic integrity averaged 6.36, which equates to a water quality grading of Fairly Poor (Figure 3). This grading is the best of all three streams.

Albert Street Ditch

Aquatic habitat data for Albert Street Ditch are summarized in Table 1. The stream at this site is the smallest of the three, having an average wetted with of 1.42 m and maximum depth of 0.17 m. It has relatively coarse substrate (gravel), and is a relatively fast-flowing creek (average hydraulic head of 10 mm) with moderate flow volumes (average of 25.7 L/s). This stream has the lowest water temperature (average of 17.9 ^{o}C) and dissolved oxygen concentrations (average of 9.7 mg/L). The average phosphorus concentration, at 58 ug/L, is the second highest of all three streams.

The top five most-common benthic invertebrate taxa, in terms of average relative abundance, include: Midges, Aquatic Sowbugs, Beetles, Caddisflies, and Blackflies (Figure 1). These taxa comprise 93.5% of the total abundance found at the site. All other taxa found comprise 6.5% of the sample, and include: Scuds, Stoneflies, Craneflies, Snails, Leeches, Misc. True Flies, Dragonflies, Horse/Deerflies, Aquatic Earthworms, True Bugs, Damselflies, Mosquitoes, Clams, No-see-ums, Crayfish, Mites, and Mayflies. The maximum number of unique taxa recorded at this site is 15, and this site has the highest average number of taxa found per year of all three streams, at 12.7 (Figure 3). The average composition of sensitive taxa is 3.9% (Figure 3), and members of these taxa were found within the creek during every sampling year. The calculated Index of Biotic Integrity averaged 6.60, which equates to a water quality grading of Poor (Figure 3).

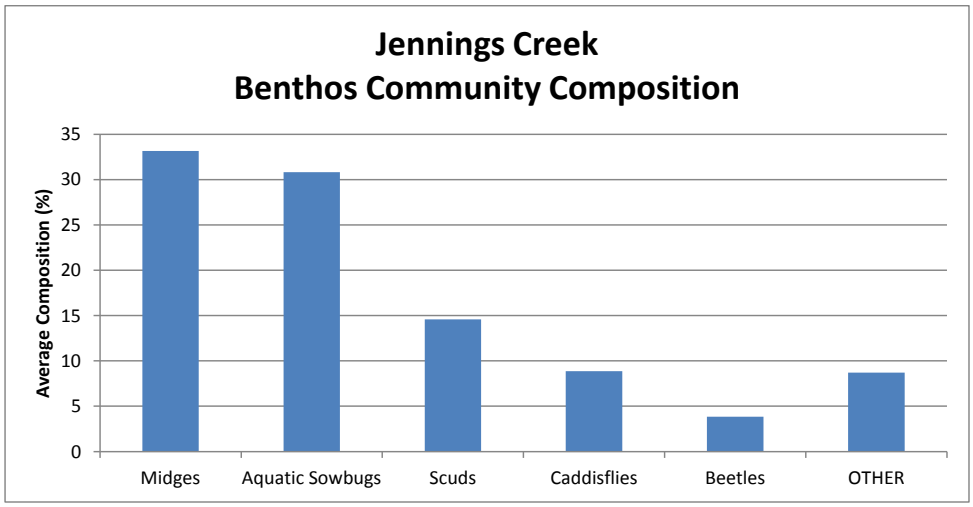
Sucker Creek

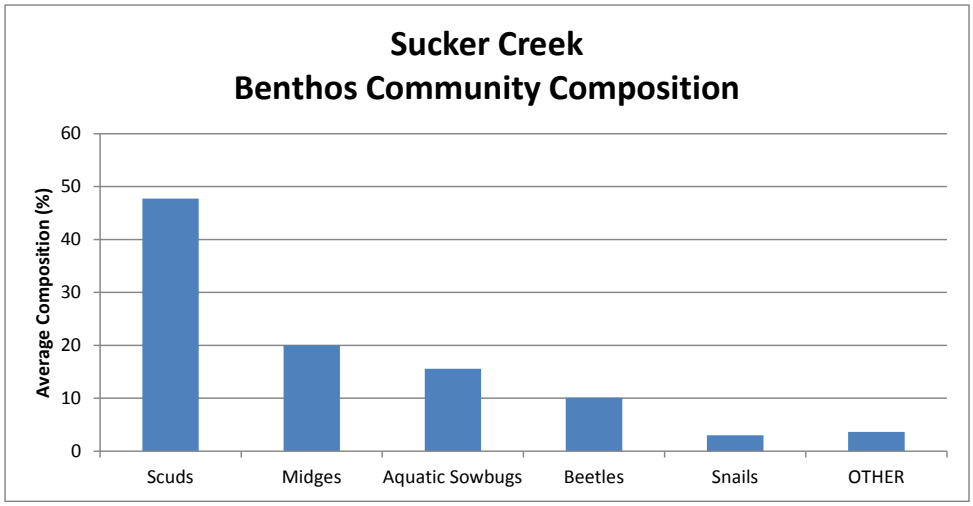
Aquatic habitat data for Sucker Creek are summarized in Table 1. The stream at this site has an average wetted width of 1.57 m, and an average maximum depth of 0.16 m. It has the finest substrate (sand), is the slowest-flowing (average hydraulic head of 1 mm), has the least amount of flow (average flow of 19.3 L/s), and the highest water temperatures (average of 20.5 ^{o}C) of all three streams. The average phosphorus concentration is 97 ug/L, which is the highest of all three streams.

The top five most-common benthic macroinvertebrate taxa, in terms of average relative abundance, include: Scuds, Midges, Aquatic Sowbugs, Beetles, and Snails (Figure 2). These taxa comprise 96.4% of the total abundance found at the site. All other taxa found comprise 3.6% of the sample, and include: Clams, True Bugs, Misc. True Flies, Stoneflies, Caddisflies, Mayflies, Leeches, Crayfish, Horse/Deerflies, Mites, and Dragonflies. The maximum number of unique taxa recorded at this site is 12, which is the lowest of all streams (Figure 3). Taxa not present include: Hydras, Flatworms, Nematodes, Aquatic Earthworms, Damselflies, Dobson/Alderflies, Aquatic Moths, Mosquitoes, No-See-Ums, Craneflies, and Blackflies. The average composition of sensitive taxa is 0.8%, which is the lowest of all three streams (Figure 3). Members of these taxa were found within the creek during every sampling year in relatively low numbers. The calculated index of Biotic Integrity averages 6.69, which equates to a water quality grading of Poor (Figure 3).

Table 1: Average and range of aquatic habitat conditions encountered.

Aquatic Habitat	Jennings Creek			Albert Street Ditch			Sucker Creek		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Wetted Width (m)	**4.6**	4.0	6.2	**1.42**	0.97	1.65	**1.57**	1.00	2.07
Maximum Depth (m)	**0.26**	0.19	0.35	**0.17**	0.12	0.27	**0.16**	0.09	0.24
Dominant Substrate	**Cobble**	Gravel	Cobble	**Gravel**	Gravel	Gravel	**Sand**	Sand	Sand
Hydraulic Head (mm)	**17**	12	25	**10**	5	18	**1**	0	3
Water Flow (L/s)	**77.1**	28.1	156.6	**25.7**	4.4	65.7	**19.3**	10.2	33.3
Water Temperature (^{o}C)	**18.5**	15	23.2	**17.9**	13.7	20.6	**20.5**	14.6	23.8
Dissolved Oxygen (mg/L)	**10.4**	9.1	11.6	**9.7**	7.1	12.3	**9.8**	7.1	12.3
Total Phosphorus (ug/L)	**49**	21	110	**58**	32	80	**97**	45	140





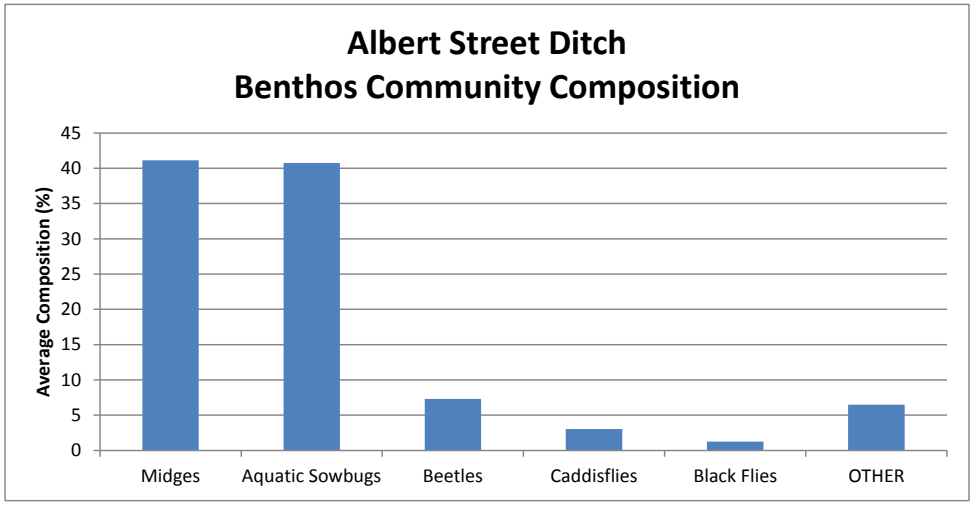


Figure 2: Average benthos community composition, showing top five taxa in terms of relative abundance.

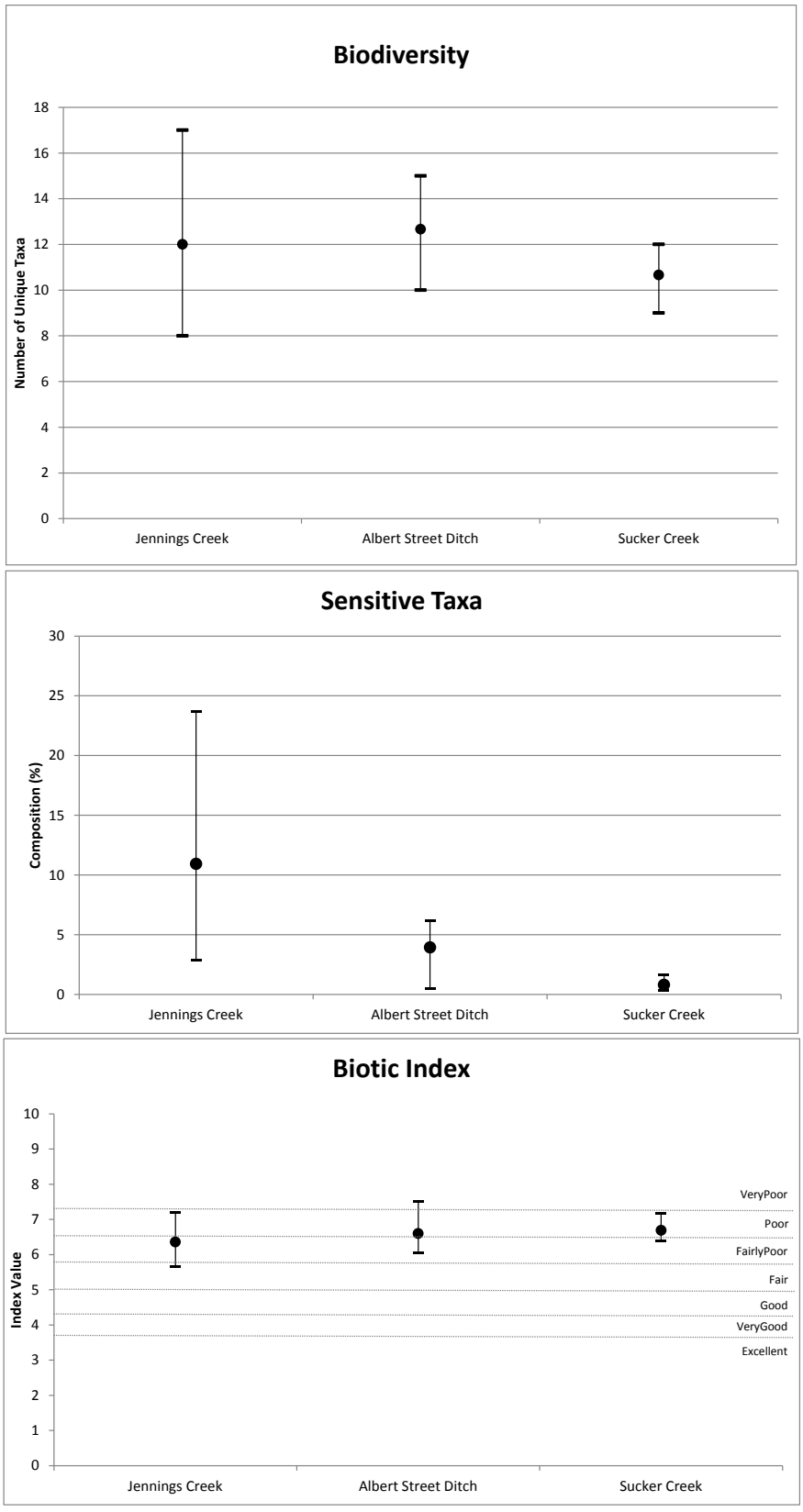


Figure 3: Average biodiversity, sensitive taxa, and Biotic Index values.

DISCUSSION

The three sample streams are considered perennial and provide year-round habitat for aquatic species. Sucker Creek is a slow-moving, pool-type stream with fine substrates, whereas Jennings Creek is swift-flowing, riffle-pool-type stream with coarse substrates. Albert Street Ditch has intermediary conditions in-between. All sites have cool water temperature regimes, are well-oxygenated, and have well-vegetated banks. Average phosphorus concentrations at all sites are high, indicating a certain degree of water quality impairment originating from sources within their upstream drainage areas. Albert Street Ditch and Sucker Creek have values that are more than double and triple the Provincial Water Quality Objective of 30 ug/L (Ontario Ministry of the Environment and Energy, 1994), respectively. Notwithstanding, aquatic habitat conditions in all streams remain capable of supporting an abundance of aquatic life, as inferred from benthic macroinvertebrate collections.

The dominant benthic macroinvertebrate taxa are relatively similar at all sites, with Midges and Aquatic Sow Bugs being present in high numbers in all streams, and Scuds being present in high numbers in both Sucker Creek and Jennings Creek. Results suggest all sites are considered likely to be impaired to a certain degree because they each exhibit distinct characteristics typically associated with an Urban Stream Syndrome (TRCA, 2013), including: community compositions that are dominated by tolerant taxa (e.g., Midges and Aquatic Sow Bugs), Biotic Index grades of Fairly Poor and Poor, and high phosphorus levels. The site on Sucker Creek is likely the most impacted of the three sites because it supports the lowest biodiversity, lowest percentage of sensitive taxa, has the worst Biotic Index rating and highest phosphorus concentrations encountered. In contrast, the site in Jennings Creek is likely the least impacted of the three sites because it supports the highest biodiversity, highest percentage of sensitive taxa, best Biotic Index rating, and lowest phosphorus concentrations encountered.

The data summarized in this report provides baseline information that furthers our understanding of existing ecological and hydrological conditions of three streams within the Town of Lindsay. Through multiple years of monitoring we have confirmed the range of aquatic habitat and aquatic life we expect to encounter at these sites in late-spring/early-summer. Monitoring data from future training exercises can now be used to track shifts in key stream health indicators (e.g., biodiversity, sensitive taxa, water chemistry, etc.), compared to the baseline conditions presented in this report. Ongoing monitoring of these streams is relevant given that their close proximity to Lindsay makes them particularly vulnerable to cumulative negative impacts (e.g., increased hardened landscapes, stream realignments, etc.) that are associated with urban area expansion. These data can provide insight into the effectiveness of local land use planning decisions in terms of maintaining sustainable water resources.

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Appendix A: Aquatic habitat data

Aquatic Habitat	Jennings Creek				
	2010	2012	2013	2014	Average
Wetted Width (m)	6.2	4.1	4.3	4.0	**4.6**
Maximum Depth (m)	0.27	0.19	0.35	0.24	**0.26**
Hydraulic Head (mm)	12	12	25	17	**16.5**
Dominant Substrate	Gravel	Cobble	Cobble	Cobble	**Cobble**
Water Temperature (^{o}C)	23.2	15	16.5	19.1	**18.5**
Dissolved Oxygen (mg/L)	11.6	9.6	9.1	11.3	**10.4**
Total Phosphorus (ug/L)	110	21	30	34	**49**
Water Flow (L/s)	84.4	28.1	156.6	39.4	**77.1**

Aquatic Habitat	Albert St. Ditch			
	2010	2012	2014	Average
Wetted Width (m)	1.63	0.97	1.65	**1.42**
Maximum Depth (m)	0.27	0.12	0.12	**0.17**
Hydraulic Head (mm)	8	18	5	**10**
Dominant Substrate	Gravel	Gravel	Gravel	**Gravel**
Water Temperature (^{o}C)	20.6	19.5	13.7	**17.9**
Dissolved Oxygen (mg/L)	12.3	7.1	9.6	**9.7**
Total Phosphorus (ug/L)	80	63	32	**58**
Water Flow (L/s)	6.8	65.7	4.4	**25.7**

Aquatic Habitat	Sucker Creek			
	2010	2012	2014	Average
Wetted Width (m)	1.00	1.64	2.07	**1.57**
Maximum Depth (m)	0.16	0.09	0.24	**0.16**
Hydraulic Head (mm)	3	0	0	**1**
Dominant Substrate	Sand	Sand	Sand	**Sand**
Water Temperature (^{o}C)	23.8	23.2	14.6	**20.5**
Dissolved Oxygen (mg/L)	12.3	7.1	9.9	**9.8**
Total Phosphorus (ug/L)	140	107	45	**97**
Water Flow (L/s)	33.3	10.2	14.3	**19.3**

Appendix B: Benthic macroinvertebrate data

Taxa	Jennings Creek									Albert Street Ditch							Sucker Creek						
	2010		2012		2013		2014		Average	2010		2012		2014		Average	2010		2012		2014		Average
	#	%	#	%	#	%	#	%	%	#	%	#	%	#	%	%	#	%	#	%	#	%	%
Coelenterata (Hydra)	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0
Platyhelminthes (Flatworms)	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0
Nematoda (Roundworms)	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0
Oligochaeta (Aquatic Earthworms)	0	0.0	0	0.0	0	0.0	0	0.0	0.0	4	0.9	0	0.0	0	0.0	0.3	0	0.0	0	0.0	0	0.0	0.0
Hirudinea (Leeches)	0	0.0	0	0.0	0	0.0	0	0.0	0.0	1	0.2	1	0.5	4	1.2	0.6	0	0.0	1	0.3	0	0.0	0.1
Isopoda (Aquatic Sowbugs)	68	20.1	88	22.7	217	61.6	102	18.9	30.8	385	82.6	48	23.3	53	16.4	40.8	202	36.1	28	8.8	11	1.8	15.6
Pelecypoda (Clams)	0	0.0	0	0.0	1	0.3	2	0.4	0.2	0	0.0	0	0.0	1	0.3	0.1	2	0.4	9	2.8	2	0.3	1.2
Amphipoda (Scuds)	24	7.1	105	27.1	27	7.7	89	16.5	14.6	11	2.4	0	0.0	1	0.3	0.9	283	50.5	110	34.6	356	58.1	47.7
Decapoda (Crayfish)	1	0.3	0	0.0	0	0.0	1	0.2	0.1	1	0.2	0	0.0	0	0.0	0.1	0	0.0	1	0.3	0	0.0	0.1
Acarina (Water Mites)	32	9.5	0	0.0	6	1.7	5	0.9	3.0	1	0.2	0	0.0	0	0.0	0.1	1	0.2	0	0.0	0	0.0	0.1
Ephemeroptera (Mayflies)	8	2.4	7	1.8	7	2.0	9	1.7	2.0	1	0.2	0	0.0	0	0.0	0.1	1	0.2	0	0.0	2	0.3	0.2
Anisoptera (Dragonflies)	6	1.8	0	0.0	0	0.0	0	0.0	0.4	0	0.0	2	1.0	1	0.3	0.4	1	0.2	0	0.0	0	0.0	0.1
Zygoptera (Damselflies)	1	0.3	0	0.0	0	0.0	0	0.0	0.1	2	0.4	0	0.0	0	0.0	0.1	0	0.0	0	0.0	0	0.0	0.0
Plecoptera (Stoneflies)	0	0.0	0	0.0	0	0.0	2	0.4	0.1	5	1.1	1	0.5	3	0.9	0.8	5	0.9	0	0.0	1	0.2	0.4
Hemiptera (True Bugs)	7	2.1	1	0.3	0	0.0	1	0.2	0.6	4	0.9	0	0.0	0	0.0	0.3	1	0.2	7	2.2	0	0.0	0.8
Megaloptera (Fishflies, Alderflies)	3	0.9	0	0.0	0	0.0	0	0.0	0.2	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0
Trichoptera (Caddisflies)	72	21.3	28	7.2	3	0.9	33	6.1	8.9	18	3.9	0	0.0	17	5.2	3.0	3	0.5	1	0.3	0	0.0	0.3
Lepidoptera (Aquatic Moths)	3	0.9	0	0.0	0	0.0	0	0.0	0.2	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	0	0.0	0.0
Coleoptera (Beetles)	4	1.2	14	3.6	12	3.4	39	7.2	3.9	1	0.2	32	15.5	20	6.2	7.3	5	0.9	70	22.0	45	7.3	10.1
Gastropoda (Snails)	1	0.3	0	0.0	0	0.0	0	0.0	0.1	1	0.2	3	1.5	2	0.6	0.8	5	0.9	25	7.9	1	0.2	3.0
Chironomidae (Midges)	101	29.9	137	35.3	79	22.4	243	45.0	33.2	22	4.7	111	53.9	210	64.8	41.1	51	9.1	62	19.5	193	31.5	20.0
Tabanidae (Horse/Deerflies)	0	0.0	0	0.0	0	0.0	1	0.2	0.0	0	0.0	0	0.0	3	0.9	0.3	0	0.0	1	0.3	0	0.0	0.1
Culicidae (Mosquitos)	2	0.6	0	0.0	0	0.0	0	0.0	0.1	2	0.4	0	0.0	0	0.0	0.1	0	0.0	0	0.0	0	0.0	0.0
Ceratopogonidae	0	0.0	0	0.0	0	0.0	0	0.0	0.0	0	0.0	0	0.0	1	0.3	0.1	0	0.0	0	0.0	0	0.0	0.0

Taxa	Jennings Creek									Albert Street Ditch							Sucker Creek						
	2010		2012		2013		2014		Average	2010		2012		2014		Average	2010		2012		2014		Average
	#	%	#	%	#	%	#	%	%	#	%	#	%	#	%	%	#	%	#	%	#	%	%
(No-See-Ums)																							
Tipulidae (Crane Flies)	3	0.9	1	0.3	0	0.0	3	0.6	0.4	7	1.5	2	1.0	0	0.0	0.8	0	0.0	0	0.0	0	0.0	0.0
Simuliidae (Black Flies)	0	0.0	0	0.0	0	0.0	6	1.1	0.3	0	0.0	4	1.9	6	1.9	1.3	0	0.0	0	0.0	0	0.0	0.0
Other Diptera (Misc. True Flies)	2	0.6	7	1.8	0	0.0	4	0.7	0.8	0	0.0	2	1.0	2	0.6	0.5	0	0.0	3	0.9	2	0.3	0.4
TOTAL	**338**	**100**	**388**	**100**	**352**	**100**	**540**	**100**	**100**	**466**	**100**	**206**	**100**	**324**	**100**	**100**	**560**	**100**	**318**	**100**	**613**	**100**	**100**
Biodiversity (Number of taxa)	17	-	9	-	8	-	14	-	12.0	15	-	10	-	13	-	12.7	11	-	12	-	9	-	10.7
Sensitive Taxa (Mayflies, Stoneflies, Caddisflies)	-	23.7	-	9.0	-	2.8	-	8.1	10.9	-	5.2	-	0.5	-	6.2	3.9	-	1.6	-	0.3	-	0.5	0.8
Biotic Index (Modified Hilsenhoff approach)	5.65	-	6.41	-	7.19	-	6.20	-	6.36	7.50	-	6.24	-	6.06	-	6.60	7.16	-	6.38	-	6.53	-	6.69