Memorandum
October 29 2010

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Through: Steve Kroeger, NCDWQ
From: Cathy Tyndall, NCDWQ

Subject: Macroinvertebrate sampling results – Crawford Branch, Macon County, Little Tennessee River Basin.

Note: This memorandum represents work completed for Task 6 (Biological Sampling) in the Franklin to Fontana Local Watershed Plan Scope of Work.

Background and History

Crawford Branch is a small tributary to the Little Tennessee River that flows through the town of Franklin. The upper reaches are characterized by residential neighborhoods and a small amount of agriculture. For years, local citizens have expressed concerns regarding the water quality in Crawford Branch. It is classified as class C waters.

In May 2010, benthic macroinvertebrate sampling was conducted at two sites in Crawford Branch and one in Dalton Creek (Table, 1 Figure 1) in support of the local watershed planning (LWP) effort in the Franklin to Fontana area. The intent of the 2010 benthic sampling was to compare the current benthic community to historic conditions and to obtain a bioclassification for Crawford Branch. Bioclassifications (rating) can now be assigned to small streams (drainage areas less than three square miles) since approval of the small stream criteria in May 2009 (NCDWQ 2009). Previously, small streams were assigned a rating of Not Rated or Not Impaired. Dalton Creek served as a comparison site. The Dalton Creek watershed is experiencing land disturbance from residential development, but the watershed lacks urban influences, agriculture, and livestock.

The NCDWQ sampled macroinvertebrates in Crawford Branch in 1999 (Table 2) and the 2000 Little Tennessee River Basinwide Assessment report stated that, "Although Crawford Branch is too small (three meters wide) to receive a bioclassification, the invertebrate community clearly indicated severe stress (only seven EPT taxa and all rare) at a downstream site on East Main Street. Urban development in this portion of the Crawford Branch watershed results in a high percentage of impervious surface area, and such development often results in toxic stress from the runoff. Another portion of Crawford Branch was evaluated by sampling upstream at Franklin Memorial Park. Much higher EPT taxa richness was found at this site (24) with five abundant species".

Table 1. Macroinvertebrate sampling locations in Crawford Branch and Dalton Creek May 2010

	Crawford Branch at Franklin Memorial Park	Crawford Branch at East Main Street	Dalton Creek off Dalton Creek Drive
Map Number	1	2	3
Latitude (º)	35.1803	35.1839	35.2673
Longitude (º)	-83.3889	-83.3753	-83.3634
Drainage area (mi²)	1.8	2.3	1.4

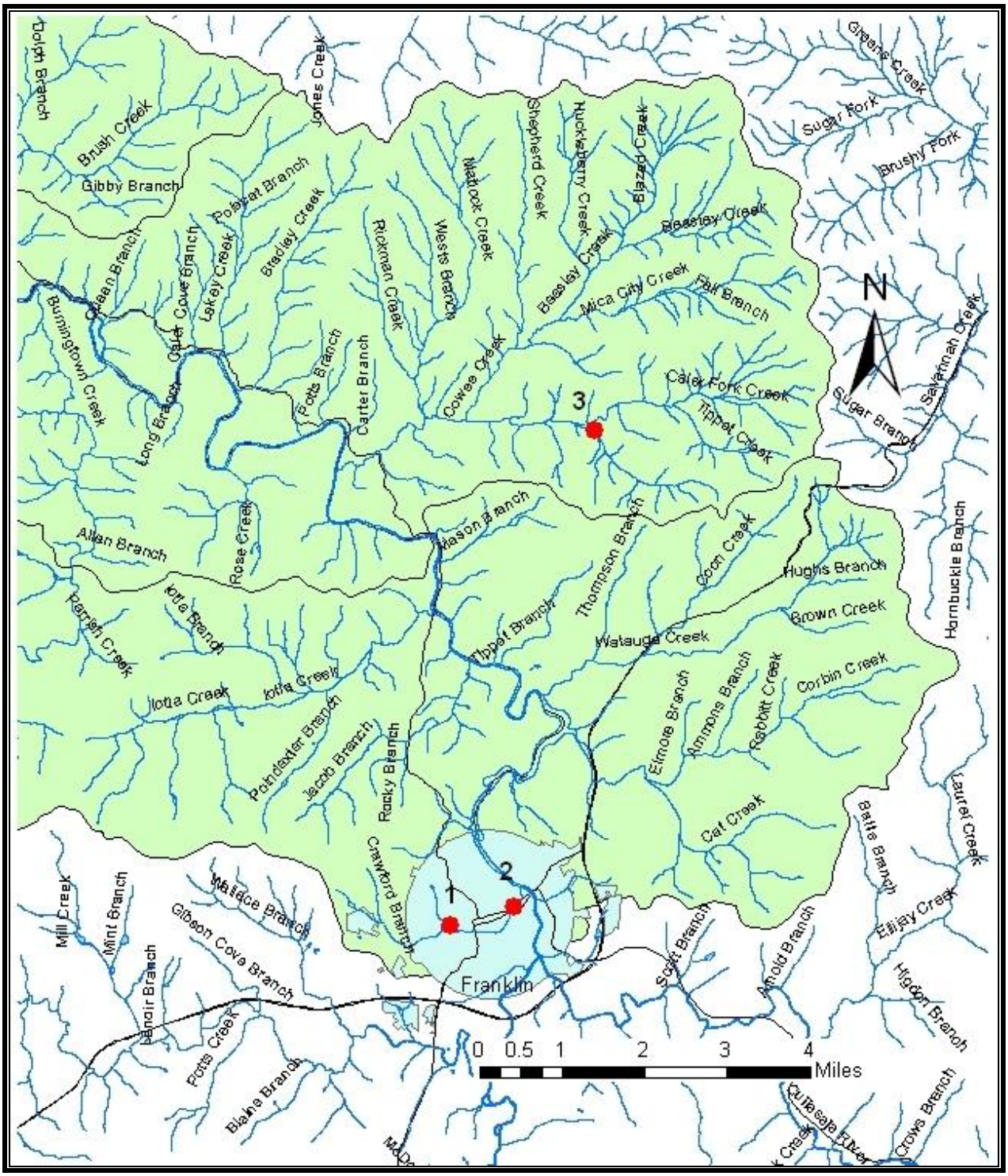

Figure 1. Sampling locations in Crawford Branch and Dalton Creek May 2010.

Table 2. 1999 Historical Crawford Branch benthic data (Note: The 1999 data are not directly comparable to 2010 data due to different sampling times of year and different methods.)

	Crawford Branch at Franklin Memorial Park	Crawford Branch at East main Street
Collection date	21-Jun-99	21-Jun-99
Map number	1	2
Sample method	EPT	Full Scale
Richness		
Ephemeroptera	10	3
Plecoptera	6	0
Trichoptera	8	4
Total EPT	24	7
Odonata	-	2
Megaloptera	-	0
Coleoptera	-	3
Chironomidae	-	13
non-Chironomidae Diptera	-	2
Oligochaeta	-	2
Mollusca	-	1
Other taxa	-	3
Total taxa richness	-	33
Other biological metrics		
EPT abundance	87	7
EPT Biotic Index	3.04	4.29
NCBI	-	7.51
Bioclassification	Not Impaired	Not Rated

Methods

Benthic Macroinvertebrates

Benthic macroinvertebrates (2010) were collected using the NCDWQ Biological Assessment Unit's Qual 4 method (NCDWQ 2006a). This method is typically used for streams that have a drainage area of three square miles or less. The NCDWQ small stream criteria (NCDWQ 2009) were used to determine the bioclassifications.

The Qual 4 collection method is comprised of four samples including the collection of one riffle-kick, one bank/root mat sweep, one leaf pack, and visual collections. These collections are used to inventory the aquatic fauna and produce an indication of the relative abundance for each taxon. Organisms are identified to the lowest possible taxon and enumerated as Rare (1-2 specimens, denoted by "R" on taxa tables), Common (3-9 specimens, "C"), or Abundant (≥10 specimens, "A").

Several data analysis summaries (metrics) are calculated from the benthic data to facilitate the detection of physical habitat and/or water quality problems. These metrics are based on a long history of observations and studies that show unstressed streams and rivers have higher invertebrate diversity and a relatively high proportion of intolerant species. Taxa within the

three EPT insect orders (Ephemeroptera, Plecoptera and Trichoptera) are generally intolerant of many kinds of pollution. Therefore, higher EPT taxa richness values indicate better water quality. Conversely, polluted streams have lower invertebrate diversity and are dominated by tolerant species.

The diversity of the invertebrate fauna is evaluated using taxa richness (i.e. the total number of distinct taxa present); the tolerance of the stream community is evaluated using a Biotic Index (derived from the general response of each taxon to the presence of stressors). Both tolerance values for individual taxa and the final biotic index values for the sample have a range of 0-10 with higher numbers indicating more tolerant taxa and more polluted conditions respectively. Mountain criteria were applied to all of the sites.

Habitat Evaluation

Habitat evaluations were conducted at the monitoring locations using the NCDWQ Biological Assessment Unit's (BAU) habitat assessment method for Mountain/Piedmont Streams (NCDWQ 2006a). The habitat assessment assigns a numerical score from 1-100 for the reach of stream sampled, based on channel modification, instream habitat, bottom substrate, pool variety, riffle habitats, bank stability and vegetation, light penetration, and width of the riparian zone. More specifically, these habitat evaluations assess the quality and quantity of instream habitat, the quality and quantity of the stream's riparian zone, and also evaluate detrimental impacts on stream habitat such as bank erosion and substrate embeddedness. No criteria have been developed to rate habitat scores, but the higher the score, the better the overall habitat. Habitat submetrics are depicted in Table 3.

Physical-Chemical Data

Measurements for pH were collected from each site using an Accumet AP61 meter. Data for temperature, dissolved oxygen, and specific conductance were collected using a YSI-85 multimeter for all sites. All measurements were made in accordance with standard operating procedures (NCDWQ 2006a). Physical measurements are included in Table 3.

Table 3. Historical and 2010 habitat metrics and physicochemical results for Crawford Branch and Dalton Creek

	Crawford Br at Franklin Memorial Park	Crawford Br at Franklin Memorial Park	Crawford Branch at E. Main St.	Crawford Branch at E. Main St.	Dalton Creek off Dalton Cr Dr
Collection date	21-Jun-99	20-May-10	21-Jun-99	20-May-10	20-May-10
Map number	1	1	2	2	3
Habitat Scores					
Channel modification (5)	3	2	0	2	5
In-stream habitat (20)	13	15	10	12	16
Bottom substrate (15)	6	6	3	8	8
Pool variety (10)	4	0	4	0	6
Riffle habitats (16)	16	16	14	12	16
Bank stability/vegetation (14)	10	5	14	7	8
Light penetration (10)	8	2	0	7	7
Riparian zone width (10)	4	0	2	0	1
Total Habitat (100)	64	46	47	48	67
Other Habitat					
Average stream width (m)	2	1.2	3	2	1.5
Average stream depth (m)	0.2	0.2	0.3	0.3	0.2
Canopy (%)	40	0	10	40	70
Substrate (%)					
Boulder	10	0	15	10	10
Cobble	20	30	25	25	30
Gravel	25	35	10	15	25
Sand	40	25	40	35	25
Silt	5	10	10	15	10
Physicochemical					
Temperature (ºC)	18.8	16.0	18.8	14.0	16.0
Dissolved oxygen (mg/L)	7.9	9.8	6.4	10.6	9.2
Specific conductance (µmhos/cm)	40	40	51	49	26
pH	7.2	6.5	7.1	6.5	6.5

[1] Numbers in parenthesis represent the maximum score for the sub-metric.

Sampling Results

Benthic Macroinvertebrates

Table 4. 2010 Benthic Sampling Results for Crawford Branch and Dalton Creek

	Crawford Branch at Franklin Memorial park	Crawford Branch at East Main Street	Dalton Creek off Dalton Creek Road
Collection date	20-May-10	20-May-10	20-May-10
Map number	1	2	3
Sample method	Qual 4	Qual 4	Qual 4
Criteria	Small Stream	Small Stream	Small Stream
Richness			
Ephemeroptera	7	2	13
Plecoptera	5	1	11
Trichoptera	6	2	11
Total EPT	18	5	35
Odonata	3	1	4
Megaloptera	0	0	0
Coleoptera	2	1	5
Chironomidae	10	12	1
non-Chironomidae Diptera	5	2	5
Oligochaeta	2	2	2
Mollusca	1	0	1
Other taxa	0	0	0
Total taxa richness	41	23	53
Other biological metrics			
EPT abundance	81	11	173
EPT Biotic Index	2.78	4.45	1.88
NCBI	3.65	5.76	2.05
Bioclassification	Good	Fair	Excellent

Crawford Branch at Franklin Memorial Park (Map Number 1)

Based on the taxa collected and using the small stream rating methodology (NCDWQ 2009), this site received a Good bioclassification. Eighteen EPT taxa were collected, including seven mayfly taxa, five stonefly taxa, and six caddisfly taxa. Most of the taxa collected were moderately tolerant with a few intolerant taxa. Some of the intolerant taxa collected were the stoneflies *Isoperla holochlora*, *Leuctra*, *Remenus bilobatus*, and the caddisflies *Glossosoma* spp. and *Diplectrona modesta*. It is interesting that *Glossosoma* was

abundant at this site since it is considered to be intolerant of silt and sediment. The EPT BI was 2.78 and the NC BI was 3.65.

Crawford Branch at East Main Street (Map Number 2)

This site is downstream of most of the town of Franklin and received a Fair bioclassification using the small stream criteria. Only five EPT taxa were collected at this site. This was similar to 1999 when only seven EPT taxa were collected. Most taxa present at the Franklin Memorial Park site were not collected at this location. All of the EPT taxa were very low in abundance (one to four individuals). There was only one individual stonefly collected, a *Leuctra*. Blackflies, megadrile oligocheates, and several midges were the only taxa that were abundant. The EPT BI increased to 4.45 and the NC BI increased to 5.76.

Dalton Creek off Dalton Creek Road (Map Number 3)

In May 2010, using the small stream criteria (NCDWQ 2009), Dalton Creek received an Excellent bioclassification. Thirty-five EPT taxa were collected. This included 11 stonefly taxa, 16 mayfly taxa, and 11 caddisfly taxa. This is a high number of EPT taxa for a stream with such a small drainage area (1.4 square miles). Many of the taxa were intolerant and indicators of high quality water. Very few midges were collected in Dalton Creek. Both the EPT BI (1.88) and the NC BI (2.05) were low.

Habitat and Physical-Chemical Parameters

The habitat scores were very similar for the upstream (46) and downstream (48) benthic sites on Crawford Branch. Both sites have extensive channel modification, poor pool habitat, and narrow riparian zones. The upper site at the Memorial Park has very little vegetation other than grass on the stream banks. The substrate at the upper site was mostly gravel and cobble with a high percent of sand (25%) and silt (10%). It was estimated to be 40-80% embedded. The substrate at the lower site at East Main Street contained a mixture of gravel, cobble, and boulders, but was

also very embedded. There was a very narrow strip of vegetation that included small trees and shrubs that provided more shade to the stream at this location than at the upper (Memorial Park) site. Similar to the upper site, the lower Crawford Branch site had a high percentage of sand (35%) and silt (15%) in the substrate. Dalton Creek scored 67 for overall habitat. It scored high for its natural channel, areas favorable for benthic colonization, and riffle habitats. However, deep, straight incised banks were noted and the substrate was estimated to contain 35% sand and silt, which would be an indication of land disturbance upstream. At the Dalton Creek sampling site, the riparian zones were fairly narrow.

At the time of sampling, the physical-chemical measurements were within typical ranges for the area. Typical of urban areas, the specific conductance values were slightly elevated in the Crawford Branch watershed (40 to 49 µmhos/cm). Higher values have been recorded in Crawford Branch beginning in 2008 with field work in the LWP. The highest recorded value was 58 µmhos/cm at the Crawford Branch East Main Street site. Specific conductance is a measure of the ability of water to conduct an electric current and is a useful indicator of water quality conditions. Thus, higher values for specific conductance are associated with higher concentrations of dissolved substances. The dissolved substances may or may not represent pollution. Specific conductance generally increases with increasing concentrations of nitrite+nitrate (NOx) nitrogen and sometimes, fecal coliform. The specific conductance in Dalton Creek was 26 µmhos/cm. Dissolved oxygen and pH values were within normal ranges for Crawford Branch and Dalton Creek.

Conclusions

The benthic macroinvertebrate community clearly declines in Crawford Branch as it flows through the town of Franklin. The benthic fauna at the upper Memorial Park site rated Good and contained 18 EPT taxa including several intolerant taxa. At the downstream site, the rating declined to Fair, indicating impaired water quality conditions. Five EPT taxa were collected and only one individual stonefly. The collection of only one stonefly implies severe water quality issues and possibly that toxicity is an issue in Crawford Branch.

Both Crawford Branch sites have poor habitat. Riparian zones are narrow and the substrate is filled with sand and silt. The stream is straight from channelization and lacks adequate pool habitat. Since the habitat is poor at both sites, it is not considered to be the cause of the declining benthic fauna at the lower Crawford Branch site.

Presently, Dalton Creek supports an intolerant benthic community including taxa that are sensitive to sediment. Dalton Creek was notable in that eleven different stoneflies were collected in this small stream. This is an unusually high number of stonefly taxa for a stream that has a drainage area of only 1.4 square miles. It is evident that Dalton Creek is affected by development in its watershed by the steep, incised banks and the amount of sand and silt in the substrate (35%). This small stream warrants close observation as conditions may start to decline as development increases in the watershed.

References

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Appendix 1. 1999 and 2010 list of taxa in Crawford Branch and Dalton Creek

			Crawford Br Franklin Memorial Park 21 Jun 1999	Crawford Br Franklin Memorial Park 20 May 2010	Crawford Br E. Main Street 21 Jun 1999	Crawford Br E. Main Street 20 May 2010	Dalton Creek off Dalton Cr Road 28 Oct 2008	Dalton Creek off Dalton Cr Road 20 May 2010
Ephemeroptera								
	Baetidae	BAETIS FLAVISTRIGA	R		R			
		BAETIS INTERCALARIS	C	A		C		
		BAETIS PLUTO	C	C		C	C	
		BAETIS TRICAUDATUS		A				A
		CENTROPTILUM SPP (dubious)			R			
		PLAUDITUS DUBIUS GR	A				R	A
		PSEUDOCLOEON FRONDALE		C				
	Baetiscidae	BAETISCA CAROLINA					C	
		BAETISCA SPP			R			
	Caenidae	BRACHYCERCUS SPP	R					
	Ephemerellidae	DANNELLA LITA						C
		DRUNELLA CORNUTELLA						R
		EPHEMERELLA DOROTHEA		A				A
		TELAGONOPSIS DEFICIENS	A	C				C
	Ephemeridae	EPHEMERA SPP						R
	Heptageniidae	EPEORUS VITREUS						C
		HEPTAGENIA SPP						A
		LEUCROCUTA SPP						R
		MACCAFFERTIUM MODESTUM	A	C			A	
		MACCAFFERTIUM PUDICUM					C	
		MACCAFFERTIUM TERMINATUM						A
		STENACRON PALLIDUM	R					
	Isonychiidae	ISONYCHIA SPP	C					C
	Leptophlebiidae	PARALEPTOPHLEBIA SPP	A				C	C
Plecoptera								
	Capniidae	ALLOCAPNIA SPP					A	
	Chloroperlidae	HAPLOPERLA BREVIS						R
		SUWALLIA MARGINATA	R					
		SWELTSA SPP					R	
	Leuctridae	LEUCTRA SPP	C	A		R		C
	Nemouridae	AMPHINEMURA SPP	R	C				C
	Peltoperlidae	TALLAPERLA SPP	R				R	A
	Perlidae	ACRONEURIA ABNORMIS	R				A	A
		ECCOPTURA XANTHENES					R	
		PARAGNETINA IMMARGINATA						R
		PERLESTA SPP	R					C
	Perlodidae	CULTUS DECISUS COMPLEX					C	

		ISOPERLA HOLOCHLORA		C				A
		ISOPERLA NR HOLOCHLORA		R				R
		MALIREKUS HASTATUS					R	
		REMENUS BILOBATUS		C				C
	Pteronarcyidae	PTERONARCYS PROTEUS						A
		PTERONARCYS SPP					C	
	Taeniopterygidae	TAENIOPTERYX SPP					R	
Trichoptera								
	Brachycentridae	BRACHYCENTRUS NIGROSOMA					R	
	Glossosomatidae	GLOSSOSOMA SPP	C	A			C	C
	Hydropsychidae	CERATOPSYCHE BRONTA					C	R
		CERATOPSYCHE SPARNA	C		R		A	
		CHEUMATOPSYCHE SPP		C	R	C	C	C
		DIPLECTRONA MODESTA	A	R	R		C	A
		HYDROPSYCHE BETTENI	C				C	
		HYDROPSYCHIDAE		R				
	Lepidostomatidae	LEPIDOSTOMA SPP		R				C
	Leptoceridae	TRIAENODES IGNITUS	C					
	Limnephilidae	PYCNOPSYCHE SPP	C	C	R	R	C	C
	Philopotamidae	DOLOPHILODES SPP					A	A
	Polycentropodidae	POLYCENTROPUS SPP						R
	Rhyacophilidae	RHYACOPHILA CAROLINA						C
		RHYACOPHILA FUSCULA	R					C
	Uenoidae	NEOPHYLAX CONSIMILIS	R					A
Odonata								
	Aeshnidae	BOYERIA VINOSA		C		R		
	Calopterygidae	CALOPTERYX SPP		R			C	R
	Cordulegasteridae	CORDULEGASTER SPP					R	R
	Gomphidae	GOMPHUS SPP		R	R		R	
		HAGENIUS BREVISTYLUS						R
		LANTHUS SPP					R	R
	Libellulidae	PLATHEMIS LYDIA			R			
Coleoptera								
	Dryopidae	HELICHUS SPP			R			C
	Elmidae	PROMORESIA TARDELLA						R
		STENELMIS N SP		R		R		R
		STENELMIS SPP					R	
	Hydrophilidae	LACCOBIUS SPP			R			
		SPERCHOPSIS TESSELLATUS						R
		TROPISTERNUS SPP			R			
	Psephenidae	PSEPHENUS HERRICKI					C	A
	Ptilodactylidae	ANCHYTARSUS BICOLOR		R				
Chironomidae								
	Chironomidae	BRILLIA SPP		C		A		
		CARDIOCLADIUS SPP		A		R		
		CHIRONOMUS SPP			A			
		CRICOTOPUS ANNULATOR COMPLEX		C		A		
		CRICOTOPUS BICINCTUS			C	R		
		CRICOTOPUS INFUSCATUS GR			C			

		CRYPTOCHIRONOMUS FULVUS		R			
		EUKIEFFERIELLA CLARIPENNIS GR			C		
		EUKIEFFERIELLA DEVONICA GR			R		
		EUKIEFFERIELLA TIROLENSIS				R	
		PARALAUTERBORNIELLA NIGROHALTERALIS		R			
		PARAMETRIOCNEMUS SPP	C	C	C	R	
		PARATENDIPES SPP	R				
		PHAENOPSECTRA PUNCTIPES GR		C			
		POLYPEDILUM AVICEPS	R		C	R	
		POLYPEDILUM SCALAENUM GR		R			
		POTTHASTIA LONGIMANA		R			
		PRODIAMESA OLIVACEA		C	R		
		RHEOCRICOTOPUS ROBACKI		C			
		RHEOTANYTARSUS SPP	R		C		
		TANYTARSUS SP 6		C			
		THIENEMANIELLA XENA	R				
		THIENEMANNIMYIA GR	R	A	C	R	
		TVETENIA BAVARICA GR	A		C	R	C
non-Chironomidae Diptera							
	Blephariceridae	BLEPHARICERA SPP					R
	Ceratopogonidae	PALPOMYIA COMPLEX	C				
	Dixidae	DIXA SPP	C				R
	Simuliidae	SIMULIUM SPP	C	C	A	R	R
	Tipulidae	ANTOCHA SPP	R			R	
		DICRANOTA SPP					C
		TIPULA SPP		C		A	
		TIPULIDAE	C		C		C
Oligochaeta							
	Lumbriculidae	LUMBRICULIDAE	R	R	C		
	Megadrile	MEGADRILE OLIGOCHAETE	C		A		R
	Naididae	NAIS SPP				C	R
	Tubificidae	ILYODRILUS TEMPLETONI		R			
Crustacea							
	Cambaridae	CAMBARIDAE		R			
	Gammaridae	CRANGONYX SPP		R			
Gastropoda							
	Physidae	PHYSA SPP		C			
	Pleuroceridae	ELIMIA SPP	A			R	C
Other							
	Hydracarina	HYDRACARINA		C			

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