Division of Water Quality
Biological Assessment Unit
November 9, 2004

MEMORANDUM

To: Michelle Woolfolk
Through: Trish MacPherson, Jimmie Overton
From: Niki Flint
Subject: May 2004 macroinvertebrate sampling of Perry Creek watershed Neuse subbasin 02) for TMDL stressor identification.

BACKGROUND

Perry Creek is a heavily urbanized stream in Wake County in the northeast portion of the city of Raleigh. The watershed is located in the Northern Outer Piedmont ecoregion within subbasin 02 of the Neuse River basin. The stream flows generally east towards its confluence with the Neuse River. There are two major impoundments in the system, Greshams Lake on Perry Creek and a lake at Camp Durant on an unnamed tributary (UT) to Perry Creek. Greshams Lake divides the mainstem into two use classifications: from the source to the dam is designated as Class B (primary use is recreational) NSW (nutrient sensitive waters), and from the dam to the confluence with the Neuse River is Class C (aquatic life use, secondary recreational) NSW. The UT Perry Creek is likewise divided into two designations: Class B NSW from the source to the dam at Camp Durant, and Class C NSW from the dam at Camp Durant to the confluence with Perry Creek. Smaller impoundments are also found within the watershed: two above Greshams Lake on Perry Creek, one above the Lake at Camp Durant, and two in the upper watershed of an unnamed tributary originating near US 401.

The entire length of Perry Creek is considered impaired, and is 303(d) listed due to biological data. Potential historical sources of impairment include a minor non-municipal point source, urban runoff, and storm sewers. There was one NPDES permitted discharger in the watershed. It was permitted 0.025 MGD outflow to UT Perry Creek, which flows into Greshams Lake from the south side of the lake. The facility's permit expired in 1997, however, and it is currently offline. No other dischargers are currently operating in the Perry Creek watershed.

Perry Creek was sampled three times at the SR 2006 location: in 1995 and 2000 for basinwide sampling, and for a special study in 1996. Each survey employed the EPT sampling method and resulted in a Fair bioclassification. The July 1995 basinwide survey concluded the stream was affected by nonpoint source runoff. Post-hurricane sampling in December of 1996 (Biological Assessment Unit Memorandum B-970117) again documented the effect of nonpoint source runoff. Hurricane damage could not be determined apart from prior nonpoint source degradation of the stream. The 2001 Basinwide Assessment Report (based on data from the July 2000 sampling) addressed flow-related impact in addition to sediment loading, nutrient loading, and high conductivity. It was noted that during high flow events, water backed up in Perry Creek from the Neuse River. This resulted in lack of flow and further stressed the benthic community in Perry Creek.

Water chemistry samples were collected during a reconnaissance survey in January of 2004 by Intensive Survey Unit (ISU) staff (Memorandum, January 23, 2004). Four sites on Perry Creek (including the historically sampled site at SR 2006) and three UT Perry Creek sites were targeted for basic physical parameters: temperature, dissolved oxygen, pH, specific conductance, and flow velocity (Figure 1). Temperature ranged from 4.6 to 9.1 ºC, dissolved oxygen fell between 10.0 and 11.9 mg/l, and pH was 6.1 to 7.7. Specific conductance was lower (78-90 µS/cm) in tributaries and at the most upstream main stem site than the remaining main stem sites. Main stem sites ranged from 117 (site PC7 at SR 2006) to 149 µS/cm (at PC3, the site immediately below Greshams Lake). Surface flow was greatest in the upper watershed at PC2 (Perry Creek

at SR 2012, 1.07 ft/sec). At the downstream most site on Perry Creek at SR 2006, the flow was 0.78 ft/sec.

Benthic sampling of Perry Creek in 2004 was performed by BAU to confirm potential sources of stress to the system for TMDL development and determine the current status of the condition of the stream.

METHODS

(For a more detailed explanation of methods, please consult Standard Operating Procedures For Benthic Macroinvertebrates, Biological Assessment Unit, July 2003)

Sampling Methods

Benthic macroinvertebrates were collected at all sites for the investigation using the Division of Water Quality's standard qualitative (Full Scale) sampling procedure (NCDENR 2003). This method includes 10 composite samples: two kick net samples, three bank sweeps, two rock or log washes, one sand sample, one leaf pack sample, and visual collections from large rocks and logs.

The purpose of these collections was to inventory the aquatic fauna and produce an indication of the relative abundance for each taxon. Organisms were classified as Rare (1-2 specimens), Common (3-9 specimens), or Abundant ($\geq$10 specimens).

Data Interpretation

Several data-analysis summaries (metrics) can be produced from standard qualitative samples to detect water quality problems. These metrics are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts. The tolerance of the stream community is evaluated using a biotic index.

EPT taxa richness (EPT S) is used with DWQ criteria to assign water quality ratings (bioclassifications). "EPT" is an abbreviation for Ephemeroptera + Plecoptera + Trichoptera, insect groups that are generally intolerant of many kinds of pollution. Higher EPT taxa richness values usually indicate better water quality. Water quality ratings are also based on the relative tolerance of the macroinvertebrate community as summarized by the North Carolina Biotic Index (NCBI). Both tolerance values for individual species and the final biotic index values have a range of 0-10, with higher numbers indicating more tolerant species or more polluted conditions. Water quality ratings assigned with the biotic index numbers were combined with EPT taxa richness ratings to produce a final bioclassification, using criteria for piedmont streams. The appropriate seasonal corrections were made as needed. Sites with drainage areas of less than three square miles could not be assigned a bioclassificaiton. Instead, the site was classified as Not Impaired if the stream would receive a Good-Fair or better rating using DWQ EPT criteria developed for larger streams. Small streams that would have a minimum bioclassification of Fair or Poor continue to be Not Rated.

EPT abundance (EPT N) and total taxa richness (ST) calculations also are used to help examine between-site differences in water quality. When the EPT taxa richness rating and the biotic index differ by one bioclassification, the EPT abundance value was used to produce the final site rating.

Habitat Evaluation

Habitat evaluations were made using the Biological Assessment Unit's Habitat Assessment Field Data Sheet- Mountain/Piedmont Streams (Revision 5). This evaluation is based on best professional judgment of seven habitat metrics and assigns a numerical score from 0-100 for the 100 meter reach of stream sampled based on channel modification, instream habitat, bottom substrate, pool variety, riffle habitats, bank stability and vegetation, light penetration, and riparian

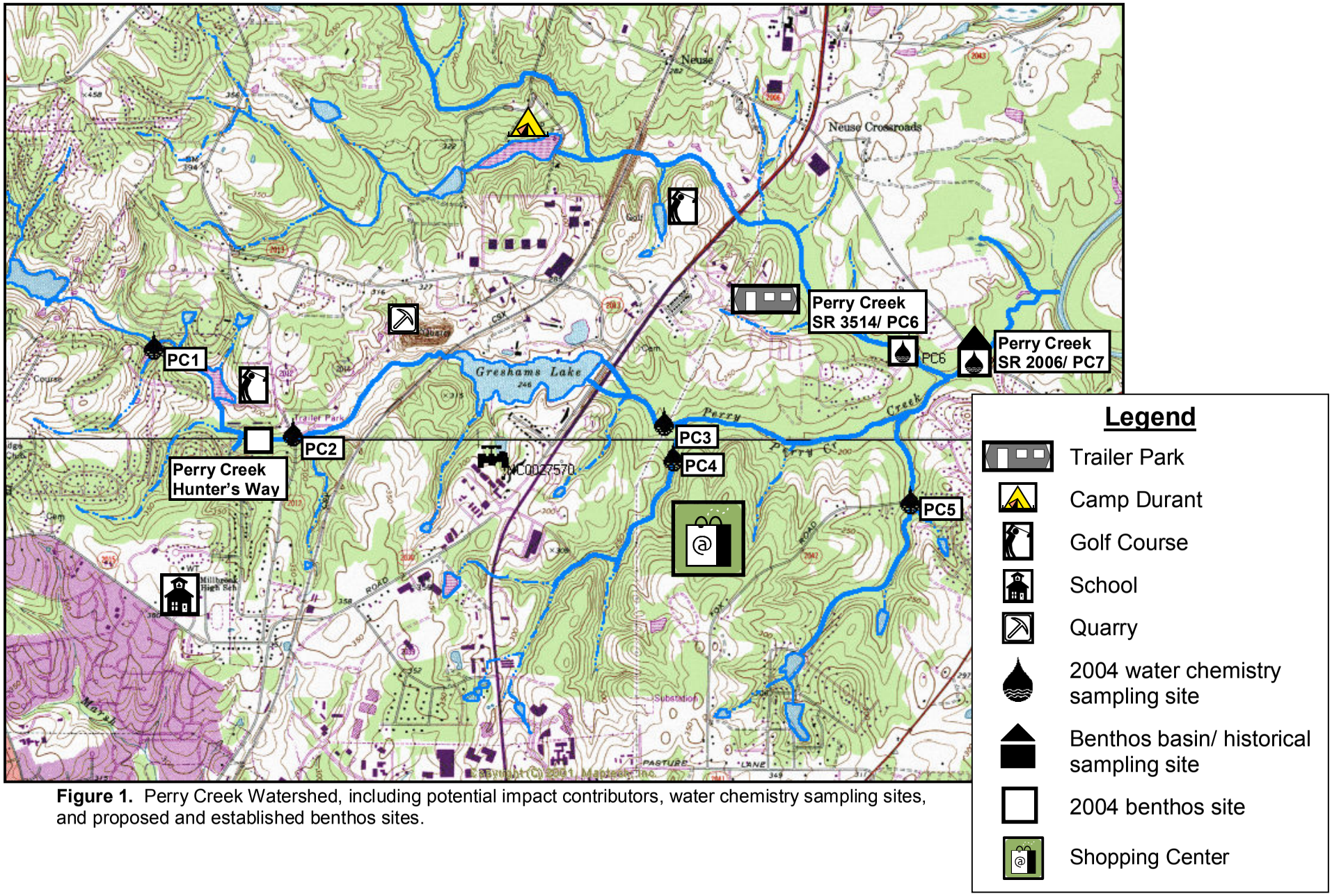


Figure 1. Perry Creek Watershed, including potential impact contributors, water chemistry sampling sites, and proposed and established benthos sites.

vegetative zone width. Scores are given for each of the seven metrics and are then totaled (100 pints possible). Streams of monitoring stations within major ecoregion types and size categories can be compared to on another and to reference locations.

Documentation of habitat characteristics at a sampling site can identify limiting factors that can affect biological communities. Habitat assessment provides baseline information on stream conditions so that chances resulting from natural or human causes can be identified or predicted. Habitat assessments can also explain changes in the biota from alteration of stream conditions, such as land use changes and channelization.

Physical –Chemical
Field measurements were taken at the time of sampling for temperature, dissolved, oxygen, conductivity, and pH using a YSI 85 meter and a Fisher Scientific Accumet pH meter.

SAMPLE SITES

Urbanization has historically posed accessibility and flow problems for Perry Creek, and during the 2004 survey, proved to limit the ability to sample the stream. At the time of sampling, flows were low. Rainfall was about six inches lower than it typically is at that time of year. The most recent rains occurred more than a week prior to sampling and were relatively insignificant. Of the few sites where flow was evident, accessibility was hampered by construction activities or dangerous roadway conditions. Unfortunately, one of the three sites sampled was further eliminated by close proximity to an impoundment. Ultimately, a suitable site representing the upstream portion of the watershed could not be found.

Perry Creek at Hunters Way
This site was considered the only plausible location in the upper watershed as it had favorable flow compared to other upstream locations. However, it proved to be a poor location, positioned 500 meters downstream from an impoundment. Sampling below dams is not recommended, as downstream benthic migration/colonization is inhibited by the physical structures. For this reason, though the community structure will be assessed at this site, a rating cannot be assigned to it.


Downstream view: deep but gently sloping and heavily vegetated banks and long shallow riffle.


Upstream view. The left culvert delivers a trickle to the stream, presumably from townhouses just visible in the background.

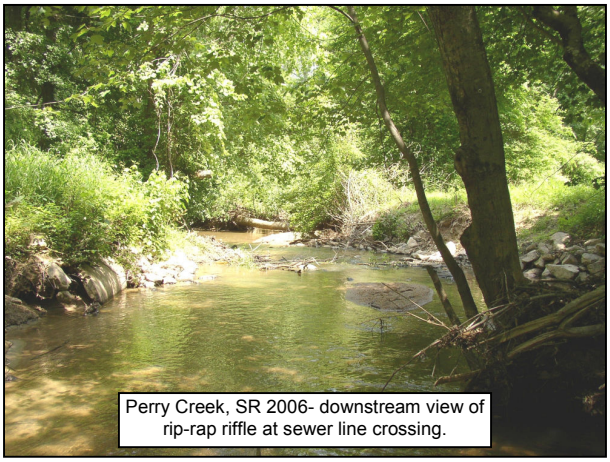
Drainage area at this site was 3.5 square miles. Surrounding the sampling reach were a townhouse community (with associated parking lots) and single family residences. Upstream of the reach (within the 500 meters below the impoundment), the stream flowed through a golf course. The stream appeared channelized, which likely occurred as the area was developed. Within the sampling reach, banks were stabilized by rip rap and shrubs, and lined with healthy hardwoods, shrubs, and grasses. Riparian areas of grass and trees offered narrow buffers. The entire upper portion of the sampling reach was a long shallow gravel and cobble riffle. Root mats were abundant. The downstream quarter of the reach was a series of rip-rap riffles pouring

into pools. Downstream beyond the sampling reach, sand dominated the deeper slow-moving run, and riparian areas were minimized by encroaching residences. Habitat was given a score of 71, indicating favorable instream habitat despite lacking riparian areas.

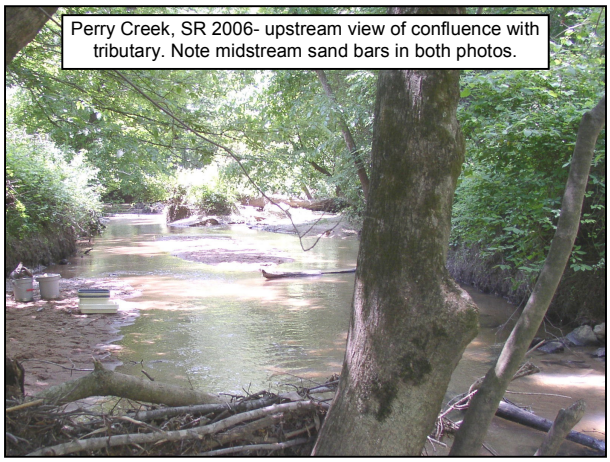
Perry Creek at SR 2006

This downstream site has been sampled previously, but road/ bridge construction at SR 2006 complicated direct access to the site at the time of sampling. Instead, access was reached via a UT. The sampling reach was moved slightly upstream of the bridge to avoid any construction activities, and included the segment of stream from that point to just below the confluence with the UT.

The drainage area at this site was 9.5 square miles. The riparian area was forested and wide. Banks were well vegetated but exhibited moderate erosion, and were taller and steeper than at the upstream and UT sites. Instream, undercut banks and roots provided the majority of favorable habitat, as the substrate was mostly sand and had a substantial amount of silt. Bars were actively developing, and the stream had a flashy appearance. Banks were unstable. A sewer line crossing provided rip-rap to the stream and a riparian break midway through the sampling reach. Habitat was given a score of 52.



Perry Creek, SR 2006- downstream view of rip-rap riffle at sewer line crossing.



Perry Creek, SR 2006- upstream view of confluence with tributary. Note midstream sand bars in both photos.

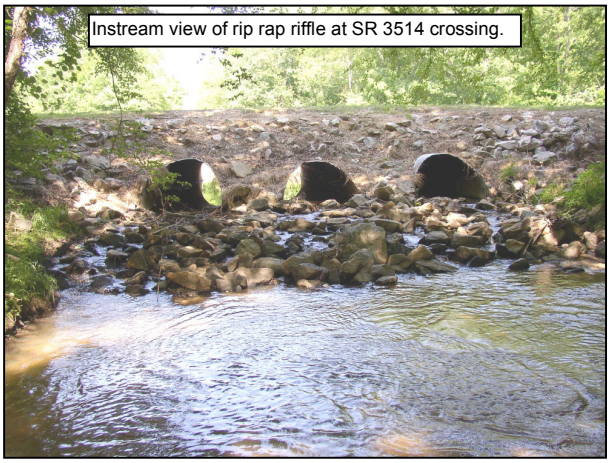
UT Perry Creek at SR 3514

An established neighborhood lies adjacent to the left bank of this tributary for approximately half its length. Though the canopy was minimal and grass lawns reached the banks near the SR 3514 crossing, the majority of the subdivision was composed of older homes on large lots that were for the most part wooded (as opposed to maintained lawns). Near the road crossing, the banks were fortified with rip rap, and a side stream (pool) was constructed just below the road crossing to handle runoff from the neighborhood. The drainage area at this site was approximately two square miles.

Upstream view of riparian zone from SR 3514 crossing.

The portion of the stream that was sampled, however, was surrounded by deciduous forest. The single interruption in the riparian zone was a sewer line that ran parallel to the left bank the majority of the length of the reach (though at a distance from the bank), and crossed the stream at the lower end of the sampling reach. Instream habitat was limited to undercut banks

and healthy root mats. Banks were short and stable. Except for the rip rap riffle at the upstream boundary and a couple gravel chub beds, bottom substrate was composed entirely of sand. This stream also appeared flashy and bar formation was evident, though not to as great a degree as on the main stem. Habitat was assessed a score of 54.


Instream view of rip rap riffle at SR 3514 crossing.


Downstream view of sampling reach, sandy substrate, wooded riparian area, and stable banks.

RESULTS

Benthic macroinvertebrates have consistently rated Fair in Perry Creek since 1995, and continued that trend in 2004. For the 2004 survey, the main stem at SR 2006 was assessed a Fair rating with (seasonally corrected) biotic index (BI) value of 7.09. The UT Perry Creek at SR 3514 site was classified as Not Rated due to its small drainage area, but with a BI of 7.12 compared to large streams that were assessed Fair ratings. (Table 1) The UT Perry Creek site, though still composed of an extremely tolerant benthic community, had greater numbers of macroinvertebrates in general. Compared to the downstream (SR 2006) main stem site, total taxa richness (70 versus 62), EPT richness (10 versus 9) and EPT abundance (77 versus 67) values were slightly greater in the tributary. Less exposure to urban/suburban pressures in the smaller watershed, combined with older, more established, less densely populated housing developments might explain this slight difference. Because *Chironomus* were abundant at both sites, mentum deformity tests were performed in order to assess possible toxicity influence. Few deformities were observed, indicating nontoxic conditions. Both sites (as did the upstream site), lacked specific indicator taxa and exhibited highly tolerant benthic communities, suggesting considerable impact from urban/suburban pressures.

The upstream (Hunters Way) main stem site was Not Rated due to close proximity to an impoundment, but its high seasonally corrected BI (7.17) and low EPT richness and abundance values (5 and 34, respectively) suggest a degraded benthic assemblage. The benthic community was very sparse and composed of highly tolerant taxa. The assemblage was so meager as to even be devoid of indicator species. (Even filter feeders, which are expected to be dominant below impoundments, were lacking overall.) It is highly likely that flow at the site may be minimal or stop altogether during periods of little rainfall, as flow is interrupted upstream of this site by the impoundment. The sampling reach was uncharacteristic of other portions of the stream, with higher gradient, a rocky substrate, and rip-rap reinforced banks. The reach appeared to provide favorable habitat, but, as at the time of sampling, the relatively low volume of water providing flow was merely the water draining from the lower gradient run between the sampling reach and the dam. The lack of benthos in general is a strong indication that the golf course impoundment in conjunction with surrounding development pressures and periods of low or no flow have adversely impacted Perry Creek at the upstream site.

Table 1. Station summary data of all benthos sites in the Perry Creek watershed, from 1995 to present. Shaded columns denote samples collected for the current (2004) survey.

	Perry Cr Hunters Way 5/11/2004	Perry Cr SR 2006 7/25/1995	Perry Cr SR 2006 12/9/1996	Perry Cr SR 2006 7/6/2000	Perry Cr SR 2006 5/10/2004	UT Perry Cr SR 3514 5/10/2004
COMMUNITY						
Ephemeroptera	2	5	6	6	5	6
Plecoptera	0	0	3	0	0	0
Trichoptera	3	3	2	2	4	4
Coleoptera	4	0	0	0	8	4
Odonata	5	0	0	0	7	8
Megaloptera	0	0	0	0	1	1
Diptera: Chironomidae	13	0	0	0	26	31
Misc. Diptera	5	0	0	0	4	4
Oligochaeta	4	0	0	0	3	5
Crustacea	1	0	0	0	2	1
Mollusca	3	0	0	0	2	4
Other	4	0	0	0	1	1
Total Taxa Richness	44	8	11	8	63	70
EPT Richness	5	8	11	8	9	10
Seasonal Corr (- out of season spp)	5	8	8	8	9	10
EPT Abundance	34	30	51	50	67	77
Biotic Index	6.97	-	-	-	6.88	6.92
Seasonal Correction	7.17	-	-	-	7.08	7.12
EPT BI	6.97	5.87	5.57	5.23	6.26	5.84
Bioclassification	Not Rated	Fair	Fair	Fair	Fair	Not Rated
HABITAT						
Stream Width	3	9	5	7	5	4
Average Depth	0.1	0.2	0.2	0.2	0.2	0.2
Flow/ Current	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Bank Height	1.5				1.5	0.5
Bank Angle (°)	60				90	90
Bank Erosion	None	Severe	Severe	Moderate	Moderate	None
Canopy (%)	98	90	50	80	70	90
Canopy Type	Deciduous	Deciduous	Deciduous	Deciduous	Deciduous	Deciduous
Aufwuchs	None	None-Moderate	Moderate	Abundant	None	None
Pedostemum	None	None	None	None	None	None
Tribs Present?	No	No	No	No	Yes	No
Substrate (%)						
Boulder	20	0	0	0	0	0
Rubble	30	0	0	0	0	0
Gravel	30	10	35	20	0	10
Sand	20	80	60	80	70	90
Silt	0	10	5	0	30	0
Other	0	0	0	0	0	0
Habitat Score	71	60	70	56	54	56
CHEMISTRY						
Temp ºC	22	27	6	25	22	21.2
DO mg/l	6.3	6.9	--	8.2	7.1	7.7
Cond µS/cm	116	110	66	150	148	115
pH	6.7	7	--	7.2	6.6	6.7
LOCATION/ GENERAL						
Basin (subbasin)	Neuse 02	Neuse 02	Neuse 02	Neuse 02	Neuse 02	Neuse 02
County	Wake	Wake	Wake	Wake	Wake	Wake
Latitude	355230	355250	355250	355250	355247	355249
Longitude	783556	783250	783250	783250	783253	783309
Collection Card	9376	6887	7232	8141	9375	9374
Sample Type	Full Scale	EPT	EPT	EPT	Full Scale	Full Scale
Drainage Area (approx sq mi)	3.5	9.5	9.5	9.5	9.5	2

DISCUSSION

Perry Creek is stressed by urban pressures from its source to the confluence with the Neuse River. Moderate to high-density residential and commercial development is ubiquitous, numerous impoundments are found throughout the watershed, large portions of the streams are culverted or maintained as ditches (one such culvert runs a substantial distance underground, beneath Triangle Town Center), a major interstate and US highway traverse the stream. All off which contribute to degradation of riparian, bank, hydrographic, and instream habitat and to the aquatic communities in the stream. Typical of urban streams, Perry Creek exhibited flow-related impact (hydromodification, bank erosion), sediment loading, high conductivity, and, ultimately, a degraded benthic community. These trends were noted in previous surveys, and have continued through the current study.

CC: Darlene Kucken, Planning Branch

Appendix 1. Taxa collected from the Perry Creek watershed, from 1995 to present. Shaded columns denote samples collected for the current (2004) survey.

	Perry Cr Hunters Way 5/11/2004	Perry Cr SR 2006 7/25/1995	Perry Cr SR 2006 12/9/1996	Perry Cr SR 2006 7/6/2000	Perry Cr SR 2006 5/10/2004	UT Perry Cr SR 3514 5/10/2004
EPHEMEROPTERA						
BAETIS FLAVISTRIGA	A	R		C	A	A
BAETIS INTERCALARIS				R	A	
BAETIS PLUTO					R	C
BAETIS PROPINQUUS		C	R	C	A	A
CAENIS SPP	C	C	A			
CENTROPTILUM SPP			R			
EPHEMERELLA CATAWBA			R			
ISONYCHIA SPP		R		A		R
LEPTOPHLEBIA SPP			R			
PARACLOEODES N SP						C
STENONEMA MODESTUM		A	A	A	C	A
TRICORYTHODES SPP				A		
PLECOPTERA						
ALLOCAPNIA SPP			A			
CLIOPERLA CLIO			R			
TAENIOPTERYX SPP			C			
TRICHOPTERA						
CHEUMATOPSYCHE SPP	A	A	A	A	A	A
HYDROPSYCHE BETTENI	A		C		A	A
OECETIS PERSIMILLIS	R	R			A	A
TRIAENODES IGNITUS		R		C	C	A
COLEOPTERA						
ANCYRONYX VARIEGATUS					A	A
BEROSUS SPP					R	
DUBIRAPHIA VITTATA					R	
HELICHUS SP					R	C
HYDATICUS						R
HYDROBIOMORPHA CASTA					R	
MACRONYCHUS GLABRATUS	R				A	
NEOPORUS SPP	C					
SCIRTES SP	R					
STENELMIS SPP	R					R
STENELMIS CRENATA					R	
TROPISTERNUS SPP					R	
ODONATA						
ARGIA SPP	A				A	A
BOYERIA VINOSA	C					A
CALOPTERYX SPP	R				C	C
ENALLAGMA SPP	A				A	A
EPIAESCHNA SPP					C	
GOMPHUS SPP					R	C
HELOCORDULIA SPP					R	
MACROMIA SPP						R
PROGOMPHUS OBSCURUS	R				C	C
SOMATOCHLORA SPP						R
MEGALOPTERA						
NIGRONIA SPP					R	
NIGRONIA FASCIATUS						R
DIPTERA: CHIRONOMIDAE						
ABLABESMYIA MALLOCHI					A	C
BRILLIA SPP					R	C
CRICOTOPUS BICINCTUS: C/O SP1						A
ORTHOCLADIUS (EUORTHOCLADIUS): C/O SP3					R	

	Perry Cr Hunters Way 5/11/2004	Perry Cr SR 2006 7/25/1995	Perry Cr SR 2006 12/9/1996	Perry Cr SR 2006 7/6/2000	Perry Cr SR 2006 5/10/2004	UT Perry Cr SR 3514 5/10/2004
CRICOTOPUS INFUSCATUS GR: C/O SP5					A	R
CRICOTOPUS/ORTHOCLADIUS SP7					C	
CHIRONOMUS SPP	R				A	A
CLADOTANYTARSUS SPP					A	
CONCHAPELOPIA GROUP	C				A	A
CORYNONEURA SPP					C	
CORYNONEURA LOBATA						A
CORYNONEURA SP C EPLER						R
CRYPTOCHIRONOMUS SPP	R				A	A
CRYPTOTENDIPES SPP					C	
DICROTENDIPES MODESTUS					R	
DICROTENDIPES NEOMODESTUS						R
TVETENIA BAVARICA GR (E SP1)						C
EUKIEFFERIELLA CLARIPENNIS GR (E SP11)						R
EUKIEFFERIELLA BREHMI GR (E SP12)	R					
EUKIEFFERIELLA GRACEI GR (ESP14)					C	C
TVETENIA DISCOLORIPES GR (E SP3)					R	
GLYPTOTENDIPES SPP	R					
MICROTENDIPES SPP	A					C
MICROTENDIPES SP1					R	
NANOCLADIUS SPP					C	C
NILOTANYPUS FIMBRIATUS	R					
POLYPEDILUM CONVICTUM	A				A	A
POLYPEDILUM FALLAX						R
POLYPEDILUM HALTERALE						R
POLYPEDILUM ILLINOENSE						A
POLYPEDILUM SCALAENUM	A				A	A
PARAPHAENOCLADIUS						R
PARATANYTARSUS SPP					A	A
PHAENOPSECTRA SPP						A
PHAENOPSECTRA FLAVIPES						C
POTTHASTIA LONGIMANUS					C	
PROCLADIUS SPP					C	R
RHEOCRICOTOPUS EMINELLOBUS						R
RHEOCRICOTOPUS ROBACKI	R				C	A
RHEOTANYTARSUS SPP					A	C
SAETHERIA TYLUS	R					
TANYTARSUS SPP	C					
TANYTARSUS SP2C						R
THIENEMANIELLA SPP	A				A	
THIENEMANIELLA XENA					R	A
TRIBELOS SPP					A	R
XESTOCHIRONOMUS SUBLETTEI						R
MISC. DIPTERA						
ANTOCHA SPP	A				R	A
EMPIDIDAE	R					
PALPOMYIA (COMPLEX)					R	C
SIMULIUM (PHOSTERODOROS) SPP	C					
SIMULIUM VITTATUM	C				A	C
TIPULA SPP	A				C	A

	Perry Cr Hunters Way 5/11/2004	Perry Cr SR 2006 7/25/1995	Perry Cr SR 2006 12/9/1996	Perry Cr SR 2006 7/6/2000	Perry Cr SR 2006 5/10/2004	UT Perry Cr SR 3514 5/10/2004
OLIGOCHAETA						
ILYODRILUS TEMPLETONI					C	
LIMNODRILUS HOFFMEISTERI					C	
LUMBRICULIDAE	C					C
MEGADRILE OLIGOCHAETE	C					
NAIS SPP						C
SLAVINA APPENDICULATA	R					R
STYLARIA LACUSTRIS					C	C
TUBIFICIDAE	C					R
CRUSTACEA						
CAECIDOTEA SP (STREAMS)	C					A
CAMBARUS LATIMANUS					R	
PROCAMBARUS ACUTUS					R	
PELECYPODA						
CORBICULA FLUMINEA					C	R
PISIDIUM SPP	A				A	R
GASTROPODA						
FERRISSIA SPP						R
MENETUS DILATATUS	R					
PHYSELLA SPP	C					R
OTHER						
DUGESIA TIGRINA	A					C
ERPOBDELLA/MOOREOBDELLA	C				R	
HELOBDELLA TRISERIALIS	R					
HYDRACARINA	R					