Missouri
Department of
Natural Resources

Stream Survey Sampling Report

Phase III
Hinkson Creek Stream Study
Columbia, Missouri
Boone County

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Prepared For:

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Division of Environmental Quality
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EXECUTIVE SUMMARY

The Missouri Department of Natural Resources, Water Protection Program, Water Pollution Control Branch placed a 14-mile segment of Hinkson Creek on the 1998 list of impaired waters designated under section 303(d) of the federal Clean Water Act for “unspecified pollutants” due to urban runoff. A history of fish kills, the physical alteration of stream channels and adjacent riparian corridors, and other problems associated with urbanization have resulted in the designated beneficial uses becoming impaired. These urbanization concerns include the potential for water quality degradation, increased flow intensity due to stormwater runoff of impervious surfaces, and the likely detrimental effects of development on the stream channel and riparian areas.

Biological monitoring during the fall of 2001 and the spring of 2002 by the Missouri Department of Natural Resources, Field Services Division, Environmental Services Program determined that the biological integrity of Hinkson Creek was impaired for approximately 14 miles below the Interstate 70 bridge crossing. Therefore, it was determined that further water quality work was required to confirm the impairment of the aquatic community and attempt to determine the nature and source(s) of the impairment. The Environmental Services Program’s Water Quality Monitoring Section began in 2003, the first year of a three-year study of the impaired segment. Study methods consisting of a combination of biological and chemical monitoring combined with toxicity testing were then implemented in the upper portion of the 303(d) listed segment. Water and sediment samples were collected from main-stem Hinkson Creek and storm drainages located within this portion of Hinkson Creek.

Results of the phase I study documented that the aquatic community was impaired in Hinkson Creek between I-70 and Broadway and that the impairment extended downstream. Toxicity tests documented toxicity in approximately 20% of stormwater discharges and in main-stem Hinkson Creek at Broadway. Toxicity Identification Evaluation procedures implicated a variety of urban-associated chemical constituents including organic chemicals (polycyclic aromatic hydrocarbons, pesticides, petroleum compounds, and metals) in some stormwater discharges and high levels of sodium and calcium chloride in snowmelt samples. Although the presence of chemicals and toxicity of stormwater does not automatically translate to toxicity in-stream, it did suggest possible contaminants and sources that are likely contributors to in-stream effects. In-stream toxicity was documented in Hinkson Creek at the Broadway bridge during the snowmelt sampling. This observation is significant because it ties in-stream effects to a particular runoff event.

Escherichia coli *(E. coli)* counts occasionally exceeded recommended levels during phase I and may have resulted from a variety of sources. The presence of this fecal bacterium is particularly significant because as urbanization continues in the Hinkson Creek watershed human recreational contact with the stream will likely increase.

A visual sediment survey documented increased sediment in the impaired segment of Hinkson Creek compared to upstream estimates. Observations of land disturbance and erosion suggested an explanation for this increase in sedimentation.

Phase II of the Hinkson Stream Study was performed in a similar manner as was phase I. Because the source and type of pollutant(s) were listed as unknown, a water quality triad was used to document

impairments to the aquatic community and identify pollutants that are likely contributing to those impairments. The water quality triad is an integrated assessment of information obtained from the aquatic community, chemical analyses, and toxicity testing. The steps in the triad include documenting that impairment to the aquatic community still exists, testing a variety of in-stream, stormwater, and sediment samples for toxicity using a bioluminescent microorganism (*Vibrio fischeri*) and in some cases a freshwater daphnid (*Ceriodaphnia dubia*). The purpose of this was to correlate effects of laboratory test organisms with in-stream effects on the biological community. Toxic samples were further manipulated using Toxicity Identification Evaluation procedures which are standard procedures that allowed us to determine what broad classes of chemical compounds (e.g., metals, organics) might be causing or contributing to the observed toxicity. The final step in the triad was to analyze the toxic samples for the chemical constituents indicated through the Toxicity Identification Evaluation procedures.

The Hinkson Creek phase II findings are summarized below:

In-situ conductivity values were higher in Hinkson Creek during base flow when compared to reference/control streams within the same Ecological Drainage Unit (EDU).

Turbidity levels were highest at the Highway 63 connector and old Highway 63 sites during base flow events. High turbidity during periods of low or base flow conditions is indicative of in-stream activity such as that which occurs during land disturbance activities.

Chloride values in Hinkson Creek were approximately 40% higher when compared to reference/control streams within the same EDU during base flow events.

Toxicity tended to be sporadic. None of the sampled drainages were found consistently toxic. Of the stormwater samples collected, eight (8) samples were toxic to the Microtox organisms. Metals (arsenic, chromium, copper, lead, nickel, zinc), organic constituents (e.g., PAHs), and plasticizers were the main constituents found.

Semipermeable Membrane Device (SPMD) analyses indicated the presence of several low-level semi-volatile organic chemicals (e.g., pesticides and/or breakdown products, phthalates, and pharmaceutical drugs) that have the potential to bioaccumulate in aquatic organisms.

Biological metrics describing the macroinvertebrate community at Station 6 during this study exhibited improvement compared to spring samples collected in 2002 and 2004 and, for the first time among three sample seasons, were sufficient to merit a fully supporting Stream Condition Index (SCI) score. Compared to 2002, Taxa Richness increased by 14 taxa and Ephemeroptera/Plecoptera/Trichoptera Taxa (EPT Taxa) nearly doubled, increasing by 7.

The improvement in metric scores and the increasing similarity index between Station 6 and Station 7 could be interpreted as a demonstration that Station 6 is developing better potential to support a diverse macroinvertebrate community. This increased potential at Station 6 may result from a decrease of the quantity and frequency of perturbations that were observed and/or suspected in previous years (e.g., sewer bypasses, petroleum products, insecticides, road salt, and sediment).

Although Station 6 appears to have improved compared to previous years, the macroinvertebrate community within the urbanized reach nevertheless showed some important differences compared to the upstream reference reach. Most notably, Station 3.5 had a fraction of the number of mayflies and stoneflies compared to each of the other stations. In addition, each of the urbanized reaches had much higher numbers of tubificid worms than Station 7. Tubificids were nearly twice as abundant at Station 3.5 than at the next nearest site. Tubificid worms tend to be tolerant of sediment and also organic pollutants. This might reflect previously documented inputs of sediment and organic loading (e.g., bypasses, etc.).

The final phase of the study was completed in June 2006 and focused on the lower portion of Hinkson Creek, tributaries entering the lower portion, and selected upstream sites sampled during phase I and II. Methods used, again, were similar to those from the earlier phases of the study. Samples were collected during base flow and storm events and analyzed for toxicity, nutrients, metals, organic chemicals, and E. coli bacteria. In addition, field measurements of pH, temperature, specific conductivity, dissolved oxygen, and discharge were collected. Macroinvertebrate sampling was conducted at four sites in the fall 2005 and spring 2006. Final results of the fall 2005 sampling indicated 2 sites (5.5 and 3.5) in the urbanized portion of Hinkson Creek continue to be partially supporting of aquatic life as compared to the most upstream site (#7). Final results of the spring 2006 sampling indicated just one site (#2, located near the Twin Lakes Recreation Area) was partially supporting of aquatic life when compared to the control site on Bonne Femme Creek. The Bonne Femme site was used as the control during this phase of the study due to it being more comparable in size to Hinkson Creek in this lower section.

Results of phase III water sample analyses did not indicate toxicity or measure organic chemical constituents above laboratory detection levels. This may have been due to the lack of clearly defined stormwater inputs to main-stem Hinkson Creek as compared to the previously studied segments. Chloride concentrations during base flow conditions were considerably higher in the lower portion of Hinkson Creek than in the upper sites sampled during phases I and II. Although base flow chloride concentrations were not higher in the tributaries sampled during phase III, stormwater samples collected from Flat Branch Creek were high, reaching 283 mg/L on 12-14-05.

Data loggers that recorded temperature and dissolved oxygen concentrations over an 8-week period showed that lower dissolved oxygen appeared to correlate better with pool stagnation at low flows that result from extended dry periods than with stormwater inputs resulting from precipitation events. Dissolved oxygen readings fell below the water quality criteria of 5.0 mg/L 10%-15% of the time at the Highway 63 connector after an extended dry period and from 44%-62% of the time at the Broadway stream crossing. Dissolved oxygen conditions improved following rainfall events.

With the growing amount of impervious surfaces located in the Hinkson Creek watershed, we can suspect that hydrologic changes have and will continue to occur in Hinkson Creek. Other urban stream studies have documented links between development and alterations to the natural landscape. There appears to be a strong correlation between the imperviousness of a drainage basin and the health of its receiving streams (Arnold and Gibbons 1996, US EPA 1993, Stankowski 1972, Schueler 1994). As the percentage of the land covered by impervious surface increases, there is a consistent degradation of water quality. Degradation occurs at relatively low levels of imperviousness (10-20%) and worsens as more areas are paved. The US EPA (1993) also reported that urbanization negatively affects streams and results in water quality problems such as loss of habitat, increased temperatures, sedimentation, and loss of fish populations.

Progressive and innovative land management and land use practices are needed to prevent further degradation of Hinkson Creek and other urban streams located throughout the state of Missouri. Low impact development such as decreasing and slowing stormwater discharges and creating grassy and/or vegetative swales to capture small precipitation events that allow water to percolate through the soil to recharge groundwater systems are methods that can help mitigate detrimental effects of urbanization on streams. Educational efforts focusing on the importance of stormwater management practices are currently being used in the Great Lakes region and in the eastern and western coastal regions and should be increasingly considered in Midwestern communities.

1.0 Introduction

In 1998 the Missouri Department of Natural Resources, Division of Environmental Quality, Water Protection Program, Water Pollution Control Branch placed approximately 14 miles of Hinkson Creek on the impaired waters list designated under section 303(d) of the federal Clean Water Act. Hinkson Creek was listed as impaired for "unspecified pollutants" due to urban runoff. The impaired beneficial use was listed as "protection of warm water aquatic life." This means that Hinkson Creek does not meet the following criteria: "waters in which naturally occurring water quality and habitat conditions allow the maintenance of a wide variety of warm-water biota, including naturally reproducing populations of recreationally important fish species…" (MO CSR 2004).

During the state fiscal year 2001, the Water Pollution Control Branch requested that the Field Services Division, Environmental Services Program **(ESP)**, Water Quality Monitoring Section **(WQMS)** conduct an assessment of the aquatic macroinvertebrate community to determine the biological integrity of Hinkson Creek. As a result, an aquatic macroinvertebrate community study was conducted (MDNR 2002a) during the fall of 2001 and spring of 2002. Information obtained from the study showed impairment to the aquatic macroinvertebrate populations within the urbanized reach surveyed. Biological metrics comparisons were made against similar size, high quality streams within the same geographical area. The study results indicated that Hinkson Creek downstream of the Interstate 70 (**I-70**) bridge crossing was only "partially supporting" for aquatic life and confirmed stream impairment as summarized below.

- During the fall 2001 season, the number of invertebrates in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPT**) taxa were similar among stations. A slight increase in both the total numbers of taxa and EPT taxa occurred in downstream stations, likely due to an increase in water quantity downstream. The percent EPT (# of EPT taxa/total # of taxa present) tended to be slightly greater upstream of the impaired segment.

- During the spring 2002 season, there was a sharp decline of EPT taxa in the urban portion of Hinkson Creek, with a significant decline in the order Plecoptera. The total number of taxa also declined substantially. Percent EPT was greater upstream of the impaired segment.

Because of the aquatic macroinvertebrate findings, further work was required to determine the nature and cause of impairment. The Water Pollution Control Branch requested that the WQMS conduct a comprehensive study of main-stem Hinkson Creek and major storm drainages located within the impaired segment of Hinkson Creek. The phase I study was conducted from July 2003 to June 2004 with phase II beginning in July 2004 and continuing through June 2005. The final phase began in July 2005 with field work ending June 2006. The studies consisted of water quality and sediment monitoring, toxicity testing, and additional biological sampling through the duration of the study.

1.1 Study Area

Hinkson Creek is a Missouri Ozark border stream. It is located in a unique area that is characterized as a transitional zone between the Glaciated Plains and Ozark Natural Divisions (Thom and Wilson

1980). Pfleiger (1989) stated that streams within this region generally originate on level uplands underlain by shale and descend into rolling to hilly terrain underlain by limestone. The soil type within the Hinkson Creek watershed drains soils located geographically in the Central Clay Pan and Central Mississippi Valley Wooded Slopes regions (USDA 1978). According to the "Characteristics of Ecoregions of Iowa and Missouri" map (Chapman et al. 2002), the soil type within the upper segments of Hinkson Creek is characterized as being loamy till with well developed clay pan. Pennsylvanian sandstone, limestone, and shale also characterize this region. The soil types within the lower segments of Hinkson Creek are characterized as being thin cherty clay and silty to sandy clay. Mississippian and Pennsylvanian limestone, sandstone, and shale with considerable bedrock exposure characterize this region.

Hinkson Creek originates northeast of Hallsville, in Boone County, and flows approximately 26 miles in a southwesterly direction to its mouth at Perche Creek (Figure 1). The Hinkson Creek watershed is approximately 88.5 square miles. The land use in the upper portion of the watershed consists of rural pastureland and wooded areas, whereas the lower portion of the watershed is within the urbanized section of Columbia. The upper reaches of Hinkson Creek (from Mount Zion Church Road to approximately Providence Road) are classified as a Class C stream, where the stream may cease flowing in dry periods but maintains permanent pools that support life. The beneficial uses in this reach consist of "livestock and wildlife watering," "protection of warm water aquatic life and human health associated with fish consumption," and "whole body contact recreation – category B". The lower reaches of Hinkson Creek (from approximately Providence Road to Perche Creek) are classified as a Class P stream, where the stream is capable of maintaining permanent flow even in drought periods. The beneficial uses in this reach consist of "livestock and wildlife watering," "protection of warm water aquatic life and human health - fish consumption," "whole body contact recreation – category B," and "secondary contact recreation." During phase III of this study, the Hinkson Creek sampling locations were located within both the Class P and C reach.

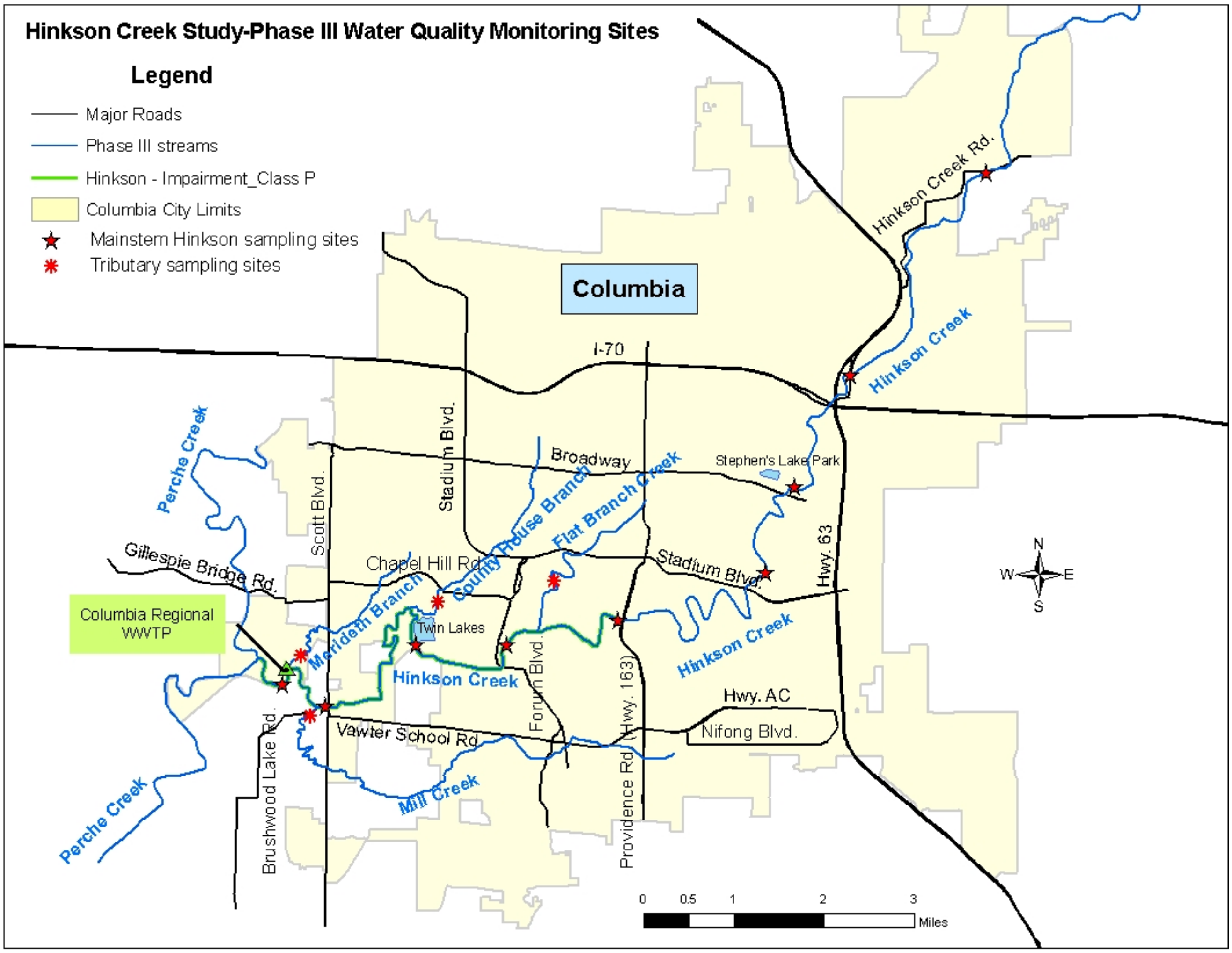
The state of Missouri is divided into 17 aquatic ecological drainage unit (EDU) systems. Hinkson Creek is located within the Ozark/Moreau/Loutre EDU (Sowa et al. 2004). The streams listed in Figure 2 are reference stream locations selected by WQMS aquatic biologists to represent the best attainable biological and habitat quality conditions of streams in the Ozark/Moreau/Loutre EDU. Biological and habitat data from these reference streams and Bonne Femme Creek (control) were used for comparisons with Hinkson Creek.

Bonne Femme Creek is a nearby drainage within the same EDU that flows through a rural rather than urban watershed. It was used as a control stream during the biological and water quality portions of the study. Bonne Femme Creek originates southeast of Columbia and flows southwest through a watershed dominated by forestland. The stream reach assessed is Class P with beneficial use designations of "livestock and wildlife watering," "protection of warm water aquatic life and human health associated with fish consumption," and "whole body contact recreation – category A."

Bonne Femme Creek was chosen as a control in the study due to several factors: its close proximity to the study stream within the same EDU; a watershed of comparable size to the middle reaches of Hinkson Creek; and a relative lack of urbanization in the watershed. The biological and water quality comparisons were conducted to determine whether biological and/or water quality impairment exists in a system largely comprised of urban runoff compared to one that lacks urban influence.

Several tributaries of Hinkson Creek located in the lower section of the Hinkson Creek study area were also monitored. Figure 1 shows the location of the tributaries.

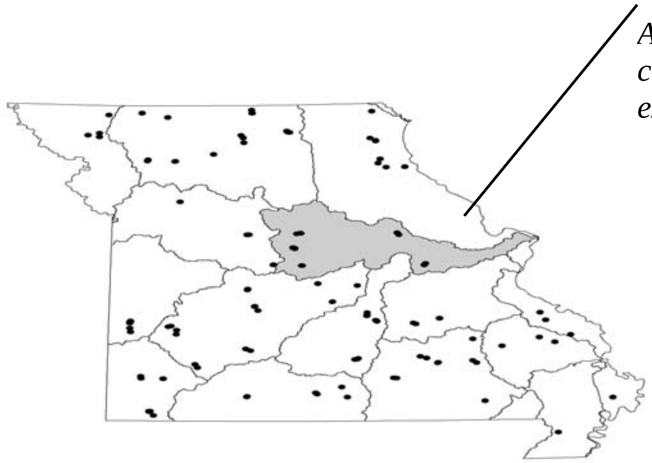
Figure 1. Map of the Hinkson Creek Phase III Study Area



According to the 2001-2004 land cover data (MoRAP 2005) the following watersheds consisted of the approximated categories:

Watershed	Watershed size (sq. miles)	% Urban	% Cropland	% Grass-land	% Forest/ woodland
Hinkson Creek	88.5	21	10	38	26
Bonne Femme	50.5	3	22	34	36
Flat Branch	3.76	35	0	31	34
County House Branch	2.49	14	0	40	45
Mill Creek	6.17	16	2	53	28
Meredith Branch	2.77	8	4	64	25

Figure 2. Ecological Drainage Units of Missouri and Location of Biological Reference Sites



Ozark/Moreau/Loutre EDU

An EDU is a region in which biological communities and habitat conditions can be expected to be similar.

Reference Stream within the Ozark/Moreau/Loutre EDU:

Boeuf Creek
Burris Creek
Loutre River
Moniteau Creek
Bonne Femme (control)

EDU Regions, MoRAP Map Series 2002-001

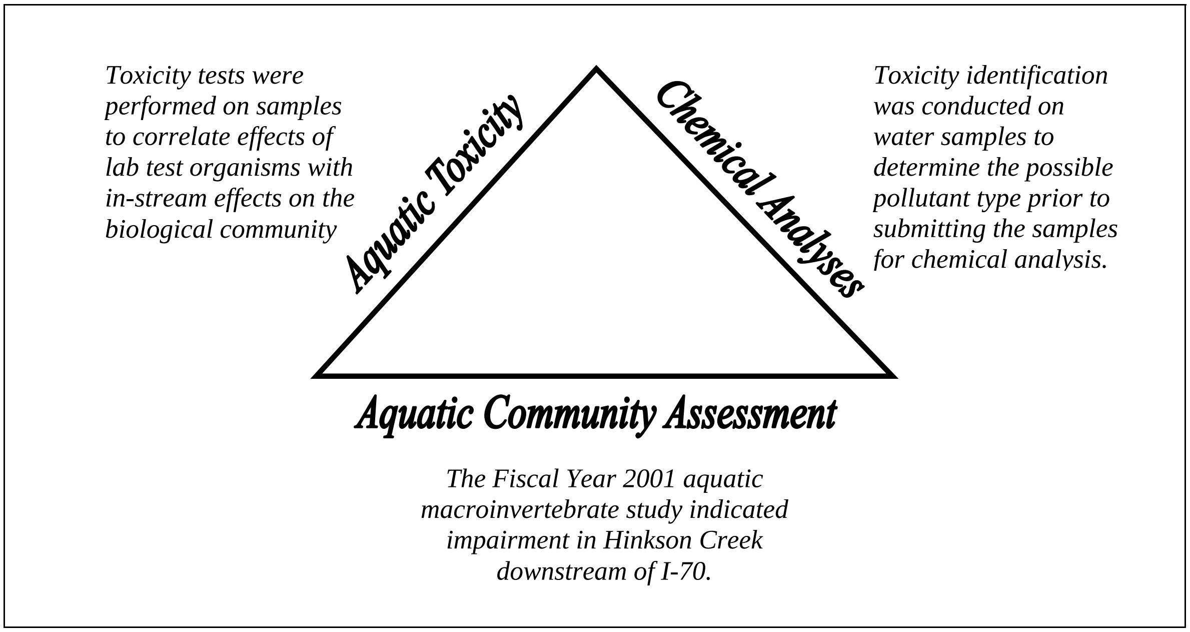
• = Sampling Locations

1.2 Study Design

As discussed in the phase I report (MDNR 2004), the source and the type of pollutant(s) were unknown. Therefore, a water quality triad was used to document impairments to the aquatic community and identify pollutants that are likely contributing to those impairments. The triad is a non-numeric, weight of evidence approach that is becoming frequently used as a regulatory tool for water quality impact assessment and management (Lee and Lee-Jones 2002, Burton and Pitt 2002). This approach is an integrated assessment of information obtained from the aquatic organism assemblages, chemical analyses, and toxicity testing.

Figure 3 summarizes how the water quality triad was implemented during this study. Because the macroinvertebrate data indicated impairment to Hinkson Creek, it was necessary to collect a series of water samples for testing. Before the samples were submitted for chemical analysis, aquatic toxicity was determined using a Microtox test system. If the water samples were found to be toxic, a Toxicity Identification Evaluation procedure was conducted to determine the possible pollutant type(s) (e.g., organic, metals, etc). The water samples were then submitted for analysis based on the toxicity identification results. The toxicity methods are explained in detail in section 2.1 of this report.

Figure 3. The Water Quality Triad



Toxicity tests were performed on samples to correlate effects of lab test organisms with in-stream effects on the biological community

Toxicity identification was conducted on water samples to determine the possible pollutant type prior to submitting the samples for chemical analysis.

The Fiscal Year 2001 aquatic macroinvertebrate study indicated impairment in Hinkson Creek downstream of I-70.

1.3 Study Objectives

The overall objective for the three-phase study was to conduct a water quality assessment of the entire "impaired" 14-mile segment of Hinkson Creek in phases as summarized below:

- The first phase of the study was conducted during the 2004 state fiscal year and concentrated on an approximately 2-mile segment of Hinkson Creek between the I-70 and Broadway bridge crossings.

- The second phase of the study began during July 2004 and continued throughout the 2005 state fiscal year that ended June 30, 2005. The phase II portion of the study concentrated on an approximately 5-mile long segment of Hinkson Creek located between the Broadway bridge and Recreational Drive low-water bridge crossing (located just upstream of Providence Road).

- The third phase of the Hinkson Creek study began in July 2005 and continued throughout the 2006 state fiscal year that ended June 30, 2006. The third phase focused on an approximately 7.5-mile long segment of Hinkson Creek from Recreational Drive low-water bridge crossing to Perche Creek.

The intent of the three-part study was to locate possible pollutant sources and identify contaminants contributing to impairment of the stream. Main-stem Hinkson Creek, major stormwater drainages, and major tributaries were monitored throughout each phase of the study.

During the third phase of the study, a Quality Assurance Project Plan (MDNR QAPP 2006) was submitted to the Water Pollution Control Branch. In summary, the plan consisted of:

- analyzing main-stem Hinkson Creek water quality samples collected during base flows;
- analyzing main-stem Hinkson Creek water quality samples collected following rainfall events in excess of 0.5 inches of rain;
- analyzing stormwater sample collections from major tributaries located between Recreational Drive low-water bridge crossing and Perche Creek;
- conducting Microtox testing on water samples collected from main-stem Hinkson Creek during base flows and storm events;
- conducting Microtox testing on water samples collected from major tributaries located throughout the study reach;
- conducting a follow-up study of the FY 2003 biological assessment at four locations, focusing on the stream reach located between Forum Boulevard and Scott Boulevard.

2.0 Hinkson Creek Phase III Study Methods

The methods that were used during this study were consistent with the department's standard operating procedures, Standard Methods (APHA 1998), and widely accepted by the scientific community. The specifics regarding a particular sampling event (e.g., the type of equipment used and when and where samples were collected) will be discussed in the respective sections.

2.1 Aquatic Toxicity Testing Methods

2.1.1 Microtox Bacterial Bioluminescence Overview

The toxicity of surface waters and stormwaters was determined for samples collected during the study using the Microtox bacterial bioluminescence test (APHA 1998). Establishing a connection between observed toxicity in waters and documented impairments in the aquatic community is a critical step when the potential for toxic components exists. Microtox has been shown to correlate well with other standard toxicity test organisms, including fathead minnows (*Pimephales promelas*) and daphnids (*Ceriodaphnia dubia*) (Bulich et al. 1981, Kaiser and Palabrica 1991, Munkittrick, K.R. et al. 1991). In Microtox, the commercially available freeze-dried strain of the bacterium *Vibrio fischeri* is exposed to water samples. Under suitable conditions, the bacteria convert a portion of their metabolic respiratory energy into visible light that can be measured by a photometer. Under adverse (toxic) conditions, this rate of light production is affected and is typically reduced in proportion to the toxicity of the test sample. The greater the toxicity, the greater the percent effect level that is recorded by the photometer.

2.1.2 Microtox Screens for Water Samples

Microtox acute toxicity tests were used to screen water samples for further toxicity and/or chemical analyses. Surface water and stormwater samples were screened using the Microtox SOLO acute toxicity test or the Microtox Basic test (Microtox Omni 1999). A finding of toxicity in these screening tests resulted in further Microtox analyses of portions of the toxic sample that were manipulated using standard Toxicity Identification Evaluation procedures (US EPA 1991). The purpose of manipulating toxic samples prior to additional testing was to attempt to determine broad classes of chemicals that might be causing or contributing to the toxicity. For example, if toxicity is reduced or eliminated following filtration, it might indicate that the toxic component was adhering to suspended particles. Toxicity that is reduced or eliminated in the presence of a strong chelating agent, such as EDTA, might indicate that metals are a toxic component. Toxicity that is reduced or eliminated following passage of the sample through a Solid Phase Extraction **(**C_{18}**)** column might indicate that non-polar organic chemicals are contributing to the toxicity.

Characterizing the observed toxicity into broad chemical classes allowed for more specific analyses of those constituents that were more likely causing or contributing to the toxic conditions in the sample. The objective was to increase the likelihood of documenting pollutants having a deleterious effect on Hinkson Creek and its aquatic community.

2.2 Water Quality Monitoring Methods

2.2.1 Collection Methods

All field instruments were calibrated according to the manufacturer's instructions. The water samples were collected in appropriate sample containers (MDNR 2003a), handled, and transported to the ESP state environmental laboratory according to standard procedures (MDNR 2002b). The samples received a numbered label and were placed on ice in a cooler. The corresponding label number was entered onto a chain-of-custody record form indicating the location, date and time of collection, any field measurements, and parameters to be analyzed (MDNR 2005a and MDNR 2003b). Custody of the water samples was maintained by ESP field personnel until relinquishing them to the state environmental laboratory sample custodian within the ESP in Jefferson City, Missouri.

2.2.2 Analytical Methods

All water analyses were conducted in accordance with methods outlined in the Quality Assurance Project Plan for Hinkson Creek (MDNR QAPP 2005). Nutrients and chloride were analyzed using a Lachat QuickChem 8000. Total recoverable metals (except mercury) were analyzed using a Varian Vista MPX Inductively Coupled Plasma - Optical Emission Spectrometer or Varian Inductively Coupled Plasma - Mass Spectrometer. Mercury analysis was performed using a Perkin Elmer Flow Injection Mercury System 100 cold vapor analyzer. Non filterable residue (**NFR**) was analyzed with a Lab-Line oven, Boekel desiccator, and Sartorius analytical balance. Qualitative organic analyses (**QOA**), base neutral/acid extractables (**BNAs**), volatile organic analyses (**VOA**), and petroleum fractions were analyzed using a Varian Saturn 2000R Ion Trap Gas Chromatograph/Mass Spectrometer. Because of the qualitative nature of the QOA, individual peaks produced by the gas chromatograph are identified but not quantified. In order to quantify a given chemical that is identified through QOA, an internal standard of that chemical must be run for comparison. All samples were screened with a Microtox SOLO acute toxicity test using a Microbics Model 500 Toxicity Analyzer. Bacteriological (*Escherichia coli*) samples were analyzed with an IDEXX Colilert Quantitray system.

2.3 Biological Assessment Monitoring

2.3.1 Biological Collection Methods

The biological assessment monitoring was conducted according to the MDNR Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**: MDNR 2003c). In summary, macroinvertebrates were collected using a multi-habitat sampling method. The sampling was conducted in a stream reach approximately twenty times the average width of the stream and encompassed two riffle sequences or two meander sequences. Hinkson Creek is considered a "riffle/pool" predominant stream and, therefore, macroinvertebrate samples were collected from three predominant habitats: flowing water over coarse substrate (e.g., riffle); non-flowing water over depositional substrate (e.g., pool); and rootmat substrate. Each macroinvertebrate sample was a composite of six subsamples within each habitat. The sampling periods occurred during periods of stable base flow before peak aquatic insect emergence times. In general, macroinvertebrate sampling occurs in the spring from mid-March through mid-April and in the fall from mid-September through mid-October.

Samples from each major habitat were collected and preserved with 10% formalin. Habitat samples were kept separate to provide the ability to factor out habitat differences among sites.

2.3.2 Biological Assessment Methods

Macroinvertebrate identifications were made to the lowest possible taxonomic level (usually genus or species) and according to MDNR-FSS-209 *Taxonomic Levels for Macroinvertebrate Identifications* (MDNR 2005b). The macroinvertebrates from each habitat were evaluated using the following metrics:

- Taxa Richness (**TR**)
  Reflects the health of the community through a measurement of the number of taxa present. In general, the total number of taxa increases with improving water quality, habitat diversity, and habitat suitability. Taxa Richness is calculated by counting all taxa from the subsampling effort.

- Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPT Taxa**)
  Is the total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera. This value summarizes taxa richness within the insect taxonomic orders that are generally considered to be pollution sensitive. The EPT Taxa index generally increases with higher water quality.

- Biotic Index (**BI**)
  Developed as a means to detect organic pollution. Tolerance values for each taxon range from 1 to 10, with higher values indicating increased tolerance.

- Shannon Diversity Index (**SDI**)
  Is a measure of community composition that takes into account both richness and evenness. It assumed that a more diverse community is a more healthy community. Diversity increases as the number of taxa increases and as the distribution of individuals among those taxa is more evenly distributed.

The above four metrics were aggregated into a single value presented as the Stream Condition Index (**SCI**). The SCI is calculated according to Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure for each season and year and is based upon data collected from reference streams within the same EDU as the study stream. The SCI scores were divided into three categories. Study reaches that scored from 16-20 were considered fully biologically supporting, scores from 10-14 were considered partially biologically supporting, and scores of 4-8 were considered non-biologically supporting of aquatic life.

The study stream was then evaluated by calculating the metrics, scoring them using the scale determined in the SCI, and totaling the scores into a single value. The study stream is then ranked for aquatic life sustainability using the following criteria for Warm Water Reference Streams in the Ozark/Moreau/Loutre Ecological Drainage Unit:

	Score = 5	**Score = 3**	**Score = 1**
TR	>71	71-36	<36
EPT Taxa	>13	13-6	<6
BI	<6.45	6.45-8.22	>8.22
SDI	>2.80	2.80-1.40	<1.40

3.0 Hinkson Creek Phase III Water Quality Monitoring

To increase efficiency, various sampling devices were utilized during the study. The following sections describe the sampling efforts and results obtained during the Hinkson Creek study to assess water quality. For reporting the information in table and graphical purposes, the following sampling locations were coded in the manner listed below:

Main-stem Hinkson Creek	**Tributaries/Control Streams**
Hinkson Creek Road (**HCR**)	Flat Branch (**FLB**)
Hwy 63 Connector (**63C**)	County House Branch (**CHB**)
Broadway (**BWY**)	Mill Creek (**MLC**)
Stadium Boulevard (**STD**)	Meredith Branch (**MDB**)
Recreational Drive (**RCD**)	Bonne Femme Creek (**BNF**)
Forum Boulevard (**FRB**)	
Twin Lakes Recreational Area (**TWR**)	
Scott Boulevard (**SCB**)	
South of Columbia Wastewater Plant (**CWP**)	

3.1 Base Flow Water Quality Monitoring

3.1.1 Base Flow Background

Base flow monitoring provides information regarding the quality of the water in stream systems during normal flow conditions and allows comparisons to be made longitudinally, to reference/control streams, and during high flow events.

3.1.2 Base Flow Sample Collection Overview

All samples were collected in sample containers approved by the Missouri Department of Natural Resources and in accordance with the standard operating procedure (MDNR 2003a). The samples remained in the custody of WQMS field personnel until they were relinquished to the ESP laboratory located in Jefferson City.

Four (4) base flow water quality samples were collected from nine sites located on main-stem Hinkson Creek and one (1) site on Bonne Femme Creek. Depending on flow conditions, surface water grab samples were also collected from the four (4) tributaries.

Surface water grab samples were collected and analyzed for the following parameters: ammonia as nitrogen (**NH_3-N**), nitrite plus nitrate as nitrogen (**NO_2+NO_3-N**), total nitrogen (**T (N)**), total phosphorus (**T (P)**), NFR, chloride (**Cl**), volatile suspended solids (**VSS**), turbidity, and Microtox toxicity. Bacteriological samples for *E. coli* were collected throughout the study. Surface water grab samples were also collected for petroleum fractions, QOA, and VOA, but only submitted for analysis based upon the Microtox toxicity results.

In situ field measurements were collected for the following: water temperature, pH, specific conductivity, and dissolved oxygen (**DO**). In-stream discharge measurements were collected using a Marsh-McBirney Flo-Mate 2000.

3.1.3 Base Flow Microtox Toxicity Results

None of the base flow water quality samples collected from Hinkson Creek or its tributaries were found to be toxic to the Microtox organisms (Table 1).

3.1.4 Base Flow Water Quality Monitoring Results and Discussion

Specific Conductivity

Average conductivity values were higher during the phase III sampling than from those measured during phase I or phase II. This was evident not only from the four upstream Hinkson Creek sites and the site on Bonne Femme Creek but also the new downstream Hinkson Creek sites and tributaries. In general, phase III conductivity readings were higher in most Hinkson Creek locations than from the tributaries sampled. The exception would be Flat Branch Creek, which had an average conductivity value higher than all Hinkson sites except the Hinkson Creek Road location. The lowest average readings were from the control site on Bonne Femme Creek. As noted in the phase II report, the higher conductivity readings in Hinkson Creek at the Hinkson Creek Road location could possibly be due to influences from the of the city of Columbia Sanitary Landfill and/or past coal mining activities that occurred during the late 1960's to early 1970's. The extremely dry conditions experienced during the FY06 sampling period may also have been a factor in the elevated readings.

Bacteriological Samples - Escherichia coli

E. coli is a member of the total coliform group and is associated with fecal contamination. "Whole body contact – level B" is a recently added beneficial use listed for Hinkson Creek. Historical studies have indicated high levels of fecal bacteria present at various times. Over the past several years, raw wastewater bypasses from municipal sewer system manholes have reportedly entered Hinkson Creek, with some resulting in fishkills (MDNR, Environmental Emergency Response database [http://www.dnr.mo.gov/meerts/index.do]). This repeated influx of untreated wastewater is of particular concern because as urbanization encompasses more of the Hinkson Creek watershed, the chances of recreational contact with its waters is increased. The objective of bacteriological monitoring was to gather background data in Hinkson Creek during various flow conditions. Episodic elevated *E. coli* were noted throughout the study during base flow conditions. According to Table A of 10 CSR-20.7.031 of the Water Quality Standards, *E. coli* levels should not exceed a geometric mean of 548 colony forming units (cfu) per 100 milliliters (mL) of water during the recreational season (from April 1 to October 31). Elevated *E. coli* levels were noted in Hinkson Creek at the following sampling locations during phase III, however, further investigation is needed to determine sources or if in-stream exceedances occur during the recreational season.

Hinkson Creek Monitoring Sites with Elevated *E. coli* Levels

Site Name	***E. coli* Result**
HCR	1730 cfu/100 mL
STD	387 & 920*
SCB	325*

*Result occurred outside of recreational season

Turbidity

Average turbidity levels during phase III were lower from all sampling sites as compared to levels found during the phase II monitoring. This may be the result of less frequent precipitation events and less land disturbance activities in the immediate vicinity during the phase III portion of the study. When comparing turbidity values from all sites sampled during phase III, the Hinkson Creek sites were generally higher than those from the tributaries. The turbidity levels also tended to increase at the three most downstream Hinkson Creek locations (Twin Lakes, Scott Blvd., and the Columbia WWTF).

Nonfilterable Residue

Like turbidity, NFR values tended to be lower during phase III as compared to phase II from Hinkson Creek and tributary sites. NFR values mimicked those of turbidity in that Hinkson sites tended to be higher than those from the tributaries. This again may be the result of less frequent precipitation events and less land disturbance in the immediate vicinity during the phase III study period.

Chloride

Chloride levels at Hinkson Creek sites during phase III baseflow sampling were considerably higher than those measured from Hinkson Creek sites in phase I or II. This was in contrast to the tributaries where levels were slightly lower during phase III than those found during phase II. The average chloride levels from Bonne Femme Creek did not differ significantly from those recorded during the earlier studies. Chloride values for Hinkson Creek during phase III ranged from 25.6 milligrams per liter (mg/L) to 333 mg/L.

According to the US EPA (1988), the major anthropogenic sources of chloride in surface water come from deicing salt, urban and agricultural runoff, and discharges from municipal wastewater and industrial plants. All of these occur in the Hinkson Creek watershed. Elevated chloride and conductivity values during base flow periods may also be a result of long term use of de-icing agents used on roadways and parking lots in the form of sodium chloride (salt). The salt accumulates in the soils along roadways and migrates through the soil where, over time, it has the potential to leach into groundwater and surface waters (D'Itri 1992, Hanes et al. 1970, and Kaushal et al. 2005).

Nutrients

The nutrient data collected during the base flow portion of the phase II and III study was found to be within the expected ranges for a stream within the Ozark/Moreau/Loutre EDU. Slightly elevated NO_2+NO_3 as N and total nitrogen readings occurred during the December 2004 sampling event and corresponded with the higher flow regimes.

In-stream Discharge

In-stream discharge measurements varied from < 0.01 cubic feet per second (cfs) in the upper sections of Hinkson Creek to 3.93 cfs in the lower reaches. The average base flow discharge for each site is calculated below:

Site Name	Average Discharge (cfs)	Site Name	Average Discharge (cfs)
HCR	0.13	CWP	3.07
63C	0.81	FLB	0.21
BWY	1.35	CHB	---
STD	1.43	MLC	0.46
RCD	1.80	MDB	---
FRB	2.51	BNF	0.64
TWR	2.08		
SCB	2.20		

3.2 Dissolved Oxygen Monitoring

3.2.1 Dissolved Oxygen Monitoring Background

The ability of a body of water to support aquatic life is dependent on the level of dissolved oxygen (DO) contained within it. Oxygen is dissolved into water by diffusion from the atmosphere, aeration as water tumbles through a riffle or over a fall, and photosynthesis. Oxygen is depleted from the water as plants respire and as they die and decompose. As these processes occur daily, a DO curve can be plotted. DO levels depend on the physical, chemical, and biochemical activities within the body of water. Several factors such as temperature, nutrient loading from run-off, flow, and dissolved or suspended solids also influence DO levels.

A DO study was conducted from July 28-September 21, 2005. The objective of the study was to document the potential effects of run-off from impervious surfaces after extended periods of hot, dry weather.

3.2.2 Dissolved Oxygen Data Collection

Dissolved oxygen and temperature data was collected at two sites on Hinkson Creek using two AQUAsonde dataloggers from Eco Instruments. One datalogger was deployed at the 63 Connector site while the other was deployed downstream below where the drainages from the Broadway Marketplace retail complex enter Hinkson Creek. The dataloggers were secured to a cement block and tethered to the bank to prevent tampering and/or loss during high flow events. Dataloggers were checked weekly during the deployment and after periods of high flow. During the weekly checks, data was downloaded and the dataloggers were recalibrated and checked for bio-fouling. If bio-fouling had occurred the dataloggers were cleaned with DI water and a Kim-Wipe prior to re-deployment. Downloaded data was then used to plot the daily fluctuations in DO and temperature.

3.2.3 Dissolved Oxygen Results and Discussion

The results of the dissolved oxygen dataloggers are given in Appendix F. Weather during the datalogger deployment period ranged from the typical summer pattern of high temperatures and dry conditions to a period of cooler temperatures interspersed with occasional rainfall events. The ideal circumstance of a heavy late afternoon rain shower combined with hot ambient temperatures did not occur during the datalogger deployment period. As a result, in-stream measurements of temperature and dissolved oxygen generally reflected the typical pattern associated with the ambient conditions.

Precipitation data was obtained from the Missouri Historical Agricultural Weather Database (University of Missouri Extension, Appendix F). Precipitation occurred August 12-16 (4.5 inches), August 18 (1.54 inches), August 23-26 (2.83 inches), September 13 (0.4 inches), September 15 (0.72 inches), and September 19 (2.87 inches). Precipitation events did tend to flatten-out (stabilize) both temperature and dissolved oxygen readings for a brief time, but did not appear to support our hypothesis that rainfall would result in large decreases in dissolved oxygen and increases in temperature as a result of runoff from hot paved streets and parking lots. Only once, on September 19, 2005, did this hypothesis appear to be supported following 2.87 inches of rain in a 24-hour period.

Low flows during hot weather that result in stagnation of pools and increased diurnal fluctuations in dissolved oxygen levels may account as much or more for periods of low dissolved oxygen than stormwater influences. The lowest dissolved oxygen concentrations occurred at both the Highway 63 connector and at the Broadway street crossing following periods of dry weather and hot conditions. During weeks 1 and 2, dissolved oxygen concentrations fell below the 5.0 mg/L water quality criteria at the Highway 63 connector 10% (16 of 156 readings) and 15% (25 of 168 readings), respectively. Hinkson Creek downstream from the Broadway Marketplace drainage had dissolved oxygen readings below the criteria 44% (67 of 154 readings) and 62% (95 of 154 readings) during the same two-week period. This area had only received approximately 0.5 inches of precipitation during the previous month.

Weeks 3, 4, and 5 of the datalogger deployment experienced 4.5, 2.24, and 2.14 inches of rain respectively. The greatest percentage of readings below 5.0 mg/L during this time frame was 17% (25 of 168 readings) at the Highway 63 connector on week 3. Broadway had 4% (6 of 135 readings). During weeks 4 and 5 only 3 of 720 readings (both sites combined) were below the dissolved oxygen criteria.

No precipitation was recorded during weeks 6 and 7. No readings below the criteria were recorded at either site on week 6 and only 2% (4 of 168) at the Highway 63 connector and 10% (17 of 168) at Broadway were below the criteria.

Nearly three inches of rain fell in the region on September 19, 2005 (week 8). No readings below 5.0 mg/L were recorded at the Highway 63 connector. A dissolved oxygen drop was observed on the 19th that may have been influenced by the precipitation event, but may also have simply been due to normal diurnal fluctuations. A total of 9% (12 of 130 readings) fell below the criteria, eight of which occurred on September 19, 2005.

3.3 Stormwater Monitoring

3.3.1 Stormwater Monitoring Background

Characteristics of heavily populated urban areas include more impervious surfaces, automobiles and emissions, construction, and chemicals used for pest control, maintenance of roadways, and golf courses. Urban stream studies, such as those conducted by the USGS (2002a & b), have found that a variety of chemical constituents can be deposited on impervious surfaces (e.g., roadways, parking lots, rooftops, compacted soils) during dry periods. During rainfall events, these constituents are transported into streams as the runoff moves across the impervious surfaces.

3.3.2 Stormwater Sample Collection Overview

In order to identify major discharges and drainages entering the lower portion of Hinkson Creek, an in-stream reconnaissance was conducted in July 2005 similar to the one conducted during phase II. From this survey it was determined that like phase II, many of the drainage ditches and pipes would be inaccessible for monitoring while others were draining natural areas (parks, trails, etc.) and sites of small size. One difference noted from earlier phases of the study was that the lower portion of Hinkson Creek received discharges from four tributaries each of which had drainages of significant area. It was decided that stormwater samples would be collected from these tributary streams which would reflect inputs from a variety of land uses.

Three types of water collection techniques were conducted over the course of the study: ISCO samplers, passive stage samplers, and surface water grab samples. ISCO automatic wastewater samplers were used in conjunction with ISCO Model 1640 Liquid Level Sample Actuators to collect samples from several drainages during significant runoff events. Depending on the water level and placement of the actuator's sensor, the ISCO Liquid Level Sample Actuator initiated the programmed sampling routine of the automatic sampler. The actuator was placed above the base of the discharge channel, near the intake line of the ISCO sampler. The actuator was set so that when the water level reached a predetermined height the actuator would trigger, sending a signal to the ISCO automatic wastewater sampler to initiate the sampling routine. The samplers were set to collect a composite sample of the leading edge of the runoff event (MDNR 2002c). The ISCO samplers were initially set at Mill Creek, Meredith Creek (near the Columbia WWTF), and County House Branch, but were later replaced with passive stage samplers. The passive stage samplers were constructed by WQMS staff and consisted of an array of sample bottles (usually three to four) attached at a fixed height to a 6.5 ft. metal fence post. The post would be driven into the streambed at the sampling site and the sample bottle array mounted to the post at the desired height. The sample bottles were fitted with modified caps which had an intake port through which water flowed as the stream level rose. An exhaust vent fitted with a length of tubing was also provided on the cap for the escape of air as the bottle filled. A stage sampler was initially deployed on Flat Branch Creek due to that site's potential for vandalism. Others were later used at the other locations where the ISCO samplers had been deployed due to their ease of use and low cost.

3.3.3 Stormwater Microtox Toxicity

None of the stormwater samples collected from the tributaries or the main-stem Hinkson Creek sites were found to be toxic to the Microtox organisms (Table 2).

3.3.4 Stormwater Monitoring Analytical Results and Discussion

Although stormwater runoff is not normally a regulated discharge, it can pose a threat to the aquatic systems in the receiving stream. The US EPA (1995) describes nonpoint source runoff pollution as that associated with rainwater or melting snow that washes off impervious surfaces (roads, bridges, parking lots, rooftops, etc.). Runoff picks up dirt and dust, rubber and metal deposits from tire wear, antifreeze and engine oil, pesticides and fertilizers, discarded debris such as cups, plastic bags, cigarette butts, pet waste, and other litter where it is ultimately carried into our lakes, rivers, streams, and oceans. A few of the constituents found in the stormwater discharges are discussed below. Many of the same components found during this study were also found in urban stream studies conducted by other researchers (USGS 2002a & b).

Stormwater samples were collected on six occasions during the phase III sampling period. All of the events fell between the months of September 2005 and March 2006. During four of the events samples were collected only from the major tributaries while two of the events included the most downstream site on Hinkson Creek (**CWP**). Please refer to Table 2 and Appendix B for a complete list of all the reported analytical results.

Since the 303(d) list designated pollutants in Hinkson Creek as unknown, a holistic approach was necessary to determine which pollutants might be present. During the four sampling events occurring September through December 2005, samples were analyzed for the following parameters: Microtox screen, total recoverable metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn), hardness, QOA, VOA, BNA, petroleum fractions, chloride, NFR, and *E. coli*. During the two sampling events in January and March 2006, samples were analyzed for the following: Microtox screen, chloride, NFR, VSS, and *E. coli*. Turbidity was also measured during these last two events in addition to field measurements of pH, temperature, dissolved oxygen, and specific conductivity, which were collected during all sampling events. Precipitation data were collected from a weather station located at Sandborn Field at the University of Missouri-Columbia campus (Agricultural Electronic Bulletin Board http://agebb.missouri.edu/).

Bacteriological – E. coli

E. coli values from stormwater samples collected from monitoring locations on the four tributaries exceeded 2400 mpn/100 mL in ten of sixteen samples. Pet and other animal waste can enter stormwater that discharges to the creeks. USGS (2002a) reported that genetic source tracking of *E. coli* in the Blue River and Brush Creek in Kansas City, Missouri showed nearly equal contributions from dogs, geese, and humans.

Specific Conductivity

The highest conductivity reading (1690 µS/cm) was collected from County House Branch on December 14, 2005. This tributary also had the highest average conductivity value (834.3 µS/cm) of the four tributaries sampled during storm events. The lowest average conductivity values (454.5 µS/cm) were collected from Meredith Branch. Pure rainwater contains very little ions and, therefore, has very low conductivity. When elevated conductivity values are found in stormwater runoff, it is an indication that the rainwater runoff is picking up and transporting materials deposited on the ground and/or impervious surfaces.

Chloride

Flat Branch Creek had significantly higher chloride levels than those from the other three tributaries or from the three sites sampled on Hinkson Creek. Chloride levels of stormwater ranged from 14.3 mg/L at Mill Creek to 283 mg/L from Flat Branch. Chloride is a component used in road salt that is widely used throughout the United States. In addition, chlorides are a common component in individual and municipal domestic sewage systems and are frequently found in urban settings as a result of bypasses, broken distribution lines, etc. For background purposes, chloride samples were collected throughout the study from main-stem Hinkson Creek and from the stormwater drainages. The purpose of the sampling was to compare the non-snow event data to the winter snowmelt event data. However, during the winter of 2005-2006, central Missouri experienced a mild winter in which a significant snowfall accumulation event did not occur.

Turbidity

Turbidity values collected from the storm drainages ranged from 8.3 NTU (County House Branch) to 296 NTU (Mill Creek). Mill creek also had the highest average turbidity value of 184.7 NTU (values ranged from 80.1 NTU to 296 NTU) while Flat Branch had the lowest average of 21 NTU (values ranged from 8.3 NTU to 43.6 NTU).

Discharge

In-stream discharge measurements were not determined during storm events due to the use of the passive stage samplers and remote automatic sampling by the ISCO samplers. In an urban setting, where population densities and areas of impervious surface are greatest, excessive runoff events negatively impact the hydrology of the receiving stream (Stankowski 1972). Increased peak flow rates in the receiving stream increase channelization which, in turn, results in loss and degradation of in-stream and riparian habitats and in-stream sedimentation due to stream channel scour and stream bank erosion (Arnold and Gibbons 1996, Booth and Jackson 1997, Wang 2001). Increased peak flow events inevitably cause changes in water quality (e.g., suspended sediments) (Byron and Goldman 1989, Trimble 1997) and biotic composition (e.g., invertebrates and fish) (Richards et al. 1996, Yoder et al. 1999).

Table 1. Hinkson Creek Phase III Base Flow Water Quality Sample Results

Site Name	Sample #	Toxicity Result	pH (pH Units)	Spec.Cond. (uS/cm)	Temp. (C)	D.O. (mg/L)	E. coli (mpn/100ml)	Turbidity (NTU)	NFR (mg/L)	VSS (mg/L)	Chloride (mg/L)	Total P (mg/L)	NH3 as N (mg/L)	NO2 + NO3 as N (mg/L)	Total N (mg/L)	Discharge (cfs)
8/2/2005																
HCR	0503756	Not Toxic	7.53	1010	25.0	6.45	1730	3.31	11.0	---	75.4	---	<0.03	0.07	---	---
63C	0503757	Not Toxic	7.75	881	24.4	3.76	35	3.31	14.0	---	53.7	---	<0.03	<0.01	---	---
BWY	0503758	Not Toxic	7.60	808	26.2	3.64	18	13.0	23.0	---	51.2	---	<0.03	<0.01	---	---
STD	0503759	Not Toxic	7.64	497	26.0	5.87	21	13.0	8.00	---	34.3	---	<0.03	0.06	---	---
RCD	0503838	Not Toxic	7.68	466	25.2	5.66	6	1.88	10.0	---	25.6	---	<0.03	0.04	---	---
FRB	0503840	Not Toxic	7.48	509	26.7	3.54	50	5.07	9.00	---	39.4	---	<0.03	0.01	---	---
TWR	0503743	Not Toxic	7.51	501	27.0	5.65	17	6.14	17.0	---	31.8	0.12	<0.03	0.02	0.52	0.27
SCB	0502561	Not Toxic	7.50	567	26.0	6.09	72	7.70	15.0	---	38.3	0.09	<0.03	<0.01	0.48	0.64
CWP	0503744	Not Toxic	7.77	583	29.2	10.3	127	18.5	28.0	13.0	40.3	0.14	<0.03	<0.01	0.44	0.70
FLB	0503839	Not Toxic	7.62	592	23.6	3.21	231	<1.00	5.00	---	49.2	---	<0.03	0.04	---	---
BFN	0503742	Not Toxic	7.45	543	30.7	11.2	38	5.19	11.0	---	12.7	---	<0.03	0.13	---	---
10/17/2005																
HCR	0503376	Not Toxic	7.81	1540	17.0	8.50	133	3.00	5.00	---	217	0.04	<0.03	0.04	0.63	---
63C	0503377	Not Toxic	8.10	802	17.3	9.55	98	10.0	10.0	---	35.6	0.04	<0.03	<0.01	0.39	---
BWY	0503378	Not Toxic	7.94	792	18.2	11.2	56	2.00	<5.00	---	41.2	0.02	<0.03	<0.01	0.34	---
STD	0503379	Not Toxic	8.04	653	18.2	9.93	387	2.00	<5.00	---	33.7	0.05	<0.03	0.02	0.36	0.32
RCD	0503380	Not Toxic	7.82	657	17.7	8.17	88	3.00	<5.00	---	36.3	0.03	<0.03	<0.01	0.24	1.00
FRB	0506613	Not Toxic	7.77	649	15.5	8.49	70	4.00	<5.00	---	42.4	0.03	<0.03	0.13	0.28	1.44
TWR	0506616	Not Toxic	7.72	608	17.4	9.15	65	6.00	<5.00	---	36.7	0.03	<0.03	0.03	0.28	1.67
SCB	0506618	Not Toxic	7.71	614	14.8	8.63	43	4.00	<5.00	---	32.7	0.03	<0.03	0.02	0.28	2.25
CWP	0506621	Not Toxic	7.88	575	14.0	8.87	105	5.00	<5.00	---	26.9	0.05	<0.03	<0.01	0.25	3.54
FLB	0506614	Not Toxic	7.85	791	15.0	7.73	79	1.00	<5.00	---	74.5	0.10	<0.03	0.03	0.30	0.23
CHB	0506617	Not Toxic	7.73	659	16.3	4.69	61	<1.00	<5.00	---	29.4	0.07	<0.03	0.07	0.26	---
MLC	0506619	Not Toxic	8.13	556	14.1	9.19	313	3.00	<5.00	---	23.0	0.09	<0.03	<0.01	0.26	0.57
MDB	0506620	Not Toxic	7.82	552	13.7	6.78	38	6.00	5.00	---	21.2	0.12	<0.03	<0.01	0.31	---
BNF	0506615	Not Toxic	7.60	452	13.2	7.25	28	3.00	12.0	---	8.49	0.05	<0.03	0.10	0.34	0.43

Site Name	Sample #	Toxicity Result	pH (pH Units)	Spec.Cond. (uS/cm)	Temp. (C)	D.O. (mg/L)	E. coli (mpn/100ml)	Turbidity (NTU)	NFR (mg/L)	VSS (mg/L)	Chloride (mg/L)	Total P (mg/L)	NH3 as N (mg/L)	NO2 + NO3 as N (mg/L)	Total N (mg/L)	Discharge (cfs)
12/13/2005																
HCR	0506568	Not Toxic	7.09	922	1.10	13.3	5	1.36	<5.00	---	61.3	0.01	0.03	0.15	0.35	0.05
63C	0506569	Not Toxic	7.56	948	1.80	12.5	16	4.69	5.00	---	46.7	0.02	0.03	0.02	0.19	0.73
BWY	0506570	Not Toxic	7.28	1170	1.30	14.1	13	2.87	<5.00	---	105	0.02	0.03	<0.01	0.25	0.89
STD	0506883	Not Toxic	7.28	957	2.00	13.1	920	2.88	<5.00	---	57.7	0.03	0.14	0.04	0.44	0.72
RCD	0506884	Not Toxic	7.24	405	2.30	13.6	15	3.04	<5.00	---	60.3	0.04	0.03	<0.01	0.19	2.14
RCD - Dup	0506885	Not Toxic	7.26	405	2.30	13.6	29	2.81	7.00	---	60.2	0.03	0.03	<0.01	0.18	---
FRB	0506654	Not Toxic	7.99	1100	2.10	13.8	41	5.09	<5.00	---	333	0.05	0.64	0.26	3.26	3.12
TWR	0506653	Not Toxic	8.02	950	1.30	13.1	28	7.90	<5.00	---	80.3	0.05	0.09	0.11	0.69	3.50
SCB	0506651	Not Toxic	7.99	847	1.10	12.5	13	9.56	<5.00	---	49.6	0.04	0.03	0.06	0.22	2.90
CWP	0506648	Not Toxic	7.95	819	0.50	11.9	18	9.37	<5.00	---	44.7	0.05	0.03	0.05	0.22	4.11
FLB	0506655	Not Toxic	8.14	1780	1.90	13.1	61	<1.00	<5.00	---	122	0.08	0.03	0.33	0.46	0.20
CHB	0506652	Not Toxic	8.01	710	4.30	12.3	16	<1.00	<5.00	---	32.2	0.04	0.03	0.10	0.19	0.03
MLC	0506650	Not Toxic	8.24	656	0.60	12.8	37	3.62	<5.00	---	20.9	0.05	0.03	<0.01	0.17	0.46
MDB	0506649	Not Toxic	8.06	773	1.00	11.7	46	2.45	<5.00	---	29.2	0.08	0.03	0.05	0.24	0.06
BNF	0506886	Not Toxic	7.56	218	3.50	13.0	21	2.63	<5.00	---	13.1	0.04	0.03	0.06	0.22	0.60
2/27/2006																
HCR	0602536	Not Toxic	7.75	1180	4.20	12.1	14	10.9	6.00	---	116	0.03	<0.03	0.12	0.59	0.15
63C	0602537	Not Toxic	8.02	868	4.90	12.4	4	8.60	<5.00	---	39.2	0.01	<0.03	<0.01	0.18	0.15
BWY	0602538	Not Toxic	8.00	917	5.10	12.5	1	5.16	<5.00	---	48.3	<0.01	<0.03	<0.01	0.24	0.92
STD	0602539	Not Toxic	7.87	884	3.50	12.9	34	5.61	<5.00	---	47.0	0.01	<0.03	<0.01	0.30	1.18
RCD	0602540	Not Toxic	7.95	854	3.70	13.2	6	5.15	<5.00	---	58.1	0.05	<0.03	0.07	0.42	2.26
RCD - Dup	0602541	Not Toxic	7.99	854	3.70	13.2	9	4.99	<5.00	---	58.1	0.02	<0.03	0.07	0.37	---
FRB	0602546	Not Toxic	7.75	816	5.80	17.6	10	4.83	<5.00	---	59.6	0.04	<0.03	<0.01	0.27	2.98
TWR	0602544	Not Toxic	7.55	798	5.20	15.7	9	7.76	<5.00	---	58.5	0.04	<0.03	<0.01	0.28	2.86
SCB	0602550	Not Toxic	7.72	804	4.30	15.5	325	11.4	<5.00	---	56.6	0.05	<0.03	<0.01	0.26	3.02
CWP	0602547	Not Toxic	8.01	751	6.00	14.4	29	10.4	<5.00	---	52.5	0.04	<0.03	<0.01	0.22	3.93
FLB	0602545	Not Toxic	7.91	826	6.60	15.0	2	<1.00	<5.00	---	99.9	0.03	<0.03	0.02	0.14	0.21
CHB	0602543	Not Toxic	7.49	727	7.60	15.8	8	<1.00	<5.00	---	42.8	0.01	<0.03	0.04	0.15	---
MLC	0602549	Not Toxic	7.93	649	3.40	14.9	10	5.66	<5.00	---	29.0	0.02	<0.03	<0.01	0.14	0.34
MDB	0602548	Not Toxic	7.72	684	2.70	15.1	10	3.40	<5.00	---	31.2	0.03	<0.03	<0.01	0.17	---
BNF	0602542	Not Toxic	8.01	463	5.90	13.8	<1	4.52	8.00	---	15.0	0.04	<0.03	0.03	0.31	0.88

Table 2. Hinkson Creek Phase III Stormwater Water Quality Sample Results

Site Name	Sample #	Toxic Y/N	pH (pH Units)	Spec. Cond. (umhos/cm)	Temp.(C)	D.O. (mg/L)	E. coli (mpn/100ml)	Turbidity (NTU)	NFR (mg/L)	VSS (mg/L)	Cl (mg/L)	Ar (ug/L)	Cd (ug/L)	Ca (mg/L)	Cr (ug/L)	Cu (ug/L)	Hardness (mg/L)	Pb (ug/L)	Mg (mg/L)	Hg (ug/L)	Ni (ug/L)	Na (mg/L)	Zn (ug/L)
9/14/2005																							
Flat Br.	0503375	N	7.18	357	21.5	3.95	>2419.6		290		82.1	4.71	1.00	99.3	8.06	51.2	320	44.5	17.6	0.08	8.96		254
9/15/2005																							
Mill Cr.	0503372	N	7.72	495	19.3	7.35	>2419.6		402		24.3	5.99	0.24	61.6	6.85	7.84	194	8.52	9.82	0.05	10.0		32.2
Meredith Br.	0503373	N	7.78	260	19.0	7.60	>2419.6		446		18.8	6.23	0.22	58.1	8.81	10.6	187	8.67	10.2	0.05	13.0		44.7
10/20/2005																							
Mill Cr.	0506630	N	7.84	183	16.0	9.10	>2419.6	296	3030		14.3	22.0	0.66	56.8	47.8	45.3	210	53.3	16.6	0.17	56.2		187
Meredith Br.	0506631	N	7.74	191	15.8	8.72	>2419.6	195	787		20.0	8.24	0.24	68.9	17.1	18.0	225	14.6	12.9	0.05	22.1		71.3
Co. House Br.	0506632	N	7.51	309	16.4	7.38	>2419.6	11.0	366		27.0	2.84	0.79	99.1	3.34	35.9	283	13.1	8.63	0.05	6.04		108
Flat Br.	0506633	N	6.34	254	16.5	7.64	>2419.6	10.0	450		37.3	5.58	1.17	73.4	13.2	30.6	226	64.9	10.3	0.13	12.5		271
12/14/2005																							
Mill Cr.	0505161	N	8.16	675	2.40	13.3	325	80.1	306	17.0	20.8	1.97	0.20	84.9	0.43		258	3.77	11.2	0.05	2.61	21.4	6.41
HCR WWTP	0505162	N	8.06	748	1.00	12.3	387	27.8	40.0	5.00	41.9	1.00	0.20	91.4	0.84		283	0.98	13.2	0.05	3.07	31.8	4.66
Meredith Br.	0505163	N	8.21	715	2.70		>2419.6	29.0	65.0	7.00	28.6	1.00	0.20	92.1	0.30		286	0.86	13.7	0.05	2.27	25.7	2.35
Co. House Br.	0505164	N	8.05	1690	5.40	11.0	>2419.6	8.30	57.0	12.0	34.7	2.52	0.20	69.4	0.84		198	5.30	5.90	0.05	1.88	24.8	49.8
Flat Br.	0505165	N	8.06	748	5.40	12.3	>2419.6	8.38	48.0	11.0	283	1.00	0.20	97.5	0.92		323	4.82	19.4	0.05	2.96	204	24.4

Site Name	Sample #	Toxic Y/N	pH (pH Units)	Spec. Cond. (umhos/cm)	Temp.(C)	D.O. (mg/L)	E. coli (mpn/100ml)	Tur-bidity (NTU)	NFR (mg/L)	VSS (mg/L)	Cl (mg/L)	Ar (ug/L)	Cd (ug/L)	Ca (mg/L)	Cr (ug/L)	Cu (ug/L)	Hard-ness (mg/L)	Pb (ug/L)	Mg (mg/L)	Hg (ug/L)	Ni (ug/L)	Na (mg/L)	Zn (ug/L)
1/30/2006																							
HCR WWTP	0602001	N	8.05	650	6.80	10.1	461	83.8	254	20.0	43.9												
Meredith Br.	0602002	N	8.18	652	5.50	10.3	1990	33.1	207	12.0	29.7												
Mill Cr.	0602003	N	8.24	570	6.70	10.5	488	178	502	26.0	34.8												
Co. House Br.	0602004	N	8.15	504	7.60	10.1	113	43.6	97.0	16.0	27.0												
Flat Br.	0602005	N	8.28	779	7.90	12.2	95	23.3	44.0	9.00	92.0												
HCR E. Walnut	0602006	N	8.32	612	9.30	9.70	435	242	334	40.0	35.0												
HCR Rd	0602007	N	8.24	888	7.20	11.3	365	14.0	26.0	5.00	51.8												
3/6/2006																							
Flat Br.	0602024	N	7.94	845	11.6	10.4	461	14.9	54	13	105												

4.0 Hinkson Creek Biological Assessment (Phase II, Spring and Fall of 2005)

This addendum to the Phase II Hinkson Creek Stream Study (MDNR, 2006) includes biological assessment data from samples collected during the fall 2005 sampling season. These samples were being processed when the overall phase II study was finalized and could not be included in the report at that time. Samples used for this report were collected, processed, and analyzed using identical methods and station locations as those used during spring 2005 and described in the phase II study.

Fall season biological criteria derived for the Ozark/Moreau/Loutre EDU Biocriteria Reference Sites used to calculate Stream Condition Index values for sample sites are listed in Table 3.

Table 3. Biological Criteria for Warm Water Reference Streams in the Ozark/Moreau/Loutre EDU, Fall Season

	Score = 5	Score = 3	Score = 1
TR	>68	68-34	<34
EPT Taxa	>13	13-6	<6
BI	<7.05	7.05-8.52	>8.52
SDI	>3.08	3.08-1.54	<1.54

This portion of the study added a biological component to the water quality survey and focused on the segment of stream being evaluated relative to stormwater and sediment monitoring. The study area consisted of approximately 5.5 miles of Hinkson Creek, with all but the upper site (Station 7) being included in the impaired segment. A total of four Hinkson Creek biological monitoring stations were surveyed:

Station Reference Number	Station Location
7	Hinkson Creek Road
6	East Walnut Street
5.5	Broadway
3.5	Recreation Drive (east of Providence Road)

Please refer to Appendix A, Map C for the general locations of the biological monitoring stations. Sampling was conducted during the spring and fall of 2005. Comparisons of the Hinkson Creek macroinvertebrate community were made longitudinally among stations, with the downstream three stations compared to Station 7. Station 7, located approximately 4.5 miles upstream of I-70, is in a rural portion of the watershed and serves as a comparison to downstream reaches with more urban influence. Hinkson Creek macroinvertebrate data also were compared to reference streams within the same EDU.

The macroinvertebrate data were analyzed in two specific ways. First, upstream to downstream longitudinal comparisons of Hinkson Creek were made. Secondly, data from Hinkson Creek were compared to macroinvertebrate community data collected from biological criteria reference streams within the same EDU and the same watershed size classification. Biocriteria data collected from these streams in previous survey years constituted the basis of the comparison.

4.1 Hinkson Creek Longitudinal Comparison

The macroinvertebrate community from the mostly rural Hinkson Creek Station 7 again was compared with the community within this study's urbanized reach (Stations 3.5, 5.5, and 6) to observe whether the differences observed in previous biological assessments (MDNR 2002, 2004) were still present. Biological indices that exhibited longitudinal trends within the study reach included EPT Taxa, Shannon Diversity Index, and to a lesser extent, Biotic Index (Table 4). Numbers of EPT Taxa tended to decrease while progressing downstream and, although Taxa Richness was lower in the two downstream stations, this difference was slight. Biotic Index, a biological metric indicative of the macroinvertebrate community's overall tolerance to organic pollution, was again highest at Station 3.5 and lowest at the two upstream stations. Whereas SDI values were comparable among sites in spring, the two downstream stations had considerably lower SDI values in the fall season. Due to the reduced values of three of the four biotic indices at the two downstream stations, Stream Condition Index scores at Station 3.5 and Station 5.5 were insufficient to achieve fully supporting status.

Table 4. Hinkson Creek Metric Values and Scores, Fall 2005, Using Ozark/Moreau/Loutre Biocriteria Reference Database

Station #	TR	EPT Taxa	BI	SDI	SCI	Support
#7 Value	78	16	7.12	3.29		
#7 Score	5	5	3	5	18	**Full**
#6 Value	78	11	7.04	3.32		
#6 Score	5	3	5	5	18	**Full**
#5.5 Value	69	10	7.33	2.88		
#5.5 Score	5	3	3	3	14	Partial
#3.5 Value	72	9	7.45	2.91		
#3.5 Score	5	3	3	3	14	Partial

4.2 Comparison of Hinkson Creek versus Ozark/Moreau/Loutre EDU Biocriteria Reference Sites

As explained in the phase II report, Hinkson Creek biological metrics were compared to those of biocriteria reference sites to assess the applicability of using reference data for this study. With respect to comparability, fall 2005 metrics exhibited similar trends as those observed in spring 2005 data.

4.3 Macroinvertebrate Percent and Community Composition

Macroinvertebrate Taxa Richness, EPT Taxa, and percent EPT Taxa are presented in Table 5. This table also provides percent composition data for the five dominant macroinvertebrate families at each Hinkson Creek station. The percent relative abundance data were averaged from the sum of three macroinvertebrate habitats—coarse substrate, non-flow, and rootmat—sampled at each station.

Fall 2005 macroinvertebrate samples from Hinkson Creek upstream control Station 7 contained 78 total taxa and 16 EPT Taxa (Table 5). Test Station 6 also contained 78 total taxa, but only 11 EPT Taxa. The remaining two test stations had slightly lower Taxa Richness and similar numbers of EPT Taxa compared to Station 6. Mayflies composed a higher proportion of the sample in each of the downstream test stations whereas caddisflies made up a higher percentage of the sample collected at the upstream control station. No stoneflies were collected during the fall season. As with spring samples, one mayfly species, *Caenis latipennis*, was present among the five most dominant taxa at all sites. In spring, *C. latipennis* tended to make up a lower percentage of samples in downstream stations. By contrast, there was no such trend in fall samples and *C. latipennis* actually composed a higher percentage of the samples collected in the urbanized downstream reaches. Caddisflies (Trichoptera) not only made up a higher percentage of the sample at Station 7 compared to the downstream stations, they were also more diverse at the upstream station. There were six caddisfly genera at Station 7, four at Station 6, two at Station 5.5, and three at Station 3.5. The caddisfly *Cheumatopsyche* was the most numerous genus at each of the stations, accounting for at least 84 percent of caddisfly individuals collected in samples. This genus also had the highest Biotic Index value (i.e., more tolerant of organic pollution) of all caddisflies collected from Hinkson Creek in fall 2005. Generally, caddisfly taxa with lower Biotic Index values (less tolerant) were collected at Station 7; only two individuals that would be considered sensitive (in this case, “sensitive” meaning taxa with a Biotic Index <1.0) were found among the three downstream samples. Chironomidae (midge) larvae were the dominant taxa at the two upstream sites (Stations 6 and 7) and were much less abundant at the remaining downstream sites. Tubificid worms showed an opposite trend, being present among the top five taxa at each of the test stations and making up an increasing percentage of taxa while progressing downstream. Although present in Station 7 samples, tubificids were not sufficiently abundant to rank among the top five taxa. Riffle beetles (Elmidae) were among the dominant taxa at all stations and made up the highest percentage of the sample at Station 5.5, being slightly more abundant than tubificids. A single genus, *Stenelmis*, made up between 80 and 84 percent of elmids among the test stations, but only 38 percent at the control station. At Station 7, *Dubiraphia* was the dominant riffle beetle taxon. These two genera accounted for at least 91 percent of riffle beetle abundance at all stations.

Table 5. Fall 2005 Hinkson Creek Macroinvertebrate Composition

Variable-Station	7	6	5.5	3.5
Taxa Richness	78	78	69	72
Number EPT Taxa	16	11	10	9
% EPT Taxa	21	14	14	13
% Ephemeroptera	13.4	22.9	19.8	22.6
% Plecoptera	--	--	--	--
% Trichoptera	9.5	3.7	4.9	2.5
% Dominant Families				
Chironomidae	26.1	37.5	15.4	18.7
Elmidae	18.3	14.0	23.0	17.6
Physidae	9.6	--	--	--
Caenidae	9.3	16.5	14.7	17.8
Hydropsychidae	8.0	--	4.8	--
Tubificidae	--	6.7	22.8	28.1
Heptageniidae	--	4.6	--	--
Corbiculidae	--	--	--	4.3

4.4 Percent EPT Taxa Comparison

The percent EPT Taxa was determined to provide another way to compare macroinvertebrate data among sites. The calculation of relative abundance tends to normalize sites relative to differences in stream size, discharge, and other factors. The total number of taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera were divided by the total number of taxa collected at each site to obtain this percentage. Table 5 provides a comparison of the percent EPT Taxa found in each of the Hinkson Creek sample sites.

The percentage of EPT Taxa in fall samples collected from the Ozark/Moreau/Loutre EDU reference streams between 1998 and 2001 made up an average of 21 percent (range 14-35) of the total number of taxa. This EDU average equals the 21 percent at Station 7 and was comparable to that found in fall 2003 Hinkson Creek samples (MDNR 2004). Although the percent EPT Taxa at Station 6 has demonstrated an increasing trend among three spring sampling events, no such trend is evident among fall samples. Percent EPT Taxa for the fall index period at Station 6 was highest in 2003, with 2001 and 2005 being nearly equal.

4.5 Biological Assessment Discussion (Phase II, Spring and Fall of 2005)

As was the case with the spring data, EPT Taxa values tended to decline in downstream stations and, although Taxa Richness values were lower in the urbanized portion of the study reach, the difference was slight and did not affect the scores for that metric. One reason that there was not a substantial difference observed among sites was that aquatic worms (of the taxonomic families Tubificidae, Enchytraeidae, and Lumbricidae) exhibited a relatively high diversity in each of the two downstream stations and served to elevate the Taxa Richness values. Whereas Station 7 had three and Station 6 had four worm taxa, Station 5.5 had eight and Station 3.5 had seven. In terms of Taxa Richness, these additional worm taxa partially offset the relatively low diversity among Trichoptera and Hemiptera occurring at the two downstream stations. A Quantitative Similarity Index (**QSI**) calculation was performed to measure taxa similarity among stations in an attempt to further describe differences in the macroinvertebrate community within the study reach. The lowest scores occurred when comparing Station 7 with Station 3.5 (QSI = 46.3) and Station 5.5 (QSI = 47.9). This trend is similar to the spring data, except that the QSI scores for fall are considerably lower. The highest QSI score occurred when comparing Station 3.5 to Station 5.5 (QSI = 75.5). Despite overall biological metric similarities between Stations 7 and 6, the QSI value of 57.0 was relatively low, indicating that the macroinvertebrate community of Station 6 is aligned more closely with that of the remaining urbanized stations than the control site.

Stations 7 and 6 had fully supporting SCI scores that were equal to one another in both spring and fall. Spring and fall scores also were equal at Station 3.5, but were both partially supporting at this site. The SCI score at Station 5.5 fell from 16 (fully supporting) in spring to 14 (partially supporting) in fall due to a decline in the Shannon Diversity Index score. The remaining biological metrics at this site were the same as in spring. Station 5.5 was the only site to change supportability status during this study.

Overall, based on the biological metrics used to describe the macroinvertebrate community in this study, conditions within Hinkson Creek seem to be similar compared to spring. Notable differences exist between the upstream control Station 7 and Station 6 in the number of EPT Taxa, percent EPT Taxa, and abundance of caddisflies. However, EPT Taxa tended to decline in downstream stations, although there was not a corresponding trend with Taxa Richness. Taxa Richness values were highest at the two middle stations, with the up- and downstream stations equal to each other at slightly lower levels. There were no consistent differences among sites to explain the relatively low Taxa Richness levels at Station 3.5 and Station 7. Some taxa that were present in lower numbers at Station 7 compared to the middle stations included mollusks and chironomids. Taxa underrepresented at Station 3.5, compared to the middle stations, included mollusks, caddisflies, and chironomids. The fact that there were only minor differences in Taxa Richness among sites is reflected in the Quantitative Similarity Index (QSI) (MDNR 2003), a measure of taxa similarity between two sample stations. The lowest scores occurred when comparing Station 7 with Station 3.5 (QSI = 63.7) and Station 5.5 (QSI = 64). Comparing Station 6 with Station 5.5 yielded the highest QSI score of 75.9. As expected, based on a review of the biological metrics, the two middle sites are most similar to one another and, despite equality in the Taxa Richness metric at Stations 7 and 3.5, the macroinvertebrate community is not equitable at the two sites.

5.0 Phase III Hinkson Creek Biological Assessment (Spring of 2006)

Biological assessment monitoring was conducted in the spring of 2006 as part of the overall assessment of the lower reach of Hinkson Creek. This portion of the study adds a biological component to the water quality survey and is focused on the segment of stream being evaluated for stormwater and sediment effects. The study reach consisted of approximately 4 miles of Hinkson Creek, all of which is included in the impaired segment. A total of three Hinkson Creek biological monitoring stations were surveyed with Bonne Femme Creek serving as a local control stream:

Station Reference Number	Station Location
Hinkson Creek Station 3	Forum Boulevard
Hinkson Creek Station 2	Twin Lakes Recreation Area
Hinkson Creek Station 1	Scott Boulevard
Bonne Femme Creek Station 1	Nashville Church Road

Past studies that focused on stream segments located upstream of this study reach were compared to Hinkson Creek Station 7, which lies in a non-urbanized portion of the watershed. Because the survey reach for this assessment was conducted lower in the watershed, Hinkson Creek Station 7 was considered too small to adequately serve as a control. Bonne Femme Creek Station 1 was more comparable in size to the study reach and met the condition of having a relatively undeveloped watershed.

5.1 Hinkson Creek Longitudinal and Bonne Femme Creek Comparison

In addition to comparing Hinkson Creek stations to one another, the macroinvertebrate community from Bonne Femme Creek, a system that has been used as a local control stream through the duration of the Hinkson Creek project, was compared with the community within this study's urbanized reach (Hinkson Creek Stations 1, 2, and 3). Taxa Richness values were nearly the same at the upstream and downstream Hinkson Creek stations, whereas Station 2 Taxa Richness values were somewhat lower (Table 6). Taxa Richness at each Hinkson Creek station was lower than the Bonne Femme Creek control site, although only Station 2 had a sufficiently low value to result in a lower score for this metric.

Table 6. Hinkson Creek and Bonne Femme Creek Metric Values and Scores, Spring 2006, Using Ozark/Moreau/Loutre Biocriteria Reference Database

Station #	TR	EPT Taxa	BI	SDI	SCI	Support
Hinkson #3 Value	73	10	7.15	3.00		
Hinkson #3 Score	5	3	3	5	16	Full
Hinkson #2 Value	69	6	7.30	3.22		
Hinkson #2 Score	3	3	3	5	14	Partial
Hinkson #1 Value	75	7	7.28	3.27		
Hinkson #1 Score	5	3	3	5	16	Full
B. Femme #1 Value	79	15	6.46	3.15		
B. Femme #1 Score	5	5	3	5	18	Full

Numbers of EPT Taxa were highest at the upstream site and were lower at the two downstream stations. None of these differences in EPT Taxa values were sufficient to affect the scores. EPT Taxa were more abundant at the control site, with Bonne Femme Creek achieving the highest possible score for this metric. In contrast to EPT Taxa values, Shannon Diversity Index values were lowest at the upstream site and nearly equal at the remaining downstream locations. Hinkson Creek Shannon Diversity Index scores were comparable to or slightly higher than that of the control and all sites achieved the highest possible score. Biotic Index values also were similar among Hinkson Creek sites and were slightly higher than those of Bonne Femme Creek; there was no difference in Biotic Index scores among all sites, however. Each of the differences among biological metric values noted above was minor and, with the exception of Taxa Richness at Station 2, was insufficient to result in altering the metrics' scores. The Station 2 Taxa Richness value, which was two taxa less than what was required for a maximum score for this metric, resulted in the only difference in metric scores among the Hinkson Creek stations and subsequent failure of Station 2 to achieve fully supporting status.

5.2 Comparison of Hinkson Creek versus Ozark/Moreau/Loutre EDU Biocriteria Reference Sites

The metrics calculated for Hinkson Creek were compared to biological criteria derived for the Ozark/Moreau/Loutre EDU Biocriteria Reference Sites. These criteria are listed for the spring sample season in Table 6. This comparison was made to assess the degree to which using biological criteria was applicable for Hinkson Creek. Most of the biocriteria reference streams are fourth and fifth order and, because this Hinkson Creek survey reach is a fourth order stream, it was inferred that the comparisons using criteria based on the suite of reference streams was appropriate.

5.3 Macroinvertebrate Percent and Community Composition

Macroinvertebrate Taxa Richness, EPT Taxa, and percent EPT Taxa are presented in Table 7. This table also provides percent composition data for the five dominant macroinvertebrate families at each Hinkson Creek station. The percent relative abundance data were averaged from the sum of three macroinvertebrate habitats—coarse substrate, non-flow, and rootmat—sampled at each station.

Spring 2006 macroinvertebrate samples from the Bonne Femme control station contained 79 total taxa and 15 EPT Taxa (Table 7). Each of the Hinkson Creek test stations had slightly lower numbers, ranging from 69 total taxa at Station 2 to 75 at Station 1. The two downstream test stations had fewer than half the EPT Taxa abundance compared to the control, with Station 3 achieving a total of 10. One mayfly species, *Caenis latipennis*, was among the dominant five taxa at each of the stations. It was the only mayfly taxon present at Station 1 and one of two present at the remaining Hinkson Creek sites. By comparison, Bonne Femme Creek had a total of six mayfly taxa, a majority of which (77 percent) were *C. latipennis*. Caenid mayflies, chironomids (midges), tubificid worms, and riffle beetles (Elmidae) were present among the five dominant taxa groups at each study site. Chironomid percentages were roughly comparable among Hinkson Creek sites, but contributed a lower percentage to Bonne Femme Creek samples. Tubificid worms were second in abundance in each Hinkson Creek sample and made up nearly identical percentages among sites. Tubificids also were among the dominant taxa at Bonne Femme Creek, but accounted for a slightly lower percentage of the sample compared to Hinkson Creek. Elmid beetles were abundant in comparable percentages at each study site with the exception of Hinkson Creek Station 2, where they made up a much lower percentage of the sample.

Hinkson Creek Station 3 had slightly more EPT Taxa, but no distinct longitudinal trends were evident among Hinkson Creek sites. When comparing Hinkson Creek to Bonne Femme Creek, however, several differences were evident. Mayflies and caddisflies tended to make up a higher percentage of the overall sample at Bonne Femme Creek, with the exception being that caddisflies contributed nearly equally at Hinkson Creek Station 1 and the Bonne Femme Creek site. Stoneflies were nearly absent in Hinkson Creek and, when present in samples, were represented by only a single individual at Stations 1 and 3. This observation contrasts with Bonne Femme Creek, in which four genera of stoneflies were observed, accounting for four percent of the sample.

Table 7. Spring 2006 Hinkson Creek and Bonne Femme Creek Macroinvertebrate Composition

Variable-Station	**Hinkson #3**	**Hinkson #2**	**Hinkson #1**	**B. Femme #1**
Taxa Richness	73	69	75	79
Number EPT Taxa	10	6	7	15
% EPT Taxa	13.7	8.7	9.3	19.0
% Ephemeroptera	3.3	4.2	3.6	6.9
% Plecoptera	<0.1	0.0	<0.1	4.0
% Trichoptera	0.3	0.4	1.1	1.2
% Dominant Families				
Chironomidae	67.5	73.8	71.9	59.5
Tubificidae	10.8	9.8	10.8	7.0
Elmidae	8.3	1.7	5.0	8.0
Caenidae	2.7	4.0	3.3	5.3
Simuliidae	2.7	--	--	--
Coenagrionidae	2.0	--	1.8	--
Corbiculidae	--	2.8	--	--
Crangonyctidae	--	--	--	5.4

5.4 Percent EPT Taxa Comparison

The percent EPT Taxa was determined to provide another way to compare macroinvertebrate data among sites. This calculation tends to normalize sites relative to differences in stream size, discharge, and other factors. The total number of taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera was divided by the total number of taxa collected at each site to obtain this percentage. Table 7 provides a comparison of the percent EPT Taxa found in each of the Hinkson and Bonne Femme creek sample sites.

EPT Taxa in spring samples collected from Ozark/Moreau/Loutre EDU reference streams between 1998 and 2001 made up an average of 22 percent (range 19-27) of the total number of taxa. EPT Taxa at Bonne Femme Creek made up 19 percent of total taxa whereas EPT Taxa among all Hinkson Creek stations were considerably lower than the average for the references or for the local control stream. Hinkson Creek EPT Taxa averaged 11 percent (range 9-14), which is comparable to the levels observed in spring samples during the 2002 study (mean = 12, range 10-15) (MDNR 2002).

5.5 Biological Assessment Discussion

Despite having the highest number of EPT Taxa among Hinkson Creek stations, Station 3 had slightly lower Taxa Richness than Station 1. This difference was a result of Station 1 having higher numbers of Crustacea and Chironomidae taxa, which offset the slightly lower numbers of EPT Taxa. Station 2 had the lowest Taxa Richness and EPT Taxa values among all stations. No single taxa group accounted for the lower Taxa Richness at Station 2; however, there were slightly fewer chironomids, no Hemiptera, and no Plecoptera taxa which, when combined, explain much of the reduction in this metric. With the exception of Shannon Diversity Index, Bonne Femme Creek biological metric values exceeded those of each Hinkson Creek site. The Biotic Index value at Bonne Femme Creek, although not sufficiently low to result in a higher score, was likely due to this site having a lower abundance and fewer taxa of tubificid worms compared to Hinkson Creek. In addition to fewer tolerant taxa being present at Bonne Femme Creek, certain relatively sensitive taxa such as mayflies, stoneflies, and caddisflies were present in greater numbers and diversity than at Hinkson Creek.

Biological metrics observed in this study are, with few exceptions, very similar to those observed in 2002. In 2002 each of the lower three Hinkson Creek stations failed to achieve fully supporting status, whereas in 2006 only Station 2 scored partially supporting. The only biological metric that scored differently when comparing the two studies was Taxa Richness. Taxa Richness increased by nine at Station 1 and by three at Station 3; these additional taxa were sufficient to raise the score for this single metric from three to five which, in turn, caused the Stream Condition Index for these two sites to increase from 14 (partially supporting) to 16 (fully supporting). In looking at the taxa that generated the majority of this increase, however, there were more taxa that are generally considered tolerant (Tubificidae and Chironomidae) with a concomitant decrease of three mayfly taxa and one caddisfly taxon. There was one stonefly taxon (represented by a single individual) in the 2006 sample, compared to none in 2002. With the exception that this individual contributed to the EPT Taxa metric, its presence is unlikely to represent any significant change in water quality since the 2002 study.

Despite two of the three lower Hinkson Creek stations increasing in status from partially to fully supporting, the biological community is largely unchanged compared to conditions observed in 2002. As described above, only one station demonstrated a notable increase in Taxa Richness (which resulted mostly from an increase in tolerant taxa), whereas the remaining stations changed very little. Among the remaining biological metrics, there were no consistent trends that would indicate notable changes in the aquatic community since the 2002 study.

6.0 Phase III Hinkson Creek Study Summary

According to the US EPA (1994), nonpoint source pollution is the number one cause of water quality impairment in the United States, accounting for the pollution of approximately 40% of all waters surveyed across the nation. As found in this study and others, there is typically not one pollutant or entity that is the sole cause of impairment to streams that flow through urbanized areas. Impairments to urbanized streams are often a reflection of what is occurring in the watershed. As was found during this study and discussed by Waters (1995), stormwaters can carry a variety of materials such as road salt, herbicides/pesticides, and PAHs, along with other organic materials. The Hinkson Creek phase III findings are summarized below:

None of the stormwater samples collected from the tributaries or the main-stem Hinkson Creek sites were found to be toxic to the Microtox organisms

Elevated *E. coli* levels were found on four occasions at three different locations on Hinkson Creek during phase III base flow sampling. Stormwater samples collected from the four tributaries frequently exceeded the 2419 mpn/100mL level.

Average turbidity levels during phase III were lower from all sampling sites as compared to levels found during the phase II monitoring. This may be the result of less frequent precipitation events during the phase III portion of the study. When comparing turbidity values from all sites sampled during phase III, the Hinkson Creek sites were generally higher than those from the tributaries. Like turbidity, NFR values tended to be lower during phase III as compared to phase II from Hinkson Creek and tributary sites. NFR values mimicked those of turbidity in that Hinkson sites tended to be higher than those from the tributaries.

Data loggers that recorded temperature and dissolved oxygen concentrations over an 8-week period showed that lower dissolved oxygen appeared to correlate better with pool stagnation at low flows that result from extended dry periods than with stormwater inputs resulting from precipitation events. Dissolved oxygen conditions generally improved following rainfall events.

Chloride levels at Hinkson Creek sites during phase III baseflow sampling were considerably higher than those measured from Hinkson Creek sites in phase I or II. This was in contrast to the tributaries where levels were slightly lower during phase III than those found during phase II. Flat Branch Creek had significantly higher chloride levels than those from the other three tributaries or from the three sites sampled on Hinkson Creek. Chloride levels of stormwater ranged from 14.3 mg/L (Mill Creek) to 283 mg/L from Flat Branch.

The nutrient data collected during the base flow portion of the phase II and III study was found to be within the expected ranges for a stream within the Ozark/Moreau/Loutre EDU.

The improvement in macroinvertebrate metric scores and the increasing similarity index between Station 6 and Station 7 could be interpreted as a demonstration that Station 6 is developing better potential to support a diverse macroinvertebrate community. This increased potential at Station 6 may result from a decrease of the quantity and frequency of perturbations that were observed and/or suspected in previous years (e.g., sewer bypasses, petroleum products, insecticides, road salt, and sediment).

The macroinvertebrate community within the urbanized reach showed some important differences compared to the upstream reference reach. Most notably, Station 3.5 had a fraction of the number of mayflies and stoneflies compared to each of the other stations. In addition, each of the urbanized reaches had much higher numbers of tubificid worms than Station 7. Tubificids were nearly twice as abundant at Station 3.5 than at the next nearest site. Tubificid worms tend to be tolerant of sediment and also organic pollutants. The higher abundance of tubificids within the urbanized reach might reflect previously documented inputs of sediment and organic loading (e.g., bypasses, etc.).

Growth and development within the city of Columbia in the last few years have dramatically increased. With increasing urbanization, more impacts to Hinkson Creek are likely. As best described by Booth and Jackson (1997): "urbanization of a watershed degrades both the form and the function of the downstream aquatic system, causing changes that can occur rapidly and are very difficult to avoid or correct."

With the growing amount of impervious surfaces located in the Hinkson Creek watershed, we can suspect that hydrologic changes have and will continue to occur in Hinkson Creek. Other urban stream studies cited within this report have documented links between development and alterations to the natural landscape. There appears to be a strong correlation between the imperviousness of a drainage basin and the health of its receiving streams (Arnold and Gibbons 1996, US EPA 1993, Stankowski 1972, Schueler 1994). As the percentage of the land covered by impervious surfaces increases, there is a consistent degradation of water quality. Degradation occurs at relatively low levels of imperviousness (10-20%) and worsens as more areas are paved. The US EPA (1993) also reported that urbanization negatively affects streams and results in water quality problems such as loss of habitat, increased temperatures, sedimentation, and loss of fish populations. These negative impacts can be mitigated to varying degrees, however, by proper planning and use of low impact development techniques.

Progressive and innovative land management and land use practices are needed to prevent further degradation of Hinkson Creek and other urban streams located throughout the state of Missouri. Low impact development, such as decreasing and slowing stormwater discharges and creating grassy and/or vegetative swales to capture small precipitation events that allow water to percolate through the soil to recharge groundwater systems, is a method that can help mitigate detrimental effects of urbanization on streams. The following EPA link provides further information: http://www.epa.gov/owow/nps/lid/. Educational efforts focusing on the importance of stormwater management practices are currently being used in the Great Lakes region and in the eastern and western coastal regions and are becoming increasingly considered in Midwestern communities.

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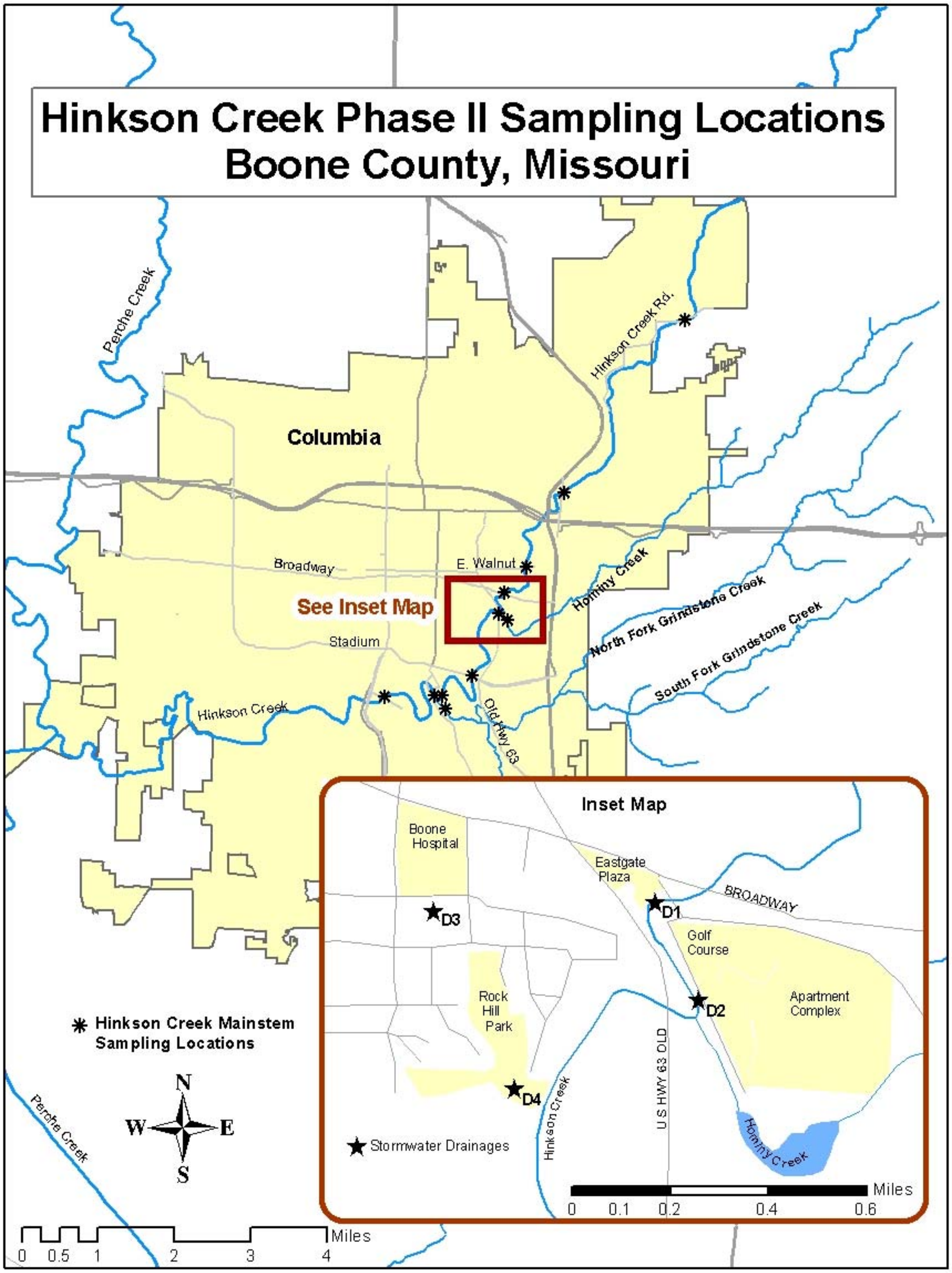
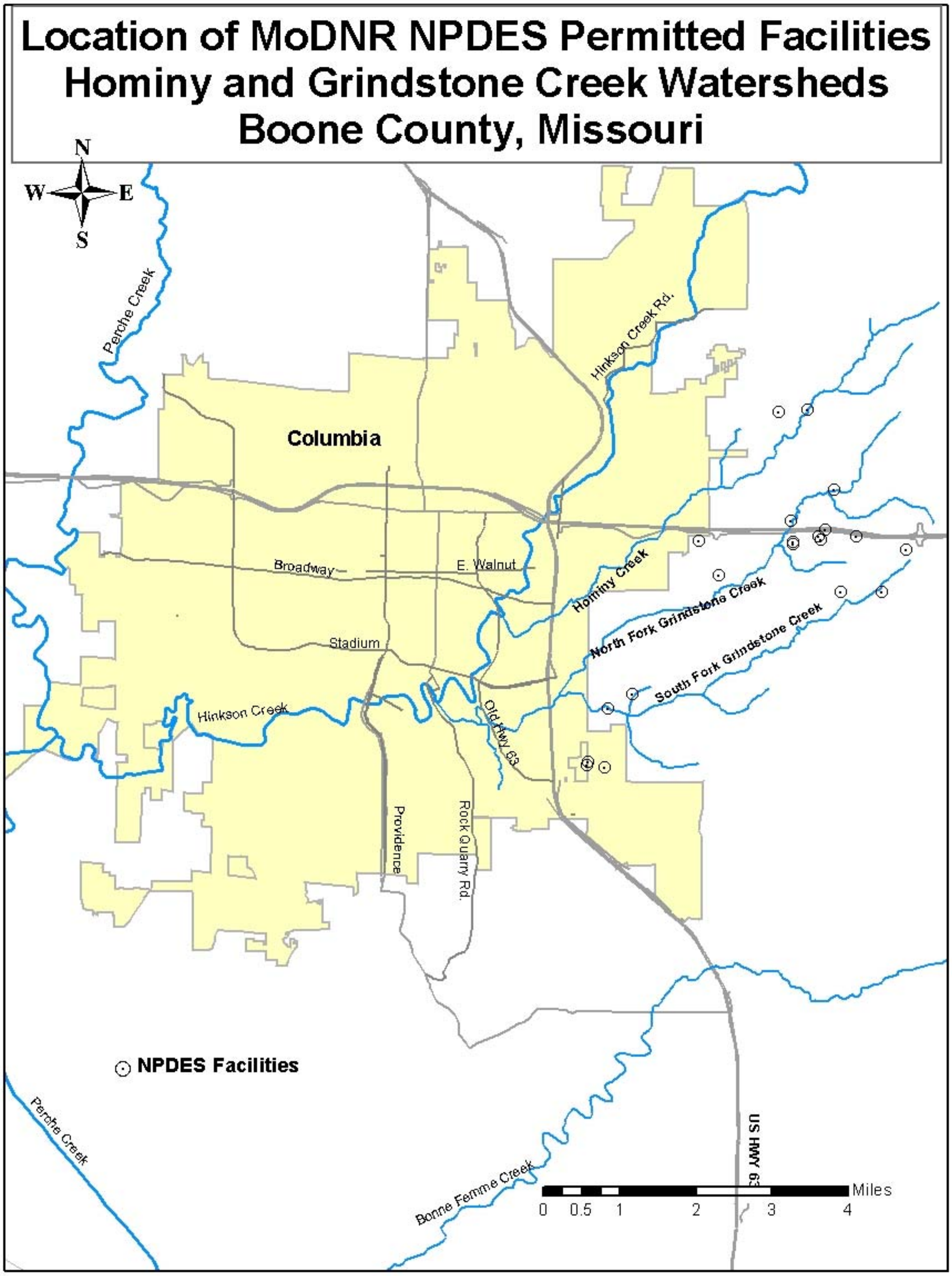
APPENDIX A

Hinkson Creek Maps

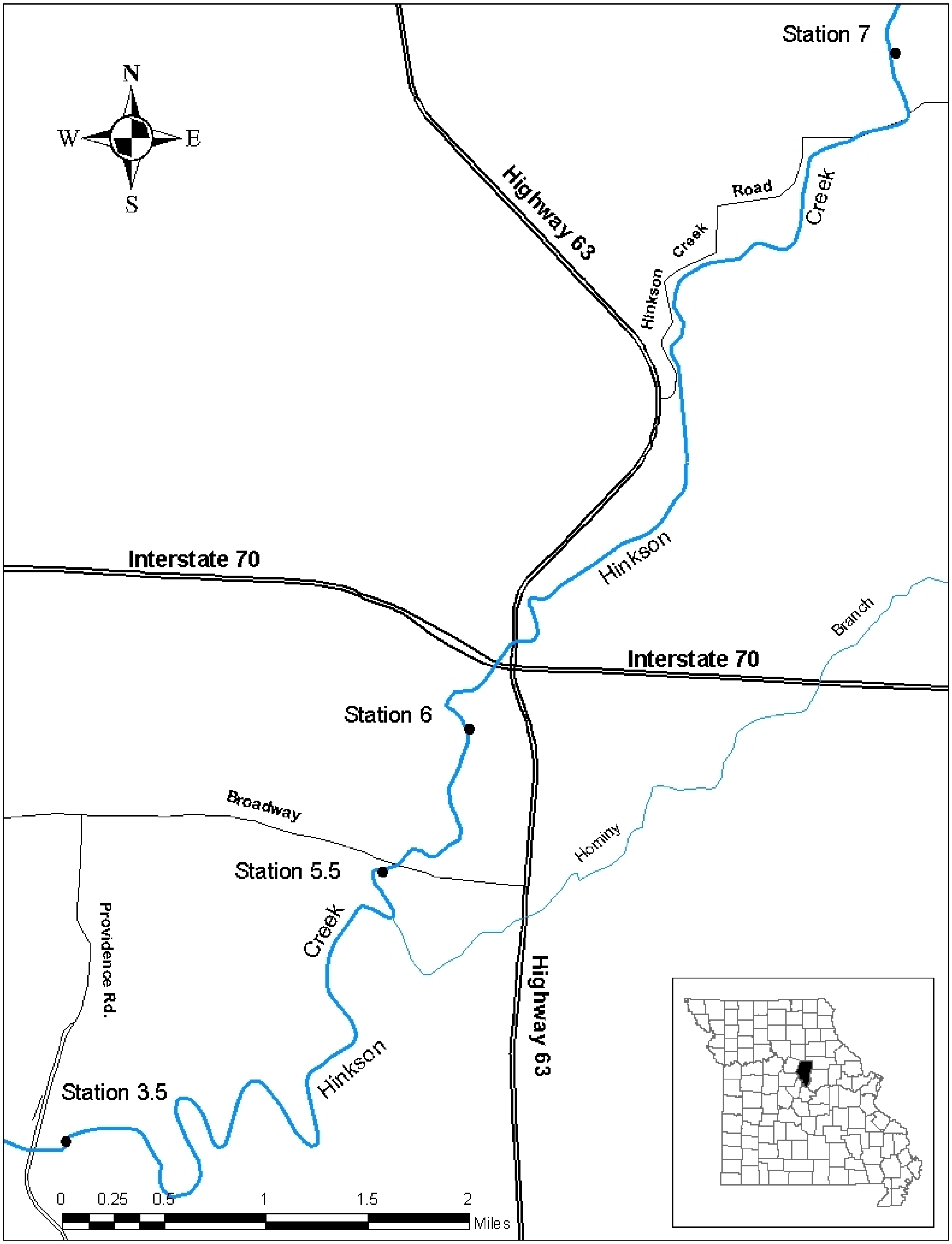
Map A. Hinkson Creek Water Quality Monitoring Locations



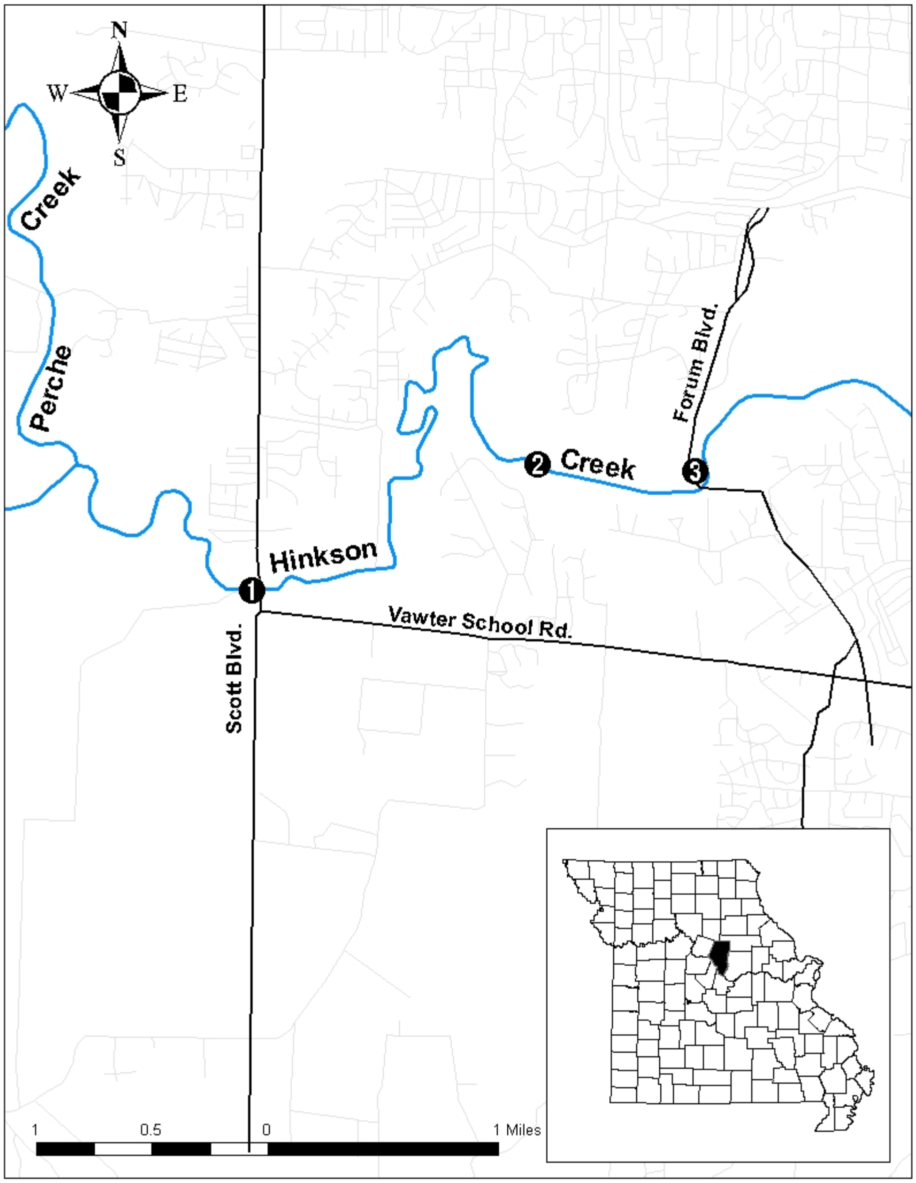
Map B. Location of MDNR NPDES Facilities in the Hominy and Grindstone Creek Watersheds



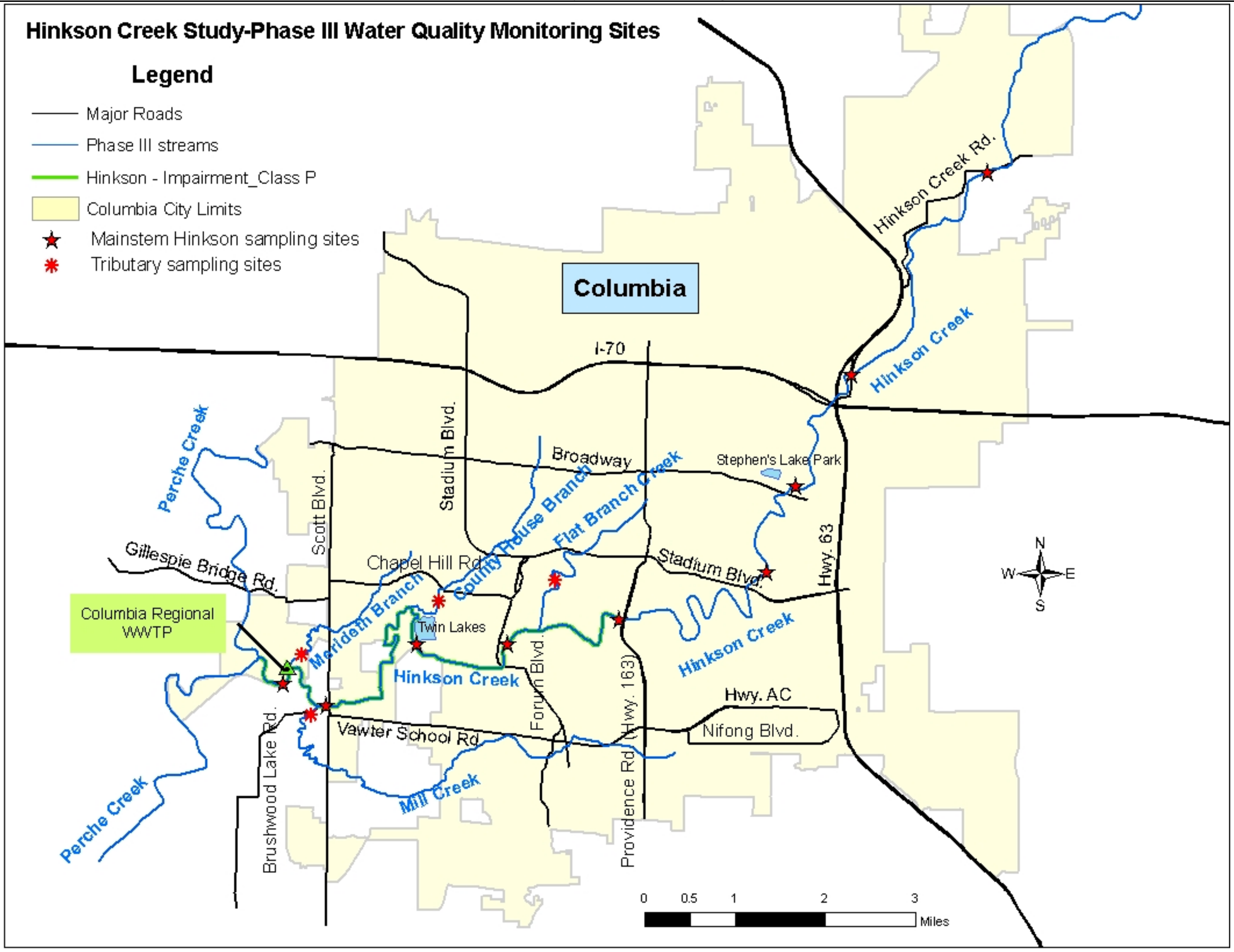
Map C. Hinkson Creek Macroinvertebrate Monitoring Locations



Map D. Hinkson Creek Spring 2006 Macroinvertebrate Monitoring Locations



Map E. Hinkson Creek Phase III Water Quality Monitoring Sites



APPENDIX B
Collection of All Analytical Results

Hinkson Creek
Base Flow Monitoring
Analytical Results

Hinkson Creek
Stormwater Monitoring
Analytical Results

APPENDIX C

Hinkson Creek Spring and Fall 2005 Macroinvertebrate Taxa Lists

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503026], Station #3.5, Sample Date: 4/18/2005 9:15:00 AM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	CS	NF	RM
AMPHIPODA			
Crangonyx	8		6
Hyalella azteca			9
COLEOPTERA			
Berosus	1		
Dubiraphia	1	4	10
Helichus basalis	1		
Hydroporus			5
Macronychus glabratus			2
Peltodytes		1	
Stenelmis	112	4	
DECAPODA			
Orconectes virilis	-99		
DIPTERA			
Ablabesmyia			1
Ceratopogoninae	3	3	2
Chaoborus		1	
Chironomus	1	48	5
Cladotanytarsus	31	34	
Corynoneura			2
Cricotopus bicinctus	3		4
Cricotopus/Orthocladius	294	4	4
Cryptochironomus	5	7	
Cryptotendipes		4	
Demicryptochironomus	8		
Dicrotendipes	1		2
Eukiefferiella	1		
Hexatoma	1		
Hydrobaenus	12	2	24
Microtendipes	2		2
Nanocladius			9
Paracladopelma		1	
Parakiefferiella		2	12
Parametriocnemus	8		
Paratanytarsus	3	2	186
Paratendipes	7	13	1
Polypedilum convictum grp	53		
Polypedilum halterale grp		21	
Polypedilum illinoense grp		1	
Polypedilum scalaenum grp	6	1	1
Procladius		3	5
Simulium	4		
Stenochironomus	1		
Stictochironomus	7	26	
Tabanidae		1	
Tanytarsus	2	2	11
Thienemanniella	1		3
Thienemannimyia grp.	8		8
Tipula	-99		

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503026], Station #3.5, Sample Date: 4/18/2005 9:15:00 AM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	CS	NF	RM
EPHEMEROPTERA			
Acerpenna	2		
Baetis	2		
Caenis latipennis	7	1	19
Stenonema femoratum	4		
Tricorythodes	1		
ISOPODA			
Caecidotea	4	1	4
LIMNOPHILA			
Menetus			1
LUMBRICINA			
Lumbricidae	1		
ODONATA			
Argia			2
Enallagma			27
Gomphus			-99
Somatochlora			-99
PLECOPTERA			
Perlesta	7		
TRICHOPTERA			
Cheumatopsyche	2		
Hydroptila	2		
TRICLADIDA			
Planariidae	4		
TUBIFICIDA			
Branchiura sowerbyi		2	
Enchytraeidae	2	1	
Limnodrilus cervix		3	
Limnodrilus claparedianus		11	
Limnodrilus hoffmeisteri	23	8	1
Tubificidae	37	63	10
VENEROIDEA			
Corbicula	-99		
Sphaeriidae	3	1	

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503027], Station #5.5, Sample Date: 4/18/2005 10:20:00 AM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	1
AMPHIPODA			
Hyalella azteca			8
ARHYNCHOBDELLIDA			
Erpobdellidae	2	-99	
COLEOPTERA			
Dubiraphia	2	4	
Dytiscidae		1	
Hydroporus	1	6	3
tenelmis S	89	11	18
DECAPODA			
Orconectes virilis			-99
DIPTERA			
Ablabesmyia		2	1
Ceratopogoninae	2		3
Chaoborus		1	
Chironomus	1	37	
Cladotanytarsus	4	10	
Corynoneura	1		3
Cricotopus bicinctus	2		2
Cricotopus/Orthocladius	460	9	24
Cryptochironomus	6	8	
Dicrotendipes	4		
Diptera		11	
Eukiefferiella brevicalcar grp	5		
Hemerodromia	1		
Hexatoma	-99		
Hydrobaenus		2	7
Labrundinia		1	
Larsia		1	
Limnophyes			1
Micropsectra		1	1
Microtendipes			1
Nanocladius	1		4
Ormosia		1	
Parachironomus		2	
Paracladopelma		3	
Parakiefferiella	1	9	25
Parametriocnemus	5		
Paratanytarsus	4	10	142
Paratendipes		8	
Polypedilum convictum grp	128	1	
Polypedilum halterale grp		4	
Polypedilum illinoense grp			8
Polypedilum scalaenum grp	3	6	
Procladius		15	
Psectrocladius			2
Pseudosmittia			1

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503027], Station #5.5, Sample Date: 4/18/2005 10:20:00 AM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	CS	NF	RM
Simulium	15		
Stictochironomus	3	37	
Tanytarsus	2	6	3
Thienemanniella	1		
Thienemannimyia grp.	7		5
Tipula	-99		
EPHEMEROPTERA			
Acerpenna	4		
Caenis latipennis	11	14	21
Hexagenia limbata		2	
Stenacron	1	1	
Stenonema femoratum	8	1	
HEMIPTERA			
Pelocoris			1
ISOPODA			
Caecidotea	3	11	1
LIMNOPHILA			
Ancylidae	3	1	1
Lymnaeidae			1
Menetus			2
Physella			5
LUMBRICINA			
Lumbricidae		1	
ODONATA			
Argia	1		3
Enallagma			17
Gomphus			-99
PLECOPTERA			
Perlesta	40	2	
TRICHOPTERA			
Cheumatopsyche	2		
Chimarra	1		
Hydroptila	11		
Polycentropus		1	
TUBIFICIDA			
Branchiura sowerbyi	3	2	
Enchytraeidae	1		
Limnodrilus cervix		2	
Limnodrilus claparedianus		4	
Limnodrilus hoffmeisteri	12	12	1
Tubificidae	17	26	1
VENEROIDEA			
Sphaeriidae	8		11

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503028], Station #6, Sample Date: 4/18/2005 11:50:00 AM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		5	
AMPHIPODA			
Crangonyx	1		6
BRANCHIOBDELLIDA			
Branchiobdellida			3
COLEOPTERA			
Dubiraphia		3	5
Hydroporus		1	
tenelmis S	63	12	21
DECAPODA			
Orconectes virilis		-99	-99
DIPTERA			
Ablabesmyia		2	
Ceratopogoninae		8	
Chironomus		12	
Cladotanytarsus	10	51	7
Corynoneura		4	2
Cricotopus bicinctus	1		2
Cricotopus trifascia	1		
Cricotopus/Orthocladius	229	7	132
Cryptochironomus	3	3	2
Demicryptochironomus			1
Dicrotendipes	1		
Diptera		3	
Eukiefferiella	45		2
Hemerodromia	5		
Hydrobaenus	3	7	5
Limnophyes			1
Microtendipes			1
Nanocladius	1	1	4
Natarsia	1		
Nilotanypus			1
Paracladopelma		1	
Parakiefferiella		9	3
Parametriocnemus	6		
Paratanytarsus		25	35
Paratendipes	8	3	1
Polypedilum convictum grp	112	1	4
Polypedilum fallax grp		2	
Polypedilum halterale grp		5	
Polypedilum illinoense grp	1	1	
Polypedilum scalaenum grp		2	
Rheotanytarsus	1		3
Simulium	30		
Smittia		1	
Stempellinella		1	
Stictochironomus		28	1
Tabanidae	1		

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503028], Station #6, Sample Date: 4/18/2005 11:50:00 AM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	CS	NF	RM
Tabanus	2		
Tanytarsus		3	
Thienemanniella	2	1	2
Thienemannimyia grp.	6	2	11
Tipula	2		-99
Tribelos			1
Zavrelimyia	2		
EPHEMEROPTERA			
Acentrella	2		2
Acerpenna			2
Baetis	3		
Caenis latipennis	5	7	40
Heptageniidae	1		2
Leptophlebiidae			1
Stenacron	1		
Stenonema femoratum	7	-99	
ISOPODA			
Caecidotea			5
LIMNOPHILA			
Physella			-99
ODONATA			
Anax			1
Argia	1		
Arigomphus		-99	
Calopteryx			1
Hagenius brevistylus		1	
Progomphus obscurus		1	
PLECOPTERA			
Amphinemura	1		
Perlesta	51	1	11
TRICHOPTERA			
Cheumatopsyche	1		
Hydroptila	2		1
Ironoquia		-99	
TUBIFICIDA			
Branchiura sowerbyi	1		
Enchytraeidae	2	1	
Limnodrilus hoffmeisteri	2	2	
Tubificidae	18	31	1
VENEROIDEA			
Sphaeriidae		1	

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503029], Station #7, Sample Date: 4/18/2005 1:00:00 PM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		8	
AMPHIPODA			
Crangonyx		2	4
Hyalella azteca			21
COLEOPTERA			
Dubiraphia		5	14
Hydroporus		10	3
Peltodytes		1	
Stenelmis	105	11	16
DECAPODA			
Orconectes virilis			-99
DIPTERA			
Ablabesmyia		2	
Ceratopogoninae	5	6	
Chironomus	1	12	
Chrysops	1		
Cladotanytarsus	72	32	
Corynoneura		9	2
Cricotopus/Orthocladius	196	16	110
Cryptochironomus	3	7	
Cryptotendipes		1	
Demicryptochironomus	12		
Dicrotendipes	1	1	1
Eukiefferiella brevicalcar grp	51		4
Hemerodromia	1		1
Hexatoma	2	-99	
Hydrobaenus	1	12	3
Larsia	1		
Micropsectra			2
Nanocladius		1	12
Nilothauma			1
Ormosia	1		
Paracladopelma		2	
Parakiefferiella	1	11	3
Parametriocnemus	5		
Paratanytarsus	3	24	26
Paratendipes	11	2	
Polypedilum		5	1
Polypedilum convictum grp	29		
Polypedilum halterale grp		6	
Polypedilum illinoense grp		1	2
Polypedilum scalaenum grp	27	6	
Procladius		1	
Rheotanytarsus	1		
Simulium	18		1
Stictochironomus	12	7	
Tanytarsus			6
Thienemanniella	3		

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503029], Station #7, Sample Date: 4/18/2005 1:00:00 PM
CS = Coarse Substrate; NF = Non-Flow; RM = Rootmat; -99 = present in samples

ORDER: TAXA	**CS**	**NF**	**RM**
Thienemannimyia grp.	1	8	11
Tipula	-99		-99
EPHEMEROPTERA			
Acentrella	6		2
Acerpenna			1
Caenis latipennis	2	18	64
Leptophlebiidae		3	8
Nixe		4	
Stenacron	1	1	
Stenonema femoratum	-99		
HEMIPTERA			
Microvelia			1
ODONATA			
Calopteryx			1
Enallagma		1	6
Gomphus		-99	
PLECOPTERA			
Amphinemura	2		
Perlesta	38		6
TRICHOPTERA			
Helicopsyche	3		
Hydroptila	1		
Ironoquia			1
Oecetis			1
Triaenodes			5
TRICLADIDA			
Planariidae			1
TUBIFICIDA			
Enchytraeidae	1		
Limnodrilus claparedianus	1	1	
Limnodrilus hoffmeisteri	7	1	
Tubificidae	3	2	
VENEROIDEA			
Sphaeriidae	1		-99

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503075], Station #3.5, Sample Date: 9/15/2005 8:45:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	**CS**	**NF**	**RM**
"HYDRACARINA"			
Acarina			2
AMPHIPODA			
Hyalella azteca			3
ARHYNCHOBDELLIDA			
Erpobdellidae	1		
COLEOPTERA			
Berosus			3
Dubiraphia	17	6	10
Helichus lithophilus	1		
Lutrochus		1	
Macronychus glabratus			3
Stenelmis	144	1	16
DECAPODA			
Orconectes virilis	-99		1
DIPTERA			
Ablabesmyia	4	5	3
Anopheles			2
Ceratopogoninae	3	6	2
Chironomus	1	3	
Cladotanytarsus	12	7	
Corynoneura			2
Cricotopus bicinctus			1
Cricotopus/Orthocladius	8		
Cryptochironomus	4	6	
Cryptotendipes	2	1	
Dicrotendipes	6	4	1
Ephydridae		1	
Forcipomyiinae			1
Hemerodromia	1		
Labrundinia	1		2
Mesosmittia			1
Microtendipes	1		
Nilotanypus			1
Paracladopelma		1	
Paralauterborniella		2	
Paratanytarsus		3	1
Polypedilum convictum grp	15	1	4
Polypedilum halterale grp		1	
Polypedilum illinoense grp	4	1	43
Procladius		5	
Pseudochironomus	2		
Rheotanytarsus	1		1
Stictochironomus		1	
Tabanidae			1
Tanytarsus	13	4	25
Thienemanniella	1		
Thienemannimyia grp.	2		2

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503075], Station #3.5, Sample Date: 9/15/2005 8:45:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

Tipula			1
EPHEMEROPTERA			
Acerpenna	10		2
Caenis latipennis	114	60	25
Procloeon		4	9
Stenacron	9		
Stenonema femoratum	10	5	
Tricorythodes	5		
HEMIPTERA			
Rhagovelia			1
Trepobates			1
LIMNOPHILA			
Ancylidae	3		
Lymnaeidae			1
Physella			3
ODONATA			
Argia	6		2
Basiaeschna janata			-99
Calopteryx			1
Enallagma			11
Pachydiplax longipennis			1
Progomphus obscurus		2	
TRICHOPTERA			
Cheumatopsyche	25		
Hydroptila	1		
Oecetis		3	
TUBIFICIDA			
Aulodrilus			2
Branchiura sowerbyi	11	11	2
Enchytraeidae	1		
Ilyodrilus templetoni		1	
Limnodrilus claparedianus		29	
Limnodrilus hoffmeisteri	27	9	
Tubificidae	92	116	14
VENEROIDEA			
Corbicula	43	5	1
Sphaeriidae	2		

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503076], Station #5.5, Sample Date: 9/15/2005 10:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
AMPHIPODA			
Hyalella azteca	2		3
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	
COLEOPTERA			
Berosus	6		
Dubiraphia	2	24	
Enochrus	1		
Peltodytes			6
Stenelmis	201	2	2
DECAPODA			
Orconectes virilis	-99		-99
DIPTERA			
Ablabesmyia	3	2	
Ceratopogoninae	1	5	
Chaoborus	22	14	3
Chironomus	2	2	
Cladotanytarsus	13	2	
Cricotopus bicinctus	3	1	
Cryptochironomus	9	5	
Cryptotendipes		1	
Dicrotendipes	14	1	
Forcipomyiinae	3		
Glyptotendipes		1	
Hemerodromia	2		
Hexatoma	-99		
Paratanytarsus	1		
Polypedilum convictum grp	22		
Polypedilum illinoense grp	5		13
Polypedilum scalaenum grp	5		
Procladius		6	
Rheotanytarsus	2		
Stictochironomus		3	
Tanypus		2	
Tanytarsus	28	2	
Thienemannimyia grp.	7		
Tipula			1
EPHEMEROPTERA			
Acerpenna	3		
Baetis	1		
Caenis latipennis	110	38	
Callibaetis			4
Hexagenia limbata		-99	
Procloeon		2	2
Stenacron	15	3	
Stenonema femoratum	19	2	
HEMIPTERA			
Corixidae	1	1	1

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503076], Station #5.5, Sample Date: 9/15/2005 10:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Mesovelia			1
Notonecta			-99
Ranatra kirkaldyi			1
Ranatra nigra			1
Rheumatobates			1
Trepobates		1	8
Veliidae			1
ISOPODA			
Caecidotea	1		
LIMNOPHILA			
Ancylidae	6	1	
Helisoma	-99		
Lymnaeidae			3
Physella	3		
LUMBRICINA			
Lumbricidae	-99		
ODONATA			
Argia	9		1
Gomphidae		1	
Perithemis		-99	
TRICHOPTERA			
Cheumatopsyche	46	1	2
Nyctiophylax	1		
TRICLADIDA			
Planariidae	3		
TUBIFICIDA			
Aulodrilus		2	
Branchiura sowerbyi	9	2	
Enchytraeidae			4
Limnodrilus cervix		2	
Limnodrilus claparedianus		10	
Limnodrilus hoffmeisteri	7	4	
Tubificidae	63	130	
VENEROIDEA			
Corbicula	7		
Sphaeriidae	9	5	

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503077], Station #6, Sample Date: 9/15/2005 12:10:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	
AMPHIPODA			
Hyalella azteca			3
BRANCHIOBDELLIDA			
Branchiobdellida	1		1
COLEOPTERA			
Berosus	1	1	
Dubiraphia	1	11	19
Peltodytes			1
Scirtidae			3
Stenelmis	149	6	3
DECAPODA			
Orconectes virilis	2		
DIPTERA			
Ablabesmyia	18	12	1
Anopheles			2
Ceratopogoninae	1	7	1
Chaoborus	1	13	
Chironomus	1	7	1
Cladotanytarsus	3	23	1
Corynoneura		1	1
Cricotopus bicinctus			1
Cricotopus/Orthocladius	42		7
Cryptochironomus	9	6	
Dicrotendipes	21	8	10
Dixella			1
Dolichopodidae			1
Endochironomus			1
Ephydridae	1		
Forcipomyiinae	5	2	
Glyptotendipes		2	11
Hexatoma	1		
Labrundinia		4	10
Microtendipes	8	1	
Nanocladius	1	2	
Natarsia		1	
Nemotelus			3
Nilotanypus	4		
Paratanytarsus	1	2	43
Phaenopsectra			1
Polypedilum	3		1
Polypedilum convictum grp	42		
Polypedilum halterale grp	1	1	
Polypedilum illinoense grp	17	2	25
Polypedilum scalaenum grp	3	1	
Procladius		3	
Rheotanytarsus			1

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503077], Station #6, Sample Date: 9/15/2005 12:10:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Stempellinella		2	
Stictochironomus		8	
Tabanus	-99		
Tanytarsus	67	18	29
Thienemannimyia grp.	15		1
Tipula	-99		3
EPHEMEROPTERA			
Acerpenna	2		
Baetis	14		
Caenis latipennis	105	112	6
Callibaetis			4
Procloeon		2	1
Stenacron	19	14	
Stenonema femoratum	16	14	
HEMIPTERA			
Aquarius			1
Mesovelia			3
Microvelia		2	
Neoplea			1
Rhagovelia	1		
Rheumatobates			38
Trepobates			14
Veliidae			7
LIMNOPHILA			
Ancylidae	2	1	1
Physella	4		5
MEGALOPTERA			
Sialis		-99	
ODONATA			
Argia	22		2
Enallagma			28
Libellula			1
TRICHOPTERA			
Cernotina		1	
Cheumatopsyche	47		
Helicopsyche	1		
Oecetis		1	
TUBIFICIDA			
Branchiura sowerbyi	11	7	
Limnodrilus hoffmeisteri	1	1	
Tubificidae	44	24	3
VENEROIDEA			
Corbicula	1	1	
Sphaeriidae	7	2	3

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0503078], Station #7, Sample Date: 9/15/2005 1:30:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	6
AMPHIPODA			
Hyalella azteca			22
COLEOPTERA			
Berosus	1		14
Dubiraphia		29	147
Enochrus	4		
Scirtidae			10
Stenelmis	119		8
DECAPODA			
Orconectes virilis			1
DIPTERA			
Ablabesmyia	28	11	11
Ceratopogoninae		9	1
Chironomus	1	22	
Chrysops		1	1
Cladotanytarsus	7	8	
Corynoneura	1		2
Cricotopus bicinctus	2		
Cricotopus/Orthocladius		1	
Cryptochironomus	2	3	
Cryptotendipes		3	
Dicrotendipes	8	3	4
Endochironomus			1
Forcipomyiinae	2	3	1
Glyptotendipes	1		13
Hemerodromia	5		
Hexatoma	1		
Labrundinia	8	1	18
Larsia	1		
Microtendipes			1
Muscidae	-99		
Parachironomus	1		1
Paralauterborniella		1	
Paratanytarsus	1		45
Pentaneura	1		
Phaenopsectra			2
Polypedilum convictum grp	57	1	
Polypedilum halterale grp		1	
Polypedilum illinoense grp	35		5
Polypedilum scalaenum grp		1	
Procladius		3	
Rheotanytarsus	2		
Simulium	1		
Stictochironomus	1	7	
Tabanus	-99		
Tanytarsus	41	12	10

Aquid Invertebrate Database Bench Sheet Report

Hinkson Ck [0503078], Station #7, Sample Date: 9/15/2005 1:30:00 PM

CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Thienemannimyia grp.	41		1
Tribelos			1
EPHEMEROPTERA			
Acerpenna	20		
Caenis latipennis	38	67	48
Caenis punctata			1
Centroptilum		2	
Hexagenia limbata		19	
Leptophlebiidae			3
Paracloeodes		1	
Procloeon		3	
Stenacron	1	2	
Stenonema femoratum	11	7	
HEMIPTERA			
Microvelia			2
Rheumatobates		1	1
Trepobates			1
Veliidae			2
LIMNOPHILA			
Ancylidae	1	1	13
Menetus			99
Physella	23		136
ODONATA			
Argia	2	1	14
Basiaeschna janata			-99
Dromogomphus		1	
Enallagma			59
Ischnura			2
TRICHOPTERA			
Cheumatopsyche	132	1	
Chimarra	2		
Helicopsyche	7		2
Hydroptila	1		
Limnephilidae			1
Triaenodes			12
TRICLADIDA			
Planariidae			2
TUBIFICIDA			
Limnodrilus claparedianus		1	
Limnodrilus hoffmeisteri	1	1	
Tubificidae	5	56	1
VENEROIDEA			
Sphaeriidae	4	2	22

Appendix D

Hinkson & Bonne Femme Creek Spring 2006 Macroinvertebrate Taxa Lists

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602657], Station #1, Sample Date: 4/13/2006 9:45:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		2	
AMPHIPODA			
Crangonyx	1		
Hyalella azteca		1	-99
COLEOPTERA			
Berosus		2	
Dubiraphia		4	9
Hydrophilidae		1	
Stenelmis	43	4	
Tropisternus			-99
DIPTERA			
Ablabesmyia		18	21
Ceratopogoninae	7	3	1
Chironomus	1	28	1
Cladotanytarsus	5	7	
Corynoneura	2		1
Cricotopus bicinctus			1
Cricotopus/Orthocladius	94	15	10
Cryptochironomus	2	12	
Cryptotendipes		20	
Dicrotendipes	45	25	17
Diptera		4	
Eukiefferiella	1		
Hydrobaenus	9	14	2
Larsia	2	1	
Mesosmittia	1		
Nanocladius			1
Nilotanypus	3		
Nilothauma	2	2	
Ormosia	1	1	
Parachironomus			1
Paralauterborniella		3	
Paratanytarsus		2	
Paratendipes	3	2	
Phaenopsectra			1
Polypedilum	3		12
Polypedilum convictum grp	170		
Polypedilum halterale grp	29	11	
Polypedilum illinoense grp	4	6	69

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602657], Station #1, Sample Date: 4/13/2006 9:45:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Polypedilum scalaenum grp	31	7	40
Procladius		1	
Rheotanytarsus	1		1
Saetheria	1		
Simulium	12		
Stictochironomus	3	1	
Tanytarsus	13	13	30
Thienemanniella	11		
Thienemannimyia grp.	5		15
Tribelos			1
EPHEMEROPTERA			
Caenis latipennis	9	11	20
Stenacron		1	
Stenonema femoratum	1	1	
HEMIPTERA			
Belostoma			-99
Microvelia			1
ISOPODA			
Caecidotea			3
LIMNOPHILA			
Ancylidae		1	
Menetus			1
Physella			-99
LUMBRICINA			
Lumbricina			1
ODONATA			
Argia		1	5
Calopteryx			3
Enallagma			15
Ischnura			1
Libellula		2	
PLECOPTERA			
Isoperla	1		
RHYNCHOBDELLIDA			
Piscicolidae		2	
TRICHOPTERA			
Cheumatopsyche	2	1	
Cyrnellus fraternus			1
Hydroptila	4	2	4
TRICLADIDA			

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602657], Station #1, Sample Date: 4/13/2006 9:45:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Planariidae	2		1
TUBIFICIDA			
Branchiura sowerbyi		4	
Enchytraeidae	2	2	
Ilyodrilus templetoni		4	2
Limnodrilus cervix		2	1
Limnodrilus claparedianus	3	3	
Limnodrilus hoffmeisteri	12	22	2
Tubificidae	24	48	2
VENEROIDEA			
Corbicula	1	6	-99

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602658], Station #2, Sample Date: 4/13/2006 11:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
N/A			
Gordiidae	4		
"HYDRACARINA"			
Acarina			1
AMPHIPODA			
Crangonyx	1		1
COLEOPTERA			
Berosus	1		-99
Dubiraphia			1
Macronychus glabratus	1		
Stenelmis	16	2	2
DIPTERA			
Ablabesmyia		3	27
Ceratopogoninae	1	1	
Chironomus	13	80	19
Cladotanytarsus	18	9	
Corynoneura	3		
Cricotopus bicinctus	5	2	4
Cricotopus/Orthocladius	131	2	15
Cryptochironomus	9	14	
Cryptotendipes		5	1
Dicrotendipes	14	3	18
Diptera		11	
Endochironomus			1
Eukiefferiella	1		
Glyptotendipes			1
Hydrobaenus	2		5
Labrundinia	2		
Nilothauma			1
Ormosia	3		
Paracladopelma		2	
Parametriocnemus	1		
Paratanytarsus		1	1
Paratendipes	5		1
Phaenopsectra			2
Polypedilum	16		10
Polypedilum convictum grp	114		13
Polypedilum halterale grp	97	44	1
Polypedilum illinoense grp	8	6	33
Polypedilum scalaenum grp	39	1	

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602658], Station #2, Sample Date: 4/13/2006 11:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	**CS**	**NF**	**RM**
Simulium	15		3
Stictochironomus	7	5	
Tanytarsus	11	6	27
Thienemanniella	23		7
Thienemannimyia grp.	7	1	30
Tipula			1
EPHEMEROPTERA			
Acerpenna			1
Caenis latipennis	14	6	31
Stenonema femoratum		1	
ISOPODA			
Caecidotea	1		
LIMNOPHILA			
Ancylidae	1		
Menetus			1
Physella		1	2
LUMBRICINA			
Lumbricina		2	
ODONATA			
Argia			11
Basiaeschna janata			1
Calopteryx			1
Enallagma			8
Ischnura			1
Progomphus obscurus	2	1	
TRICHOPTERA			
Ceraclea			1
Cheumatopsyche	1		1
Hydroptila	1		2
TRICLADIDA			
Planariidae		1	
TUBIFICIDA			
Aulodrilus		1	
Branchiura sowerbyi		1	
Enchytraeidae		1	
Ilyodrilus templetoni		1	
Limnodrilus claparedianus	2	7	
Limnodrilus hoffmeisteri	14	30	1
Quistradrilus multisetosus		1	
Tubificidae	10	55	2

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602658], Station #2, Sample Date: 4/13/2006 11:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
VENEROIDEA			
Corbicula	36		
Sphaeriidae		6	3

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602659], Station #3, Sample Date: 4/13/2006 11:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		1	
AMPHIPODA			
Crangonyx	1		
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		-99
BRANCHIOBDELLIDA			
Branchiobdellida		1	
COLEOPTERA			
Berosus		1	3
Dubiraphia			3
Macronychus glabratus			1
Stenelmis	82	4	11
DIPTERA			
Ablabesmyia		24	14
Ceratopogoninae		5	2
Chironomus		102	4
Cricotopus/Orthocladius	108	15	20
Cryptochironomus	3	16	
Cryptotendipes		3	
Dicrotendipes	5	12	11
Diptera		2	
Eukiefferiella	1		
Hydrobaenus		6	5
Labrundinia		1	1
Nanocladius	1		3
Nilotanypus			1
Nilothauma			1
Paracladopelma		5	
Paralauterborniella		1	
Parametriocnemus	1		
Paratanytarsus			7
Paratendipes		1	2
Phaenopsectra			1
Polypedilum	12	1	4
Polypedilum convictum grp	244	4	2
Polypedilum halterale grp		1	1
Polypedilum illinoense grp	8		73
Polypedilum scalaenum grp	10	12	8
Procladius		1	

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602659], Station #3, Sample Date: 4/13/2006 11:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Rheotanytarsus	1	2	1
Simulium	33		
Stempellinella			1
Stictochironomus		6	
Tabanus	-99		
Tanytarsus	1	3	11
Thienemanniella	6		1
Thienemannimyia grp.	8	4	16
Tipula	-99		
Tribelos			1
EPHEMEROPTERA			
Baetidae	1		
Caenis latipennis	4	7	22
Stenacron	1		
Stenonema femoratum	3		1
Tricorythodes		1	
HEMIPTERA			
Ranatra nigra			-99
LIMNOPHILA			
Ferrissia			5
Menetus			12
Physella			3
LUMBRICINA			
Lumbricina	4		
ODONATA			
Argia			13
Calopteryx			-99
Enallagma			12
Macromia			-99
Progomphus obscurus		-99	
PLECOPTERA			
Perlidae	1		
TRICHOPTERA			
Cheumatopsyche	-99		1
Hydroptila	1		1
Ironoquia			1
Rhyacophila	-99		
TRICLADIDA			
Planariidae			1
TUBIFICIDA			

Aquid Invertebrate Database Bench Sheet Report
Hinkson Ck [0602659], Station #3, Sample Date: 4/13/2006 11:30:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	**CS**	**NF**	**RM**
	3	1	1
Enchytraeidae	1	2	3
Ilyodrilus templetoni	2		
Limnodrilus claparedianus		1	
Limnodrilus hoffmeisteri	17	35	5
Tubificidae	46	16	6
VENEROIDEA			
Corbicula	3	5	-99
Sphaeriidae			3

Branchiura sowerbyi	

Aquid Invertebrate Database Bench Sheet Report

Bonne Femme Ck [0602680], Station #1a, Sample Date: 4/13/2006 1:30:00 PM

CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
N/A			
"HYDRACARINA"			
Acarina	1	3	
AMPHIPODA			
Crangonyx	31	6	34
Hyalella azteca			4
BRANCHIOBDELLIDA			
Branchiobdellida			1
COLEOPTERA			
Dubiraphia			13
Helichus lithophilus			1
Macronychus glabratus			1
Scirtidae			1
Stenelmis	84	7	
DECAPODA			
Orconectes virilis			1
Palaemonetes kadiakensis			1
DIPTERA			
Ablabesmyia	2	12	10
Ceratopogoninae	10	2	
Chironomus		5	
Cladotanytarsus	4	3	1
Corynoneura	1	2	10
Cricotopus/Orthocladius	74	3	42
Cryptochironomus	4	7	
Dicrotendipes		2	7
Diptera		1	
Eukiefferiella	6		
Hexatoma	10	1	
Hydrobaenus	2	1	9
Krenosmittia	1		
Labrundinia			4
Larsia		1	3
Nanocladius			2
Natarsia	6	1	1
Nilotanypus	4		
Nilothauma			2
Paratanytarsus	1		5
Paratendipes	2	35	1

Aquid Invertebrate Database Bench Sheet Report
Bonne Femme Ck [0602680], Station #1a, Sample Date: 4/13/2006 1:30:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Polypedilum	4	1	
Polypedilum convictum grp	296	3	
Polypedilum halterale grp		60	4
Polypedilum scalaenum grp	13	25	7
Pseudochironomus	1		
Rheocricotopus	2		
Rheotanytarsus	1		1
Stenochironomus			1
Stictochironomus		4	
Tabanus	2		
Tanytarsus	9	3	46
Thienemanniella	2		1
Thienemannimyia grp.	17		6
Tipula	-99		-99
Tipulidae		1	
Zavreliella		1	
EPHEMEROPTERA			
Acerpenna	1		1
Baetis	2		
Caenis latipennis	9	9	52
Hexagenia limbata		1	
Stenacron	1	1	2
Stenonema femoratum	4	1	7
ISOPODA			
Caecidotea	14	5	13
LIMNOPHILA			
Menetus			1
Physella			10
MEGALOPTERA			
Sialis			1
ODONATA			
Argia			1
Calopteryx			-99
Enallagma			10
Libellula			-99
Macromia			1
PLECOPTERA			
Amphinemura	3		
Haploperla	1		
Isoperla	45		

Aquid Invertebrate Database Bench Sheet Report
Bonne Femme Ck [0602680], Station #1a, Sample Date: 4/13/2006 1:30:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

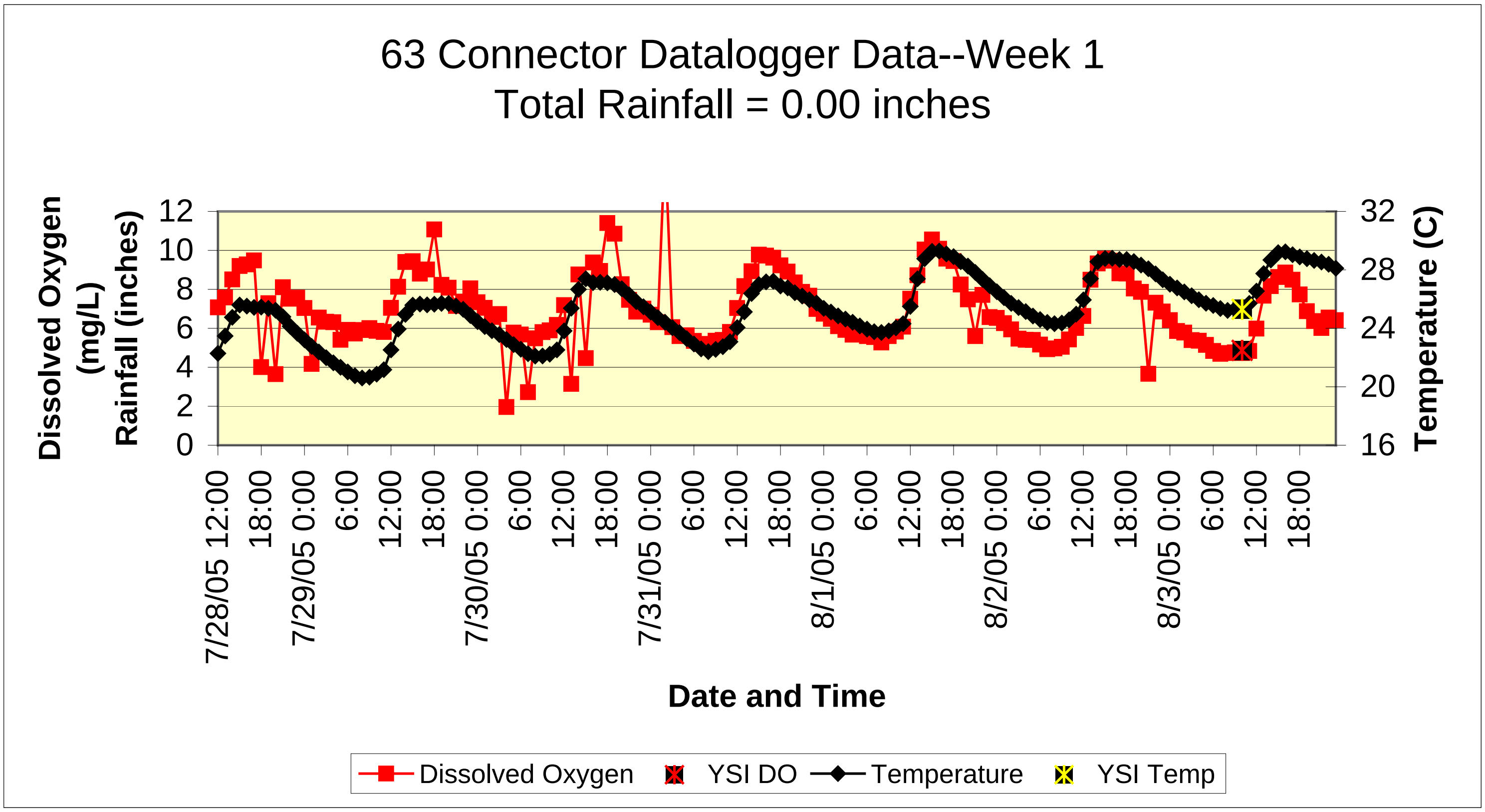
ORDER: TAXA	CS	NF	RM
Perlesta	4		-99
RHYNCHOBDELLIDA			
Piscicolidae		1	
TRICHOPTERA			
Cheumatopsyche			1
Chimarra	13		
Oecetis	1		
Polycentropodidae	1		
Pycnopsyche			-99
TRICLADIDA			
Planariidae			1
TUBIFICIDA			
Branchiura sowerbyi		3	
Limnodrilus cervix		27	
Limnodrilus hoffmeisteri	2	10	1
Tubificidae	6	43	
VENEROIDEA			
Sphaeriidae			4

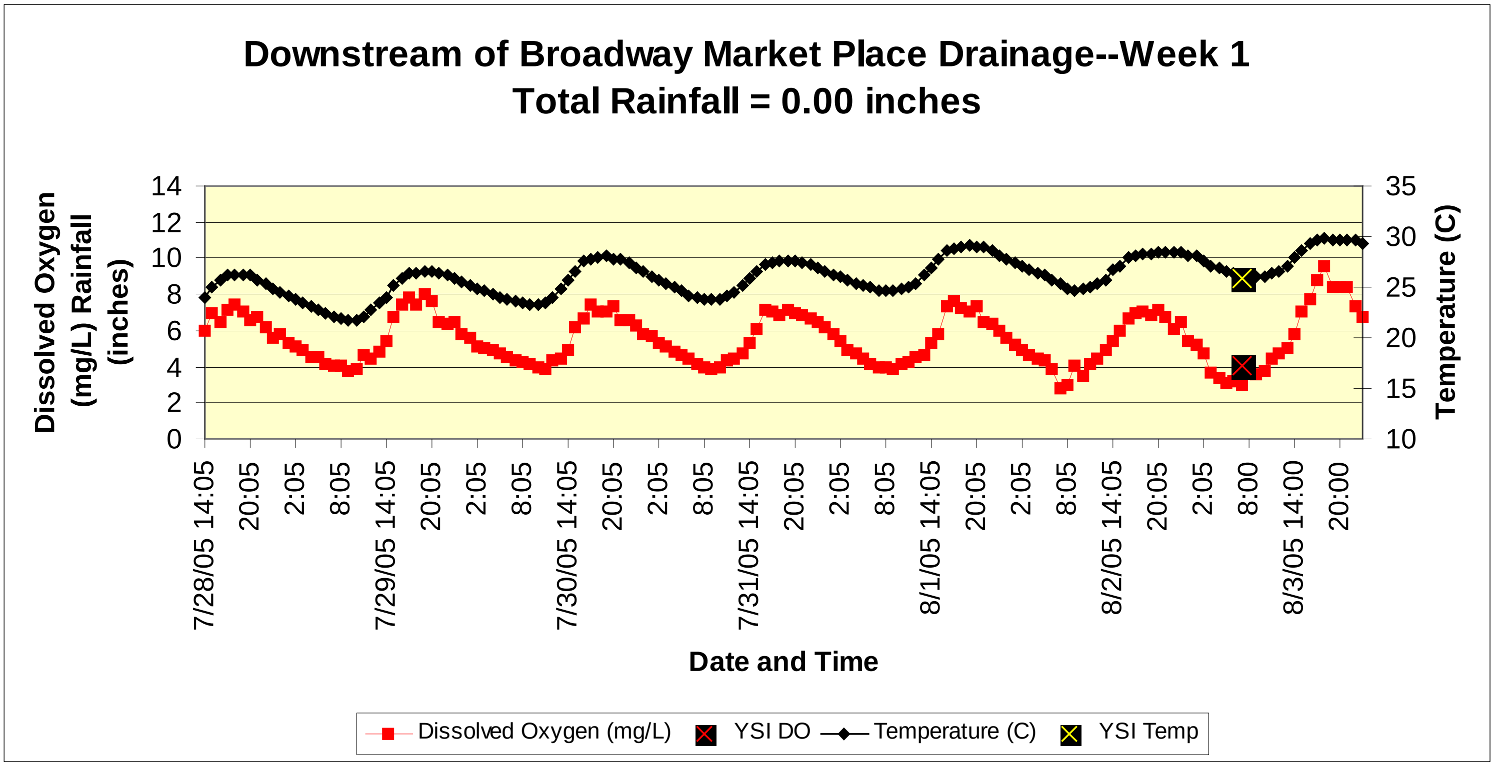
APPENDIX E

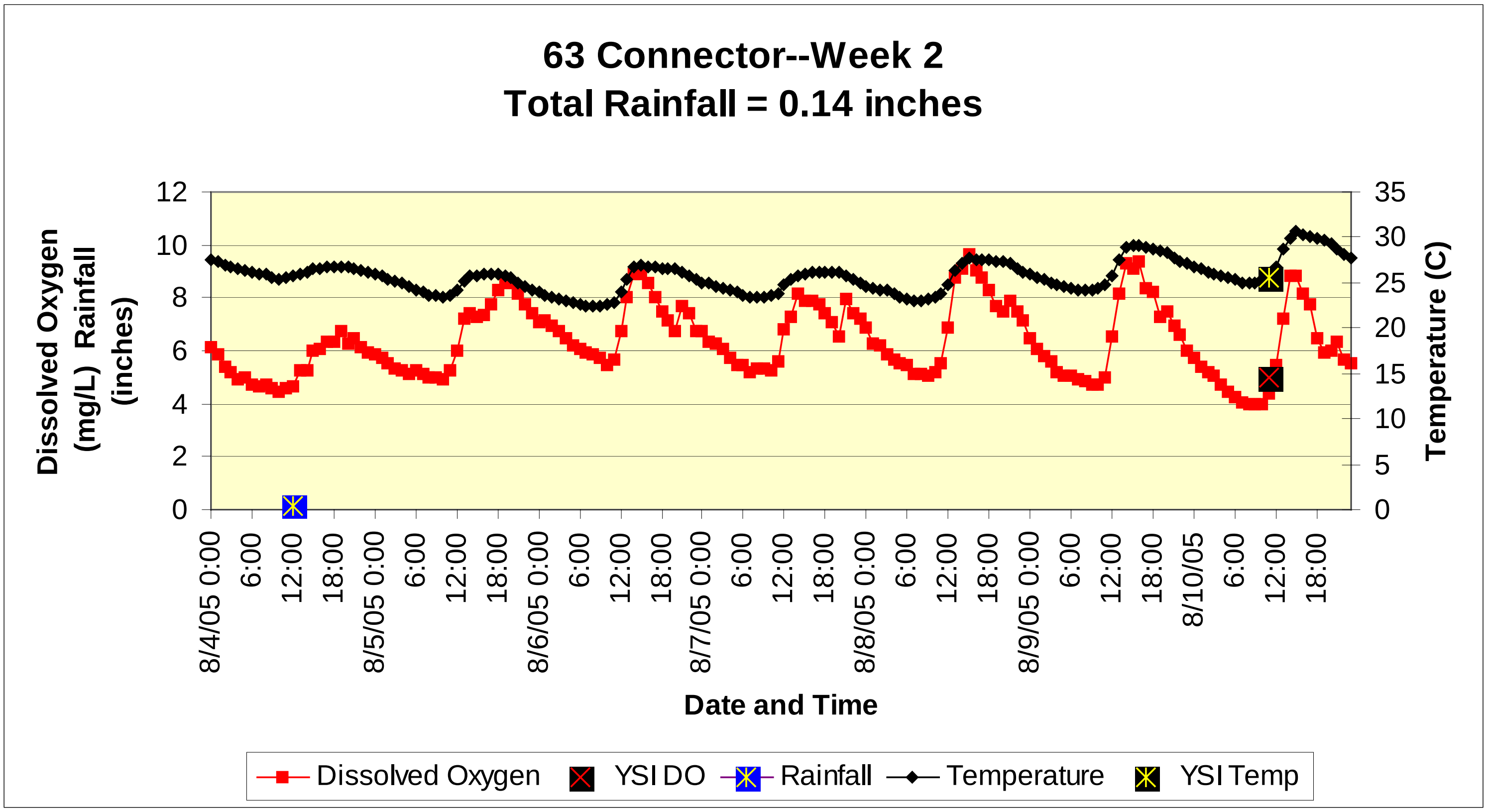
Phase III Hinkson Creek
Precipitation Data

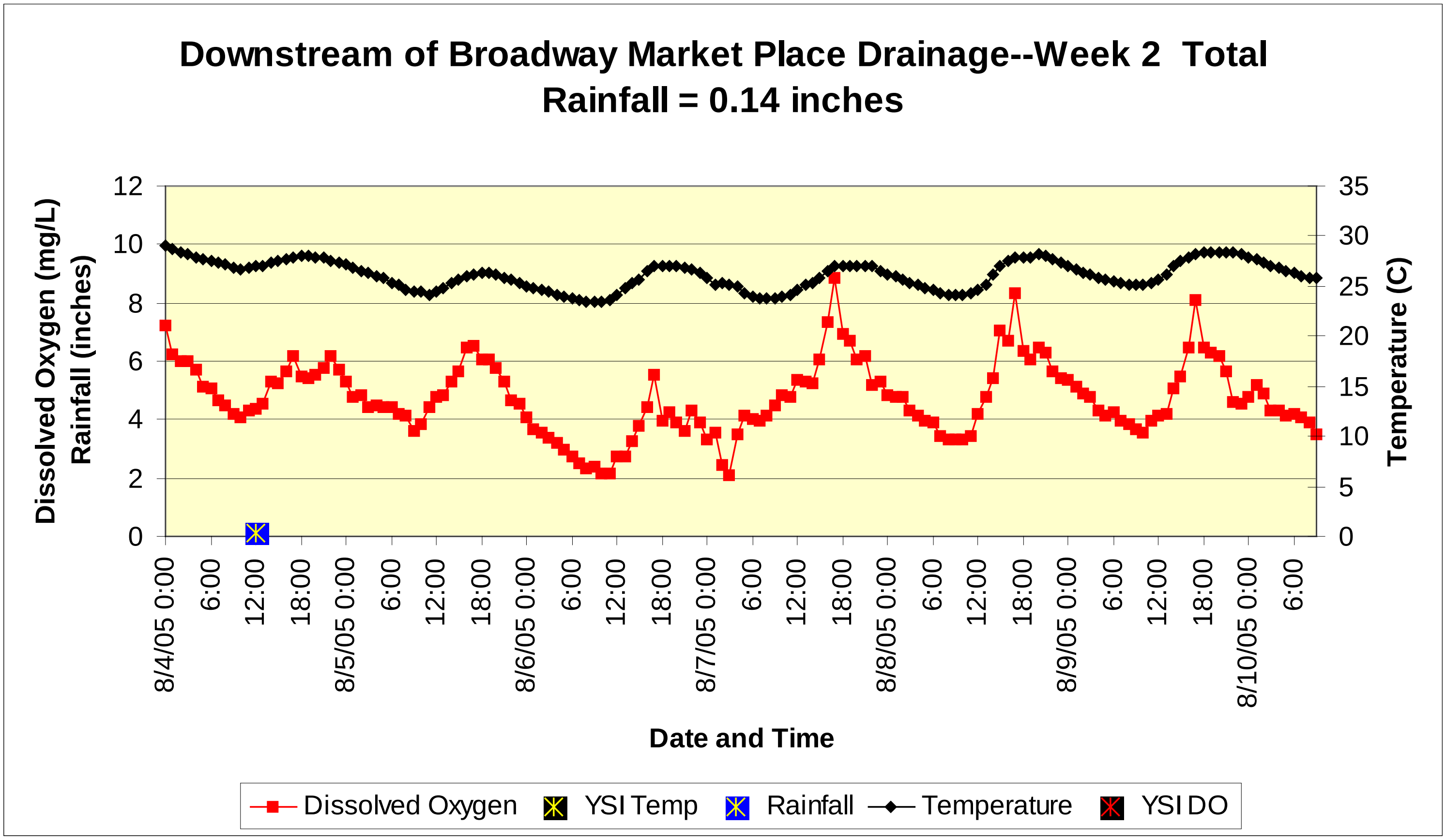
APPENDIX F

Phase III Hinkson Creek
Dissolved Oxygen Datalogger Results

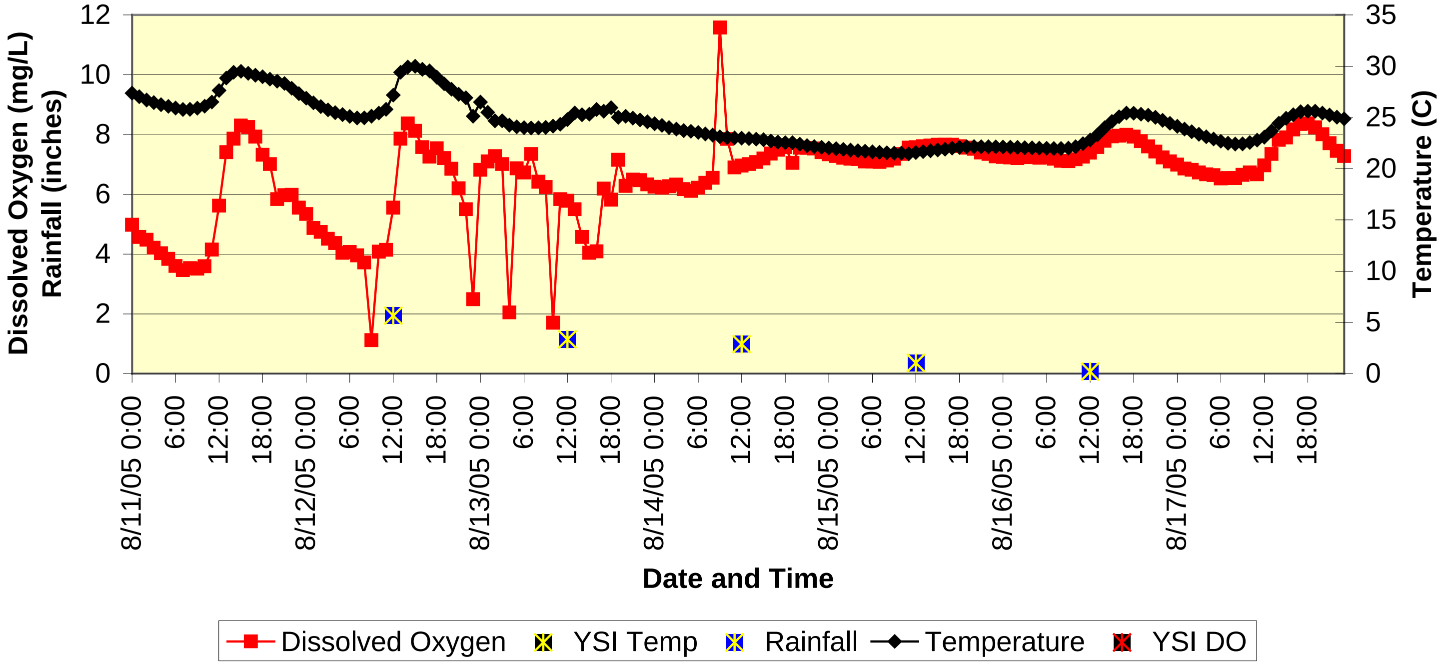

63 Connector Datalogger Data--Week 1
Total Rainfall = 0.00 inches
Dissolved Oxygen (mg/L)
Rainfall (inches)
12
10
8
6
4
2
0
32
28
24
20
16
Temperature (C)
7/28/05 12:00
18:00
7/29/05 0:00
6:00
12:00
18:00
7/30/05 0:00
6:00
12:00
18:00
7/31/05 0:00
6:00
12:00
18:00
8/1/05 0:00
6:00
12:00
18:00
8/2/05 0:00
6:00
12:00
18:00
8/3/05 0:00
6:00
12:00
18:00
Date and Time
Dissolved Oxygen
YSI DO
Temperature
YSI Temp


Downstream of Broadway Market Place Drainage--Week 1
Total Rainfall = 0.00 inches
Dissolved Oxygen (mg/L) Rainfall (inches)
14
12
10
8
6
4
2
0
35
30
25
20
15
10
Temperature (C)
7/28/05 14:05
20:05
2:05
8:05
7/29/05 14:05
20:05
2:05
8:05
7/30/05 14:05
20:05
2:05
8:05
7/31/05 14:05
20:05
2:05
8:05
8/1/05 14:05
20:05
2:05
8:05
8/2/05 14:05
20:05
2:05
8:00
8/3/05 14:00
20:00
Date and Time
Dissolved Oxygen (mg/L)
YSI DO
Temperature (C)
YSI Temp

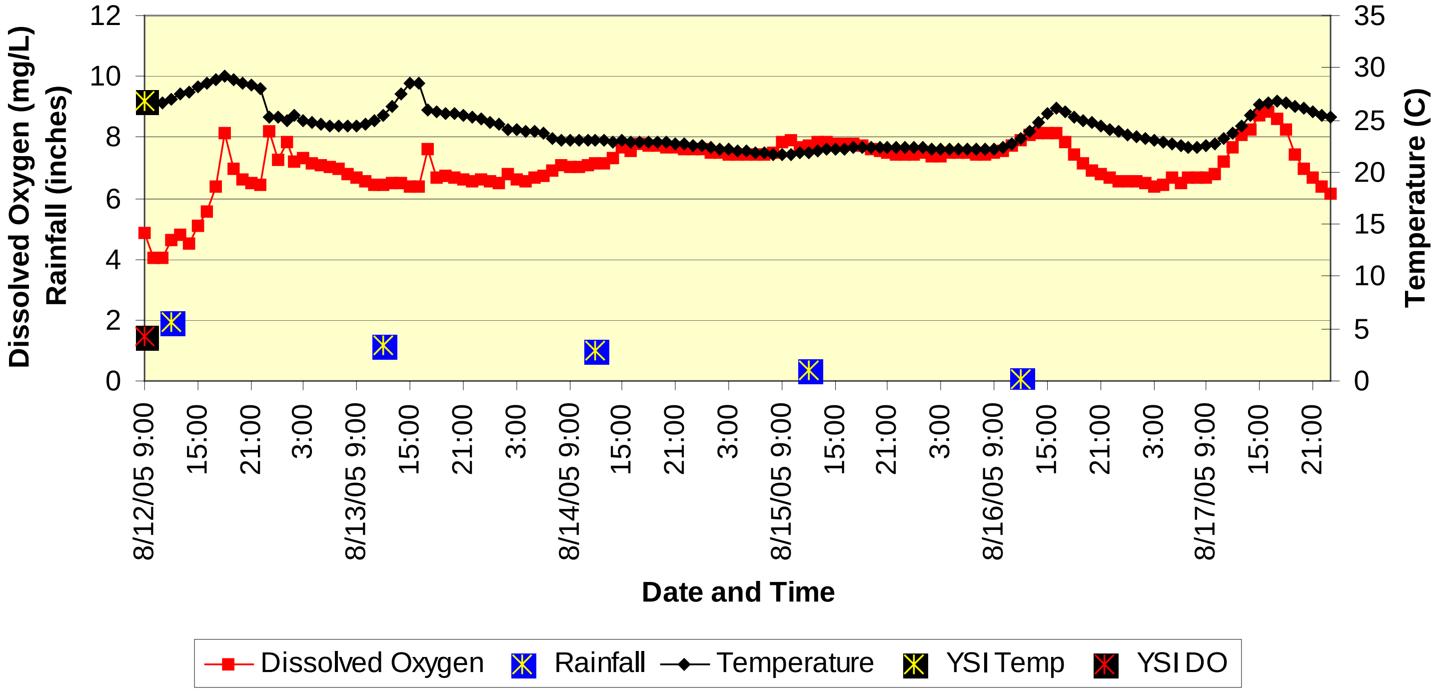

63 Connector--Week 2
Total Rainfall = 0.14 inches
Dissolved Oxygen (mg/L) Rainfall (inches)
Temperature (C)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
8/4/05 0:00
6:00
12:00
18:00
8/5/05 0:00
6:00
12:00
18:00
8/6/05 0:00
6:00
12:00
18:00
8/7/05 0:00
6:00
12:00
18:00
8/8/05 0:00
6:00
12:00
18:00
8/9/05 0:00
6:00
12:00
18:00
8/10/05
6:00
12:00
18:00
Date and Time
Dissolved Oxygen
YSI DO
Rainfall
Temperature
YSI Temp


Downstream of Broadway Market Place Drainage--Week 2 Total Rainfall = 0.14 inches
Dissolved Oxygen (mg/L) Rainfall (inches)
Temperature (C)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
8/4/05 0:00
6:00
12:00
18:00
8/5/05 0:00
6:00
12:00
18:00
8/6/05 0:00
6:00
12:00
18:00
8/7/05 0:00
6:00
12:00
18:00
8/8/05 0:00
6:00
12:00
18:00
8/9/05 0:00
6:00
12:00
18:00
8/10/05 0:00
6:00
Date and Time
Dissolved Oxygen
YSI Temp
Rainfall
Temperature
YSI DO

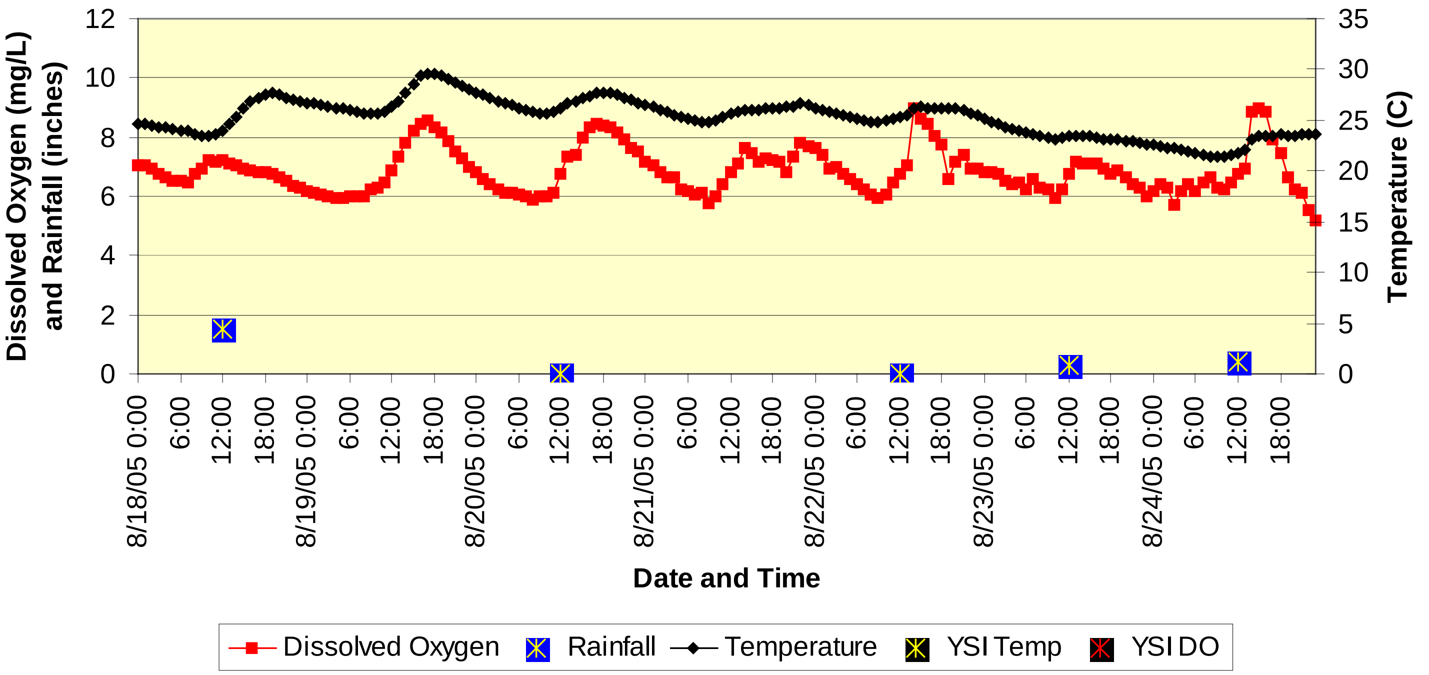
63 Connector--Week 3
Total Rainfall = 4.51 inches



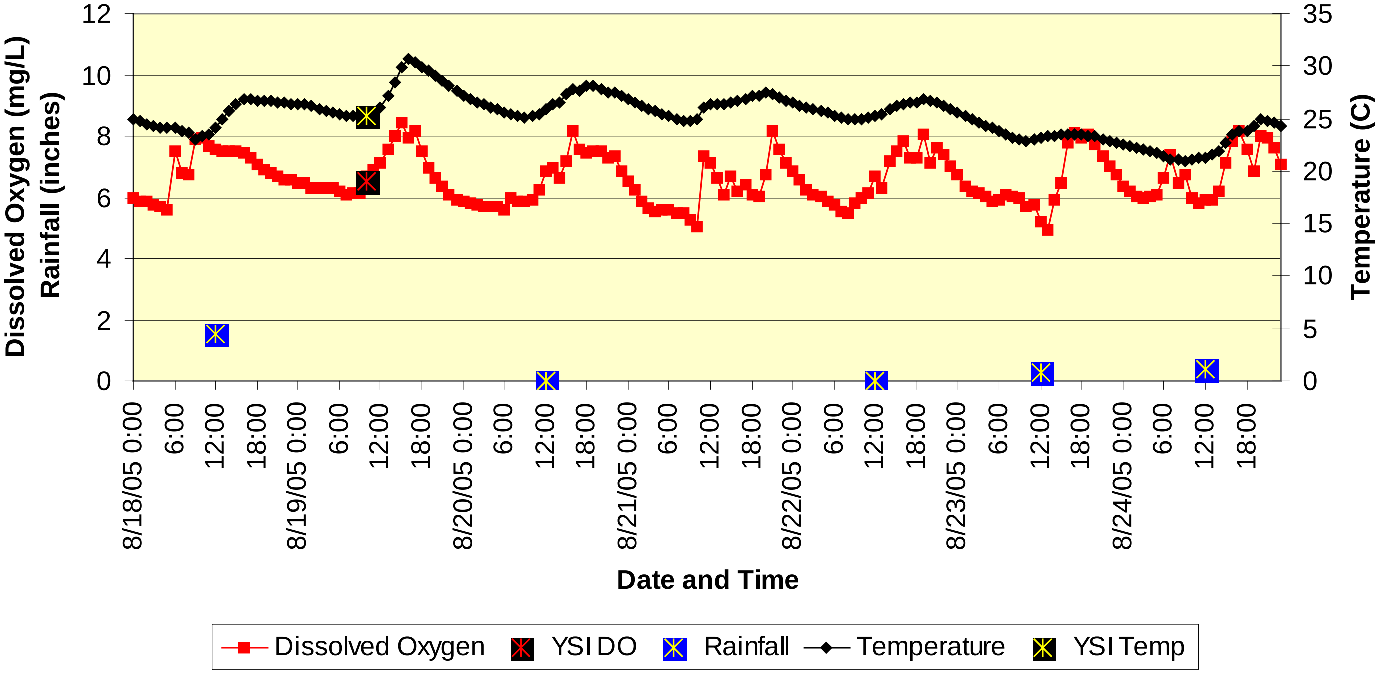
Downstream of Broadway Market Place Drainage--Week 3
Total Rainfall = 4.51 inches

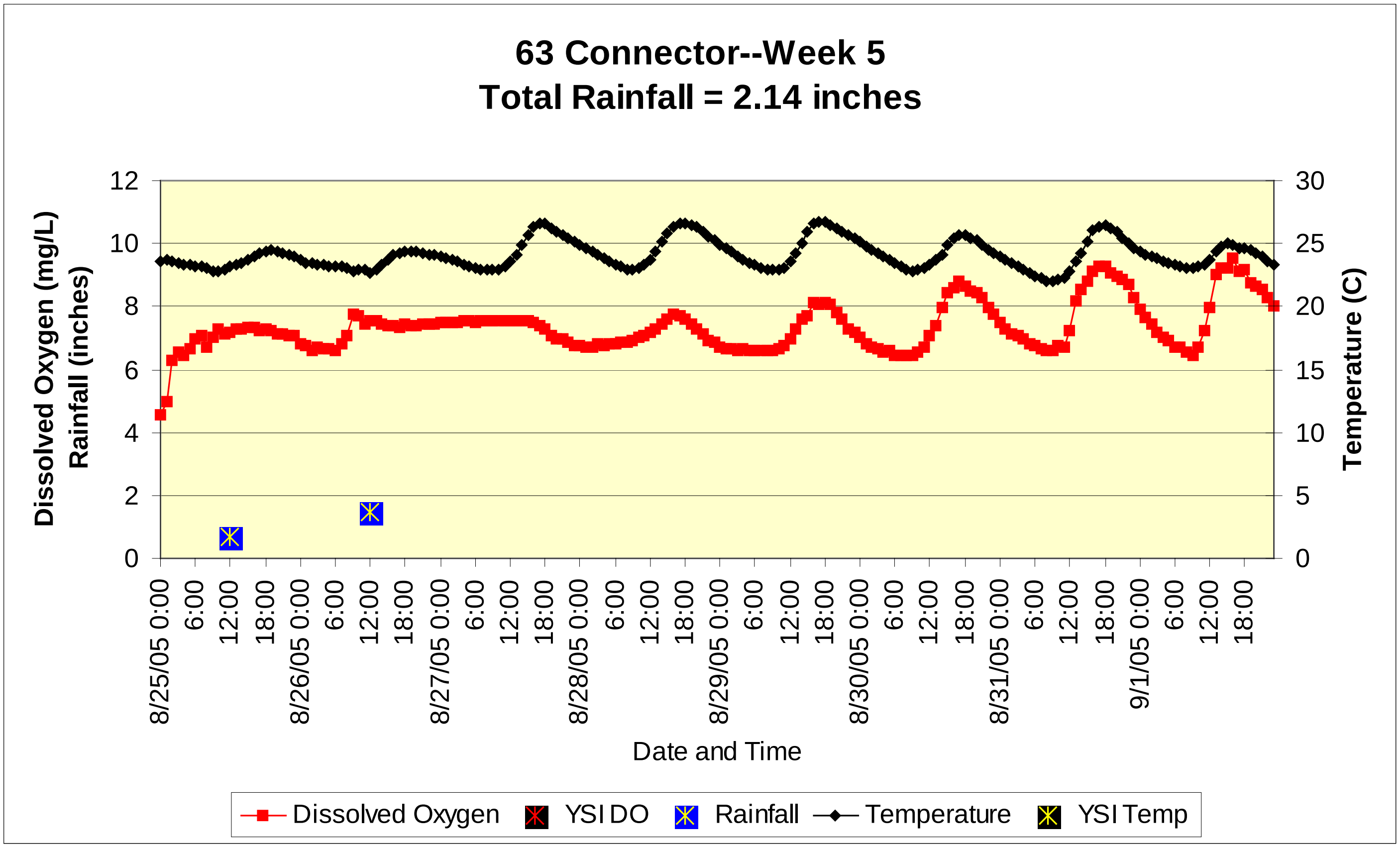


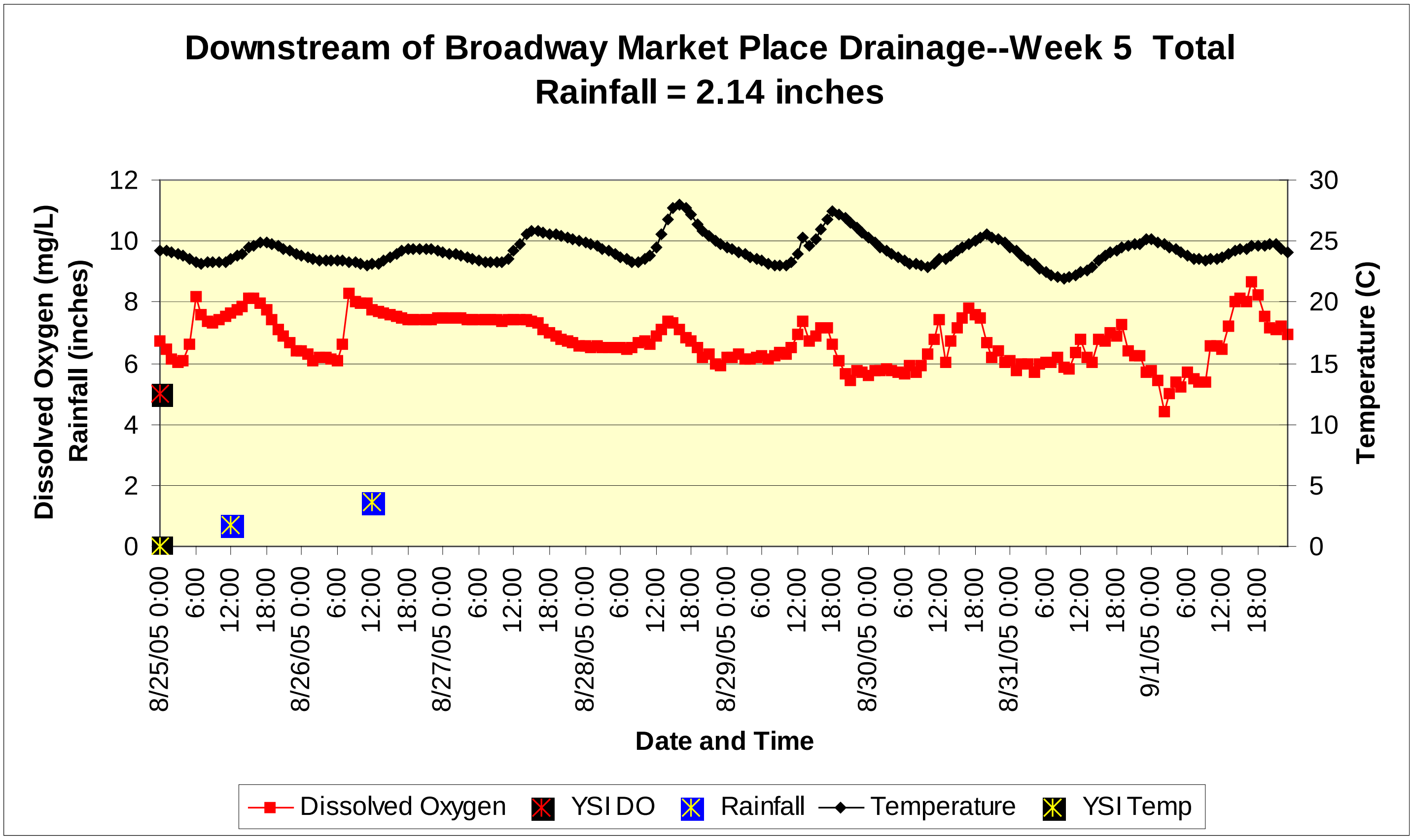
63 Connector--Week 4
Total Rainfall = 2.25 inches



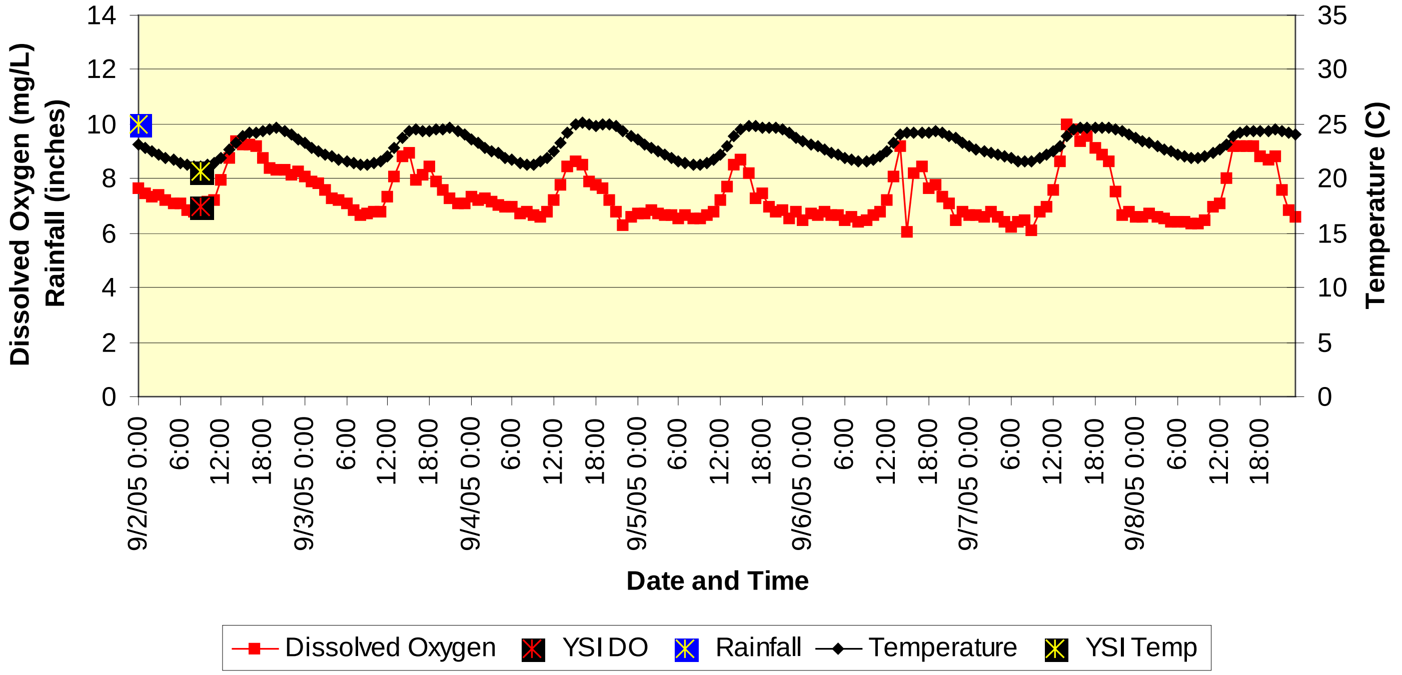
Downstream of Broadway Market Place Drainage--Week 4 Total Rainfall = 2.25 inches



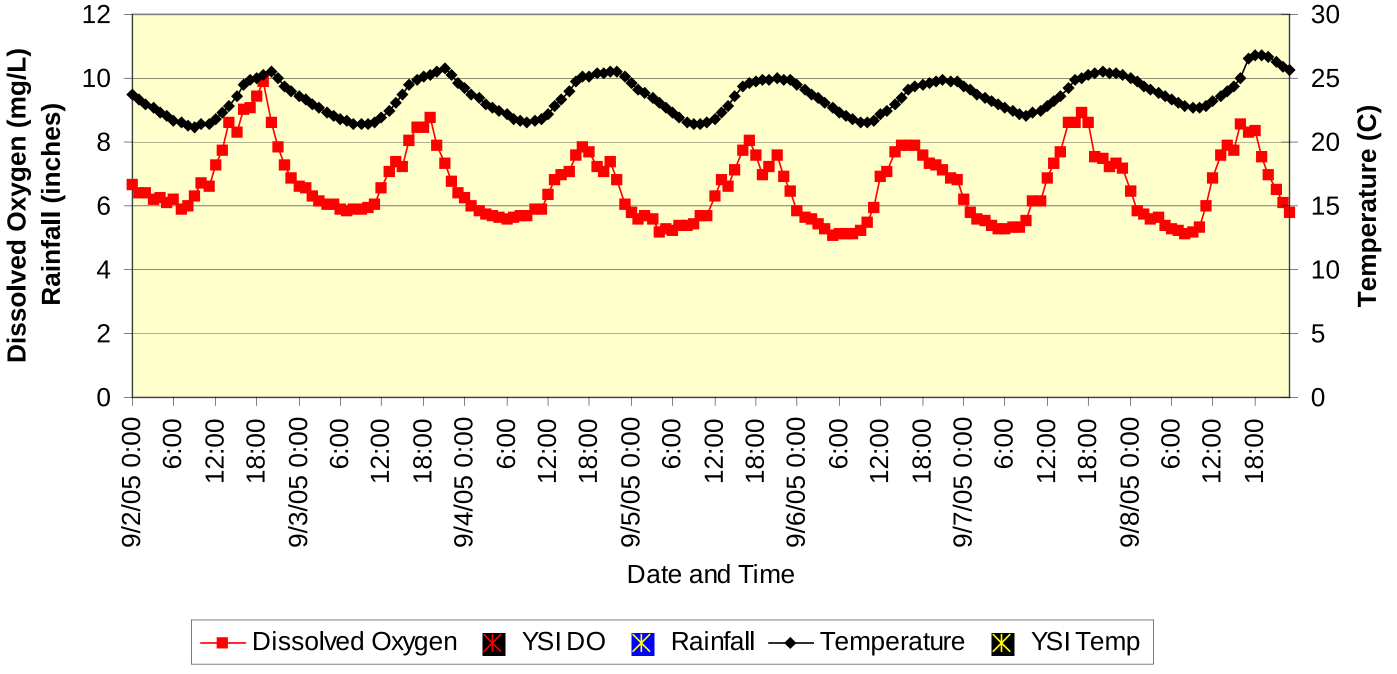

63 Connector--Week 5
Total Rainfall = 2.14 inches
Dissolved Oxygen (mg/L)
Rainfall (inches)
Temperature (C)
12
10
8
6
4
2
0
30
25
20
15
10
5
0
8/25/05 0:00
6:00
12:00
18:00
8/26/05 0:00
6:00
12:00
18:00
8/27/05 0:00
6:00
12:00
18:00
8/28/05 0:00
6:00
12:00
18:00
8/29/05 0:00
6:00
12:00
18:00
8/30/05 0:00
6:00
12:00
18:00
8/31/05 0:00
6:00
12:00
18:00
9/1/05 0:00
6:00
12:00
18:00
Date and Time
Dissolved Oxygen
YSI DO
Rainfall
Temperature
YSI Temp

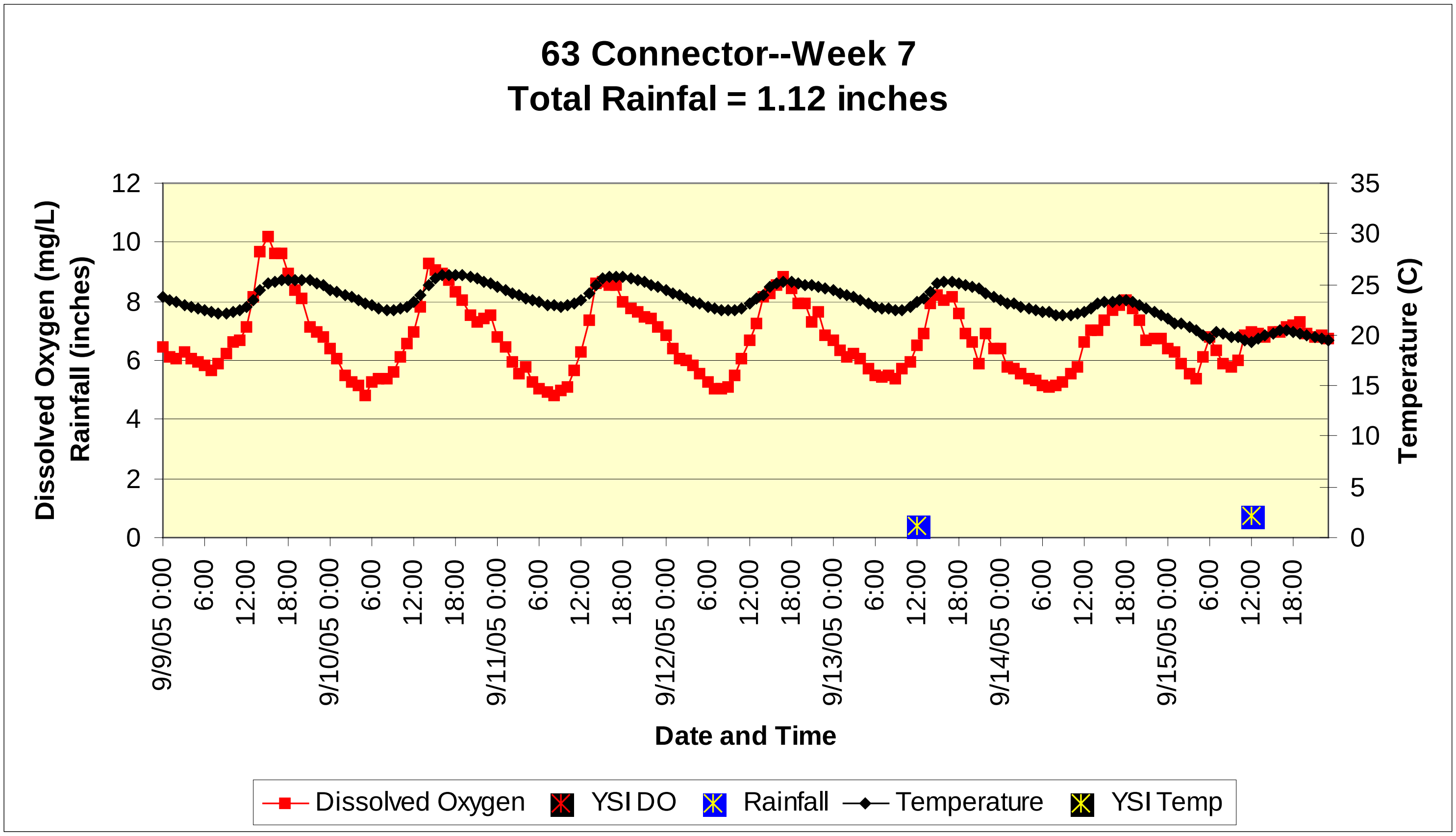

Downstream of Broadway Market Place Drainage--Week 5 Total
Rainfall = 2.14 inches
Dissolved Oxygen (mg/L)
Rainfall (inches)
Temperature (C)
12
10
8
6
4
2
0
30
25
20
15
10
5
0
8/25/05 0:00
6:00
12:00
18:00
8/26/05 0:00
6:00
12:00
18:00
8/27/05 0:00
6:00
12:00
18:00
8/28/05 0:00
6:00
12:00
18:00
8/29/05 0:00
6:00
12:00
18:00
8/30/05 0:00
6:00
12:00
18:00
8/31/05 0:00
6:00
12:00
18:00
9/1/05 0:00
6:00
12:00
18:00
Date and Time
Dissolved Oxygen
YSI DO
Rainfall
Temperature
YSI Temp

63 Connector--Week 6
Total Rainfall 0.00 inches

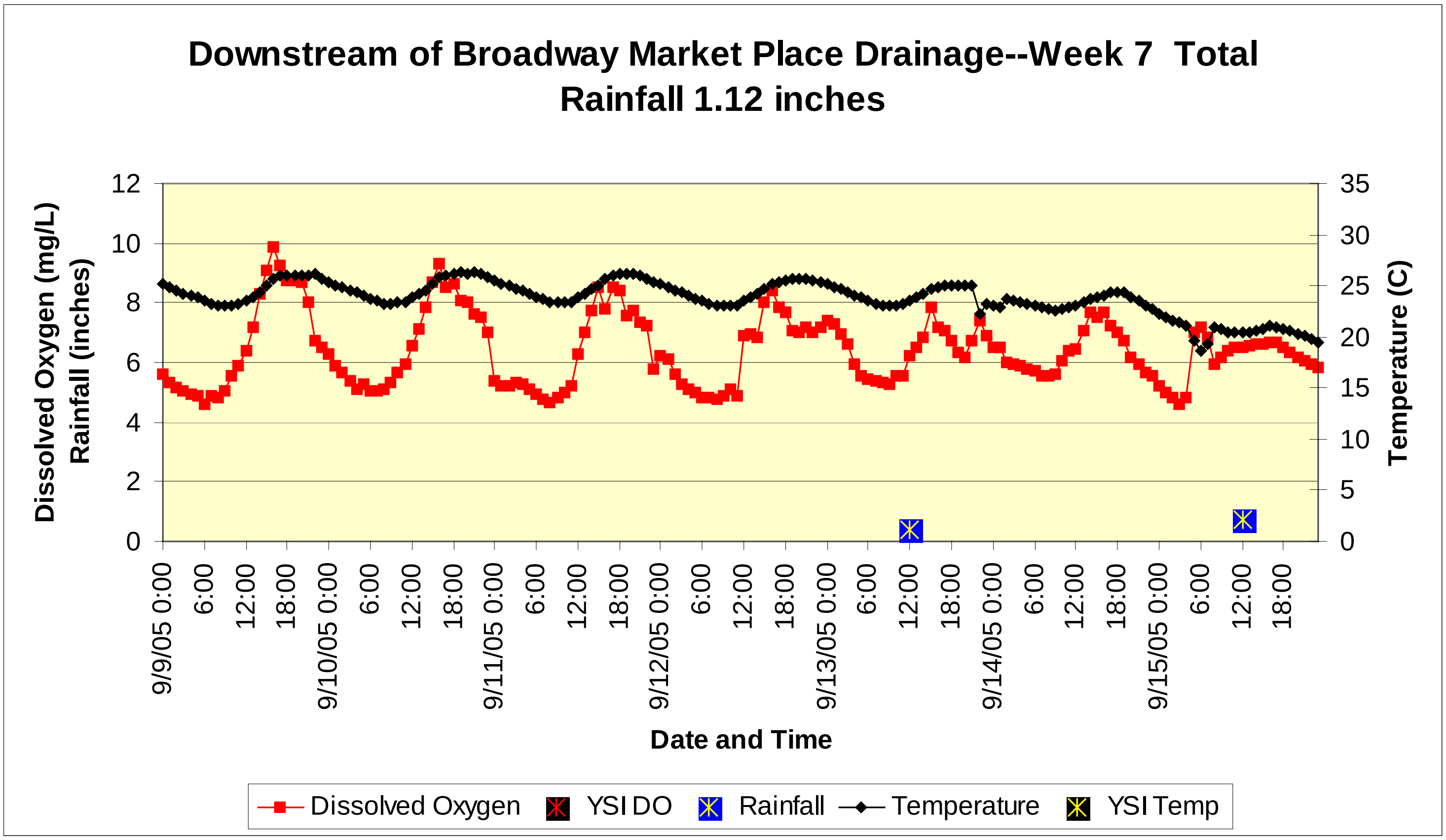


Downstream of Broadway Market Place Drainage--Week 6 Total Rainfall 0.00 inches



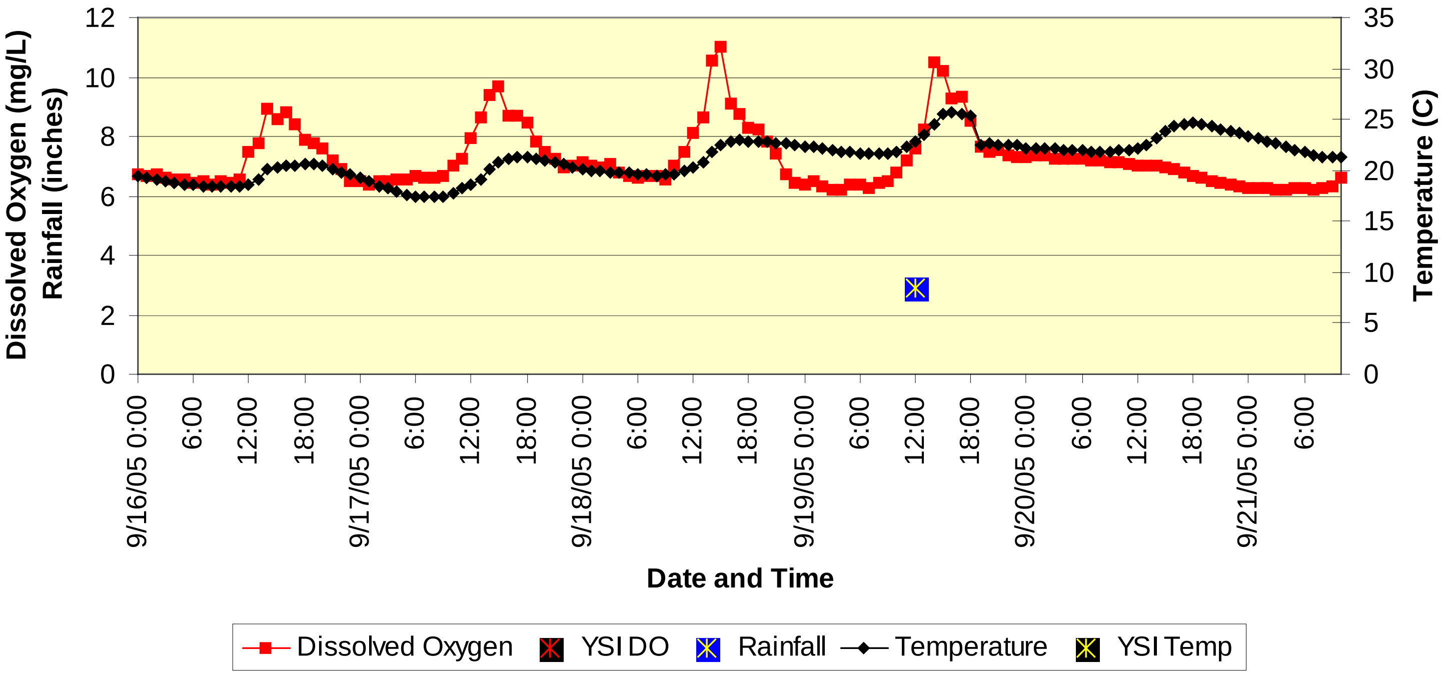


63 Connector--Week 7
Total Rainfall = 1.12 inches



Downstream of Broadway Market Place Drainage--Week 7 Total Rainfall 1.12 inches

63 Connector--Week 8
Total Rainfall 2.87 inches



Downstream of Broadway Market Place Drainage--Week 8 Total Rainfall 3.59 inches