TITLE: Bronx River biological assessment, Atlantic Ocean-Long Island Sound Basin, Westchester and Bronx counties, New York.

AGENCY: Bode, Robert W.// New York (State). Stream Biomonitoring Unit

CHECKLIST: March 2004: 185.

New York State
Department of Environmental Conservation

Division of Water



# Bronx River

## Biological Assessment

2003 Survey





GEORGE E. PATAKI, *Governor*  ERIN M. CROTTY, *Commissioner*

# BRONX RIVER

## BIOLOGICAL ASSESSMENT

Atlantic Ocean -Long Island Sound Basin
Westchester and Bronx Counties, New York

Survey dates: June 4 and September 17, 2003
Report date: December 31, 2003


Robert W. Bode
Margaret A. Novak
Lawrence E. Abele
Diana L. Heitzman
Alexander J. Smith

Stream Biomonitoring Unit
Bureau of Water Assessment and Management
Division of Water
NYS Department of Environmental Conservation
Albany, New York

CONTENTS

Stream: Bronx River

Reach: Valhalla to Bronx, New York

NYS Drainage Basin: Atlantic Ocean -Long Island Sound Basin

Background:

The Stream Biomonitoring Unit sampled four stations on the Bronx River in the reach between Valhalla and Bronx, New York on June 4 and September 17, 2003. The purpose of the sampling was to assess general water quality, and compare results to those of previous surveys. In the present sampling, traveling kick samples for macroinvertebrates were taken in riffle areas using methods described in the Quality Assurance document (Bode et al., 2002) and summarized in Appendix I. The contents of each sample were field-inspected to determine major groups of organisms present, and then preserved in alcohol for laboratory inspection of a 100-specimen subsample. Macroinvertebrate community parameters used in the determination of water quality included species richness, biotic index, EPT value, and Percent Model Affinity, (see Appendices II and III). Table 2 provides a listing of sampling sites, and Table 3 provides a listing of all macroinvertebrate species collected in the present survey. This is followed by macroinvertebrate data reports, including individual site descriptions and raw invertebrate data from each site.

Results and Conclusions:

1. Based on the macroinvertebrate data, water quality in the Bronx River was assessed as slightly impacted at Valhalla and moderately impacted from White Plains to Bronx,. Siltation and organic wastes impact the river at Valhalla, while municipal/industrial discharges, including substances of organic and/or toxic nature, affected the downstream sites. Compared to previous studies, water quality in the Bronx River appears unchanged.

Discussion

Previous macroinvertebrate sampling of the Bronx River by the Stream Biomonitoring Unit includes sampling in 1998 at the same 4 sites as in the present survey. That study concluded that the upstream Valhalla site had slightly impacted water quality, and the remaining sites from White Plains to the Bronx had moderately impacted water quality (Bode et al., 1999). Similar conclusions had been reached in a 1997 study by Charles Cutietta-Olsen (Cutietta-Olson, 1998). Samples collected at the same sites in 2002 by Cutietta-Olsen and processed by the Stream Biomonitoring Unit resulted in all sites being assessed as moderately impacted (unpublished data), although the Valhalla site was at the top of that category, close to being slightly impacted. Water quality declined linearly from upstream to downstream. Compared to the 1997 and 1998 studies, it appeared that slight improvement had occurred at White Plains (Station 2), where a large sewage input was indicated in 1998. The input was identified by fecal coliform sampling conducted by Joesph Marcogliese (NYS DEC) in 1999, documenting very high levels in White Plains that pointed to a sewage discharge into the city storm drain system. The situation was reported to be remediated after this, and Cutietta-Olson's 2002 study found mayflies at the site for the first time.

In the present survey the upstream Valhalla site was assessed as having slightly impacted water quality, and the remaining sites from White Plains to the Bronx had moderately impacted water quality (Figure 1). Sampling at the Bronx site in this survey was delayed until September due to high flows during the July sampling of the 3 upstream sites. The results of sampling at these 4 sites are similar to those of the 1997 and 1998 macroinvertebrate surveys (Figure 2).

Impact Source Determination (ISD, Table 1) indicates that siltation and organic wastes may be impacting the river at Valhalla, while municipal/industrial discharges, including substances of organic and/or toxic nature, affect the downstream sites. Mayflies, generally associated with good water quality, are suitable indicator organisms for monitoring water quality in the Bronx River. In Cutietta-Olson's 2002 sampling, mayflies were found at Valhalla and at White Plains. In the present survey, mayflies were found only at the upstream site in Valhalla. In future samplings, the presence of mayflies should be monitored as an indicator of recovery in the Bronx River.

Although the input of raw sewage identified by Marcogliese between Stations 3 and 4 was corrected in 1999, many discharges remain in the Bronx River. Impacts in the river are currently caused by municipal and industrial discharges and runoff, including many illegal sanitary connections to storm sewers. For many years the stream was stocked annually with brown trout, but this was recently discontinued. A 1997 contaminant trackdown study by Joseph Spodaryk (1999) projected that many fish in the Bronx River would have total chlordane levels exceeding the FDA limit.

Literature Cited:

Bode, R. W., M. A. Novak, L. E. Abele, and D. Carlson. 1999. Bronx River biological assessment. New York State Department of Environmental Conservation, Technical Report, 36 pages.

Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2002. Quality assurance work plan for biological stream monitoring in New York State. New York State Department of Environmental Conservation, Technical Report, 115 pages.

Cutietta-Olson, Charles. 1998. Results of a benthic survey conducted at four sites on the Bronx River on September 20-21, 1997. Technical Report, 33 pages.

Spodaryk, J. 1999. PISCES contaminant trackdown studies, Bronx and Mamaroneck Rivers, 1997. New York State Department of Environmental Conservation, Technical Memorandum, 17 pages.

Overview of field data

On the dates of sampling, June 4 and September 17, 2003, the Bronx River at the sites sampled (Stations 1-4) was 6-10 meters wide, 0.1-0.4 meters deep, and had current speeds of 110-125 cm/sec in riffles. Dissolved oxygen was 5.8-9.7 mg/l, specific conductance was 292-503 μmhos, pH was 7.3-7.4 and the temperature was 13.2-18.9 ºC. Measurements for each site are found on the field data summary sheets.

Figure 1. Biological Assessment Profile of index values, Bronx River, 2003. Values are plotted on a normalized scale of water quality. The line connects the mean of the four values for each site, representing species richness, EPT richness, Hilsenhoff Biotic Index, and Percent Model Affinity. See Appendix IV for more complete explanation.

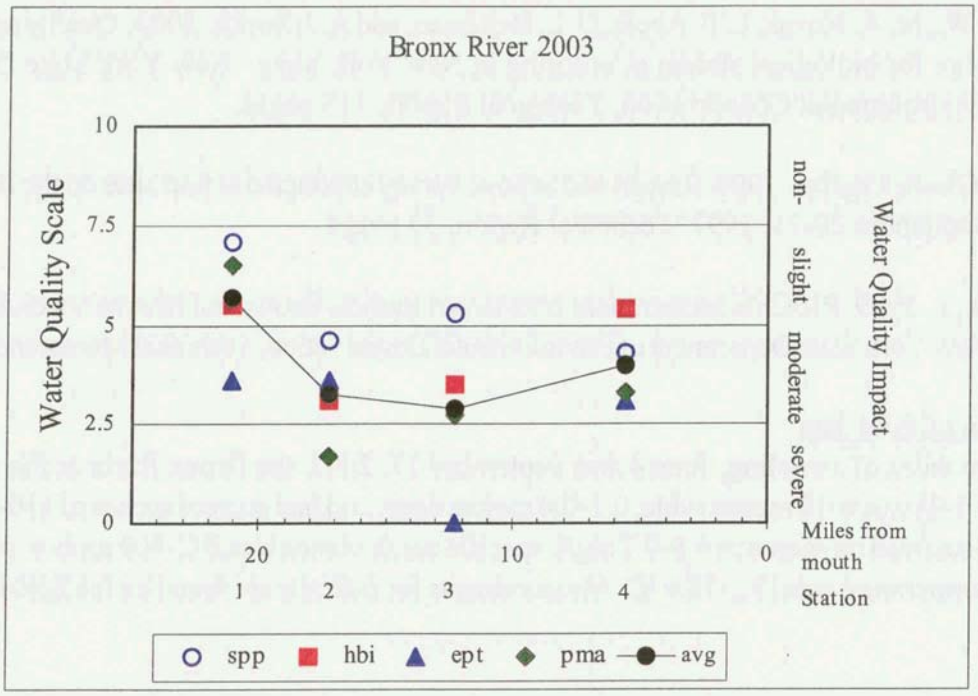



Figure 2. Comparison of 2003 results with previous biological results.. Values are plotted on a normalized scale of water quality.

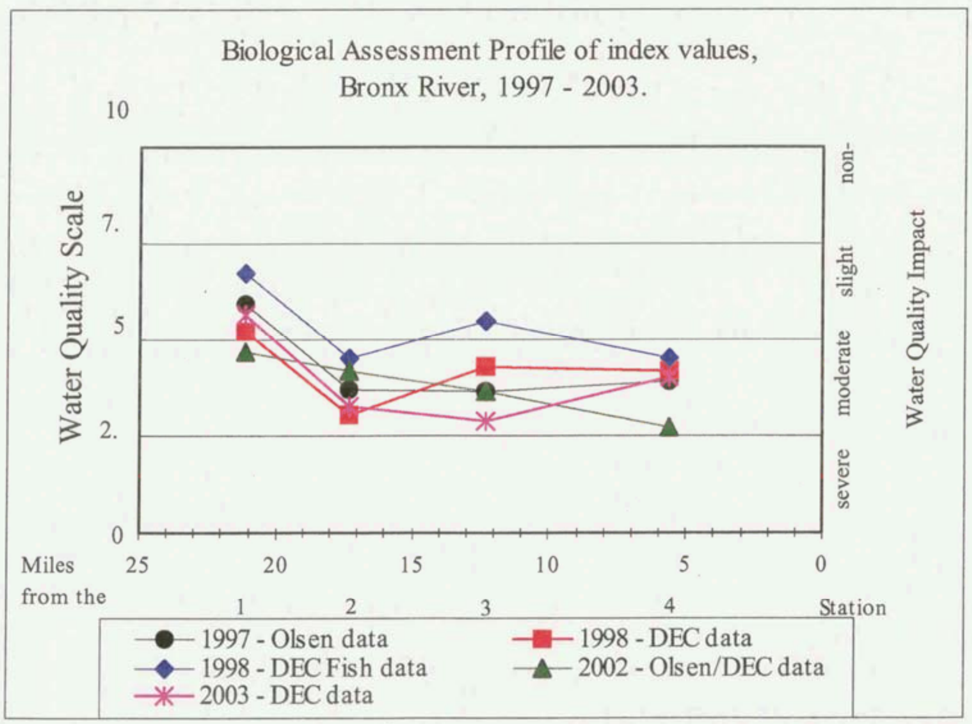


Table 1. Impact Source Determination, Bronx River, 2003. Numbers represent similarity to community type models for each impact category. The highest similarities at each station are highlighted. Similarities less than 50% are less conclusive. Highest numbers represent probable type of impact. See Appendix X for further explanation.

| | STATION | | | |
|---|---|---|---|---|
| Community Type | BRNX 01 | BRNX 02 | BRNX 03 | BRNX 04 |
| Natural: minimal human impacts | 36 | 19 | 20 | 23 |
| Nutrient additions; mostly nonpoint, agricultural | 37 | 19 | 20 | 43 |
| Toxic: industrial, municipal, or urban run-off | 37 | 48 | 35 | 51 |
| Organic: sewage effluent, animal wastes | 44 | 52 | 47 | 47 |
| Complex: municipal/industrial | 32 | 83 | 40 | 48 |
| Siltation | 45 | 34 | 35 | 43 |
| Impoundment | 33 | 48 | 42 | 59 |

| STATION | COMMUNITY TYPE |
|---|---|
| BRNX-01 | Siltation, organic |
| BRNX-02 | Complex |
| BRNX-03 | Organic (impoundment may be spurious) |
| BRNX-04 | Toxic, complex, organic (impoundment may be spurious) |

TABLE 2. STATION LOCATIONS FOR THE BRONX RIVER, WESTCHESTER AND BRONX COUNTIES, NEW YORK (see Figures 3-4).

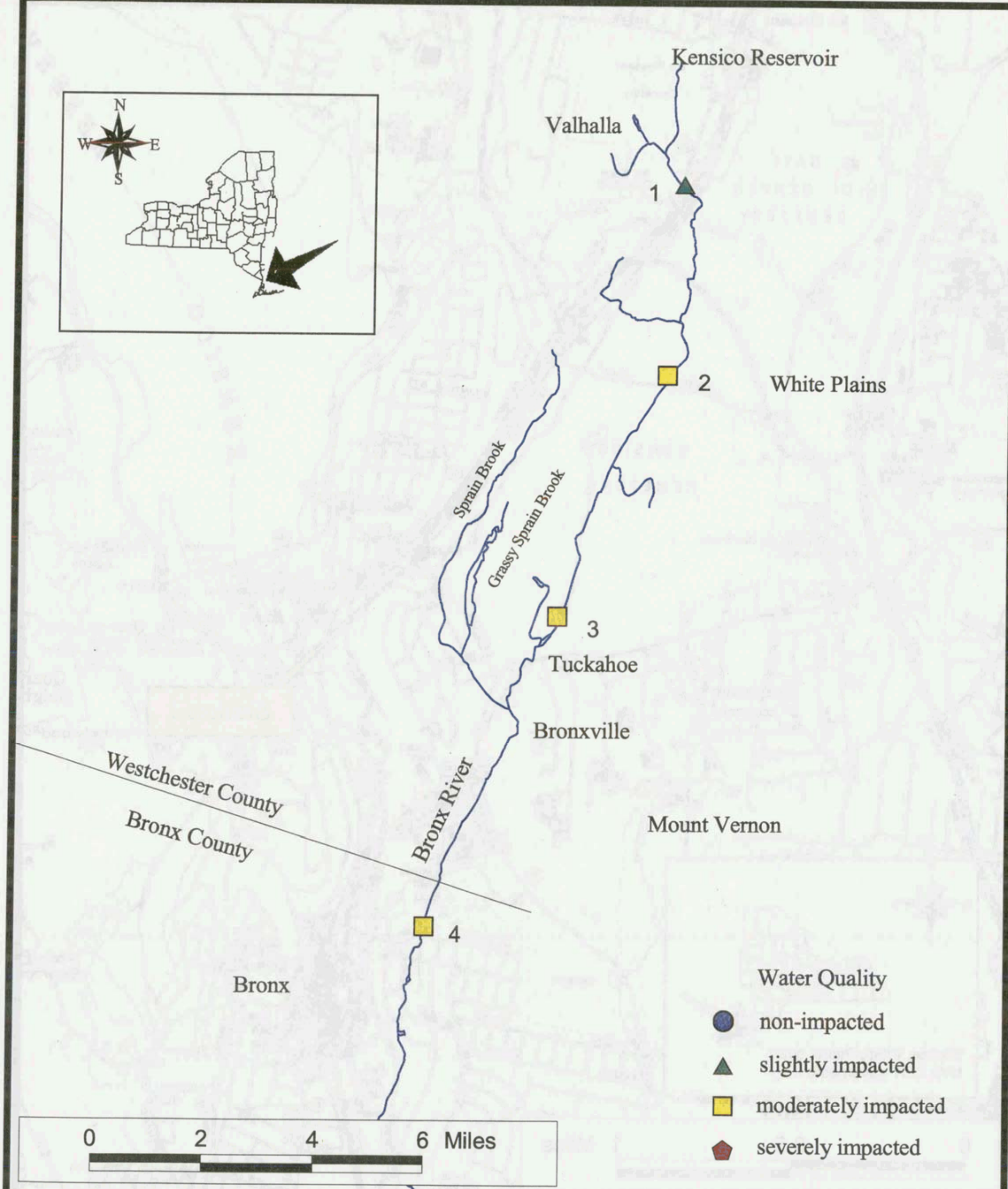
01 Valhalla, New York
20 meters above Legion Avenue
21.1 miles above mouth
latitude/longitude: 41°04'27"; 73°46'35"

02 White Plains, New York
20 meters below Bronx R. Parkway bridge
17.3 miles above mouth
latitude/longitude: 41°01'27"; 73°46'59"

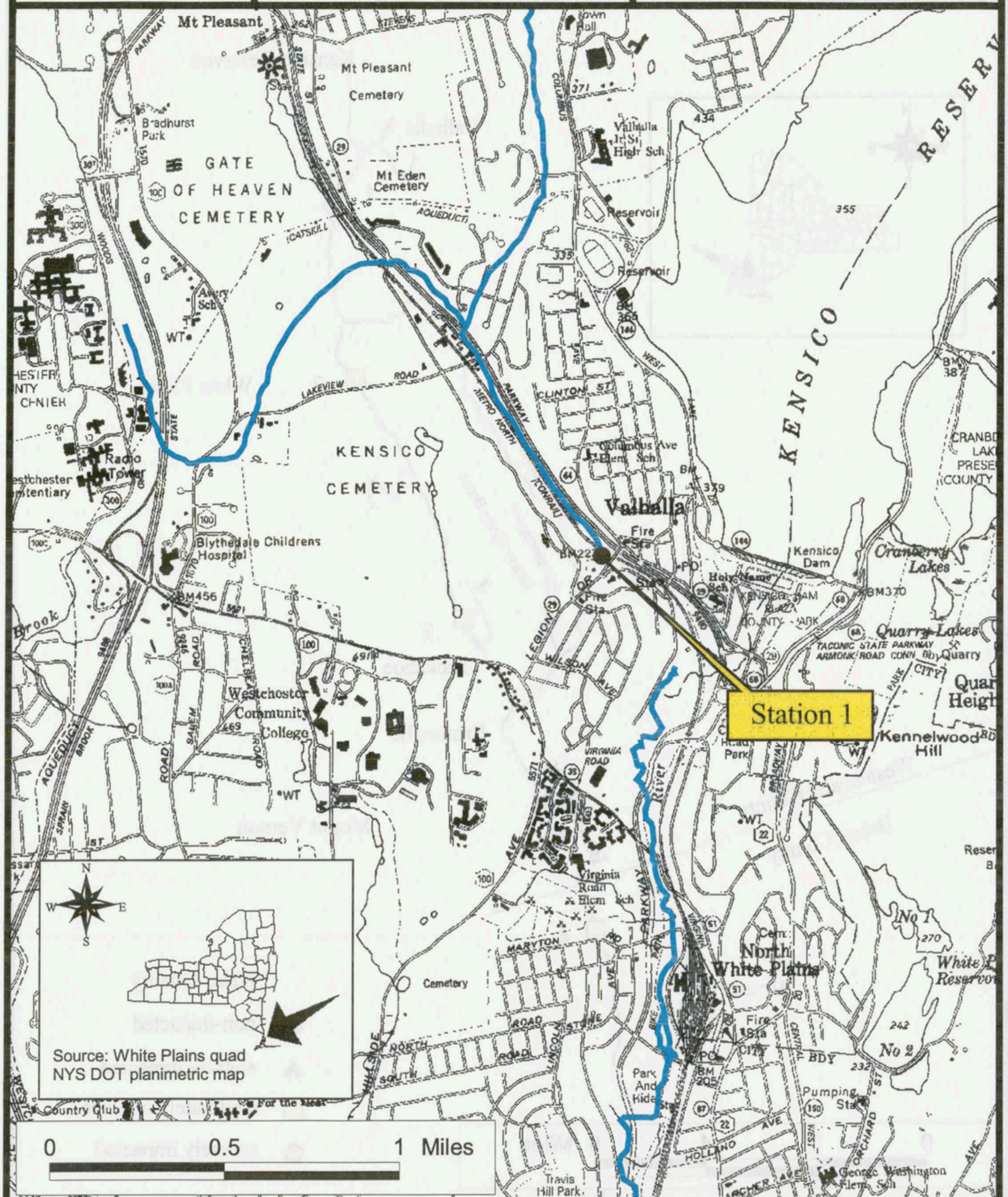
03 Tuckahoe, New York
above Crestwood Station
12.3 miles above mouth
latitude/longitude: 40°57'39"; 73°49'15"

04 Bronx, New York
150 meters above E. Gun Hill Rd. bridge
5.6 miles above mouth
latitude/longitude: 40°52'48"; 73°52'07"

| Figure 3 | Site Overview Map | Bronx River |
| --- | --- | --- |



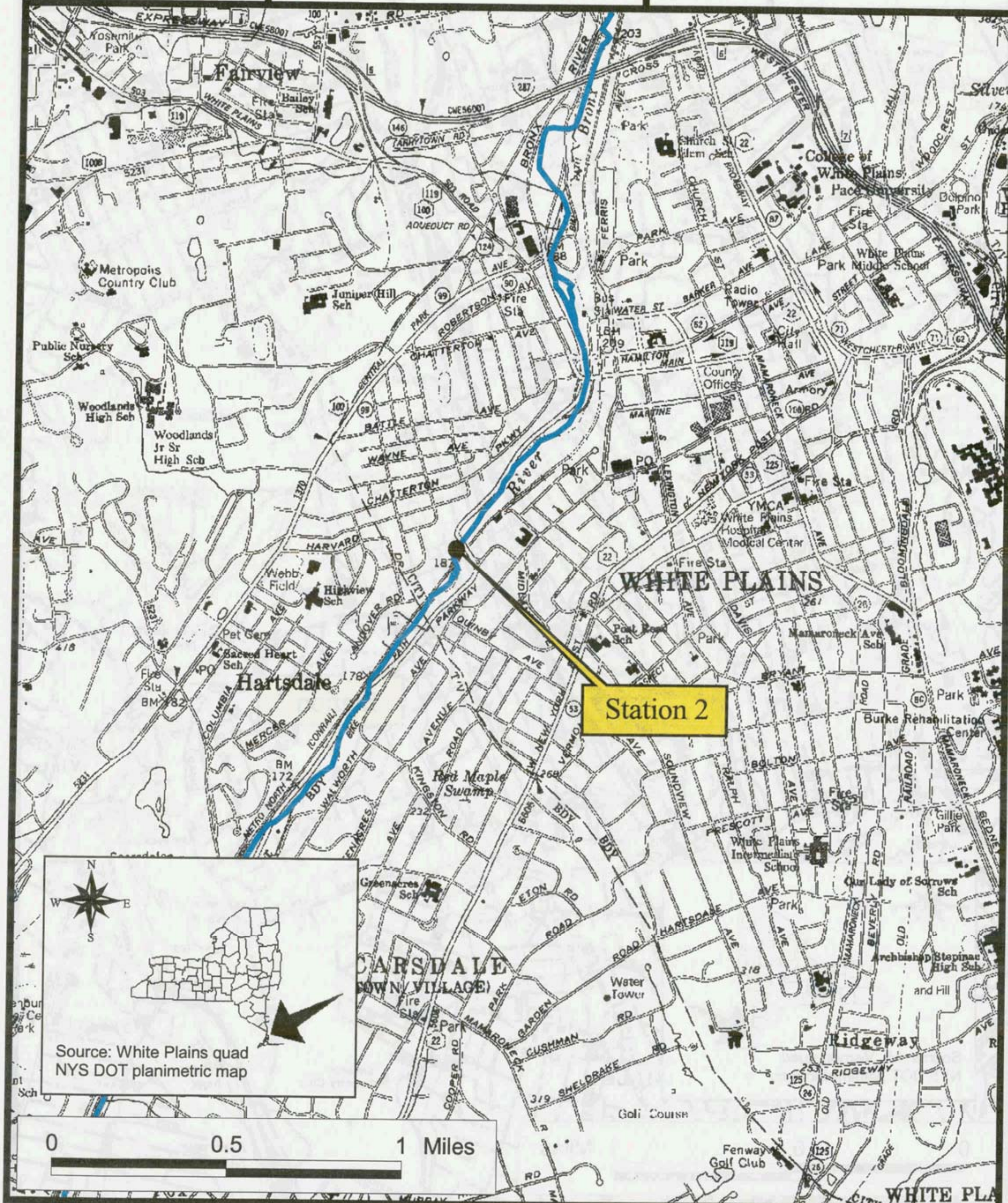
| Figure 4a | Site Location Map | Bronx River |
|---|---|---|





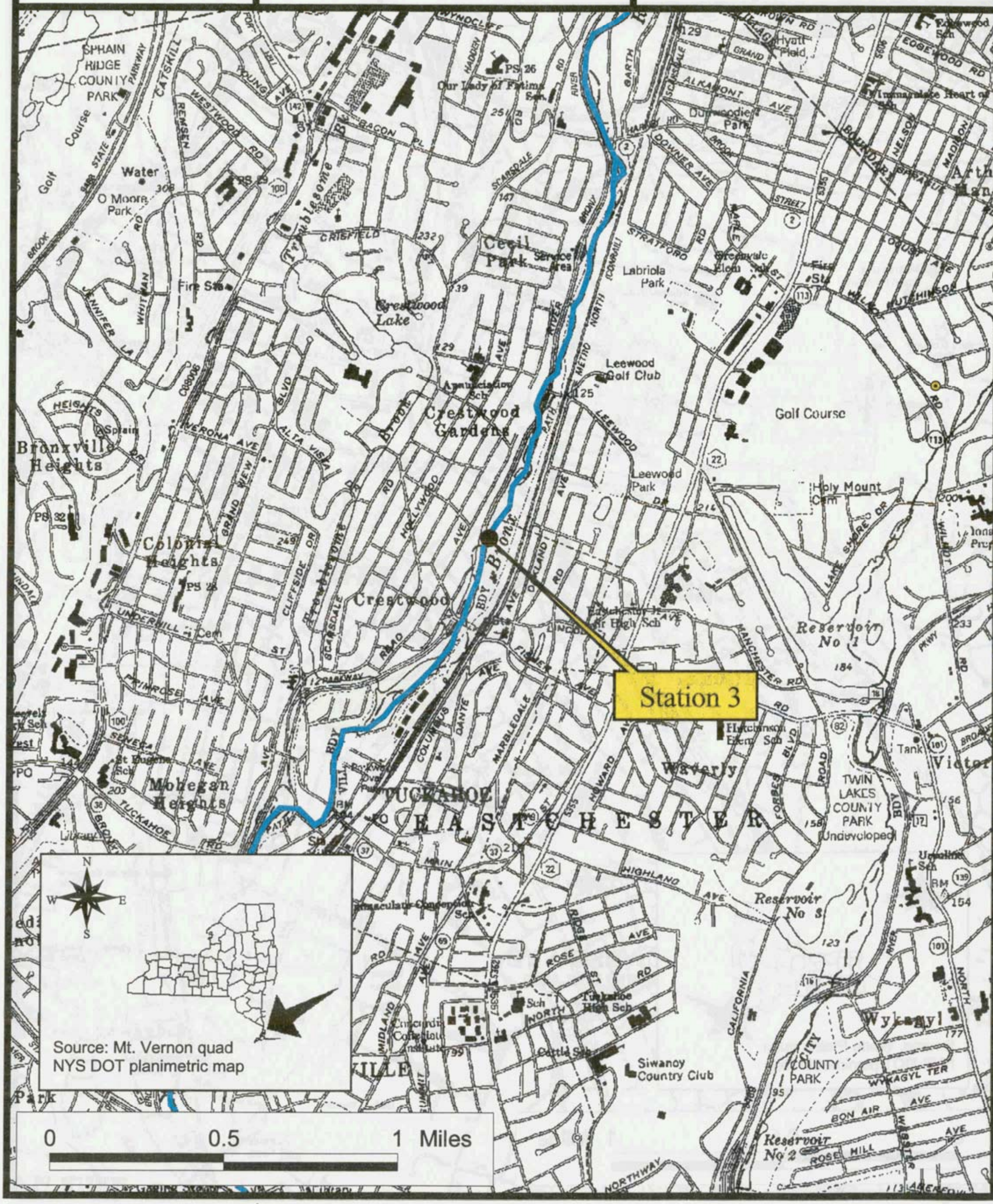

stream flow

| Figure 4b | Site Location Map | Bronx River |
| --- | --- | --- |




stream flow

| Figure 4c | Site Location Map | Bronx River |
|---|---|---|




stream flow

| Figure 4d | Site Location Map | Bronx River |
|---|---|---|


stream flow

## TABLE 3. MACROINVERTEBRATE SPECIES COLLECTED IN BRONX RIVER, WESTCHESTER AND BRONX COUNTIES, NEW YORK, 2003.

PLATYHELMINTHES
  TURBELLARIA
    Undetermined Turbellaria
OLIGOCHAETA
  LUMBRICIDA
    Undetermined Lumbricina
  LUMBRICULIDA
   Lumbriculidae
    Eclipidrilus sp.
    Undetermined Lumbriculidae
  TUBIFICIDA
   Enchytraeidae
    Undetermined Enchytraeidae
   Tubificidae
    Undet. Tubificidae w/o cap. setae
   Naididae
    Nais behningi
    Nais bretscheri
    Nais elinguis
    Nais variabilis
    Ophidonais serpentina
    Slavina appendiculata
HIRUDINEA
   Glossiphoniidae
    Undetermined Hirudinea
MOLLUSCA
  GASTROPODA
   Physidae
    Undetermined Physidae
ARTHROPODA
CRUSTACEA
  AMPHIPODA
   Gammaridae
    Gammarus sp.
INSECTA
  EPHEMEROPTERA
   Baetidae
    Baetis brunneicolor
    Baetis intercalaris
  COLEOPTERA
   Elmidae
    Optioservus sp.
    Stenelmis sp.
NEUROPTERA
  Sisyridae
   Undetermined Sisyridae
TRICHOPTERA
  Hydropsychidae
   Cheumatopsyche sp.
   Hydropsyche betteni
  Hydroptilidae
   Hydroptila sp.
DIPTERA
  Empididae
   Hemerodromia sp.
  Chironomidae
   Tanypodinae
    Thienemannimyia gr. spp.
   Diamesinae
    Diamesa sp.
   Orthocladiinae
    Brillia flavifrons
    Cricotopus bicinctus
    Cricotopus tremulus gr.
    Cricotopus trifascia gr.
    Cricotopus vierriensis
    Nanocladius sp.
    Orthocladius nr. dentifer
    Parametriocnemus lundbecki
    Rheocricotopus robacki
    Tvetenia bavarica gr.
    Undetermined Orthocladiinae
   Chironominae
    Chironomini
     Chironomus sp.
     Dicrotendipes fumidus
     Endochironomus nigricans
     Polypedilum flavum
     Polypedilum illinoense
     Stictochironomus sp.
     Xenochironomus xenolabis
    Tanytarsini
     Micropsectra polita
     Paratanytarsus confusus
     Tanytarsus guerlus gr.
     Tanytarsus sp.

STREAM SITE: Bronx River, Station 1
LOCATION: Valhalla, NY, upstream of Legion Avenue
DATE: June 4, 2003
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

| | | | |
|---|---|---|---|
| PLATYHELMINTHES | | | |
| TURBELLARIA | | | |
| | Planariidae | Undetermined Turbellaria | 1 |
| ANNELIDA | | | |
| OLIGOCHAETA | | | |
| LUMBRICIDA | | Undetermined Lumbricina | 2 |
| TUBIFICIDA | Enchytraeidae | Undetermined Enchytraeidae | 2 |
| | Tubificidae | Undet.Tubificidae w/o cap. setae | 2 |
| | Naididae | Nais bretscheri | 6 |
| | | Slavina appendiculata | 1 |
| MOLLUSCA | | | |
| GASTROPODA | | | |
| | Physidae | Undetermined Physidae | 1 |
| ARTHROPODA | | | |
| CRUSTACEA | | | |
| AMPHIPODA | Gammaridae | Gammarus sp. | 3 |
| INSECTA | | | |
| EPHEMEROPTERA | Baetidae | Baetis brunneicolor | 7 |
| | | Baetis intercalaris | 5 |
| COLEOPTERA | Elmidae | Optioservus sp. | 3 |
| | | Stenelmis sp. | 10 |
| TRICHOPTERA | Hydropsychidae | Hydropsyche betteni | 1 |
| DIPTERA | Empididae | Hemerodromia sp. | 6 |
| | Chironomidae | Diamesa sp. | 8 |
| | | Cricotopus vierriensis | 5 |
| | | Parametriocnemus lundbecki | 11 |
| | | Rheocricotopus robacki | 2 |
| | | Tvetenia bavarica gr. | 4 |
| | | Chironomus sp. | 1 |
| | | Endochironomus nigricans | 1 |
| | | Polypedilum flavum | 1 |
| | | Stictochironomus sp. | 14 |
| | | Paratanytarsus confusus | 2 |
| | | Tanytarsus guerlus gr. | 1 |

SPECIES RICHNESS 25 (good)
BIOTIC INDEX 6.10 (good)
EPT RICHNESS 3 (poor)
MODEL AFFINITY 58 (good)
ASSESSMENT slightly impacted
IMPACT SOURCE siltation (45%), organic (44%)
DESCRIPTION The kick sample was taken 20 meters upstream of the bridge culvert. The stream flow was very high from the previous night's rain. Stream habitat was judged to be adequate, with a substrate of rubble, gravel, and sand. The invertebrate community was dominated by facultative midges, beetles, and worms, and water quality was assessed as slightly impacted.

STREAM SITE: Bronx River, Station 2
LOCATION: White Plains, NY, 100 meters downstream of the Bronx River Parkway bridge
DATE: June 4, 2003
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

| | | | |
|---|---|---|---|
| ANNELIDA | | | |
| OLIGOCHAETA | | | |
| TUBIFICIDA | Tubificidae | Undet. Tubificidae w/o cap. setae | 1 |
| | Naididae | Nais behningi | 16 |
| | | Nais bretscheri | 2 |
| | | Nais elinguis | 43 |
| | | Ophidonais serpentina | 1 |
| ARTHROPODA | | | |
| INSECTA | | | |
| TRICHOPTERA | Hydropsychidae | Cheumatopsyche sp. | 1 |
| | | Hydropsyche betteni | 2 |
| | Hydroptilidae | Hydroptila sp. | 1 |
| DIPTERA | Empididae | Hemerodromia sp. | 1 |
| | Chironomidae | Brillia flavifrons | 2 |
| | | Cricotopus bicinctus | 12 |
| | | Cricotopus tremulus gr. | 10 |
| | | Cricotopus trifascia gr. | 3 |
| | | Orthocladius nr. dentifer | 1 |
| | | Chironomus sp. | 1 |
| | | Polypedilum illinoense | 1 |
| | | Tanytarsus sp. | 2 |

SPECIES RICHNESS 17 (poor)
BIOTIC INDEX 8.02 (poor)
EPT RICHNESS 3 (poor)
MODEL AFFINITY 30 (very poor)
ASSESSMENT moderately impacted
IMPACT SOURCE complex (83%)
DESCRIPTION The sampling site was downstream of the Bronx River Parkway in White Plains. The macroinvertebrate fauna was heavily dominated by tolerant worms, yielding a very high similarity to a community model for faunas impacted by municipal/industrial discharges. Water quality was assessed as moderately impacted.

STREAM SITE: Bronx River, Station 3
LOCATION: Tuckahoe, NY, upstream of Crestwood Station
DATE: June 4, 2003
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

| | | | |
|---|---|---|---|
| ANNELIDA | | | |
| OLIGOCHAETA | | | |
| LUMBRICIDA | Enchytraeidae | Undetermined Lumbricina | 3 |
| TUBIFICIDA | Tubificidae | Undetermined Enchytraeidae | 1 |
| | | Undet. Tubificidae w/o cap. setae | 5 |
| | Naididae | Nais bretscheri | 1 |
| | | Nais elinguis | 17 |
| | | Ophidonais serpentina | 1 |
| HIRUDINEA | | | |
| | Glossiphoniidae | Undetermined Hirudinea | 1 |
| ARTHROPODA | | | |
| CRUSTACEA | | | |
| AMPHIPODA | Gammaridae | Gammarus sp. | 9 |
| INSECTA | | | |
| NEUROPTERA | Sisyridae | Undetermined Sisyridae | 3 |
| DIPTERA | Chironomidae | Cricotopus bicinctus | 8 |
| | | Cricotopus tremulus gr. | 2 |
| | | Cricotopus trifascia gr. | 2 |
| | | Nanocladius sp. | 1 |
| | | Undetermined Orthocladiinae | 1 |
| | | Dicrotendipes fumidus | 35 |
| | | Polypedilum illinoense | 5 |
| | | Xenochironomus xenolabis | 2 |
| | | Paratanytarsus confusus | 1 |
| | | Tanytarsus sp. | 2 |

SPECIES RICHNESS 19 (good)
BIOTIC INDEX 7.72 (poor)
EPT RICHNESS 0 (very poor)
MODEL AFFINITY 35 (poor)
ASSESSMENT moderately impacted
IMPACT SOURCE organic (47%), impoundment (42%)
DESCRIPTION The sample was taken in Tuckahoe at Crestwood Station, a short distance downstream of the County Parks facility. The stream substrate was mostly rubble, gravel, and sand. The macroinvertebrate fauna was dominated by sewage-tolerant midges and worms, and water quality was assessed as moderately impacted.

STREAM SITE: Bronx River, Station 4
LOCATION: Bronx, NY, upstream of East Gun Hill Road bridge
DATE: September 17, 2003
SAMPLE TYPE: Kick sample
SUBSAMPLE: 100 individuals

| | | | | |
|---|---|---|---|---|
| PLATYHELMINTHES | | | | |
| TURBELLARIA | | | | |
| | | Planariidae | Undetermined Turbellaria | 1 |
| ANNELIDA | | | | |
| OLIGOCHAETA | | | | |
| LUMBRICULIDA | | Lumbriculidae | Eclipidrilus sp. | 1 |
| | | | Undetermined Lumbriculidae | 2 |
| TUBIFICIDA | | Enchytraeidae | Undetermined Enchytraeidae | 5 |
| | | Tubificidae | Undet. Tubificidae w/o cap. setae | 1 |
| | | Naididae | Nais bretscheri | 23 |
| | | | Nais variabilis | 5 |
| ARTHROPODA | | | | |
| CRUSTACEA | | | | |
| AMPHIPODA | | Gammaridae | Gammarus sp. | 7 |
| INSECTA | | | | |
| TRICHOPTERA | | Hydropsychidae | Cheumatopsyche sp. | 32 |
| | | | Hydropsyche betteni | 3 |
| DIPTERA | | Empididae | Hemerodromia sp. | 6 |
| | | Chironomidae | Cricotopus bicinctus | 3 |
| | | | Cricotopus tremulus gr. | 1 |
| | | | Cricotopus vierriensis | 1 |
| | | | Polypedilum illinoense | 3 |
| | | | Tanytarsus sp. | 6 |

SPECIES RICHNESS 16 (poor)
BIOTIC INDEX 6.20 (good)
EPT RICHNESS 2 (poor)
MODEL AFFINITY 39 (poor)
ASSESSMENT moderately impacted
IMPACT SOURCE impoundment (59%), toxic (51%), complex (48%), organic (47%)
DESCRIPTION This site was sampled in September, as the water level was too high during the June sampling trip. The stream habitat was judged to be adequate, with a substrate of rubble, gravel, and sand. The macroinvertebrate fauna was dominated by facultative worms and caddisflies. Most metrics improved compared to Station 3, but water quality was still in the range of moderately impacted water quality.

| FIELD DATA SUMMARY | | | | |
|---|---|---|---|---|
| **STREAM NAME: Bronx River** | **DATE SAMPLED: 6/4/2003 & 9/17/2003** | | | |
| **REACH: Valhalla to Bronx** | | | | |
| **FIELD PERSONNEL INVOLVED: Abele, Bode & Smith, Gabriel** | | | | |
| **STATION** | 01 | 02 | 03 | 04 |
| **ARRIVAL TIME AT STATION** | 10:40 | 11:20 | 12:05 | 8:55 (9/17/03) |
| **LOCATION** | Valhalla | White Plains | Tuckahoe | Bronx |
| **PHYSICAL CHARACTERISTICS** | | | | |
| **Width (meters)** | 6 | 10 | 10 | 10 |
| **Depth (meters)** | 0.3 | 0.3 | 0.4 | 0.1 |
| **Current speed (cm per sec.)** | 110 | 110 | 110 | 125 |
| **Substrate (%)** | | | | |
| **Rock (>25.4 cm, or bedrock)** | 0 | 0 | 0 | 10 |
| **Rubble (6.35 - 25.4 cm)** | 30 | 40 | 40 | 20 |
| **Gravel (0.2 – 6.35 cm)** | 30 | 20 | 30 | 30 |
| **Sand (0.06 – 2.0 mm)** | 30 | 20 | 20 | 30 |
| **Silt (0.004 – 0.06 mm)** | 10 | 10 | 10 | 10 |
| **Embeddedness (%)** | 10 | 10 | 10 | 50 |
| **CHEMICAL MEASUREMENTS** | | | | |
| **Temperature ($^{o}$C)** | 13.4 | 13.2 | 13.5 | 18.9 |
| **Specific Conductance (umhos)** | 336 | 292 | 326 | 503 |
| **Dissolved Oxygen (mg/l)** | 9.3 | 8.8 | 9.7 | 5.8 |
| **pH** | 7.4 | 7.3 | 7.3 | 7.4 |
| **BIOLOGICAL ATTRIBUTES** | | | | |
| **Canopy (%)** | 50 | 50 | 50 | 75 |
| **Aquatic Vegetation** | | | | |
| **algae – suspended** | | | | |
| **algae – attached, filamentous** | | | | XX |
| **algae - diatoms** | | | | |
| **macrophytes or moss** | | | | |
| **Occurrence of Macroinvertebrates** | | | | |
| **Ephemeroptera (mayflies)** | X | | | |
| **Plecoptera (stoneflies)** | | | | |
| **Trichoptera (caddisflies)** | X | X | X | X |
| **Coleoptera (beetles)** | | | | |
| **Megaloptera(dobsonflies,alderflies)** | | | | |
| **Odonata (dragonflies, damselflies)** | | | | |
| **Chironomidae (midges)** | X | X | X | X |
| **Simuliidae (black flies)** | | | | X |
| **Decapoda (crayfish)** | | | | |
| **Gammaridae (scuds)** | X | X | X | X |
| **Mollusca (snails, clams)** | | | | |
| **Oligochaeta (worms)** | X | | X | X |
| **Other** | | X | X | X |
| **FAUNAL CONDITION** | Good | Poor | Poor | Poor |

## APPENDIX I. BIOLOGICAL METHODS FOR KICK SAMPLING

A. Rationale. The use of the standardized kick sampling method provides a biological assessment technique that lends itself to rapid assessments of stream water quality.

B. Site Selection. Sampling sites are selected based on these criteria: (1) The sampling location should be a riffle with a substrate of rubble, gravel, and sand. Depth should be one meter or less, and current speed should be at least 0.4 meters per second. (2) The site should have comparable current speed, substrate type, embeddedness, and canopy cover to both upstream and downstream sites to the degree possible. (3) Sites are chosen to have a safe and convenient access.

C. Sampling. Macroinvertebrates are sampled using the standardized traveling kick method. An aquatic net is positioned in the water at arms' length downstream and the stream bottom is disturbed by foot, so that the dislodged organisms are carried into the net. Sampling is continued for a specified time and for a specified distance in the stream. Rapid assessment sampling specifies sampling 5 minutes for a distance of 5 meters. The net contents are emptied into a pan of stream water. The contents are then examined, and the major groups of organisms are recorded, usually on the ordinal level (e.g., stoneflies, mayflies, caddisflies). Larger rocks, sticks, and plants may be removed from the sample if organisms are first removed from them. The contents of the pan are poured into a U.S. No. 30 sieve and transferred to a quart jar. The sample is then preserved by adding 95% ethyl alcohol.

D. Sample Sorting and Subsampling. In the laboratory the sample is rinsed with tap water in a U.S. No. 40 standard sieve to remove any fine particles left in the residues from field sieving. The sample is transferred to an enamel pan and distributed homogeneously over the bottom of the pan. A small amount of the sample is randomly removed with a spatula, rinsed with water, and placed in a petri dish. This portion is examined under a dissecting stereomicroscope and 100 organisms are randomly removed from the debris. As they are removed, they are sorted into major groups, placed in vials containing 70 percent alcohol, and counted. The total number of organisms in the sample is estimated by weighing the residue from the picked subsample and determining its proportion of the total sample weight.

E. Organism Identification. All organisms are identified to the species level whenever possible. Chironomids and oligochaetes are slide-mounted and viewed through a compound microscope; most other organisms are identified as whole specimens using a dissecting stereomicroscope. The number of individuals in each species, and the total number of individuals in the subsample is recorded on a data sheet. All organisms from the subsample are archived, either slide-mounted or preserved in alcohol. Following identification of a subsample, if the results are ambiguous, suspected of being spurious, or do not yield a clear water quality assessment, additional subsampling may be required.

## APPENDIX II. MACROINVERTEBRATE COMMUNITY PARAMETERS

1. Species richness. This is the total number of species or taxa found in the sample. Expected ranges for 100-specimen subsamples of kick samples in most streams in New York State are: greater than 26, non-impacted; 19-26, slightly impacted; 11-18, moderately impacted; less than 11, severely impacted.

2. EPT value. EPT denotes the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organism subsample. These are considered to be mostly clean-water organisms, and their presence generally is correlated with good water quality (Lenat, 1987). Expected ranges from most streams in New York State are: greater than 10, non-impacted; 6-10, slightly impacted; 2-5, moderately impacted; and 0-1, severely impacted.

3. Biotic index. The Hilsenhoff Biotic Index is a measure of the tolerance of the organisms in the sample to organic pollution (sewage effluent, animal wastes) and low dissolved oxygen levels. It is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0-10 scale, tolerance values range from intolerant (0) to tolerant (10). For purposes of characterizing species' tolerance, intolerant = 0-4, facultative = 5-7, and tolerant = 8-10. Values are listed in Hilsenhoff (1987); additional values are assigned by the NYS Stream Biomonitoring Unit. The most recent values for each species are listed in the Quality Assurance document (Bode et al., 1996). Ranges for the levels of impact are: 0-4.50, non-impacted; 4.51-6.50, slightly impacted; 6.51-8.50, moderately impacted; and 8.51-10.00, severely impacted.

4. Percent Model Affinity is a measure of similarity to a model non-impacted community based on percent abundance in 7 major groups (Novak and Bode, 1992). Percentage similarity is used to measure similarity to a community of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other. Ranges for the levels of impact are: >64, non-impacted; 50-64, slightly impacted; 35-49, moderately impacted; and <35, severely impacted.

---


Bode, R.W., M.A. Novak, and L.E. Abele. 1996. Quality assurance work plan for biological stream monitoring in New York State. NYS DEC technical report, 89 pp.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. The Great Lakes Entomologist 20(1): 31-39.

Lenat, D. R. 1987. Water quality assessment using a new qualitative collection method for freshwater benthic macroinvertebrates. North Carolina DEM Tech. Report. 12 pp.

Novak, M.A., and R.W. Bode. 1992. Percent model affinity: a new measure of macroinvertebrate community composition. J. N. Am. Benthol. Soc. 11(1):80-85.

## APPENDIX III. LEVELS OF WATER QUALITY IMPACT IN STREAMS.

The description of overall stream water quality based on biological parameters uses a four-tiered system of classification. Level of impact is assessed for each individual parameter, and then combined for all parameters to form a consensus determination. Four parameters are used: species richness, EPT value, biotic index, and percent model affinity. The consensus is based on the determination of the majority of the parameters; since parameters measure different aspects of the community, they cannot be expected to always form unanimous assessments. The ranges given for each parameter are based on 100-organism subsamples of macroinvertebrate riffle kick samples, and also apply to most multiplate samples, with the exception of percent model affinity.

1. <u>Non-impacted</u>

Indices reflect very good water quality. The macroinvertebrate community is diverse, usually with at least 27 species in riffle habitats. Mayflies, stoneflies, and caddisflies are well-represented; the EPT value is greater than 10. The biotic index value is 4.50 or less. Percent model affinity is greater than 64. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges which minimally alter the biota.

2. <u>Slightly impacted</u>

Indices reflect good water quality. The macroinvertebrate community is slightly but significantly altered from the pristine state. Species richness usually is 19-26. Mayflies and stoneflies may be restricted, with EPT values of 6-10. The biotic index value is 4.51-6.50. Percent model affinity is 50-64. Water quality is usually not limiting to fish survival, but may be limiting to fish propagation.

3. <u>Moderately impacted</u>

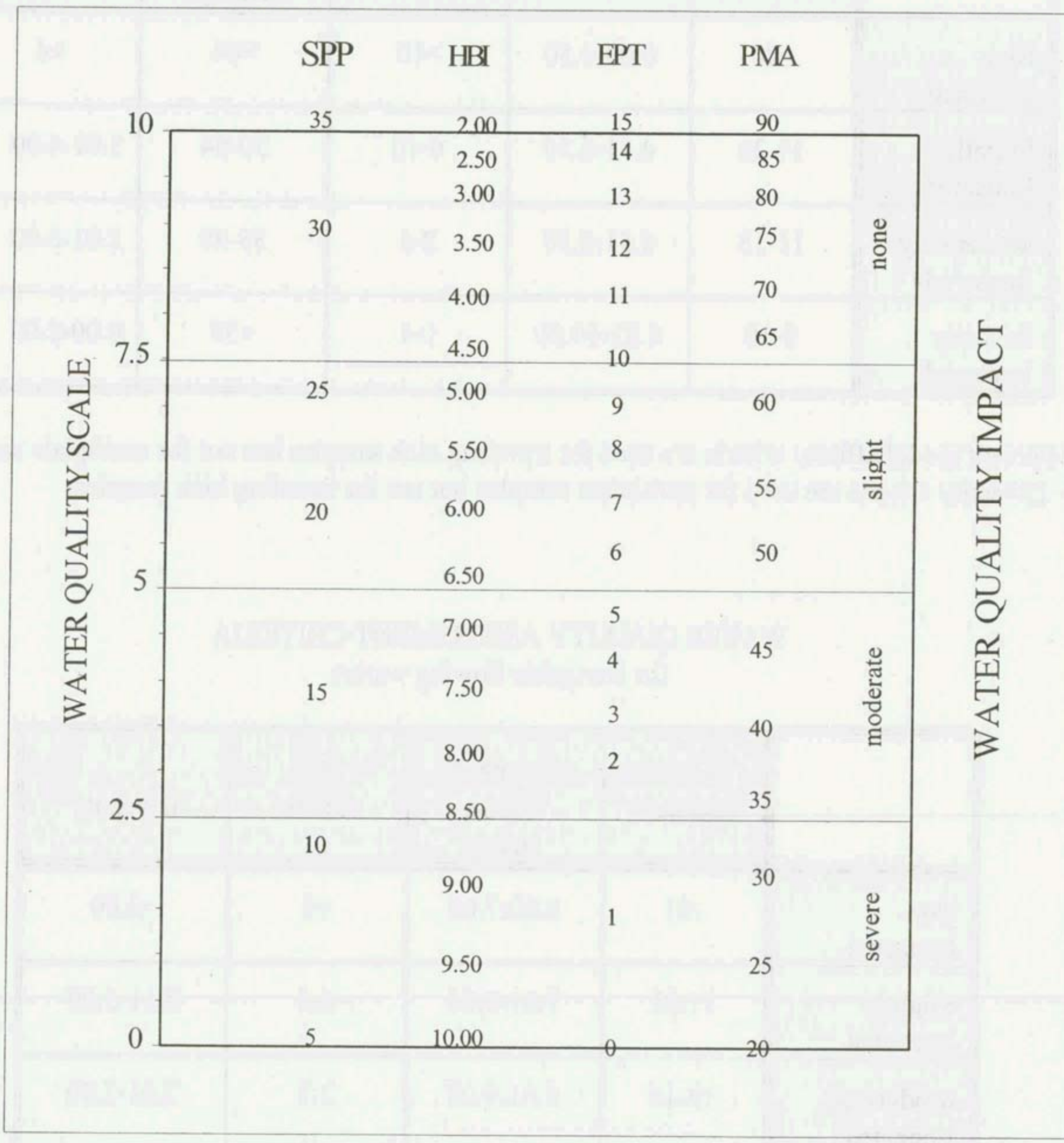
Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree from the pristine state. Species richness usually is 11-18 species. Mayflies and stoneflies are rare or absent, and caddisflies are often restricted; the EPT value is 2-5. The biotic index value is 6.51-8.50. The percent model affinity value is 35-49. Water quality often is limiting to fish propagation, but usually not to fish survival.

4. <u>Severely impacted</u>

Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. Species richness is 10 or less. Mayflies, stoneflies, and caddisflies are rare or absent; EPT value is 0-1. The biotic index value is greater than 8.50. Percent model affinity is less than 35. The dominant species are almost all tolerant, and are usually midges and worms. Often 1-2 species are very abundant. Water quality is often limiting to both fish propagation and fish survival.

APPENDIX IV. BIOLOGICAL ASSESSMENT PROFILE OF INDEX VALUES

The Biological Assessment Profile of index values, developed by Mr. Phil O'Brien, Division of Water, NYS DEC, is a method of plotting biological index values on a common scale of water quality impact. Values from the four indices defined in Appendix II are converted to a common 0-10 scale as shown in the figure below. To plot survey data, each site is positioned on the x-axis according to river miles from the mouth, and the scaled values for the four indices are plotted on the common scale. The mean scale value of the four indices represents the assessed impact for each site.



## APPENDIX V.
## WATER QUALITY ASSESSMENT CRITERIA

for non-navigable flowing waters

| | Species Richness | Hilsenhoff Biotic Index | EPT Value | Percent Model Affinity# | Diversity* |
|---|---|---|---|---|---|
| Non-Impacted | >26 | 0.00-4.50 | >10 | >64 | >4 |
| Slightly Impacted | 19-26 | 4.51-6.50 | 6-10 | 50-64 | 3.01-4.00 |
| Moderately Impacted | 11-18 | 6.51-8.50 | 2-5 | 35-49 | 2.01-3.00 |
| Severely Impacted | 0-10 | 8.51-10.00 | 0-1 | <35 | 0.00-2.00 |

# Percent model affinity criteria are used for traveling kick samples but not for multiplate samples.
* Diversity criteria are used for multiplate samples but not for traveling kick samples.

## WATER QUALITY ASSESSMENT CRITERIA

for navigable flowing waters

| | Species Richness | Hilsenhoff Biotic Index | EPT Value | Diversity |
|---|---|---|---|---|
| Non-Impacted | >21 | 0.00-7.00 | >5 | >3.00 |
| Slightly Impacted | 17-21 | 7.01-8.00 | 4-5 | 2.51-3.00 |
| Moderately Impacted | 12-16 | 8.01-9.00 | 2-3 | 2.01-2.50 |
| Severely Impacted | 0-11 | 9.01-10.00 | 0-1 | 0.00-2.00 |

APPENDIX VI.

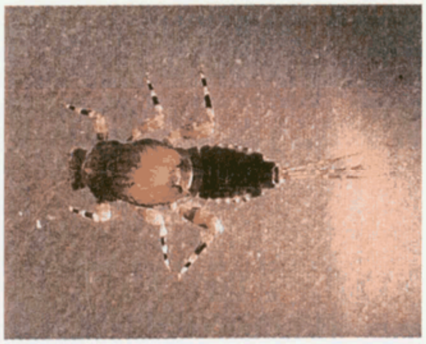
# THE TRAVELING KICK SAMPLE


Rocks and sediment in the riffle are dislodged by foot upstream of a net; organisms dislodged are carried by the current into the net. Sampling is continued for five minutes, as the sampler gradually moves downstream to cover a distance of five meters.

APPENDIX VII. A.

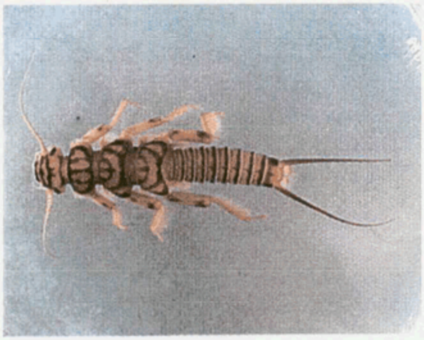
# AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE GOOD WATER QUALITY

Mayfly nymphs are often the most numerous organisms found in clean streams. They are sensitive to most types of pollution, including low dissolved oxygen (less than 5 ppm), chlorine, ammonia, metals, pesticides, and acidity. Most mayflies are found clinging to the undersides of rocks.



*MAYFLIES*

Stonefly nymphs are mostly limited to cool, well-oxygenated streams. They are sensitive to most of the same pollutants as mayflies, except acidity. They are usually much less numerous than mayflies. The presence of even a few stoneflies in a stream suggests that good water quality has been maintained for several months.

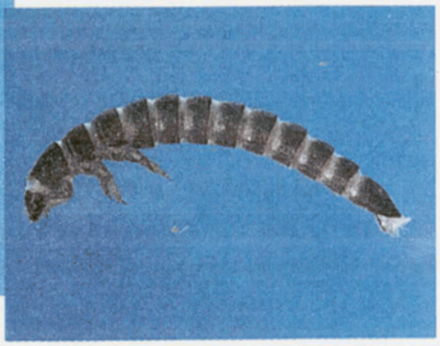


*STONEFLIES*

Caddisfly larvae often build a portable case of sand, stones, sticks, or other debris. Many caddisfly larvae are sensitive to pollution, although a few are tolerant. One family spins nets to catch drifting plankton, and is often numerous in nutrient-enriched stream segments.

*CADDISFLIES*

The most common beetles in streams are riffle beetles and water pennies. Most of these require a swift current and an adequate supply of oxygen, and are generally considered clean-water indicators.



*BEETLES*

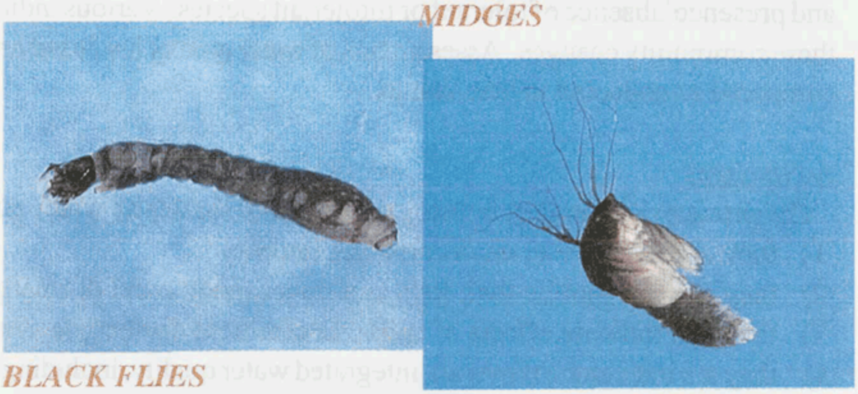
APPENDIX VII. B.

# AQUATIC MACROINVERTEBRATES THAT USUALLY INDICATE POOR WATER QUALITY

Midges are the most common aquatic flies. The larvae occur in almost any aquatic situation. Many species are very tolerant to pollution. Large, red midge larvae called "bloodworms" indicate organic enrichment. Other midge larvae filter plankton, indicating nutrient enrichment when numerous.

*MIDGES*

Black fly larvae have specialized structures for filtering plankton and bacteria from the water, and require a strong current. Some species are tolerant of organic enrichment and toxic contaminants, while others are intolerant of pollutants.

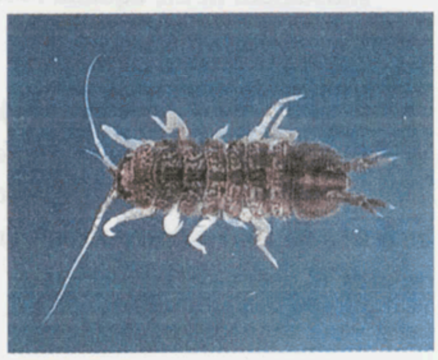


*BLACK FLIES*

The segmented worms include the leeches and the small aquatic earthworms. The latter are more common, though usually unnoticed. They burrow in the substrate and feed on bacteria in the sediment. They can thrive under conditions of severe pollution and very low oxygen levels, and are thus valuable pollution indicators. Many leeches are also tolerant of poor water quality.

*WORMS*

Aquatic sowbugs are crustaceans that are often numerous in situations of high organic content and low oxygen levels. They are classic indicators of sewage pollution, and can also thrive in toxic situations.



*SOWBUGS*

Digital images by Larry Abele, New York State Department of Environmental Conservation, Stream Biomonitoring Unit.

# APPENDIX VIII. THE RATIONALE OF BIOLOGICAL MONITORING

Biological monitoring as applied here refers to the use of resident benthic macroinvertebrate communities as indicators of water quality. Macroinvertebrates are larger-than-microscopic invertebrate animals that inhabit aquatic habitats; freshwater forms are primarily aquatic insects, worms, clams, snails, and crustaceans.

## Concept

Nearly all streams are inhabited by a community of benthic macroinvertebrates. The species comprising the community each occupy a distinct niche defined and limited by a set of environmental requirements. The composition of the macroinvertebrate community is thus determined by many factors, including habitat, food source, flow regime, temperature, and water quality. The community is presumed to be controlled primarily by water quality if the other factors are determined to be constant or optimal. Community components which can change with water quality include species richness, diversity, balance, abundance, and presence/absence of tolerant or intolerant species. Various indices or metrics are used to measure these community changes. Assessments of water quality are based on metric values of the community, compared to expected metric values.

## Advantages

The primary advantages to using macroinvertebrates as water quality indicators are:

1) they are sensitive to environmental impacts
2) they are less mobile than fish, and thus cannot avoid discharges
3) they can indicate effects of spills, intermittent discharges, and lapses in treatment
4) they are indicators of overall, integrated water quality, including synergistic effects and substances lower than detectable limits
5) they are abundant in most streams and are relatively easy and inexpensive to sample
6) they are able to detect non-chemical impacts to the habitat, such as siltation or thermal changes
7) they are vital components of the aquatic ecosystem and important as a food source for fish
8) they are more readily perceived by the public as tangible indicators of water quality
9) they can often provide an on-site estimate of water quality
10) they can often be used to identify specific stresses or sources of impairment
11) they can be preserved and archived for decades, allowing for direct comparison of specimens
12) they bioaccumulate many contaminants, so that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain

## Limitations

Biological monitoring is not intended to replace chemical sampling, toxicity testing, or fish surveys. Each of these measurements provides information not contained in the others. Similarly, assessments based on biological sampling should not be taken as being representative of chemical sampling. Some substances may be present in levels exceeding ambient water quality criteria, yet have no apparent adverse community impact.

# APPENDIX IX. GLOSSARY

**assessment**: a diagnosis or evaluation of water quality

**benthos**: organisms occurring on or in the bottom substrate of a waterbody

**biomonitoring**: the use of biological indicators to measure water quality

**community**: a group of populations of organisms interacting in a habitat

**drainage basin**: an area in which all water drains to a particular waterbody; watershed

**EPT value**: the number of species of mayflies, stoneflies, and caddisflies in a sample

**facultative**: occurring over a wide range of water quality; neither tolerant nor intolerant of poor water quality

**fauna**: the animal life of a particular habitat

**impact**: a change in the physical, chemical, or biological condition of a waterbody

**impairment**: a detrimental effect caused by an impact

**index**: a number, metric, or parameter derived from sample data used as a measure of water quality

**intolerant**: unable to survive poor water quality

**macroinvertebrate**: a larger-than-microscopic invertebrate animal that lives at least part of its life in aquatic habitats

**organism**: a living individual

**rapid bioassessment**: a biological diagnosis of water quality using field and laboratory analysis designed to allow assessment of water quality in a short turn-around time; usually involves kick sampling and laboratory subsampling of the sample

**riffle**: wadeable stretch of stream usually with a rubble bottom and sufficient current to have the water surface broken by the flow; rapids

**species richness**: the number of macroinvertebrate species in a sample or subsample

**station**: a sampling site on a waterbody

**survey**: a set of samplings conducted in succession along a stretch of stream

**tolerant**: able to survive poor water quality

## APPENDIX X. METHODS FOR IMPACT SOURCE DETERMINATION

**Definition** Impact Source Determination (ISD) is the procedure for identifying types of impacts that exert deleterious effects on a waterbody. While the analysis of benthic macroinvertebrate communities has been shown to be an effective means of determining severity of water quality impacts, it has been less effective in determining what kind of pollution is causing the impact. Impact Source Determination uses community types or models to ascertain the primary factor influencing the fauna.

**Development of methods** The method found to be most useful in differentiating impacts in New York State streams was the use of community types, based on composition by family and genus. It may be seen as an elaboration of Percent Model Affinity (Novak and Bode, 1992), which is based on class and order. A large database of macroinvertebrate data was required to develop ISD methods. The database included several sites known or presumed to be impacted by specific impact types. The impact types were mostly known by chemical data or land use. These sites were grouped into the following general categories: agricultural nonpoint, toxic-stressed, sewage (domestic municipal), sewage/toxic, siltation, impoundment, and natural. Each group initially contained 20 sites. Cluster analysis was then performed within each group, using percent similarity at the family or genus level. Within each group four clusters were identified, each cluster usually composed of 4-5 sites with high biological similarity. From each cluster a hypothetical model was then formed to represent a model cluster community type; sites within the cluster had at least 50 percent similarity to this model. These community type models formed the basis for Impact Source Determination (see tables following). The method was tested by calculating percent similarity to all the models, and determining which model was the most similar to the test site. Some models were initially adjusted to achieve maximum representation of the impact type. New models are developed when similar communities are recognized from several streams.

**Use of the ISD methods** Impact Source Determination is based on similarity to existing models of community types (see tables following). The model that exhibits the highest similarity to the test data denotes the likely impact source type, or may indicate "natural", lacking an impact. In the graphic representation of ISD, only the highest similarity of each source type is identified. If no model exhibits a similarity to the test data of greater than 50%, the determination is inconclusive. The determination of impact source type is used in conjunction with assessment of severity of water quality impact to provide an overall assessment of water quality.

**Limitations** These methods were developed for data derived from 100-organism subsamples of traveling kick samples from riffles of New York State streams. Application of the methods for data derived from other sampling methods, habitats, or geographical areas would likely require modification of the models.

NATURAL

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PLATYHELMINTHES | - | - | - | - | - | - | - | - | - | - | - | - | - |
| OLIGOCHAETA | - | - | 5 | - | 5 | - | 5 | 5 | - | - | - | 5 | |
| HIRUDINEA | - | - | - | - | - | - | - | - | - | - | - | - | - |
| GASTROPODA | - | - | - | - | - | - | - | - | - | - | - | - | |
| SPHAERIIDAE | - | - | - | - | - | - | - | - | - | - | - | - | |
| ASELLIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - |
| GAMMARIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Isonychia | 5 | 5 | - | 5 | 20 | - | - | - | - | - | - | - | - |
| BAETIDAE | 20 | 10 | 10 | 10 | 10 | 5 | 10 | 10 | 10 | 10 | 5 | 15 | 40 |
| HEPTAGENIIDAE | 5 | 10 | 5 | 20 | 10 | 5 | 5 | 5 | 5 | 10 | 10 | 5 | 5 |
| LEPTOPHLEBIIDAE | 5 | 5 | - | - | - | - | - | - | 5 | - | - | 25 | 5 |
| EPHEMERELLIDAE | 5 | 5 | 5 | 10 | - | 10 | 10 | 30 | - | 5 | - | 10 | 5 |
| Caenis/Tricorythodes | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PLECOPTERA | - | - | - | 5 | 5 | - | 5 | 5 | 15 | 5 | 5 | 5 | 5 |
| Psephenus | 5 | - | - | - | - | - | - | - | - | - | - | - | - |
| Optioservus | 5 | - | 20 | 5 | 5 | - | 5 | 5 | 5 | 5 | - | - | - |
| Promoresia | 5 | - | - | - | - | - | 25 | - | - | - | - | - | - |
| Stenelmis | 10 | 5 | 10 | 10 | 5 | - | - | - | 10 | - | - | - | 5 |
| PHILOPOTAMIDAE | 5 | 20 | 5 | 5 | 5 | 5 | 5 | - | 5 | 5 | 5 | 5 | 5 |
| HYDROPSYCHIDAE | 10 | 5 | 15 | 15 | 10 | 10 | 5 | 5 | 10 | 15 | 5 | 5 | 10 |
| HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE | 5 | 5 | - | - | - | 20 | - | 5 | 5 | 5 | 5 | 5 | - |
| SIMULIIDAE | - | - | - | 5 | 5 | - | - | - | - | 5 | - | - | - |
| Simulium vittatum | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EMPIDIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TIPULIDAE | - | - | - | - | - | - | - | - | 5 | - | - | - | - |
| CHIRONOMIDAE | | | | | | | | | | | | | |
| Tanypodinae | - | 5 | - | - | - | - | - | - | 5 | - | - | - | - |
| Diamesinae | - | - | - | - | - | - | 5 | - | - | - | - | - | - |
| Cardiocladius | - | 5 | - | - | - | - | - | - | - | - | - | - | - |
| Cricotopus/ Orthocladius | 5 | 5 | - | - | 10 | - | - | 5 | - | - | 5 | 5 | 5 |
| Eukiefferiella/ Tvetenia | 5 | 5 | 10 | - | - | 5 | 5 | 5 | - | 5 | - | 5 | 5 |
| Parametriocnemus | - | - | - | - | - | - | - | 5 | - | - | - | - | - |
| Chironomus | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Polypedilum aviceps | - | - | - | - | - | 20 | - | - | 10 | 20 | 20 | 5 | - |
| Polypedilum (all others) | 5 | 5 | 5 | 5 | 5 | - | 5 | 5 | - | - | - | - | - |
| Tanytarsini | - | 5 | 10 | 5 | 5 | 20 | 10 | 10 | 10 | 10 | 40 | 5 | 5 |
| TOTAL | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

NONPOINT NUTRIENTS, PESTICIDES

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| PLATYHELMINTHES | - | - | - | - | - | - | - | - | - | - |
| OLIGOCHAETA | - | - | - | 5 | - | - | - | - | - | 15 |
| HIRUDINEA | - | - | - | - | - | - | - | - | - | - |
| GASTROPODA | - | - | - | - | - | - | - | - | - | - |
| SPHAERIIDAE | - | - | - | 5 | - | - | - | - | - | - |
| ASELLIDAE | - | - | - | - | - | - | - | - | - | - |
| GAMMARIDAE | - | - | - | 5 | - | - | - | - | - | - |
| Isonychia | - | - | - | - | - | - | - | 5 | - | - |
| BAETIDAE | 5 | 15 | 20 | 5 | 20 | 10 | 10 | 5 | 10 | 5 |
| HEPTAGENIIDAE | - | - | - | - | 5 | 5 | 5 | 5 | - | 5 |
| LEPTOPHLEBIIDAE | - | - | - | - | - | - | - | - | - | - |
| EPHEMERELLIDAE | - | - | - | - | - | - | - | 5 | - | - |
| Caenis/Tricorythodes | - | - | - | - | 5 | - | - | 5 | - | 5 |
| PLECOPTERA | - | - | - | - | - | - | - | - | - | - |
| Psephenus | 5 | - | - | 5 | - | 5 | 5 | - | - | - |
| Optioservus | 10 | - | - | 5 | - | - | 15 | 5 | - | 5 |
| Promoresia | - | - | - | - | - | - | - | - | - | - |
| Stenelmis | 15 | 15 | - | 10 | 15 | 5 | 25 | 5 | 10 | 5 |
| PHILOPOTAMIDAE | 15 | 5 | 10 | 5 | - | 25 | 5 | - | - | - |
| HYDROPSYCHIDAE | 15 | 15 | 15 | 25 | 10 | 35 | 20 | 45 | 20 | 10 |
| HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE | - | - | - | - | - | - | - | - | - | - |
| SIMULIIDAE | 5 | - | 15 | 5 | 5 | - | - | - | 40 | - |
| Simulium vittatum | - | - | - | - | - | - | - | - | 5 | - |
| EMPIDIDAE | - | - | - | - | - | - | - | - | - | - |
| TIPULIDAE | - | - | - | - | - | - | - | - | - | 5 |
| CHIRONOMIDAE | | | | | | | | | | |
| Tanypodinae | - | - | - | - | - | - | 5 | - | - | 5 |
| Cardiocladius | - | - | - | - | - | - | - | - | - | - |
| Cricotopus/ Orthocladius | 10 | 15 | 10 | 5 | - | - | - | - | 5 | 5 |
| Eukiefferiella/ Tvetenia | - | 15 | 10 | 5 | - | - | - | - | 5 | - |
| Parametriocnemus | - | - | - | - | - | - | - | - | - | - |
| Microtendipes | - | - | - | - | - | - | - | - | - | 20 |
| Polypedilum aviceps | - | - | - | - | - | - | - | - | - | - |
| Polypedilum (all others) | 10 | 10 | 10 | 10 | 20 | 10 | 5 | 10 | 5 | 5 |
| Tanytarsini | 10 | 10 | 10 | 5 | 20 | 5 | 5 | 10 | - | 10 |
| TOTAL | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| | MUNICIPAL/INDUSTRIAL | | | | | | | | TOXIC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | A | B | C | D | E | F |
| PLATYHELMINTHES | - | 40 | - | - | - | 5 | - | - | - | - | - | - | 5 | - |
| OLIGOCHAETA | 20 | 20 | 70 | 10 | - | 20 | - | - | - | 10 | 20 | 5 | 5 | 15 |
| HIRUDINEA | - | 5 | - | - | - | - | - | - | - | - | - | - | - | - |
| GASTROPODA | - | - | - | - | - | 5 | - | - | - | 5 | - | - | - | 5 |
| SPHAERIIDAE | - | 5 | - | - | - | - | - | - | - | - | - | - | - | - |
| ASELLIDAE | 10 | 5 | 10 | 10 | 15 | 5 | - | - | 10 | 10 | - | 20 | 10 | 5 |
| GAMMARIDAE | 40 | - | - | - | 15 | - | 5 | 5 | 5 | - | - | - | 5 | 5 |
| Isonychia | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BAETIDAE | 5 | - | - | - | 5 | - | 10 | 10 | 15 | 10 | 20 | - | - | 5 |
| HEPTAGENIIDAE | 5 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LEPTOPHLEBIIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EPHEMERELLIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Caenis/Tricorythodes | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PLECOPTERA | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Psephenus | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Optioservus | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Promoresia | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Stenelmis | 5 | - | - | 10 | 5 | - | 5 | 5 | 10 | 15 | - | 40 | 35 | 5 |
| PHILOPOTAMIDAE | - | - | - | - | - | - | - | 40 | 10 | - | - | - | - | - |
| HYDROPSYCHIDAE | 10 | - | - | 50 | 20 | - | 40 | 20 | 20 | 10 | 15 | 10 | 35 | 10 |
| HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| SIMULIIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Simulium vittatum | - | - | - | - | - | - | 20 | 10 | - | 20 | - | - | - | 5 |
| EMPIDIDAE | - | 5 | - | - | - | - | - | - | - | - | - | - | - | - |
| CHIRONOMIDAE | | | | | | | | | | | | | | |
| Tanypodinae | - | 10 | - | - | 5 | 15 | - | - | 5 | 10 | - | - | - | 25 |
| Cardiocladius | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cricotopus/ Orthocladius | 5 | 10 | 20 | - | 5 | 10 | 5 | 5 | 15 | 10 | 25 | 10 | 5 | 10 |
| Eukiefferiella/ Tvetenia | - | - | - | - | - | - | - | - | - | - | 20 | 10 | - | - |
| Parametriocnemus | - | - | - | - | - | - | - | - | - | - | - | 5 | - | - |
| Chironomus | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Polypedilum aviceps | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Polypedilum (all others) | - | - | - | 10 | 20 | 40 | 10 | 5 | 10 | - | - | - | - | 5 |
| Tanytarsini | - | - | - | 10 | 10 | - | 5 | - | - | - | - | - | - | 5 |
| TOTAL | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

SEWAGE EFFLUENT, ANIMAL WASTES

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| PLATYHELMINTHES | - | - | - | - | - | - | - | - | - | - |
| OLIGOCHAETA | 5 | 35 | 15 | 10 | 10 | 35 | 40 | 10 | 20 | 15 |
| HIRUDINEA | - | - | - | - | - | - | - | - | - | - |
| GASTROPODA | - | - | - | - | - | - | - | - | - | - |
| SPHAERIIDAE | - | - | - | 10 | - | - | - | - | - | - |
| ASELLIDAE | 5 | 10 | - | 10 | 10 | 10 | 10 | 50 | - | 5 |
| GAMMARIDAE | - | - | - | - | - | 10 | - | 10 | - | - |
| Isonychia | - | - | - | - | - | - | - | - | - | - |
| BAETIDAE | - | 10 | 10 | 5 | - | - | - | - | 5 | - |
| HEPTAGENIIDAE | 10 | 10 | 10 | - | - | - | - | - | - | - |
| LEPTOPHLEBIIDAE | - | - | - | - | - | - | - | - | - | - |
| EPHEMERELLIDAE | - | - | - | - | - | - | - | - | 5 | - |
| Caenis/Tricorythodes | - | - | - | - | - | - | - | - | - | - |
| PLECOPTERA | - | - | - | - | - | - | - | - | - | - |
| Psephenus | - | - | - | - | - | - | - | - | - | - |
| Optioservus | - | - | - | - | - | - | - | - | 5 | - |
| Promoresia | - | - | - | - | - | - | - | - | - | - |
| Stenelmis | 15 | - | 10 | 10 | - | - | - | - | - | - |
| PHILOPOTAMIDAE | - | - | - | - | - | - | - | - | - | - |
| HYDROPSYCHIDAE | 45 | - | 10 | 10 | 10 | - | - | 10 | 5 | - |
| HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE | - | - | - | - | - | - | - | - | - | - |
| SIMULIIDAE | - | - | - | - | - | - | - | - | - | - |
| Simulium vittatum | - | - | - | 25 | 10 | 35 | - | - | 5 | 5 |
| EMPIDIDAE | - | - | - | - | - | - | - | - | - | - |
| CHIRONOMIDAE | | | | | | | | | | |
| Tanypodinae | - | 5 | - | - | - | - | - | - | 5 | 5 |
| Cardiocladius | - | - | - | - | - | - | - | - | - | - |
| Cricotopus/ Orthocladius | - | 10 | 15 | - | - | 10 | 10 | - | 5 | 5 |
| Eukiefferiella/ Tvetenia | - | - | 10 | - | - | - | - | - | - | - |
| Parametriocnemus | - | - | - | - | - | - | - | - | - | - |
| Chironomus | - | - | - | - | - | - | 10 | - | - | 60 |
| Polypedilum aviceps | - | - | - | - | - | - | - | - | - | - |
| Polypedilum (all others) | 10 | 10 | 10 | 10 | 60 | - | 30 | 10 | 5 | 5 |
| Tanytarsini | 10 | 10 | 10 | 10 | - | - | - | 10 | 40 | - |
| TOTAL | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| | SILTATION | | | | | IMPOUNDMENT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | A | B | C | D | E | F | G | H | I | J |
| PLATYHELMINTHES | - | - | - | - | - | - | 10 | - | 10 | - | 5 | - | 50 | 10 | - |
| OLIGOCHAETA | 5 | - | 20 | 10 | 5 | 5 | - | 40 | 5 | 10 | 5 | 10 | 5 | 5 | - |
| HIRUDINEA | - | - | - | - | - | - | - | - | - | 5 | - | - | - | - | - |
| GASTROPODA | - | - | - | - | - | - | - | 10 | - | 5 | 5 | - | - | - | - |
| SPHAERIIDAE | - | - | - | 5 | - | - | - | - | - | - | - | - | 5 | 25 | - |
| ASELLIDAE | - | - | - | - | - | - | 5 | 5 | - | 10 | 5 | 5 | 5 | - | - |
| GAMMARIDAE | - | - | - | 10 | - | - | - | 10 | - | 10 | 50 | - | 5 | 10 | - |
| <u>Isonychia</u> | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BAETIDAE | - | 10 | 20 | 5 | - | - | 5 | - | 5 | - | - | 5 | - | - | 5 |
| HEPTAGENIIDAE | 5 | 10 | - | 20 | 5 | 5 | 5 | - | 5 | 5 | 5 | 5 | - | 5 | 5 |
| LEPTOPHLEBIIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| EPHEMERELLIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| <u>Caenis</u>/<u>Tricorythodes</u> | 5 | 20 | 10 | 5 | 15 | - | - | - | - | - | - | - | - | - | - |
| PLECOPTERA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| <u>Psephenus</u> | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 |
| <u>Optioservus</u> | 5 | 10 | - | - | - | - | - | - | - | - | - | - | - | 5 | - |
| <u>Promoresia</u> | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| <u>Stenelmis</u> | 5 | 10 | 10 | 5 | 20 | 5 | 5 | 10 | 10 | - | 5 | 35 | - | 5 | 10 |
| PHILOPOTAMIDAE | - | - | - | - | - | 5 | - | - | 5 | - | - | - | - | - | 30 |
| HYDROPSYCHIDAE | 25 | 10 | - | 20 | 30 | 50 | 15 | 10 | 10 | 10 | 10 | 20 | 5 | 15 | 20 |
| HELICOPSYCHIDAE/ BRACHYCENTRIDAE/ RHYACOPHILIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | - |
| SIMULIIDAE | 5 | 10 | - | - | 5 | 5 | - | 5 | - | 35 | 10 | 5 | - | - | 15 |
| EMPIDIDAE | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CHIRONOMIDAE | | | | | | | | | | | | | | | |
| Tanypodinae | - | - | - | - | - | - | 5 | - | - | - | - | - | - | - | - |
| <u>Cardiocladius</u> | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| <u>Cricotopus/ Orthocladius</u> | 25 | - | 10 | 5 | 5 | 5 | 25 | 5 | - | 10 | - | 5 | 10 | - | - |
| <u>Eukiefferiella/ Tvetenia</u> | - | - | 10 | - | 5 | 5 | 15 | - | - | - | - | - | - | - | - |
| <u>Parametriocnemus</u> | - | - | - | - | - | 5 | - | - | - | - | - | - | - | - | - |
| <u>Chironomus</u> | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| <u>Polypedilum aviceps</u> | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| <u>Polypedilum</u> (all others) | 10 | 10 | 10 | 5 | 5 | 5 | - | - | 20 | - | - | 5 | 5 | 5 | 5 |
| Tanytarsini | 10 | 10 | 10 | 10 | 5 | 5 | 10 | 5 | 30 | - | - | 5 | 10 | 10 | 5 |
| TOTAL | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |