4

Evaluating the Biological Effects of Combined Sewer Overflows in New York

As a followup to the Ohio study, a design for an additional CSO bioassessment case study was developed. For this study, the State of New York was selected for the following reasons:

- Active CSOs are known to exist in several cities of the state.
- Historical data and assessments would likely be available.
- The state is dedicated to biological monitoring and assessment.

In addition to the objectives of the Ohio project (Section 3.0), the New York study was also designed to evaluate the effect of method variation on RBP performance: specifically, when varying the level of method intensity and rigor (screening level assessment, subsample size and taxonomic level), are the same conclusions reached regarding impairment of water resource integrity? The different levels of taxonomy are meant to roughly correspond to RBPII (family-level) and RBPIII (genus/species-level). RBPI has no standardized sampling and is based primarily of hand-turning of the substrate (cobble and gravel) and an estimate of relative abundance of higher taxonomic groups (i.e., family or order). Thus, the additional objectives for this study are meant to examine the effects of these differences on assessments; they are:

- To evaluate the ability of RBPI to detect CSO effects on the aquatic biota;
- To evaluate the effects of taxonomic level (family vs. genus/species) on metric behavior and overall assessments; and
- To evaluate the effects of subsample size (100-organism vs. 300-organism) on metric behavior and overall assessments.

RBPIII results are presented in this section; the evaluations of method variation are presented in Section 5.

4.1 Site Selection and Location Description

Eleven sampling stations were selected for this investigation: three stations each for the CSO-affected streams, Canastota Creek, Harbor Brook, and Onondaga Creek, and one station each for two regional reference sites on the Tioughnioga River (West Branch) and Furnace Brook (Table 4-1). Sampling stations on CSO receiving streams had the same general placement as in the Ohio study, with one location upstream of CSO outfalls, another downstream of at least initial CSO outfalls, and the third well downstream of any outfalls. The stations on Onondaga Creek, Harbor Brook, and Furnace Brook are located in Syracuse; those on Canastota Creek and the Tioughnioga River are in Canastota and Homer, respectively (Figure 4-1). The regional reference site selected by the New York Department of Environmental Conservation (NYDEC) for Onondaga Creek was the West Branch Tioughnioga River. Furnace Brook, south of Syracuse, was selected as the regional reference for Canastota Creek and Harbor Brook but was subsequently dropped after the evaluation of the biological metrics indicated impairment; the upstream reference site on Canastota Creek was used for reference instead. Table 4-1 presents detailed descriptions of sampling locations.

4.2 Results

4.2.1 Taxonomy and Metrics

Taxonomic results and counting exceptions are presented in Appendix B. Bioassessment scoring criteria were developed by dividing the metric value range into equal quadrisections, from the lowest possible value of a metric score (usually 0) to the 95th percentile of the maximum value observed for each metric. The scoring criteria for the genus/species-level, 300-organism subsample, which were used for the biological assessments, are presented in Table 4-2. Note that separate criteria were developed (Table 4-2) based on least-impaired conditions in Canastota Creek (for assessment of stations in that stream

Table 4-1 Biological sampling stations located in or near Syracuse, New York. Sampled 20-23 September 1993.

SITE	STATION TYPE	WATERBODY	GEOGRAPHIC DESCRIPTION OF SITE
CC1	Upstream Reference	Canastota Creek	Canastota Creek, off of Rt. 5 in Canastota, 1 block east of Mt. Pleasant Rd., ~50 meters upstream of the Rt. 5 bridge.
CC2	CSO Impact	Canastota Creek	Canastota Creek, downstream of Canastota Village, ~60 meters upstream of the Main St. bridge (across from Joe A. Stagnitti La.).
CC3	CSO Impact	Canastota Creek	Canastota Creek, perpendicular to Main St., behind the STP, ~12 meters upstream of the agricultural ditch on the left (upstream) side of the entrance field (behind STP).
HB1	Upstream Reference	Harbor Brook	Harbor Brook, ~150 meters upstream of the flow dissipator and ~350 meters upstream of the Velasko Rd. bridge.
HB2	CSO Impact	Harbor Brook	Harbor Brook, ~5 meters downstream of the State Fair Blvd. bridge, Syracuse.
HB3	CSO Impact	Harbor Brook	Harbor Brook, ~10 meters upstream of the Hiawatha Blvd. bridge, downstream of the pipe. RBP I only at this station.
CHR4*	Regional Reference	Furnace Brook	Furnace Brook, off of McDonald and Reinman Sts., behind Corcoran High School gym, just upstream of the asphalt bank.
OC1	Upstream Reference	Onondaga Creek	Onondaga Creek, in Kelly Park off of Dorwin Ave., ~75 meters upstream of the USGS gauging station.
OC2	CSO Impact	Onondaga Creek	Onondaga Creek, ~10 meters downstream of the Newell St. bridge between Vale and Onondaga Creek Blvd.
OC3	CSO Impact	Onondaga Creek	Onondaga Creek, ~30 meters upstream of footbridge behind the Utility Life Bldg.at the end of Plum St.; ~0.5 miles upstream of Onondaga Lake.
OC4	Regional Reference	Tioughnioga River (West Branch)	Tioughnioga River, in Durkee Memorial Park, Homer, NY, ~15 meters downstream of the Hwy. 11 bridge.

CC = Canastota Creek OC = Onondaga Creek HB = Harbor Brook CHR4 = Furnace Brook

* This station was not used in development of the scoring criteria due to biological impairment. Station CC1 was used for comparison for Canastota Creek and Harbor Brook.

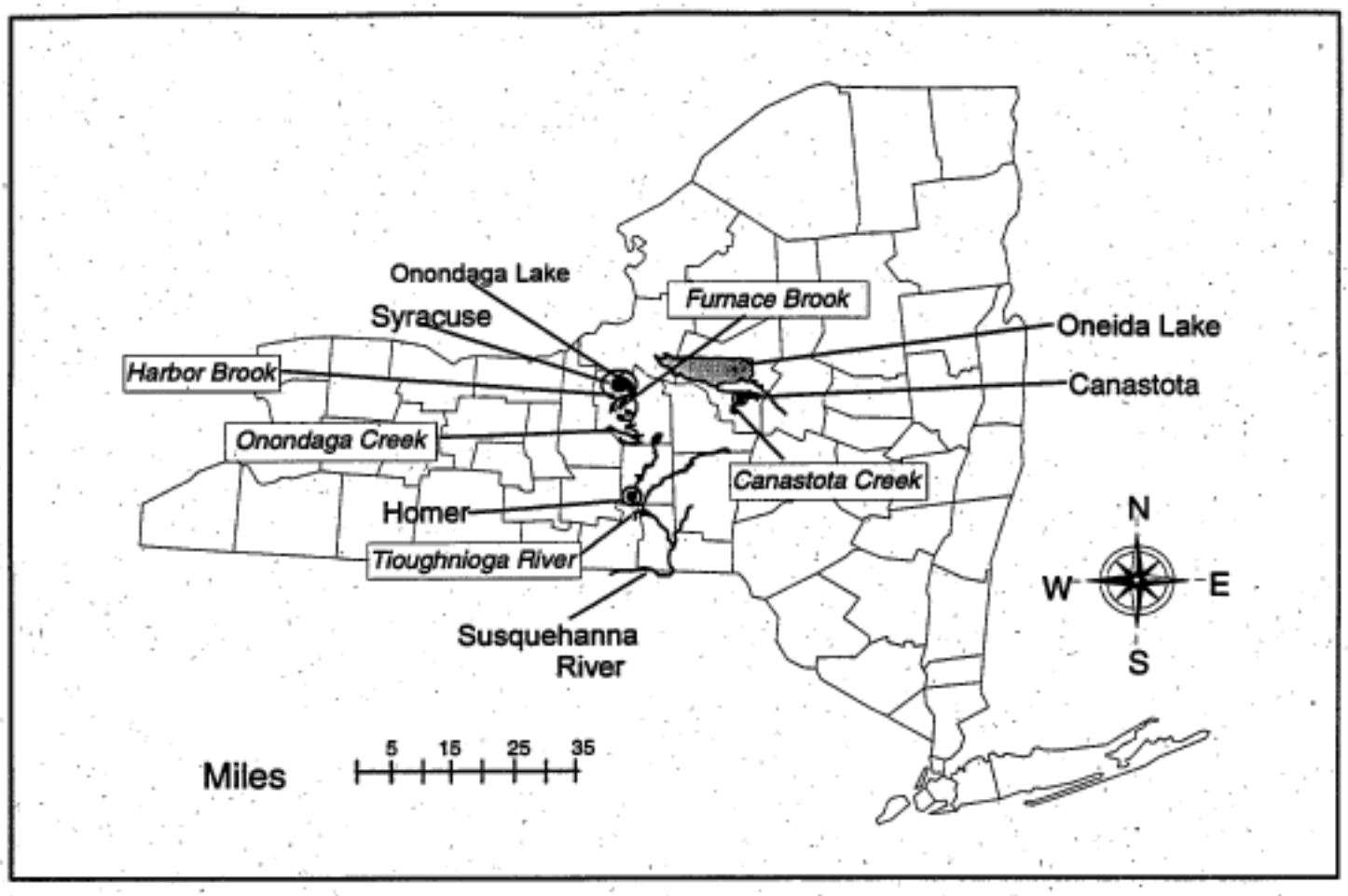

Figure 4-1. State of New York. Rivers and streams sampled for the biological assessment of combined sewer overflow effects, September 1993.

and Harbor Brook) and in the Tioughnioga River (for assessment of Onondaga Creek stations). The calculated or enumerated values for each of the metrics are given in Table 4-3.

4.2.2 Canastota Creek at Canastota, New York

4.2.2.1 Historical Information

The Canastota Creek watershed covers a drainage area of approximately 8.5 square miles and includes Cowaselon and Canaseroga Creeks. The drainage area encompasses Canastota, Lakeport, and agricultural lands. Canastota Creek flows through the town of Canastota and joins Cowaselon Creek on the northwest side of town. Before the construction of the WWTP, sewage was discharged directly into the lower part of Canastota Creek. At the time of the initial biological survey of these streams (Preddice 1975), the WWTP discharge was directly into Cowaselon Creek upstream of the Canastota Creek confluence.

A sample collected just downstream of the Main Street (Canastota) bridge in 1975, comprised a relatively tolerant macroinvertebrate assemblage (Preddice 1975) (Table 4-4). Several of these groups are indicative of potential organic enrichment; they were also found in low density. Other organisms at this site were *Cladophora* (Chlorophycophyta [green algae]) and some blue-green algae (Cyanophyophyta), and several species of bottom-feeding fishes (blacknose dace, longnose dace, creek chub, and white sucker). In spite of the appearance of suitable substrate quality and flow conditions, the low number of benthic macroinvertebrates found, combined with their relative tolerance, indicated a potential of simultaneous toxic input and nutrient enrichment (Preddice 1975). This assessment was considered consistent with the presence of both green and blue-green algae. The upstream source of toxicants was not determined; however, it was learned that an herbicide, atrazine, had been used. At the time, atrazine was considered to have only limited toxic effects on insects (Weed Science Society 1974) and, therefore, was not considered the source of the problem (Preddice 1975).

Table 4-2 Scoring criteria developed for the benthic macroinvertebrate assemblage, 300-organism subsample. For a description of the development of scoring criteria, see Section 2.3.1.

ASSESSMENT SCORES	SCORING CRITERIA							
	0	2	4	6	0	2	4	6
METRIC	Canastota Creek, Harbor Brook				Onondaga Creek, Tioughnioga River			
1. Taxa Richness	≤10	21-11	32-22	≥33	≤10	21-11	32-22	≥33
2. HBI	≥6.3	4.2-5.2	2.1-4.1	0-2.0	≥5.1	3.4-5.0	1.7-3.3	0-1.6
3. Sc/(Sc+Fil) x 100	7.7-0	15.5	23.3-15.6	≥23.4	≥13.3	26.7-13.4	40.1-26.8	≥40.2
4. EPT/(EPT+Chir) x 100	≤21.5	43.1-21.6	64.7-43.2	≥64.8	≤22.9	45.9	68.9	≥69
5. % Cont. Dom. Taxon	45.9	30.6-45.8	15.3-30.5	0-15.2	≥17.7	11.8-17.6	5.9-1.7	0-5.8
6. EPT Index	3-0	7-4	11-8	≥12	4-0	9-5	14-10	≥15
7. Shredders/Total x 100	2.2-0	4.5-2.3	6.8-4.6	≥6.9	3.7-0	7.5-3.8	4.3-7.6	≥11.4
8. H/T x 100	≥71.4	47.6-71.3	23.8-47.5	0-23.7	≥71.4	47.6-71.3	23.8-47.5	0-23.7
9. Pinkham-Pearson	2.3-0	4.7-2.4	7.1-4.8	≥2.7	2.0-0	4.1-2.1	6.2-4.2	≥6.3
10. QSI-Taxa	13.3-0	26.7-13.4	40.1-26.8	≥40.2	7.8-0	15.7-7.9	23.6-15.8	≥23.7
11. DIC-5	≤1	2	3	≥4	≤0	1	2	≥3
12. QSI-FFG	20.7-0	41.5-20.8	62.3-41.6	≥62.4	13.6-0	27.3-13.7	41-27.4	≥41.1

It was also discovered that a sewage/stormwater bypass pipe was present in the channel. This pipe was acknowledged as the probable source of nutrient loadings during storm flow (Preddice 1975).

More recently, at another site downstream of the Main Street bridge, Canastota Creek was found to be moderately impacted (Bode et al. 1993). Samples taken in early summer (19 June 1990) produced 24 percent midges (Chironomidae) and 69 percent aquatic earthworms (Oligochaeta), both of which are considered tolerant to severe pollution including conventional toxics, eutrophication, and habitat degradation. No mayflies, stoneflies, or caddisflies (Ephemeroptera, Plecoptera, and Trichoptera, respectively) were found, and the HBI fell in the "moderate impact" category.

4.2.2.2 Sampling Station Description and Habitat Quality

Three sampling stations were selected on Canastota Creek (Figure 4-2). The regional reference site for this stream was located on Furnace Brook (Station CHR4). Habitat assessment scores, along with measurements of dissolved oxygen, temperature, and conductivity, are presented in Table 4-5.

Furnace Brook, Station CHR4. This station was recommended by NYDEC for the regional reference for both Canastota Creek and Harbor Brook. The habitat quality rated optimal in all parameters except riparian vegetative zone width, which rated 15. The substrate was composed of cobble and small boulders with well-developed riffles. The riparian vegetation was very good, and the banks were stable. The habitat assessment score was 212. However, a

Table 4-3 Metric values calculated from 300-organism subsamples; based on genus/species level taxonomy. Bioassessment scores (in parentheses) are derived by comparing metric values to scoring criteria (Table 4-2).

METRIC	SAMPLING STATIONS								
	CC1	CC2	CC3	HB1	HB2	OC4	OC1	OC2	OC3
1. Taxa richness	31(4)	43(6)	31(4)	21(2)	18(2)	42(6)	41(6)	26(4)	23(4)
2. HBI	4.5(4)	5.1(2)	5.1(2)	5.7(2)	8.4(0)	4.4(2)	6.1(0)	5.5(0)	6.6(0)
3. Scr/(Scr + Fc) x 100	32.4(6)	26(6)	17(4)	0(0)	0(0)	56(6)	10.8(0)	0(0)	16.7(2)
4. EPT/(EPT + Chir) x 100	80.8(6)	60.4(4)	90.4(6)	56.3(4)	0(0)	92.3(6)	26.2(2)	58.6(4)	7.4(0)
5. % Contr. Dom. Taxon	28.1(4)	14.1(6)	25.8(4)	63.9(0)	60.1(0)	22.5(0)	11(4)	17(2)	24.4(0)
6. EPT Index	11(4)	10(4)	8(4)	7(2)	1(0)	18(6)	7(2)	6(2)	1(0)
7. (Shred/Tot) x 100	7.7(6)	9.2(6)	2.8(2)	7.5(6)	0.6(0)	4.5(2)	11(4)	13.1(6)	15.8(6)
8. (Hydro/Trich) x 100	94.1(0)	99.1(0)	100(0)	98.3(0)	0(6)	69.3(2)	97.8(0)	99.2(0)	100(0)
9. Pinkham-Pearson index	UR(6)	9.7(6)	6.6(4)	1.6(0)	0.7(0)	RR(6)	6.7(6)	8.4(6)	5.9(4)
10. QSI Tax x 100	UR(6)	55(6)	56(6)	25(2)	12(0)	RR(6)	19(4)	33(6)	11(2)
11. DIC-5	UR(6)	3(4)	3(4)	2(2)	1(0)	RR(6)	0(0)	1(2)	0(0)
12. QSI-FFG x 100	UR(6)	87.4(6)	77.6(6)	45.1(4)	28(2)	RR(6)	55.7(6)	57.2(6)	25.9(2)
Total (with paired) metrics	58	56	46	24	10	54	34	38	22
Biology (with paired) % comparison to reference	--	96	79	41	17	--	63	70	41
Total (without paired) metrics	34	34	26	16	8	30	18	18	14
Biology (without paired) % comparison to reference	--	100	76	47	23	--	60	60	47
Habitat score	139	132	92	182	57	191	86	114	118
Habitat % comparison to reference	--	95	66	131	41	--	45	60	62

No scrapers or filterer-collectors taken in sample.
UR = upstream reference
RR = regional reference (regional reference was not used for Canastota Creek and Harbor Brook, Section 4.2.2.2).
Note: station HB3 was not included in the biological assessment due to severe habitat alterations.

Table 4-4 Primary taxonomic composition of benthic macroinvertebrate samples taken by Preddice (1975). Canastota Creek, Canastota, New York, 29 July 1975.

TAXON	HIGHER LEVEL CATEGORY	COMMON NAME
Physa	Gastropoda: Physidae	snails
Asellus	Isopoda: Asellidae	sowbugs
Lumbricidae	Oligochaeta	aquatic earthworms
Tendepedidae	Diptera	true flies
Heptageniidae	Ephemeroptera	mayflies
Tricladida	Turbellaria	planarians (flatworms)
Hirudinea	Oligochaeta	leeches
Elmidae	Coleoptera	riffle beetles

hyperabundance of amphipods was found (nearly 76 percent of the 300-organism subsample was Gammarus); therefore, this station was not used as a representative of reference conditions. Furnace Brook was not used to establish scoring criteria.

Canastota Creek, Station CC1 (upstream reference). The station farthest upstream does not receive CSO input at or above this location. At this location the stream is approximately 2.5 meters wide with a dense canopy cover and variable bank stability. Where the samples were taken, the banks were in relatively stable condition with little evidence of accelerated erosion; however, areas of active bank erosion were observed upstream. The riparian vegetative zone on either side of the stream was less than 6 meters due to human activity. The substrate available for benthic fauna at this site consisted of a good mix of boulder and cobble, and well-developed riffles were prevalent. However, there were some problems with sedimentation and substrate embeddedness. The habitat assessment rating score was 149 (Table 4-5).

Canastota Creek, Station CC2. This station was the first station on Canastota Creek below CSO outfalls. Relative to the upstream reference station, CC2 had a reduced canopy cover, a predominantly sand and gravel bottom with a high degree of embeddedness, and less well-defined riffles. The stream here was approximately 3 meters wide and had moderately unstable banks with very poor riparian vegetation zones. The habitat assessment rating score was 132 (Table 4-5).

Canastota Creek, Station CC3. Station CC3 is behind the Sewage Treatment Plant; the stream in this area is approximately 3 meters wide. Sampling took place approximately 12 meters upstream from the agricultural ditch that enters on one the side of the stream. The habitat structure at this station was also more degraded than that of CC1. The substrate consisted almost entirely of sand; there was substantial sediment deposition and evidence of past channelization. The riparian buffer zone and the condition of the banks were both scored very poor. The habitat assessment rating score for this station was 92 (Table 4-5).

Overall, the best habitat quality on Canastota Creek was found at the upstream reference site, station CC1. The two downstream stations both experienced degradation in channel characteristics and poor riparian vegetative protection. The individual components of the physical habitat structure that were rated in the poor and marginal ranges, at both stations CC2 and CC3, were related to the lack of riparian buffer zone and the high degree of embeddedness. In addition, at CC3 the condition of the banks and increase in sediment deposition related to erosion were rated poor. Station CC3 rated consistently lowest in most habitat parameters, which is reflected in the percent comparability (66 percent) to the reference station. Habitat condition should be considered degraded at station CC3; habitat quality should not be limiting to the biological condition at Stations CC1 or CC2, despite some problems at CC2.

4.2.2.3 Biological Assessments

The stations on Canastota Creek were assessed for the RBPI as slightly to moderately impaired (CC1) and moderately impaired (CC2, CC3). A further description of this screening-level assessment and how it compares to the more rigorous RBPIII assessment can be found in Section 5.1.

For biological assessments using CC1 as the reference site, metric totals without paired metrics were used for percent comparisons. The upstream (CC1) and middle (CC2) stations were very similar in their biological condition, the latter having the same assessment score as the former (Table 4-3). However, more detailed interpretation of individual metric values shows substantial differences in number of taxa. Twelve additional taxa were found at CC2, eight of which were genera of the Chironomidae (Appendix B), a group generally considered to be pollution-tolerant. All of the additional midge genera have designated

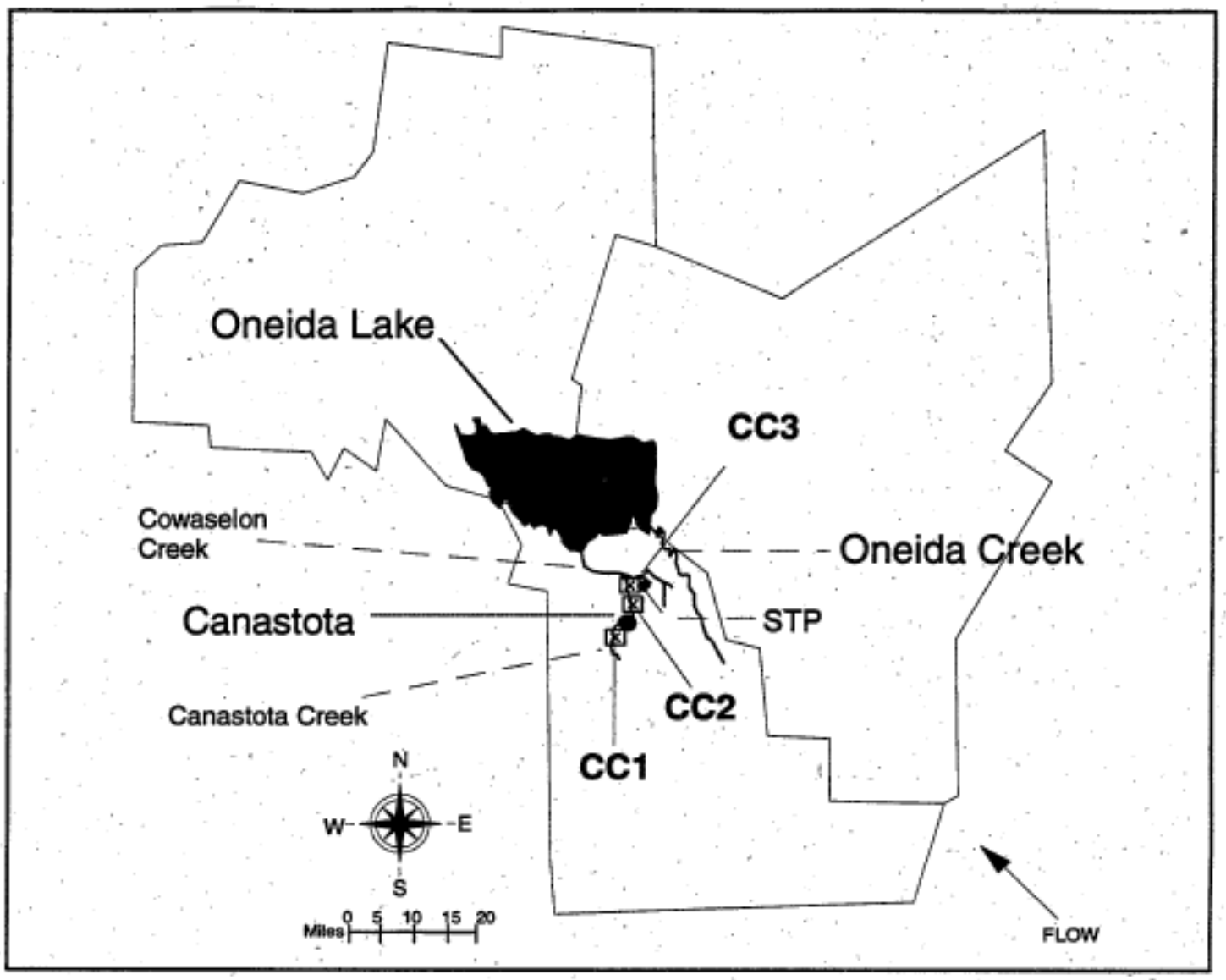

Figure 4-2. Locations of sampling stations on Canastota Creek. STP = Sewage Treatmant Plant.

tolerance values of 5 or above, indicating their high tolerance of or potential for positive response to pollution. The high tolerance values caused an increase in the HBI. There was also a higher proportion of Stenelmis (Coleoptera: Elmidae: riffle beetles) at CC2 than was seen upstream. This might have been due to a combination of increased growths of periphyton and filamentous green algae responding to removal of some of the canopy (providing increased light), and upstream organic enrichment.

Station CC3 had habitat that was further degraded and a biota that compared at 76 percent to that at the upstream-most site, substantiating what was seen at the upstream stations. That is, there is likely some organic enrichment of Canastota Creek occurring upstream of any CSO effects, possibly from agricultural activities. Though none of the three stations had excessively high values for the metric "percent contribution of dominant taxon," samples from each were dominated by the Hydropsychidae, often seen in high numbers in organically enriched streams. The degree of habitat degradation between CC1 and CC2 (11 percent change) is less than that between CC2 and CC3 (30 percent change), but both indicate either nonimpairment (CC2) or only slight impairment. However, in the absence of a suitable (nonimpaired or minimally impaired) regional reference site for comparison, CC1 and CC2 should be considered slightly to moderately impaired; CC3, moderately impaired.

4.2.3 Harbor Brook in Syracuse, New York

4.2.3.1 Historical Information

Historical data on Harbor Brook (11.8 square miles drainage area) are from NYDEC sampling at stations near Highway

Table 4-5 Canastota Creek habitat assessment rating score.

HABITAT PARAMETERS (0 - 20)		SCORES			
		Canastota Creek Sampling Stations			
		CC1	CC2	CC3	CHR4[a]
Substrate and Instream Cover	Instream Cover (Fish)	12	13	8	19
	Epifaunal Substrate	16	11	10	19
	Embeddedness	13	8	7	16
	Velocity/Depth Regimes	18	12	7	19
Channel Morphology	Channel Alteration	17	10	14	16
	Sediment Deposition	4	10	5	18
	Frequency of Riffles	19	12	8	19
	Channel Flow Status	13	15	8	19
Riparian	Conditions of Banks	12	10	5	18
	Bank Vegetative Protection	15	14	9	17
	Grazing or Other Disruptive Pressure	8	14	10	17
	Riparian Vegetative Zone Width (Least Buffered Side)	2	3	1	15
TOTAL SCORE		149	132	92	212
Physicochemical Parameters	Temp (°C)	12	11.8	14.2	10.5
	pH	8	8.23	8.88	8
	Conductivity	16.38	15.91	---[b]	---[b]
	DO	10.3	8.5	8.1	9.8

[a] Furnace Brook, regional reference site, not used in biological assessments due to impairment.
[b] Lack of physicochemical data is due to equipment failure.

173 at Split Rock and another station approximately 0.8 kilometer upstream from the mouth into Onondaga Lake (Bode et al. 1989). The upstream station at Split Rock is approximately 1.5 miles south (upstream) of HB1 of this study. At the Split Rock station the benthic macroinvertebrate assemblage was assessed as moderately impacted. This stream is known to be intermittent (Bode et al. 1989), and the abundance of taxa tolerant to temporary desiccation influenced this assessment. Bode et al. stated that the chemical water quality might actually have been nonimpacted.

The second station assessed by Bode et al. was located between HB2 and HB3 (Bode et al. 1989). The channelized and degraded habitat produced a sample made up mostly of Chironomidae, Oligochaeta, Hirudinea, and Amphipoda (midges, earthworms, leeches, and scud, respectively). All four parameters rated as poor (species richness, 8; biotic index, 9.7; EPT value, 0; and percent model affinity, 15) and resulted in an assessment of "severely impacted." Descriptions of these parameters are presented in Bode et al. (1989, 1993) and Bode and Novack (1995).

4.2.3.2 *Sampling Station Description and Habitat Quality Assessments*

Three sampling stations were selected on Harbor Brook (Figure 4-3). It was not possible, however, to include HB3 in the biological assessments due to the deep, soft bottom, which is not suitable for a wadable kick net sample. The length of Harbor Brook within this study was completely channelized. Approximately 150 meters downstream from the farthest upstream station (HB1) is a flow dissipator, through which water enters an emergent-macrophyte-filled retention basin. Further downstream, the water is subjected

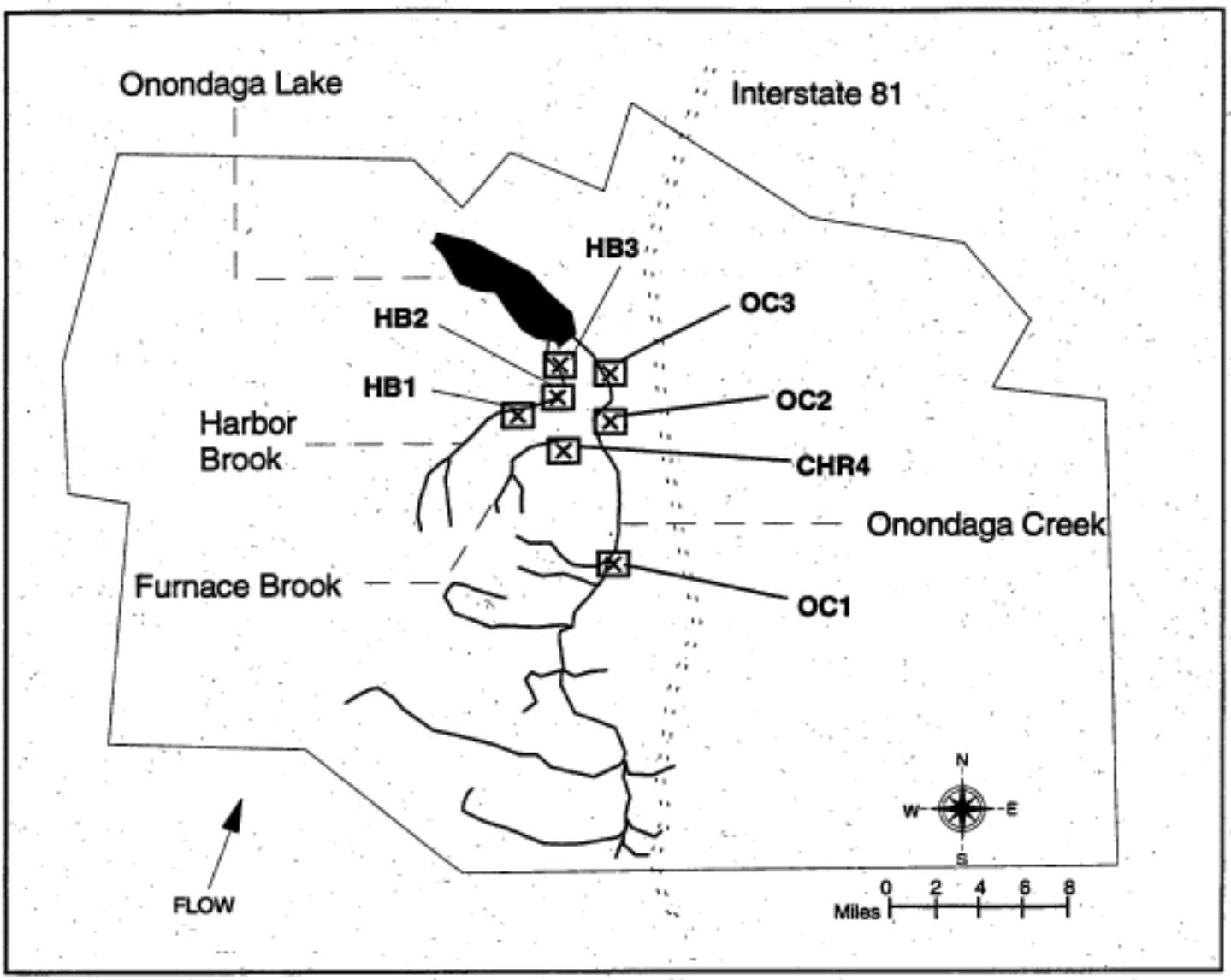

Figure 4-3. Locations of sampling stations on Onondaga Creek, Harbor Brook, and Furnace Brook.

to a flow splitter; the flow then enters a cement- and rock-sided channel; this type of channel with armored sides continues for the rest of the length of Harbor Brook. For some intermediate distance in the study length, the stream has been closed on the top, making it essentially a subsurface channel. The second and third sampling stations (HB2 and HB3, respectively) were located just downstream from where the channel was no longer covered; that is, in the section between State Fair Boulevard and Hiawatha Street. Thus, there is a major difference in habitat quality between the sampling site farthest upstream (HB1) and the two downstream sites, which should be recalled in these comparisons. The regional reference site for this stream (Furnace Brook [Station CHR4]) was dropped as the regional reference site; therefore the upstream station on Canastota Creek (CC1) was used for reference. Habitat assessment scores, along with measurements of dissolved oxygen, temperature, and conductivity, are presented in Table 4-6.

Harbor Brook, Station HB1. This station was located approximately 150 meters upstream of the flow dissipator and about 350 meters upstream of Velasko Road. The stream was approximately 2.5 meters wide, and the substrate was composed of cobble and gravel with very little embeddedness. The frequency of riffles was optimal as was the condition of the banks and the riparian vegetative protection. Even though the stream was located among relative heavy urbanization, its physical quality was very good. This site scored high on the habitat assessment at 182.

Harbor Brook, Station HB2. HB2 was located approximately 5 meters downstream of the State Fair Boulevard bridge off Hiawatha Street. The stream was completely channelized with no riffles and very slow-moving water; the width was approximately 2 meters. The substrate at this station was mostly sand with a little gravel. The only parameters scored above poor or marginal were channel

Table 4-6 Harbor Brook habitat assessment scores.

HABITAT PARAMETERS (0 - 20)		SCORES			
		Harbor Brook Sampling Stations			
		HB1	HB2	HB3	CHR4[a]
Substrate and Instream Cover	Instream Cover (Fish)	16	2	2	19
	Epifaunal Substrate	19	1	0	19
	Embeddedness	12	5	1	16
	Velocity/Depth Regimes	18	1	1	19
Channel-Morphology	Channel Alteration	13	1	1	16
	Sediment Deposition	17	1	1	18
	Frequency of Riffles	17	1	1	19
	Channel Flow Status	12	18	19	19
Riparian	Conditions of Banks	17	18	19	18
	Bank Vegetative Protection	18	7	10	17
	Grazing or Other Disruptive Pressure	18	1	1	17
	Riparian Vegetative Zone Width (Least Buffered Side)	5	1	1	15
TOTAL SCORE		182	57	54	212
Physicochemical Parameters	Temp (°C)	13	12.5	---[b]	10.5
	pH	7.95	7.86	---[b]	8
	Conductivity	---[b]	---[b]	---[b]	---[b]
	DO	9	7.3	---[b]	9.8

[a] Furnace Brook, regional reference site, not used in biological assessments due to impairment.
[b] Lack of physicochemical data is due to equipment failure.

flow status and condition of banks; the banks were armored. This station had severely degraded habitat and scored only 57.

Harbor Brook, Station HB3. This station, located about 5 meters upstream of the Hiawatha Street bridge, was extremely degraded. All habitat parameters scored in the poor range except for the channel flow status and condition of banks (due to the armored sides). The substrate at this site was a grayish-black muck; the stream was too deep here to be considered "wadable" for sampling. The habitat assessment score for HB3 was 54.

The poor habitat at both HB2 and HB3 can be considered to be extremely limiting to the biological condition of this stream.

4.2.3.3 Biological Assessments

Screening-level assessments (RBPI) indicate moderate (HB1) to severe (HB2, HB3) impairment on Harbor Brook. Comparisons between the screening-level assessment and the RBPIII assessment are discussed in Section 5.1.

Because of the extreme habitat alteration, samples could not be taken from what was to be the downstream-most station (HB3). As discussed in Section 4.2.2.2, the regional reference site for Harbor Brook (Furnace Creek) was dropped as a baseline comparison due to biological impairment; station CC1 was used for reference. HB1 and HB2 scored 41 percent and 17 percent comparability, respectively, to the upstream site on Canastota Creek (CC1). The upstream station (HB1) had a metric score for "percent contribution of dominant taxon" of 63.9 that represented

246 *Gammarus* (Crustacea: Amphipoda: Gammaridae); the second most dominant, comprising another 15 percent of the individuals, was of the caddisfly family Hydropsychidae (Trichoptera: *Cheumatopsyche*, *Hydropsyche*). Both of these groups are considered to be tolerant to some level of habitat degradation, positively responsive to nutrient enrichment (Hydropsychidae, *Gammarus*), and tolerant to some potentially toxic inputs (*Gammarus*). Compared to CC1, this station had a lower taxa richness, higher HBI, higher percent dominant taxon, and lower EPT index. Each shows the expected direction of the metric value change when exposed to physical and chemical degradation.

The downstream station (HB2) had completely different habitat and flow regime. Here, the two most dominant taxa were *Chironomus* (Diptera: Chironomidae) (60 percent, 194 individuals of 385 total) and *Gammarus* (66 individuals). The genus *Chironomus* is one of the taxa more tolerant of chemical pollution and habitat degradation. Also found were 13 specimens of a cyclopoid copepod (Crustacea: Copepoda) normally found in lakes and reservoirs. At this station, water was deep and slow-moving, perhaps making it suitable for copepods. There were six different genera of Oligochaeta (aquatic earthworms) that are as a whole considered to be tolerant of a range of severity in habitat degradation. The HBI was 8.4 in contrast to the 5.7 and 4.5 of HB1 and CC1, respectively. This is indicative of a sample dominated by individuals of pollution-tolerant taxa.

Even though the habitat and most of the benthic metrics differed substantially between HB1 and HB2, the "taxa richness" of the stations was nearly identical. This is an illustration of why single measurement parameters should not be relied upon for performing biological assessments; rather, single parameters should be used to interpret overall multimetric assessment scores and aid in determining causes of impairment. Station HB1 should be considered moderately impaired and HB2 severely impaired.

4.2.4 Onondaga Creek in Syracuse, New York

4.2.4.1 Historical Information

The Onondaga Creek drainage covers approximately 111 square miles. It traverses rural agricultural communities, a Native American reservation, and downtown Syracuse. Bode et al. (1989) sampled Onondaga Creek at two locations, one about 1 mile upstream of Onondaga Lake and the other near Cardiff just off Webster Road and about 15 miles upstream of the first site. The site upstream of Onondaga Lake was assessed as "severely impacted" in 1989 (Bode et al. 1989) and 1990 (Bode et al. 1993). In 1993 Bode et al. found only Chironomidae and Oligochaeta, both considered to be strongly pollution-tolerant. Other characteristics of the sample were eight species (poor), a biotic index of 9.7 (poor), EPT value 0 (poor), and percent model affinity 15 percent (poor).

Tissue analysis of caddisflies collected at the site indicated no elevated levels of metals above background levels; crayfish had elevated levels of the PCB aroclor 1254 (0.42 µg/g, which is below the U.S. Food and Drug Administration action level of 2 ppm). Parameters of concern in the water column were aluminum, iron, lead, mercury, zinc, dissolved solids, and both total and fecal coliform; manganese was borderline. Bottom sediments contained levels of copper, zinc, lead, mercury, PCBs, and DDE above background levels but below assessment criteria levels. Toxicity testing indicated that significant mortality and reproductive impairment occurred in assays during 1990.

It should also be noted that 17 miles of Onondaga Creek upstream of Syracuse are affected by mud boils. These geomorphic reactions to excessive groundwater drawdown result in periodic episodes of hyperturbidity. Also, sections of this creek have been closed to fishing due to brine discharges and mining operations. In spite of the hyperturbidity, the macroinvertebrate community at the NYDEC upstream station located in Cardiff was found to be in "slightly impacted" condition in 1989 and 1990, with 24 species, a biotic index of 6, EPT value of 4, and 68 percent model affinity (Bode et al. 1993).

4.2.4.2 Sampling Station Descriptions and Habitat Quality

Tioughnioga River, West Branch, Station OC4. The Tioughnioga River was selected as the regional reference for Onondaga Creek (Figure 4-4). This station was located in Homer, New York, just downstream of the Highway 11 bridge and upstream from potential backwater influence resulting from a slow segment of the river that probably widened during construction of Interstate 81. Habitat quality was rated optimal for most of the parameters. The substrate was composed of cobble, and riffles were well-developed and prevalent. The lowest habitat score was for the riparian buffer zone width. The overall habitat assessment score was 191 (Table 4-7). Habitat quality would not limit the biological communities at this regional reference site.

Three sampling stations were selected on Onondaga Creek (Figure 4-3). The entire length of Onondaga Creek downstream of the Onondaga Tribal Reservation is channelized, and the state of the streambanks differs at all three stations. At the upstream station, the banks are mown and grassy; at the middle station, they are armored; and at the farthest downstream station, they consist of rubble and debris with some weedy vegetation. Habitat

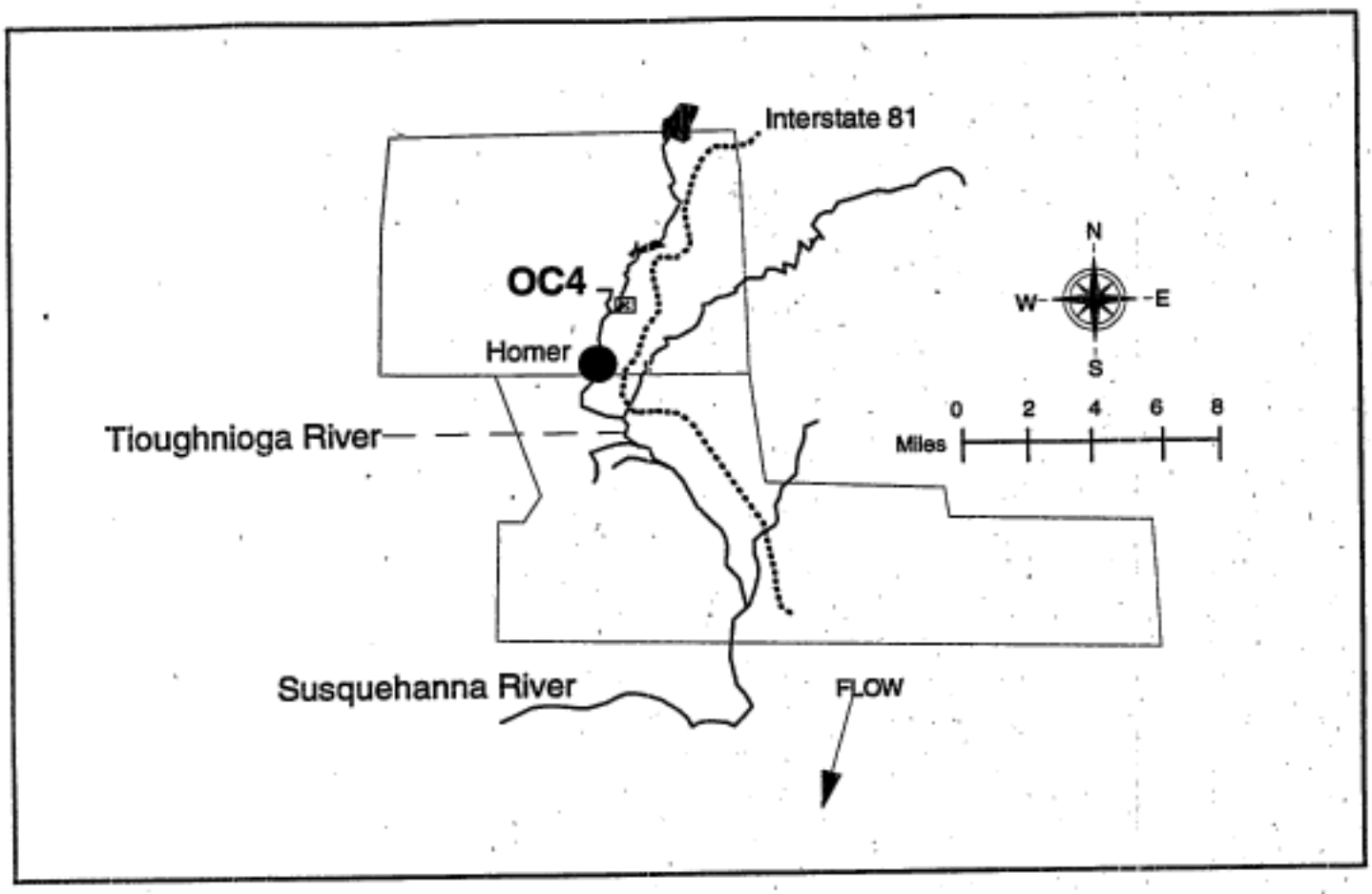

Figure 4-4. Location of sampling station on the Tioughnioga River (West Branch).

assessment scores along with measurements of dissolved oxygen, temperature, and conductivity are presented in Table 4-7.

Onondaga Creek, Station OC1. Station OC1 was estimated as approximately 50 meters wide and is channelized. This station was used as the upstream reference station because it was located above any CSO outfalls. The substrate was composed of mainly gravel with a high degree of embeddedness, there were no fast water riffles present at this site, and the velocity/depth regime was rated "very poor." The habitat variability at this site was minimal. The banks were stable but very little riparian buffer existed. According to DEC staff water was unusually clear at this station (S. Cook, personal communication, September 1993), at the time of sampling. The habitat assessment score was 86.

Onondaga Creek, Station OC2. The stream at this station was approximately 8 meters wide and was completely channelized with concrete armored sides. The substrate was composed of cobble with intermittent riffles; there was little embeddedness and sediment deposition. There was no riparian vegetative buffer zone, but the condition (i.e., stability) of the banks was rated optimal due to the armored sides. The habitat assessment score was 114.

Onondaga Creek, Station OC3. This station was located approximately 0.8 kilometer upstream of Onondaga Lake. The stream was approximately 10 meters wide with cobble substrate and intermittent, well-developed riffles. Riparian zone scores were the lowest rated at this station, which had little to no buffer zone and little bank vegetative protection. The overall habitat assessment score was 118.

The upstream reference station, OC1, was rated the poorest in the habitat assessment. The habitat at this station would seem to be the limiting factor for the development of the biological community. Although the bank vegetative stability at this site was rated in the optimal range, upstream erosion caused a marked increase in embeddedness and sediment deposition, which decreases the amount and variety of epifaunal substrate habitat available for colonization. The habitat assessments for the two CSO receiving stations were scored higher than that for OC1 in all instream habitat characteristics because there was a lack of apparent sedimentation and embeddedness. In spite of the absolute channelization with

Table 4-7 Onondaga Creek habitat assessment scores.

HABITAT PARAMETERS (0 - 20)		SCORES			
		Onondaga Creek Sampling Stations			
		OC1	OC2	OC3	OC4[a]
Substrate and Instream Cover	Instream Cover (Fish)	5	10	11	16
	Epifaunal Substrate	7	18	16	19
	Embeddedness	3	17	11	15
	Velocity/Depth Regimes	2	7	10	16
Channel-Morphology	Channel Alteration	1	1	3	13
	Sediment Deposition	6	16	13	16
	Frequency of Riffles	2	5	8	19
	Channel Flow Status	18	17	16	18
Riparian	Conditions of Banks	19	19	16	19
	Bank Vegetative Protection	18	1	7	17
	Grazing or Other Disruptive Pressure	4	3	6	15
	Riparian Vegetative Zone Width (Least Buffered Side)	1	0	1	8
TOTAL SCORE		86	114	118	191
Physicochemical Parameters	Temp (°C)	12.5	15	13.5	13
	pH	8.14	7.85	7.89	8.03
	Conductivity	---[b]	---[b]	---[b]	---[b]
	DO	10.6	9.8	8.3	10

[a] Tioughnioga River, regional reference site.
[b] Lack of physicochemical data is due to equipment failure.

mortared block banks, sufficient stands of older deciduous trees were present to supply substantial leaf litter and woody debris to the channel.

4.2.4.3 Biological Assessments

Screening level assessments (RBPI) for Onondaga Creek indicated moderate (OC1) to moderate-severe (OC2, OC3) impairment; the regional reference site on the Tioughnioga River was screened as having slight impairment. Further comparisons between the screening and rigorous assessments is discussed in Section 5.1.

This creek has been channelized along most of its length; for each of the three sites sampled in this study, characteristics of the channelization differed markedly and might temper conclusions. The upstream-most station, OC1, is in a section of the channel that is very wide and shallow and produced 39 taxa (in essence identical to the 40 from the Tioughnioga River, the regional reference site). Of these 39, however, 24 were genera of Chironomidae (midges), considered to be an overall pollution-tolerant taxon. This finding is reflected in its relatively high HBI of 6.1, contrasted to the 4.4 of the Tioughnioga site (OC4). Although *Cryptochironomus* (Chironomidae) accounts for the 11 percent dominant taxon (29 individuals), another 3 genera produced 23, 22, and 19 individuals. *Hydropsyche* and *Limnodrilus* (Oligochaeta: Tubificidae) were also dominant in these samples; they are both considered relatively pollution tolerant and often respond positively to organic nutrients. Station OC1

was calculated as being 63 percent comparable to the regional reference site and should be considered to have moderate impairment.

Station OC2, the middle station on Onondaga Creek and the first to receive CSO inputs, produced a sample that seemed to have a biological condition slightly improved over that seen at OC1. This is due primarily to a higher EPT-Chironomidae ratio, higher percentage of shredders in the sample, and higher QSI-Taxa (Table 4-3). However, as with OC1, the dominant taxa was comprised of Hydropsychidae and Chironomidae. This station was 70 percent comparable to the regional reference and should be considered to have moderate impairment.

The farthest downstream station, OC3, was rated as 41 percent comparable to the regional reference site. It produced a sample that was dominated primarily by *Nais* and *Ophidonais* (Oligochaeta: Naididae) (24 percent and 20 percent of total sample, respectively), and *Cricotopus* (Diptera: Chrionomidae) (12 percent of total sample). Also represented in a larger proportion than other taxa in this sample were *Dugesia* (Turbellaria) and Hydracarina sp. (Acari). All of these groups are considered to be tolerant to some levels of physical habitat degradation and toxicant input, and they often respond positively to increased nutrient loads. Station OC3 should be considered as severely impaired. Heavy urbanization effects make it difficult to isolate CSO effects in Onondaga Creek. However, excessive algal growth and high numbers of tolerant taxa suggest that substantial organic enrichment had occurred; the nutrient loading had likely originated with the CSOs.