

*A Biotic Index Evaluation of
Bassett Creek and Plymouth Creek: 2000*

*Prepared for
Bassett Creek Water Management Commission*

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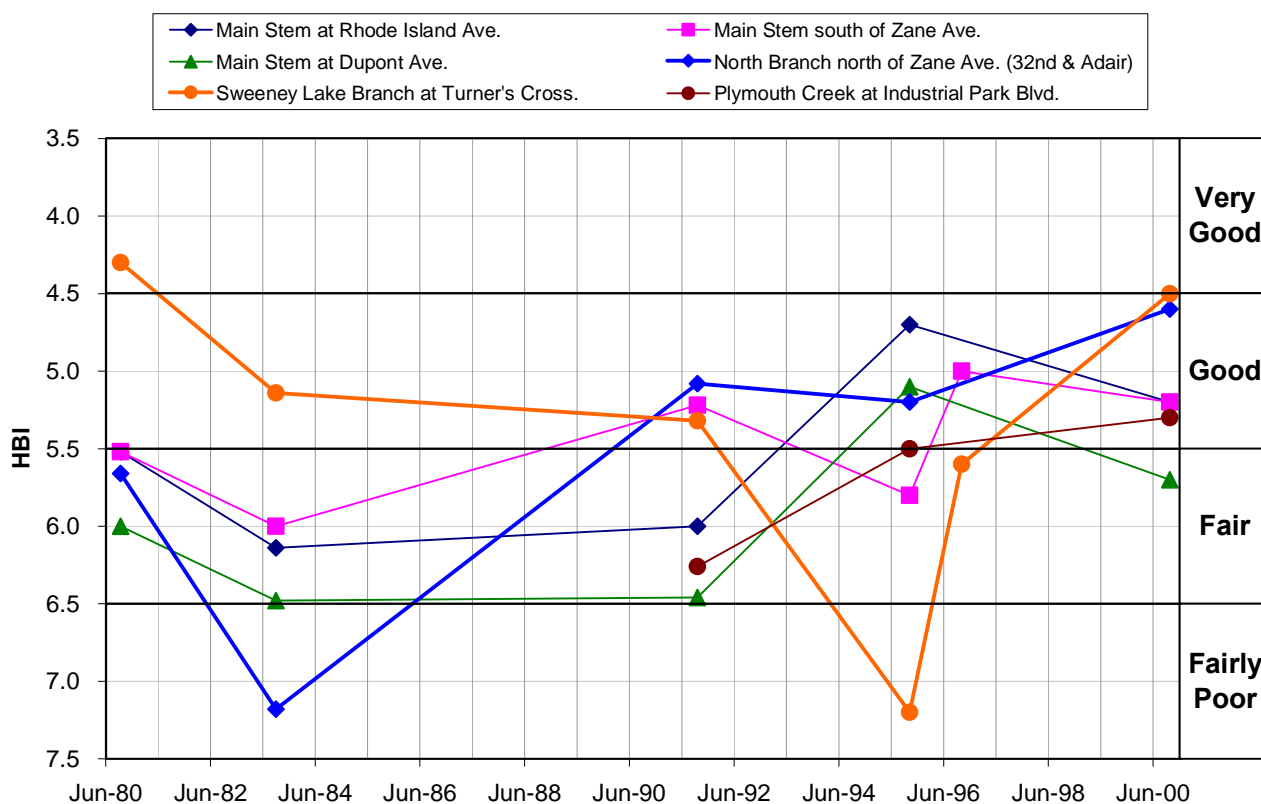
1.0 Executive Summary

Based on the results of bioindicators, the water quality in Bassett Creek from 1995 to 2000 generally remained in the *õgoodõ* range. However, the following exceptions were noted:

- Sweeney Lake Branch had water quality in the fairly poor and fair ranges during 1995 and 1996, respectively
- Main Stem South of Zane Avenue had water quality in the fair range during 1995
- Main Stem at Dupont Avenue had water quality in the fair range during 2000

The changes between 1995 and 2000 were not significant in five of the six stations. The exception was the Sweeney Lake Branch, which showed a significant improvement in water quality in 2000.

The biotic index results are summarized in the following figure:



Scientists use biological indicators to measure the amount of oxygen-demanding pollutants entering a stream. The biological indicators are benthic invertebrates, such as midge and caddisfly larvae. Their ability to tolerate low oxygen levels in water is graded. The average grade for all organisms found at a site is called the biotic index. Bassett Creek has been evaluated with the Hilsenhoff Biotic

Index (HBI) since 1980. A second index, the Invertebrate Community Index (ICI), was applied to the 1995 and 2000 data, as a second opinion. It, too, is an average grade of tolerance to pollution, but it uses a wider range of invertebrates and is based on Ohio streams, rather than Wisconsin streams. The second index is not based strictly on tolerance to low oxygen levels, and is, therefore, considered a measure of broader pollutant impacts.

Both biotic indices generally gave similar water quality classifications, but again, the exception was Sweeney Lake Branch station. Comparing the Sweeney Lake Branch to the other six stations, the HBI indicated it had the highest water quality, whereas the ICI indicated it had the lowest water quality. This discrepancy between the two indices suggest the oxygen-demanding pollutants are low at the Sweeney Lake Branch, but other pollutants or stressors, as reflected in the ICI, may be affecting the macroinvertebrates.

Notable changes in water quality should prompt a look at stormwater flow patterns, land-use changes, and watershed management practices. To identify the actual stressors, additional water quality monitoring would be needed. The monitoring would need to include collection of storm event runoff using automatic samplers and flow loggers. Water quality parameters could include total and dissolved phosphorus, total suspended solids, and metals.

Based on the results of the 2000 monitoring program, the following recommendations should be considered:

- Given the improvements in water quality that have occurred over the last 20 years and the stable water quality conditions of the last five years, the Commission's management efforts appear to be benefiting the water quality in Bassett Creek. Therefore, the Commission should continue to pursue the BMPs that have been installed in the last decade.
- The results of the biotic indices demonstrate they are useful in the long-term monitoring of water quality in Bassett Creek. Therefore, the Commission should continue to use the two biotic indices.
- To maintain the long-term monitoring record, the Commission should continue to sample all stations again in 5 years.

2.0 Introduction

Evaluating benthic macroinvertebrates (bottom-dwelling aquatic organisms) in a stream provides a long-term assessment of its water quality. The two biotic indices described in this report use biological indicator organisms to evaluate stream water quality. The types of organisms living on the stream bottom depend on the available habitat. The quality of the habitat is affected by the water quality. Water quality is degraded when pollutants enter a stream. Organic pollutants and nutrients cause a loss of oxygen. Organisms sensitive to low oxygen concentrations in the water are only able to survive in the highest water quality. There are tolerant invertebrate species that can survive in low oxygen conditions, and their presence indicates low water quality (i.e., organic pollution). Other stressors, such as high suspended solids concentration or high metals concentrations, can also affect the macroinvertebrate community. This report uses two biotic indices because one index is an indicator of organic pollution and the other index is an indicator of a broader range of pollutants.

During 1980, 1983, 1991, 1995, and 2000 benthic macroinvertebrates were collected from Plymouth Creek, the Sweeney Lake Branch, and from the North Branch and Main Stem of Bassett Creek to evaluate their water quality and to detect changes in water quality over time. This report presents the results of the benthic invertebrate monitoring on September 28, 2000 for the Bassett Creek Water Management Organization. Technical data regarding identification of macroinvertebrates and biotic index calculations are included, respectively, in Appendix A and Appendix B.

3.0 Methods

Monitoring for the presence or absence of biological indicator organisms provides *indirect* evidence of transitory changes in stream water quality related to storm runoff. Benthic invertebrates are exposed to all the temporal variations in stream water quality and integrate the quality of passing water. The presence of pollution-tolerant organisms and/or the absence of pollution-sensitive organisms demonstrate the adverse water-quality impacts of urban runoff better than do grab samples, and at a lower cost than storm-event sampling.

Benthic invertebrate samples were collected from Plymouth Creek, the Sweeney Lake Branch, and the North Branch and Main Stem of Bassett Creek on September 28, 2000. The sampling locations are identified as follows and are shown on Figure 1:

- Main Stem of Bassett Creek at Rhode Island Avenue in Golden Valley.
- Main Stem of Bassett Creek south of Zane Avenue North in Crystal.
- Main Stem of Bassett Creek at Dupont Avenue, upstream of the conduit, in Minneapolis.
- North Branch of Bassett Creek at 32nd Street and Adair in Crystal.
- Sweeney Lake Branch of Bassett Creek at Turner's Crossroad in Golden Valley.
- Plymouth Creek at Industrial Park Boulevard in Plymouth.

The locations are the same as in previous surveys, except for the North Branch location. In previous surveys, the North Branch was sampled just north of Zane Avenue. In 1995, this location had silted in and was no longer a representative habitat for the stream. A short distance upstream, however, at 32nd and Adair, the habitat was characteristic of the stream, and macroinvertebrates were collected at that site.

At each sample location, samples were collected from riffle areas where the flow was fairly rapid and the substrate was composed of gravel and small stones. Samples were collected by disturbing the creek bottom and allowing dislodged invertebrates to drift into a D-frame aquatic net downstream. Rocks and other substrate materials were also examined for invertebrates. Samples were collected for a total of 30 minutes at each sample location. All invertebrate samples were preserved in 80 percent alcohol and later identified in the laboratory.

Hilsenhoff's Biotic Index (HBI) has been used in all surveys to assess water quality at the sample stations, based on the macroinvertebrate communities (Hilsenhoff, 1982 and 1987). It was developed from research on more than 1,000 small streams in Wisconsin.

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Figure 1 Location of Biotic Index Sampling stations

Small streams such as Bassett Creek usually have few types of organisms because of their size, regardless of their water quality. Even though small streams have fewer types of organisms than larger streams, research indicates that HBI provides a good indication of water quality. Hilsenhoff describes the index as “a measure of organic and nutrient pollution, which causes lower dissolved oxygen levels” (Hilsenhoff, 1987). The HBI uses tolerance values assigned to species of arthropods (aquatic insects, amphipods, and isopods). Tolerance values indicate the species’ ability to survive in low-oxygen conditions and range from 0 to 10. The lower the value, the less tolerant the species to low dissolved oxygen. A tolerance value of 0 is assigned to species collected only in unaltered streams of very high water quality, and a 10 is assigned to species known to occur in severely polluted or significantly disturbed streams. Intermediate values have been assigned to species known to occur in streams with various degrees between good water quality and poor water quality. The following table shows how the biotic index values were used to determine water quality and the degree of organic pollution of the stream locations.

| Biotic Index | Water Quality | Degree of Organic Pollution |
|---------------------|----------------------|--------------------------------------|
| 0.00-3.50 | Excellent | No apparent organic pollution |
| 3.51-4.50 | Very good | Possible slight organic pollution |
| 4.51-5.50 | Good | Some organic pollution |
| 5.51-6.50 | Fair | Fairly significant organic pollution |
| 6.51-7.50 | Fairly poor | Significant organic pollution |
| 7.51-8.50 | Poor | Very significant organic pollution |
| 8.51-10.00 | Very poor | Severe organic pollution |

Beginning in 1995, the HBI has been supplemented with a second index that is calculated like the HBI but uses tolerance values derived from the Invertebrate Community Index (ICI), developed by the Ohio Environmental Protection Agency (DeShon, 1995). The ICI-based index uses the same data collected for the HBI but includes a wider range of invertebrates (e.g., Annelida and Mollusca). The ICI tolerance values were derived from the abundance of each taxa and the quality of the streams in which they were found. The scale for the ICI ranges from 0 to 60, with 60 being the highest quality. Like the HBI, the numeric scores are grouped according to water-quality categories, ranging from poor to exceptional. Those categories are not used here, however, because they specifically reference Ohio sites. The index is used here instead as a relative measure for comparison with the HBI (i.e., as a second opinion).

4.0 Results and Discussion

In general, the evaluation of Bassett Creek benthic macroinvertebrates indicates water quality in 2000 remained good and Sweeney Lake Branch had significant improvements in water quality. The HBI and ICI-based index for 1995 and 2000 are compared in Figure 2. The scales of the two indices are different. ICI uses a scale of 0 to 60, with 60 being the highest possible water quality. HBI uses a scale of 0 to 10, with 0 being high water quality and 10 being low water quality. The HBI scale is based on the tolerance of aquatic macroinvertebrates to low dissolved-oxygen concentration: A species assigned a value of 1 has a low tolerance to low dissolved oxygen and a species assigned a value of 9 is very tolerant. In the figure, the HBI scale is on the left and the ICI scale on the right. To avoid confusion, the indices are scaled to indicate improving water quality with increasing bar height.

The HBI- and ICI-based index values provide differing evaluations of stream water quality. The ICI-based index values are primarily a general indicator of pollutant loads in the stream and are not indicative of specific pollutants. Its relatively low inter-station variability suggests the general pollutant load in Bassett Creek/Plymouth Creek sample locations is relatively similar. However, the types of pollutants comprising the total load may vary between locations. In addition, the impact of pollutants on the stream's dissolved oxygen level may vary between stations. The HBI values are indicative of stream oxygen levels. HBI values exhibited greater inter-station variability than ICI values. The HBI variability is indicative of varying oxygen levels between stations. Despite differences in evaluation between the two indices, both indices provide the same overall evaluation of Bassett and Plymouth creeks.

Temporal water quality changes were evaluated from historical and current Bassett/Plymouth Creek HBI data. The results are summarized in Table 1. The Methodology of Hilsenhoff, 1987, was used to summarize all data prior to evaluation. Water quality changes were determined to be of statistical significance when temporal differences in HBI values exceeded 0.84 (Narf, et. al, 1984). The Sweeney Lake Branch was the only station to show a significant change in the HBI between 1995 and 2000. None of the changes (between 1995 and 2000) in the HBI at other stations were significant.

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Figure 2 Bassett Creek Macroinvertebrates Study HBI and ICI-Based Indices

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Table 1 HBI and ICI-Based Index for Six Macroinvertebrate Stations on Bassett and Plymouth Creeks

Figure 3 shows a graphical comparison of the HBI values at all stations since biomonitoring began in 1980. The designated water quality classes for the HBI are shown on the right vertical axis. The evaluation indicated the following:

- Statistically significant water-quality improvement occurred at the Sweeney Lake Branch location between 1995 and 2000; the water quality in 2000 was the best it has been since 1980.
- No statistically significant water-quality changes occurred at the other five stations between 1995 and 2000; however, over the 20-years period of biomonitoring, these stations have shown significant improvements in water quality

The results from each of the monitoring stations are discussed in the following sections.

4.1 Plymouth Creek

The HBI evaluation of Plymouth Creek indicates its water quality has improved from fair in 1991 to borderline fair-good in 1995¹ and remained about the same in 2000 (5.5 in 1995 and 5.3 in 2000).

The city of Plymouth has been concerned about the water-quality impacts of development in the watershed. Consequently, the city has implemented the Bassett Creek Water Quality Policy, which included ponding to mitigate impacts of stormwater runoff. It appears that these best management practices have had their intended beneficial impact, and that the water quality of Plymouth Creek has been protected from degradation despite rapid development in the watershed.

4.2 Sweeney Lake Branch

In 1995, this station had shown a remarkable decline in water quality, based on the HBI, prompting a return visit in 1996. The HBI in 1996 indicated water quality was significantly better than observed in 1995. In 2000, water quality again improved significantly in comparison to 1996. The water quality classification changed from fairly poor in 1995 to fair in 1996, and then to borderline good/very good in 2000. The Sweeney Lake Branch was the only station to show a degradation in water quality from 1991 to 1995 and the only station to show a significant improvement in 2000.

¹ As noted in the 1991 Biotic index Evaluation, efforts to evaluate Plymouth Creek's water quality during 1980 and 1983 were unsuccessful because of insufficient numbers of organisms in the stream. The HBI cannot be used when fewer than 50 organisms are collected. Plymouth Creek is an intermittent stream, and the number of organisms living in it is dependent upon streamflow. Low flows during 1980 and 1983 limited the colonization of the stream to a few organisms.

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Figure 3 Stream Water Quality Summary Based on Biological Indicators

The water quality degradation in 1995 is believed to be due to runoff from a large construction site located immediately upstream from this sample location. The construction project began approximately one month prior to sample collection. Rainstorms washed sediment and silt from the construction project into the stream during this one-month period.

The ICI-based index value for this station in 1995 and 2000 exhibited a different pattern from the HBI. The ICI did not indicate the poor water quality in 1995 and it showed a slight reduction in water quality in 2000. Moreover, the ICI for Sweeney Lake Branch was the lowest of all stations in 2000, while the HBI was the highest of all stations.

This suggests that while the HBI indicates the organic pollution has decreased at the Sweeney Lake Branch, there remains other stressors on the macroinvertebrate community that are reflected in the ICI but not the HBI. Notable changes in water quality should prompt a look at stormwater flow patterns, land-use changes, and watershed management practices. To identify the actual stressors, additional water quality monitoring would be needed. The monitoring would need to include collection of storm event runoff using automatic samplers and flow loggers. Water quality parameters could include total and dissolved phosphorus, total suspended solids, and metals.

4.3 North Branch

The HBI evaluation indicates the water quality at the North Branch of Bassett Creek has remained good since 1991. The water quality may have improved from 1995 to 2000, although the difference in the HBI (5.2 and 4.6) was not significant. The stable water quality noted in recent years was preceded by a significant improvement in water quality between 1983 and 1991. This improvement was believed caused by cessation of construction activities (bridge and culvert replacement) at several locations along the North Branch that had occurred between 1980 and 1983. As noted above, the sample location for the North Branch in 1995 was moved upstream from the previous location because the latter site no longer represented the habitat of the North Branch.

4.4 Main Stem

The HBI evaluation indicated water quality may have declined at the three Main Stem stations, but the differences between 1995 and 2000 are not significant. All the stations have shown a significant improvement in water quality since the 1980s. It will be particularly important to watch the water quality at Dupont Avenue to be sure the apparent decline in 2000 does not continue.

5.0 Recommendations

The 2000 benthic macroinvertebrate monitoring program has shown that significant changes in water quality occurred in the Sweeney Lake Branch since 1995, but the other stations remain stable. Given the large, urbanized watershed that Bassett Creek drains, the expectations are that water quality is not likely to improve beyond the existing good to fair conditions.

The addition of the ICI-based index in this study provides a "second opinion" on water quality based on biological indicators. It shows that while the organic pollutant load is apparently different among the stations, the general benthic invertebrate habitat is fairly consistent among the stations. The two indices did not, however, agree for the Sweeney Lake Branch: the HBI indicated very good water quality in 2000 and the ICI indicated fairly poor water quality. These results may indicate that organic (i.e., oxygen-demanding) pollutants are not a problem in the Sweeney Lake Branch, but there are other pollutants affecting the benthic invertebrates at this station. Additional monitoring would be needed to discern the reason for the difference between the two indices. The additional monitoring could look at suspended solids, nutrients, and metals as the likely pollutants affecting the biotic indices.

Based on the results of the 2000 monitoring program, the following recommendations should be considered:

- Given the improvements in water quality that have occurred over the last 20 years and the stable water quality conditions of the last 5 years, the Commission's management efforts appear to be benefiting the water quality in Bassett Creek. Therefore, the Commission should continue to pursue the BMPs that have been installed in the last decade.
- The results of the biotic indices demonstrate they are useful in the long-term monitoring of water quality in Bassett Creek. Therefore, the Commission should continue to use the two biotic indices.
- To maintain the long-term monitoring record, the Commission should continue to sample all stations again in 5 years.

In general, the Bassett Creek Water Management Organization should continue management practices that preserve or improve the current water quality of Bassett Creek.

References

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Table 1 HBI and ICI-Based Index for Six Macroinvertebrate Stations on Bassett and Plymouth Creeks

| Station (difference from previous year) | HBI | | | | | ICI* | | | |
|---|---------|-----------------|-----------------|------------------|-----------------|-------------------------|----------|---------|---------|
| | 9/19/80 | 9/8/83 | 9/24/91 | 10/12/95 | 10/8/96 | 9/28/00 | 10/12/95 | 10/8/96 | 9/28/00 |
| Main Stem at Rhode Island Ave. | 5.5 | 6.1 (0.62) | 6.0 (-0.14) | 4.7 (-1.3**) | | 5.2 (0.5) | 39.1 | | 40.4 |
| Main Stem south of Zane Ave. | 5.5 | 6.0 (0.48) | 5.2 (-0.78) | 5.8 (0.58) | 5.0 (-0.8) | 5.2 (-0.6 / 0.2) | 41.1 | 41.7 | 39.9 |
| Main Stem at Dupont Ave. | 6.0 | 6.5 (0.48) | 6.5 (-0.02) | 5.1 (-1.36**) | | 5.7 (0.6) | 35.1 | | 38.6 |
| North Branch north of Zane Ave. (32nd & Adair) | 5.7 | 7.2 (1.52**) | 5.1 (-2.1**) | 5.2 (0.12) | | 4.6 (-0.6) | 34.5 | | 39.6 |
| Sweeney Lake Branch at Turner's Cross. | 4.3 | 5.1 (0.84) | 5.3 (0.18) | 7.2 (1.88**) | 5.6 (-1.6**) | 4.5 (-2.7** / 1.1**) | 34.2 | 38.5 | 29.3 |
| Plymouth Creek at Industrial Park Blvd. | | | 6.3 | 5.5 (-0.76) | | 5.3 (-0.2) | 40.8 | | 40.8 |

* The ICI-based Index is not the actual ICI as used by the Ohio EPA. Like the HBI, it is an average of species tolerance values. The actual ICI uses other metrics that are referenced to relatively pristine streams in Ohio and are therefore not appropriate as Minnesota biometrics.

** Indicates significant difference from previous sample period; differences greater than 0.84 or less than -0.84 are considered statistically significant; for 9/28/00, the first value is the difference from 10/12/95 and the second value is the difference from 10/8/96.