Shingle Creek and Bass Creek Biotic Integrity Stressor ID

Prepared for

Shingle Creek Watershed Management Commission

Minnesota Pollution Control Agency

September 2010

wq-iw11-11n

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Wenck File #1240-83

Prepared for:

SHINGLE CREEK WATERSHED MANAGEMENT COMMISSION

MINNESOTA POLLUTION CONTROL AGENCY

September 2010

Prepared by:

WENCK ASSOCIATES, INC.
1800 Pioneer Creek Center
P.O. Box 249
Maple Plain, Minnesota 55359-0249
(763) 479-4200

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Executive Summary

This Stressor Identification (ID) report evaluates the factors that are the likely cause or causes of biological impairment in Shingle Creek and its tributary Bass Creek, in Hennepin County, Minnesota. This analysis was prepared using the United States Environmental Protection Agency's and Minnesota Pollution Control Agency's Stressor Identification guidance and the US EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS). CADDIS is a methodology for conducting a stepwise analysis of candidate causes of impairment. CADDIS characterizes the potential relationships between candidate causes and stressors and identifies the probable stressors based on the strength of evidence from available data.

In 2006, Shingle Creek (reach 07010206-506) was added to Minnesota's 303(d) List of Impaired Waters for biological impairment. Bass Creek (reach 07010206-527) was added in 2002. The MPCA has developed an Index of Biotic Integrity (IBI) to evaluate the biological health of streams in the State. Currently, an IBI has been developed for two biological communities: fish and macroinvertebrates. Shingle Creek is impaired based on the macroinvertebrate IBI (M-IBI) while Bass Creek is impaired based on the fish IBI (F-IBI).

Limited data are available to evaluate the integrity of the fish and macroinvertebrate communities and the effects of potential stressors. Fish data is over ten years old and available at only two locations. Droughts in 2008 and 2009 prevented an update of the fish surveys for the streams. Existing data suggests an unexpected fish species richness in Shingle Creek, with a more limited and pollution-tolerant community in Bass Creek. There is more recent and more spatially distributed macroinvertebrate data, but there are only a few data points for each location. The macroinvertebrate community is dominated by pollution-tolerant taxa, although sites with slightly better habitat appear to support some more moderately-tolerant organisms.

Potential candidate causes of the impairments that were ruled out based on a review of available data include: temperature, pH, nutrients, turbidity/TSS, and toxic chemicals. Five stressors that are potential candidate causes were examined in more detail: low dissolved oxygen; altered habitat; loss of connectedness; altered hydrology; and ionic strength, specifically chloride. Shingle Creek is also listed as an Impaired Water due to low levels of dissolved oxygen, and both Shingle and Bass Creeks are listed for excess levels of chloride.

These five stressors were evaluated according to CADDIS' structured, weight-of-evidence approach to determine which stressor or stressors were the likely candidate cause or causes of the impairments to Shingle and Bass Creek. The evidence for altered hydrology is strongest followed closely by dissolved oxygen and lack of habitat. While the loss of connectedness and ionic strength are plausible stressors and are likely contributing to the impairment, there is less direct evidence of their role. Altered hydrology, dissolved oxygen, and habitat are interrelated and interacting. The probable causes established in this stressor identification process will be addressed in the Shingle Creek and Bass Creeks Biota and Dissolved Oxygen TMDL.

1.0 Introduction

1.1 PURPOSE

This Stressor Identification (ID) report evaluates the factors that are the likely cause or causes of biological impairment in Shingle Creek and its tributary Bass Creek, in Hennepin County, Minnesota. This analysis was prepared using the United States Environmental Protection Agency's (US EPA) and Minnesota Pollution Control Agency's (MPCA) Stressor Identification guidance and the US EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS). CADDIS is a methodology for conducting a stepwise analysis of candidate causes of impairment. CADDIS characterizes the potential relationships between candidate causes and stressors, and identifies the probable stressors based on the strength of evidence from available data.

1.2 PROBLEM IDENTIFICATION

Shingle Creek (Reach 07010206-506) was first placed on the 2006 State of Minnesota's 303(d) list of impaired waters for impairment of aquatic life as measured by aquatic macroinvertebrate bioassessments. Bass Creek (Reach 07010206-527) was first placed on the 2002 State of Minnesota's 303(d) list of impaired waters for impairment of aquatic life as measured by fish bioassessments. Both are urban streams in an almost entirely developed urban and suburban watershed.

1.3 WATERSHED AND STREAM DESCRIPTIONS

The Shingle Creek watershed covers 44.7 square miles in east-central Hennepin County. The main stem of Shingle Creek begins in Brooklyn Park and flows generally southeast to its confluence with the Mississippi River in Minneapolis. Shingle Creek is formed at the junction of Bass Creek and Eagle Creek at approximately the interchange of I-94 and Boone Avenue (Figure 1.1). Shingle Creek is about 11 miles long and drops approximately 66 feet from source to mouth. Bass Creek is the outlet of Bass Lake, and is approximately 2.4 miles long. Bass Creek is formed at the weir that controls the level of Boulder Ridge Pond, the last in a series of wetlands downstream of Bass Lake. Upstream of Bass Lake, a series of ditches connecting and draining wetlands and discharging to Bass Lake is designated Upper Bass Creek and is not part of this study.

Shingle Creek and its tributaries flow through various landscapes, ranging from parkland and greenway to residential backyards and commercial/industrial areas. There are several sizable flow-through wetlands on the streams, including the 400+ acre Palmer Lake basin.

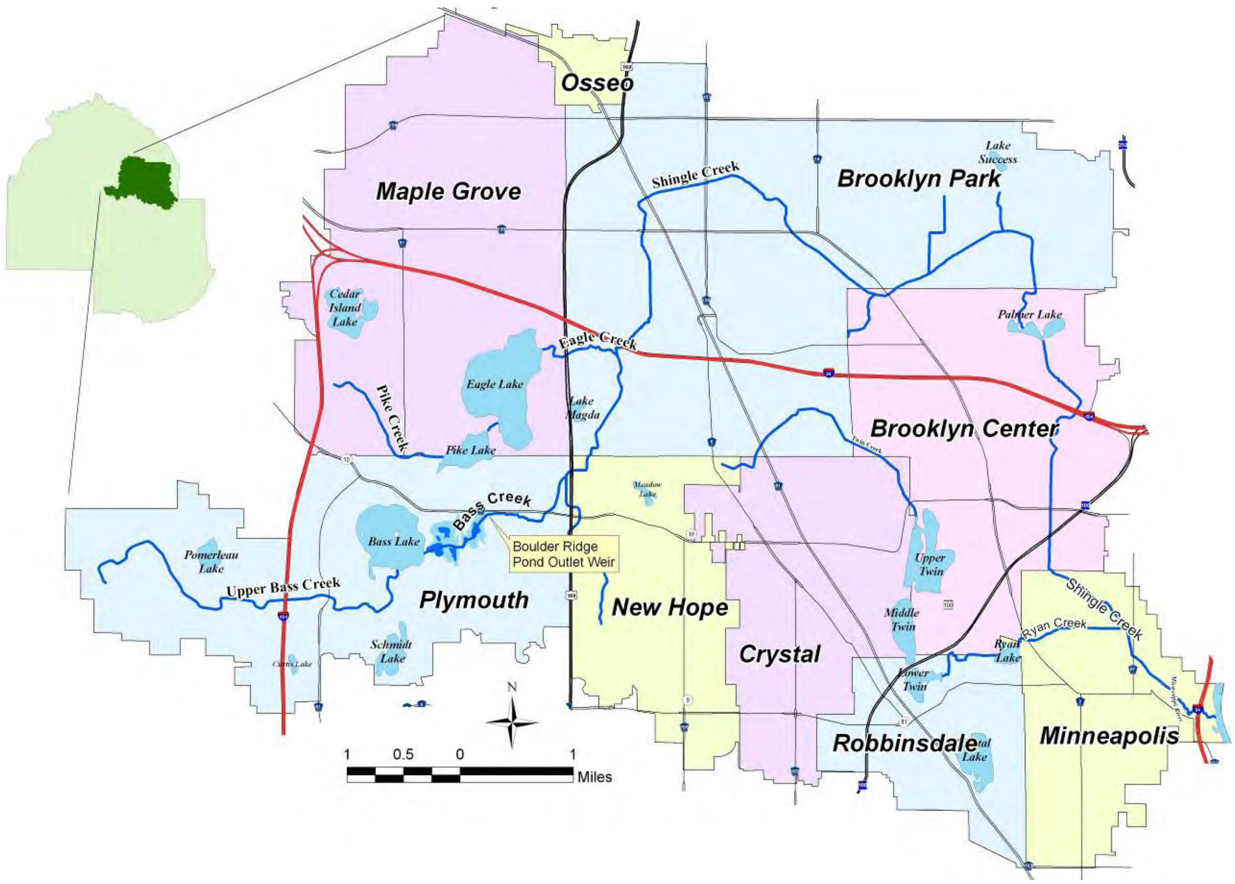


Figure 1.1. The Shingle Creek watershed in Hennepin County, Minnesota.

1.4 LAND USE

The Shingle Creek watershed is almost entirely developed. Table 1.1 details 2005 land use, which is illustrated on Figure 1.2. Single family residential is the largest land use classification at 44 percent of the total watershed area. Park, Recreation, and Open Space uses constitute about 10 percent of the watershed area, and about 15.5 percent of the watershed area is used for commercial or industrial purposes. A large gravel mining area in the upper watershed is being redeveloped in phases with mixed commercial and residential use ("Arbor Lakes"). About seven percent of the watershed is undeveloped, and those lands are mainly wetland in the upper watershed (Plymouth and Maple Grove). Only a few agricultural parcels remain in the upper watershed, and those are primarily grazing lands. The entire watershed is on average 30-35 percent impervious. The lower watershed is more densely developed and is more impervious than the upper watershed.

A network of storm sewers and channels drains the entire watershed. There are at least 60 mapped storm sewer outfalls into Shingle and Bass Creeks, and there are almost certainly additional unmapped discharges. About 20 open channels, some natural small streams and some man-made ditches, also discharge to the creek, mostly in Brooklyn Park. Much of the upper watershed developed after the Shingle Creek Watershed Management Commission (Commission) enacted stormwater detention and treatment regulations so there is significant treatment and stormwater rate control in place. However, most of the lower watershed is lacking pretreatment and rate control. Cities in the lower watershed are incorporating detention and treatment into street reconstruction and redevelopment projects but it will be decades before the retrofit of the lower watershed is complete.

Table 1.1. 2005 land use in the Shingle Creek watershed.

LAND USE	Area (acres)	Percent
Single Family Residential	12,530	43.8%
Park, Recreation or Preserve	2,837	9.9%
Industrial and Utility	2,476	8.7%
Undeveloped	2,054	7.2%
Commercial	1,933	6.8%
Institutional	1,464	5.1%
Water	1,301	4.5%
Major Highways	1,180	4.1%
Extractive	1,108	3.9%
Multi-Family Residential	944	3.3%
Airport	382	1.3%
Mixed Use	162	0.6%
Agriculture	160	0.6%
Railway	68	0.2%
Farmsteads	14	0.0%
TOTAL	28,612	

Source: Metropolitan Council, derived from city Comprehensive Plans.

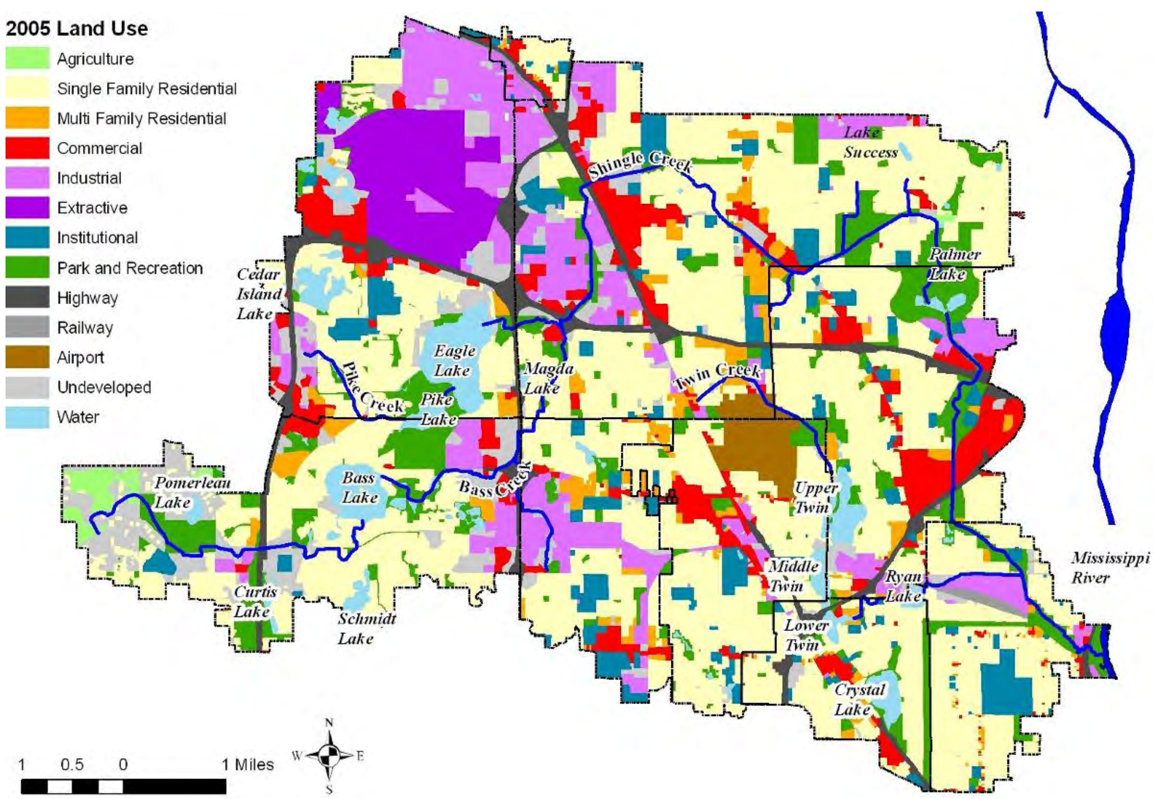


Figure 1.2. 2005 land use in the Shingle Creek watershed.

1.5 HISTORIC WATERSHED AND STREAM CONDITIONS

Pre-European settlement stream conditions and morphology were inferred by examining notes from the Public Land Survey (PLS), accounts of early settlers, and old aerial photos. That part of Crystal Lake Township (Township 118 Range 21) outside of the Minneapolis survey and Brooklyn Township (Township 119 Range 21) were first surveyed in 1855. By that date, the notes reveal, all of the land in the area had been claimed, and a number of small farms were already beginning to appear. The land cover was generally prairie and what at the time was called oak openings (oak savanna). The far western part of the watershed, near the headwaters of what would become Bass Creek, was part of the Big Woods.

While there are no detailed maps or drawings of Shingle Creek showing its pre-European settlement morphology, the PLS notations and township sketches provide some information. Shingle Creek crosses section lines in several places, and at each crossing the surveyor notes the location of the creek, its estimated width, and sometimes its depth. The township sketches depict Shingle Creek using a wavy line that indicates a meandering stream.

The public land survey notes and maps suggest that early Shingle Creek was a shallow, heavily meandering stream 10 feet wide or less that flowed through savanna and prairie in its upper reaches. At one point, the surveyor noted the creek meandered across the section line five times within 600 feet. Just north of Palmer Lake, the land became marshy and the creek widened. South of Palmer Lake, the creek became wider than its current width, and flowed through extensive wetlands that were sometimes more than a half-mile wide. At one location, in the wide hay marsh south of where Brooklyn Center's Civic Center and the Hennepin County Brookdale Service Center now stand, the surveyor described the creek as being 75 feet wide – essentially a large, flow-through wetland.

The PLS did not show either upper or lower Bass Creek on the township maps. The 1873 Plat Map of Hennepin County shows a short, small stream draining to Eagle Creek, in approximately the location of lower Bass Creek from what would now be about Cherokee Drive. It is likely that this was a constructed or enhanced outlet to the Cherokee Drive wetland. The 1889 Plat Map of Brooklyn Township shows a longer stream extending upstream almost to the current TH 169 crossing.

The 1902 USGS topographic map for the area shows Bass Creek extending to the large wetland complex in the northwest quadrant of Bass Lake Road and TH 169. That map also shows what could be a small channel connecting the upstream end of that wetland with the Timber Shores/Boulder Ridge complex at the outlet of Bass Lake.

What is clear from examining these maps is that Eagle Lake and Eagle Creek were the historic headwaters of what would later become known as Shingle Creek. Lower Bass Creek (that is, Bass Creek downstream of Bass Lake), was either an intermittent channel too small to be recorded on the PLS and then later ditched to drain wetlands and/or provide agricultural drainage, or it was created to provide those functions. In any case, by about 1900 it existed in approximately its current alignment, at least from Bass Lake Road to the confluence with Eagle Creek.

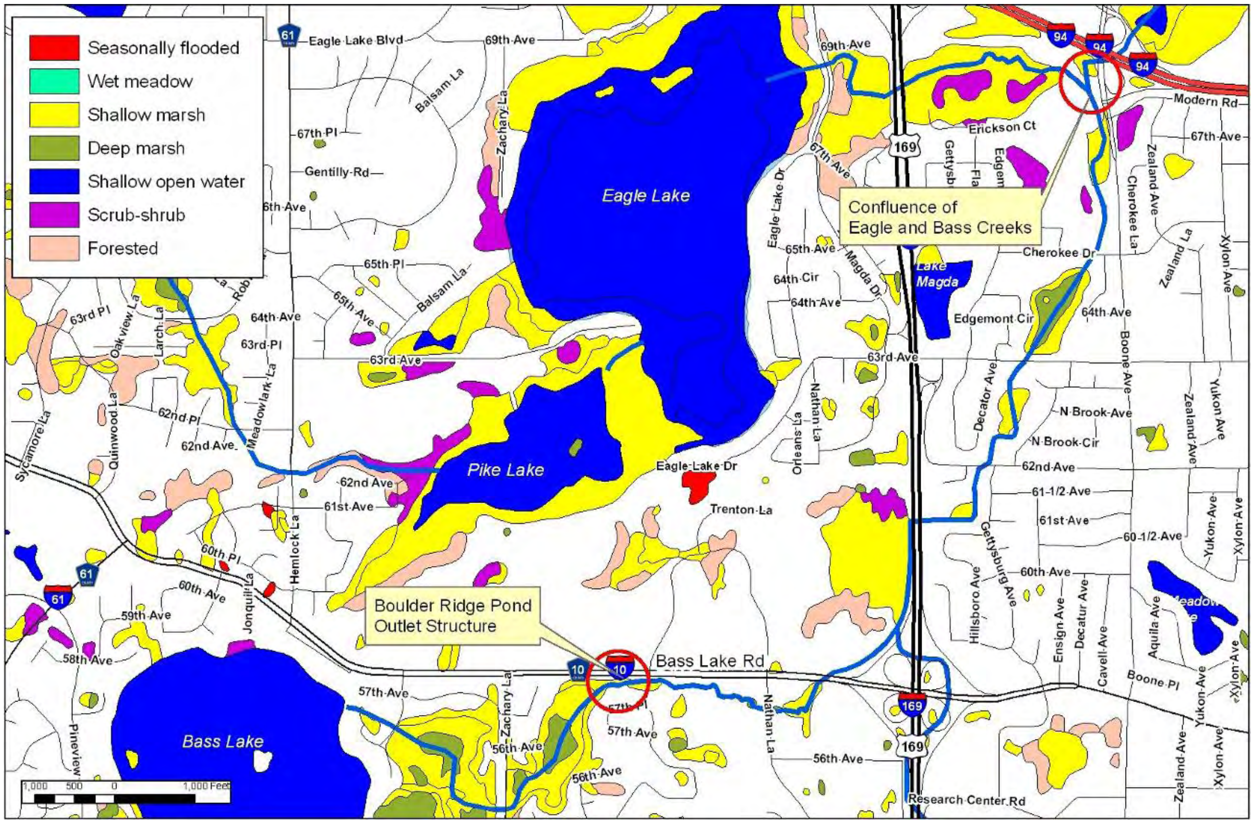


Figure 1.3. Bass Creek and National Wetlands Inventory wetlands.

In 1910 Hennepin County dredged and straightened Shingle Creek from Xerxes Avenue in Brooklyn Park through Brooklyn Center to about Webber Park in Minneapolis as County Ditch #13. An aerial photo from 1947 (see Figure 1.4) shows that upstream of Xerxes Avenue the creek still retained its meandering character, which apparently still existed until a 1960 project straightened and ditched the reach from Brooklyn Boulevard west of Zane to Brooklyn Boulevard south of Regent. That project may have also included installation of a small dam just upstream of the northern Brooklyn Boulevard crossing to provide for a small recreational pool. As the channel was straightened in Brooklyn Park, two small drop structures were added to accommodate elevation changes. In the late 1950s the creek in North Minneapolis was relocated and dredged. In the late 1960s, to provide for the expansion of the Brookdale Shopping Center in Brooklyn Center, the creek was confined to a 900 foot long culvert under its parking lot.

In the late 1970s, a seven foot drop structure on Shingle Creek in Webber Park near Lyndale Avenue North was constructed as part of the I-94 construction project from downtown Minneapolis to I-694. Shingle Creek was straightened and lowered to facilitate construction of the freeway.

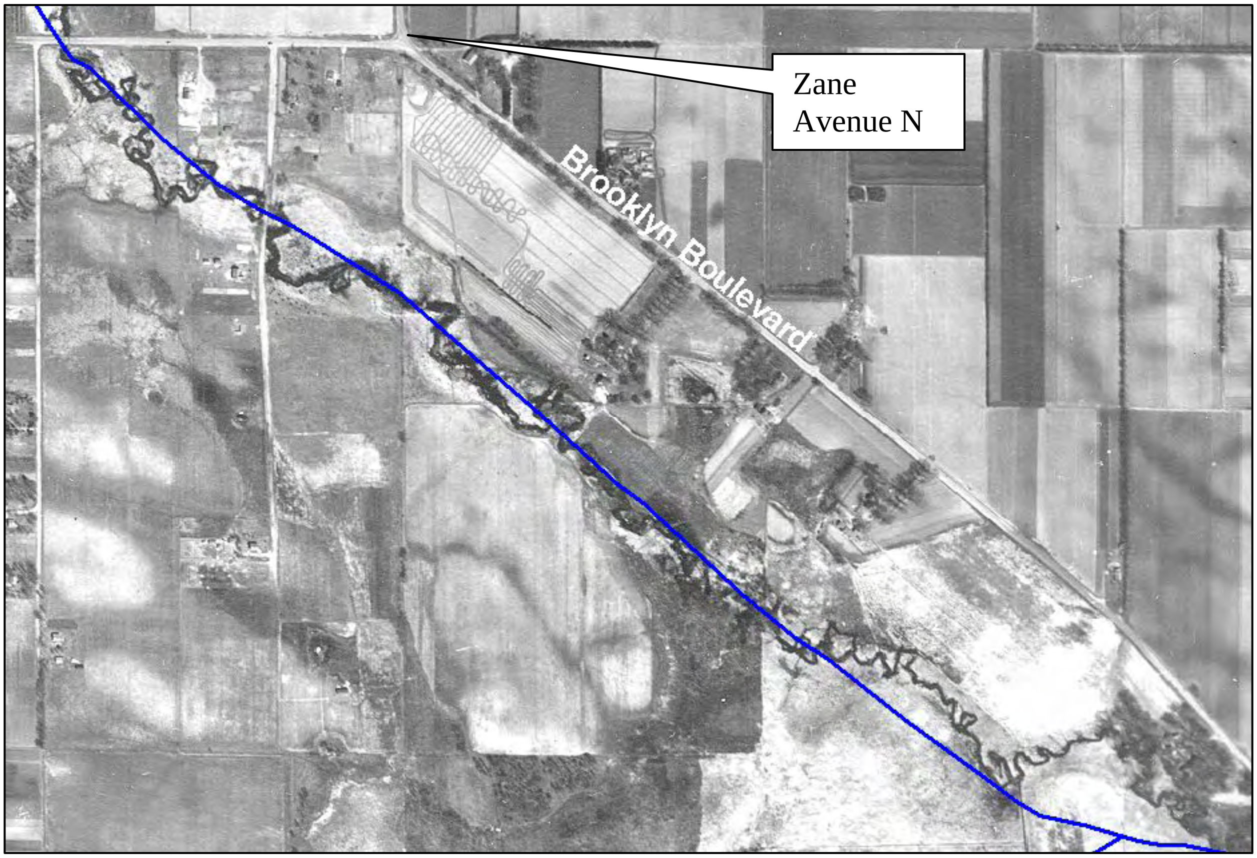


Figure 1.4. 1947 aerial photo of Shingle Creek downstream of Zane Avenue in Brooklyn Park.
Note: The blue line is the current stream alignment, constructed in 1960.

1.6 CURRENT STREAM CONDITIONS

Today both Shingle Creek and Bass Creek are important components of the storm drainage system for nine cities. Flows in the two streams are dominated by urban stormwater.

The Commission undertook condition surveys of Shingle Creek, Bass Creek, and other streams in the watershed in 2003 and 2006 and published the findings in the 2004 Shingle Creek Corridor Study and 2007 Phase II Stream Assessment. These assessments found that the streams have been straightened, channelized and dredged, and function mainly to convey stormwater from the watersheds to Shingle Creek and the Mississippi River. The streambanks are relatively stable, although some erosion, downcutting, and lateral cutting continue in localized areas.

Riparian buffer width varies considerably, in some cases hundreds of feet and in others the stream passes through residential back yards with no buffer at all. Most of the riparian vegetation is cattail marsh, lowland hardwood forest, or a mix of invasive, cultivated, or opportunistic herbaceous species. Little in-stream habitat is available for fish, macroinvertebrates, and other aquatic life. There are very few natural stream features such as riffles and pools and meanders.

The Commission monitors stream stage at 15 minute intervals at two water quality monitoring sites on the stream, and maintains an updated rating curve for those sites to calculate flow. The USGS site at Queen Avenue is monitored continuously, and real-time flow and water quality data are available on-line at http://waterdata.usgs.gov/mn/nwis/uv?05288705.

The hydrologic regime for Shingle Creek above Palmer Lake is different than below Palmer Lake. Below Palmer Lake, except in the most extreme drought conditions, there is always flow in the stream, usually bank to bank. Above Palmer Lake, base flow is often not sufficient to fill the channel and substrate becomes exposed. The upper reaches often go nearly dry, with flow reduced to a small trickle. In both of these reaches, storm hydrographs show a very “flashy” stream that rises quickly but then discharges quickly. This is typical of urban streams, and is a result of increased impervious surface increasing runoff and decreasing base flow. No flow data are available for Bass Creek, but by observation the stream upstream of the Cherokee Drive wetland flows only seasonally/intermittently.

The Commission monitors water quality in Shingle Creek at two locations and publishes that data in an annual Water Quality Report. Water quality is typical of an urban stream in the Twin Cities Metro Area for most chemical and physical parameters. However, Shingle Creek was placed on the 1998 State of Minnesota 303(d) list of impaired waters for excessive chloride concentration, and in 2007 a TMDL was approved for that impairment. Bass Creek was placed on the draft 2010 303(d) list for excess chloride concentration. In addition, in 2004 Shingle Creek was placed on the 303(d) list for low dissolved oxygen. Much of the upper watershed developed under watershed regulations so there is significant water quality treatment and stormwater rate control in place. Much of the lower watershed is lacking in pretreatment and rate control.

2.0 Description of the Impairment

In 2006, Shingle Creek (reach 07010206-506) was added to Minnesota's 303(d) List of Impaired Waters for biological impairment. Bass Creek (reach 07010206-527) was added in 2002. The MPCA has developed an Index of Biotic Integrity (IBI) to evaluate the biological health of streams in the State. Currently, an IBI has been developed for two biological communities, fish and macroinvertebrates. Shingle Creek is impaired based on the macroinvertebrate IBI (M-IBI) while Bass Creek is impaired based on the fish IBI (F-IBI).

2.1 AVAILABLE DATA

2.1.1 Fish

The Shingle Creek and Bass Creek fisheries are located in an urban setting with varying habitat quality and type throughout the streams. The streams are channelized, and lack quality and variety in stream habitat for fish populations. Some quality riffle areas with gravel and cobble substrate are present, but the majority of fish habitat exists in the form of deep glides and pools, overhanging vegetation, and woody debris. There is an overall lack of aquatic vegetation to be utilized as fish habitat in the stream. There are several fish barriers, including a seven foot drop structure in Webber Park in Minneapolis just upstream of the Mississippi River that effectively prevents fish from swimming upstream from the River. There are other, smaller drop structures along Shingle Creek.

Lakes connected to Shingle and Bass Creeks provide refuge for fish during low flow periods in which fish become stressed by large temperature and dissolved oxygen changes. These larger waterbodies also provide breeding and nursery areas for many fish species. However, all of those lakes are cut off from access by outlet control structures. There are some connected wetlands and backwaters that could provide high-flow refugia.

There is a limited amount of fish community data available for Shingle and Bass Creeks, and most of that data is nearly ten years old or older. Attempts were made in 2007, 2008, and 2009 to update that data for the purpose of this Stressor ID, but due to extended periods of low flow conditions, sampling was unable to occur. Sampling will be updated in the next few years when conditions permit. Available data is detailed in Appendix A.

A survey of the fish community was conducted by the Commission in 1996 following the guidelines for Rapid Bioassessment established by the EPA. This survey was in partnership with the USGS as part of its National Water Quality Assessment Program (NAWQA). The MPCA completed fish surveys on Shingle and Bass Creeks in 2000 as part of a study of urban stream fish communities in the Twin Cities Metropolitan Area. In all surveys, the samples were collected using electrofishing equipment in different reaches of the stream. The fish were identified by species, and the species composition was used to interpret biological health and water quality conditions in the stream. The species richness, the total number of species present in Shingle Creek, was at or slightly above the average for other metropolitan area streams. The fish species present indicate that Shingle Creek is a warm water fishery. Both the Commission and MPCA sampling was completed at the USGS monitoring site at Queen Avenue in Minneapolis. This site has a sandy bottom and some small riffle areas. Several hundred feet upstream is an area with a sandy gravel bottom and a larger riffle.

Both fish collections on Shingle Creek (see Appendix A) were dominated by white suckers and bigmouth shiner, both of which are moderately tolerant of turbid and lower oxygen conditions. Other taxa collected in the surveys that are considered moderately tolerant include Johnny darters, madtoms and black crappie. The riffles and sandy gravel streambed in the vicinity likely increase the diversity of the fish community at this location. However, a significant number of tolerant individuals and taxa were also present, typical of degraded urban streams.

Fish sampling conducted on Bass Creek in 2000 by the Minnesota Department of Natural Resources (DNR) indicated very low species richness, dominated by tolerant individuals. The survey found only five species: brook stickleback, fathead minnows, central mud minnows, common carp, and a few green sunfish. The fathead minnow were most abundant, unsurprising as they and the other species identified are tolerant of turbid, low-oxygenated water.

The Upper Mississippi River Basin Index of Biotic Integrity (IBI) for moderate sized streams draining 35 to 200 square miles is calculated from a series of metrics. These include:

- Total number of species
- Number of darter, sculpin and madtom species
- Number of wetland species (*tolerant species not included*)
- Number of intolerant species
- Percent of individuals that are tolerant species
- Number of invertivore species (*tolerant species not included*)
- Number of piscivore species
- Percent lithophils
- Number of fish per 100 meters (*tolerant species not included*)
- Percent DELT anomalies

(Niemela and Feist, 2002)

Fish monitoring locations are shown in Figure 2.1. Fish community IBI scores for Shingle and Bass Creeks are shown in Figure 2.2. Table 2.1 compares the streams on some of the IBI metrics.

Table 2.1. Comparison of Shingle and Bass Creeks on various fish IBI metrics.

Metric	Shingle Creek	Bass Creek
# of species	10 - 15	5
Madtom, sculpin and darters	1-2	0
Wetland species	0 - 2	0
Intolerant species	0	0
% tolerant individuals	25 - 95%	100%
Pisciverous species	0 - 2	0
Lithophils (gravel spawners)	0 - 2	0
Fish IBI	49-55	12

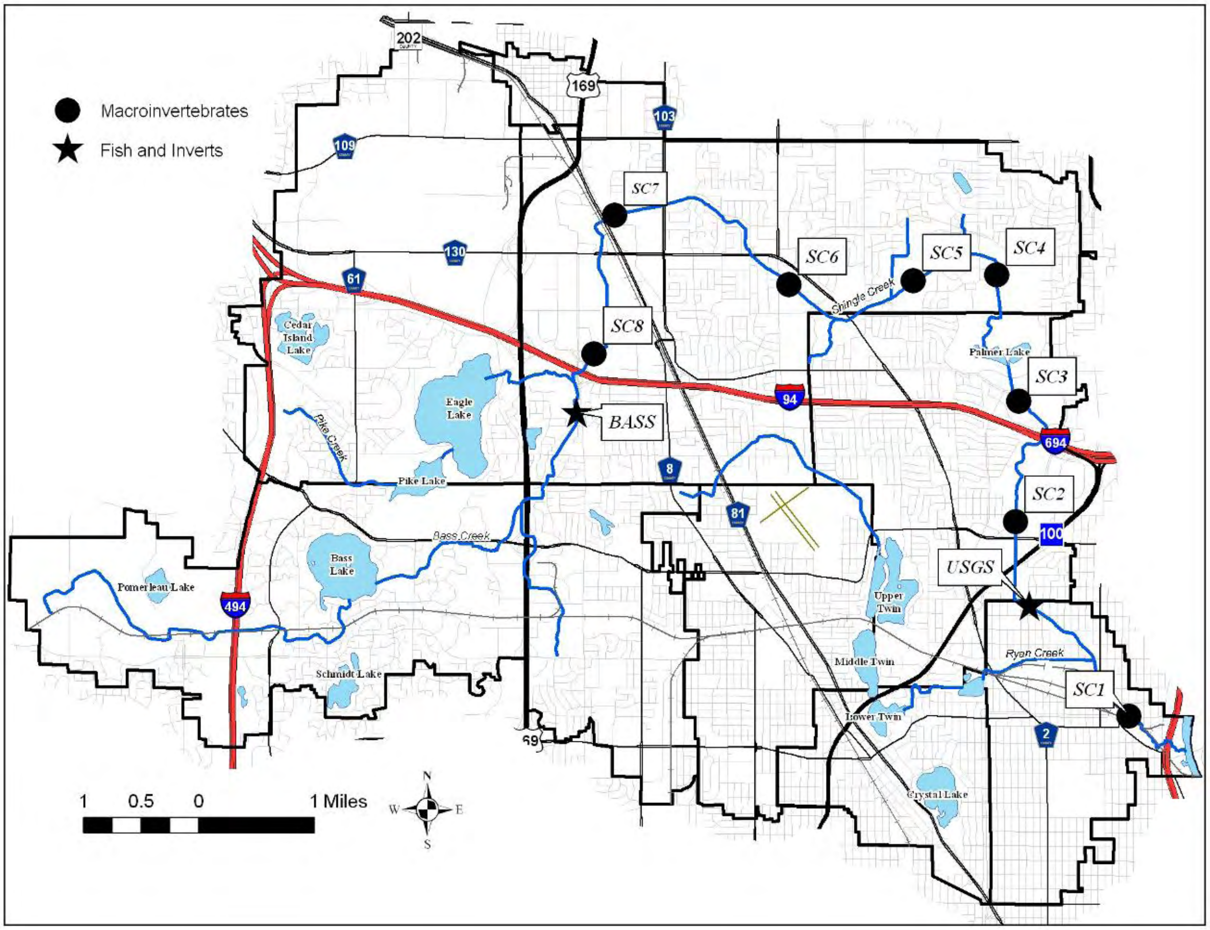


Figure 2.1. Biotic monitoring locations on Shingle and Bass Creeks.

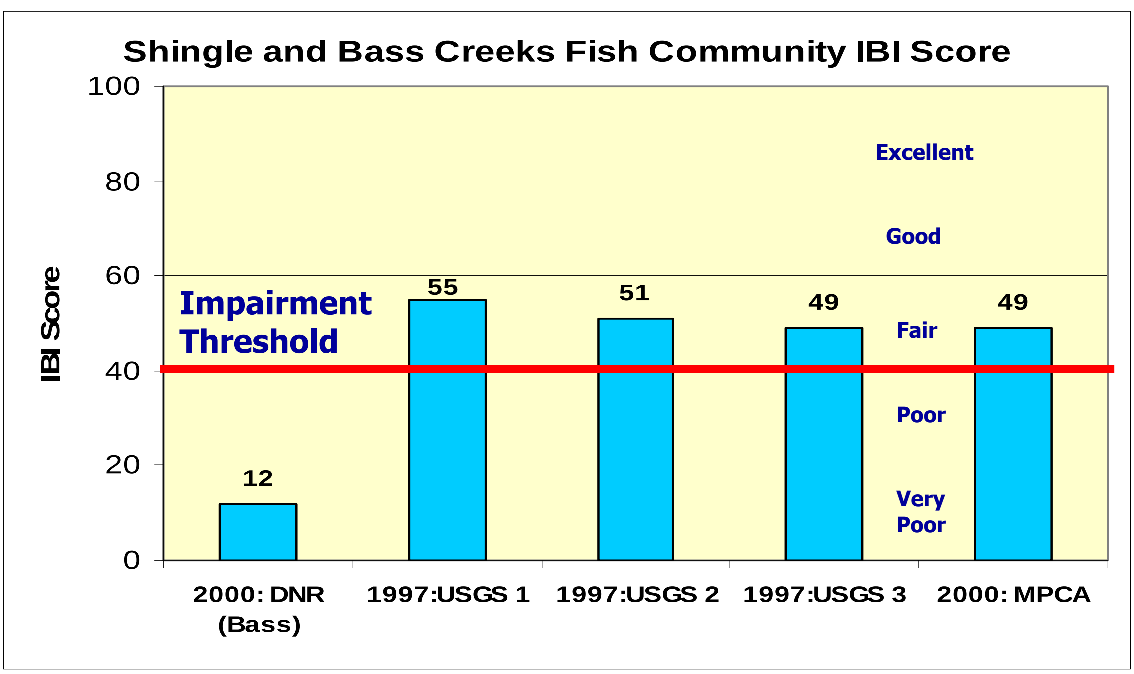


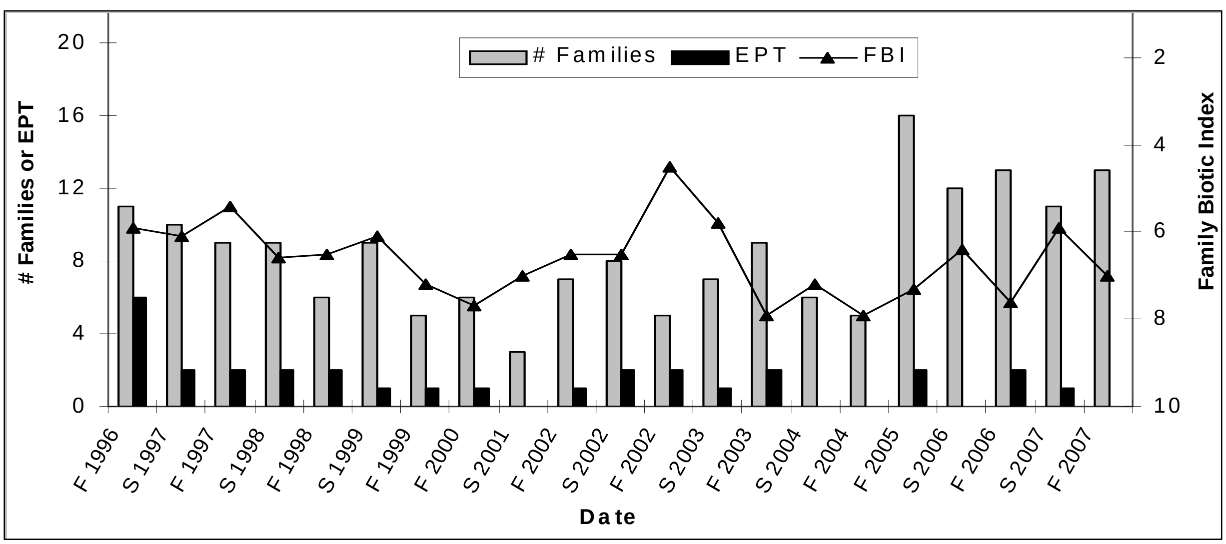
Figure 2.2. Fish IBI scores from past fish surveys.
Note: All locations are Shingle Creek unless noted, and are shown on Figure 2.1. The 1997 survey was conducted at three subreach locations at the USGS site on Shingle Creek.

2.1.2 Macroinvertebrates

Macroinvertebrate habitat conditions vary throughout Shingle and Bass Creeks. The best habitat is a sinuous channel, hard bottom substrate, and a diversity of microhabitats such as pools, riffles, undercut banks, woody debris, and riparian zone variety. Most of the stream reaches are highly channelized, have a low riffle/pool ratio, lack in stream cover, and have soft bottom sediments which are frequently changing.

Macroinvertebrate data is available from two sources: ongoing volunteer monitoring and monitoring conducted for special studies such as the Shingle Creek Corridor Study and the Shingle Creek Chloride TMDL. Some additional sampling was conducted for this stressor ID, but the low flow conditions in 2007-2009 severely limited sampling locations. Except for the volunteer data, sampling follows the MPCA multi-habitat method, collecting a composite sample from up to five different habitat types within a sample reach. Available data is detailed in Appendix A.

Volunteer sampling. Volunteers have collected macroinvertebrates on Shingle Creek through Hennepin County's River Watch program since 1996. Through this program, the county coordinates student and adult volunteers who use the River Watch protocols to collect physical, chemical, and biological data to help determine the health of streams. The results of this type of invertebrate sampling are qualitative, and are used as one indicator of the stream's health. The River Water program uses the Family Index of Biotic Integrity, which provides a general indication of stream condition. One of the most valuable aspects of the program is its time series data. One site on Shingle Creek has been monitored by Park Center High School students since 1996 (see Figure 2.3). The increase in number of families found starting in 2005 is likely a reflection of a 2003 change in sampling procedure, which now uses a multi-habitat sampling protocol, as well as a wet year in 2005.



Note: Graphic by Hennepin County Environmental Services. F=Fall and S=Spring.
Figure 2.3. Family biotic index, Shingle Creek at Park Center High School near Noble Avenue North.

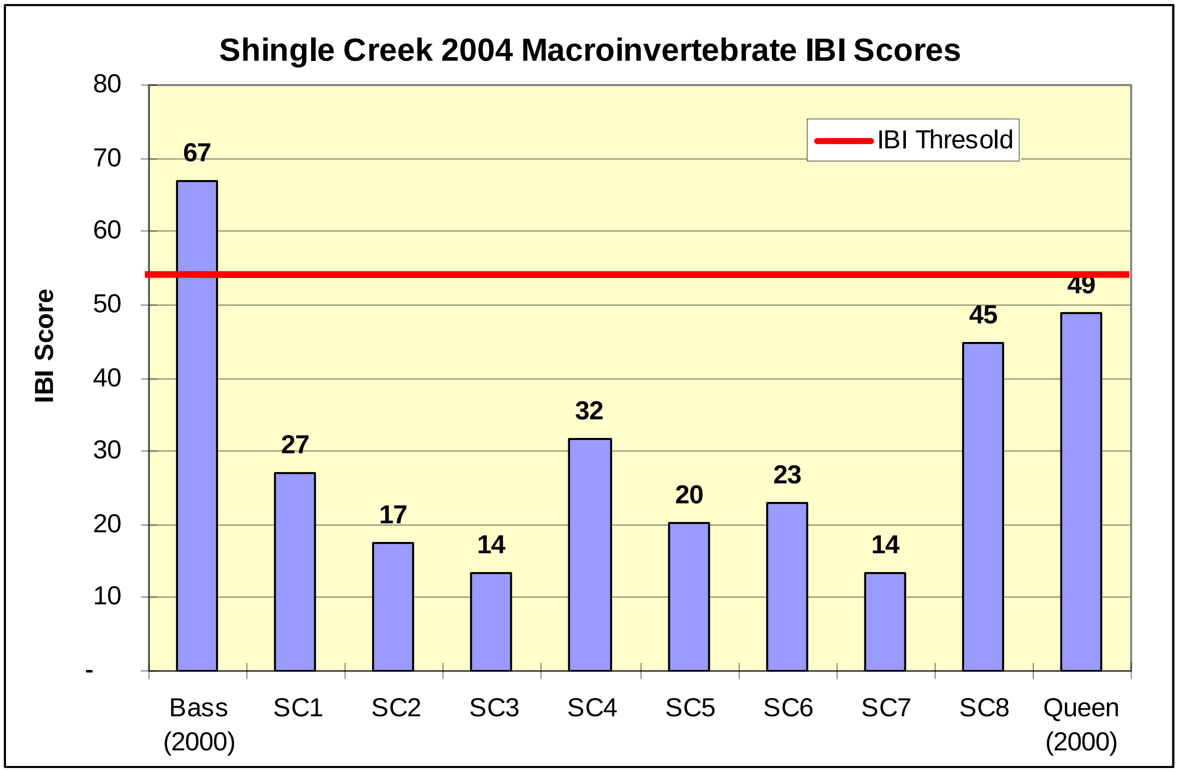


Figure 2.4. Stream macroinvertebrate sampling results in Shingle and Bass Creeks.
Note: All locations are Shingle Creek unless noted, and are shown on Figure 2.1.

Other sampling. The DNR and the MPCA conducted macroinvertebrate monitoring on Bass and Shingle Creeks in 2000. Other macroinvertebrate sampling has been completed by the Commission for the Shingle Creek Corridor Study (2004) and for the Shingle Creek Chloride TMDL (2003) (see Figure 2.1 for locations). The results are shown in Figure 2.4. Interestingly, while Bass Creek exhibited a low fish IBI in 2000, its macroinvertebrate IBI was better than the impairment threshold. And Shingle Creek, which showed a fish IBI better than the impairment threshold, scored poorly on the macroinvertebrate threshold.

The Upper Mississippi River Basin Index of Biotic Integrity for riffle/run streams draining less than 500 square miles is calculated from a series of metrics. These include:

- Number of Trichoptera taxa
- Number of Ephemeroptera and Trichoptera taxa
- Number of Diptera taxa
- Number of Orthocladiinae and Tanytarsini taxa
- Number of intolerant taxa
- Number of scraper taxa
- Number of collector-gatherer taxa
- Percent of Trichoptera (excluding Hydropsychidae)
- Percent non-insect
- Hilsenhoff's Biotic Index

(Genet, J. and J. Chirhart, 2004)

Most notably in Shingle Creek, sampling found a very low number of taxa of the functional feeding groups clingers and collector-gatherers, and a low number of taxa from the group scrapers. This is consistent with the lack of substrate available for those species: few riffles, little woody debris, little overhanging vegetation, and a sandy, silty stream bottom. The sampling also found a low number of the intolerant taxa Ephemeroptera and Trichoptera, and in general found a low number of intolerant taxa. As with the fish sampling results, this is not surprising for streams with significant input of urban runoff.

Table 2.2 compares Shingle Creek and Bass Creek on some important metrics that are components of the IBI. Many of the sampled sites were dominated by taxa that are often found in wetlands, reflecting both the low-gradient morphology of the stream as well as the influence of the many riparian wetlands.

Table 2.2. Comparison of Shingle and Bass Creeks on various macroinvertebrate IBI metrics.

Metric	Shingle Creek	Bass Creek
EPT taxa	3 – 5	10
Intolerant taxa	0	3
Percent tolerant	29 – 93 %	4 %
HBI score	5.5 – 8.5	4.1
IBI score	14 - 49	67

Note: Data includes both 2000 DNR and MPCA sampling as well as 2005 Commission sampling.

Some sampling was also completed in 2008 for this study (Table 2.3), although conditions were very poor due to the drought conditions. Several sites could not be sampled because they were dry, and those that were sampled were at very low flows. Pike Creek is a small stream in Plymouth/Maple Grove that was restored in 2001 and is provided for comparison purposes.

Table 2.3. Shingle Creek 2008 macroinvertebrate metrics.

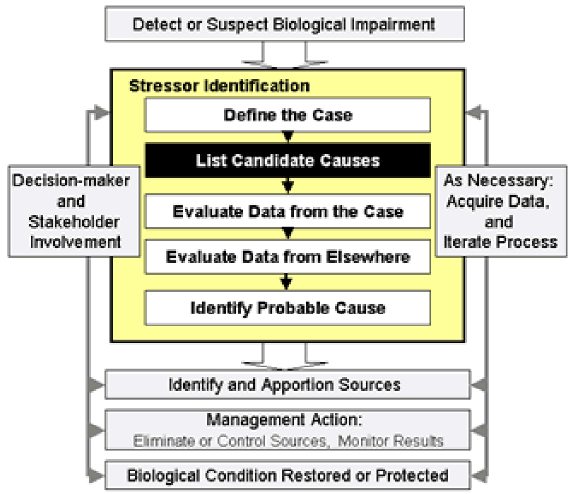
Metric	SC1	USGS (Queen)	Palmer Lake		Zane Rock Cascade		Pike Creek
			SC3 (outlet)	SC4 (inlet)	SC6 (below)	SC6 (above)	
POET taxa	9	2	4	4	1	4	8
Intolerant taxa	1	0	0	0	0	0	0
Percent tolerant	82%	96%	87%	76%	92%	76%	86%
HBI score	6.9	8.1	7.4	6.3	8.3	8.0	7.2
IBI – 2008	39.5	24.2	30.0	31.1	8.6	23.1	37.2

2.2 SUMMARY OF DATA

Limited data are available for Shingle and Bass Creeks. Fish data are available at only a few locations for a few years, and are over ten years old. More recent and better spatially distributed data are available for macroinvertebrates, but these data, too, are temporally limited. There are a few sites on Shingle Creek that are monitored through the student volunteer River Watch program where there are some time series data. Given the limited data, it is difficult to see conclusive trends or draw definitive conclusions about the biotic integrity of Shingle and Bass Creeks.

Although the data are limited, fish species richness on Shingle Creek is unexpected given that the stream is disconnected from the Mississippi River by the drop structure in Webber Park. It is likely that Bass and Shingle Creeks are populated by fish swept into the stream when lake levels on Bass Lake and the Twin/Ryan Lake chain overtop the lake outlet structures. Some reproduction may be occurring in the several riparian wetlands or in the Palmer Lake basin. Both the volunteer and Commission/DNR/MPCA macroinvertebrate sampling results show the community to be dominated by tolerant taxa, although sites with somewhat better habitat appear to support some moderately intolerant organisms. The species composition in most reaches of the stream indicates environmental stress, poor water quality, and/or poor quality of habitat.

3.0 Candidate Causes



3.1 CANDIDATE CAUSES

The CADDIS Stressor Identification analysis is a stepwise procedure that begins by defining the case, as set forth in sections 1 and 2 of this report, and then identifying potential, or candidate causes of the defined impairment.

The initial step is to identify all the potential causes and then to eliminate those that are not supported by evidence or are unlikely to be significant factors in the impairment. The remaining candidate causes are then evaluated in more detail.

3.2 CANDIDATE CAUSES RULED OUT

Monitoring data collected by the Commission and by the USGS were used in this assessment. The Commission operates two flow and water quality monitoring sites on Shingle Creek: SC-0 near the outlet (known as SC1 for biotic monitoring) and SC-3 in the upper watershed (known as SC6 for biotic monitoring), and none on Bass Creek (Figure 3.1). The USGS operates a site at Queen Avenue in Minneapolis (SC-1) which provides flow and some limited water quality data. The USGS has performed periodic in-depth water quality analyses at that site as part of its National Water Quality Assessment (NAWQA) program. Two water quality synoptic surveys performed in 2008 for the dissolved oxygen TMDL being prepared for Shingle Creek concurrent with this study provide longitudinal data along Shingle Creek and at two sites on Bass Creek. Monitoring locations are shown on Figure 3.1 and data is presented in Tables 3.1 and 3.2 below.

3.2.1 Temperature

Both Shingle and Bass Creeks are classified as warm-water streams and fish and macroinvertebrate assemblages evolved for warm-water systems are less sensitive to temperature swings. Figure 3.2 shows maximum temperature data collected in 2008 at the monitoring sites SC-0 and SC-3, showing a temperature range typical of a warm water stream (Allan 1995). Maximum daily temperature in mid summer was typically in the 20-25°C range, with some days at 25-27°C. Top fish species such as northern pike and channel catfish, which would typically be found in a stream such as Shingle Creek, prefer stream temperatures that do not exceed 29-30°C (Inskip 1982; McMahon et al. 1982). Other typical fish such as bluntnose minnow and madtom can tolerate temperatures of 30°C+, while central stonerollers prefer a maximum of 27°C (Becker 1983).

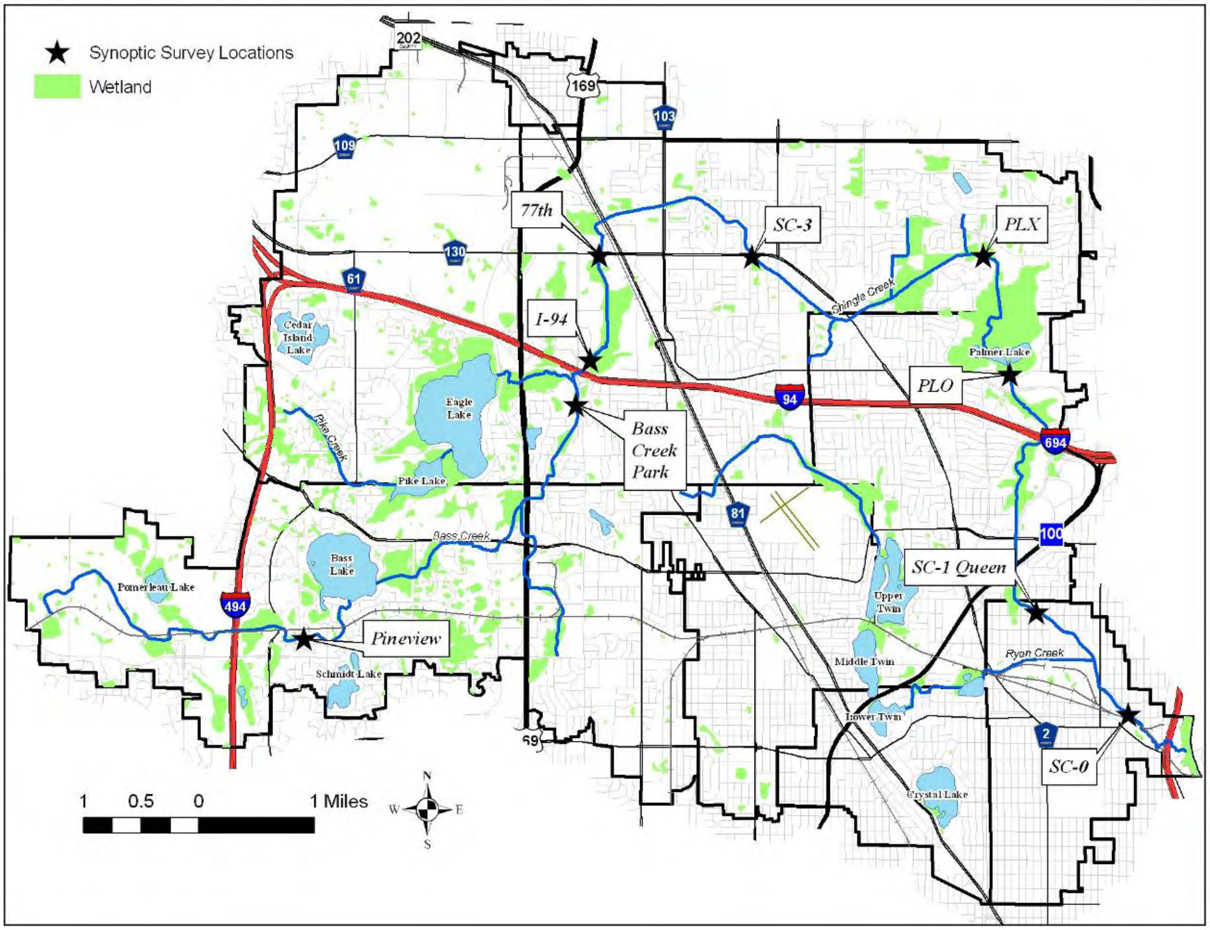


Figure 3.1. 2008 synoptic survey sampling locations on Shingle and Bass Creeks.

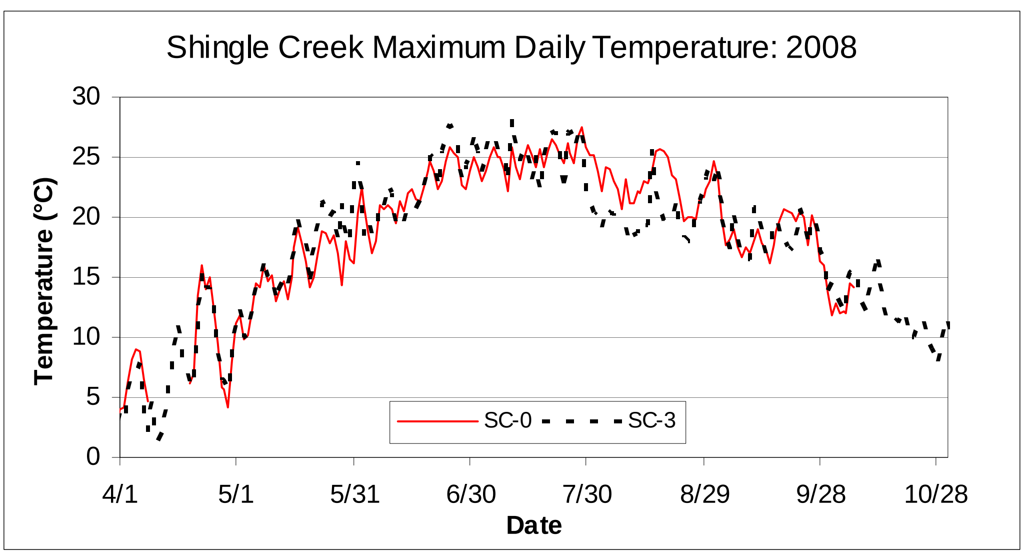


Figure 3.2. Maximum daily temperature at two locations in Shingle Creek, 2008.

Diel temperature fluctuations can also affect growth, metabolism, reproduction, emergence, and distribution of fish, macroinvertebrates and other aquatic species. Vannote and Sweeney (1980) analyzed data collected by the USGS on various streams and found that diel temperature fluctuation in natural streams varied by stream order. Temperature in third order streams such as Shingle Creek was found on average to vary by a maximum of 8-9°C per day. Figure 3.3 shows diel temperature fluctuations in 2008, which ranged from 1°C to nearly 9°C.

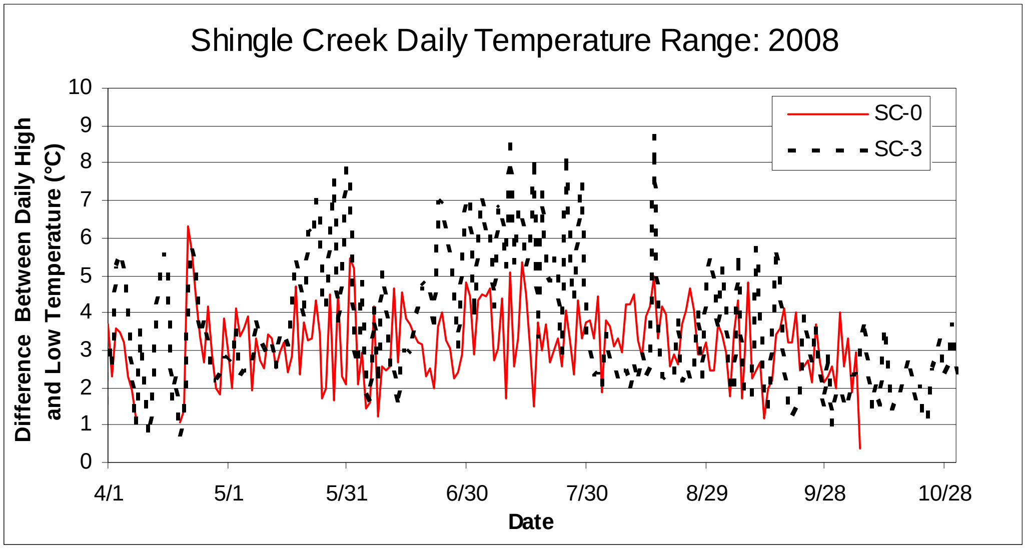


Figure 3.3. Diel temperature range in Shingle Creek in 2008.

Temperature was eliminated as a candidate stressor for Shingle Creek because the temperature range observed in Shingle Creek falls within the range typically found in warm water, third order streams, and because the observed temperatures are within the range tolerated by fish species naturally found in Minnesota warm water streams. Not enough data is available to evaluate temperature effects in Bass Creek.

Temperature may, however, be a contributing factor in the consistently low dissolved oxygen concentrations in both streams. As urban streams, Shingle and Bass Creeks receive stormwater runoff that has been warmed by pavement and other surfaces, and by extended detention in stormwater ponds. When this runoff is discharged into the stream, it may warm the stream temperature, reducing its ability to retain oxygen.

3.2.2 pH

The synoptic survey collected pH data at several sites on Shingle and Bass Creeks (Tables 3.1 and 3.2). Measured pH is on the lower end of the ecoregion range, but is still generally neutral, and well above the pH value of 5.0 or less that is typically associated with acidification impacts to the biota (Allan 1995). The applicable pH standard for most Class 2 waters in Minnesota is a minimum of 6.5 and a maximum of 8.5 (MPCA 2010). pH was eliminated as a candidate stressor because data indicate the pH range observed in Shingle and Bass Creeks falls within the range necessary to support aquatic life.

3.2.3 Nutrients

The synoptic survey collected nutrient data at several sites on Shingle and Bass Creeks (Tables 3.1 and 3.2)

Table 3.1. Physical and chemical parameters, June 2008 synoptic survey, compared to ecoregion values.

Parameter	Typical Ecoregion Values	Pine-view	Bass Creek Park	I-94	77th	SC-3	PLX	PLO	Queen	SC-0
Tempera-ture (Celsius)	2 - 21	20.07	18.19	19.7	17.93	17.93	16.46	22.25	20.87	21
DO (mg/L)		5.25	7.27	5.25	4.49	5.78	6.01	12.55	4.65	5.25
pH	7.9 – 8.3	7.31	7.55	7.48	7.5	7.54	7.71	7.95	7.61	7.48
Total Phos-phorus (µg/L)	60 – 150	150	260	130	130	120	120	160	110	99
Ortho-P (µg/L)		21	75	42	55	47	25	19	20	20
TKN (µg/L)		1300	1000	840	810	800	1100	1200	1100	1000
NH_3 (µg/L)		210	140	29	22	55	18	150	220	170
Nitrate (µg/L)	40 – 260	<20	45	25	22	32	270	120	140	200
5-day BOD (mg/L)	1.5 – 3.2	<1.00	7.80	<1.0	<1.0	<1.0	<1.0	3.4	2.4	2.1
Ultimate BOD (mg/L)		1.90	10.00	8.3	7.8	7.8	7.5	12	10	9.6
TOC (mg/L)		17	15	12	13	12	10	12	12	11
Chlorophyll a (µg/L)		1.2	1.7	8	2.8	1.7	4	10	4	4.1

Note: Refer to Figure 3.1 for site locations.

Table 3.2. Physical and chemical parameters, September 2008 synoptic survey, compared to ecoregion values.

Parameter	Typical Ecoregion Values	Pine-view	Bass Creek Park	I94	77th	SC-3	PLX	PLO	SC-1 Queen	SC-0
Tempera-ture (Celsius)	2 - 21	11.45	12.25	16.52	15.32	15.01	13.98	18.65	19.18	19.05
DO (mg/L)		8.16	3.87	6.02	4.98	5.92	6.47	6.55	6.17	6.65
pH	7.9 – 8.3	7.80	7.52	7.82	8.17	8.71	7.92	7.79	7.83	7.74

Parameter	Typical Ecoregion Values	Pine-view	Bass Creek Park	I94	77th	SC-3	PLX	PLO	SC-1 Queen	SC-0
Total Phos-phorus (µg/L)	60 – 150	62	280	92	99	74	75	180	92	71
Ortho-P (µg/L)		26	71	33	44	27	11	22	14	11
TKN (µg/L)		670	1900	830	660	840	920	1500	1000	670
NH_3 (µg/L)		120	600	110	100	110	260	240	190	160
Nitrate (µg/L)	40 – 260	<20	70	68	71	48	420	120	230	320
5-day BOD (mg/L)	1.5 – 3.2	<1.00	5.39	<1.00	<1.00	<1.00	<1.00	4.99	3.4	2.37
Ultimate BOD (mg/L)		1.51	10.40	4.35	4.32	4.12	4.06	13.8	6.55	5.06
TOC (mg/L)		9.4	12	10	9.9	9.3	6.9	8.3	7.5	6.8
Chlorophyll a (µg/L)		1.3	30.0	1.9	2.5	1.9	3.6	42	15	14

The chemical parameters collected as part of the synoptic survey in Shingle and Bass Creeks generally fall within the ecoregion 25th to 75th percentiles, with the exception of phosphorus, nitrogen, and chlorophyll-a values recorded at the sampling sites downstream of flow-through wetlands such as the outlet of the Palmer Lake basin (PLO). Palmer Lake is a 400+ acre wetland basin with a small area of shallow open water through which Shingle Creek flows. Numerous small channels convey stormwater into and through the wetland basin, which is very flat and responsive to those inflows. Even a small rain event will flood the basin which will then discharge into the Creek, which is the likely cause for the elevated nutrient levels.

Similarly, the Bass Creek Park sampling site is downstream of a large flow-through wetland known as Cherokee Drive Wetland (Figure 3.1). This wetland tends to dry out and become re-wetted periodically throughout the summer. Mats of algae and floating vegetation can often be seen being discharged from the wetland downstream into Bass Creek. The 77th Avenue site is also located downstream of a large, flow-through wetland (known as Northland Wetland), but the nutrient parameters are not as elevated as at the other wetland-dominated sites.

While the elevated nutrient levels are not toxic to fish or macroinvertebrates, nutrients in streams impact the biota through eutrophication, or the increased growth of plants and algae. Excessive nutrient levels may cause accelerated growth of periphyton, phytoplankton and macrophytes. At lower levels, breakdown of this accelerated plant growth may increase consumption of dissolved oxygen from the water column, while elevated levels may result in excessive phytoplankton growth that reduces light penetration and decreases available habitat and shelter for fish and macroinvertebrates. No aquatic vegetation data are available for either Shingle Creek or Bass Creek.

Two synoptic survey locations where higher than average phosphorus and nitrogen levels were measured are also associated with low levels of dissolved oxygen. While nutrient levels at other locations on the stream are generally within ecoregion averages and typical for an urban stream, the analysis for the dissolved oxygen TMDL indicates that the water quality of streamflow discharged from these wetlands may be a contributing factor to the dissolved oxygen impairment.

Nutrients were eliminated as a candidate stressor because concentrations are at non-toxic levels. In addition, there are limited or no systematic data for periphyton, phytoplankton, or macrophytes to evaluate eutrophication impacts. Nutrients and eutrophication may be a contributing cause to the dissolved oxygen impairment.

3.2.4 Turbidity/TSS

While some turbidity data have been collected on Shingle Creek, most of the available data are for total suspended solids (TSS). TSS was not collected as part of the synoptic survey, but it is a routine parameter collected by the Commission in Shingle Creek. Minimal TSS or turbidity data are available for Bass Creek. Figure 3.4 displays TSS data collected since 1996 at two monitoring sites: SC-0, or the outlet, and SC-3, in the upper watershed. The values in Shingle Creek often exceed typical conditions in the North Central Hardwood Forest. For purposes of evaluating whether a stream is impaired by excess turbidity, the MPCA has established a relationship between TSS concentration and turbidity, and in the North Central Hardwood Forest has established 100 mg/L of TSS as a surrogate for the turbidity standard. Under certain storm event conditions Shingle Creek does exceed that TSS surrogate. However, as noted on Figure 3.4 the number of exceedances does not meet the threshold for an impairment listing.

Higher than ecoregion typical values could be a result of streambank erosion, however the Shingle Creek Corridor Study condition analysis concluded that both Shingle and Bass Creeks were generally stable with limited and localized streambank mass wasting and the stream assessment found only a few locations of evident aggradation or excess embeddedness, or areas with a silty streambed. Most of those sites were downstream of storm sewer outfalls or in low-velocity areas. The likely source of TSS in these streams is fine sediments conveyed in stormwater runoff from developed areas.

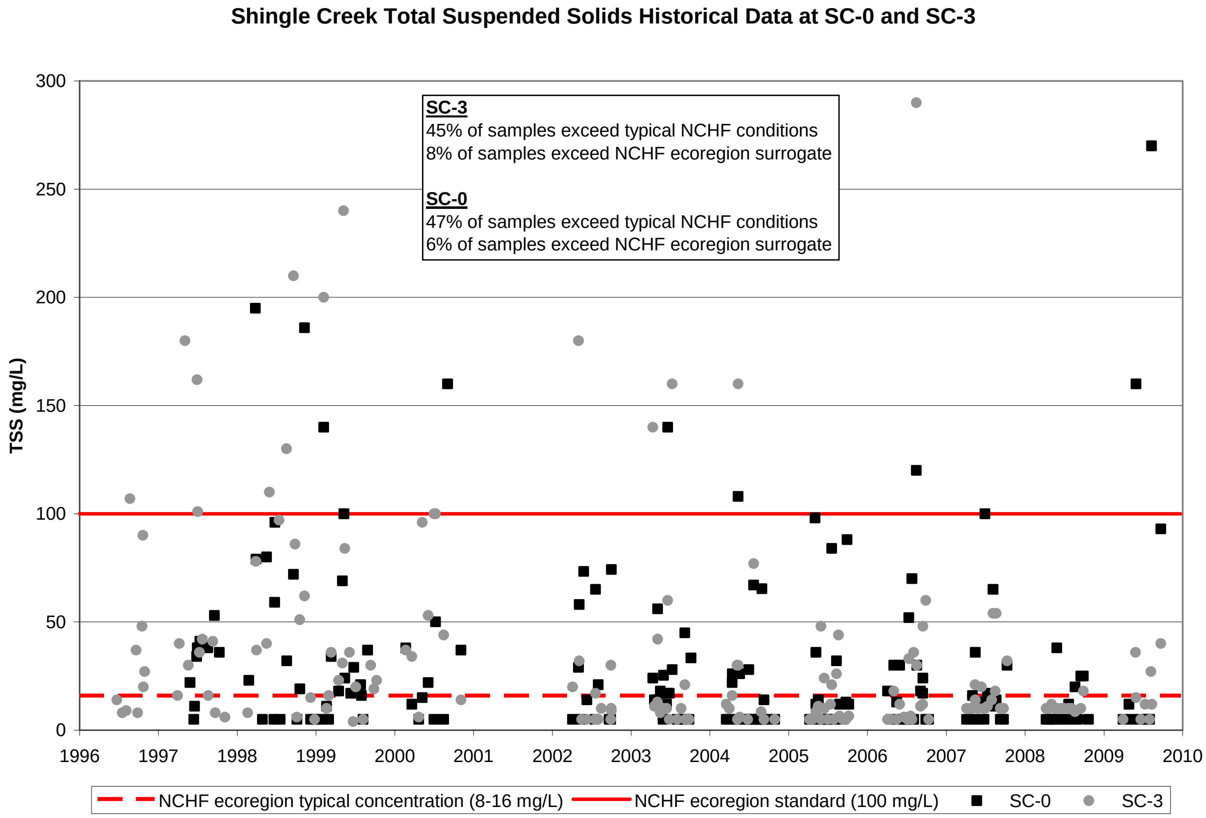


Figure 3.4. TSS data for Shingle Creek, 1996-2009.

Turbidity was eliminated as a candidate stressor because the TSS surrogate data meets State of Minnesota turbidity standards. However, sediment conveyed to the streams or contributed from streambank erosion may impact biotic integrity in other ways than simply contributing to turbidity. There are some locations on both streams where there is aggradation of sediment, and some evidence of fine sediment accumulating in pools. These impacts are localized and not typical of the streams, but may be contributing to the biotic impairment in some locations by altering substrate and pool habitat.

3.2.5 Toxics

The most detailed data on toxic chemicals available on Shingle Creek is the water quality assessment performed by the USGS at the Queen Avenue site in 1996 as part of the ongoing National Assessment of Water Quality (NAWQA). Shingle Creek was selected to represent an urban stream in the Upper Mississippi River basin. As a part of that study the USGS sampled surface and groundwater quality, sediment chemistry, and biotic condition for metals, herbicides, pesticides, and other potential contaminants.

This study found elevated concentrations of some trace elements in streambed sediment in the Upper Mississippi study unit (Kroening et al. 2000). Streambed sediment samples were collected from 27 sites, including three in Shingle Creek, and fish samples were taken at 25 sites, including the three Shingle Creek sites. The study sites included urban and rural streams and the

Minnesota, Mississippi, and St. Croix Rivers, and trace levels of antimony, cadmium, copper, lead, nickel and zinc were strongly related to urban land use. Shingle Creek was the most highly urbanized stream studied, and sediment samples taken at three locations in Shingle Creek contained amounts of most of these elements above baseline concentrations. Trace elements in streambed sediment have the potential to be released back into the water column under certain physical and chemical conditions, such as periods of extremely low dissolved oxygen concentrations or pH, and also may be transported to downstream locations during high flows. Fish liver samples were taken and analyzed to determine the bioavailability of these trace elements. There was no clear pattern in the distribution of trace elements in fish livers across the study unit. There generally were no relations between the concentration of trace elements measured in the streambed sediment and those measured in fish livers. Cadmium was detected in white sucker liver samples from the SC-0 site on Shingle Creek in Minneapolis. While the sediments sampled from that site also contained elevated levels of cadmium, the study found no clear relationship between sediment concentration and detection in fish livers. This study concluded that chemistry and liver sample findings in the Upper Mississippi study unit were consistent with findings at 20 other NAWQA sites across the United States. No follow up on Shingle Creek has been done.

3.3 PHYSICAL AND CHEMICAL STRESSORS THAT CANNOT BE RULED OUT

Five stressors that cannot be ruled out were identified, including two water quality impairments. Data collected by the Commission and the USGS at the Queen Avenue site indicate dissolved oxygen levels that frequently fall below the 5 mg/L necessary to sustain aquatic life. In 2004 Shingle Creek was listed as an Impaired Water due to persistently low dissolved oxygen. Chloride data collected by the USGS at the Queen Avenue site led the MPCA in 1998 to list Shingle Creek as an Impaired Water due to high chloride concentrations. In 2010 the MPCA added Bass Creek to the draft list of Impaired Waters, also for excess chloride. Both these impairments are likely stressors to the biotic community in the streams.

In addition, as urban streams, Shingle and Bass Creeks experience “flashy” flows as well as extended periods of very low base flow. High imperviousness in the watershed has increased the volume and rate of stormwater runoff and decreased infiltration crucial to maintaining base flow. As noted above, in late summer portions of Upper Shingle Creek and Bass Creek experience reduced flows that do not fill the streambank, and often go dry or nearly dry. Below Palmer Lake, Shingle Creek retains flow in all but extreme drought conditions. Shingle Creek below Palmer Lake went dry in 1988 and 2008.

Shingle and Bass Creeks are also highly altered streams that have been straightened, channelized, dredged, and in at least one location lined with concrete. There is a general lack of suitable habitat, although there are some areas where some habitat features have been restored. A number of migration barriers have decreased connectedness of habitat.

3.3.1 Low Dissolved Oxygen

Living aquatic organisms such as fish and macroinvertebrates require oxygen to sustain life. This oxygen is supplied by molecules of gas dissolved in water. Oxygen enters the water by absorption directly from the atmosphere or by aquatic plant and algae photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter. Dissolved oxygen (DO) fluctuates over the course of the day. As vegetation photosynthesizes throughout the daylight hours, the production of DO exceeds the use of DO by respiration and decomposition, and DO increases. Overnight, photosynthesis ceases and DO falls as a result of ongoing respiration and decomposition, and DO levels are at their lowest in the early morning. This pattern is the DO diurnal cycle.

The volume of DO is measured in milligrams of O_2 per liter of water, and is dependant on temperature, air pressure, and other factors influencing aeration and deoxygenation. In streams such as Shingle and Bass Creeks, these factors may include physical factors such as stream temperature, stream velocity, water clarity, and reaeration structures such as riffles; or chemical factors such as sediment oxygen demand and nutrients. The State of Minnesota standard for dissolved oxygen in Class 2B waters such as Shingle and Bass Creeks is to maintain not less than 5 mg/L of DO as a daily minimum.

Decreases in DO levels can cause changes in the types and numbers of fish and aquatic macroinvertebrates in surface waters, and shift the community composition to species that are tolerant of lower levels or wider diel swings in DO.

3.3.1.1 Dissolved Oxygen in Shingle and Bass Creeks

A DO TMDL is underway for Shingle Creek concurrent with this Stressor ID. Data collected for that study included longitudinal grab sample surveys as well as synoptic continuous DO measurements as part of two time-of-travel dye studies. All these studies indicate that both streams experience significant fluctuations in dissolved oxygen, and frequently fall below the 5.0 mg/L standard necessary to sustain aquatic life. Figure 3.5 displays a longitudinal dissolved oxygen profile of the streams taken over a few hours in the morning of August 17, 2007.

The continuous DO data collected as part of the ongoing DO TMDL show variability in the diurnal cycle at different sites in the watershed (Figures 3.6 and 3.7). Of particular interest are the very wide diurnal swings at the outlet of Palmer Lake. Shingle Creek flows through the 400+ acre wetland basin that contains about 40 acres of shallow open water. Also of note is that at least one of the sites, at Xerxes Avenue North, never fell below the 5 mg/L standard during either of the time of travel studies.

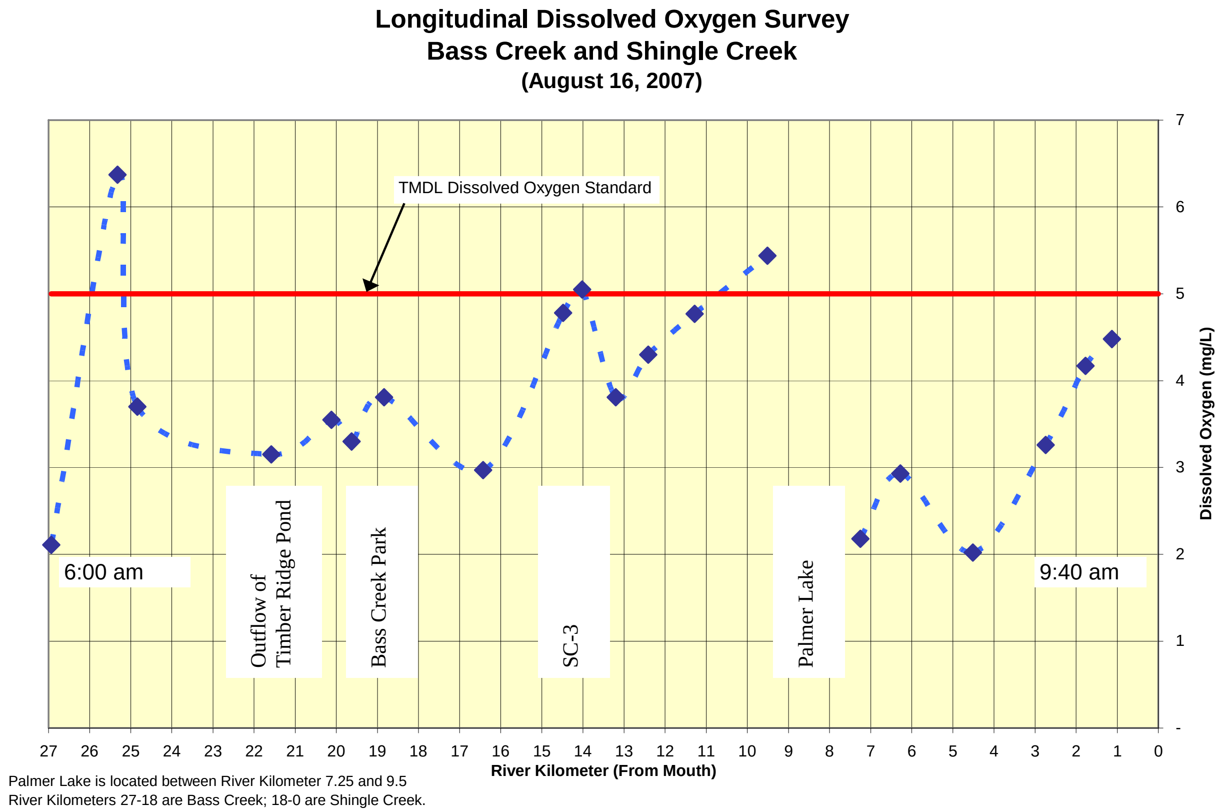


Figure 3.5. August 16, 2007 longitudinal dissolved oxygen survey, Shingle and Bass Creeks.
Note: Survey started at the upstream end at 6:00 AM and ended at 9:40 AM.

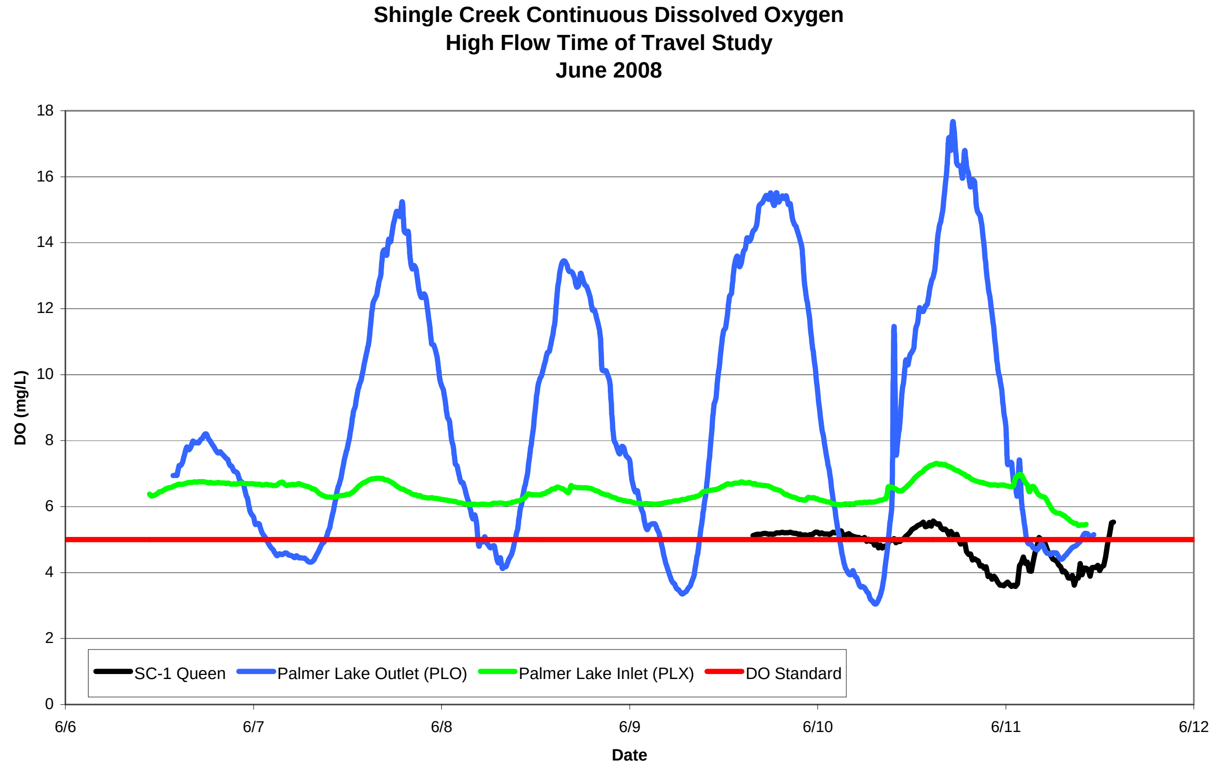


Figure 3.6. Shingle Creek continuous dissolved oxygen profile, June 2008 dye study (high flow).

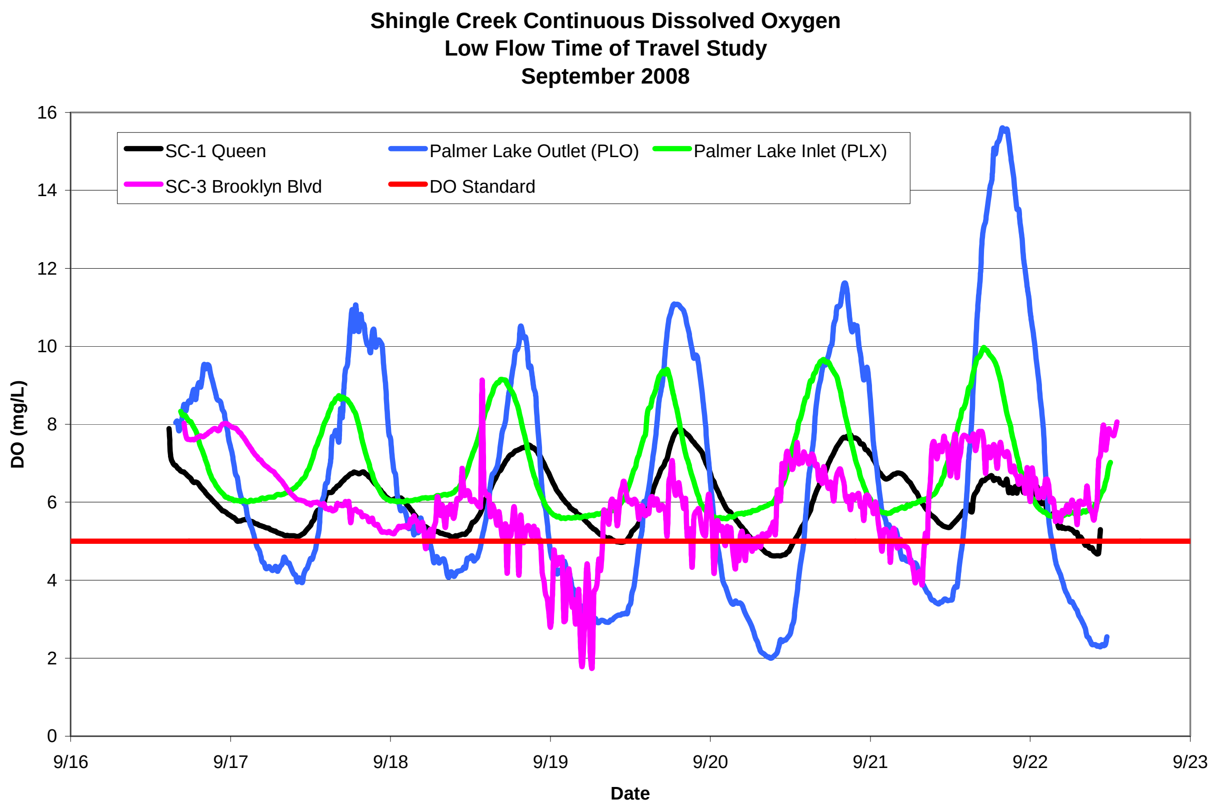


Figure 3.7. Shingle Creek continuous dissolved oxygen profile, September 2008 dye study (low flow).

Figure 3.8 below shows a plot of macroinvertebrate IBI scores against dissolved oxygen data for Shingle Creek. Fish data is only available at river kilometers 3.2 and 18.8. There does not appear to be a clear relationship between DO and IBI scores. DO is low throughout the stream, even at the few locations where there appears to be slightly better biotic integrity.

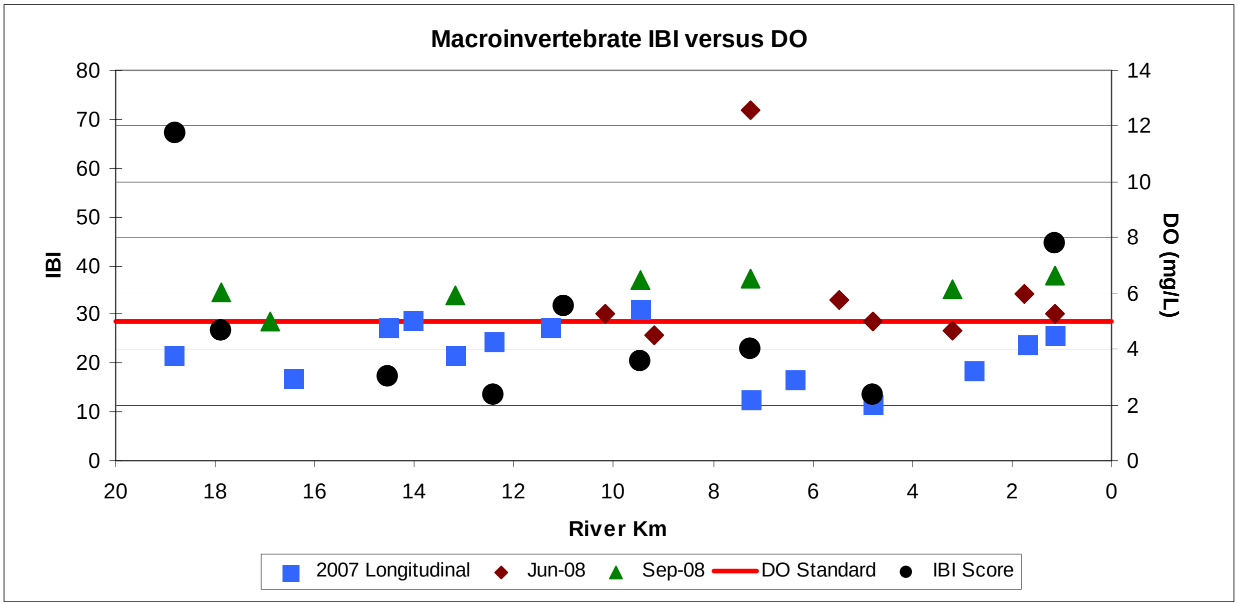


Figure 3.8. DO readings taken during the August 17, 2007 longitudinal survey and the 2008 dye studies plotted versus macroinvertebrate IBI score.
Note: River kilometer 18.8 is Bass Creek at Bass Creek Park. All other data is Shingle Creek.

The MPCA has revised its guidance for evaluating DO data for the purposes of determining impairment. Starting in 2010, a greater number of observations are required, only data obtained prior to 9:00 A.M. will be considered, and the 5 mg/L minimum threshold must be met for a certain frequency depending on time of year. Table 3.3 shows the revised criteria and the relevant Shingle Creek data. Shingle Creek exceeds the revised DO impairment listing criteria.

Table 3.3. 2010 Revised DO impairment listing criteria and relevant Shingle Creek data.

Criterion	Requirement	Shingle Creek Data
Number of independent observations	20 observations (over at least 2 years)	725 total observations, 121 (17%) less than 5 mg/L
May-September observations	Must be taken prior to 9:00 A.M. over at least two years	36 confirmed May-September pre-9:00 A.M. observations over 9 years
DO standard must be met during May-September AND	90% of the time (no more than 10% below standard)	36 observations, 15 (42%) less than 5 mg/L
DO standard must be met during October-April	90% of the time (no more than 10% below standard)	255 observations, 8 (3%) less than 5 mg/L
Number of violations	Must be at least 3	At least 23 violations

3.3.1.2 Sources and Causal Pathways Model For DO

The Shingle Creek model prepared for the Shingle Creek and Bass Creeks Biota and Dissolved Oxygen TMDL suggests that channel modification and hydrologic alteration are interacting stressors contributing to the low levels of dissolved oxygen. The TMDL concludes that one of the primary causes of low dissolved oxygen in Shingle Creek (and likely in Bass Creek) is that the channel shape has been altered to a wide, trapezoidal channel with a flat bottom, to better convey high streamflows. Periods of very low flow have also been increased through a reduction in infiltration in the watershed. These conditions lead to periods of excess sediment oxygen demand from the overwide streambed. Figure 3.9 illustrates a typical late summer condition with exposed sediments; shallow, stagnant pools; and excessive algae growth, all of which deplete dissolved oxygen. In addition, reaeration structures such as riffles have been removed to reduce channel roughness and improve channel flow capacity. This can lead to extended periods of low dissolved oxygen.

Figure 3.9. Shingle Creek upstream of SC-3 in late summer.

While the literature is clear that low levels of dissolved oxygen are a stressor to both fish and macroinvertebrates, the Shingle and Bass Creeks dissolved oxygen data does not show a clear relationship between levels of dissolved oxygen and macroinvertebrate assemblage. While some sites experience a wide diurnal swing, for the most part average DO hovers just above or below the 5 mg/L standard throughout the stream. In Shingle Creek the macroinvertebrate IBI indicates an impaired community yet the fish IBI indicates a non-impaired community. The longitudinal study included a grab sample DO reading at Bass Creek Park in Brooklyn Park indicating DO at just under 4 mg/L. However, at that location the macroinvertebrate IBI indicates a non-impaired community and the fish IBI indicates an impaired community. It should be noted that the available data is very limited. The fish data is limited in spatial and temporal extent. Macroinvertebrate data is spatially well-distributed, but is limited temporally.

The site with the best IBI, SC-0, exhibited dissolved oxygen levels similar to other sites, yet the macroinvertebrate community at that site in 2004 was dominated by two taxa of Hydropsychidae

– Cheumatopsyche and Hydropsyche - both of which are considered moderately intolerant of low dissolved oxygen. Two individuals of the moderately intolerant riffle beetle Stenelmis were also found at that site in 2004. However, most of the macroinvertebrate and fish taxa collected at the various Shingle Creek monitoring sites and Bass Creek are tolerant of low dissolved oxygen and turbid conditions.

Figure 3.10 below shows the potential sources and causal pathways for low dissolved oxygen in Shingle and Bass Creeks. This model is discussed in more detail in the Shingle Creek and Bass Creeks Biota and Dissolved Oxygen TMDL. This model suggests that channel modification and hydrologic alteration are interacting stressors contributing to the low levels of dissolved oxygen.

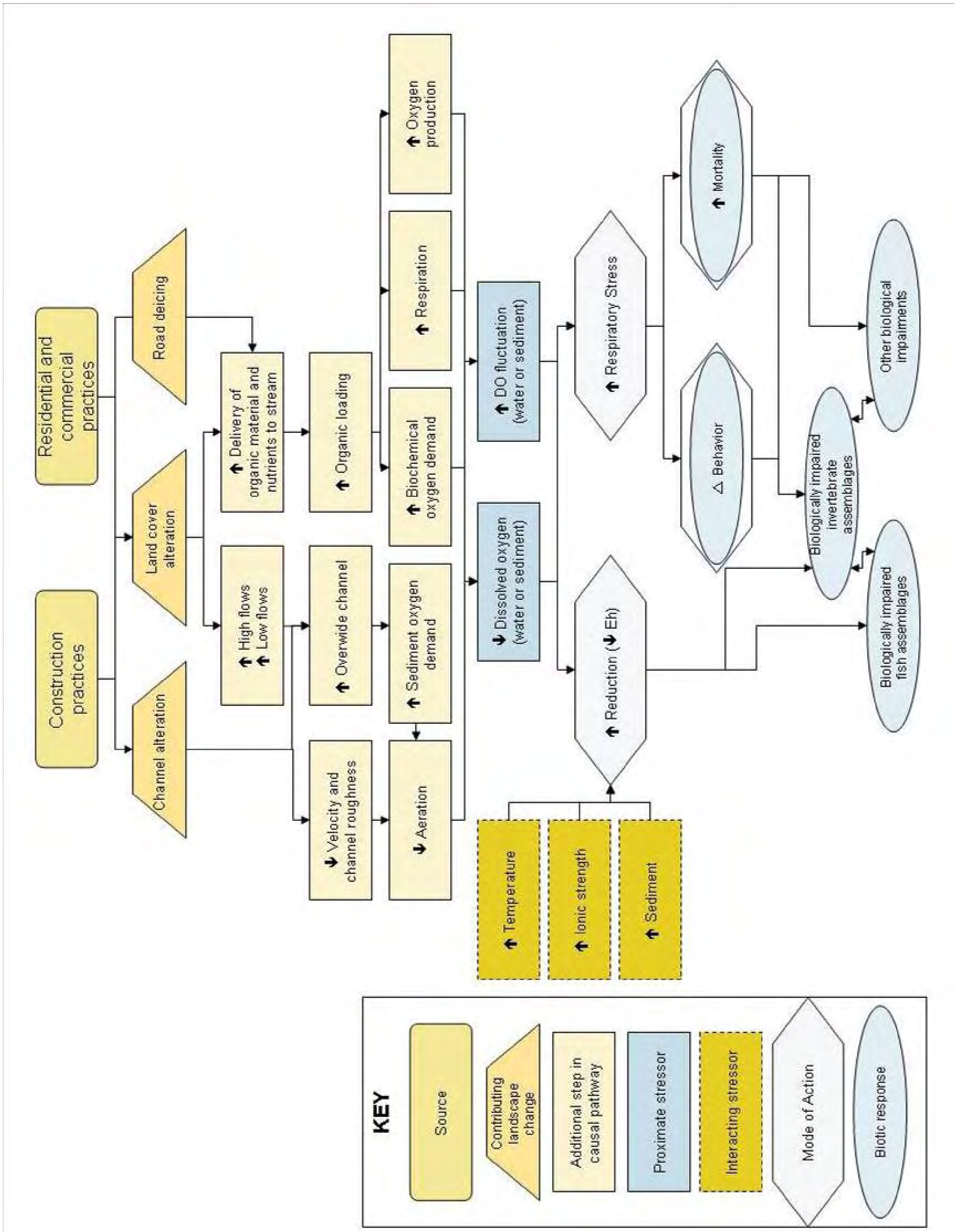


Figure 3.10. Conceptual model describing the sources and causal pathway for dissolved oxygen.

3.3.2 Altered Habitat

Habitat describes the place where an organism lives or occurs. In streams, habitat for macroinvertebrates and fish includes the rocks and sediments of the stream bottom and banks; the plants growing in the stream or attached to rocks or debris in the stream; grasses and leaf litter and other organic material that falls into the stream; and logs, sticks, twigs, and other woody debris. Habitat also includes elements of stream structure: streambed depressions that provide deeper pools of water; side channels, backwaters or other stream formations that are places outside the primary flow channel; and the vegetation on and adjacent to the streambank.

Each species has a specific set of habitat requirements, but can often tolerate conditions that are not quite ideal. Habitat complexity is necessary to provide an environment with a variety of attributes that can support robust assemblage of organisms. For example, a streambed with areas of sand, gravel, and cobble provides a more complex habitat than a streambed that is dominated by sand.

Stream habitat condition is often measured by the number of habitat types present; the quality of the habitat (e.g., frequency and depth of pools; D_{50} particle size of streambed materials; embeddedness); and the amount of habitat (e.g., volume of organic debris available; amount of in-stream cover). Several habitat indices are available, including the Ohio Qualitative Habitat Evaluation Index, the EPA Rapid Bioassessment Protocol, and the Minnesota Stream Habitat Assessment Protocol. These indices rate various attributes of a stream that are important components of habitat complexity, and are useful when comparing various sites.

3.3.2.1 Habitat in Shingle and Bass Creeks

Shingle and Bass Creeks are highly impacted urban streams. Most of Shingle Creek has been straightened and no longer lies within the historic channel. The creek from Xerxes Avenue in Brooklyn Park to Webber Park in Minneapolis, was straightened and dredged in 1910 by Hennepin County as Ditch #13 and retains that designation and jurisdiction. Bass Creek appears to be comprised of man-made channels or dredged ephemeral streams connecting and outletting wetlands. The streambanks of both streams are relatively stable, although some erosion, downcutting, and lateral cutting continue in localized areas. Most of the riparian vegetation is cattail marsh, lowland hardwood forest, or a mix of invasive, cultivated, or opportunistic herbaceous species.

The biological integrity of both streams is compromised by the lack of complex habitat for macroinvertebrates and fish. The streams exhibit minimal sinuosity and very few of the riffle and pool sequences that characterize natural streams. The pools present tend to be shallow, although some new riffle and pool habitat has been constructed in Minneapolis and in Brooklyn Park. Woody debris, vital for habitat and substrate diversity, is generally absent. Both streams are characterized by lack of habitat diversity, shallow pool depth, absence of riffles, and poor quality riparian vegetation. There are few backwaters or offline areas available to provide refuge to fish and invertebrates during times of high flow. The shallow pools and flat channel bottom provide minimal refuge during low flows.

The streambed is primarily coarse to fine sand and silt, with few areas of gravels and other larger substrate materials that aquatic insects and fish prefer. Water control structures located throughout the creek act as barriers to fish migration, and alter stream geomorphology, substrate, and flow. Siltation and sediment embedding are occurring behind the structures.

There is some scattered streambank armoring and wooden shoring, and a portion of Shingle Creek in Webber Park is concrete-lined. There is little woody debris, overhanging vegetation, and few leaf packs that provide habitat and food. Vegetated buffer width is variable, ranging from hundreds of feet wide in park and wetland areas to a few feet or less in developed areas. The character of the buffer is also variable, ranging from simply an unmowed strip on the streambank to a dense floodplain forest with a closed canopy. The dense wooded reaches are too shady, limiting the growth of streambank and aquatic vegetation. Buckthorn and other invasive species are present in much of the riparian zone.

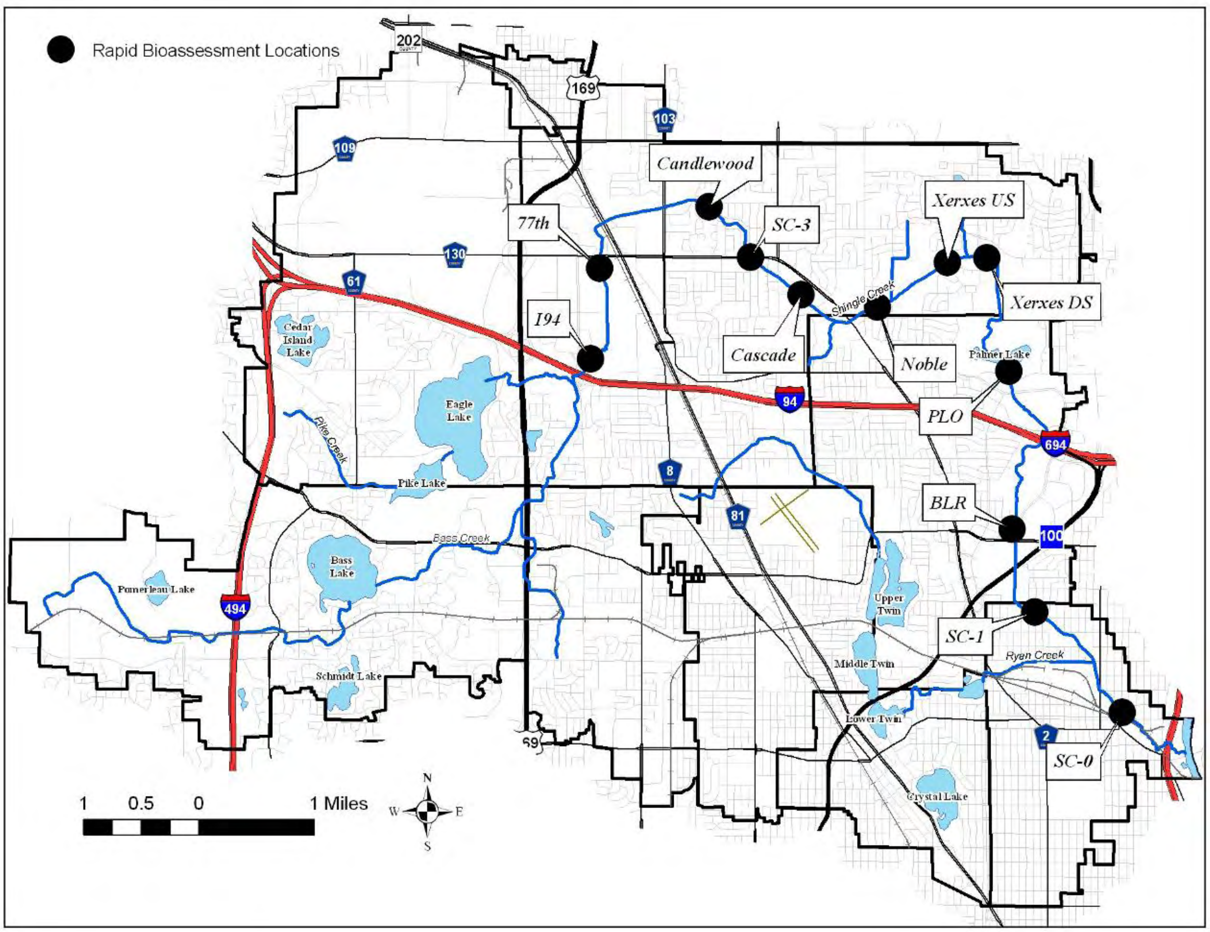


Figure 3.11. Habitat and channel condition assessment sites.

Various sites on Shingle and Bass Creeks were assessed for habitat and channel condition as it relates to the ability to support biotic life (Figure 3.11). Two methods were used: a Rosgen Level II and Pfankuch Stability Analysis to evaluate stream morphology and stability, and the EPA’s Rapid Bioassessment Protocol (RBP). Those results are shown below in Table 3.4.

Table 3.4. Stream site, stability, and biotic condition versus macroinvertebrate IBI.

Site	River Km	Rosgen Stream Type	D_{50} Bed Particle Size (mm)	Pfankuch Stream Stability Index	Rosgen-Pfankuch Reach Condition	Rapid Bioassessment Protocol		IBI
						Score	Condition	
SC-0	1.13	C4	28.0	94	Fair	85	Marginal	44.7
SC-1	3.2	C5c	0.22	122	Poor	82	Marginal	24.2
BLR	4.78	B5c	0.135	114	Poor	76	Marginal	13.5
PLO	7.25	B4c	6.5	101	Poor	106	Marginal	22.8
Xerxes DS	9.46	B4c	6.8	100	Poor	84	Marginal	20.3
Xerxes US	10.5	B5c	0.2	114	Poor	90	Marginal	N/A
Noble	11.29	B5c	0.2	101	Poor	100	Marginal	31.7
Cascade	12.42	B5c	0.2	90	Fair/Poor	112	Marginal-Suboptimal	13.5
SC-3	13.18	B5c	0.68	N/A	NA	88	Marginal	23.1
Candlewood	14.52	B5c	0.2	117	Poor	80	Marginal	17.4
77th	16.44	B5c	0.2	123	Poor	77	Marginal	N/A
I94	17.87	E6	0.06	99	Poor	123	Suboptimal	26.8

Note: IBI impairment threshold is 54. See Figure 3.11 for locations.

The RBP assesses various factors on a scale of 0 to 20, with 20 being the reference condition. A total of 200 points is possible. Table 3.5 shows the factor score by site. Cells that are highlighted represent scores considered above average, while the cells outlined in heavier outline and shown in italics are considered Optimal.

Each category is scored on a scale of 0-20, with:	20-16	Optimal
	15-11	Suboptimal
	10-6	Marginal
	5-0	Poor
Or where each bank is scored separately:	10-9	Optimal
	8-6	Suboptimal
	5-3	Marginal
	2-0	Poor
The overall RBP scores are categorized:	166-200	Optimal
	113-165	Suboptimal
	60-112	Marginal
	<60	Poor

Table 3.5. Rapid bioassessment protocol factor scores for each site on Shingle Creek.

Assessment Factor	Site											
	SC-0	SC-1	BLR	PLO	Xerxes DS	Xerxes US	Noble	Cascade	SC-3	Candlewood	77th	I94
Substrate/Cover	10	10	6	9	6	7	8	11	8	3	10	***19***
Pool Substrate	8	8	6	14	6	6	8	10	10	7	8	12
Pool Variability	9	8	8	13	13	14	7	10	8	12	2	11
Sediment Deposition	11	6	4	6	11	8	11	6	11	6	5	8
Channel Flow Status	15	***17***	14	15	9	10	13	***16***	6	13	9	15
Channel Alteration	6	6	6	9	8	10	12	***16***	5	8	13	11
Channel Sinuosity	4	4	4	4	6	9	7	12	6	2	4	7
Bank Stability - L	4	2	6	6	6	4	4	7	7	3	5	5
Bank Stability – R	4	2	6	3	4	4	4	8	7	3	4	6
Veg Protection –L	5	3	6	8	4	3	4	4	***9***	4	2	6
Veg Protection - R	4	3	4	3	3	4	4	4	***9***	4	2	6
Riparian Width - L	2	6	3	8	4	4	***9***	4	1	***9***	4	8
Riparian Width - R	3	7	3	8	4	7	***9***	4	1	6	***9***	***9***
Total (200 possible)	**85**	**82**	**76**	**106**	**84**	**90**	**100**	**112**	**88**	**80**	77	**123**
M-IBI Score	44.7	24.2	13.5	22.8	20.3	N/A	31.7	13.5	23.1	17.4	N/A	26.8

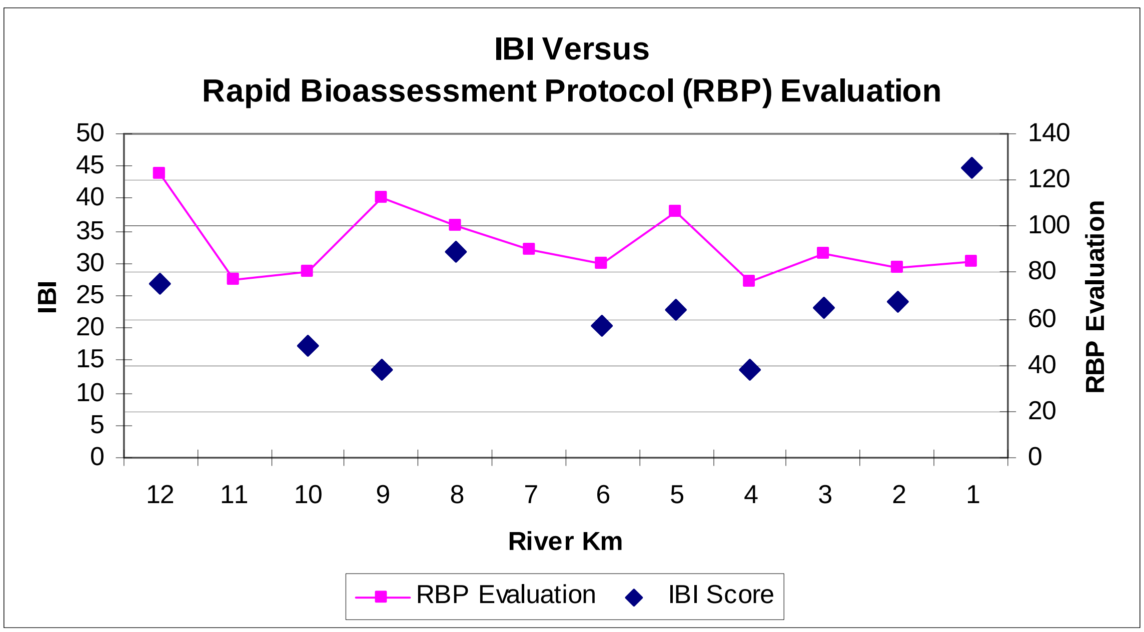


Figure 3.12. Rapid bioassessment protocol score plotted against the macroinvertebrate IBI score for Shingle Creek.

Figure 3.12 graphs the rapid bioassessment protocol total score against the macroinvertebrate IBI for sites on Shingle Creek. The RBP is an index summarizing several factors that contribute to biotic conditions, including type and availability of substrate and cover; pool substrate and diversity; evidence of sediment deposition and embeddedness; channel condition and alteration; streambank conditions; and the type and extent of riparian vegetation buffer. While these factors do vary from site to site along the stream, in general the condition score is considered Marginal or at best Suboptimal. No location along Shingle Creek was evaluated as having Fair or Good conditions.

The Rosgen Level II and Pfankuch stream stability analysis can identify stream reaches that are at higher potential for instability and thus more susceptible to habitat impacts such as sediment deposition, loss of streambank vegetation, and increased turbidity. The Rosgen analysis considers stream morphological characteristics such as bankfull depth and width, slope, flood-prone width, and streambed D_{50} particle size to categorize a stream reach into one of several standard stream types. The Pfankuch analysis then evaluates the streambanks and streambed on several factors such as evidence of mass wasting; bank protection; evidence of stream cutting or deposition; streambed embeddedness; evidence of scouring; presence of aquatic vegetation; and other factors to assess stream stability. The reach condition rating is based on the score and the Rosgen channel type.

Table 3.6 details the Pfankuch stream stability risk assessment factor scores by site. In general reach condition was considered Poor, indicating a higher risk of stream instability. Figure 3.13 graphs the results against macroinvertebrate IBI scores. Cells that are highlighted represent scores considered above average, while the cells outlined in heavier outline and shown in italics are considered Excellent.

Table 3.6. Detailed Pfankuch stream stability rating scores by Shingle Creek site.

Category		**SC-0**	**SC-1**	**BLR**	**PLO**	**Xerxes DS**	**Xerxes US**	**Noble**	**Cascade**	**SC-3**	**Candlewood**	**SC77**	**I94**
Upper banks	Landform slope	6	8	6	6	4	6	4	4	N/A	6	4	***2***
	Mass wasting	9	9	6	9	6	9	6	6	N/A	9	6	6
	Debris jam potential	4	6	4	6	4	4	4	6	N/A	***2***	6	4
	Vegetative bank protection	9	9	9	9	9	9	9	9	N/A	9	12	9
Lower banks	Channel capacity	2	2	2	2	***1***	2	2	2	N/A	***1***	3	2
	Bank rock content	4	8	6	6	6	8	8	6	N/A	8	8	8
	Obstructions to flow	4	4	4	4	4	4	4	4	N/A	4	4	6
	Cutting	12	12	6	6	6	12	6	6	N/A	12	6	***4***
	Deposition	12	16	16	12	16	12	12	12	N/A	16	16	16
Bottom	Rock angularity	3	3	4	3	3	2	4	***1***	N/A	4	4	3
	Brightness	2	2	6	***1***	***1***	2	2	***1***	N/A	2	2	***1***
	Consolidation of particles	4	9	8	4	6	16	6	6	N/A	6	8	6
	Bottom size distribution	8	12	16	12	12	12	12	12	N/A	16	16	12
	Scouring and deposition	12	18	18	18	18	12	18	12	N/A	18	24	18
	Aquatic vegetation	3	4	3	3	4	4	4	3	N/A	4	4	2
TOTAL		**94**	**122**	**114**	**101**	**100**	**114**	**101**	**90**	**N/A**	**117**	**123**	**99**
Stream Type		C4	C5c	B5c	B4c	B4c	B5c	B5c	B5c	B5c	B5c	B5c	E6
Reach Condition		Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor	N/A	Poor	Poor	Poor

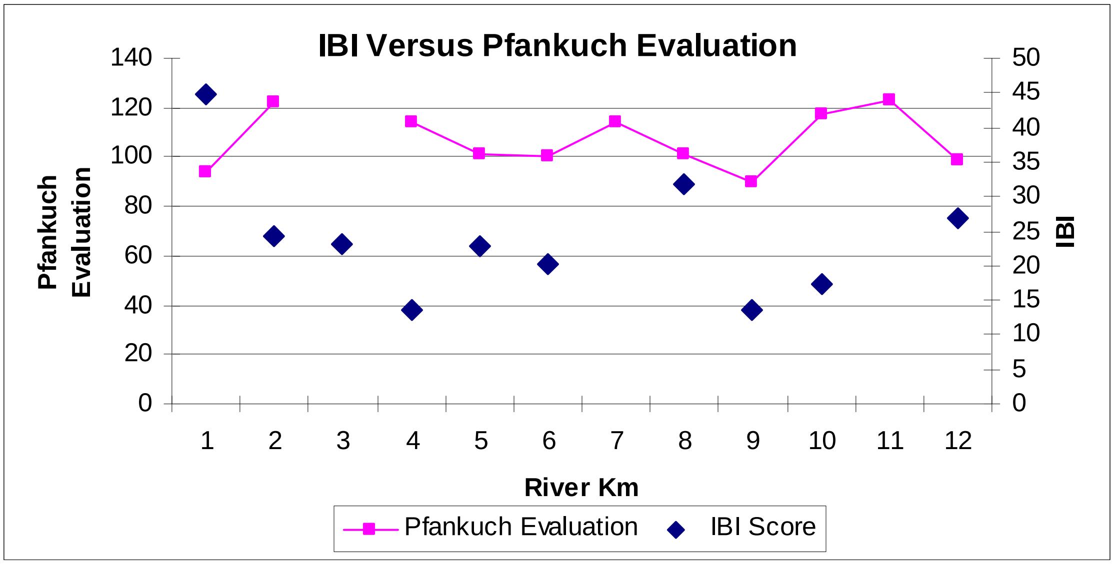


Figure 3.13. Pfankuch stream stability rating by site versus M-IBI score.

3.3.2.2 Sources and Causal Pathways Model for Altered Habitat

There does not appear to be an easily-definable relationship between the habitat indices and the M-IBI scores. The site with the best IBI score (although still below the impairment threshold) is site SC-0, the outlet monitoring station near Webber Park in Minneapolis. That site is the only one to be considered "Fair" using the Rosgen/Pfankuch stream stability evaluation. The RBP score rates that site as "Marginal." However, when considering individual metrics, that site scores well on streambed factors such as a low amount of deposition and embeddedness. The streambed material is also less uniform than other locations, including sand, gravel, and cobble with a D_{50} particle size of 28 mm, coarse gravel (Table 3.4). Just upstream of SC-0 is a series of riffles added in the 1990s as a part of the Minneapolis/Hennepin County Humboldt Greenway project. The dominant family of organisms found in the 2004 macroinvertebrate collection at this site was Hydropsychidae, net-spinning caddisflies. These were found in much more limited numbers elsewhere on Shingle Creek, where streambed material is more uniformly sand and sandy silt and where fewer structures such as riffles are available for net attachment.

The Commission/USGS and MPCA fish collections took place at the USGS site at SC-1 (Figure 3.11). This site did not score highly on the RBP or the Rosgen/Pfankuch stream stability evaluation. However, that site did score above the impairment threshold on the fish IBI, and several moderately tolerant fish species were collected. As noted in Section 2.1.1 above, it is likely that riffles and an area of sandy gravel streambed several hundred feet upstream of the site, which was not captured by the RBP, support a greater diversity of species than would be expected.

Figure 3.14 models the likely habitat alteration sources and causal pathways resulting in biotic impairment in Shingle and Bass Creeks.

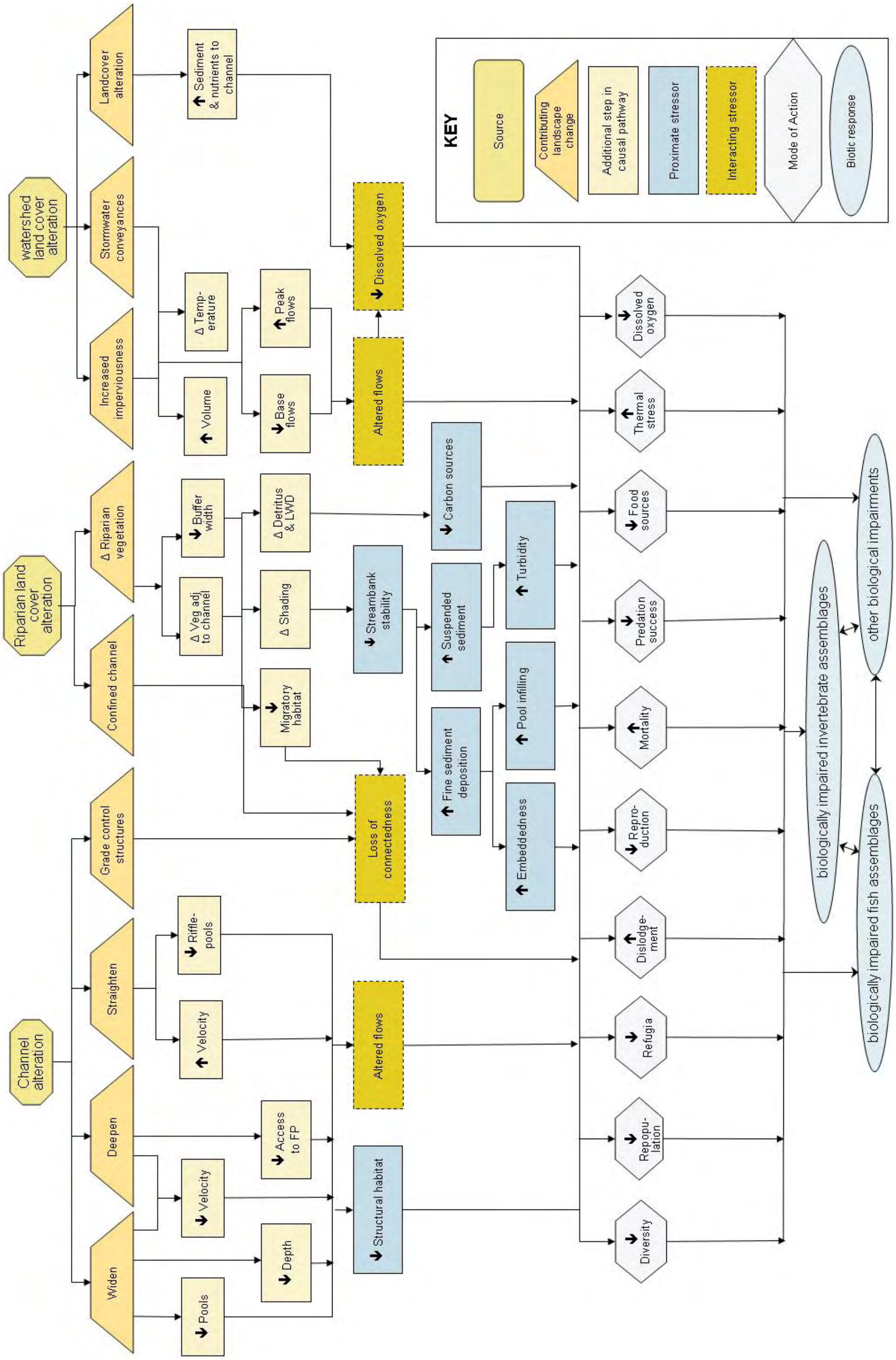


Figure 3.14. Conceptual model describing the sources and causal pathway for altered habitat.

3.3.3 Loss of Connectedness

Connectedness and connectivity are important concepts in ecology, referring to the contiguousness of landscapes and features. Contiguous landscapes such as stream corridors provide continuous, connected habitat that allow organisms to move freely between locations, whether based on different life cycle needs (e.g., spawning habitat, feeding habitat), need for refuge from unusual conditions (e.g., deeper pools during drought or off-line refugia such as wetlands during high flows), or other needs (e.g., dispersing to an area with greater availability of food).

Especially in altered and impacted urban streams, conditions may periodically reduce or eliminate a population of an organism or assemblage. Drought, excessive flow, and physical alteration are some stressors that occur infrequently but which may result in impacts to the local biota. When those conditions stabilize, populations are reestablished through colonization from other locations. Most commonly, recolonization occurs from upstream or downstream reaches or from connected lakes or wetlands. Some organisms with flight capability or which are otherwise mobile may colonize from other, unconnected water resources.

As areas develop, humans may introduce barriers that disconnect landscapes. Stream structures may prohibit movement between reaches. Removal of habitat such as replacement of wooded cover with a residential land use may eliminate the protected habitat corridor for recolonization between unconnected water resources. These barriers create isolated stream reaches that may or may not have access to life cycle habitats, or with limited recolonization potential.

3.3.3.1 Connectedness in Shingle and Bass Creeks

There are significant barriers to the migration of fish and other aquatic species at several locations along both Shingle Creek and Bass Creek (Figure 3.15), including the following:

1. A seven-foot drop structure in Webber Park upstream from Lyndale Avenue North in Minneapolis that disconnects Shingle Creek from the Mississippi River (Figure 3.16). While this structure limits the ability of fish and other aquatic species to swim upstream from the River, it has the beneficial impact of protecting Shingle Creek and upstream resources from invasion by unwelcome exotic and invasive species.
2. A weir and concrete spillway and dual 700-foot long, 12x12 foot box culverts that carry Shingle Creek under the parking lot at Brookdale Shopping Center.
3. A two-foot concrete drop structure in Brookdale Park downstream from Noble Avenue North in Brooklyn Park.
4. A four-foot concrete drop structure downstream of Zane Avenue in Brooklyn Park has been replaced with a rock cascade in a Shingle Creek restoration project completed in 2007.
5. A five-foot sheet pile and rock dam upstream of Brooklyn Boulevard was replaced with a rock cascade as part of a 2008 Shingle Creek restoration project.
6. An outlet structure limiting outflow from Eagle Lake.

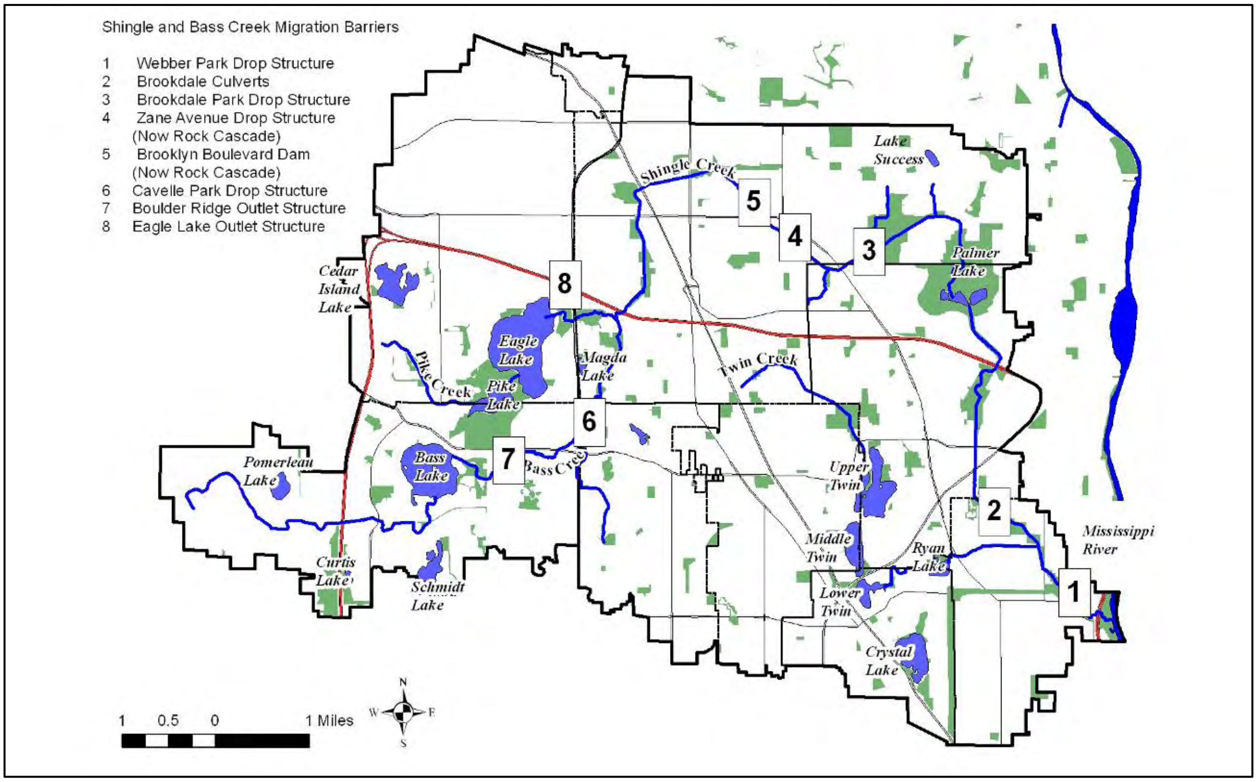


Figure 3.15. Connectedness barriers on Shingle and Bass Creeks.

Figure 3.16. Drop structure in Webber Park that disconnects Shingle Creek from the Mississippi River.

3.3.3.2 Sources and Causal Pathways Model for Loss of Connectedness

Physical barriers on Shingle and Bass Creeks likely significantly inhibit connectivity and limit recolonization. One of the most significant fish barriers is the seven-foot drop structure in Webber Park that disconnects Shingle Creek from the Mississippi River (Figure 3.16). River species are unable to swim upstream to colonize Shingle Creek, thus most fish in Shingle and Bass Creeks are lake species that have been swept over the Bass and Eagle Lakes outlet structures. Several other drop structures have been constructed over the years as the streams were straightened, further disconnecting and isolating stream reaches. Two significant barriers in Brooklyn Park have been removed in the past five years through stream restoration projects. A four-foot drop structure downstream of Zane Avenue has been removed and replaced with a long rock cascade, and a six-foot sheet pile weir just upstream has also been removed and replaced with a rock cascade. However, a two-foot drop structure in Brookdale Park between Noble and Xerxes Avenues continues to serve as a barrier between upper Shingle Creek and the potential spawning and refuge areas in the Palmer Lake basin.

Land cover change has also fragmented habitat and limits connectivity. There are two Minnesota DNR Regionally Significant Ecological Areas on Shingle Creek (the Palmer Lake basin and an area south of North Hennepin Community College along Shingle Creek between Broadway and Candlewood Drives in Brooklyn Park) and numerous riparian wetlands. However, except for Palmer Lake these are relatively small patches of natural land cover interspersed with areas of dense urban and suburban development, with developed land cover extended to the banks of the two streams. This limits the ability of terrestrial and aquatic species to move between reaches or to recolonize from other lakes and streams in the area.

Figure 3.17 models the likely loss of connectedness sources and causal pathways resulting in biotic impairment in Shingle and Bass Creeks.

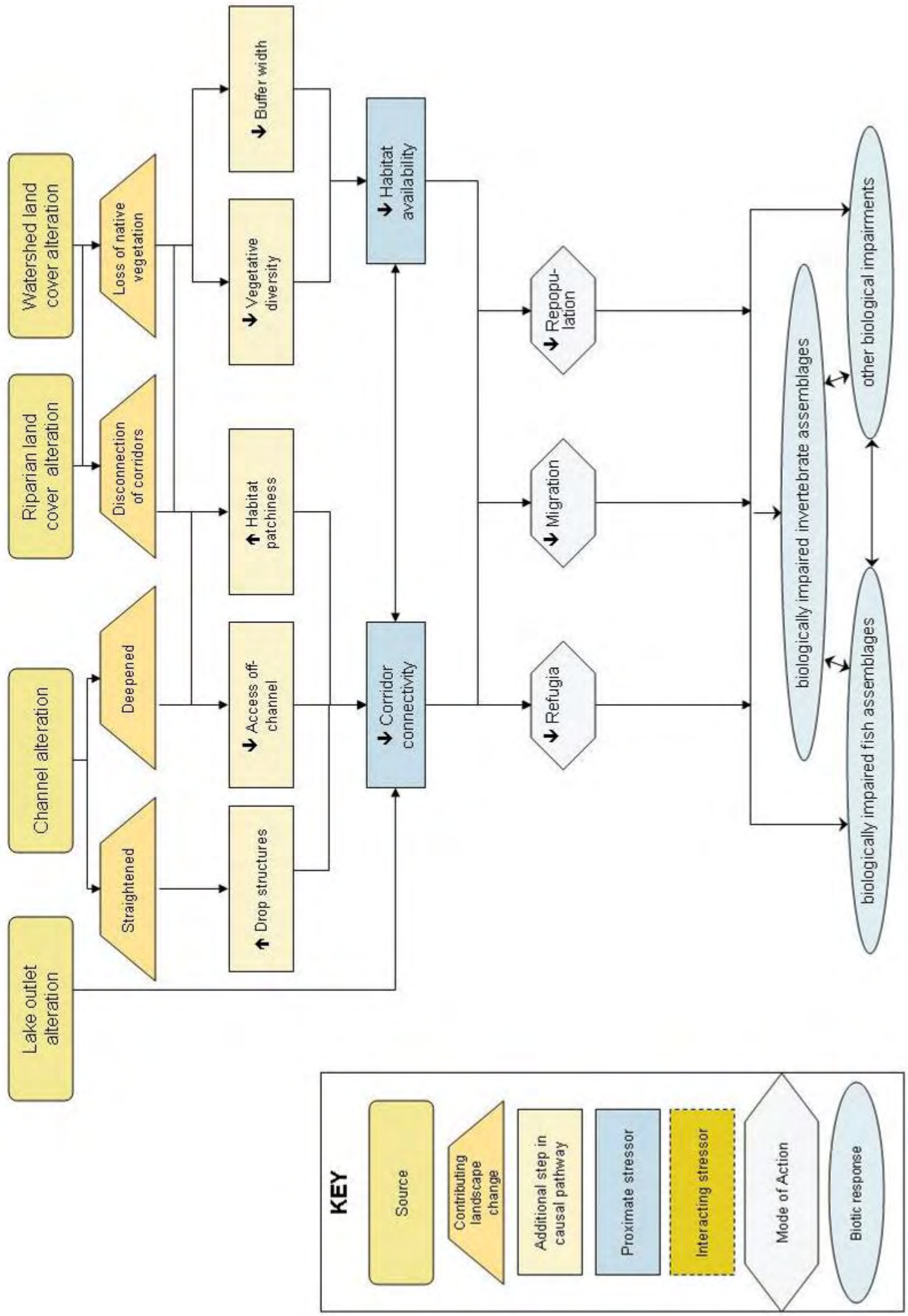


Figure 3.17. Conceptual model describing the sources and causal pathway for loss of connectedness.

3.3.4 Altered Hydrology

Loss of flow, low flows, or prolonged duration of low flow conditions can reduce overall habitat availability by decreasing water volume and wetted channel area. Prolonged duration of low flows tends to favor macroinvertebrate and fish species that prefer standing-water habitats.

High-flow events can physically remove species from the channel to a downstream location. High flows also mobilize pebbles, sediment, woody debris, and plant material that can dislodge organisms. Frequent high-flow events can decrease species richness by eliminating or reducing populations that have not developed coping mechanisms, such as an ability to cling to substrate or burrow into sediments. Macroinvertebrate assemblages may shift to include more species with relatively short life cycles.

King's County, Washington conducted an extensive study of the hydrology and biology of Puget Sound lowland streams to determine if a relationship could be developed between flow alteration and biotic integrity (Cassin et al. 2005). Flow regime, including low-flow and high-flow pulse events and intervals between events, the percent of time above the mean 2-year flow, and other metrics were assessed in relation to the B-IBI (benthic IBI). This analysis found that higher B-IBI scores were characteristic of sites with longer periods of stable flows between pulses, fewer pulses, and a less flashy hydrograph. However, the analysis stopped short of defining an "ideal" hydrologic regime.

Poff and Allan (1995) evaluated a large database of USGS flow and stream fish assemblage data at sites in Minnesota and Wisconsin and found that in streams with more variable flow the fish community selected to species that prefer slow velocities, have generalized feeding strategies and are tolerant to silt. They theorize that hydrologic regime is an integrator of various environmental constraints such as temperature, habitat volume, velocity, and the amount and extent of ice buildup in winter.

3.3.4.1 Hydrology in Shingle and Bass Creeks

Flow in Shingle and Bass Creeks has been fundamentally altered from pre-development conditions. A network of storm sewers and channels efficiently deliver runoff to the streams, which rise rapidly and fall almost as rapidly. The increased imperviousness of the watershed and decreased infiltration to groundwater has significantly reduced base flow, and the streams are often dry by mid-summer. The hydrology of the streams is thus extremely variable.

A recent rain event hydrograph illustrates the flashiness of Shingle Creek. On August 19, 2009 the northern Metro area suburbs experienced a 2-year, 3-hour rain event, receiving 1.8 inches in 3 hours. Figure 3.18 is a storm event hydrograph for monitoring location SC-3 that shows streamflow and precipitation starting at about 10:00 a.m. through about 11:00 p.m. Streamflow was recorded in cubic feet per second (cfs) at 15 minute intervals, and precipitation was recorded in inches per hour. A light misty rain started falling in mid morning, with about 0.2 inches received in about three hours. Flow started increasing in the Creek almost immediately, and the level logger at SC-3 showed a stream stage increase of about four inches.

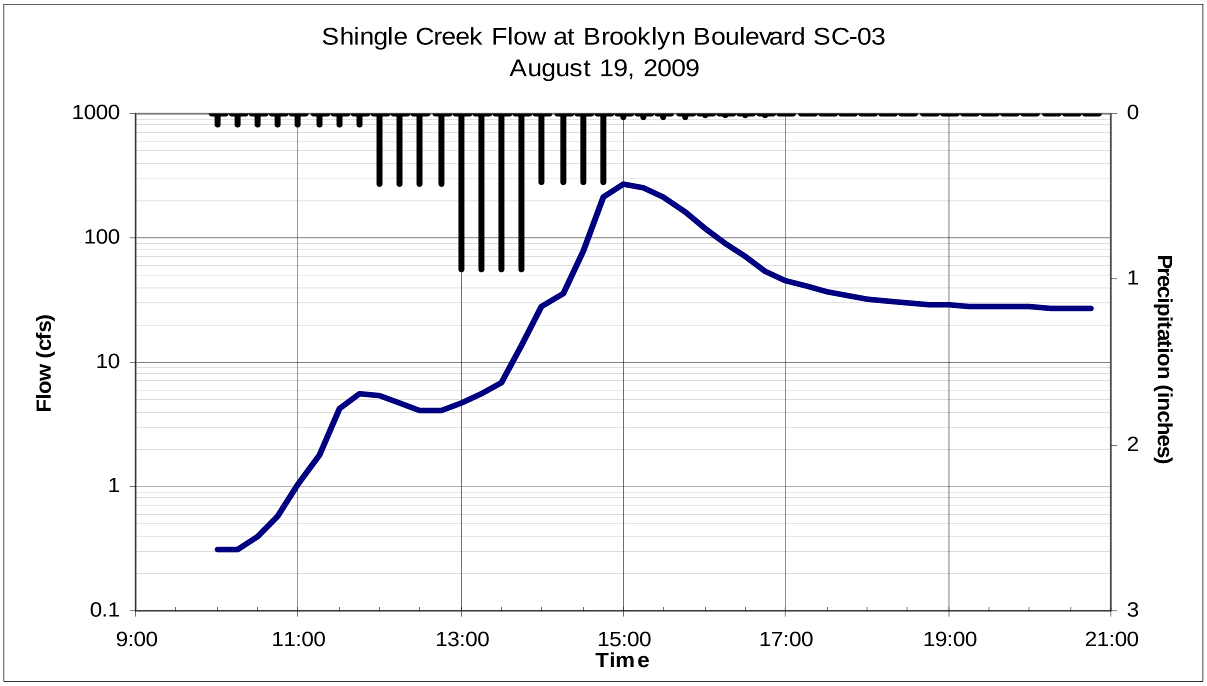


Figure 3.18. August 19, 2009 storm event hydrograph.

As the storm grew in intensity, 0.42 inches of rain fell in the first hour of the event (noon-1 p.m.), 0.94 inches in the second hour (1 p.m. – 2 p.m.), and 0.41 inches in the third hour (2 p.m. to 3 p.m.). Streamflow increased from 4.7 cfs to 268 cfs in two hours, and stream stage rose another 3.4 feet. After 3 p.m. the precipitation tapered off and streamflow and stage fell, but stayed at about 20 cfs for the next few days as upstream ponds, wetlands, and other storage areas discharged.

Figure 3.19 illustrates flow variability over a ten year period at monitoring site SC-0, which is in Webber Park in Minneapolis near the outlet of the Creek into the Mississippi River. This figure shows the variability in flows pulsing from low to very high as the Creek conveys runoff from the 44.7 square mile urban watershed.

As previously described, there is a distinct hydrologic difference between Shingle Creek below Palmer Lake and Shingle Creek above Palmer Lake. Shingle Creek above Palmer Lake experiences extended periods of very low to no flow. Flow duration curves for the three Shingle Creek flow monitoring sites are shown on Figure 3.20. SC-0 and the USGS monitoring station at Queen are both located downstream of Palmer Lake and exhibit similar flow duration curves. However, SC-3 is located above Palmer Lake, and the flow duration curve indicates that flow at the site is very low (< 1 cfs) or nonexistent about 28 percent of the time.

No flow data is available for Bass Creek, but by observation the stream upstream of TH 169 (refer to Figure 1.3) is intermittent, and flows only to convey runoff and snowmelt. Downstream of TH 169 to the confluence with Eagle Creek streamflow can be variable. Large riparian wetlands such as Cherokee Wetland between 63rd Avenue North and Cherokee Drive discharge groundwater to the stream but in late summer that basin is often drawn down by the extensive cattail vegetation, and less flow is discharged into Bass Creek.

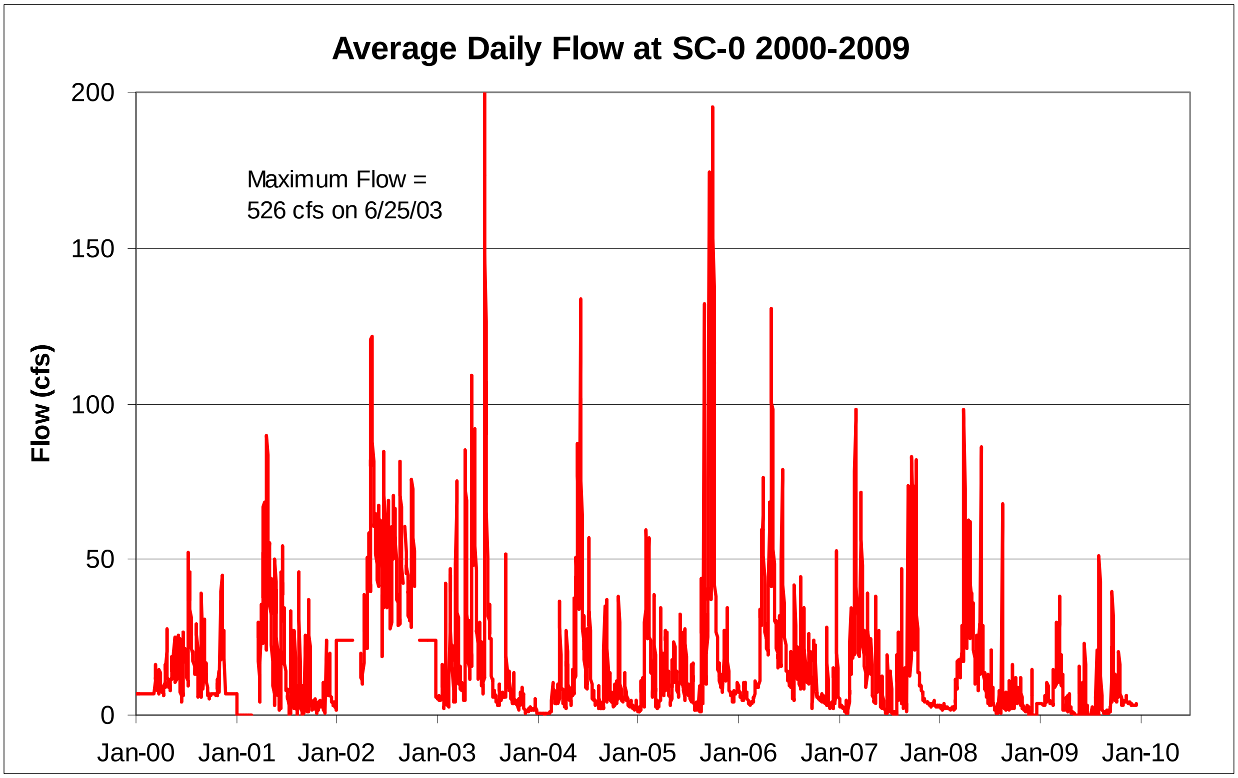


Figure 3.19. Streamflow recorded at station SC-0 in Minneapolis near the Shingle Creek outlet, 2000-2009.

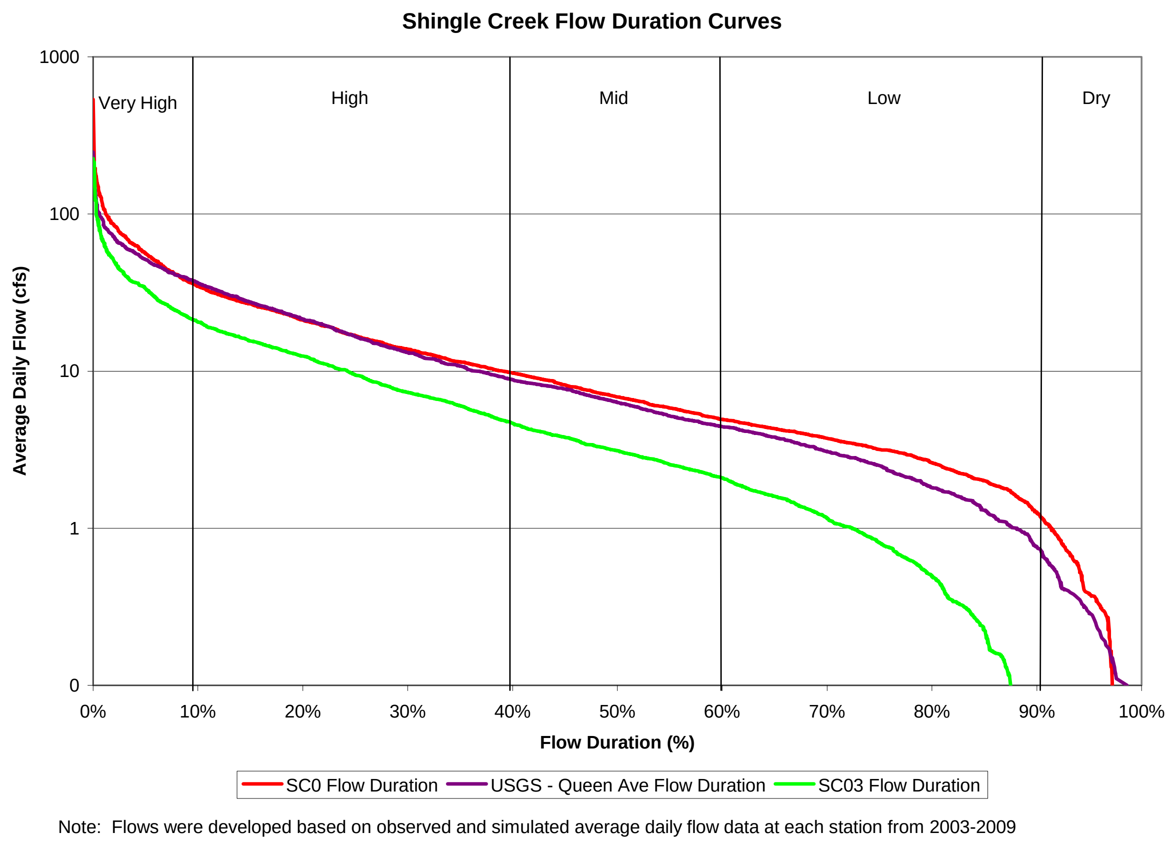


Figure 3.20. Flow duration curves for monitoring sites on Shingle Creek.

3.3.4.2 Sources and Causal Pathways Model for Flow Alteration

Urbanization in the Shingle Creek watershed has altered hydrology in Shingle and Bass Creeks. As discussed in Section 1.5 above, Public Land Survey information suggests that prior to European settlement, Shingle Creek above Palmer Lake was a narrow meandering prairie stream. Below Palmer Lake, Shingle Creek was wider and ran through extensive riparian wetlands that were subsequently drained and filled for agriculture and development. It is likely that Shingle Creek above Palmer Lake was historically intermittent, while Palmer Lake and the riparian wetlands contributed to maintaining flow in the lower Creek. Bass Creek appears to be a series of channels either created or altered to drain wetlands. It too was likely historically intermittent.

The increase in impervious surface has increased both the frequency and magnitude of peak flows compared to the presettlement condition. The Shingle Creek Watershed Management Commission has had regulations in place since 1985 requiring that runoff rates from new development and redevelopment not exceed runoff rates under predevelopment conditions. However, much of the lower watershed developed prior to 1985 when no limitation was in place.

The increase in impervious surface has also reduced infiltration to surficial groundwater, reducing base flow in both streams. Downstream of Palmer Lake, Shingle Creek usually is able to sustain a baseflow that fills the channel, although it may be only inches deep. Upstream of Palmer Lake, Shingle Creek is often reduced to a low flow channel between pools, and in lower precipitation years can go completely dry between rain events. Bass Creek is intermittent for most of the year, generally sustaining a flow only in spring. The Commission has had regulations in place since 2003 requiring new development and redevelopment to infiltrate the first 0.5" of runoff from impervious surfaces. However, as with rate control, much of the lower watershed developed prior to 2003 when no infiltration requirement was in place. The infiltration requirement has not been in place long enough to evaluate its effects on reducing peak rates and increasing base flow.

Altered hydrology is reflected in the taxa found in Shingle and Bass Creeks. Poff and Allan (1995) found that fish showed distinct affiliation with sites of differing hydrology. The fish species at Bass Creek were all found by Poff and Allan to be more frequently present in streams with variable hydrology than streams with stable hydrology. However, the dominant taxa in Shingle Creek at the USGS site, which has a more stable hydrology (i.e., there is usually water in the stream), are found both in stable and variable streams.

Except where there are riffles and pools and a sand-gravel streambed, the macroinvertebrate community in both Shingle and Bass Creeks is dominated by taxa found in wetlands.

Figure 3.21 models the likely hydrologic alteration sources and causal pathways resulting in biotic impairment in Shingle and Bass Creeks.

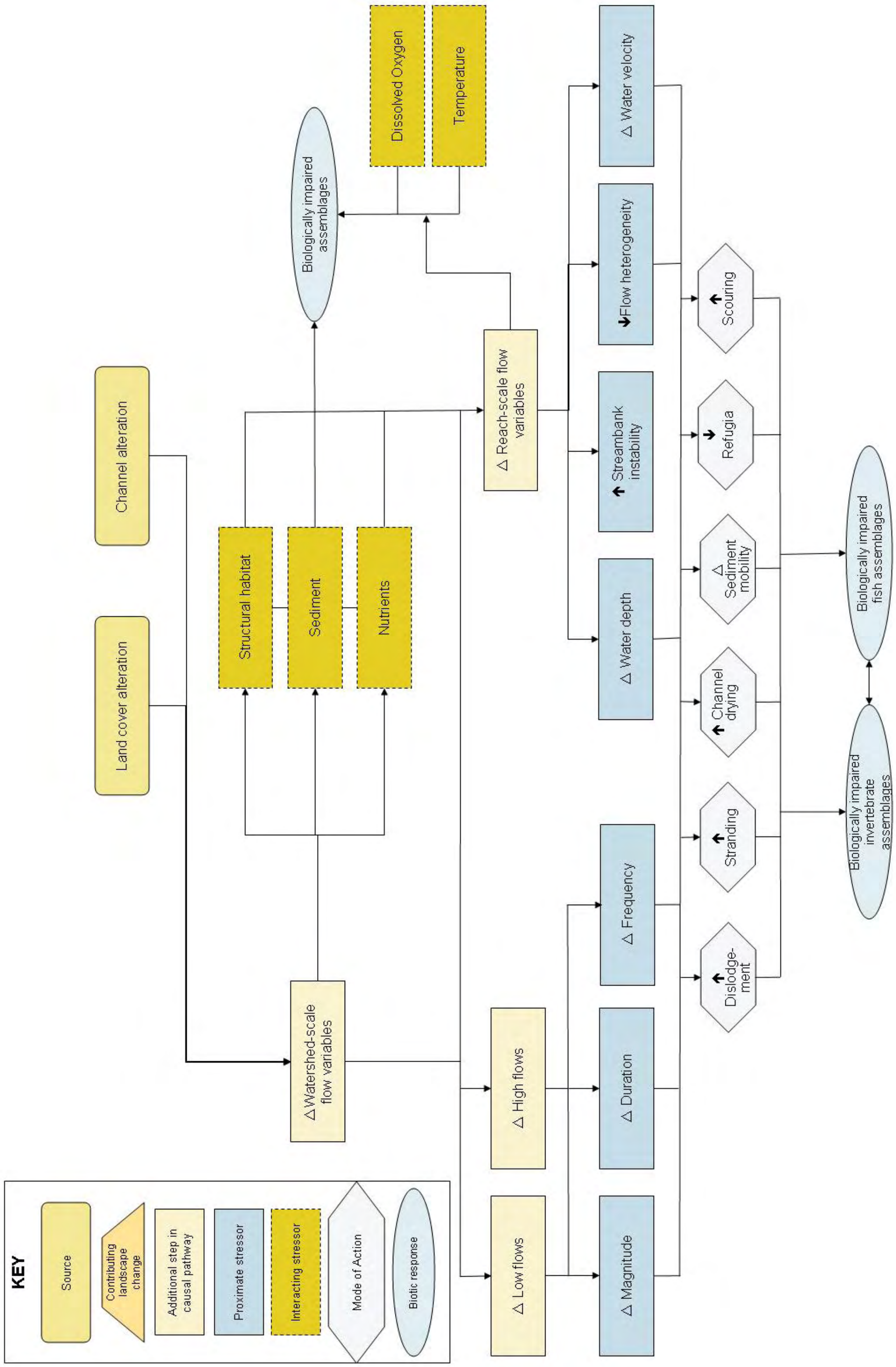


Figure 3.21. Conceptual model describing the sources and causal pathway for altered hydrology.

3.3.5 Ionic Strength

Shingle Creek is an Impaired Water due to chloride concentrations in excess of state water quality standards. A TMDL for that impairment was completed and approved in 2007. That TMDL linked the excessive chloride concentrations to the application of road salt for winter de-icing in the 44.7 square mile watershed, which is crisscrossed with a dense network of local, county, and state roads, highways, and interstate highways. Bass Creek was added to the Impaired Waters list in 2010 for excess chloride.

The Minnesota chloride standards are a four-day average of 230 mg/L for chronic exposure, or 860 mg/L for one hour are based on fish toxicity levels. Evens and Frick (2001) summarized a number of studies investigating salinity tolerance in fish between 11,500 mg/L and 15,000 mg/L NaCl. Minnows, bluegill, and sunfish all began to experience significant mortality at these salinities. For long term (greater than 7 day exposures), the literature review found that mortality began to be observed at concentrations above 1,000 mg/L.

Key research on the impact of road salt on stream macroinvertebrate communities was completed by B. J. Blasius and R. W. Merritt (2002). The research team performed both laboratory and field studies on two streams in Michigan to evaluate the possible impact of road salt at various concentrations on mortality, drift, and community function. Blasius and Merritt found that short-term exposures to various chloride concentrations did not appear to negatively impact drift or increase mortality.

Crowther and Hynes (1977) conducted field experiments in streams in Ontario, Canada and found that adding road salt in solution to experimentally-modified streams had no significant effect on organism drift until concentrations exceeded 1,000 mg/L, and then only for some species.

M. E. Benbow and R. W. Merritt (2004) investigated possible chronic exposure effects by performing laboratory and field studies on macroinvertebrates in standing water wetlands adjacent to heavily-salted highways in Michigan. Shingle and Bass Creeks tend to be dominated by wetland macroinvertebrate species due to their low gradients and the numerous riparian and in-line wetlands. Their conclusion is that a reasonable range for estimated 96 hour LC_{50} chloride concentration is 3,000 to 5,000 mg/L for the species studied, *Callibaetis fluctuans* (a mayfly), *Chaoborus americanus* (phantom midge), *Physella integra* (a snail), and *Hyalella azteca* (a scud). The experimental concentrations were significantly greater than the typical concentrations they found in standing water wetlands in Michigan, as well as the concentrations found in Shingle and Bass Creeks.

Most experimental work regarding chloride impacts to fish and macroinvertebrates focuses on defining acute or chronic lethality, with less study evaluating moderate concentrations. Studies also tend to focus on individual species rather than communities or guilds. It is not entirely clear from the literature, for example, how the timing of acute concentrations affects the structure of the fish and macroinvertebrate communities, or the impact of chronically elevated concentrations. There are potential impacts from chloride use that may impact the biota in other ways. Additives and impurities in road salt may introduce toxic metals and nutrients into the stream. Salt spray from a stream road crossing may kill streambank vegetation, destabilizing banks and increasing erosion and sedimentation in the stream. Minimal research has been completed on the cumulative effect of these other impacts on biotic integrity.

3.3.5.1 Chloride in Shingle and Bass Creeks

Shingle Creek and Bass Creek experience periods of excess chloride concentration, typically during spring snowmelt and during short winter snowmelt events. During these winter and early spring events, short-term chloride concentrations in excess of 1,000 mg/L have been recorded. By about May of each year chloride concentrations fall below the 230 mg/L chronic exposure standard and stay well below that standard until snow season begins around November. Figure 3.22 shows modeled and measured chloride in Shingle Creek in 2008.

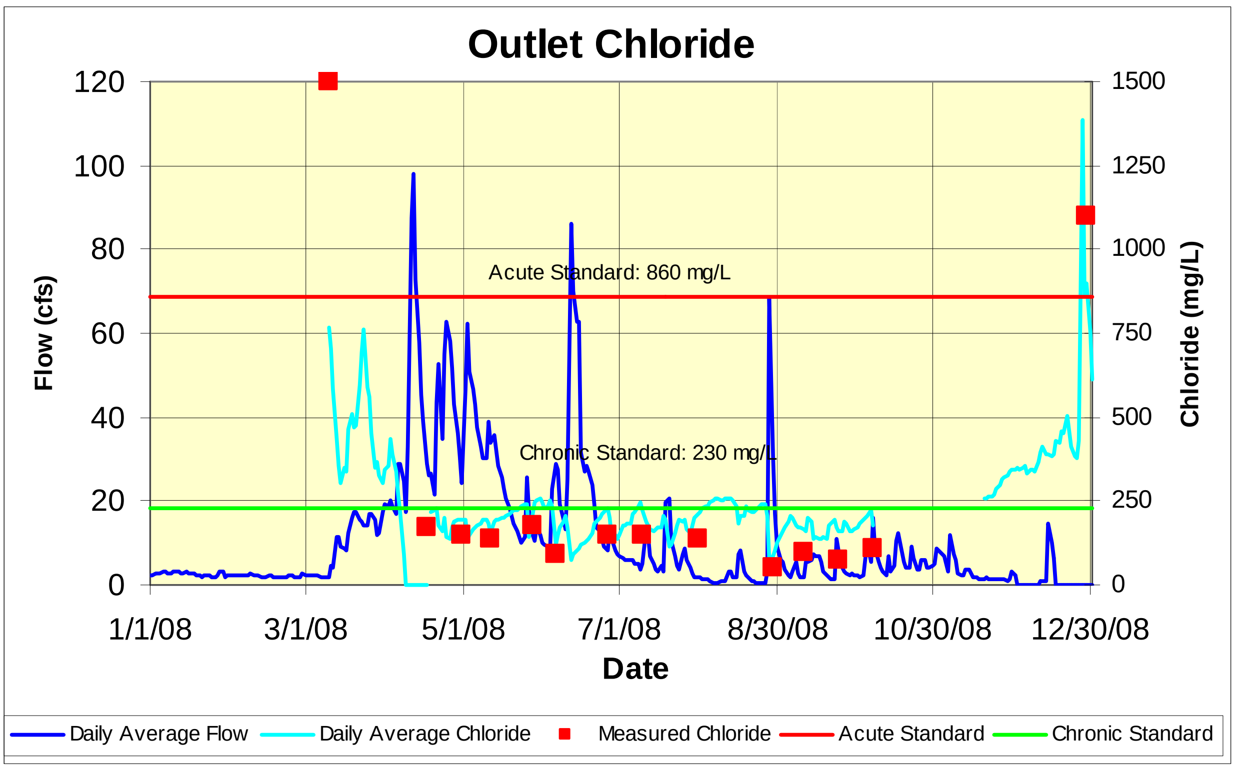


Figure 3.22. 2008 chloride concentrations at the outlet of Shingle Creek.

3.3.5.2 Sources and Causal Pathways Model for Ionic Strength

A key factor in evaluating the potential role of chloride as a stressor in Shingle and Bass Creeks is the timing of peak concentrations. Fish and macroinvertebrate spawning and emergence in cold climates generally occurs from late April through August, depending on water temperature. As can be seen on Figure 3.22, in Shingle Creek the highest chloride concentrations occur during winter and early spring snowmelt, and by late April concentrations fall below the 230 mg/L chronic exposure standard.

Evens and Frick (2001) conducted an extensive literature review evaluating the effects of road salt on aquatic ecosystems. While impacts varied by species, in experimental conditions mortality impacts in fish and macroinvertebrates were not observed until long-term (i.e., greater than 7 days) exposures of greater 1,000 mg/L were present. While Shingle Creek experiences occasional short-duration pulses in excess of 1,000 mg/L during the winter and early spring, exposures during the spring, summer, and fall typically are less than 200 mg/L.

However, individual species have elevated sensitivity to chloride at chronic exposure levels less than those acute levels, and at concentrations that Shingle Creek may exhibit for extended periods of time in the late spring. For example, Environment Canada (2005) noted that the No-Observed-Effect Concentration (NOEC) for the 33-day early life stage test for survival of fathead minnow was 252 mg chloride/L. Fathead minnow are present in Shingle Creek at the USGS monitoring site, and were the dominant species in terms of number of individuals collected at the Bass Creek monitoring site.

Environment Canada estimates 5% of aquatic species in streams would be affected (median lethal concentration) at chloride concentrations of about 210 mg/L, and 10% of species would be affected at chloride concentrations of about 240 mg/L. Because Shingle Creek often experiences periods when chloride concentration approaches those levels, chloride may be contributing to the lack of species that are intolerant of poor water quality conditions.

Horrigan et al. (2005) developed a method to assign a salinity sensitivity score to various taxa based on an Australian dataset of 2,580 samples collected over eight years. Each taxon is assigned a score of 1-very tolerant, 5-tolerant, or 10-sensitive. While many of the taxa in their study are not native to Minnesota streams, some of the sensitive and tolerant taxa are found in Shingle Creek (Table 3.7). The most sensitive taxa found in Shingle Creek where there are more than just a few individuals present are Hydropsychidae and Simuliidae. These were most prevalent at SC-0 and in Reach 5, both at sampling locations with small riffles nearby and a sandy gravel streambed. This suggests that in the presence of desirable habitat saline-sensitive taxa may be able to tolerate the levels of chloride in Shingle Creek.

Table 3.7. Salinity sensitivity of macroinvertebrates sampled in 2004 in Shingle Creek.

	Number of Individuals by Salinity Sensitivity				
Site Name	**1**	**5**	**10**	**Unknown**	**Grand Total**
SC-0	4	42	163	97	306
Reach 2	40	125		340	505
Reach 3	44	176	1	246	467
Reach 4	64	148	1	97	310
Reach 5	46	149	14	179	388
SC-3 (Reach 6)	88	1,319		118	1,525
Reach 7	20	199		88	307
Reach 8	12	124	2	272	410
Grand Total	318	2,282	181	1,437	4,218

Note: 1-very tolerant, 5-tolerant, or 10-sensitive (Horrigan et al. 2005).

Figure 3.23 models the likely ionic strength-chloride concentration sources and causal pathways resulting in biotic impairment in Shingle and Bass Creeks.

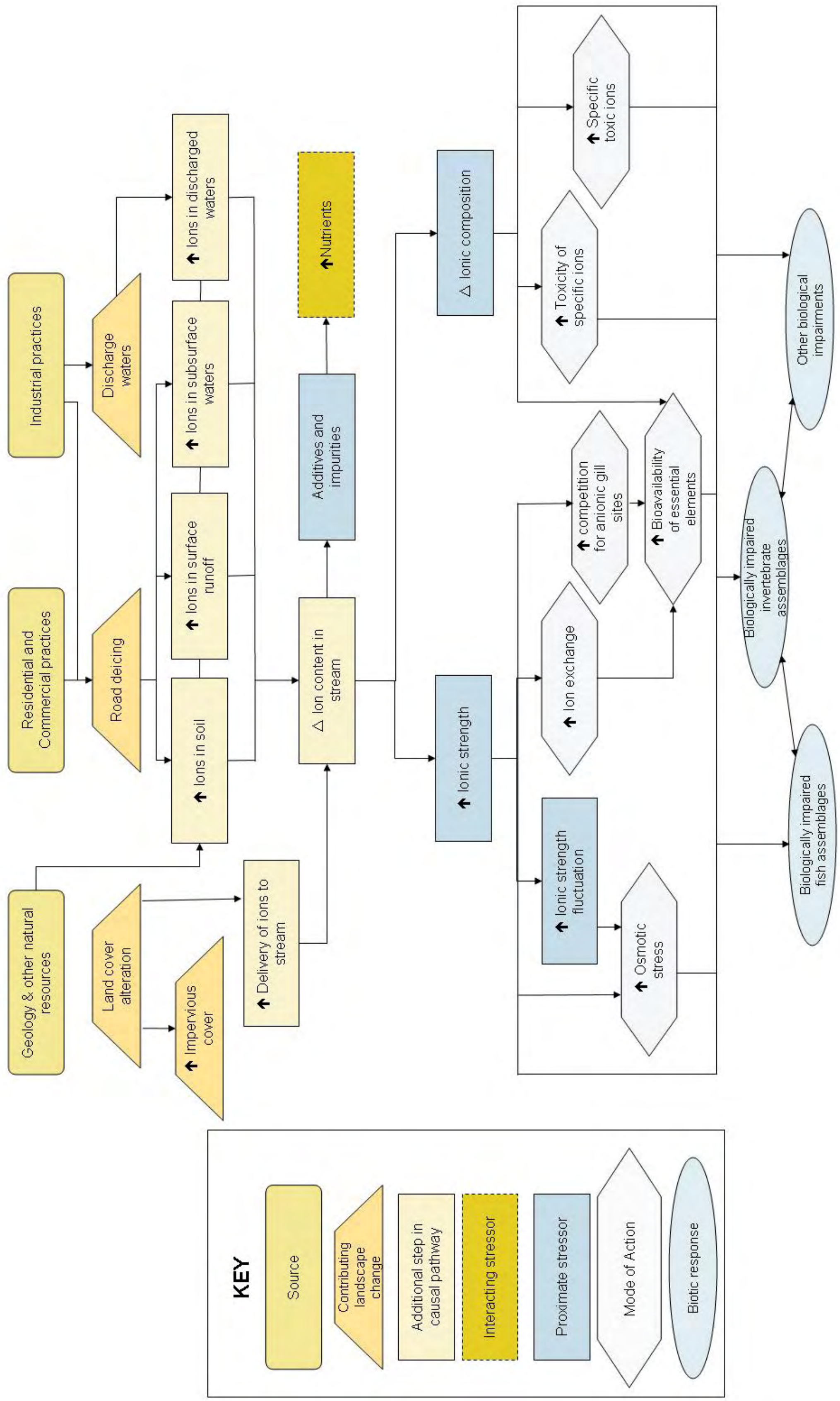
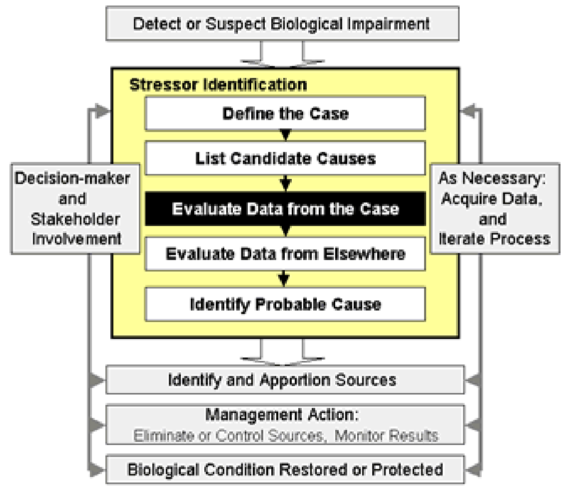


Figure 3.23. Conceptual model describing the sources and causal pathway for ionic strength -chloride.

4.0 Data from the Case



4.1 CAUSAL ANALYSIS

In this CADDIS Stressor Identification step, data from the case is assembled and analyzed with two goals in mind:

- To develop consistent and credible evidence that will allow the confident elimination of very improbable causes, or to use symptoms to refute or diagnose a cause, and
- To begin building the body of evidence for the candidate causes that cannot be eliminated or diagnosed, to identify the most probable causes.

Each type of evidence is evaluated, and the degree to which each type of evidence supports or weakens a case is scored using a standard system. Data from the case may show that it is impossible or extremely improbable that a candidate cause produced the observed effect; if this happens, that candidate cause can be eliminated from further consideration. Certain symptoms may allow for a confident diagnosis or refutation of a candidate cause. The evidence generated by analyzing associations among data or observations from the case will typically fall into one of the types listed in Table 4.1.

Table 4.1. Types of evidence that use data from the case.

Type of Evidence	**Concept**
Evidence Using Data From the Case	
Spatial/Temporal Co-Occurrence	The biological effect is observed where and when the causal agent is observed and is not observed in the absence of the agent.
Evidence of Exposure or Biological Mechanism	Measurements of the biota show that relevant exposure has occurred or that other biological processes linking the causal agent with the effect have occurred.
Causal Pathway	Precursors of a causal agent (components of the causal pathway) provide supplementary or surrogate evidence that the biological effect and causal agent are likely to have co-occurred.
Stressor-Response Relationships From the Field	The intensity or frequency of biological effects at the site increases with increasing levels of exposure to the causal agent or decrease with decreasing levels.
Manipulation of Exposure	Field experiments or management actions that decrease or increase exposure to a causal agent decrease or increase the biological effect.
Laboratory Tests of Site Media	Laboratory tests of site media can provide evidence of toxicity, and Toxicity Identification Evaluation (TIE) methods can provide evidence of specific toxic chemicals, chemical classes, or non-chemical agents.
Temporal Sequence	The cause must precede the biological effect.

Type of Evidence	Concept
Verified Prediction	Knowledge of the causal agent's mode of action permits prediction of unobserved effects that can be subsequently confirmed.
Symptoms	Biological measurements (often at lower levels of biological organization than the effect) can be characteristic of one or a few specific causal agents. A set of symptoms may be diagnostic of a particular cause if they are unique to that cause.
Evidence Using Data From Other Systems	
Mechanistically Plausible Cause	The relationship between the cause and biological effect must be consistent with known principles of biology, chemistry and physics, as well as properties of the affected organisms and the receiving environment.
Stressor-Response in Other Field Studies	At the impaired sites, the cause must be at levels sufficient to cause similar biological effects in other field studies.
Stressor-Response in Other Lab Studies	Within the case, the cause must be at levels associated with related biological effects in laboratory studies.
Stressor-Response in Ecological Models	Within the case, the cause must be at levels associated with effects in mathematical models simulating ecological processes.
Manipulation Experiments at Other Sites	At similarly impacted locations outside the case sites, field experiments or management actions that increase or decrease exposure to a cause must increase or decrease the biological effect.
Analogous Stressors	Agents similar to the causal agent at the impaired site should lead to similar effects at other sites.
Evaluating Multiple Lines of Evidence	
Consistency of Evidence	Confidence in the argument for or against a candidate cause is increased when many types of evidence consistently support or weaken it.
Explanatory Power of Evidence	Confidence in the argument for a candidate cause is increased when a post hoc mechanistic, conceptual, or mathematical model reasonably explains any inconsistent evidence.

Data are analyzed in terms of associations that might support, weaken or refute the case for a candidate cause. This Strength of Evidence analysis is a systematic approach that sorts through the available data to determine the most probable cause or causes based on weight of evidence. Each of the types of evidence is scored based on the degree to which it supports or weakens the case using pluses (++) or minuses (--). The number of pluses or minuses depends on the likelihood that an association might be observed by chance rather than because of the true cause.

A score of O indicates that the evidence neither supports nor weakens the case for the cause, a D is diagnostic of the cause and an R refutes the case for the cause.

4.1.1 Weight of Evidence: Dissolved Oxygen

Literature and experiments conducted elsewhere confirm that low levels of dissolved oxygen can adversely affect biotic community composition and richness. The macroinvertebrate and fish taxa present in Shingle and Bass Creeks are generally tolerant of low oxygen conditions. For example fish sampling at the Bass Creek site found an abundance of fathead minnows, which are tolerant of turbid, low oxygenated water. However, the available data does not present a clear relationship between low dissolved oxygen and impaired biota. There are sites on Shingle and Bass Creeks with low dissolved oxygen conditions that support moderately tolerant taxa and an unimpaired fish or macroinvertebrate biotic community. More data from additional sites and multiple years is necessary to clarify the strength of the case. Table 4.2 evaluates the sufficiency of evidence that dissolved oxygen is a cause of impaired fish and macroinvertebrate communities.

Table 4.2. Weight of evidence table: dissolved oxygen.

Types of Evidence	Findings	Score
Evidence using data from Shingle and Bass Creeks		
Spatial/temporal co-occurrence	Violations of the dissolved oxygen standard are found throughout the entire watershed. There is no apparent direct relationship between dissolved oxygen levels and fish or macroinvertebrate scores.	O
Evidence of exposure, biological mechanism	The fish and macroinvertebrate communities are exposed to low dissolved oxygen throughout the watershed.	++
Causal pathway	Dissolved oxygen concentrations in Shingle Creek are very low at times below Palmer Lake where the fish community is not impaired, and in Bass Creek at Bass Creek Park where the macroinvertebrate community is not impaired.	-
Field evidence of stressor-response	The low dissolved oxygen concentrations are present throughout the watershed, some monitoring locations are dominated by taxa that are more tolerant of low oxygen conditions, but a spatial gradient of biotic response is not present in the available data.	+
Field experiments /manipulation of exposure	Low dissolved oxygen concentrations are present throughout both streams. Where reaeration structures have been introduced to increase dissolved oxygen, no biotic data is available to evaluate effect.	O
Laboratory analysis of site media	No laboratory experiments have been conducted.	O
Temporal sequence	Limited biological and monitoring data is available to determine temporal sequence of the cause.	O
Verified or tested predictions	Dissolved oxygen concentrations are very low at times below Palmer Lake where the fish community is not impaired and in Bass Creek at Bass Creek Park where the macroinvertebrate community is not impaired. However, the majority of the taxa present are considered tolerant of low oxygen conditions. The available data is somewhat predictive of biotic response, however, more data is necessary to clarify the seemingly contradictory findings.	+
Symptoms	The impairment of the fish and macroinvertebrate communities appears to be influenced by multiple factors, including dissolved oxygen.	+
Evidence using data from other systems		
Mechanistically plausible cause	Lack of adequate dissolved oxygen concentrations is known to reduce the health or richness of fish and macroinvertebrate communities through a shift toward tolerant species or an exclusion of sensitive species.	+
Stressor-response in other field studies	Field studies in Minnesota and adjacent states have documented the impacts of low dissolved oxygen levels on fish community health. However, the impacts of dissolved oxygen cannot be easily seen within Shingle and Bass Creeks with the available data.	O
Stressor-response in other lab studies	All fish and macroinvertebrates require adequate dissolved oxygen for survival. Laboratory studies have documented the required levels for a variety of species.	+
Stressor-response in ecological models	No ecological modeling data is available.	O
Manipulation experiments at other sites	No experimental data is available.	O

Types of Evidence	Findings	Score
Analogous stressors	No analogous stressors are available.	O
Multiple lines of evidence		
Consistency of evidence	Low dissolved oxygen levels can severely impair the fish and macroinvertebrate communities within a system but the evidence of the effect of dissolved oxygen levels within Shingle and Bass Creek is not as clearly defined with the available biological data.	O
Explanatory power of evidence	There is no clear spatial gradient of low dissolved oxygen levels and impaired biotic community. However, it is likely the low dissolved oxygen levels are contributing to the abundance of tolerant taxa throughout Shingle and Bass Creeks.	++

4.1.2 Weight of Evidence: Altered Habitat

Shingle Creek has been dramatically altered from its pre-settlement natural form. Bass Creek is a series of ditches, some man-made and some excavated ephemeral streams, that connect and outlet wetlands. Both streams have been straightened and channelized to improve efficiency of stormwater conveyance, and both contain minimal physical features to provide a varied habitat for fish and macroinvertebrate life-cycle functions. The individual metrics in the fish IBI indicate low species overall richness and a lack of lithophils, reflective of the uniform, sandy stream bottom through most of the stream and lack of varied habitat.

The macroinvertebrate IBI metrics indicate a low number of taxa from the functional feeding groups clingers and scrapers. This is consistent with the lack of substrate available for these species: few riffles, little woody debris, little overhanging vegetation, and a sandy, silty stream bottom. In some locations, such as the monitoring site SC-0 where habitat improvements including created riffle-pool sequences and a gravel-cobble streambed have been made, macroinvertebrate diversity appears to be richer and more supportive of moderately tolerant organisms. Table 4.3 evaluates the sufficiency of evidence that altered habitat is a cause of impaired fish and macroinvertebrate communities in these streams.

Table 4.3. Weight of evidence table: altered habitat

Types of Evidence	Findings	Score
Evidence using data from Shingle and Bass Creeks		
Spatial/temporal co-occurrence	The channel of both streams has been altered along the entire watershed. The Rapid Bioassessment Protocol scores habitat and stream conditions as Marginal. Species richness is low at all locations, with certain functional groups that require varied habitat such as gravel, cobble or boulder not present.	+
Evidence of exposure, biological mechanism	Species richness is low at all locations, with certain functional groups that require varied habitat such as gravel, cobble or boulder not present.	++
Causal pathway	Where habitat is limited, fish and macroinvertebrate communities lack richness. Where habitat has been enhanced, there appears to be greater diversity, e.g., at SC-0 clingers and scrapers are present where riffles and a gravel-cobble streambed have been added but those functional groups are lacking where that substrate is not or is minimally present. The fish community at SC-1 is richer than would be expected given the habitat suitability. Fish data overall is limited spatially and temporally. This item is scored + rather than ++ because more fish data is needed to better understand the strength of	+

Types of Evidence	Findings	Score
	the causal pathway for fish.	
Field evidence of stressor-response	Where habitat is most limited, fish and macroinvertebrate communities lack richness. Where habitat has been enhanced, there is a greater diversity, e.g., at SC-0 clingers and scrapers are present where riffles and gravel-cobble streambed have been added but those functional groups are lacking where those habitats are not present. There is limited data on biotic conditions prior to that habitat improvement project. Additional habitat improvement projects have been undertaken, but drought conditions in 2008 and 2009 limited the ability to take post-construction macroinvertebrate samples for comparison to pre-construction conditions.	+
Field experiments /manipulation of exposure	Limited data is available. Where habitat has been improved at one location, there is increased macroinvertebrate diversity. There have been additional stream restoration projects on Shingle Creek but drought conditions over two years have limited the ability to evaluate the biotic response.	O
Laboratory analysis of site media	Laboratory experiments were not conducted.	O
Temporal sequence	Limited biological data is available to determine temporal sequence of the cause.	O
Verified or tested predictions	Limited data is available. Where habitat has been improved at one location, there is more macroinvertebrate diversity than locations where habitat has not been improved.	+
Symptoms	The impairment of the fish and macroinvertebrate communities appear to be influenced by multiple factors including the lack of in-channel habitat. The limited data supports this candidate cause but is insufficient to be diagnostic.	+
Evidence using data from other systems		
Mechanistically plausible cause	Reduced habitat diversity or quality within a stream channel is documented to result in a shift in the fish and macroinvertebrate communities, including abundance of tolerant species or extirpation of intolerant species.	++
Stressor-response in other field studies	Field studies in Minnesota and adjacent states have documented the impacts of altered aquatic habitat on fish and macroinvertebrate community richness.	++
Stressor-response in other lab studies	In-channel habitat conditions are rarely documented in laboratory experiments.	O
Stressor-response in ecological models	Habitat suitability models for various fish species indicate that they have habitat preferences at various life stages.	+
Manipulation experiments at other sites	There is limited field data available, and most field experiments evaluate manipulation of a single habitat feature (such as adding large woody debris or altering streambed composition) rather than manipulating a variety of habitats.	O
Analogous stressors	No analogous stressors are available.	O
Multiple lines of evidence		
Consistency of evidence	Where habitat is limited, fish and macroinvertebrate communities lack richness. Where habitat has been improved, there appears to be a richer macroinvertebrate community. Limited data is available to evaluate the evidence relative to the fish community. The limited data supports this candidate cause but is insufficient to be diagnostic.	+
Explanatory power of evidence	In-channel habitat is severely altered throughout the watershed, and alteration appears to be reflected in the composition of the macroinvertebrate and fish communities. The evidence is mixed due to a lack of data, both spatially and temporally.	++

4.1.3 Weight of Evidence: Altered Hydrology

The altered hydrology in the urbanized Shingle Creek watershed affects the biota in Shingle and Bass Creeks in two ways. First, Shingle and Bass Creeks are essential parts of the storm drainage system, so they periodically convey very high flows, with the streams rising rapidly during a storm event, and then falling nearly as rapidly as the stormflow passes through the system. Second, the increased amount of imperviousness in the watershed has reduced infiltration to the surficial groundwater that provides a base flow of water in the streams. As a result, Bass Creek and Shingle Creek above Palmer Lake routinely experience extended periods of low or no flow. The Palmer Lake Basin and other riparian wetlands downstream appear to discharge groundwater sufficiently to maintain flow in Shingle Creek except under drought. However, because the channel has been altered to a wide, flat-bottomed, trapezoidal channel to facilitate stormwater discharge, the Creek is often only inches deep and flows at very low velocities. Table 4.4 evaluates the sufficiency of evidence that altered hydrology is a cause of impaired fish and macroinvertebrate communities in these streams.

Table 4.4. Weight of evidence table: altered hydrology.

Types of Evidence	Findings	Score
Evidence using data from Shingle and Bass Creeks		
Spatial/temporal co-occurrence	A distinct gradient of the fish community is present above and below Palmer Lake. Macroinvertebrate data suggests a slightly more robust assemblage is present in wetter years that sustain a base flow.	+
Evidence of exposure, biological mechanism	Hydrology is altered throughout the watershed. Intermittent flows are typically present upstream of Palmer Lake and in Bass Creek.	++
Causal pathway	Fish impaired sites are above Palmer Lake where there is a lack of continuous flow. Macroinvertebrate data suggests a slightly more robust assemblage is present in wetter years that sustain a base flow.	++
Field evidence of stressor-response	A distinct gradient in the fish and macroinvertebrate communities can be seen where there is continuous flow compared to where the channel frequently has intermittent flow.	++
Field experiments /manipulation of exposure	No field manipulation has occurred. Some channel restoration has occurred on Shingle Creek that includes reshaping the channel with a low-flow channel, but due to drought conditions no fish or macroinvertebrate collections have taken place post-construction.	O
Laboratory analysis of site media	Laboratory experiments are not available.	O
Temporal sequence	The altered hydrology has been present for many decades, and no biological data is available prior to its alteration.	O
Verified or tested predictions	The fish community below Palmer Lake is not impaired where continuous flow is present within the channel. Macroinvertebrate data suggests a slightly more robust assemblage is present in wetter years that sustain a base flow.	+
Symptoms	A distinct gradient in the fish and macroinvertebrate communities can be seen where there is continuous flow compared to where the channel frequently has intermittent flow.	D
Evidence using data from other systems		
Mechanistically plausible cause	Alterations of flow regimes, including extended intermittency, are known to affect species richness and to favor taxa that are adapted to high flows (e.g., clingers) or to low flows.	+
Stressor-response in other field studies	Field studies in Minnesota and adjacent states have documented the impacts of altered flow regime on fish and macroinvertebrate community health. The lack of stable base flow and corresponding	++

Types of Evidence	Findings	Score
	increase in intermittency as well as the increase in peak flows appear to be reflected in the fish and macroinvertebrate communities in Shingle and Bass Creek.	
Stressor-response in other lab studies	Duplication of watershed wide hydrological conditions and alterations is difficult in laboratory experiments.	O
Stressor-response in ecological models	Habitat suitability models for various fish species indicate that they have maximum-minimum velocity preferences as well as varying tolerances to wide ranges in velocities. Similar models are not available for macroinvertebrates.	+
Manipulation experiments at other sites	Simulated frequent high flows have been found to alter relative abundance, favor opportunistic species, and disturb natural macroinvertebrate species succession (Hemphill et al. 1983).	+
Analogous stressors	No analogous stressors are available.	O
Multiple lines of evidence		
Consistency of evidence	The evidence from within the system and from other similar systems supports that the altered flow regime is a cause of fish and macroinvertebrate community impairment.	+
Explanatory power of evidence	The flow regime is altered throughout the watershed, including increased periods of intermittency or extreme high flows. Intermittency and reduced baseflow is more frequent above Palmer Lake and in Bass Creek. The fish community below Palmer Lake is not impaired where continuous flow is present within the channel. Macroinvertebrate data suggests a slightly more robust assemblage is present in wetter years that sustain a base flow.	++

4.1.4 Weight of Evidence: Loss of Connectedness

Loss of connectedness affects biotic integrity in two significant ways. First, barriers between streams such as Shingle and Bass Creeks and lakes and large wetlands eliminate those waterbodies as refugia during stressful times such as periods of low flow. Lake outlet control structures are present on Bass Lake and Eagle Lake, disconnecting Bass Creek and Eagle Creek from the lakes. Barriers also affect migration and repopulation of communities. The seven foot drop structure on Shingle Creek in Webber Park disconnects Shingle Creek from the Mississippi River, eliminating the ability of fish from the river to swim upstream and colonize Shingle Creek. Other structures at various locations on Shingle and Bass Creeks limit migration and mobility and create disconnected reaches that have limited refugia and means to repopulate. Table 4.5 evaluates the sufficiency of evidence that loss of connectedness is a cause of impaired fish and macroinvertebrate communities in these streams.

Table 4.5. Weight of evidence table: loss of connectedness.

Types of Evidence	Findings	Score
Evidence using data from Shingle and Bass Creeks		
Spatial/temporal co-occurrence	Barriers between resources are spatially distributed along the stream but evidence is insufficient to link their presence to specific biotic impacts.	O
Evidence of exposure, biological mechanism	Physical barriers (drop structures, lake outlet structures) limit connectivity between reaches and lakes/wetlands and disconnect Shingle Creek from the Mississippi River.	++
Causal pathway	Barriers and disconnectedness are present and are likely limiting mobility and recolonization, but available data is insufficient to evaluate the effects on the biota or the strength of the case.	+

Types of Evidence	Findings	Score
Field evidence of stressor-response	Available data is insufficient to evaluate the effects on the biota or the strength of the case.	O
Field experiments /manipulation of exposure	No field experiments have been conducted.	O
Laboratory analysis of site media	No laboratory data are available.	O
Temporal sequence	Anecdotal data suggests that Shingle Creek supported a more robust fish community prior to the construction of the Webber Park drop structure, but there is no quantitative data.	O
Verified or tested predictions	Available data is insufficient to evaluate the effects on the biota or the strength of the case.	O
Symptoms	Barriers and lack of connectedness may be a factor in the impaired fishery status of Bass Creek. Barriers and lack of connectedness separate Bass Creek from upstream Eagle Lake and Bass Lake and downstream Palmer Lake, limiting potential for recolonization. Barriers on Shingle Creek may impede macroinvertebrate drift and thus potential for recolonization.	+
Evidence using data from other systems		
Mechanistically plausible cause	Literature and observation indicates that species require access to a multiplicity of habitats both for life cycle needs as well as refugia from conditions such as very high or low flows or periods of low dissolved oxygen.	+
Stressor-response in other field studies	Field studies in Minnesota and elsewhere have observed reduced species richness in streams with barriers or which are otherwise disconnected.	++
Stressor-response in other lab studies	No lab studies available.	O
Stressor-response in ecological models	No ecological models available.	O
Manipulation experiments at other sites	There are numerous examples of the beneficial impacts of the removal of fish barriers both in Minnesota and elsewhere.	+
Analogous stressors	No analogous stressors are available.	O
Multiple lines of evidence		
Consistency of evidence	Barriers and disconnectedness are present and are likely limiting mobility and recolonization, but available data is insufficient to evaluate the effects on the biota or the strength of the case.	O
Explanatory power of evidence	Barriers and disconnectedness are present and are likely limiting mobility and recolonization, but available data is insufficient to evaluate the effects on the biota or the strength of the case.	O

4.1.5 Weight of Evidence: Ionic Strength

While organisms are exposed to elevated levels of chloride in Shingle and Bass Creeks, the highest concentrations in the streams are found during winter runoff and spring snowmelt, when most fish and macroinvertebrates are dormant or have found refuge in off-line habitat. While excess chloride concentrations do occur during the other months, it is more likely to result in a short-term acute exposure than a lengthy or chronic exposure. However, it is important to note that even during summer low-flows Shingle Creek sometimes approaches the 230 mg/L concentration that is the chronic exposure standard. Table 4.6 evaluates the sufficiency of evidence that ionic strength as measured by chloride concentration is a cause of impaired fish and macroinvertebrate communities in these streams.

Table 4.6. Weight of evidence table: ionic strength

Types of Evidence	Findings	Score
Evidence using data from Shingle and Bass Creeks		
Spatial/temporal co-occurrence	Violations of the chloride standard are found in both Shingle and Bass Creeks. Macroinvertebrate and fish surveys indicate the biotic community is dominated by taxa that are tolerant of degraded water quality. However, several chloride-sensitive macroinvertebrate taxa are present in Shingle Creek (although not in Bass Creek).	---
Evidence of exposure, biological mechanism	The biotic community is exposed to chloride levels throughout the watershed that exceed the acute and chronic toxicity standard.	++
Causal pathway	Chloride levels are elevated at times below Palmer Lake where the fish community is not impaired, and in Bass Creek where the macroinvertebrate community is not impaired.	-
Field evidence of stressor-response	Elevated chloride concentrations are present throughout the watershed but a spatial gradient of response is not present.	+
Field experiments /manipulation of exposure	Field experiments performed elsewhere have manipulated exposure and documented toxicity effects, although at concentrations much greater than found in Shingle or Bass Creeks.	+
Laboratory analysis of site media	Laboratory experiments are not available.	O
Temporal sequence	Limited biological data is available to determine temporal sequence of the cause.	O
Verified or tested predictions	Violations of the chloride standard are found in both Shingle and Bass Creeks. Macroinvertebrate and fish surveys indicate the biotic community is dominated by taxa that are tolerant of degraded water quality. However, several chloride-sensitive macroinvertebrate taxa are present in Shingle Creek.	-
Symptoms	While the fish and macroinvertebrate communities are impaired and are dominated by pollution-tolerant species, chloride-sensitive species are present and may indicate that there are multiple stressors affecting community richness and composition.	+
Evidence using data from other systems		
Mechanistically plausible cause	Toxicity studies have established that certain fish and macroinvertebrate taxa are sensitive to chloride concentration.	+
Stressor-response in other field studies	Field studies conducted in other states have documented the impacts high chloride levels have on fish and macroinvertebrate taxa. However, the impacts of chloride concentrations to biota cannot be easily seen within Shingle and Bass Creeks.	O
Stressor-response in other lab studies	The impacts of increased salinity on freshwater fish communities have been investigated in laboratory studies, however at concentrations higher than observed in Shingle and Bass Creeks.	+
Stressor-response in ecological models	No ecological modeling data is available.	O
Manipulation experiments at other sites	Field studies conducted in streams and wetlands have demonstrated that certain macroinvertebrate taxa are sensitive to chloride concentration. However, the effect appears to be very localized.	O
Analogous stressors	Degraded water quality, increased chloride levels or salinity, can limit fish and macroinvertebrate richness through a shift toward tolerant species or an exclusion of sensitive species.	++

Types of Evidence	Findings	Score
Multiple lines of evidence		
Consistency of evidence	Elevated chloride concentrations can stress or be toxic to certain sensitive fish and macroinvertebrate taxa and reduce community richness, but the evidence of this effect in Shingle and Bass Creek is not clearly defined.	O
Explanatory power of evidence	There is no clear spatial gradient of elevated chloride concentrations and impaired fish community, and there are chloride-sensitive macroinvertebrate taxa found in Shingle Creek. However, it is likely the elevated chloride concentrations are contributing to the abundance of tolerant species throughout Shingle and Bass Creeks. Additional data would be helpful in better understanding relationship between chloride concentration and biotic response in Shingle and Bass Creeks.	O

5.0 Probable Causes

The strength of evidence for the five candidate causes – low dissolved oxygen, lack of habitat, altered hydrology, loss of connectedness, and ionic strength - is summarized in Table 5.1. The evidence for altered hydrology is strongest followed closely by dissolved oxygen and lack of habitat. While the loss of connectedness and ionic strength are plausible stressors and are likely contributing to the impairment, there is less direct evidence of their role. Altered hydrology, dissolved oxygen, and habitat are interrelated. The probable causes established in this stressor identification process will be addressed in the Shingle Creek and Bass Creeks Biota and Dissolved Oxygen TMDL.

Table 5.1. Weight of evidence table.

	Low Dissolved Oxygen	**Altered Habitat**	**Altered Hydrology**	**Loss of Connected-ness**	**Ionic Strength**
Types of Evidence	**Score**	**Score**	**Score**	**Score**	**Score**
Evidence using data from Shingle and Bass Creeks					
Spatial/temporal co-occurrence	O	+	+	O	---
Evidence of exposure, biological mechanism	++	++	++	++	++
Causal pathway	-	+	++	+	-
Field evidence of stressor-response	+	+	++	O	+
Field experiments /manipulation of exposure	O	O	O	O	O
Laboratory analysis of site media	O	O	O	O	O
Temporal sequence	O	O	O	O	O
Verified or tested predictions	+	+	+	O	-
Symptoms	+	+	D	+	+
Evidence using data from other systems					
Mechanistically plausible cause	+	++	+	+	+
Stressor-response in other field studies	O	++	++	++	+
Stressor-response in other lab studies	+	O	O	O	+
Stressor-response in ecological models	O	+	+	O	O
Manipulation experiments at other sites	O	O	+	+	O
Analogous stressors	O	O	O	O	++
Multiple lines of evidence					
Consistency of evidence	O	+	+	O	O
Explanatory power of evidence	++	++	++	O	O

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Appendix A

Fish and Macroinvertebrate Data

1995 Shingle Creek WMC/USGS Fish Collection

USGS Monitoring Station, Queen Avenue N
Minneapolis

Table 1 REACH 1: August 5, 1996 Electrofishing Results - Shingle Creek just Downstream from Queen Avenue

Classification	Tolerance	Number of fish caught			Length (ml)				Weight (g)				Batch Weight		
		Pass Number			Min	Max	Min	Max	Min	Max	Min	Max		Total (g)	
Class Osteichthys (Boney fishes)		1	2	seine	pass 1		pass 2		pass 1		pass 2		1	2	seine
Family Cyperinidae (minnows)															
Notropis dorsalis(bigmouth shiner)	intermediate	69	47	12	27	71	30	70	<1	3	<1	3	187	47	4
Rhinichthys (blacknose dace)	tolerant			1	29				<1						<1
Semotilus atromaculaus (creek chub)	tolerant		2	1			187	194			77	98		175	89
Pimephales promelas (fathead minnow)	tolerant	6	8	1	44	54	40	53	<1	1	<1	<1	6	9	1
Cyprinus carpio (common carp)	tolerant	31	15		31	104	67	110	<1	23	5	24	448	175	
Family Ictaluridae (catfish)															
Ictalurus melas (black bullhead)	intermediate	5	1	2		190	160			112	47		336	47	165
Noturus gyrinus (tadpole madtom)	intermediate	1	1		75		27			6	<1		6	<1	
Family Catostomidae (suckers)															
Catostomus commersoni (white sucker)	tolerant	261	197	10	48	272	47	306	1	212	<1	304	12939	9080	398
Family Umbridae (mudminnows)															
Umbra limi (central mudminnow)	tolerant	22	9		51	112	49	110	2	15	2	14	22	31	
Family Percidae (perch)															
Etheostoma nigrum (johnny darter)	intermediate	14	18	2	32	53	28	55	<1	2	<1	2	11	16	1
Perca fluvescens (yellow perch)	intermediate														
Family Centrarchidae (sunfish)															
Pomoxis nigromaculatus (black crappie)	intermediate	2			149	164			44	67			111		
Lepomis macrochirus (bluegill)	intermediate	2	1		133	135	143		49	58	83		107	83	
Lepomis cyanellus (green sunfish)	tolerant	5	3	1	85	96	70	78	11	28	7	8	92	26	11
Lepomis gibbosus (pumpkinseed)	intermediate														
Lepomis (hybrid)	intermediate		1				158				126			126	
Micropterus salmoides (largemouth bass)	intermediate	8	2		57	75	58	64	2	7			37	6	
Family Esocidae (pike)															
Esox lucius (northern pike)	tolerant	3	6		138	234	148	220	14	93	16	69		182	
Family Gasterosteidae															
brook stickleback	intermediate		1				40				<1			<1	
	Total fish caught=	429	312	30								Total weight=	14302	10003	669
	Number of species	13	15	8											

* all fishery data is preliminary data it has not yet been positively identified by the Bell Museum. collected by USGS/Montgomery Watson
Stream shicking time was 47.4 minutes for pass 1, and 35.4 minutes for pass 2.

Table 2 REACH 2: August 5, 1996 Electrofishing Results - Shingle Creek Upstream from Queen Avenue

Classification	Tolerance	Number of fish caught – Pass Number 1	2	scine	Length (ml) pass 1 Min	Max	pass 2 Min	Max	Weight (g) pass 1 Min	Max	pass 2 Min	Max	Batch Weight Total (g) 1	2	scine
Class Osteichthys (Boney fishes)															
Family Cyperinidae (minnows)															
Notropis dorsalis(bigmouth shiner)	intermediate	226	156	153	36	77	33	76	<1	3	<1	4	582	394	68
Rhinichthys (blacknose dace)	tolerant	9	15	5	35	84	35	89	<1	7	<1	8	15	25	3
Pimephales promelas (fathead minnow)	tolerant	16	12	2	41	52	39	48	<1	1	<1	<1	17	9	1
Cyprinus carpio (common carp)	tolerant		1				115				25			25	
Family Catostomidae (suckers)															
Catostomus commersoni (white sucker)	tolerant	150	176	2	50	266	39	300	3	190	<1	293	13620	9080	2
Family Umbridae (mudminnows)															
Umbra limi (central mudminnow)	tolerant	1	1		90		88		8		7		8	7	
Family Percidae (perch)															
Etheostoma nigrum (johnny darter)	intermediate	1	12		47		34	50	<1		<1		<1	10	
Family Centrarchidae (sunfish)															
Lepomis cyanellus (green sunfish)	tolerant	6	13		66	96	63	110	6	27	6	38	87	214	
Micropterus salmoides (largemouth bass)	intermediate	2	2		69	73	66	71	5	5	4	5	10	9	
Lepomis gibbosus (pumpkinseed)	intermediate	2					134				119			119	
Family Esocidae (pike)															
Esox lucius (northern pike)	tolerant	3	1		135	250	196		13	94	42		144	42	
	Total fish caught	416	389	162								Total weight=	14483	9934	74
	Number of species	10	10	4											

* all fishery data is preliminary data it has not yet been positively identified by the Bell Museum. collected by USGS/Montgomery Watson
Stream shocking time was 37.2 minutes for pass 1, and 34.8 minutes for pass 2

Table 3 REACH 3: Electrofishing Results for August 5, 1996 - Shingle Creek Upstream from Reach 2

Classification	Tolerance	Number of fish caught: Pass Number 1	2	seine	Length (ml) pass 1 Min	Max	pass 2 Min	Max	Weight (g) pass 1 Min	Max	pass 2 Min	Max	Batch Weight Total (g) 1	2	seine
Class Osteichthys (Boney fishes)															
Family Cyprinidae (minnows)															
Notropis dorsalis(bigmouth shiner)	intermediate	1			29				<1				<1		
Family Ictaluridae (catfish)															
Ictalurus melas (black bullhead)	intermediate	1				165				89			89		
Family Catostomidae (suckers)															
Catostomus commersoni (white sucker)	tolerant	90	13		50	432	55	330	<1	786	2	406	11350	1299	
Family Percidae (perch)															
Etheostoma nigrum (johnny darter)	intermediate	6	22		29	62	29	39	<1	2	<1	<1	5	11	
Perca fluvescens (yellow perch)	intermediate	1			103				14				14		
Family Centrarchidae (sunfish)															
Pomoxis nigromaculatus (black crappie)	intermediate	1			160				68				68		
Lepomis cyanellus (green sunfish)	tolerant	14	6		61	104	74	93	5	27	9	19	226	6	
Lepomis gibbosus (pumpkinseed)	intermediate	1			137				59				59		
Lepomis (hybrid)	intermediate	4			97	136			20	64			170		
Micropterus salmoides (largemouth bass)	intermediate	4	5		63	75	54	70	2	6	2	5	21	18	
Family Esocidae (pike)															
Esox lucius (northern pike)	tolerant	2	1		153	561	146		18	520	17		538	17	
	Total fish caught=	125	47	0								Total weight=	12540	1351	0
	number of species	10	4	0											

* all fishery data is preliminary data it has not yet been positively identified by the Bell Museum. collected by USGS/Montgomery Watson
Stream shocking time was 30 minutes for pass 1, and 22.8 minutes for pass 2

2000 MPCA Data Collection

USGS Monitoring Station, Queen Avenue N
Minneapolis

Minnesota Pollution Control Agency

Home | Site Index | Glossary | What's New | Ask MPCA | Visitor Center
Search

MPCA Home > EDA Search > Station Data

Connection Failure

Biological Station Information

Stream Name	SHINGLE CREEK
Waterbody Name:	Shingle Creek
Data Steward Org:	MPCA
Station ID:	00UM069
Hydrologic Unit Code (HUC):	07010206
Assessment Unit:	07010206-506
Period of Record:	2000 through 2000
Predominant substrate:	gravel
Mean Depth (cm):	26.3
Mean Width (meters):	8
Drainage Area (square miles)	27.4

Land Use	Agricultural	1.0 %
	Forest	6.0 %
	Range	2.0 %
	Urban	77.9 %
	Water	4.5 %
	Wetland	4.1 %
	Other	4.5 %

Lat/Lon: 45.0506/-93.3117 + ?
Datum: NAD83
County: Hennepin Queen Ave

Projects Associated with this Station

Project	Purpose
Biological Criteria Development	Monitoring sites are targeted across a range of human disturbance, from minimal to severe, to develop regional indices of biological integrity (IBI?s) using attributes of fish and macroinvertebrate communities.
Biological Criteria Development	Sites selected for development of biological criteria.

Site Index of Biological Integrity (IBI)

Category	IBI/Rating
Fish IBI	49
Fish Rating	Fair
Invertebrate IBI	20
Invertebrate Rating	Poor

Chemical Data

Date	Aug 07 2000
Water Temperature °C	20.80
Conductivity µmhos/cm	913.0
Field Turbidity NTU	4.10
Dissolved Oxygen mg/L	2.65
pH	7.72

Flow m³/sec	0.04545
Nitrogen mg/L	0.2
Total Phosphorus mg/L	0.094
Total Suspended Solids mg/L	6
Ammonia mg/L	0.13

Fish Found at this Site

Species	Count	Min. Length (mm)	Max. Length (mm)
Black Bullhead	1	210	210
Blacknose Dace	4	76	85
Common Carp	2	75	84
Creek Chub	3	65	135
Fathead Minnow	2	34	42
Green Sunfish	5	70	116
Hybrid Sunfish	1	56	56
Johnny Darter	17	29	57
Tadpole Madtom	1	105	105
White Sucker	44	40	251

Fish Attributes

Attribute	Value
DELT (abnormalities)	1
Darter species	1
Exotic species	1
Fish per 100 m	28.2
Game fish species	1
Gravel spawning species	2
Piscivore species	0
Pollution intolerant species	0
Pollution tolerant species	7
Special concern species	0
Total species	10

Invertebrates Found at Site

Common Name

Amphipods
Asellus
Balloon Flies
Biting Midges
Black Flies
Flatworms
Gastropods
Hirudinea
Mayflies
Midges
Narrow-Winged Damselflies tol
Net-Spinning Caddisflies intol
Oligochaeta middle
Pisidiidae
Predaceous Diving Beetles
Thienemanniyia Grp.
Water Scavenger Beetles

Invertebrate Attributes

Attribute	Value
EPT Taxa	2
Ephemeroptera Taxa	1
Hilsenhoffs Biotic Index (HBI)	4.8
Intolerant Families	0
Percent Pollution Tolerant	12.2
Percent Chironomidae	38.5
Percent Diptera	46
Percent Dominant Taxa	38.5
Percent Dominant Two Taxa	58.8
Percent Filterers	25.4
Percent Gatherer	66.3
Percent Hydropsychidae	12.8
Percent Scraper	0.9
Plecoptera Families	0
Total Families	13
Trichoptera Families	1

2000 DNR Data Collection

Bass Creek Park, Boone Avenue N
Brooklyn Park

Minnesota Pollution Control Agency

Biological Station Information

Photo not available

Stream Name	BASS CREEK
Waterbody Name:	Bass Creek
Data Steward Org:	MINNESOTA DEPT OF NAT RES
Station ID:	00UM100
Hydrologic Unit Code (HUC):	07010206
Assessment Unit:	07010206-527
Period of Record:	2000 through 2000
Predominant substrate:	
Mean Depth (cm):	
Mean Width (meters):	
Drainage Area (square miles)	7.7

Connection Failure

Lat/Lon: 45.0746/-93.3920
Datum: NAD83
County: Hennepin

Land Use

Agricultural	2.9 %
Forest	9.9 %
Range	5.5 %
Urban	71.2 %
Water	5.9 %
Wetland	4.6 %
Other	0.0 %

Projects Associated with this Station

Project	Purpose
Metro Surveys	Monitoring sites established to characterize Twin Cities Metro Area streams.
Metro Surveys	Sites sampled by Konrad Schmidt (MDNR) in 1999-2000.

Site Index of Biological Integrity (IBI)

Category	IBI/Rating
Fish IBI	12
Fish Rating	Very Poor
Invertebrate IBI	67
Invertebrate Rating	Good

Chemical Data

Date	Sep 15 2000
Water Temperature °C	12.30
Conductivity µmhos/cm	441.9
Field Turbidity NTU	13.72

Dissolved Oxygen mg/L	4.75
pH	7.45
Flow m^3/sec	
Nitrogen mg/L	
Total Phosphorus mg/L	
Total Suspended Solids mg/L	
Ammonia mg/L	

Fish Found at this Site

Species	Count	Min. Length (mm)	Max. Length (mm)
Brook Stickleback	27	45	56
Central Mudminnow	4	61	75
Common Carp	11	71	98
Fathead Minnow	141	33	64
Green Sunfish	2	39	45

Fish Attributes

Attribute	Value
DELT (abnormalities)	0
Darter species	0
Exotic species	1
Fish per 100 m	123.3
Game fish species	1
Gravel spawning species	0
Piscivore species	0
Pollution intolerant species	0
Pollution tolerant species	5
Special concern species	0
Total species	5

Invertebrates Found at Site

Common Name
Beetles
Black Flies
Caddisflies
Crane Flies
Crawling Water Beetles
Electric Light Bugs
Gastropods
Long-Horn Caddisflies
Marsh Beetles
Mayflies
Micro-Caddisflies
Midges
Narrow-Winged Damselflies
Net-Spinning Caddisflies
Oligochaeta
Perlodid Stoneflies
Predaceous Diving Beetles
Riffle Beetles
Thienemanniyia Grp.

Invertebrate Attributes

Attribute	Value
EPT Taxa	10
Ephemeroptera Taxa	5
Hilsenhoffs Biotic Index (HBI)	4.1
Intolerant Families	3
Percent Pollution Tolerant	3.7
Percent Chironomidae	50.2
Percent Diptera	51.6
Percent Dominant Taxa	50.2
Percent Dominant Two Taxa	86.3
Percent Filterers	10.5
Percent Gatherer	63.9
Percent Hydropsychidae	7.3
Percent Scraper	15.5
Plecoptera Families	2
Total Families	20
Trichoptera Families	3

Water Boatman
Water Scavenger Beetles
Winter Stoneflies

2004 Macroinvertebrate Collection

Shingle Creek WMC
Shingle Creek Corridor Study

2004 Shingle Creek Corridor Study Macroinvertebrate Collection
Metrics by Joel Chirhart, MPCA

SC1

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	***METRIC VALUE***	***METRIC SCORE***
POET	5.00	3.00
# Clinger Taxa	5.00	5.00
# Collector-Feeder	6.00	9.35
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	27.96	7.67
% Ephemeroptera	8.55	2.00
% Intolerant	0.00	0.00
% Tolerant	34.21	9.03
% Trichoptera (excluding Hydropsychidae)	0.00	0.00
HBI	5.48	8.70
IBI SCORE		44.74

SC2

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	***METRIC VALUE***	***METRIC SCORE***
POET	4.00	2.25
# Clinger Taxa	1.00	1.00
# Collector-Feeder	1.00	0.00
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	28.01	7.66
% Ephemeroptera	6.02	1.41
% Intolerant	0.00	0.00
% Tolerant	92.59	0.38
% Trichoptera (excluding Hydropsychidae)	0.23	0.32
HBI	8.46	0.53
IBI SCORE		13.54

SC3

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	***METRIC VALUE***	***METRIC SCORE***
POET	3.00	1.50
# Clinger Taxa	3.00	3.00
# Collector-Feeder	2.00	1.87
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	20.05	9.22
% Ephemeroptera	0.75	0.18
% Intolerant	0.00	0.00
% Tolerant	64.41	4.55
% Trichoptera (excluding Hydropsychidae)	0.25	0.35
HBI	7.87	2.14
IBI SCORE		22.80

SC4

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	***METRIC VALUE***	***METRIC SCORE***
POET	4.00	2.25
# Clinger Taxa	1.00	1.00
# Collector-Feeder	1.00	0.00
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	18.90	9.45
% Ephemeroptera	1.83	0.43
% Intolerant	0.00	0.00
% Tolerant	71.34	3.53
% Trichoptera (excluding Hydropsychidae)	0.00	0.00
HBI	7.31	3.67
IBI SCORE		20.32

SC5

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	***METRIC VALUE***	***METRIC SCORE***
POET	5.00	3.00
# Clinger Taxa	3.00	3.00
# Collector-Feeder	3.00	3.74
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	21.73	8.90
% Ephemeroptera	3.19	0.75
% Intolerant	0.00	0.00
% Tolerant	50.16	6.67
% Trichoptera (excluding Hydropsychidae)	0.00	0.00
HBI	6.60	5.63
IBI SCORE		31.67

SC6

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	***METRIC VALUE***	***METRIC SCORE***
POET	3.00	1.50
# Clinger Taxa	0.00	0.00
# Collector-Feeder	1.00	0.00
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	67.00	0.00
% Ephemeroptera	0.00	0.00
% Intolerant	0.00	0.00
% Tolerant	29.22	9.77
% Trichoptera (excluding Hydropsychidae)	0.20	0.28
HBI	7.95	1.92
IBI SCORE		13.47

SC7

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	*METRIC VALUE*	*METRIC SCORE*
POET	4.00	2.25
# Clinger Taxa	1.00	1.00
# Collector-Feeder	1.00	0.00
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	43.96	4.53
% Ephemeroptera	1.93	0.45
% Intolerant	0.00	0.00
% Tolerant	48.79	6.87
% Trichoptera (excluding Hydropsychidae)	0.00	0.00
HBI	7.80	2.34
IBI SCORE		17.43

SC8

Upper Mississippi River Basin IBI (Glide/Pool<40mi)

METRIC	*METRIC VALUE*	*METRIC SCORE*
POET	5.00	3.00
# Clinger Taxa	3.00	3.00
# Collector-Feeder	2.00	1.87
# Intolerant Taxa	0.00	0.00
% Dominant Taxa	66.67	0.07
% Ephemeroptera	6.50	1.52
% Intolerant	0.00	0.00
% Tolerant	82.93	1.81
% Trichoptera (excluding Hydropsychidae)	9.76	13.54
HBI	7.90	2.05
IBI SCORE		26.85

2004 Shingle Creek Corridor Study Macroinvertebrate Collection

Date Collected	Class	Order	Family	Taxon	Salinity Sensitivity	Subsample	LargeRare	Comment_One	HBI TV (taxa)	Site_Name
9/29/2004	Bivalvia			Pisidiidae		13				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Crustacea	Amphipoda	Talitridae	Hyalella		2			8	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Crustacea	Decapoda	Cambaridae	Orconectes		4				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Crustacea	Isopoda	Assellidae	Caecidotea		19				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Crustacea			Copepoda	1	2				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Crustacea			Ostracoda	1	2				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Gastropoda	Limnophila	Ancylidae	Ferrissia	5	5				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Hexapoda	Heteroptera		Corixidae	5	1		early instar		SC MPLS SHINGLE CREEK SC-0
9/29/2004	Hirudinea	Pharyngobdellida	Erpobdellidae	Erpobdella			1	Large and Rare		SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Coleoptera	Elmidae	Stenelmis	10		2	Large and Rare	5	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Ablabesmyia		1			8	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Chironomus		1			10	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Orthocladius		1		damaged	6	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Dicrotendipes		1			8	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Endochironomus		4			10	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Glyptotendipes		2			10	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Orthocladiinae	5	1		pupa(e)	6	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Polypedilum		7			6	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Rheocricotopus		1			6	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Rheotanytarsus		3			6	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Stictochironomus		2			9	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Tanypodinae	5	1		early instar	10	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Tanytarsus		1			6	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Empididae	Hemerodromia		11				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Simuliidae	Simulium	10	7				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		14				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Ephemeroptera	Baetidae	Baetis	5	17				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Ephemeroptera	Caenidae	Caenis	5	3			7	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Ephemeroptera	Heptageniidae	Heptageniidae		6		damaged		SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	10	85			5	SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	10	63				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Insecta	Trichoptera	Hydropsychidae	Hydropsychidae	10	8		early instar		SC MPLS SHINGLE CREEK SC-0
9/29/2004	Oligochaeta			Oligochaeta	5	14				SC MPLS SHINGLE CREEK SC-0
9/29/2004				Cricotopus bicinctus		2				SC MPLS SHINGLE CREEK SC-0
9/29/2004				Nematoda		1				SC MPLS SHINGLE CREEK SC-0
9/29/2004				Sigara		1				SC MPLS SHINGLE CREEK SC-0
9/29/2004	Acari			Acari		4				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Bivalvia			Pisidiidae		1				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Crustacea	Amphipoda	Talitridae	Hyalella		121			8	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Crustacea	Decapoda	Cambaridae	Orconectes		1				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Crustacea	Isopoda	Assellidae	Caecidotea		27				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Crustacea			Cladocera	5	67				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Crustacea			Copepoda	1	6				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Crustacea			Ostracoda	1	14				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Crustacea			Palmacorixa		2				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Gastropoda	Limnophila	Ancylidae	Ferrissia	5	2				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Gastropoda	Limnophila	Planorbidae	Gyraulus	1	1				SC 2 SHINGLE CREEK REACH 2

Date Collected	Class	Order	Family	Taxon	Salinity Sensitivity	Subsample	LargeRare	Comment_One	HBI TV (taxa)	Site_Name
9/29/2004	Gastropoda	Lymnophila	Lymnaeidae	Pseudosuccinea	1	2				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Gastropoda		Physidae	Physidae		1				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Hirudinea			Hirudinea		1				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Coleoptera	Dytiscidae	Liodessus	1	1		adult		SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Coleoptera	Haliplidae	Haliplus		1		larva(e)		SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Ceratopogonidae	Bezzia / Palpomyia	5	3				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Ablabesmyia		9			8	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Chironomini		4		early instar		SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Clinotanypus		1			8	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Corynoneura		1			7	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Dicrotendipes		15			8	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Endochironomus		86			10	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Glyptotendipes		28			10	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Parachironomus		6			10	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Paratanytarsus		10			6	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Paratendipes		2			8	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Polypedilum		1			6	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Procladius		3			9	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Tanypodinae	5	3		early instar	10	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Tanypodinae	5	1		pupa(e)	10	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Tanypus		1			10	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Tanytarsini		2		early instar	6	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Stratiomyidae	Odontomyia	5	1				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		8				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Ephemeroptera	Caenidae	Caenis	5	26			7	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Hemiptera	Pleidae	Neoplea	5	1				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Heteroptera	Corixidae	Trichocorixa	5	10				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Odonata-Anisoptera	Aeshnidae	Aeshna	5		1	Large and Rare	5	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Coenagrionidae	1	9		damaged		SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Enallagma	1	7				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Insecta	Trichoptera	Leptoceridae	Oecetis	5	1			8	SC 2 SHINGLE CREEK REACH 2
9/29/2004	Oligochaeta			Oligochaeta	5	10				SC 2 SHINGLE CREEK REACH 2
9/29/2004				Cricotopus (Isocladius)		1				SC 2 SHINGLE CREEK REACH 2
9/29/2004				Sigara		3				SC 2 SHINGLE CREEK REACH 2
9/29/2004	Bivalvia			Pisidiidae		1				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Crustacea	Amphipoda	Talitridae	Hyalella		65			8	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Crustacea	Isopoda	Assellidae	Caecidotea		8				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Crustacea			Cladocera	5	59				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Crustacea			Copepoda	1	10				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Gastropoda	Limnophila	Ancylidae	Ferrissia	5	19				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Gastropoda		Physidae	Physidae		9				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Hirudinea			Hirudinea		1				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Hirudinea			Hirudinea			1	Large and Rare		SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Coleoptera	Dytiscidae	Liodessus	1	1				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Coleoptera	Hydrophilidae	Tropisternus	5		1	Large and Rare		SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Chironomini		11		early instar		SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Corynoneura		1			7	SC 3 SHINGLE CREEK REACH 3

Date Collected	Class	Order	Family	Taxon	Salinity Sensitivity	Subsample	LargeRare	Comment_One	HBI TV (taxa)	Site_Name
9/29/2004	Insecta	Diptera	Chironomidae	Dicrotendipes		39			8	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Endochironomus		13			10	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Glyptotendipes		16			10	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Nanocladius		3			3	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Paratanytarsus		3			6	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Tanypodinae	5	10		early instar	10	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Tanypus		1			10	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Tanytarsini		15		early instar	6	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Simuliidae	Simulium	10	1				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		36				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Ephemeroptera	Caenidae	Caenis	5	3			7	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Heteroptera	Corixidae	Trichocorixa	5	4				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Coenagrionidae	1	13		damaged		SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Coenagrionidae	1		1	Large and Rare		SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Enallagma	1	20				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Insecta	Trichoptera	Leptoceridae	Oecetis	5	1			8	SC 3 SHINGLE CREEK REACH 3
9/29/2004	Oligochaeta			Oligochaeta	5	80				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Turbellaria			Turbellaria		2				SC 3 SHINGLE CREEK REACH 3
9/29/2004		Hemiptera	Belostomatidae	Belostoma		1				SC 3 SHINGLE CREEK REACH 3
9/29/2004		Hydroida	Hydridae	Hydra		18				SC 3 SHINGLE CREEK REACH 3
9/29/2004				Cricotopus (Isocladius)		1				SC 3 SHINGLE CREEK REACH 3
9/29/2004				Helobdella stagnalis		1				SC 3 SHINGLE CREEK REACH 3
9/29/2004				Mallochohelea		1				SC 3 SHINGLE CREEK REACH 3
9/29/2004	Bivalvia			Pisidiidae		4				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Crustacea	Amphipoda	Gammaridae	Gammarus			2	Large and Rare	4	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Crustacea	Amphipoda	Talitridae	Hyalella		22			8	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Crustacea	Decapoda	Cambaridae	Orconectes		1				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Crustacea	Isopoda	Assellidae	Caecidotea		8				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Crustacea			Cladocera	5	101				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Crustacea			Copepoda	1	48				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Gastropoda	Limnophila	Ancylidae	Ferrissia	5	1				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Gastropoda		Physidae	Physidae		5				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Hirudinea	Pharyngobdellida	Erpobdellidae	Erpobdella			3	Large and Rare		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Coleoptera	Dytiscidae	Laccophilus	1		1	Large and Rare		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Coleoptera	Dytiscidae	Liodessus	1	5		adult		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Coleoptera	Elateridae	Scirtes		1		larva(e)		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Coleoptera	Elmidae	Dubiraphia	10	1		larva(e)	6	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Coleoptera	Gyrinidae	Gyrinus	5	1		adult		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Coleoptera		Dytiscidae		12		larva(e)		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Chironomini		1				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Chironomus		1			10	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Cricotopus (Cricotopus)		3			7	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Dicrotendipes		2			8	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Endochironomus		1			10	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Micropsectra		1			7	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Paratanytarsus		2			6	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Procladius		1			9	SC 4 SHINGLE CREEK REACH 4

Date Collected	Class	Order	Family	Taxon	Salinity Sensitivity	Subsample	LargeRare	Comment_One	HBI TV (taxa)	Site_Name
9/29/2004	Insecta	Diptera	Chironomidae	Stictochironomus		1			9	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		28				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Ephemeroptera	Baetidae	Baetidae	5	1		damaged		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Ephemeroptera	Baetidae	Baetis	5	2				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Hemiptera	Nepidae	Ranatra	1		3	Large and Rare		SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Hemiptera	Pleidae	Neoplea	5	10				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Heteroptera	Corixidae	Trichocorixa	5	1				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Odonata	Aeshnidae	Anax	5		1	Large and Rare	8	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Odonata-Anisoptera	Aeshnidae	Aeshna	5		1	Large and Rare	5	SC 4 SHINGLE CREEK REACH 4
9/29/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Enallagma	1	11				SC 4 SHINGLE CREEK REACH 4
9/29/2004	Oligochaeta			Oligochaeta	5	31				SC 4 SHINGLE CREEK REACH 4
9/29/2004		Hemiptera	Belostomatidae	Belostoma			10	Large and Rare		SC 4 SHINGLE CREEK REACH 4
9/29/2004				Cricotopus bicinctus		1				SC 4 SHINGLE CREEK REACH 4
9/29/2004				Helobdella stagnalis		1				SC 4 SHINGLE CREEK REACH 4
9/29/2004				Nematoda		1				SC 4 SHINGLE CREEK REACH 4
9/30/2004	Bivalvia			Pisidiidae		5				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Crustacea	Amphipoda	Gammaridae	Gammarus		2			4	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Crustacea	Amphipoda	Talitridae	Hyalella		10			8	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Crustacea	Decapoda	Cambaridae	Orconectes			3	Large and Rare		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Crustacea	Decapoda		Decapoda			1	Large and Rare		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Crustacea	Isopoda	Assellidae	Caecidotea		26				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Crustacea			Cladocera	5	47				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Crustacea			Copepoda	1	30				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Gastropoda	Limnophila	Ancylidae	Ferrissia	5	2				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Gastropoda		Lymnaidae	Stagnicola		2				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Gastropoda		Physidae	Physidae		1		early instar		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Coleoptera	Dytiscidae	Liodessus	1	6				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Coleoptera	Hydrophilidae	Tropisternus	5	1				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Coleoptera		Dytiscidae		1		early instar		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	5	1		early instar		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Brillia		22			5	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Chironomini		11		early instar		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Chironomus		8			10	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Corynoneura		1			7	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Cricotopus (Cricotopus)		3			7	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Endochironomus		2			10	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Limnophyes		5			8	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Micropsectra		3			7	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Nanocladius		4			3	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Orthocladiinae	5	14		pupa(e)	6	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Parachironomus		2			10	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Paratanytarsus		1			6	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Polypedilum		5			6	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Rheocricotopus		2			6	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Stictochironomus		4			9	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Tanytarsini		2		early instar	6	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Schizophora	Sciomyzidae		1		pupa(e)		SC 5 SHINGLE CREEK REACH 5

Date Collected	Class	Order	Family	Taxon	Salinity Sensitivity	Subsample	LargeRare	Comment_One	HBI TV (taxa)	Site_Name
9/30/2004	Insecta	Diptera	Simuliidae	Simulium	10	8				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Stratiomyidae	Odontomyia	5	1				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Tipulidae	Tipula	10	1			4	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		41				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Ephemeroptera	Baetidae	Baetidae	5	1		damaged		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Ephemeroptera	Baetidae	Baetis	5	9				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Hemiptera	Pleidae	Neoplea	5	4				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Odonata	Aeshnidae	Anax	5	1			8	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Odonata-Zygoptera	Calopterygidae	Calopteryx		5			5	SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Coenagrionidae	1	4		early instar		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Enallagma	1	6				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	10	2				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Trichoptera	Hydropsychidae	Hydropsychidae	10	2		early instar		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Insecta	Trichoptera	Hydroptilidae	Hydroptilidae	10	1		pupa(e)		SC 5 SHINGLE CREEK REACH 5
9/30/2004	Oligochaeta			Oligochaeta	5	68				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Turbellaria			Turbellaria		2				SC 5 SHINGLE CREEK REACH 5
9/30/2004		Hemiptera	Belostomatidae	Belostoma		4				SC 5 SHINGLE CREEK REACH 5
9/30/2004				Cricotopus bicinctus		3				SC 5 SHINGLE CREEK REACH 5
9/30/2004				Lethocerus americanus			1	Large and Rare		SC 5 SHINGLE CREEK REACH 5
9/30/2004				Nematoda		1				SC 5 SHINGLE CREEK REACH 5
9/30/2004	Acari			Acari		1				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Bivalvia			Pisidiidae		2				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Crustacea	Amphipoda	Talitridae	Hyalella		29			8	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Crustacea	Decapoda	Cambaridae	Cambarus			1	Large and Rare		SC 6 SHINGLE CREEK REACH 6
9/30/2004	Crustacea			Cladocera	5	970				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Crustacea			Copepoda	1	54				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Crustacea			Ostracoda	1	2				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Gastropoda	Limnophila	Planorbidae	Gyraulus	1	27				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Gastropoda		Lymnaidae	Stagnicola		3				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Gastropoda		Physidae	Physidae		47				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Gastropoda		Planorbidae	Helisoma			8	Large and Rare		SC 6 SHINGLE CREEK REACH 6
9/30/2004	Hirudinea			Hirudinea			1	Large and Rare		SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Coleoptera	Dytiscidae	Liodessus	1	1		adult		SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Ablabesmyia		3			8	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Chironomini		5		early instar		SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Cricotopus (Cricotopus)		2			7	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Endochironomus		9			10	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Hydrobaenus		1			8	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Orthocladiinae	5	2		pupa(e)	6	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Parachironomus		3			10	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Parametriocnemus		1			5	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Tanypodinae	5	2		pupa(e)	10	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Empididae	Hemerodromia		1				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		5				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Hemiptera	Pleidae	Neoplea	5	6				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Heteroptera	Corixidae	Trichocorixa	5	1				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Odonata	Aeshnidae	Anax	5		1	Large and Rare	8	SC 6 SHINGLE CREEK REACH 6

Date Collected	Class	Order	Family	Taxon	Salinity Sensitivity	Subsample	LargeRare	Comment_One	HBI TV (taxa)	Site_Name
9/30/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Coenagrionidae	1	2		early instar		SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Enallagma	1	2				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Insecta	Trichoptera	Leptoceridae	Triaenodes	5	1			6	SC 6 SHINGLE CREEK REACH 6
9/30/2004	Oligochaeta			Oligochaeta	5	337				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Turbellaria			Turbellaria		5				SC 6 SHINGLE CREEK REACH 6
9/30/2004				Helobdella stagnalis		1				SC 6 SHINGLE CREEK REACH 6
9/30/2004	Bivalvia			Pisidiidae		1		early instar		SC 7 SHINGLE CREEK REACH 7
9/30/2004	Crustacea	Amphipoda	Talitridae	Hyalella		48			8	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Crustacea			Cladocera	5	97				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Crustacea			Copepoda	1	3				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Gastropoda	Limnophila	Planorbidae	Planorbella	1	1				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Gastropoda		Lymnaidae	Stagnicola		1				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Gastropoda		Physidae	Physidae		2				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Coleoptera	Hydrophilidae	Tropisternus	5		3	Large and Rare		SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Coleoptera		Dytiscidae		2		larva(e)		SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Ceratopogonidae	Bezzia / Palpomyia	5	1				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Ablabesmyia		1			8	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Chironomus		2			10	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Labrundinia		1			7	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Limnophyes		3			8	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Micropsectra		4			7	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Nanocladius		1			3	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Orthocladiinae	5	1		early instar	6	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Paratanytarsus		1			6	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Polypedilum		4			6	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Tanytarsini		2		early instar	6	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Ephydridae	Ephydridae		1		pupa(e)	6	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		6				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Ephemeroptera	Baetidae	Callibaetis	5	1			9	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Ephemeroptera	Caenidae	Caenis	5	3			7	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Hemiptera	Notonectidae	Notonecta	5		1	Large and Rare		SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Hemiptera	Pleidae	Neoplea	5	4				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Odonata-Anisoptera	Aeshnidae	Aeshna	5	1			5	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Odonata-Anisoptera	Aeshnidae	Aeshna	5		2	Large and Rare	5	SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Coenagrionidae	1	3		early instar		SC 7 SHINGLE CREEK REACH 7
9/30/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Enallagma	1	13				SC 7 SHINGLE CREEK REACH 7
9/30/2004	Oligochaeta			Oligochaeta	5	91				SC 7 SHINGLE CREEK REACH 7
9/30/2004		Hemiptera	Belostomatidae	Belostoma			4	Large and Rare		SC 7 SHINGLE CREEK REACH 7
9/30/2004		Hydroida	Hydridae	Hydra		8				SC 7 SHINGLE CREEK REACH 7
9/30/2004				Lethocerus americanus			1	Large and Rare		SC 7 SHINGLE CREEK REACH 7
9/30/2004	Bivalvia			Pisidiidae		2				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Crustacea	Amphipoda	Talitridae	Hyalella		246			8	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Crustacea			Cladocera	5	35				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Crustacea			Copepoda	1	7				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Gastropoda	Limnophila	Planorbidae	Planorbula	1	1				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Gastropoda		Physidae	Physidae		10				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Gastropoda		Planorbidae	Helisoma		2				SC 8 SHINGLE CREEK REACH 8

Date Collected	Class	Order	Family	Taxon	Salinity Sensitivity	Subsample	LargeRare	Comment_One	HBI TV (taxa)	Site_Name
9/30/2004	Hirudinea			Hirudinea		1				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Coleoptera	Hydrophilidae	Enochrus	5		1	Large and Rare		SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Diptera	Chironomidae	Corynoneura		1			7	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Diptera	Chironomidae	Orthocladiinae	5	2		larva(e)	6	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Diptera	Chironomidae	Parametriocnemus		1			5	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Diptera	Chironomidae	Paratanytarsus		1			6	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Diptera	Chironomidae	Tanypodinae	5	1			10	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Diptera	Simuliidae	Simulium	10	2				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Diptera	Chironomidae	Thienemannimyia Gr.		3				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Ephemeroptera	Caenidae	Caenis	5	24			7	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Hemiptera	Pleidae	Neoplea	5	4				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Heteroptera	Corixidae	Trichocorixa	5	4				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Megaloptera	Corydalidae	Chauliodes			1	Large and Rare	4	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Odonata-Anisoptera	Aeshnidae	Aeshnidae	5	1		damaged	5	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Odonata-Zygoptera	Coenagrionidae	Enallagma	1	4				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Trichoptera	Leptoceridae	Leptocerus	5	35				SC 8 SHINGLE CREEK REACH 8
9/30/2004	Insecta	Trichoptera	Leptoceridae	Oecetis	5	1			8	SC 8 SHINGLE CREEK REACH 8
9/30/2004	Oligochaeta			Oligochaeta	5	17				SC 8 SHINGLE CREEK REACH 8
9/30/2004		Hemiptera	Belostomatidae	Belostoma			5	Large and Rare		SC 8 SHINGLE CREEK REACH 8
9/30/2004				Cricotopus (Isocladius)		1				SC 8 SHINGLE CREEK REACH 8
9/30/2004				Helobdella stagnalis		2				SC 8 SHINGLE CREEK REACH 8
9/30/2004				Mallochohelea		1				SC 8 SHINGLE CREEK REACH 8
9/30/2004				Mallochohelea		1				SC 8 SHINGLE CREEK REACH 8

2008 Macroinvertebrate Collection

Shingle Creek WMC
Shingle Creek Biotic TMDL

2008 Shingle Creek Biotic TMDL Macroinvertebrate Collection
Metrics by Joel Chirhart, MPCA

Metric Values

WenckID	Location	VisitDate	POET	Clinger	Collector-filterer	Intolerant	% Dominant Taxon	% Ephemeroptera	Log % Ephem	% Intolerant Taxa	Log % Intoleramt	% Tolerant Taxa	% Tricoptera - % Hydropsychidae	Log %Tricho- %Hydro	HBI
SC-002	Upstream of Zane Ave, Brooklyn Park	08-Aug-08	4	5	2	0	19.00	-	-	-	-	75.67	-	-	8.03
SC-074	Upstream of 74th, B Park, DS Cascade	09-Sep-08	1	5	0	0	55.05	-	-	-	-	92.18	-	-	8.35
SC-PLX	Upstream of Palmer Lake at Xerxes, B Park	09-Sep-08	4	4	2	0	37.90	12.10	1.12	-	-	76.43	0.32	0.12	6.33
SC-PLO	Downstream of Palmer Lake outlet at 69th, B Ctr	09-Sep-08	4	7	3	0	20.44	2.52	0.55	3.14	0.62	86.79	-	-	7.42
SC-001	at USGS gauge on Queen Ave, Minneapolis	09-Sep-08	2	5	1	0	18.33	15.67	1.22	1.33	0.37	95.67	-	-	8.12
SC-0	Upstream of 45th Ave., Minneapolis	09-Sep-08	9	6	2	1	37.00	5.00	0.78	0.00	0.00	82.00	2.33	0.52	6.88
PC-01	Pike Creek Plymouth/Maple Grove	08-Aug-08	8	8	3	0	18.15	0.31	0.12	-	-	85.85	1.54	0.40	7.17

2008 Shingle Creek Biotic TMDL Macroinvertebrate Collection
Metrics by Joel Chirhart, MPCA

WenckID	Location	Metric Scores: POET	ClingerCh	Collector-filtererCh	IntolerantCh	DomOneCHPct	EphemeropteraPct	LogEphem	IntolerantPct	LogIntol	Tolerant Pct	Trichoptera - Hydropsychidae	Log Tricho-Hydro	HBI	IBI: IBI Score
SC-002	Upstream of Zane Ave, Brooklyn Park	2.25	5	1.87	0	9.43	-	-	-	-	2.88	-	-	1.69	23.12
SC-074	Upstream of 74th, B Park, DS Cascade	-	5	-	0	2.35	-	-	-	-	0.44	-	-	0.83	8.62
SC-PLX	Upstream of Palmer Lake at Xerxes, B Park	2.25	4	1.87	0	5.72	2.83	6.81	-	-	2.77	0.44	1.32	6.36	31.09
SC-PLO	Downstream of Palmer Lake outlet at 69th, B Ctr	2.25	7	3.74	0	9.15	0.59	3.33	-	-	1.24	-	-	3.36	30.06
SC-001	at USGS gauge on Queen Ave, Minneapolis	0.75	5	-	0	9.56	3.66	7.44	-	-	-	-	-	1.45	24.20
SC-0	Upstream of 45th Ave., Minneapolis	5.99	6	1.87	2.5	5.89	1.17	4.74	0.00	0.01	1.95	3.24	5.74	4.86	39.55
PC-01	Pike Creek Plymouth/Maple Grove	5.24	8	3.74	0	9.60	0.07	0.71	-	-	1.38	2.14	4.44	4.05	37.16

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
9/9/2008	Gammarus	Amphipod		1			Palmer Lake Inflow @ Xerxes
9/9/2008	Hyalella	Amphipod		8			Palmer Lake Inflow @ Xerxes
9/9/2008	Acari	Arachnid		1			Palmer Lake Inflow @ Xerxes
9/9/2008	Laccophilus	Coleoptera	Dytiscdae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Acilius	Coleoptera	Dytiscidae		1		Palmer Lake Inflow @ Xerxes
9/9/2008	Dytiscidae	Coleoptera	Dytiscidae	1		Damaged	Palmer Lake Inflow @ Xerxes
9/9/2008	Peltodytes	Coleoptera	Haliplidae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Hydrochus	Coleoptera	Hydrochidae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Orconectes	Decapoda	Cambaridae		1		Palmer Lake Inflow @ Xerxes
9/9/2008	Ceratopogoninae	Diptera	Ceratopogonidae	3		Early Instar	Palmer Lake Inflow @ Xerxes
9/9/2008	Brillia	Diptera	Chironomidae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Micropsectra	Diptera	Chironomidae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Natarsia	Diptera	Chironomidae	2			Palmer Lake Inflow @ Xerxes
9/9/2008	Odontomesa	Diptera	Chironomidae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Orthocladius	Diptera	Chironomidae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Tanypodinae	Diptera	Chironomidae	1		Damaged	Palmer Lake Inflow @ Xerxes
9/9/2008	Thienemannimyia Gr.	Diptera	Chironomidae	6			Palmer Lake Inflow @ Xerxes
9/9/2008	Cladopelma	Diptera	Chironomid-Red	2			Palmer Lake Inflow @ Xerxes
9/9/2008	Cryptochironomus	Diptera	Chironomid-Red	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Paratanytarsus	Diptera	Chironomid-Red	20			Palmer Lake Inflow @ Xerxes
9/9/2008	Phaenopsectra	Diptera	Chironomid-Red	7			Palmer Lake Inflow @ Xerxes
9/9/2008	Polypedilum	Diptera	Chironomid-Red	19			Palmer Lake Inflow @ Xerxes
9/9/2008	Stenochironomus	Diptera	Chironomid-Red	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Tanytarsini	Diptera	Chironomid-Red	3		Pupa	Palmer Lake Inflow @ Xerxes
9/9/2008	Anopheles	Diptera	Culicidae	2			Palmer Lake Inflow @ Xerxes
9/9/2008	Simulium	Diptera	Simuliidae	4			Palmer Lake Inflow @ Xerxes
9/9/2008	Baetis	Ephemeroptera	Baetidae	36			Palmer Lake Inflow @ Xerxes
9/9/2008	Caenis	Ephemeroptera	Caenidae	2			Palmer Lake Inflow @ Xerxes
9/9/2008	Lymnaeidae	Gastropod		1		Immature	Palmer Lake Inflow @ Xerxes
9/9/2008	Physa	Gastropod		7			Palmer Lake Inflow @ Xerxes
9/9/2008	Sphaeriidae	Gastropod		26			Palmer Lake Inflow @ Xerxes
9/9/2008	Belostoma	Hemiptera	Belostomatidae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Corixidae	Hemiptera	Corixidae	5			Palmer Lake Inflow @ Xerxes
9/9/2008	Sigara	Hemiptera	Corixidae	5			Palmer Lake Inflow @ Xerxes
9/9/2008	Trichocorixa	Hemiptera	Corixidae	7			Palmer Lake Inflow @ Xerxes
9/9/2008	Neoplea	Hemiptera	Pleida	2			Palmer Lake Inflow @ Xerxes
9/9/2008	Hirudinea	Hirudinea			1		Palmer Lake Inflow @ Xerxes

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
9/9/2008	Caecidotea	Isopod	Asellidae	4			Palmer Lake Inflow @ Xerxes
9/9/2008	Enallagma	Odonata	Coenagrionidae	8			Palmer Lake Inflow @ Xerxes
9/9/2008	Oligochaeta	Oligochaeta		119			Palmer Lake Inflow @ Xerxes
9/9/2008	Nematoda	roundworm		1			Palmer Lake Inflow @ Xerxes
9/9/2008	Leptocerus	Trichoptera	Leptoceridae	1			Palmer Lake Inflow @ Xerxes
9/9/2008	Hyalella	Amphipod		28			Palmer Lake Outlet
9/9/2008	Orconectes	Decapoda	Cambaridae	1			Palmer Lake Outlet
9/9/2008	Bezzia	Diptera	Ceratopogonidae	1			Palmer Lake Outlet
9/9/2008	Ceratopogoninae	Diptera	Ceratopogonidae	1			Palmer Lake Outlet
9/9/2008	Serromyia	Diptera	Ceratopogonidae	1			Palmer Lake Outlet
9/9/2008	Cricotopus	Diptera	Chironomidae	7			Palmer Lake Outlet
9/9/2008	Micropsectra	Diptera	Chironomidae	1			Palmer Lake Outlet
9/9/2008	Nanocladius	Diptera	Chironomidae	10			Palmer Lake Outlet
9/9/2008	Orthocladiinae	Diptera	Chironomidae	4		Pupa	Palmer Lake Outlet
9/9/2008	Paraphaenocladius	Diptera	Chironomidae	1			Palmer Lake Outlet
9/9/2008	Tanypus	Diptera	Chironomidae	13			Palmer Lake Outlet
9/9/2008	Thienemannimyia Gr.	Diptera	Chironomidae	2			Palmer Lake Outlet
9/9/2008	Chironomini	Diptera	Chironomid-Red	3		Pupa	Palmer Lake Outlet
9/9/2008	Dicrotendipes	Diptera	Chironomid-Red	2			Palmer Lake Outlet
9/9/2008	Endochironomus	Diptera	Chironomid-Red	11			Palmer Lake Outlet
9/9/2008	Glyptotendipes	Diptera	Chironomid-Red	5			Palmer Lake Outlet
9/9/2008	Parachironomus	Diptera	Chironomid-Red	1			Palmer Lake Outlet
9/9/2008	Paratanytarsus	Diptera	Chironomid-Red	9			Palmer Lake Outlet
9/9/2008	Polypedilum	Diptera	Chironomid-Red	15			Palmer Lake Outlet
9/9/2008	Rheotanytarsus	Diptera	Chironomid-Red	1			Palmer Lake Outlet
9/9/2008	Rheumatobates	Diptera	Chironomid-Red	1			Palmer Lake Outlet
9/9/2008	Tanytarsus	Diptera	Chironomid-Red	1			Palmer Lake Outlet
9/9/2008	Simulium	Diptera	Simuliidae	9			Palmer Lake Outlet
9/9/2008	Baetis	Ephemeroptera	Baetidae	4			Palmer Lake Outlet
9/9/2008	Callibaetis	Ephemeroptera	Baetidae	3			Palmer Lake Outlet
9/9/2008	Caenis	Ephemeroptera	Caenidae	1			Palmer Lake Outlet
9/9/2008	Turbellaria	Flatworm		10			Palmer Lake Outlet
9/9/2008	Gyraulus	Gastropod		3			Palmer Lake Outlet
9/9/2008	Physa	Gastropod		9			Palmer Lake Outlet
9/9/2008	Sphaeriidae	Gastropod		4			Palmer Lake Outlet
9/9/2008	Belostoma	Hemiptera	Belostomatidae		1		Palmer Lake Outlet
9/9/2008	Corixidae	Hemiptera	Corixidae	3			Palmer Lake Outlet

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
9/9/2008	Trichocorixa	Hemiptera	Corixidae	9			Palmer Lake Outlet
9/9/2008	Mesovelia	Hemiptera	Mesoveliidae	7			Palmer Lake Outlet
9/9/2008	Neoplea	Hemiptera	Pleida	6			Palmer Lake Outlet
9/9/2008	Caecidotea	Isopod	Asellidae	9			Palmer Lake Outlet
9/9/2008	Chauliodes	Megaloptera	Chauliodinae		1		Palmer Lake Outlet
9/9/2008	Anax	Odonata	Aeshnidae		1		Palmer Lake Outlet
9/9/2008	Coenagrionidae	Odonata	Coenagrionidae	65		Early Instar	Palmer Lake Outlet
9/9/2008	Enallagma	Odonata	Coenagrionidae	7			Palmer Lake Outlet
9/9/2008	Oligochaeta	Oligochaeta		50			Palmer Lake Outlet
8/8/2008	Hyalella	Amphipod		59			Pike Creek Restored Section
8/8/2008	Haliplus	Coleoptera	Haliplidae	2			Pike Creek Restored Section
8/8/2008	Enochrus	Coleoptera	Hydrophilidae	1			Pike Creek Restored Section
8/8/2008	Atrichopogon	Diptera	Ceratopogonidae	3			Pike Creek Restored Section
8/8/2008	Ceratopogon	Diptera	Ceratopogonidae	1			Pike Creek Restored Section
8/8/2008	Ablabesmyia	Diptera	Chironomidae	3			Pike Creek Restored Section
8/8/2008	Tanypodinae	Diptera	Chironomidae	2		Early Instar	Pike Creek Restored Section
8/8/2008	Thienemannimyia Gr.	Diptera	Chironomidae	14			Pike Creek Restored Section
8/8/2008	Dicrotendipes	Diptera	Chironomid-Red	1			Pike Creek Restored Section
8/8/2008	Paratanytarsus	Diptera	Chironomid-Red	49			Pike Creek Restored Section
8/8/2008	Paratendipes	Diptera	Chironomid-Red	4			Pike Creek Restored Section
8/8/2008	Polypedilum	Diptera	Chironomid-Red	15			Pike Creek Restored Section
8/8/2008	Rheotanytarsus	Diptera	Chironomid-Red	18			Pike Creek Restored Section
8/8/2008	Ephydridae	Diptera	Ephydridae	1			Pike Creek Restored Section
8/8/2008	Caenis	Ephemeroptera	Caenidae	1			Pike Creek Restored Section
8/8/2008	Gyraulus	Gastropod		36			Pike Creek Restored Section
8/8/2008	Physa	Gastropod		11			Pike Creek Restored Section
8/8/2008	Planorbella	Gastropod			1		Pike Creek Restored Section
8/8/2008	Sphaeriidae	Gastropod		15			Pike Creek Restored Section
8/8/2008	Sigara	Hemiptera	Corixidae	1			Pike Creek Restored Section
8/8/2008	Notonecta	Hemiptera	Notonectidae		1		Pike Creek Restored Section
8/8/2008	Hirudinea	Hirudinea		2			Pike Creek Restored Section
8/8/2008	Aeshna	Odonata	Aeshnidae		1		Pike Creek Restored Section
8/8/2008	Aeshnidae	Odonata	Aeshnidae	1		Damaged	Pike Creek Restored Section
8/8/2008	Coenagrionidae	Odonata	Coenagrionidae	39		Early Instar	Pike Creek Restored Section
8/8/2008	Enallagma	Odonata	Coenagrionidae	14			Pike Creek Restored Section
8/8/2008	Oligochaeta	Oligochaeta		12			Pike Creek Restored Section
8/8/2008	Cheumatopsyche	Trichoptera	Hydropsychidae	4			Pike Creek Restored Section

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
8/8/2008	Hydropsyche	Trichoptera	Hydropsychidae	3			Pike Creek Restored Section
8/8/2008	Hydropsychidae	Trichoptera	Hydropsychidae	8		Early Instar	Pike Creek Restored Section
8/8/2008	Hydroptila	Trichoptera	Hydroptilidae	1			Pike Creek Restored Section
8/8/2008	Oecetis	Trichoptera	Leptoceridae	3			Pike Creek Restored Section
8/8/2008	Ptilostomis	Trichoptera	Phyrganeidae	1			Pike Creek Restored Section
9/9/2008	Hyalella	Amphipod		22			Queen Ave USGS
9/9/2008	Neoporus	Coleoptera	Dytiscdae	1			Queen Ave USGS
9/9/2008	Scirtidae	Coleoptera	Scirtidae	1		Early Instar	Queen Ave USGS
9/9/2008	Orconectes	Decapoda	Cambaridae	3			Queen Ave USGS
9/9/2008	Ablabesmyia	Diptera	Chironomidae	2			Queen Ave USGS
9/9/2008	Cricotopus	Diptera	Chironomidae	1			Queen Ave USGS
9/9/2008	Nanocladius	Diptera	Chironomidae	4			Queen Ave USGS
9/9/2008	Natarsia	Diptera	Chironomidae	1			Queen Ave USGS
9/9/2008	Orthocladiinae	Diptera	Chironomidae	1		Pupa	Queen Ave USGS
9/9/2008	Procladius	Diptera	Chironomidae	4			Queen Ave USGS
9/9/2008	Thienemannimyia Gr.	Diptera	Chironomidae	3			Queen Ave USGS
9/9/2008	Chironomini	Diptera	Chironomid-Red	1		Pupa	Queen Ave USGS
9/9/2008	Cladopelma	Diptera	Chironomid-Red	1			Queen Ave USGS
9/9/2008	Dicrotendipes	Diptera	Chironomid-Red	5			Queen Ave USGS
9/9/2008	Endochironomus	Diptera	Chironomid-Red	22			Queen Ave USGS
9/9/2008	Glyptotendipes	Diptera	Chironomid-Red	27			Queen Ave USGS
9/9/2008	Parachironomus	Diptera	Chironomid-Red	1			Queen Ave USGS
9/9/2008	Paratanytarsus	Diptera	Chironomid-Red	6			Queen Ave USGS
9/9/2008	Polypedilum	Diptera	Chironomid-Red	2			Queen Ave USGS
9/9/2008	Rheotanytarsus	Diptera	Chironomid-Red	1			Queen Ave USGS
9/9/2008	Rheumatobates	Diptera	Chironomid-Red	2			Queen Ave USGS
9/9/2008	Hemerodromia	Diptera	Empididae	2			Queen Ave USGS
9/9/2008	Ephydridae	Diptera	Ephydridae	2			Queen Ave USGS
9/9/2008	Caenis	Ephemeroptera	Caenidae	47			Queen Ave USGS
9/9/2008	Campeloma	Gastropod		3			Queen Ave USGS
9/9/2008	Lymnaeidae	Gastropod		2		Immature	Queen Ave USGS
9/9/2008	Physa	Gastropod		12			Queen Ave USGS
9/9/2008	Corixidae	Hemiptera	Corixidae	1			Queen Ave USGS
9/9/2008	Palmacorixa	Hemiptera	Corixidae	1			Queen Ave USGS
9/9/2008	Trichocorixa	Hemiptera	Corixidae	1			Queen Ave USGS
9/9/2008	Gerridae	Hemiptera	Gerridae	7		Damaged	Queen Ave USGS
9/9/2008	Neoplea	Hemiptera	Pleida	11			Queen Ave USGS

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
9/9/2008	Hirudinea	Hirudinea		1			Queen Ave USGS
9/9/2008	Caecidotea	Isopod	Asellidae	7			Queen Ave USGS
9/9/2008	Chauliodes	Megaloptera	Chauliodinae	1			Queen Ave USGS
9/9/2008	Sisyra	Neuroptera	Sisyridae	2			Queen Ave USGS
9/9/2008	Coenagrionidae	Odonata	Coenagrionidae	25		Early Instar	Queen Ave USGS
9/9/2008	Enallagma	Odonata	Coenagrionidae	55			Queen Ave USGS
9/9/2008	Oligochaeta	Oligochaeta		9			Queen Ave USGS
9/9/2008	Hyalella	Amphipod		10			Shingle Creek @ 74th DS Cascade
9/9/2008	Acari	Arachnid		1			Shingle Creek @ 74th DS Cascade
9/9/2008	Haliplus	Coleoptera	Haliplidae	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Berosus	Coleoptera	Hydrophilidae	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Hydrophilidae	Coleoptera	Hydrophilidae	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Atrichopogon	Diptera	Ceratopogonidae	2			Shingle Creek @ 74th DS Cascade
9/9/2008	Ceratopogoninae	Diptera	Ceratopogonidae	3		Early Instar	Shingle Creek @ 74th DS Cascade
9/9/2008	Acricotopus	Diptera	Chironomidae	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Cricotopus	Diptera	Chironomidae	12			Shingle Creek @ 74th DS Cascade
9/9/2008	Orthocladiinae	Diptera	Chironomidae	3		Pupa	Shingle Creek @ 74th DS Cascade
9/9/2008	Apedilum	Diptera	Chironomid-Red	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Chironomus	Diptera	Chironomid-Red	7			Shingle Creek @ 74th DS Cascade
9/9/2008	Dicrotendipes	Diptera	Chironomid-Red	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Endochironomus	Diptera	Chironomid-Red	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Paratanytarsus	Diptera	Chironomid-Red	18			Shingle Creek @ 74th DS Cascade
9/9/2008	Nemotelus	Diptera	Stratiomyidae	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Stratiomyidae	Diptera	Stratiomyidae	1		Damaged	Shingle Creek @ 74th DS Cascade
9/9/2008	Physa	Gastropod		3			Shingle Creek @ 74th DS Cascade
9/9/2008	Sphaeriidae	Gastropod		18			Shingle Creek @ 74th DS Cascade
9/9/2008	Corixidae	Hemiptera	Corixidae	169			Shingle Creek @ 74th DS Cascade
9/9/2008	Sigara	Hemiptera	Corixidae	2			Shingle Creek @ 74th DS Cascade
9/9/2008	Trichocorixa	Hemiptera	Corixidae	13			Shingle Creek @ 74th DS Cascade
9/9/2008	Neoplea	Hemiptera	Pleida	1			Shingle Creek @ 74th DS Cascade
9/9/2008	Hirudinea	Hirudinea	Hirudinea	12			Shingle Creek @ 74th DS Cascade
9/9/2008	Coenagrionidae	Odonata	Coenagrionidae	1		Damaged	Shingle Creek @ 74th DS Cascade
9/9/2008	Oligochaeta	Oligochaeta		22			Shingle Creek @ 74th DS Cascade
9/9/2008	Nematoda	roundworm		1			Shingle Creek @ 74th DS Cascade
9/9/2008	Hyalella	Amphipod		11			Shingle Creek SC-0
9/9/2008	Laccophilus	Coleoptera	Dytiscdae	2			Shingle Creek SC-0
9/9/2008	Stenelmis	Coleoptera	Elmidae	1			Shingle Creek SC-0

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
9/9/2008	Scirtidae	Coleoptera	Scirtidae	2		Early Instar	Shingle Creek SC-0
9/9/2008	Cambaridae	Decapoda	Cambaridae	6		Immature	Shingle Creek SC-0
9/9/2008	Orconectes	Decapoda	Cambaridae	6			Shingle Creek SC-0
9/9/2008	Ceratopogoninae	Diptera	Ceratopogonidae	1		Early Instar	Shingle Creek SC-0
9/9/2008	Chaoboridae	Diptera	Chaoboridae	1		Pupa	Shingle Creek SC-0
9/9/2008	Ablabesmyia	Diptera	Chironomidae	2			Shingle Creek SC-0
9/9/2008	Nanocladius	Diptera	Chironomidae	2			Shingle Creek SC-0
9/9/2008	Natarsia	Diptera	Chironomidae	9			Shingle Creek SC-0
9/9/2008	Orthocladiinae	Diptera	Chironomidae	1		Pupa	Shingle Creek SC-0
9/9/2008	Orthocladius	Diptera	Chironomidae	1			Shingle Creek SC-0
9/9/2008	Parakiefferiella	Diptera	Chironomidae	1			Shingle Creek SC-0
9/9/2008	Paramerina	Diptera	Chironomidae	1			Shingle Creek SC-0
9/9/2008	Procladius	Diptera	Chironomidae	3			Shingle Creek SC-0
9/9/2008	Tanypodinae	Diptera	Chironomidae	1		Pupa	Shingle Creek SC-0
9/9/2008	Thienemannimyia Gr.	Diptera	Chironomidae	22			Shingle Creek SC-0
9/9/2008	Cladopelma	Diptera	Chironomid-Red	1			Shingle Creek SC-0
9/9/2008	Dicrotendipes	Diptera	Chironomid-Red	1			Shingle Creek SC-0
9/9/2008	Endochironomus	Diptera	Chironomid-Red	1			Shingle Creek SC-0
9/9/2008	Glyptotendipes	Diptera	Chironomid-Red	3			Shingle Creek SC-0
9/9/2008	Parachironomus	Diptera	Chironomid-Red	1			Shingle Creek SC-0
9/9/2008	Paratanytarsus	Diptera	Chironomid-Red	4			Shingle Creek SC-0
9/9/2008	Polypedilum	Diptera	Chironomid-Red	21			Shingle Creek SC-0
9/9/2008	Stictochironomus	Diptera	Chironomid-Red	2			Shingle Creek SC-0
9/9/2008	Tanytarsini	Diptera	Chironomid-Red	1		Pupa	Shingle Creek SC-0
9/9/2008	Simulium	Diptera	Simuliidae	2			Shingle Creek SC-0
9/9/2008	Tipula	Diptera	Tipulidae	1			Shingle Creek SC-0
9/9/2008	Tipulidae	Diptera	Tipulidae	1		Damaged	Shingle Creek SC-0
9/9/2008	Baetis	Ephemeroptera	Baetidae	2			Shingle Creek SC-0
9/9/2008	Caenis	Ephemeroptera	Caenidae	2			Shingle Creek SC-0
9/9/2008	Stenacron	Ephemeroptera	Heptigeniidae	11			Shingle Creek SC-0
9/9/2008	Campeloma	Gastropod		1			Shingle Creek SC-0
9/9/2008	Physa	Gastropod		5			Shingle Creek SC-0
9/9/2008	Sphaeriidae	Gastropod		6			Shingle Creek SC-0
9/9/2008	Belostoma	Hemiptera	Belostomatidae	1			Shingle Creek SC-0
9/9/2008	Corixidae	Hemiptera	Corixidae	3			Shingle Creek SC-0
9/9/2008	Sigara	Hemiptera	Corixidae	6			Shingle Creek SC-0
9/9/2008	Trichocorixa	Hemiptera	Corixidae	1			Shingle Creek SC-0

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
9/9/2008	Gerridae	Hemiptera	Gerridae	1		Early Instar	Shingle Creek SC-0
9/9/2008	Mesovelia	Hemiptera	Mesoveliidae	3			Shingle Creek SC-0
9/9/2008	Notonecta	Hemiptera	Notonectidae	2			Shingle Creek SC-0
9/9/2008	Neoplea	Hemiptera	Pleida	1			Shingle Creek SC-0
9/9/2008	Caecidotea	Isopod	Asellidae	111			Shingle Creek SC-0
9/9/2008	Crambidae	Lepidoptera	Crambidae	1			Shingle Creek SC-0
9/9/2008	Sialis	Neuroptera	Sialidae	2			Shingle Creek SC-0
9/9/2008	Calopteryx	Odonata	Calopterygidae	1			Shingle Creek SC-0
9/9/2008	Enallagma	Odonata	Coenagrionidae	12			Shingle Creek SC-0
9/9/2008	Oligochaeta	Oligochaeta		9			Shingle Creek SC-0
9/9/2008	Cheumatopsyche	Trichoptera	Hydropsychidae	7			Shingle Creek SC-0
8/8/2008	Hyalella	Amphipod		12			Shingle Creek SC-2 Monitoring Station
8/8/2008	Acari	Arachnid		6			Shingle Creek SC-2 Monitoring Station
8/8/2008	Haliplus	Coleoptera	Haliplidae	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Peltodytes	Coleoptera	Haliplidae	4			Shingle Creek SC-2 Monitoring Station
8/8/2008	Hydrophilidae	Coleoptera	Hydrophilidae	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Orconectes	Decapoda	Cambaridae		1		Shingle Creek SC-2 Monitoring Station
8/8/2008	Ceratopogon	Diptera	Ceratopogonidae	4			Shingle Creek SC-2 Monitoring Station
8/8/2008	Ablabesmyia	Diptera	Chironomidae	9			Shingle Creek SC-2 Monitoring Station
8/8/2008	Hydrobaenus	Diptera	Chironomidae	2			Shingle Creek SC-2 Monitoring Station
8/8/2008	Procladius	Diptera	Chironomidae	15			Shingle Creek SC-2 Monitoring Station
8/8/2008	Tanypodinae	Diptera	Chironomidae	2		Pupa	Shingle Creek SC-2 Monitoring Station
8/8/2008	Tanypus	Diptera	Chironomidae	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Thienemannimyia Gr.	Diptera	Chironomidae	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Chironomus	Diptera	Chironomid-Red	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Cladopelma	Diptera	Chironomid-Red	19			Shingle Creek SC-2 Monitoring Station
8/8/2008	Dicrotendipes	Diptera	Chironomid-Red	28			Shingle Creek SC-2 Monitoring Station
8/8/2008	Parachironomus	Diptera	Chironomid-Red	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Paratanytarsus	Diptera	Chironomid-Red	13			Shingle Creek SC-2 Monitoring Station
8/8/2008	Polypedilum	Diptera	Chironomid-Red	7			Shingle Creek SC-2 Monitoring Station
8/8/2008	Rheotanytarsus	Diptera	Chironomid-Red	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Tanytarsini	Diptera	Chironomid-Red	3		Pupa	Shingle Creek SC-2 Monitoring Station
8/8/2008	Tanytarsus	Diptera	Chironomid-Red	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Culicidae	Diptera	Culicidae	1		Damaged	Shingle Creek SC-2 Monitoring Station
8/8/2008	Ephydridae	Diptera	Ephydridae	3			Shingle Creek SC-2 Monitoring Station
8/8/2008	Lymnaeidae	Gastropod		1		Immature	Shingle Creek SC-2 Monitoring Station
8/8/2008	Physa	Gastropod		2			Shingle Creek SC-2 Monitoring Station

Date Collected	Taxon	Order	Family	Subsample	Large/Rare	Qualifier	Sample_Station_Name
8/8/2008	Sphaeriidae	Gastropod		57			Shingle Creek SC-2 Monitoring Station
8/8/2008	Valvata	Gastropod		2			Shingle Creek SC-2 Monitoring Station
8/8/2008	Corixidae	Hemiptera	Corixidae	12			Shingle Creek SC-2 Monitoring Station
8/8/2008	Sigara	Hemiptera	Corixidae	3			Shingle Creek SC-2 Monitoring Station
8/8/2008	Trichocorixa	Hemiptera	Corixidae	8			Shingle Creek SC-2 Monitoring Station
8/8/2008	Hirudinea	Hirudinea	Hirudinea	48			Shingle Creek SC-2 Monitoring Station
8/8/2008	Sialis	Neuroptera	Sialidae	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Aeshna	Odonata	Aeshnidae	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Coenagrionidae	Odonata	Coenagrionidae	5		Damaged	Shingle Creek SC-2 Monitoring Station
8/8/2008	Corduliidae	Odonata	Corduliidae	2		Early Instar	Shingle Creek SC-2 Monitoring Station
8/8/2008	Oligochaeta	Oligochaeta		12			Shingle Creek SC-2 Monitoring Station
8/8/2008	Perlesta	Plecoptera	Perlidae	1			Shingle Creek SC-2 Monitoring Station
8/8/2008	Nematoda	roundworm		9			Shingle Creek SC-2 Monitoring Station