This study was funded by the Shingle Creek Watershed Management Organization and by the Minnesota Environment and Natural Resources Trust Fund through a DNR Conservation Partners grant. Aerial photos from the Metropolitan Design Center's Image Bank are ©Regents of the University of Minnesota and used with the permission of Metropolitan Design Center.

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of Minnesota.

Print Name  Edward A. Matthiesen
Signature  
Date  August 11, 2005  License No. 16800
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Executive Summary

The Shingle Creek Watershed Commission has undertaken a comprehensive assessment of Shingle Creek and its tributary Ryan Creek for the purpose of developing a coordinated vision for the future of Shingle Creek and its tributaries. This report sets forth such a vision, including potential opportunities for short and long term improvements to improve water quality and biotic integrity of Shingle Creek and its tributaries.

Both Shingle Creek and Ryan Creek have been fundamentally impacted by urbanization. They have been straightened, channelized and dredged, and function mainly to convey stormwater from the 44 square mile watershed to the Mississippi River. There are very few natural stream features such as riffles and pools and meanders. Much of the historic riparian wetland and floodplain has been drained and filled. Shingle Creek is impaired by excessive levels of chloride and low levels of dissolved oxygen. Stream biological assessments indicate that it will likely be designated an Impaired Water for biotic integrity. Ongoing water quality monitoring also reveals fecal coliform levels high enough that it will also likely be listed as impaired for high levels of bacteria.

Above Palmer Lake, the creek was historically a shallow, narrow, meandering prairie creek. Below the Lake, the creek was wide and flowed through extensive wetlands. The hydrology of the creek has been fundamentally altered by urbanization. Storm events result in frequent high-volume flows, while base flows are reduced in volume. As a result, the channel has widened and deepened to accommodate high flows, and at low flows the stream is a mere trickle flowing through exposed mud flats. Most of Ryan Creek has been either confined to a storm sewer or relocated to a constructed channel to accommodate development. Flow is intermittent and is dependant on structures controlling lake runouts. This “flashy” hydrology has a negative impact on aquatic life and increases streambank erosion and sloughing.

Riparian vegetated buffers vary from wide areas of woodland or wetland to turf grass mowed to the edge of the creeks. Invasive vegetative species are prevalent. Riparian zone management is inconsistent. In several locations, the tree canopy is so dense that no understory or groundcover can establish, and the exposed banks are eroding and sloughing. Some banks have been hard armored. The inconsistent riparian zone management decreases habitat, increases pollutant loading from runoff, and increases erosion and sedimentation.

The vision recommended by this Corridor Study is the long-term ecological restoration of the creek channel to return some of the historic structure and ecological function and address water quality impairments. More proactive management of the riparian zone, including restoration of native plants and management of invasive species, is also recommended.

This Study does not include a prescriptive Capital Improvement Program but rather identifies areas that would most benefit from improvement, and establishes design and management standards to be used as projects and redevelopment provide opportunity for implementation.
1.0 Purpose & Methods

1.1 Purpose

The Shingle Creek watershed covers 44.5 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 I-694 and Boone Avenue interchange. The river is approximately 11 miles long and drops approximately 66 feet from its source to its mouth.

Shingle Creek is a highly disturbed system that is used extensively for storm water conveyance from the densely urbanized watershed. A significant portion of the creek was converted to a drainage ditch by Hennepin County almost one hundred years ago; while some segments have been restored to more natural form and function, other segments retain ditch characteristics. The remainder of the creek channel has been straightened, dredged, and otherwise altered so that it no longer resembles the historic creek.

Figure 1: The Shingle Creek watershed in Hennepin County
Shingle Creek and its tributaries flow through various landscapes, ranging from parkland and greenway to residential backyards to commercial/industrial areas. The Creek flows through at least three Metropolitan Council Smart Growth/Livable Communities sites that are in various stages of design and redevelopment: the Humboldt Greenway in north Minneapolis; the Brookdale Smart Growth Opportunity Site in Brooklyn Center; and the Village Creek redevelopment area in Brooklyn Park. All three of these sites focus on the Creek and its potential as an amenity.

The Shingle Creek Corridor has the potential to become a defining natural resource for the area, providing recreation opportunities, wildlife habitat, and an aesthetic amenity. The Shingle Creek Corridor Study is intended to be a comprehensive assessment of Shingle Creek to coordinate planning activities across member cities and identify potential improvements to:

- Resolve problems and capitalize on opportunities
- Improve water quality
- Improve fish and wildlife habitat
- Restore native vegetation
- Increase recreational opportunities
- Increase connectivity
- Establish new or widen existing buffers
- Improve aesthetics
- Correct erosion and sedimentation problems

The end product of the Corridor Study is a coordinated vision for the future of Shingle Creek and its tributaries; an Implementation Plan that identifies potential future projects for the restoration of Shingle Creek; and a program of management activities.

1.2 Methods

This corridor study is based on field work and analysis conducted on Shingle Creek from the Minneapolis/Brooklyn Center border to the confluence of Bass and Eagle Creeks in Brooklyn Park that forms Shingle Creek. The tributary Ryan Creek is also included in this analysis. The Minneapolis Park and Recreation Board completed a Shingle Creek Natural Area Management Plan in 2002 that included an assessment of conditions in Shingle Creek within Minneapolis. Findings of that report are incorporated into this report where appropriate. A future corridor study assessing Bass and Eagle Creeks as well as other streams in the watershed will supplement this Study.

The Study utilized several tools to assemble a complete picture of the creek channel and its influences in the landscape. These included:

**GIS Analysis.** A set of GIS coverages was assembled, including: National Wetlands Inventory (NWI), Public Waters Inventory (PWI), floodplain, current (2000) and planned (2020) land use,
and parcels. Aerial photos from 2000 and 2003 were used to correct the stream centerline as shown on the DNR streams inventory. A 300-meter buffer was determined on each side of the centerline and analysis is generally limited to that buffer area. Shingle Creek in the study area (south corporate limits of Brooklyn Center to the confluence of Eagle and Bass Creeks in Brooklyn Park) was divided into eight reaches, while Ryan Creek was divided into two reaches.

**MLCCS.** Current aerial photos were used to develop a land cover classification based on the Minnesota Land Cover Classification System. Land cover is distinct from land use, and provides more detailed information about such diverse characteristics as tree canopy, ground cover, impervious surface, and hydrology.

**Easements & public owned property.** Easement data was obtained from the abutting cities of Robbinsdale, Brooklyn Center, and Brooklyn Park. Brooklyn Park provided a GIS coverage of their easements, while Brooklyn Center provided documents and paper eighth-sections with easements drawn in. These were digitized to show approximately the location of existing easements. Robbinsdale reported that to its knowledge it had no easements along Ryan Creek. The Hennepin County parcel database was used to identify parcels within the 300 meter buffer that were under public ownership (city, county, state, school district, other public agencies).

**Stream assessment.** Two standard field instruments were used to assess conditions on Shingle Creek and its immediate riparian area. The *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish* by the EPA is a synthesis of methods successfully used across the United States and current research on assessing biological integrity of streams. The *Stream Visual Assessment* was developed by the Natural Resources Conservation Service (NRCS) Aquatic Assessment Workgroup. This assessment protocol provides a basic level of stream health evaluation that is intended to be a simple, comprehensive assessment of stream condition that maximizes ease of use. Because of its ease of use, it is a good tool for nontechnical persons to use to help with ongoing monitoring.

**Macroinvertebrate Assessment.** Macroinvertebrates were collected at eight locations along the Shingle Creek; none were sampled in Ryan Creek. This sampling was completed using the Minnesota Pollution Control Agency’s Invertebrate Sampling Procedures. Reaches 1-8 were sampled using a qualitative multi-habitat approach so that representative macroinvertebrate habitats were sampled in each reach. The samples were identified to genus by a contracted lab. Scores based on metrics assigned by the MPCA were then compiled for each reach.

**Fish.** The Study was intended to include a fish collection to update data previously collected. Staff attempted to coordinate this collection with other agencies but were unable to complete this aspect of the study before conditions became too cold. Previous fish collection data are included in this analysis.
2.0  Major Findings

2.1  Overall Condition

Shingle Creek is a highly impacted urban stream. Most of the stream 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. Much of that segment still retains its ditch character. The streambanks 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. Little in-stream habitat is available for fish, macroinvertebrates, and other aquatic life.

Water quality is degraded by nutrient enrichment, sediment, and low dissolved oxygen. Those species that are present are generally those that are the most tolerant of poor water conditions. Shingle Creek has been designated an Impaired Water by the Minnesota Pollution Control Agency (MPCA) and Environmental Protection Agency (EPA) for excessive levels of chloride and for low levels of dissolved oxygen. Based on results of sampling by the MPCA, it is expected that Shingle Creek will also be designated an Impaired Water for impaired biota on the 2006 303(d) list. As of June 2005 a Total Maximum Daily Load (TMDL) study for the chloride impairment completed in 2004 was undergoing review by the EPA. A TMDL for dissolved oxygen is expected to be completed sometime during the period 2006-2008.

The following sections summarize channel and corridor characteristics. More detailed information by reach is presented in Appendix A.
2.2 Channel Physical Characteristics

**Channel stability**  
Many of the stream reaches are incised and continue to experience some erosion, mainly sloughing of saturated streambanks. While the stream overall appears to be stable, some reaches continue some minor down lateral cutting. In a few locations, mainly where it flows through riparian wetland, the stream is starting to restore its sinuosity. Aggradation is apparent in some reaches, especially downstream of grade control structures.

**Grade controls**  
Six vertical grade controls exist along the Creek: three small drop structures, a weir, a small dam, and the 900 foot long culvert under the Brookdale parking lot. Culverts at eleven road crossings provide additional vertical grade control.

**Channel character**  
The reaches of Shingle Creek are generally Rosgen Type A5. These classifications mean most of the Creek is highly straightened with low sinuosity and low to moderate width to depth ratios. There are few riffle and pool sequences, and substrate is primarily sand and silt.
Bank erosion

There is minor bank erosion in nearly every reach of Shingle Creek. Erosion is largely a result of riparian zone management such as removal of trees and shrubs near the stream or conversely the maintenance of a thick wooded canopy that shades the banks and prevents establishment of vegetation. In two reaches turf grass maintained to the edge of the stream bank is insufficient to maintain stability.

Numerous storm sewer outfalls tend to exacerbate the bank erosion problems by high velocity and turbulent discharges directed at a near right angle to the direction of flow and at the opposite stream bank.

Storm sewer outfalls

There are 50+ identified storm sewer outfalls along the length of Shingle Creek. The outfalls tend to cause local bank erosion and scour. In addition there are about 20 open channels that discharge into the creek.

2.3 Habitat and Biological Characteristics

Riparian vegetation and floodplain

For the most part the Shingle Creek riparian zone is a wide corridor of riparian vegetation and connected floodplain, although some reaches are lacking in both. Shingle Creek flows through six large riparian wetlands and six large parks. For much of its length the creek corridor is either publicly owned or protected by easement. Where only a narrow easement or corridor is owned, some vegetated buffer is maintained in the corridor. In one reach, about 2500 feet is not owned or protected by easement, and the riparian zone is short turf grass with scattered trees and shrubs to the streambank.
Fish habitat

Fish habitat is generally poor. The creek has very few of the riffle and pool sequences that characterize natural streams. Woody debris, vital for habitat, is generally absent. The stream is characterized by low habitat, shallow pool depth, absence of riffles, and poor quality riparian vegetation.

Macroinvertebrate sampling

Aquatic macroinvertebrate sampling was undertaken in order to assess the quality of the benthic community. Macroinvertebrate communities generally ranked poorly in the Macroinvertebrate Index of Biological Integrity (M-IBI) developed by the MPCA. All of the reaches would be listed as impaired for biological integrity.

Fishery survey

Fish surveys were previously completed on Shingle Creek in three locations. The species richness, the total number of species present in the stream, 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. The pollution tolerance levels of all species captured were “tolerant” or “intermediate”, meaning these species are able to withstand degraded stream conditions.

Regionally Significant Ecological Areas

Two DNR Regionally Significant Ecological Areas are located within the corridor. The Palmer Lake Basin in its entirety carries that designation. The Minnesota County Biological Survey has record of a past sighting of one or more Blandings turtles in the Basin. The open space on the south end of the North Hennepin Community College campus adjacent to the creek corridor is also designated a Regionally Significant Ecological Area.

2.4 Summary By Reach

Prior to the beginning of the survey, 10 reaches were identified by similar attributes for assessment. The reach boundaries were determined according to changes in channel character, slope or structures. The reach length varied from one-half mile to one and one-half miles in length.
Table 1: Stream Reaches.

<table>
<thead>
<tr>
<th>Reach No.</th>
<th>Downstream Limit</th>
<th>Upstream Limit</th>
<th>Length (ft)</th>
<th>Length (mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brooklyn Center S City Limits</td>
<td>CR 10</td>
<td>2,980</td>
<td>.56</td>
</tr>
<tr>
<td>2</td>
<td>CR 10</td>
<td>I-694</td>
<td>5,530</td>
<td>1.05</td>
</tr>
<tr>
<td>3</td>
<td>I-694</td>
<td>Palmer Lake</td>
<td>4,060</td>
<td>.77</td>
</tr>
<tr>
<td>4</td>
<td>Palmer Lake</td>
<td>Xerxes Avenue</td>
<td>6,350</td>
<td>1.20</td>
</tr>
<tr>
<td>5</td>
<td>Xerxes Avenue</td>
<td>Brooklyn Boulevard (lower)</td>
<td>6,260</td>
<td>1.18</td>
</tr>
<tr>
<td>6</td>
<td>Brooklyn Boulevard (lower)</td>
<td>Brooklyn Boulevard (upper)</td>
<td>5,500</td>
<td>1.04</td>
</tr>
<tr>
<td>7</td>
<td>Brooklyn Boulevard (upper)</td>
<td>CSAH 81</td>
<td>8,550</td>
<td>1.62</td>
</tr>
<tr>
<td>8</td>
<td>CSAH 81</td>
<td>I-694</td>
<td>8,010</td>
<td>1.52</td>
</tr>
<tr>
<td>9 (Ryan)</td>
<td>Shingle Creek</td>
<td>Osseo Road</td>
<td>5,665</td>
<td>1.07</td>
</tr>
<tr>
<td>10 (Ryan)</td>
<td>Ryan Lake</td>
<td>Lower Twin Lake</td>
<td>4,050</td>
<td>.77</td>
</tr>
</tbody>
</table>

A brief description of the reaches follows. More detailed descriptions of conditions by reach are shown in Appendix A.

**Reach 1** is located between the Minneapolis/Brooklyn Center border and County Road 10. The lower two-thirds of this reach are within the Centerbrook Golf Course while the upper third is confined in a 900 foot long box culvert below the Brookdale Shopping Center parking lot. The segment through the golf course is straightened with a silty bottom and a 50 percent tree canopy that is mostly located on the west side of the reach.
Reach 2 is bounded downstream by the weir at County Road 10 and upstream by Interstate 94/694. It is straightened with a silty bottom. In the early 1980s the old ditch through Brooklyn Center’s Central Park was filled and a new wide, meandered channel was constructed to the west. Most of the reach flows through riparian wetland or parkland. A backwater channel constructed around the Brooklyn Center Civic Center provides additional flood storage, and a weir provides an emergency overflow to a storm sewer system flowing to the Mississippi River.

Reach 3 extends from Interstate 94/694 to Palmer Lake. It is straightened with a sand/silt bottom. Much of the reach flows through riparian wetland. Small gravel/cobble point bars have accumulated just downstream from the 69th Avenue bridge.

Reach 4 extends from Palmer Lake to Xerxes Avenue. Most of the reach flows through the large Palmer Lake Basin riparian wetland complex. Xerxes was the upper limit of the County Ditch #13 channelization; while the upstream half of the reach retains its ditch character, the downstream half has reverted to a meandering channel through the Basin. Most of the reach is unshaded or minimally shaded, although the upstream part is heavily shaded.
Reach 5 is bounded by Xerxes Avenue and Brooklyn Boulevard (lower). While this reach was not part of the old Ditch #13 project, over the years it has been straightened and channelized. Most of the reach is heavily shaded and flows through riparian wetland or parkland. The substrate is sandy, with aggrading sandbars and points. A small drop structure provides a two foot elevation drop.

Reach 6 extends from Brooklyn Boulevard (lower) to Brooklyn Boulevard (upper). The reach has been straightened over the years and much of it is deeply entrenched. Heavily shaded, it runs through a mixed commercial and residential area. The segment from Zane Avenue to Brooklyn Boulevard (upper crossing) has recently been improved with boulder embankments and riparian native vegetation. A drop structure provides a three foot elevation change in the middle of the reach.

Reach 7 is that part of the creek from Brooklyn Boulevard (north crossing) to CSAH 81. The creek varies in character throughout this reach. From Brooklyn Boulevard to Hampshire the creek runs through a residential area with turf grass and scattered trees in the riparian zone. The substrate is silt and muck, with significant aquatic vegetation. From Hampshire to Broadway the creek also runs through residential areas but the residences are set back farther and the immediate riparian zone is more wooded and native vegetation. The substrate is coarse to fine sand and silt. From Broadway to CSAH 81 the creek runs through an old golf course now reverting to native and invasive vegetation. The creek is narrower and deeper and heavily shaded.
<table>
<thead>
<tr>
<th>Reach 8 extends from CSAH 81 to Interstate 694. Most of the reach flows through riparian wetland or open space. The downstream half of the reach is heavily wooded while the upstream half is open, flowing through a large cattail wetland.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach 9 is that part of tributary Ryan Creek from its confluence with Shingle Creek near 49th Avenue in Minneapolis to the outlet of Ryan Lake. About half of this reach is confined to storm sewer, while the other half has been channelized as a ditch. This ditch is seasonally to intermittently flowing, primarily in the spring when Ryan Lake’s level is high enough to flow out or when there is a very large storm event. The ditch is mostly open to partly shaded.</td>
</tr>
<tr>
<td>Reach 10 is that part of Ryan Creek from its inlet into Ryan Lake to its source as an outlet from Lower Twin Lake. The lower part of this reach is seasonally to intermittently flowing, primarily in the spring when the Twin Lake chain’s water level is high enough to flow over the France Avenue Weir or when there is a very large storm event. This part of the reach flows through residential back yards, and is mostly heavily shaded. The substrate is coarse sand with some gravel. From France Avenue upstream to Lower Twin Lake the creek runs through residential and park land, through cattail wetlands, and finally through back yards to France Avenue.</td>
</tr>
</tbody>
</table>
3.0 Inventory

3.1 History

Pre-European settlement stream conditions and morphology were inferred by examining notes from the Public Land Survey, 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 199 Range 21) were first surveyed in 1855. Surveyors conducting the PLS walked each section line, recording land conditions and features and setting section and half section corners. Their notes can provide us with a snapshot of conditions prior to intensive settlement, but are limited to features the surveyors encountered along section lines. Another limitation is that the notes can vary widely in the amount of information recorded. Each township was surveyed by a contract surveyor, and adjoining townships often were completed by different surveyors. One surveyor may have taken copious notes while the surveyor in the adjoining township may have taken minimal notes, which can make assembling a complete picture difficult.

By 1855, the notes reveal, all of the land in the corridor 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. Today oak openings are called oak savanna, a now-rare landscape that is transitional between prairie and forest.

Savannas are grasslands with scattered trees providing between 30 percent and 70 percent canopy cover, and are maintained by fire. Bur oaks and a few other tree species typical of oak savannas are fire resistant. When a fire swept through a savanna area, the maples, basswood, and other fire-susceptible species burned but the oaks remained and the prairie species were rejuvenated. Fire kept the Big Woods from spreading across the entire landscape.

“"The soil of this township (T118 R21) is about 2nd rate, the timber is a scattering of bur oak and brush with a few spots of prairie. It joins the Minneapolis survey on the east and borders on the Mississippi River on the NE. The whole of said fractional township is now claimed and occupied with a number of fine farms, a few small streams and a few small lakes."

“"This township (T119 R21) is mostly a rich, dry prairie, some timber on the west side. The whole township is claimed. The Mississippi River borders on the east. There is a road running up and down near the river through the township. There are a few small lakes."

-Public Land Survey Notes 1855

Until settlers came and eliminated or managed the fires that routinely swept across prairies and savannas, the landscape in the Shingle Creek area was flat prairie in lower creek area and gently rolling savanna to wooded in the upper creek. Soils were generally sandy loam, with large areas...
of peat in the Palmer Lake Basin and other wetland areas. The “2nd rate” soils described by the public land surveyor were fine soils for the vegetable and flower farms that quickly were established across the creek corridor area.

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

Figure 2: Public Land Survey of the Lower Shingle Creek Area. The Mississippi River is on the right and the long shape in the center is Twin Lake; the top of the map is about 61st Avenue. Both Shingle Creek and its tributary Ryan Creek are depicted with a wavy line that indicates in general they were meandering streams. The bordered area shown on either side of the creek is described in the notes as a “hay marsh.”
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.

In only one location did the surveyor record creek depth. The stream was recorded as being three feet deep where it crossed the line between Sections 30 and 31, near the confluence of Eagle and Bass Creeks. (Bass Creek is not depicted on the township map.)

Figure 3: Public Land Survey of the Upper Shingle Creek Area. At right center is Palmer Lake, which is depicted here and on early plat and other maps as a much larger open-water lake than the wetland with two small open-water bays depicted after about 1900. It is likely early settlers attempted to drain the shallow lake to create more arable land. Part of the road running diagonally across the township later became Brooklyn Boulevard.
An early photograph of Shingle Creek dating from about 1900, from the Minnesota Historical Society photographic database, depicts Shingle Creek in an unknown location, probably Minneapolis. The creek is meandering, but appears to have been altered, perhaps dredged. The landscape is open, with scattered trees.

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 shows that upstream of Xerxes Avenue the creek still retained its meandering character, but as Brooklyn Park began to develop in the 1950s the creek was slowly channelized and confined. A small dam just upstream of the northern Brooklyn Boulevard crossing was constructed in the late 1950s 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.

Figure 6: 1947 aerial photo of Reach 6 in Brooklyn Park showing the historic meandering character of the creek. The superimposed line is the current creek channel.

3.2 Watershed Context

Shingle Creek drains a watershed of about 44.5 square miles. The watershed is almost entirely developed. Table 2 below details Year 2000 land use. Single family residential is the largest land use classification at 30 percent of the total watershed area. Roads and Major Highways represent about 18 percent of the watershed. Park, Recreation, and Open Space uses constitute about 9 percent of the watershed area, and about 8 percent of the watershed area was Undeveloped. The entire watershed is an average 45-50 percent impervious. The lower watershed is more densely developed and is more impervious than the upper watershed.
A network of storm sewers drains almost the entire watershed. There are at least 50 mapped storm sewer outfalls into the creek, and there are almost certainly additional unmapped discharges. About 20 open channels also discharge to the creek, mostly in Brooklyn Park. Much of the upper watershed developed after the Shingle Creek Watershed 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 2: Land Use in Shingle Creek Watershed

<table>
<thead>
<tr>
<th>LAND USE</th>
<th>Area (acres)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family Residential</td>
<td>8,759</td>
<td>30%</td>
</tr>
<tr>
<td>Roads and Major Highways</td>
<td>5,205</td>
<td>18%</td>
</tr>
<tr>
<td>Park, Recreation or Preserve</td>
<td>2,486</td>
<td>9%</td>
</tr>
<tr>
<td>Undeveloped</td>
<td>2,353</td>
<td>8%</td>
</tr>
<tr>
<td>Industrial and Utility</td>
<td>2,184</td>
<td>8%</td>
</tr>
<tr>
<td>Multi-Family Residential</td>
<td>1,696</td>
<td>6%</td>
</tr>
<tr>
<td>Commercial</td>
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<td>Institutional</td>
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<td>Water</td>
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<tr>
<td>Airport</td>
<td>370</td>
<td>1%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>285</td>
<td>1%</td>
</tr>
<tr>
<td>Mixed Use</td>
<td>94</td>
<td>0.3%</td>
</tr>
<tr>
<td>Railway</td>
<td>72</td>
<td>0.3%</td>
</tr>
<tr>
<td>Farmsteads</td>
<td>16</td>
<td>0.1%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28,771</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Metropolitan Council

3.3 Water Quality

The Commission regularly monitors water quality at two sites on the stream, at the stream outlet near Webber Park in Minneapolis (“SC-0”) and just upstream of Zane Avenue (“SC-2”). The USGS maintains an additional site at Queen Avenue as part of the National Water Quality Assessment Program (NAWQA) (“SC-1”). Data and findings are published annually by the Commission, so only a summary will be presented here. No water quality data are available for Ryan Creek.

Routine and storm event samples are collected at both Commission sites and analyzed for total phosphorus (TP), dissolved phosphorus (DP), total suspended solids (TSS), volatile suspended solids (VSS), nitrate, and chloride. Fecal coliform samples are collected at the outlet site. Continuous flow, temperature, and conductivity are monitored at the USGS site. In general,
except for chloride pollutant loadings from the watershed, chemical concentrations in the creek are typical of urban streams and are within the range observed in the Twin Cities Metro area. Total suspended solids and total phosphorus concentrations tend to be highest during storm events and during the rising limb of the hydrograph, likely a “first flush” effect resulting from the high level of impervious surface in the watershed.

Shingle Creek has been designated an Impaired Water by the Environmental Protection Agency and Minnesota Pollution Control Agency for two parameters: excess chloride concentrations, and low dissolved oxygen. Commission monitoring for fecal coliform shows excessive levels of that parameter, and it is expected that Shingle Creek will be designated Impaired for excessive fecal coliform during the next designation cycle, as well as for Impaired Biota. A TMDL for the chloride impairment is nearly complete. A TMDL for the dissolved oxygen impairment will be prepared in the coming few years.

3.4 Water Quantity

The Commission monitors stream stage at 15 minute intervals at the 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. No flow data are available for Ryan Creek, but by observation the stream downstream of the France Avenue weir to its confluence with Shingle Creek flows only seasonally/intermittently.

Storm hydrographs derived from this data show a very “flashy” stream that rises quickly but then discharges quickly. In dry times, flows can be minimal. This hydrologic regime is typical of urban streams, and generally is a result of increased impervious surface increasing runoff and decreasing base flow.

The hydrographs below show the stream flow response for a rainfall event in 2004 that produced the peak annual flow at the outlet and Queen Avenue monitoring sites and the second highest annual flow at the Zane Avenue site.

The hydrographs demonstrate the short interval between the onset of a rain event and an increase in streamflow. Both show a secondary, later peak as storage areas within the watershed discharge.
Figure 7: Shingle Creek Outlet Hydrograph

Figure 8: Zane Avenue Hydrograph
3.5  Easement Assessment

Ownership and easement records were reviewed as a part of this study. Some areas of important connected floodplain, wetland, and open space are under public ownership by the cities or by other public institutions such as the county, school districts, or economic development authorities. Where there is no public ownership, for the most part an easement is available. The most notable exception is about 2500 feet of channel in Brooklyn Park between Brooklyn Boulevard and Hampshire, where private ownership extends up to the creek.

Ownership and easement rights are important considerations as their presence or absence may provide or limit opportunities to improve the creek corridor.
Figure 9: Easements and Public Ownership
3.6 Riparian and Adjacent Land Use

The corridor is entirely urbanized, and the creek flows through park and open space, residential, commercial, and industrial areas. The immediate riparian area for much of the creek’s length is park or public open space, but that riparian corridor width is often less than 50 feet wide. Notable exceptions include the Palmer Lake Basin, Brookdale Park in Brooklyn Park, and Central Park in Brooklyn Center.

Except where the creek flows through a connected riparian wetland, the creek corridor is residential or commercial land or manicured park land with a narrow, minimally maintained buffer. Buffers are for the most part simply unmowed turf with scattered to dense trees and woody vegetation. In some locations, such as parts of Palmer Lake Basin, Brookdale Park, and the large Northland wetland complex between I-694 and Brooklyn Boulevard, the tree canopy is so dense and shaded that there is little understory or groundcover.

In two locations there is no buffer and residential lawns are maintained to the creek. Just north of CR 10 in Brooklyn Center the city owns a narrow parcel of land between the creek and adjacent single family homes. Some of those residents mow the city’s property down to the creek, causing the streambanks to erode. In Brooklyn Park, about 2500 feet of creek from Brooklyn Boulevard to Hampshire is privately owned to the streambank. Many of the adjacent residents mow their property to the edge and have experienced erosion and tree loss. Between Hampshire and Candlewood, the city owns a narrow parcel of land between the creek and adjacent single family homes. Some of those property owners mow the city’s property to the creek, resulting in eroding streambanks.
Figure 10: 2000 Land Use

2000 Land Use
- Agriculture
- Farmsteads
- Single Family Residential
- Multi-Family Residential
- Commercial/Industrial
- Extractive
- Institutional
- Park, Recreational
- Transportation
- Undeveloped
- Water

Source: Metropolitan Council

Shingle Creek Corridor Study: Land Use 2000
3.7 Connected Floodplains and Wetlands

There are several significant wetland areas connected to the creek and its floodplain, the most notable being the 500+ acre Palmer Lake Basin. As noted above in the discussion of watershed history, prior to European settlement the Basin was actually a large lake. Agricultural ditching and tiling and the construction of County Ditch #13 greatly reduced the amount of open water and resulted in the conversion of an area near the center of the basin to a Type 6 scrub-shrub wetland and the outer areas of the Basin to Type 3 shallow marsh wetlands. An aerial photo from the early 1930s drought years shows that central area as dry enough to undergo cultivation. Although it is no longer a large, open lake the basin continues to provide the most significant connected floodplain on the creek, with an estimated 2,600 acre-feet of flood storage.

Other significant floodplain storage areas include several parks, the south part of the North Hennepin Community College campus, and the large Northland wetland complex between I-694 and Brooklyn Boulevard in Brooklyn Park as well as some private property. Overflow from the channel into the floodplain is an issue in Brooklyn Center’s Central Park at the softball and baseball diamonds as well as in Centerbrook Golf Course, where flooded conditions and slow draw down disrupt recreational usage of these properties.

The extent of riparian wetlands has greatly diminished since the land survey days. Historically, the creek ran through a “hay marsh” (probably a Type 2 wet meadow) almost one-half mile in width that occupied what is now central Brooklyn Center. The smaller and narrower Type 3 wetland behind the Hennepin County Government Center is all that remains of this formerly extensive complex. The Northland wetland north of I-694 was historically much larger, and the amount of open water appears to have been reduced.

Several wetlands within the stream corridor have been filled since the National Wetlands Inventory (NWI) was taken in about 1981. Wetlands in Reach 1 were filled to provide for the construction of Centerbrook Golf Course. The construction of Brooklyn Center’s Central Park ballfields and other recreational facilities required significant wetland fill as well as relocation of the creek from its ditched channel to a wider, more meandered channel. Wetlands in Reach 3 north of I-694 were filled during the construction of the Brooklyn Center Industrial Park. Some wetland fill was placed in Reach 8 during the construction of industrial buildings north of I-694 and east of Boone Avenue. While outside of the immediate corridor but nearby, early 20th century topographic and plat maps show that an approximately 50-acre lake named Line Lake occupied the area that is now the south part of the interchange of TH 169 and Brooklyn Boulevard. The NWI shows a wetland complex just to the east of that historic lake, south of Brooklyn Boulevard between TH 169 and Boone, which has since been mostly filled for industrial development.

Functions and values analyses have not been conducted yet on the wetlands riparian to Shingle Creek. The Shingle Creek and West Mississippi Commissions’ Water Quality Plan identified wetlands riparian to streams as being of high priority for these assessments.
Figure 11: Wetlands
Figure 12: Floodplains
3.8 Macroinvertebrates

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

Volunteers have collected samples on Shingle Creek through Hennepin County’s River Watch program since 1996. Through this program, Hennepin 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. In general, sampling results show the habitat quality and species richness in Shingle Creek to be near or slightly below the average for streams in Hennepin County. The results of these assessments generally indicated below average to poor water quality conditions throughout the stream. The species composition in most reaches of the stream indicates environmental stress, poor water quality, and/or poor quality of habitat. These assessments indicated that the reaches of the stream with the lowest habitat quality also had the lowest invertebrate populations.

A survey of the macroinvertebrate communities in Shingle Creek was conducted in late fall of 2005. Sampling methods were adopted from the MPCA’s development of a Macroinvertebrate Index of Biotic Integrity (M-IBI). Reaches 1-8 were sampled using a qualitative multi-habitat approach, meaning that representative macroinvertebrate habitats were sampled in each reach. The samples were identified to genus by a contracted lab. Scores based on metrics assigned by the MPCA were then compiled for each reach.

The M-IBI scores for the sampled reaches of Shingle Creek ranged from “very poor” to “fair”, with seven of the reaches scoring as “very poor” or “poor”, and one scoring as “fair”. Reach 1 had the highest M-IBI score, but still fell below the MPCA threshold for impairment.
Figure 13: Macroinvertebrate IBI scores by reach in the Shingle Creek watershed. The MPCA threshold for determining impaired streams is included on the graph.

### 3.9 Fish

The Shingle Creek fishery is located in an urban setting with varying habitat quality and type throughout the stream. Much of the stream is channelized, and lacks quality 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.

Lakes and wetlands connected to Shingle Creek provide refuge for fish during low flow periods in which fish become stressed by large temperature and dissolved oxygen changes. These larger water bodies also provide breeding and nursery areas for many fish species.

A survey of the fish community was conducted in 1996 following the guidelines for Rapid Bioassessment established by the EPA. Another survey was conducted by the USGS in 1997. In both 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 the stream, 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. The pollution tolerance levels of all species captured was “tolerant” or “intermediate”, meaning these species are able to withstand degraded stream conditions.
3.10  **Biodiversity**

In 2003 the Minnesota DNR conducted a landscape scale assessment of the seven-county metropolitan area to identify terrestrial and wetland areas of ecological significance. Areas include places where intact native plant communities and/or native animal habitat are still found in the region and continue to provide important ecological functions such as:

- Habitat for game and non-game, including threatened, endangered, and special concern animals.
- Biological diversity.
- Connectivity in the landscape.
- Groundwater recharge and improved water quality.
- High to outstanding examples of native plant and/or animal communities or animal aggregations.

Two Regionally Significant Ecological Areas identified as part of this assessment are located within the corridor. The Palmer Lake Basin in its entirety carries that designation, as does the open space on the south end of the North Hennepin Community College campus adjacent to the creek corridor. The DNR has also classified Shingle Creek from Palmer Lake to the Mississippi River as a Metro Wildlife Corridor Focus Area.

The Palmer Lake Basin rates highly on all these criteria. It is a significant ecological resource for the area, providing nesting, breeding, and hunting habitat for a variety of wildlife. Species observed there include a variety of birds, waterfowl, deer, fox, beaver, smaller mammals, reptiles, turtles, fish, and insects.

In addition, the Minnesota County Biological Survey reports a past sighting of one or more Blandings turtles in the Palmer Lake Basin. The Blanding’s turtle (*Emydoidea blandingii*) is a state-listed threatened species. It depends upon riparian areas and a variety of wetland types, and is frequently associated with sandy upland soils for nesting.

The North Hennepin Community College site provides a sizable area of native vegetation connected to Shingle Creek.

*Figure 14: A Blanding's turtle* (Minnesota DNR).
4.0 Stream Assessment

Shingle Creek is a valuable resource, both to its riparian communities and the watershed as a whole. It is a natural resource in an urban environment, providing habitat for plants and animals and aesthetic enjoyment for humans. It provides a corridor for park, trails and transportation. Shingle Creek provides flood control, and is a primary conveyance for stormwater drainage.

4.1 Corridor Character

Shingle Creek is a highly developed urban stream that has been extensively altered since the early 1900’s. Land development in the watershed is nearly complete, with extensive impervious surface resulting in increased discharge to the creek. Flow in the creek is “flashy,” meaning the flow volume and velocity and water level rise quickly after a rain or snowmelt event, but then fall quickly as the runoff is transported to the Mississippi River.

The creek channel has been straightened and dredged with few riffles and pools, although some new riffle habitat has been constructed in Minneapolis. The substrate is fairly uniform coarse to fine sand with some silt and muck. The channel is generally flat-bottomed, with a trapezoidal shape. There is some scattered streambank armoring and wooden shoring, and a portion of the channel in Webber Park is concrete-lined.

Vegetated buffer width is quite variable, ranging from hundreds of feet wide in park and wetland areas to a few feet or less in developed areas. The vegetated buffer is also variable, ranging from simply an unmowed strip on the streambank to a dense floodplain forest with a closed canopy. There are a number of leaning or exposed trees on the streambank. Buckthorn and other invasive species are present in much of the riparian zone.

Two standard protocols were used to assess the condition of Shingle Creek and Ryan Creek. The Stream Visual Assessment Protocol, developed by a working group for the Natural Resources Conservation Service, and the Visual Assessment Protocol, developed by the EPA. These instruments were selected because they have wide acceptance, provide consistent results, and are an objective measure of various factors impacting stream conditions and health.

The streams were assessed in August and September 2004 during low flow conditions that allowed for easy access and visual inspection of the streambanks. A two-person crew walked or canoed the streams except for a few passages through cattail wetlands that were too mucky to wade and too shallow to canoe.
4.2 Stream Visual Assessment Protocol

The Stream Visual Assessment Protocol (SVAP) by the Natural Resources Conservation Service assesses various factors on a scale of 1 to 10, with 10 being the reference condition. This assessment protocol provides a basic level of stream health evaluation that is intended to be a simple, comprehensive assessment of stream condition that maximizes ease of use. It is suitable as a basic first approximation of stream condition. It can also be used to identify the need for more accurate assessment methods that focus on a particular aspect of the aquatic system. Because of its ease of use, it is a good tool for nontechnical persons to use to help with ongoing monitoring.

The SVAP is weighted more towards the riparian and streambank conditions and habitat quality, so reaches with wide, good quality riparian buffers such as Reaches 3 and 4 through the Palmer Lake Basin and wide riparian wetlands will score better than Reach 6, for example, which flows through a narrow, incised channel adjacent to commercial areas.

Not all factors are appropriate for each reach. The factors evaluated and the two ends of the scoring continuum are:

![Figure 15: Stream Visual Assessment Summary results](image)

- <6.0 Poor
- 6.1-7.4 Fair
- 7.5-8.9 Good
- >9.0 Excellent
<table>
<thead>
<tr>
<th>Assessment Factor</th>
<th>Highest Quality = 10</th>
<th>Lowest Quality = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel condition</td>
<td>A natural channel with no structures and no evidence of downcutting or excessive lateral cutting.</td>
<td>The channel is actively downcutting or widening, more than 50 percent of the reach is riprapped or channelized, or dikes or levees prevent access to the floodplain.</td>
</tr>
<tr>
<td>Hydrologic alteration</td>
<td>Flooding occurs every 1.5 – 2 years, no dams or structures are present, the stream has access to the floodplain, and the channel is not incised.</td>
<td>The channel is deeply incised, floodplain access is prevented, or flooding occurs from a 1-year event or less.</td>
</tr>
<tr>
<td>Riparian zone</td>
<td>Natural vegetation extends at least two active channel widths on each side of the stream.</td>
<td>Natural vegetation is less than a third of the active channel width on each side.</td>
</tr>
<tr>
<td>Bank stability</td>
<td>Banks are stable, low, and one-third or more of eroding surface area of bank bends is protected by roots.</td>
<td>Banks are unstable and typically high, bends and straight are actively eroding with slope failures and falling trees</td>
</tr>
<tr>
<td>Water appearance</td>
<td>Water is clear or light tea-colored with visibility 3-6 feet, with no oil sheen or film on objects</td>
<td>Water has a very turbid or muddy appearance most of the time and visibility is less than 0.5 feet. There may be obvious water pollution, floating algal mats, surface scum or sheen, or strong odors.</td>
</tr>
<tr>
<td>Nutrient enrichment</td>
<td>There is clear water, a diverse aquatic plant community, and little algal growth.</td>
<td>The water is pea green, gray, or brown with dense stands of macrophytes or severe algal blooms.</td>
</tr>
<tr>
<td>Barriers to fish movement</td>
<td>There are no barriers.</td>
<td>There are drop structures, culverts, or dams with a greater than one foot drop within the reach.</td>
</tr>
<tr>
<td>Instream fish cover</td>
<td>There are more than 7 cover types available. Cover types include: logs/large woody debris; deep pools; overhanging vegetation; boulders/ cobble; riffles; undercut banks; thick root mats; dense macrophyte beds; or isolated/backwater pools.</td>
<td>There is none or one type available</td>
</tr>
<tr>
<td>Pools</td>
<td>Deep and shallow pools are abundant, greater than 30 percent of the pool bottom is obscure due to depth, or the pool is at least 3 feet deep.</td>
<td>Pools are absent or the entire bottom is discernable.</td>
</tr>
<tr>
<td>Insect/invertebrate habitat</td>
<td>At least 5 types of habitat are available Habitat includes: fine woody debris; submerged logs; leaf packs; undercut banks; cobble; boulders; or coarse gravel.</td>
<td>None to one type available.</td>
</tr>
<tr>
<td>Canopy cover</td>
<td>25-90 percent of the water surface is shaded and there is a mix of conditions.</td>
<td>Less than 25 percent of the surface is shaded.</td>
</tr>
<tr>
<td>Riffle embeddedness</td>
<td>Gravel or cobble are less than 20 percent embedded.</td>
<td>Riffles are completely embedded.</td>
</tr>
</tbody>
</table>

(Natural Resources Conservation Service 1998)
### Table 4: Stream Visual Assessment Protocol Results

<table>
<thead>
<tr>
<th>Assessment Factor</th>
<th>1 – Mpls Boundary to CR 10</th>
<th>2 – CR 10 to I-694</th>
<th>3 – I-694 to Palmer Lake</th>
<th>4 – Palmer Lake to Xerxes</th>
<th>5 – Xerxes to Brooklyn Blvd</th>
<th>6 – Brooklyn Blvd to CSAH 81</th>
<th>7 – CSAH 81 to I-694</th>
<th>8 – CSAH 81 to I-694</th>
<th>9 – Shingle Creek to Ryan Lake</th>
<th>10 – Ryan Lake to Lower Twin Lake***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel Condition</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>2/5</td>
<td>4/8</td>
<td>7</td>
<td>8/3</td>
</tr>
<tr>
<td>Hydrologic Alteration</td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>9</td>
<td>5</td>
<td>5/3</td>
<td>7</td>
<td>7/9</td>
<td>7</td>
<td>8/3</td>
</tr>
<tr>
<td>Riparian Zone</td>
<td>8/3*</td>
<td>3</td>
<td>9</td>
<td>10/4</td>
<td>5</td>
<td>5/8</td>
<td>1/9</td>
<td>10</td>
<td>8</td>
<td>8/3</td>
</tr>
<tr>
<td>Bank Stability</td>
<td>8</td>
<td>7</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>7/2</td>
<td>6</td>
<td>7/10</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Water Appearance</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>2/5</td>
<td>6</td>
<td>-</td>
<td>5/-</td>
</tr>
<tr>
<td>Nutrient Enrichment</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>-</td>
<td>7</td>
<td>5/8</td>
<td>8/5</td>
<td>-</td>
<td>7/-</td>
</tr>
<tr>
<td>Fish Barriers</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5/1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Instream Fish Cover</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>1/4</td>
<td>2/5</td>
<td>3</td>
<td>1</td>
<td>5/2</td>
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<tr>
<td>Pools</td>
<td>3</td>
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<td>2</td>
<td>3</td>
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<td>3</td>
<td>3</td>
<td>1</td>
<td>7/1</td>
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<tr>
<td>Insect Habitat</td>
<td>3</td>
<td>3</td>
<td>8</td>
<td>7</td>
<td>3</td>
<td>2/5</td>
<td>4</td>
<td>5</td>
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<td>5/1</td>
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<tr>
<td>Canopy Cover</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>5/1</td>
<td>8</td>
<td>3/7</td>
<td>10</td>
<td>8/5</td>
<td>1</td>
<td>1/10</td>
</tr>
<tr>
<td>Riffle Embeddedness</td>
<td>8</td>
<td>-</td>
<td>8</td>
<td>-</td>
<td>8</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Total</td>
<td>63/58</td>
<td>46</td>
<td>74</td>
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<td>42/48</td>
<td>43/63</td>
<td>66/65</td>
<td>35</td>
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</tr>
<tr>
<td>Mean Score</td>
<td>5.04</td>
<td>4.18</td>
<td>6.08</td>
<td>6.54</td>
<td>4.45</td>
<td>4.09</td>
<td>4.81</td>
<td>5.95</td>
<td>3.89</td>
<td>6.0/3.18</td>
</tr>
<tr>
<td>M-IBI Score***</td>
<td>44.74</td>
<td>13.54</td>
<td>22.8</td>
<td>20.32</td>
<td>31.67</td>
<td>13.47</td>
<td>17.43</td>
<td>26.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reach 9 and France Ave to Ryan Lake were dry</td>
</tr>
</tbody>
</table>

*Where two scores are shown, subreaches within a reach were significantly different.

**The first score is for the segment between Lower Twin Lake and France Avenue, the second for the segment between France Avenue and Ryan Lake.

***MPCA M-IBI threshold for impairment is a score below 54.

**Note:** Factors are scored on a scale of 1–10, with 10 being the reference condition. Cells with more than one rating indicate that subareas within the reach vary significantly on that factor. An average is used when computing the mean score.

<table>
<thead>
<tr>
<th>Mean score</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1-7.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5-8.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;9.0</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
4.3 Rapid Bioassessment Protocol

The Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish (RBP) was developed by the Environmental Protection Agency with the assistance of a Technical Experts Panel of various experts in their fields. The protocols are intended to provide a cost-effective means of assessing biological integrity of streams, and are a synthesis of methods successfully used across the United States and current research. They are intended to be used for:

- Characterizing the existence and severity of impairment to the water resource
- Helping to identify sources and causes of impairment
- Evaluating the effectiveness of control actions and restoration activities
- Supporting use attainability studies and cumulative impact assessments
- Characterizing regional biotic attributes of reference conditions

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. The RBP more heavily weights stream channel physical conditions.

![Rapid Bioassessment Summary Results](image)

**Figure 16: Rapid Bioassessment Summary Results**

Reaches 5, 6, and 7 scored lower than other reaches because the channels have been altered, there is sediment deposition and aggradation, and the streambanks lack vegetative protection.

The factors evaluated and the two ends of the scoring continuum are:
Table 5: Rapid Bioassessment Protocol Scoring

<table>
<thead>
<tr>
<th>Assessment Factor</th>
<th>Optimal = 20</th>
<th>Poor = 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrate/cover</td>
<td>Greater than 50 percent of the substrate is favorable for colonization and fish cover. Habitat includes: mix of snags; submerged logs; undercut banks; cobbles; habitat at a stage to allow full colonization (not new fall or transient).</td>
<td>Less than 10 percent stable habitat, where the lack of habitat is obvious.</td>
</tr>
<tr>
<td>Pool substrate characterization</td>
<td>There is a mixture of substrate particles with gravel and firm sand prevalent.</td>
<td>Pool substrate is hard-pan clay or bedrock.</td>
</tr>
<tr>
<td>Pool variability</td>
<td>There is an even mix of pools present. Pool types are large-shallow, large-deep, small-shallow, small-deep.</td>
<td>The pools are small-shallow or absent.</td>
</tr>
<tr>
<td>Sediment deposition</td>
<td>There is little or no enlargement of islands or point bars and less than 20 percent of bottom affected by sediment deposition.</td>
<td>There are heavy deposits of fine material, increased bar development, more than 80 percent of the bottom changing frequently.</td>
</tr>
<tr>
<td>Channel flow status</td>
<td>Water reaches base of both banks and minimal substrate is exposed</td>
<td>There is little water in channel and mostly present as standing pools.</td>
</tr>
<tr>
<td>Channel alteration</td>
<td>Channelization or dredging is minimal</td>
<td>Banks are shored with gabion or cement, over 80 percent of the reach is channelized and disrupted.</td>
</tr>
<tr>
<td>Channel sinuosity</td>
<td>The bends in the stream increase the stream length 3-4 times longer than if it was in a straight line.</td>
<td>The channel is straight, where the waterway has been channelized for a long distance.</td>
</tr>
<tr>
<td>Bank stability (score each bank 0-10)</td>
<td>Banks are stable and evidence of erosion is minimal.</td>
<td>Banks are unstable with many eroded areas, obvious bank sloughing, and 60-100 of bank has erosional scars.</td>
</tr>
<tr>
<td>Vegetative protection (score each bank 0-10)</td>
<td>More than 90 percent of streambank surfaces and immediate riparian zone covered by a variety of all classes of native vegetation.</td>
<td>Less than 50 percent of streambank is covered by vegetation, is disrupted, or is removed to 5 centimeters in height or less.</td>
</tr>
<tr>
<td>Riparian vegetative zone width (score each bank 0-10)</td>
<td>Width is greater than 18 meters and human activities have not impacted zone.</td>
<td>The zone width is less than 6 meters, where there is little to no riparian vegetation due to human activities.</td>
</tr>
</tbody>
</table>

(Barbour et al, 1999)
Table 6: Rapid Bioassessment Protocol Results

<table>
<thead>
<tr>
<th>Assessment Factor</th>
<th>1 – Mpls Boundary to CR 10</th>
<th>2 – CR 10 to I-694</th>
<th>3 - I-694 to Palmer Lake</th>
<th>4 – Palmer Lake to Xerxes</th>
<th>5 - Xerxes to Brooklyn Blvd</th>
<th>6 – Brooklyn Blvd to CSAH 81</th>
<th>7 – CSH 81 to I-694</th>
<th>8 – CSAH 81 to 10/694</th>
<th>9 – Shingle Creek to Ryan Lake</th>
<th>10 – Ryan Lake to Lower Twin Lake**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrate/Cover</td>
<td>5</td>
<td>4</td>
<td>10</td>
<td>10</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>11/8</td>
</tr>
<tr>
<td>Pool Substrate</td>
<td>8</td>
<td>16</td>
<td>6</td>
<td>13</td>
<td>8</td>
<td>8</td>
<td>8/11</td>
<td>-</td>
<td>11/1</td>
<td></td>
</tr>
<tr>
<td>Pool Variability</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>11/1</td>
</tr>
<tr>
<td>Sediment Deposition</td>
<td>15</td>
<td>10</td>
<td>17</td>
<td>11</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>8/14</td>
<td>16</td>
<td>16/5</td>
</tr>
<tr>
<td>Channel Flow Status</td>
<td>18</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>9</td>
<td>8</td>
<td>*8/3</td>
<td>8</td>
<td>0</td>
<td>16/0</td>
</tr>
<tr>
<td>Channel Alteration</td>
<td>8</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>8</td>
<td>8</td>
<td>13</td>
<td>5</td>
<td>10/1</td>
</tr>
<tr>
<td>Channel Sinuosity</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>7/3</td>
</tr>
<tr>
<td>Bank Stability - Left</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4/7</td>
<td>7</td>
<td>6/3</td>
</tr>
<tr>
<td>Bank Stability - Right</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4/7</td>
<td>7</td>
<td>8/3</td>
</tr>
<tr>
<td>Vegetative Protection –Left</td>
<td>9</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2/7</td>
<td>7</td>
<td>6/3</td>
</tr>
<tr>
<td>Vegetative Protection - Right</td>
<td>9</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2/7</td>
<td>7</td>
<td>8/3</td>
</tr>
<tr>
<td>Riparian Zone Width - Left</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>1/4</td>
<td>10</td>
<td>3</td>
<td>5/3</td>
</tr>
<tr>
<td>Riparian Zone Width - Right</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>1/4</td>
<td>9/10</td>
<td>3</td>
<td>7/3</td>
</tr>
<tr>
<td>Total (200 possible)</td>
<td>113</td>
<td>107</td>
<td>115</td>
<td>127</td>
<td>76</td>
<td>83</td>
<td>55/56</td>
<td>81/107</td>
<td>61</td>
<td>122/37</td>
</tr>
<tr>
<td>M-IBI Score***</td>
<td>44.7</td>
<td>13.5</td>
<td>22.8</td>
<td>20.3</td>
<td>31.7</td>
<td>13.5</td>
<td>17.4</td>
<td>26.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reach 9 and France Ave to Ryan Lake were dry</td>
<td></td>
</tr>
</tbody>
</table>

*Where two scores are shown, subreaches within a reach were significantly different.
** The first score is for the segment between Lower Twin Lake and France Avenue, the second for the segment between France Avenue and Ryan Lake.
***MPCA M-IBI threshold for impairment is a score below 54.

Each category is scored on a scale of 0-20, with:

<table>
<thead>
<tr>
<th>Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-16</td>
<td>Optimal</td>
</tr>
<tr>
<td>15-11</td>
<td>Suboptimal</td>
</tr>
<tr>
<td>10-6</td>
<td>Marginal</td>
</tr>
<tr>
<td>5-0</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Or where each bank is scored separately:

<table>
<thead>
<tr>
<th>Score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-9</td>
<td>Optimal</td>
</tr>
<tr>
<td>8-6</td>
<td>Suboptimal</td>
</tr>
<tr>
<td>5-3</td>
<td>Marginal</td>
</tr>
<tr>
<td>2-0</td>
<td>Poor</td>
</tr>
</tbody>
</table>
4.4 Minneapolis Findings

In 2002 the Minneapolis Park and Recreation Board prepared a Shingle Creek Natural Area Plan summarizing the findings of a study of the Shingle Creek corridor within the city of Minneapolis. This study focused mainly on developing a riparian vegetation restoration and management plan, but also included a streambank erosion assessment and macroinvertebrate analysis.

The stream assessment portion of the Plan identified a few areas of streambank with a medium to high vulnerability to erosion, mainly near the mouth of the creek. The Plan also identified the need to restore meanders, improve in-stream habitat, stabilize streambanks, and to remove the concrete-lined portion of the creek in Webber Park.

A conceptual vegetation management and restoration plan was developed to guide planning in and maintenance of the corridor. The Plan identified the most devastating threat to the Shingle Creek project area to be the intrusion of invasive species. The riparian area should be managed to remove invasive species, restore native communities, and reduce mowed turfgrass.
5.0 Problems & Issues

5.1 Introduction

The issues identified in the stream assessment have been grouped into four general categories, but there is significant overlap. For example, management of streambank vegetation in the riparian area provides channel stability and habitat, and can also be affected by watershed processes.

5.2 Channel and Streambank Stability

The stream channel is generally stable, except in reaches where the creek flows through cattail wetlands or is impacted by a grade control structure. A stable stream channel is one that is able to transport the sediment and flows produced by its watershed in such a manner that it maintains its width/depth dimensions, profile, and pattern with aggrading or degrading (Rosgen 1996). Stream instability and evolution generally proceeds from disturbance: changes within the watershed affecting the hydrologic regime or sediment deposition; impacts to riparian vegetation; or disturbance of the channel itself. As the watershed is nearly entirely developed, major disturbances to Shingle Creek are in the past, and the creek has generally found an equilibrium in dimension, profile, and pattern. Ryan Creek is mainly constructed channel, designed to convey seasonal or peak flows, and is often dry between those events.

There are localized areas of instability. These generally include some streambank erosion, sloughing, and undercutting; channel realignment; and localized aggradation.

Three factors account for most of the minor bank erosion and sloughing observed on the creek:

- The “bouncy” stream hydrology results in a saturated streambank that increases potential for sloughing.
- In several reaches heavy canopy shading from riparian wooded areas prevents growth of streambank understory and groundcover vegetation and increases erosion potential.
- In some locations mowed turfgrass to creek increases erosion and undercutting

Channel realignment is occurring in some reaches where the creek flows through cattail wetlands. This is most notable in Reach 3, between Freeway Boulevard and 65th Avenue; in Reach 4, through the Palmer Lake Basin; and to a lesser extent Reach 8, through the Northland wetland. The realignment is occurring because the banks are low in these areas, and there has been no recent dredging or other maintenance of the ditch channels. The realignment appears mainly to be a restoration of sinuosity rather than a lateral migration. It is likely that this realignment will continue through these wetlands unless dredging or other maintenance causes the stream to become more entrenched or otherwise limits access to the floodplain.
In the Palmer Lake Basin, the realignment appears to be simply a reestablishment of the historic channel that formed as the old lake was drained, bypassed when the County Ditch #13 project created a straight ditch through the basin. After a series of drought years and resulting low water levels drained the Basin (at one point in the 1930s it was drained enough so that portions of the Basin could be cultivated), a return to years of normal precipitation resulted in flow being carried by both the ditch and the historic channel. At some point the ditch likely was obstructed or silted in, and flow returned to the historic channel.

Aggradation is apparent in some locations, most notably in Reach 5 downstream of a drop structure. Reach 5 is also heavily shaded, and there is minimal understory or ground cover to stabilize the bare streambanks. There is noticeable bank sloughing in the reach. The aggradation is resulting in some low-flow channel braiding and creation of point bars.

5.3 Riparian Vegetation Management

Riparian vegetation is quite variable. For much of its length the creek flows through parkland or open space. There are some notable exceptions, including reaches that flow through residential, commercial, and industrial areas. Buffer widths are quite variable as well. In some reaches there are wide, vegetated buffers adjacent to the creek; in other reaches the buffer is minimal or nonexistent.

Riparian vegetation management is inconsistent. Except in residential areas, it appears the management practice is “hands off,” with some removal of snags or downfalls. Invasive species are prevalent, including purple loosestrife, curlyleaf pondweed, honeysuckle, buckthorn, and reed canary grass. Several reaches are heavily wooded, providing up to 100 percent canopy shading, far in excess of the 20-70 percent recommended for warm water streams. In these areas there is little understory and little to no streambank herbaceous vegetation. Numerous leaning and undercut trees are present.

In several residential locations turf grass is maintained to the streambank, resulting in undercutting, sloughing, and bank failure. Where the canopy is open the streambank is dominated either by reed canary grass or by various invasive and opportunistic grasses that take root in unmowed buffers.

5.4 Biological Integrity

The biological integrity of Shingle Creek is compromised by the lack of effective habitat for macroinvertebrates and fish. Biological integrity is also affected by the creek’s flow regime: the flashiness of response to precipitation events and the low summertime flows. The stream morphology does not include habitat structures. There is little sinuosity and few riffles and pools, and the pools present tend to be shallow. The stream cross section is generally trapezoidal, with a mostly flat bottom. The substrate, primarily deposits eroded from the
streambanks, is coarse to fine sand and silt, which embed the gravels and other larger substrate materials that aquatic insects and fish prefer and that build up as deposits in the few pools.

Water control structures located throughout the creek act as barriers to fish migration, and alter stream geomorphology, substrate, and flow. Siltation and sediment embedding may occur behind the structures. The flow may change such that low flow impoundment conditions form behind structures and the fish species composition changes from lotic (running water) to lentic (standing water) species.

There is little woody debris, overhanging vegetation, and few leaf packs that provide habitat and food. The dense wooded reaches are too shady, limiting the growth of aquatic vegetation.

Beyond habitat, other limitations to the invertebrate populations include low flow conditions and poor water quality. Since Shingle Creek functions primarily as a conveyance for storm water, it has intermittent flow and at times it experiences extremely high flows. These high flows disrupt soft bottom sediments, displacing invertebrates living in the substrate and carrying them downstream. 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.

All of these factors are demonstrated in the M-IBI scores for the reaches in Shingle Creek. All of the reaches are impaired and demonstrated a lack of macroinvertebrate diversity dominated by pollution tolerant species. Probably the most important factor controlling macroinvertebrate health is the lack of substrate available and embededness. As the stream channel has over widened and velocities are reduced, the high quality substrates have been buried. Additionally, much of the silt can carry a high Sediment Oxygen Demand (SOD), depleting available oxygen and stressing biological communities. These factors alone result in a habitat where only the most resilient macroinvertebrates can survive.

5.5 Watershed Processes

Shingle Creek drains a highly developed watershed. At least 50 stormsewer outfalls and a dozen open channels discharge stormwater into the creek. The high degree of imperviousness in the watershed results in a “flashy” hydrology that stresses fish and wildlife. Bankfull conditions are likely met multiple times per year, compared to the once every 1.5 years of a stream in a less impervious watershed.

While the water quality in Shingle Creek is generally within the range found in urban Twin Cities streams, it is worse than that found in North Central Hardwood Forest ecosystem reference streams. It has been designated impaired for excessive chloride concentrations and low dissolved oxygen concentrations. Continued monitoring indicates that an Impaired Water designation is likely for excessive fecal coliform levels and for impaired biota based on fish and macroinvertebrate Indices of Biotic Integrity.
The chloride and fecal coliform impairments are a direct result of watershed processes – the source of these pollutants is found within the watershed and transported to Shingle Creek through runoff. The low dissolved oxygen and impaired biota impairments are a result of in-stream processes that are also related to and exacerbated by development in the watershed.

The historical Shingle Creek was a small, shallow, meandering prairie stream above Palmer Lake, and a wider, slower-moving stream that flowed through extensive floodplain and wetland below Palmer Lake. Development has impacted that floodplain and wetland significantly, by straightening and dredging the creek to make more land available for building.
6.0 Recommendations

The recommended approach to addressing the problems and issues identified in the study is to consider a long-term plan for ecological restoration of Shingle Creek and its corridor. The goals of this ecological restoration would be to:

- Eliminate or reduce impairments and achieve compliance with the Clean Water Act;
- Restore natural channel design;
- Recover biological diversity and function;
- Naturalize the stream corridor; and
- Correct existing and prevent new streambank erosion.

Implementation of this plan could be accomplished through capital improvement projects, redevelopment opportunities, routine maintenance, and management standards. The intent of this plan is not to prescribe specific improvements, but to develop a set of standards and principles to be used by riparian cities to manage the corridor so as to further its ecological restoration. Appendix C includes figures that suggest management strategies by reach.

These ecological restoration standards should be based on the following principles. To be successful, restoration must:

- Consider the chemical, physical, and biological conditions of a stream in an integrated fashion
- Consider multiple scales, including in-stream, the riparian zone, and the watershed
- Address the ongoing causes of degradation
- Be monitored on an ongoing basis to assess the effectiveness of improvements and to make corrections

The Shingle Creek Watershed Commission has established management standards for development and redevelopment requiring treatment of stormwater runoff and control of the rate of stormwater runoff. These standards have been in place for nearly 20 years, and much of the upper watershed has developed under those conditions. As redevelopment and other retrofitting opportunities occur in the lower watershed, these standards will help to moderate some of the watershed impacts that now occur. However, the fundamental impacts of urbanization on hydrology can only be mitigated, not eliminated. The most important function of Shingle Creek will always be the conveyance of stormwater from its 44 square mile urban watershed.

The Commission should continue its water quality and biological monitoring of Shingle Creek to assess ongoing conditions and to gauge the impact of improvements and management changes over time.
7.0 **Management Standards**

7.1 **Ecological Restoration Project Design Standards**

While individual projects present design challenges that are unique to that reach, the following standards are principles that should be used to guide the design of projects, whether they are large-scale restoration projects or channel maintenance and repair projects.

7.1.1 **General Principles**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No change to 100 year elevation</strong></td>
<td>Improvement projects or management strategies shall not increase the 100-year elevation of Shingle Creek nor its tributaries or floodplain storage areas.</td>
</tr>
<tr>
<td><strong>No wetland fill or floodplain fill without compensating storage in reach</strong></td>
<td>Improvement projects or management strategies that impact wetlands shall be subject to the requirements of the Wetland Conservation Act. Any fill that impacts flood storage in wetlands or floodplains shall be mitigated with compensating storage within the same subreach or reach.</td>
</tr>
<tr>
<td><strong>Use bioengineering and soft techniques where possible, using hard armoring only where erosive conditions require more stability</strong></td>
<td>The ecological restoration concept is to return the creek where possible to its native form and function. Bioengineering techniques such as the use of root wads, live stakes, brush mattresses, and long-rooted native vegetation are the preferred methods of stabilizing streambanks. However, it is recognized that under streamflow conditions these techniques may not be sufficient to provide adequate stability, for example, in the vicinity of storm sewer outfalls. Hard armoring is acceptable under those conditions, with attention paid to softening the appearance of the armoring where it does not compromise stability.</td>
</tr>
<tr>
<td><strong>Restore native vegetation to the riparian zone</strong></td>
<td>Presettlement, the creek corridor landscape was primarily prairie and oak savanna. The current corridor landscape is a mix of developed area, turfed park and open space, and cattail wetland. The long-term goal is to restore the creek riparian areas to native vegetation characteristic of these landscape types.</td>
</tr>
</tbody>
</table>
7.1.2 Channel Design Principles

**Restore historic function and increase aeration by re-creating natural meandering and pool-riffle sequences**

Natural channels meander within their floodplain. The thalweg, or deepest part of the channel, meanders as well, creating alternating pools and riffles that create habitat and aerate the stream, increasing the dissolved oxygen concentrations.

**Remove drop structures and install rock vanes every one-foot drop in elevation**

Rock vanes provide a way to “step down” elevation changes while at the same time creating a riffle-pool sequence. This allows for the removal of fish barriers, and creates new habitat structures. The rock vane also functions as a riffle, aerating the stream. The V shape pointing upstream directs flow into the pool in the middle of the channel, reducing streambank erosion.

(Left) Seven rock vanes were placed in Pike Creek between Hemlock Lane and Pike Lake in Maple Grove.
Create low flow channels to carry smaller events and base flow, and maintain a vegetated floodplain within the channel to carry flows from larger events.

Shingle Creek has naturally created a narrow channel to carry low flows and base flow here downstream of Candlewood Drive in Brooklyn Park.

As shown below, the existing flat-bottomed trapezoidal shaped channel should be replaced by a channel shape designed to carry a variety of flows.

The narrow, low flow channel should meander within the existing channel to lengthen the stream channel and reduce velocity.
7.1.3 Streambank Design Principles

Use deep-rooted native vegetation to create buffers at least five feet wide next to creek.

Turf grass roots can be only a few inches deep, but native grasses can have roots 10 to 15 feet deep. Turf grass provides no streambank stability. Native plants are resilient, anchor the streambank, take up nutrients more efficiently than turf grass, and help slow floodwater velocity.

Hard armor banks opposite storm sewer outfalls

New or reconstructed outfalls should be aligned at an angle pointing downstream to avoid erosive effects on the streambank opposite the outfall. Where it is not possible to align the outfall this way, the opposite bank should be armored with riprap.
Leaning and undercut trees should be removed either through routine maintenance or as a part of any streambank project. Because their root system is often exposed, they provide little bank stability and are at greater risk of falling. Falling can result in streambank failure and increased erosion. The debris can also block flow and cause debris and sediment to accumulate. Straight line winds in 1997 resulted in the downing of dozens of trees along the creek just upstream of Brooklyn Boulevard in Brooklyn Center.

This streambank in Brooklyn Park is armored with riprap covered with concrete. Other reaches include placed riprap, wooded shoring walls, and concrete block walls.

Use natural materials such as root wads, live stakes, brush mattresses, and deep-rooted native vegetation to provide streambank stability, using hard armoring only absolutely necessary.

Riprap should be at least 6” in diameter and be of igneous or metamorphic rock. Smaller sizes are prone to being dislodged under high shear stress. Limestone and other soft rock is worn by streamflow and chemical processes and will lose its structural integrity over time.

This technique provides more streambank stability, promotes infiltration, and softens the appearance of the riprap. Here on Pike Creek on Maple Grove, live willow stakes were planted between the riprap.
## 7.1.4 Habitat Design Principles

<table>
<thead>
<tr>
<th>Remove or minimize fish barriers</th>
<th>Remove drop structures as described in Channel Design Principles above. Culverts at stream crossings can also be a barrier to fish passage. Instead of cylindrical pipe, crossings should use an open-bottomed arch to simulate natural conditions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create low and high flow refugia</td>
<td>Low flow refuges are typically deep pools associated with low-flow channels. Larger rocks and cobble found in riffles and rocky substrate provide some refuge from high flows. Offline refuges include structures such as fish bunkers as well as backwater and side pools. Woody debris and overhanging vegetation provide refuge for fish and invertebrates alike. Root wads used for streambank stabilization and erosion control are effective refuges for fish and invertebrates.</td>
</tr>
<tr>
<td>Restore native vegetation in riparian zone to improve habitat</td>
<td>Remove the invasive and cultivated vegetation in the riparian zone and replace with native, long-rooted herbaceous vegetation, a shrub layer, and tree species appropriate for and native to the vegetative community. Overhanging vegetation provides habitat for fish and invertebrates, and leaves and small woody detritus that are an important source of organic carbon.</td>
</tr>
</tbody>
</table>
**Increase Substrate Diversity**

Increasing substrate diversity leads to areas readily colonized by macroinvertebrate communities. An important design feature is to ensure that good stream substrates such as cobble do not become imbedded through reduced channel velocities and resultant sedimentation. The diversity of habitat should include cobble, boulders, and sands as well as woody debris such as submerged logs, fine woody debris, and leaf packs.
7.2 Maintenance Standards

Maintenance within the stream corridor is inconsistent. Snags are routinely removed or not removed. Turf maintenance and mowing occurs up to the streambank or a wide buffer is left unmowed. Invasive vegetation is removed or not.

Each of the cities has policies regarding maintenance of parks and open space, and utilizes the stream corridor for different purposes. The following standards are principles that should be used to guide the management of the corridor to help achieve the goals of ecological restoration.

7.2.1 General Principles

| **Maintain a twenty foot minimum width buffer** | The Commission currently requires a vegetated buffer averaging thirty feet wide, with a minimum width of twenty feet, adjacent to watercourses or wetlands for property that undergoes development or redevelopment. In many locations along the creek, on both private and publicly owned land, the vegetated buffer is often just a narrow area left unmowed. |
| **Remove large woody debris and snags only when impacting channel capacity and flood flows and increasing erosion potential** | Snags are standing dead trees, while large woody debris includes fallen trees both in the water and out as well as limbs and other tree parts. As long as a snag is not leaning or undercut (see below) or otherwise in danger of falling, it provides valuable habitat for terrestrial life as well as an organic carbon source for terrestrial and aquatic life as it decays and breaks up. Large woody debris provides aquatic habitat as well as an organic carbon source for aquatic life. |
| **Remove leaning and undercut trees** | Undercut and leaning trees are hazardous because the root structure is usually comprised. They are more likely to fall from high winds or high velocity flows, and can cause streambank failure and erosion. |
| **Remove invasive vegetation promptly** | Buffer areas should be inspected regularly for invasive vegetation, and any found should be removed promptly. Many invasive species are hardy and adventitious, and can quickly crowd out more beneficial species. A healthy riparian zone requires a variety of plant species. |

Purple loosestrife. (North Dakota Extension Service)
Where privately-owned property abuts the creek, or where there is only a narrow city-owned or controlled parcel between private property and the creek, each city should consider enacting and enforcing standards regarding buffer maintenance. In several locations, adjacent private property owners have mowed city-owned property up to the streambank, eliminating the vegetated buffer. The Commission currently requires a minimum twenty-foot wide vegetated buffer adjacent to watercourses or wetlands for property that undergoes development or redevelopment.
8.0 References


<<http://www.ser.org/content/ecological_restoration_primer.asp>>