Huron Creek Watershed Management Plan

Completed July 31, 2009

Michigan Technological University

Center for Water and Society

Center for Water and Society
Michigan Technological University

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1. Executive Summary

A watershed is an area of land that drains surface water runoff to a particular water body such as a stream, river or lake. The boundary, or divide, of the watershed is created by the highest points of land surrounding the water body. As water travels from the watershed divide to the water body, it interacts with various natural and human-made features within the watershed. Natural features might include soils, vegetation, and streams. Examples of human-made features include building roofs, pavement and storm sewers. As the water passes through or over these various features, the quantity and quality of the water is influenced.

When trying to understand or manage the quality of a water body, it is important to understand and manage the natural and human-made features across the entire watershed. A watershed management plan (WMP) is a water-quality focused plan that addresses uses of and improvements to lands and waters within a watershed. WMP's can address an array of issues such as land use planning, zoning, development practices, vegetation management, stormwater management and cultural or historical preservation. These plans are based on goals set by a community of people who have an interest in the watershed's natural and economic resources. The plans are often initiated due to known environmental concerns or problems, but in some cases they are purely for management and prevention.

The Huron Creek watershed is located in north-central Houghton County, Michigan (see Figure 1.1). This watershed, which is 3.4 square miles in area, includes portions of the City of Houghton and Portage Township. As of 2005, land use in the watershed consisted of 33% forest, 30% commercial and residential developments, 17% agriculture and rangeland, and 20% wetlands. The watershed has been affected by human activity for decades. Mining activities, aging septic systems and closed landfills that were constructed before modern environmental requirements have contributed to water quality concerns. Commercial development in the watershed since the mid-1970's is some of the most concentrated and rapidly growing in the western Upper Peninsula, resulting in significant areas of impervious surface in the watershed. The creek has been used for recreation activities and runs through a heavily-used public park (Kestner Waterfront Park) before emptying into the Portage Canal.

Huron Creek has been monitored by the Michigan Department of Environmental Quality, among other organizations. Concentrations of copper have been found to exceed of the state aquatic life protection values (MDEQ Water Bureau, December 2007). Huron Creek was identified as being in non-attainment of the water quality standards for aquatic life and wildlife, and was listed in the Michigan 2008 Sections

303(d), 305(b), and 314 Integrated Report (http://www.michigan.gov/documents/deq/wb-swas-ir-final-2008report_230026_7.pdf) as “Not Supporting Other Indigenous Aquatic Life and Wildlife” due to copper levels.

The history of human activities and associated water quality concerns has catalyzed the development of a watershed management plan for the Huron Creek watershed. The lead organization responsible for preparing the Huron Creek watershed management plan is the Michigan Technological University Center for Water & Society (CWS). The watershed management plan has been developed through the following steps:

- formulation of a watershed advisory committee and holding regular committee meetings,
- determining designated and desired uses of the watershed,
- developing project goals,
- completing various environmental studies and field surveys,
- identifying priority areas in the watershed,
- developing recommendations for priority areas based on goals of stakeholders,
- creating an information and education strategy, and
- completing a watershed management plan.

The watershed management plan development has been funded through a US Environmental Protection Agency Section 319 Clean Water Act grant, implemented through the Michigan Department of Environmental Quality (MDEQ) Clean Michigan Initiative (CMI) program.

1.1. Advisory Committee and Vision Statement Formation

The Huron Creek Watershed Advisory Council (WAC) was formed in spring 2006. The WAC was formed by identifying critical stakeholders such as businesses, government agencies, residents, and relevant community organizations. Approximately 20 individuals participated in the WAC. The WAC met from summer 2006 through spring 2007.

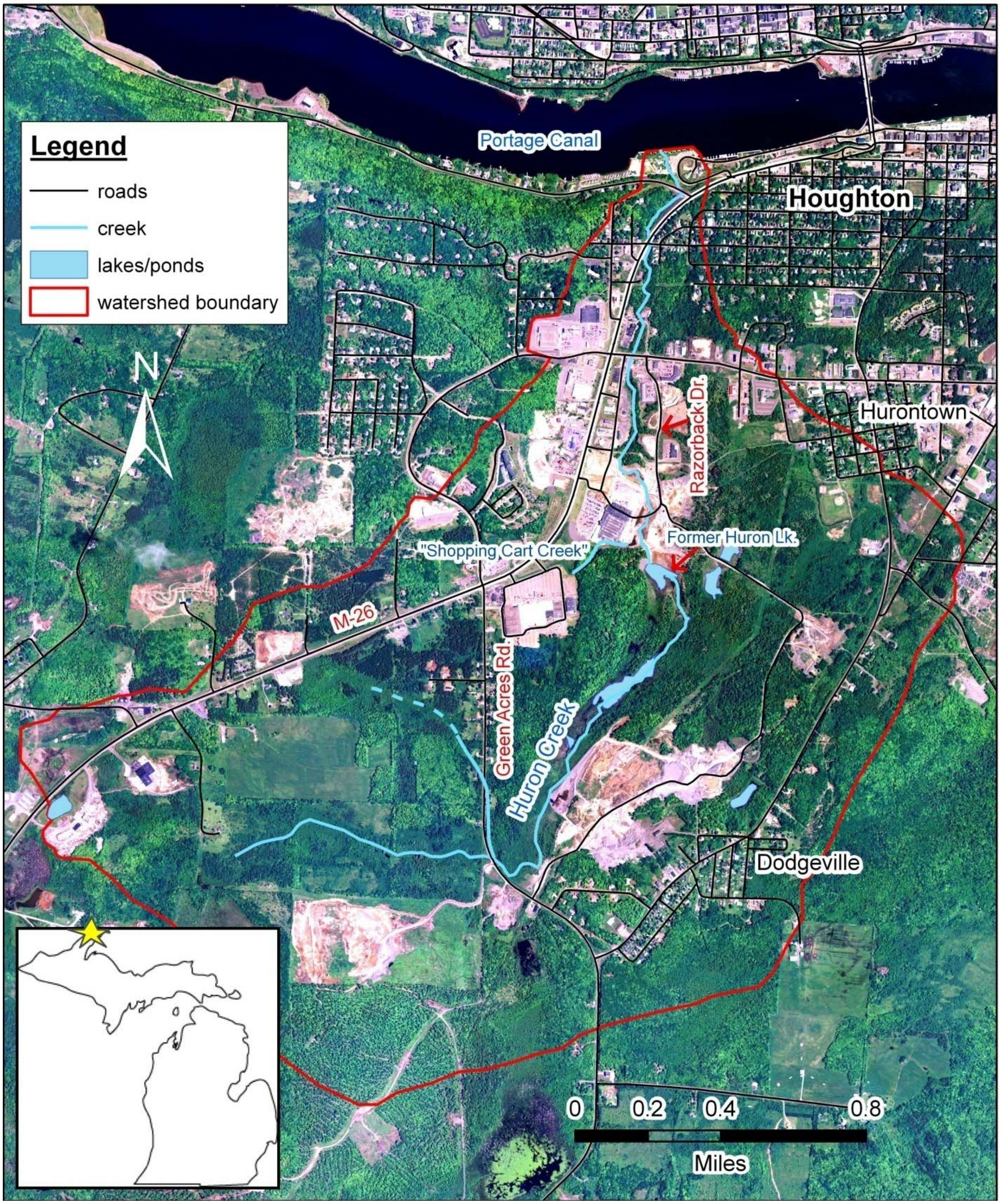


Figure 1.1. Huron Creek watershed. Created by: Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data source: 2005 NAIP 1-meter digital orthophoto.

The WAC's accomplishments included analyzing existing information on the creek and identifying the most critical problems and areas facing the watershed. The WAC created a vision statement to provide a framework upon which to build the watershed management plan:

"We see Huron Creek and its watershed as valuable to the residents of Houghton County in maintaining a sense of place compatible with the area's character. In particular, we desire a watershed and stream that:

1. *Is visually attractive and includes a stream-side vegetation buffer that is visible on the landscape;*
2. *Provides habitat for a healthy ecosystem within an urban setting;*
3. *Provides opportunities for human interactions with the stream ecosystem, with the Houghton Waterfront park and the former Huron Lake being prime sites for interaction;*
4. *Has water quality that is consistent with the previous three goals;*
5. *Provides opportunities for community education (including schools, business owners, and the public in general) on the importance of healthy watersheds and in the historical uses of this particular watershed, with interpretive signs at sites of interaction being one possible form of education."*

1.2. Identification of Designated Uses and Pollutants

A "designated use" is one of eight recognized uses of water established by the state of Michigan and federal water quality programs. Examples of designated uses are coldwater fishery, public water supply, aquatic life and wildlife habitat and partial body contact. In case of Huron Creek, three designated uses were identified, as shown in Table 1.1.

If a designated use is not being met according to the State of Michigan's water quality standards, that use is impaired. If it is thought that a designated use may be threatened by certain watershed conditions, it is referred to as threatened. A series of chemical, physical and biological surveys were conducted by the MTU Center for Water and Society from fall 2006 through spring 2008. The surveys included:

- water quality monitoring
- land use study
- hydrologic modeling
- storm drain, ditch and road crossing surveys
- geomorphology surveys[1]
- vegetation surveys
- wetland analysis

These surveys indicated that the designated uses were either impaired or threatened, as indicated in Table 1.1. The pollutants or problems that have lead to the threatened or impaired status are also indicated in Table 1.1.

Table 1.1 Designated Uses

Designated Use	Status of Designated Use	Pollutants or Problems Associated with Designated Use
Aquatic Life and Wildlife Habitat	Impaired	Metals (Copper, Iron), Nutrients (Nitrogen, Phosphorus, Ammonia), Sediment, "Flashy Flow," and Invasive Plant Species
Partial Body Contact Recreation	Threatened	Bacteria
Total Body Contact Recreation	Threatened	Bacteria

1.3. Critical Areas and Recommended Actions

The chemical, physical and biological surveys also were used to identify "Critical Areas," or locations to be the focus of management recommendations. The Critical Areas and the concerns corresponding to each area are listed in Table 1.2. Recommended actions for improving and protecting the Huron Creek watershed have been formulated to address the problems identified in the Critical Areas, in concert with the vision statement formulated by the WAC.

Table 1.3 lists the recommended actions for physical improvements, monitoring plans, and ordinances, including tasks required to complete the actions, the time frame proposed to complete the tasks, and estimates of the associated costs. The recommended actions for physical improvements are listed in a proposed order of priority based on several factors including the (a) the priority of the related pollutant or characteristic (see Section 6.1), (b) potential availability of funding for the action, (c) anticipated

[1] Geomorphology survey refers to a field analysis of the factors affecting the erosion, transport and deposition of sediment in a stream. For more detail, see Appendix J.

interest in the action by the local community. More detailed information on the physical improvements, monitoring plan, and ordinance can be found in Sections 7.3, 0, and 7.5, along with suggested partners for implementing the actions and potential sources for funding the actions.

Table 1.2 Critical Areas and Concerns

Critical Area	Related Concerns
Ray Kestner Waterfront Park	Streambank erosion and general aesthetic concerns
Former Houghton Landfill Area	Landfill leachate, erosion, stamp sands
"Shopping Cart Creek" (Man-made Tributary to Huron Creek)	Erosion
Wetland Mitigation and Creek Re-route Areas	Habitat, invasive species, stamp sands
Dakota Heights Neighborhood of Portage Township	Septic systems
Assorted Small-Scale Erosion Locations	Erosion
Watershed-wide Locations	Wetland health, general water quality, erosion, invasive vegetative species
City of Houghton, Portage Township	"Flashy" Flows, stormwater treatment, preservation of buffers

Best Management Practices (BMPs) are identified in Section 7.6 to be implemented as part of, or in combination with several of the recommended actions. BMPs are structural, vegetative or managerial practices used to treat, prevent or reduce water pollution. Suggestions for potential project partners have been identified for each recommended action, along with an estimated implementation schedule, suggested milestones for measuring progress, estimated costs and possible funding sources.

1.4. Information and Education Strategy

An Information and Education (I/E) Strategy was developed to ensure continued community involvement and stakeholder participation. Several I/E activities have occurred during the development of the watershed management plan, including:

- construction of a watershed plan development website
- public education day at the Kestner Waterfront Park (“Huron Creek Day”)
- litter clean-up days

Table 1.3 Recommended Actions

Recommended Action	Task	Estimated Cost
Physical Improvements		
Reduce Metals and Ammonia Loads to Huron Creek	1. Mitigate stamp sand area next to Huron Creek in vicinity of Ridge Road Landfill	$800 to $1,200
	2. Mitigate stamp sand in wetlands mitigation area	$1,000 to $3,800
	3. Evaluate performance of landfill leachate collection system	$500 to 1,000/yr
Further Study of Stormwater Management Issues	Conduct survey of stormwater systems and stormwater modeling; assess best management alternatives for reducing the flashy flows	$50,000
Improve Huron Creek in Kestner Waterfront Park	Stabilize banks and establish vegetative buffer	$70,000 to $85,000
Septic System and Sanitary Sewer Improvements	Connect Dakota Heights to sanitary sewer	Approximately $1 million, with USDA grant covering $724,000
Improve "Shopping Cart Creek" Area	1. Install stormwater detention pond at the source of Shopping Cart Creek.	$200,000
	2. Stabilize erosion areas	$10,000 to $36,000
	3. Establish baseline data for headcut and continue to monitor.	$0 to $1,900/yr
Improve Wetland Mitigation and Creek Re-route Areas	1. Remove invasive species and establish native plant species	$22,500 to $45,000
	2. Physical Improvements	$2,000 to $3,000
Mitigate Erosion Areas	1. Improve Ridge Road Landfill Area	$13,000 to $18,000
	2. Mitigate critical erosion locations	$100 to$3,000 for each location
Wetland Restoration	Plan and implement wetland restoration	$3,500- $140,000
Monitoring Plans		
Water Quality Monitoring	Evaluate changes and/or trends in water quality	$1,200 to $1,400/yr
Erosion and Geomorphologic Monitoring	Evaluate changes and/or trends erosion & sediment	$0 to $100/yr
Invasive Vegetative Species Monitoring	Create watershed-wide invasive species management plan and monitor invasive species	$0 to $100/yr
Ordinance		
Develop and Implement Stormwater Management Ordinance	Create and implement stormwater ordinance	Dependent on time required by government officials to pass and enforce

- storm drain stenciling event
- placement of an educational sign in the Kestner Waterfront Park
- publications in local media about the watershed and the management plan
- local school activities and community workshops at various locations along the creek

Proposed future I/E activities are described in Table 1.4, including the target audience for the activity and the estimated costs. More details on the proposed I/E activities can be found in Section 8.

Table 1.4 Proposed Information and Education Activities

Activity	**Target Audiences**	**Estimated Cost/year**
Develop and distribute information on important functions of wetlands; construct Wetland Education Station (see Section 8.2.1)	General public, K-12, tourists	Cost of information development, printing, and mailing; Education Station (deck), path, interpretive sign = $4,000 to $5,000
Develop and distribute information about the location of scenic vistas, historical sites; install educational and historical signage (see Section 8.2.2)	General public, K-12, tourists	Cost of information development, printing, and mailing; $200 to $350 per sign
Conduct training and implement volunteer water quality (see Section 8.2.3) and invasive species monitoring programs	Riparian landowners, general public, K-12, local governments	Cost of packet development and reproduction, workshops
Inform public of Implementation of recommended actions (see section 8.2.4)	General public	Minimal
Hold watershed tours to promote protection and improvement of water quality	General public, K-12, local governments	Cost of transportation
Educate about proper construction techniques and stabilization practices to minimize erosion	Developers, landowners, local governments	Cost of information development, printing, and mailing, workshops
Develop and distribute information on limiting nutrient loadings to surface water through limited use of fertilizers or low phosphorus fertilizers	Landowners, businesses, general public, local governments	Cost of information development, printing, and mailing, workshops
Educate about low impact development techniques for managing stormwater runoff	Landowners, businesses, general public, local governments	Cost of information development, printing, and mailing, workshops

1.5. Evaluation Plan

An evaluation plan was formulated to measure progress towards the watershed management plan goals and objectives and to identify any needed changes in the plan. The evaluation plan focuses on assessing progress towards completion of recommended actions, achieving water quality goals, and involvement of the public in the implementation of the plan. The evaluation plan is described in detail in Section 9.

1.6. Conclusion

The development of the Huron Creek watershed management plan has involved public input through a watershed advisory committee, technical surveys of the state of the watershed, prioritization of critical areas of needing improvement, and development of recommended actions to achieve these improvements. Implementation of the plan’s recommended actions are expected to achieve the goal of improving water quality while creating a creek that the public can enjoy and sustaining a viable aquatic ecosystem.

2. Description of the Huron Creek Watershed

2.1. Location, Size and Water Bodies

The Huron Creek watershed is a 3.4 square mile watershed located in north central Houghton County, in the Upper Peninsula of Michigan (See Figure 1.1). Communities located within this watershed include the City of Houghton, Portage Township, and the villages of Dodgeville and Hurontown. Huron Creek, the main waterway associated with the watershed, is approximately 3.3 miles in length. The creek's source derives from a wetland area in the southwest corner of the watershed. From this area the creek flows to the east and north, and empties into the Portage Canal (part of Lake Superior) at the watershed's outlet. On the way to its receiving waters, the creek passes through wooded areas, wetlands, urban areas and parks, and also passes under several road crossings.

Huron Creek has two un-named tributaries. One of these tributaries originates in an area south of M-26 and west of Green Acres Road. It then runs south and joins with Huron Creek near where Huron Creek crosses Green Acres Road. The other tributary, referred to as "Shopping Cart Creek" throughout this report, is located in the north-central portion of the watershed, and stretches between the Copper Country Mall and the Houghton Super Wal-Mart. The source of water for this tributary derives from commercial property storm drains and ditches. Prior to its discharge to Huron Creek, it passes through detention ponds that are also located on commercial property. It is unclear whether Shopping Cart Creek was a natural drainage in the past.

Other water bodies within the watershed are the wetlands occupying the bed of the former Huron Lake and small ponds and wetland areas that at times flood to an open-water type wetland habitat. The former Huron Lake is located in the north-central part of the watershed just south and east of the Houghton Super Wal-Mart. Huron Lake is referred to as "former" is because it was an impoundment created by the Huron Mining Company in 1863 by damming Huron Creek with stamp sands (Greer, 2007). Historical mining activities are discussed further in Section 2.7. However, in 2003 the dam was removed due to safety concerns, and the size of the lake dropped by an estimated 50% (Kersten, 2008). The remains of the drained lake are part of a wetland mitigation site owned by the City of Houghton. Wetland mitigation sites are discussed further in Section 2.6.2.

2.2. Political, Demographic and Economic Information

Two municipalities occupy the majority of the Huron Creek watershed: the City of Houghton and Portage Township. Adams Township also occupies a small portion of land in the southwestern part of the watershed. The villages of Dodgeville and Hurontown, also located in the watershed, are part of Portage Township. Figure 2.1 indicates the locations of Portage Township, the City of Houghton, Dodgeville, Hurontown and Dakota Heights relative to the boundaries of the Huron Creek watershed. The 2006 population of the City of Houghton was 7,014. The median income for households was $41,994 and the per capita income was $21,587. About 9.2% of families and 12.4% of the population were below the poverty line. In 2006, 3,141 people reside in Portage Township. The median income for households in the township was $33,080 and the per capital income was $17,655. About 8.1% of families and 14.2% of the population were below the poverty line (Bureau, 2008).

Major economic activities in the county include education, health care, light manufacturing, retail, forest products, tourism and accommodations and food services. Many of the large retailers in Houghton County, such as Wal-Mart, Econo Foods, Shopko, and J.C. Penny, are located in the Huron Creek watershed. Also located in the watershed area are an indoor mall, several small strip malls, and a number of commercial buildings that house government and private offices, motels, restaurants and fast food providers, small healthcare facilities, automobile service facilities, and a number of other service businesses. Michigan Technological University (Houghton) and Finlandia University (Hancock) also employ a significant workforce in Houghton County; however, neither have facilities in the watershed (Greer, 2007).

2.2.1. Water and Sewer Infrastructure

The City of Houghton's municipal drinking water treatment and distribution system draws from a groundwater aquifer whose area of recharge is outside of the Huron Creek watershed. Most of Portage Township is not connected to a water distribution system, and many homes rely on private wells. The exceptions to this are the villages of Dodgeville and Hurontown, which receive water from a treatment and distribution system maintained by Portage Township. The source for this system is a groundwater aquifer outside of the watershed (Kommes, 2008).

Wastewater from the City of Houghton and portions of Portage Township is collected and delivered to a wastewater treatment plant operated by the Portage Lake Water and Sewage Authority (PLWSA). The PLWSA wastewater treatment plant is located outside of the Huron Creek watershed, east of the City of Houghton on the Portage Canal. The villages of Dodgeville and Hurontown have wastewater collection systems that are routed to the PLWSA wastewater treatment plant (Kommes, 2008). Portage Township pays the City of Houghton for its use of the PLWSA wastewater treatment plant.

The remainder of Portage Township contained within the Huron Creek watershed does not have a wastewater collection system, and most homes rely on private septic systems. The wastewater emanating from the Dakota Heights neighborhood (see Figure 2.1) is an issue of particular concern because many of the septic systems in the neighborhood are old; are cesspools (tanks or holes filled with rock), undersized, and have more than one house on a system; are either leaking, in need of repair, or of unknown condition; and are as close as 50 feet from the stream. (Bingham, MacInnes, & Tarbutton, Personal Interviews, 2008). The Dakota Heights neighborhood is located approximately 300 feet upstream of the Kestner Waterfront Park.

Although a few leaks and failures of Portage Township septic systems have been observed, there is currently no evidence that there is direct contamination of the stream from these systems. However, the age and construction of the septic systems poses a potential threat to the water quality of Huron Creek as they are considerably more likely to fail than modern systems (Bingham, MacInnes, & Tarbutton, Personal Interviews, 2008).

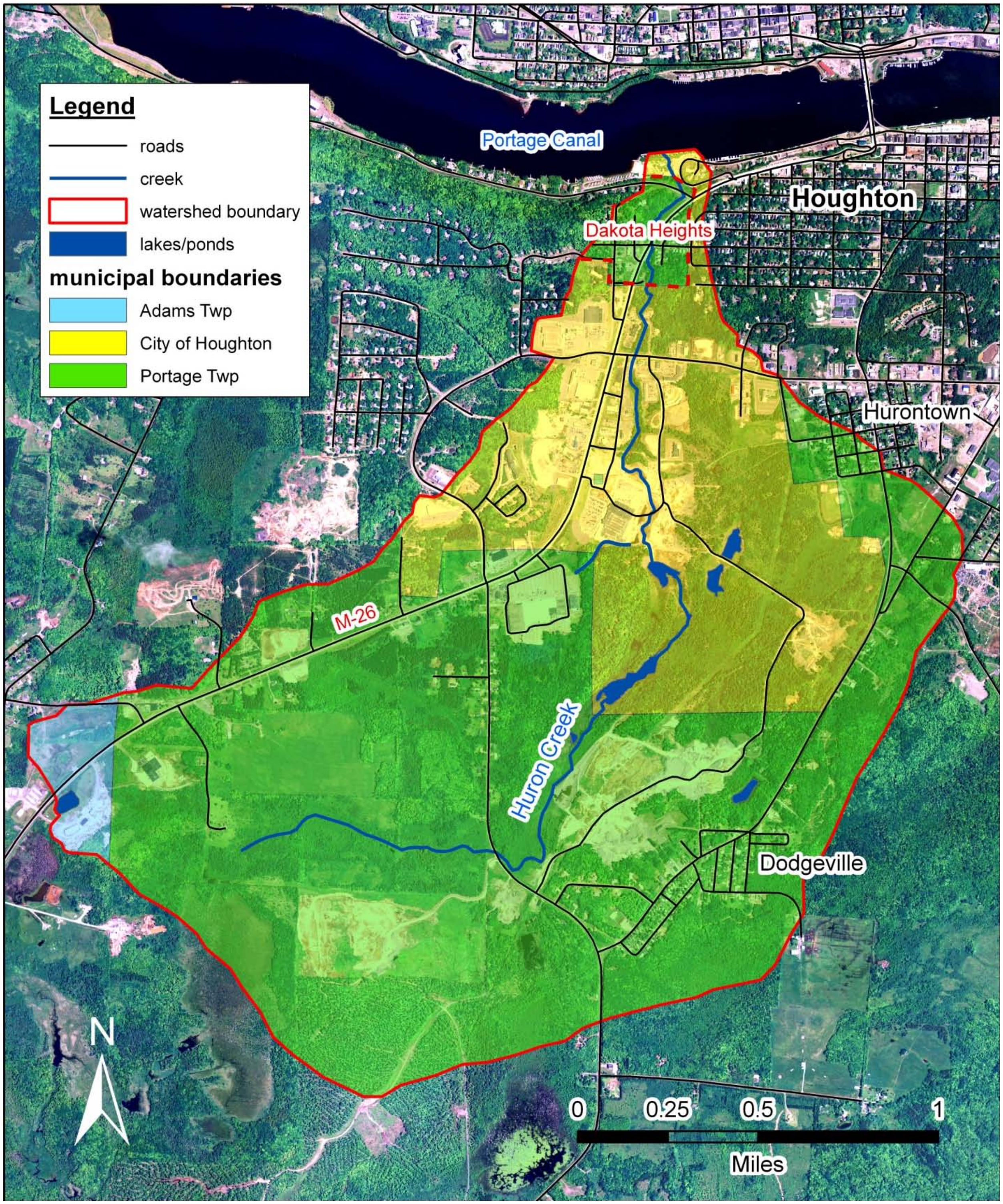


Figure 2.1. Muncipal boundaries in Huron Creek watershed. Created by: Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data source: MI Geographic Data Library; 2005 NAIP 1-meter digital orthophoto.

2.2.2. Applicable Regulations

Following are descriptions of federal, State of Michigan, Houghton County Health Department, City of Houghton and Portage Township regulations that are relevant to water quality and other environmental issues in the Huron Creek watershed.

Federal Regulations[2]

- Title 33 United States Code §1251 et seq. (1972) Clean Water Act - The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained (National Pollutant Discharge Elimination System, NPDES). Chapter 26 of Title 33 specifically addresses water pollution prevention and control. Related subchapters include:
  - Subchapter II – Describes federal grant programs for construction of wastewater treatment and collection systems.
  - Subchapter III – Lists water quality standards, effluent limitations, nonpoint source management rules and enforcement procedures.
  - Subchapter IV – Describes the NP DES program, regulations for dredging and waterway and wetland fill regulations.
  - Subchapter VI – Describes federal funding of state water pollution control programs. This includes state-implemented grant programs for watershed management plans.

- Title 7 United States Code §136; 16 U.S.C. §460 et seq. (1973) Endangered Species Act – The Endangered Species Act provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service (FWS) of the Department of the Interior maintains a worldwide list which, as of Feb. 20, 2008, included 1574 endangered species (599 are plants) and 351 threatened species (148 are plants).

State of Michigan Regulations[3]

- Part 17 Environmental Protection Act – This Act allows citizens, governments, groups and businesses to sue and be sued for actions that are detrimental to the air, water and other natural resources.
- Part 31 Water Resources Protection – This part establishes the water quality standards for surface waters. It requires permits and provides limits for potential pollution discharges.
- Part 87 Groundwater and Freshwater Protection – This act reduces the risks to the environment and public health by preventing groundwater contamination from various pollution sources such as pesticides and fertilizers.
- Part 91 Soil Erosion and Sedimentation Control – Landowners are required to reduce erosion and sedimentation in their usage of the land (such as during construction). Permits are required for any earth disturbance greater than 1.0 acre, or if it is within 500 feet of a stream, lake or non-isolated wetland.
- Part 301 Inland Navigable Lakes and Streams – A permit is required for dredging or filling of bottomlands, changing natural water flow, creating or altering artificial waterways, or similar activities within 500 feet of inland lakes and streams.

[2] From http://www.epa.gov/lawsregs/laws/index.html#cercla.
[3] State regulations from (Cotey, 2003).

- Part 303 Wetlands Protection – This part conserves and regulates the use of Michigan's wetlands. Permits are required for any filling, dredging or draining of wetlands.
- Part 365 Endangered Species Protection – Threatened or endangered wildlife, fish and plants are protected by this law. Penalties for violations are outlined.

More information on the regulations listed above can be found at the Michigan DEQ website: www.michigan.gov/deq.

Houghton County Health Department Regulations

Health code regulations fall under the Superior Environmental Health Code as defined by Section 2441 of Michigan Public Health Code, Act 368, Public Act of 1978. The code was effective March 14, 1998. It is enforced by the Western Upper Peninsula District Health Department. There are several regulations that pertain to water quality; the most relevant regulations involve the location of septic systems. The required distances between septic tanks, wells and water bodies are summarized in Table 2.1.

Table 2.1. Isolation Distances for Sewers, Septics and Privies (Superior Environmental Health Code Committee, 1998)

From / To	Sewer Lines	Septic Tanks	Absorption System	Earth Pit Privies	Vaulted Privies
Residential Well	10	50	50	100	50
Non-Community Well (Type IIB, Type III)	10	75	75	100	75
Community Well (Type IIA)	10	200	200	200	200
Property Lines	--	10	10	10	10
Foundation Wall	--	5	10	20	5
Building/Storm/ Subsoil Drains	--	5	25	25	5
Water Lines	--	10	10	10	10
Embankments	--	10	20	25	10
Lakes or Streams	--	75	75	75	75

City of Houghton Zoning Code (Houghton, 2006)

Section 98-202.D.4 (Site Plan Review Standards) – "Special attention shall be given to proper site drainage so that removal of storm waters will not adversely affect neighboring properties."

Section 98-552.A (Multiple Use Districts, Principle Uses Permitted) – "…Prior to any review, a subdivision plan shall be submitted by the developer to the city planning commission illustrating the intended use of the premises, building and housing arrangements, access routes, docking, parking and related features; and further shall indicate methods, devices and manners by which any waterway will be protected from shoreline erosion, siltation and chemical and biological pollution."

- Section 98-652 (Subdivision Open Space Plan) – This section provides guidelines for modifications to residential lot standards for incorporating open spaces into a subdivision plan. It is stated that open spaces cannot include bodies of water or swamps.

- Section 98-192 (Parking Requirements) – This section states the number of parking spaces required per unit of measure specified for each type of building or land use[4].

A zoning map for the City of Houghton is provided in Figure 2.2.

Portage Township Zoning Code (Portage Township, 2008)

Section 2.13(1)e (General Provisions, Site Development Plan) – "The Planning Commission shall determine that the proposed development is arranged: (e) To insure adequate drainage without jeopardizing adjacent or downstream properties."

Section 3.0 (Zoning Districts) – For RER, LAR, R-1, R-2, R-3 and R-4[5] zones, no dwelling can be located closer than 50 feet to the edge of a lake or stream. In cases of high banks 10 feet or higher, dwellings may be allowed to be closer. (The portion of the watershed that is in Portage Township falls into one of these zoning classifications.)

Section 4.4 (Schedule of Off-Street Parking, Loading and Unloading Requirements) – Table 2.2 describes the number of parking spaces to be provided based on the use or type of building.

A zoning map for Portage Township is provided in Figure 2.3.

Houghton County Zoning Code

At this point in time, Houghton County does not have a zoning code in place.

Table 2.2 Off-Street Parking Requirements for Portage Township, Michigan

Use	Number of Parking Spaces
Single Family	Two per dwelling unit
Two Family	Two per dwelling unit
Multi-Family*	One and one half per dwelling unit
Motels, Hotels, Lodging Houses	One per lodging unit, plus one stall for each 100 sq. ft. of retail sales or dining area
Commercial (except as specified below)	One per 200 sq. ft. of gross floor area
Furniture, appliance stores, machinery sales, wholesale storage	One per 400 sq. ft. of gross floor area
Offices, banks or public administration	One per 400 sq. ft. of gross floor area
Manufacturing, Warehousing	One for each employee on the maximum working shift, plus one for each vehicle used in the conduct of the enterprise

[4] City of Houghton Zoning Code is available online at: http://www.cityofhoughton.com/documents/CH098_9-29-06.pdf
[5] RUR = Rural Residential, RER = Resort Residential, LAR = Lakeshore Residential, R-1 = Low Density Single-Family Residential, R-2 = Medium Density Single-Family Residential, R-3 = High Density Single-Family Residential, R-4 = Medium Density Multi-Family Residential District

Use	Number of Parking Spaces
Churches, Theaters, Auditoriums, and other places of assembly	One per five seating spaces
Hospitals, Rest Homes, Nursing Homes, etc.	One per three employees, plus one per three beds

*In those cases where multi-family dwelling units are intended for occupancy by more than two (2) adults, the required parking spaces shall be increased at a rate of 1-1/2 spaces for each two (2) additional adults.

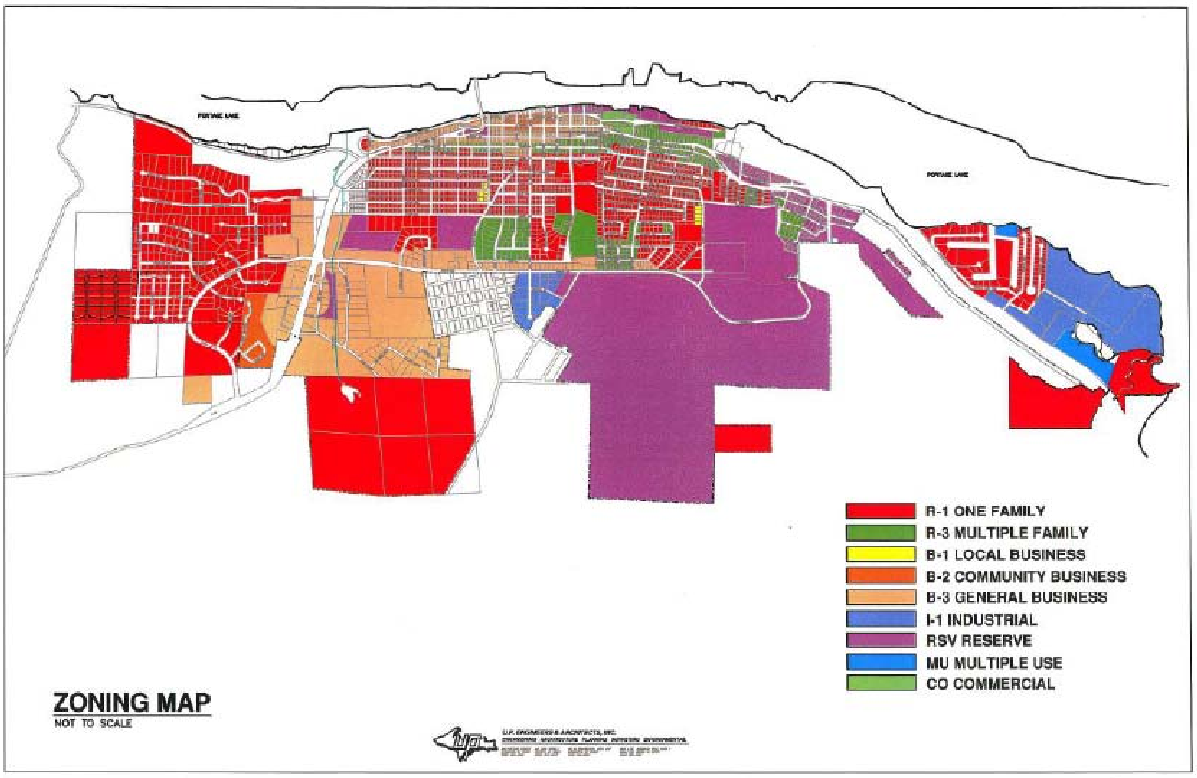


Figure 2.2. City of Houghton zoning map. Source: http://www.cityofhoughton.com/documents/Zoning_Map.pdf (accessed 3/5/09).

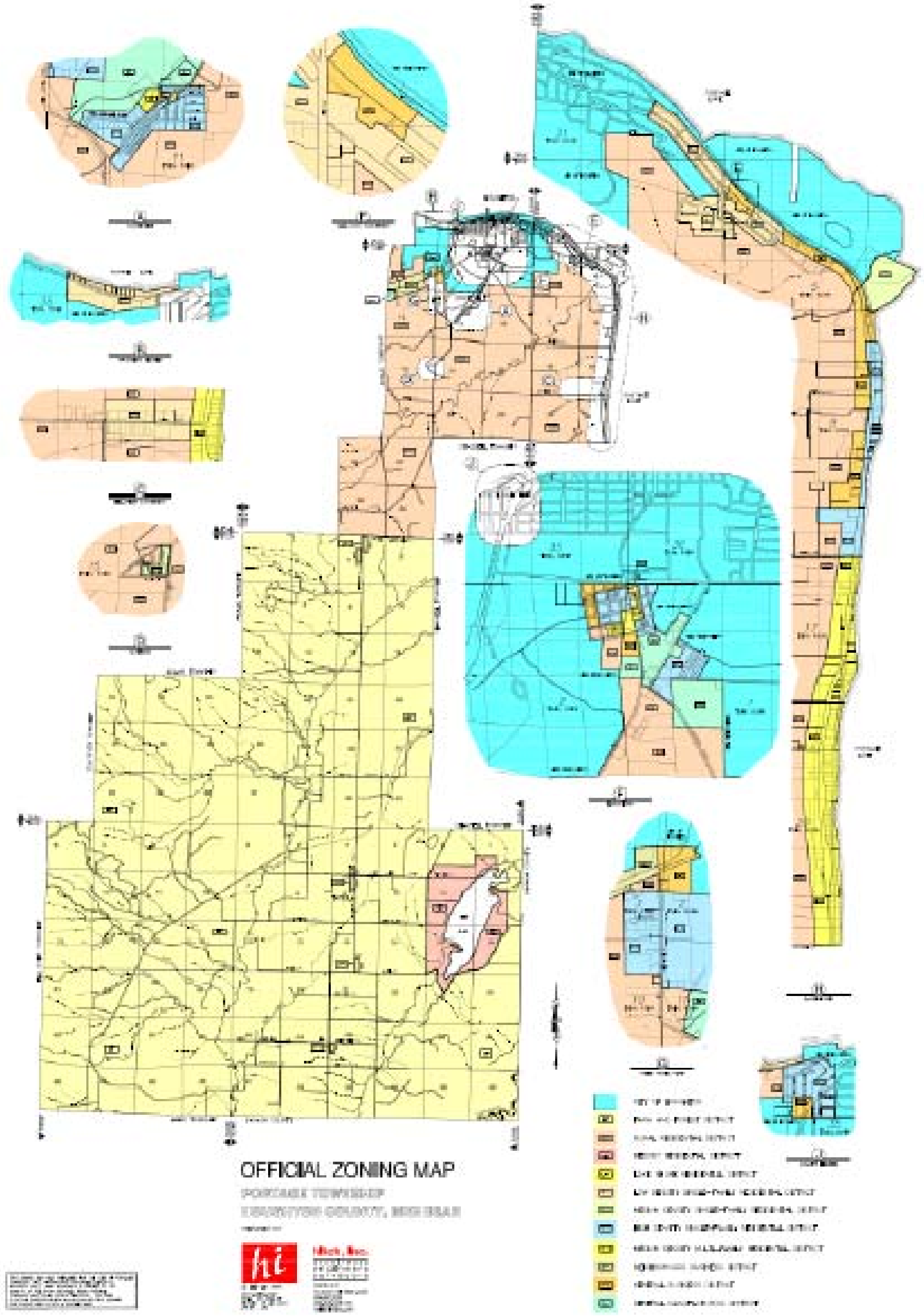


Figure 2.3 Portage Township zoning map.

2.3. Land Use and Development

2.3.1. Land Use Study

Land use information is necessary for creating the “big picture” of what is going on in a watershed. Analysis of land use data can indicate trends in what types of land use are increasing or decreasing over time, and where these changes have occurred or might occur. It can also help assess how valuable land resources such as wetlands, lakes and forests have been utilized and what affects the surrounding land use might have on them.

For this reason, a land use study was completed for the watershed in December 2006. Part of the study was to produce a land use map based on the most recently available aerial photo of the watershed, which was the National Agriculture Imagery Program (NAIP) photo from 2005. Figure 2.4 and Figure 2.5 indicate the percentages of land use in the watershed for this year. Land use maps for 1978 and 1998 also were generated using a geographical information system (GIS). The changes in land use from 1978 to 2005 are shown in Figure 2.6.

Figure 2.4, Figure 2.5, and Figure 2.6 indicate that, as of 2005, the largest land use category in the Huron Creek watershed is forested lands. These areas, combined with wetlands, comprise over 50% of the watershed (52%). The next largest land use is “urban and built up” areas. Since 1978, the only land use category showing significant growth is “urban and built up” areas which has occurred at the expense of the watershed’s forests and rangelands (Kersten, Huron Creek Watershed 2005 Land Use Map, 2006). The land use study report is included in Appendix D, which describes methods and data sources, as well as additional study results.

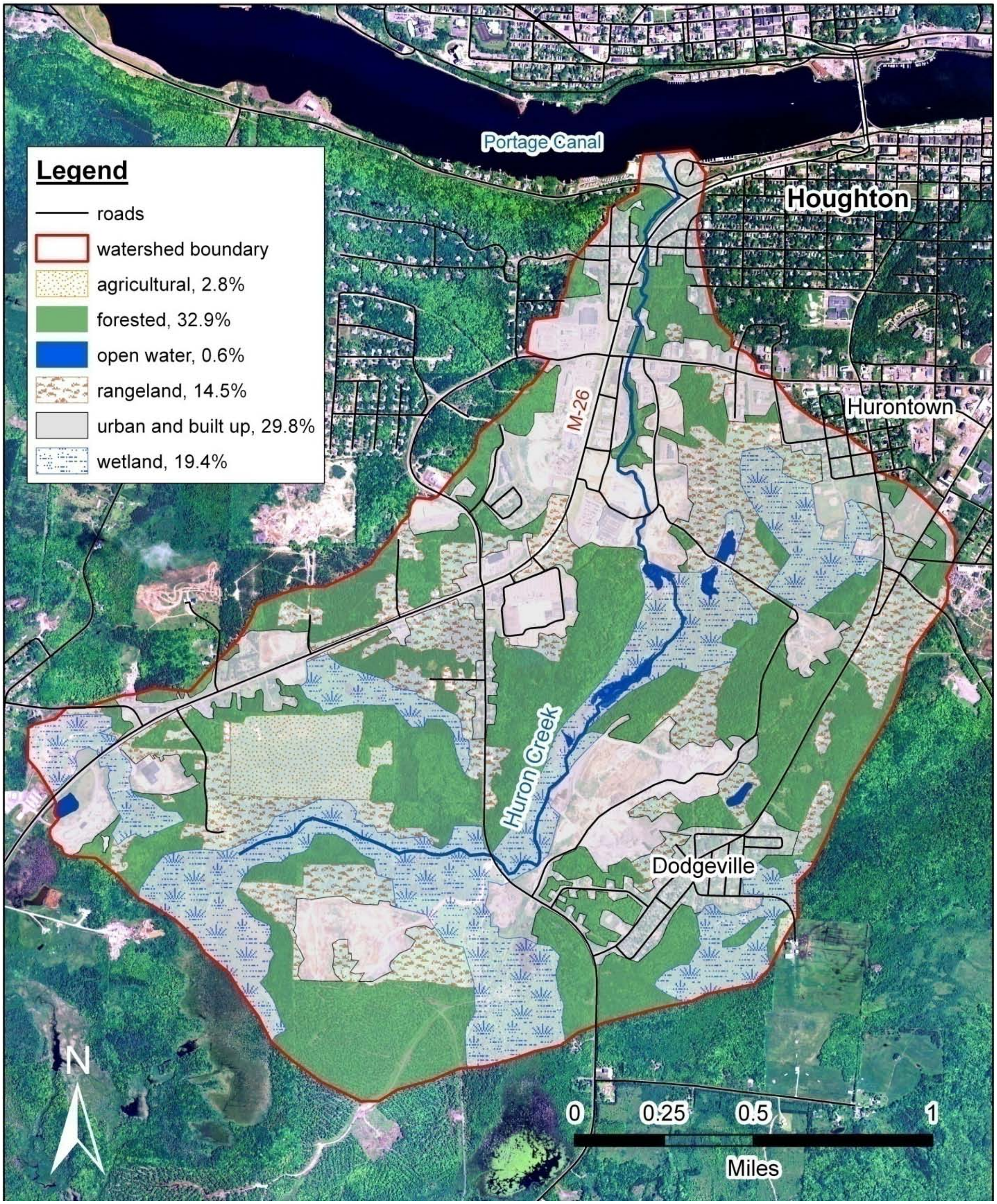


Figure 2.4 Land use in Huron Creek watershed as of 2005. Created by: Linda Kersten, 2/20/08. Map projection: NAD 1927 UTM Zone 16N. Data source: MI Geographic Data Library; 2005 NAIP 1-meter digital orthophoto.

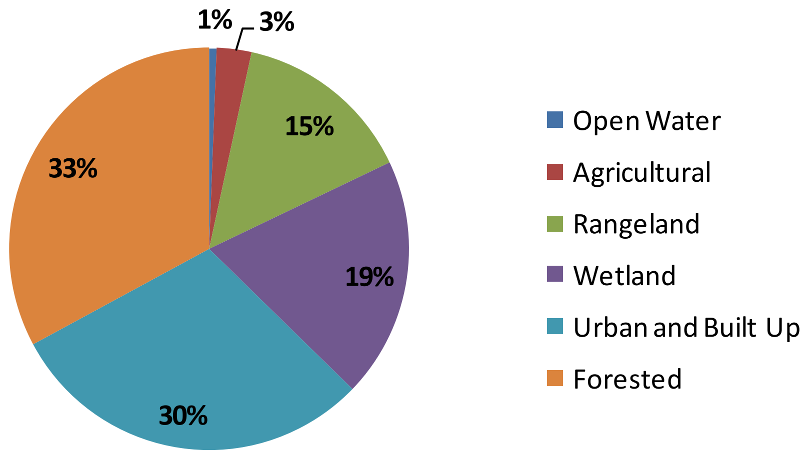


Figure 2.5 Land use distribution in Huron Creek watersheed, 2005.

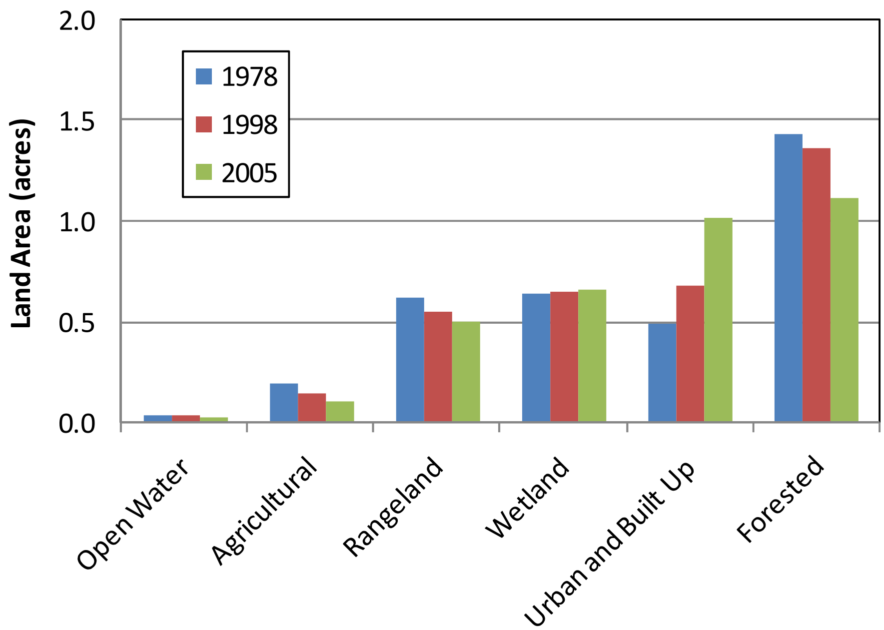


Figure 2.6 Land Use distribution in Huron Creek watershed, 1978, 1998, and 2005.

2.3.2. Development Trends

As indicated by the land use study, urban and built up areas have increased significantly in the Huron Creek watershed. As shown in Figure 2.4, the most concentrated area of development is in the north-central portion of the watershed which stretches down along Michigan Highway M-26. This stretch is commonly referred to as the "M-26 corridor." Significant commercial development began along the corridor in the mid-1970's when a furniture store, full-service grocery, and gas station were built. In 1981, the Copper Country Mall was constructed, bringing in various anchor stores and small retailers. Continued development brought in restaurants and fast-food chains, more grocery and retail stores, and multiple strip-malls (Greer, 2007). Huron Creek flows parallel to M-26 through this portion of the watershed, running directly through the middle of the development area. The progression of development in the M-26 corridor is depicted in the aerial photos in Figure 2.7.

The US Environmental Protection Agency recognizes that significant fractions of impervious surface in a watershed can impact the rate and quantity of water flowing through the watershed as well as the water quality. Studies show that on average, a typical city block generates nine times more runoff than a natural woodland area of the same size (US Environmental Protection Agency, 1996). Experts generally consider a watershed that has 11%-25% impervious surface to be "impacted," while areas that contain more than 25% impervious surfaces are considered "degraded" (Premo, B.J., D.T. Long, R.J. Huggett, D. Premo, W.W. Taylor, G.T. Wolff and K.G. Harrison, 2001) (Unknown, Michigan Department of Environmental Quality (MDEQ), 2003). If one counts parking lots and rooftop areas associated with the commercial development as 100% impervious, an analysis of the land use map in Figure 2.4 indicates that approximately 15% of the Huron Creek watershed has impervious land cover. This analysis does not include residential areas, which exhibit fractions of impervious surfaces of 20%-90%.

In the future, increased development may contribute to this level of impact. Several currently undeveloped locations in the watershed are slated for either commercial or residential development in the near future. The development areas described above are depicted in Figure 2.8. Near-future developments within the limits of the City of Houghton include (MacInnes, 2008):

- the new Saint Peter & Paul Church, to be located near the south end of Evergreen Drive,
- a commercial parcel slated for a large store or business on the south side of Sharon Avenue between Evergreen Drive and the businesses on Razorback Drive,
- a new bank and a new fitness/rehabilitation center to be located on Razorback Drive to the east of Wal-Mart,
- extension and improvement of Razorback Drive to the southwest of Wal-Mart, extending to Superior Road,
- addition of a new road off of the north side of the Razorback extension (#4) to provide access to an area of new residential and commercial development, and
- a large commercial parcel for sale to the south of Wal-Mart and to the east of the Copper Country Mall, and
- a 10-acre residential development located to the north of highway M-26 and west of Green Acres Road.

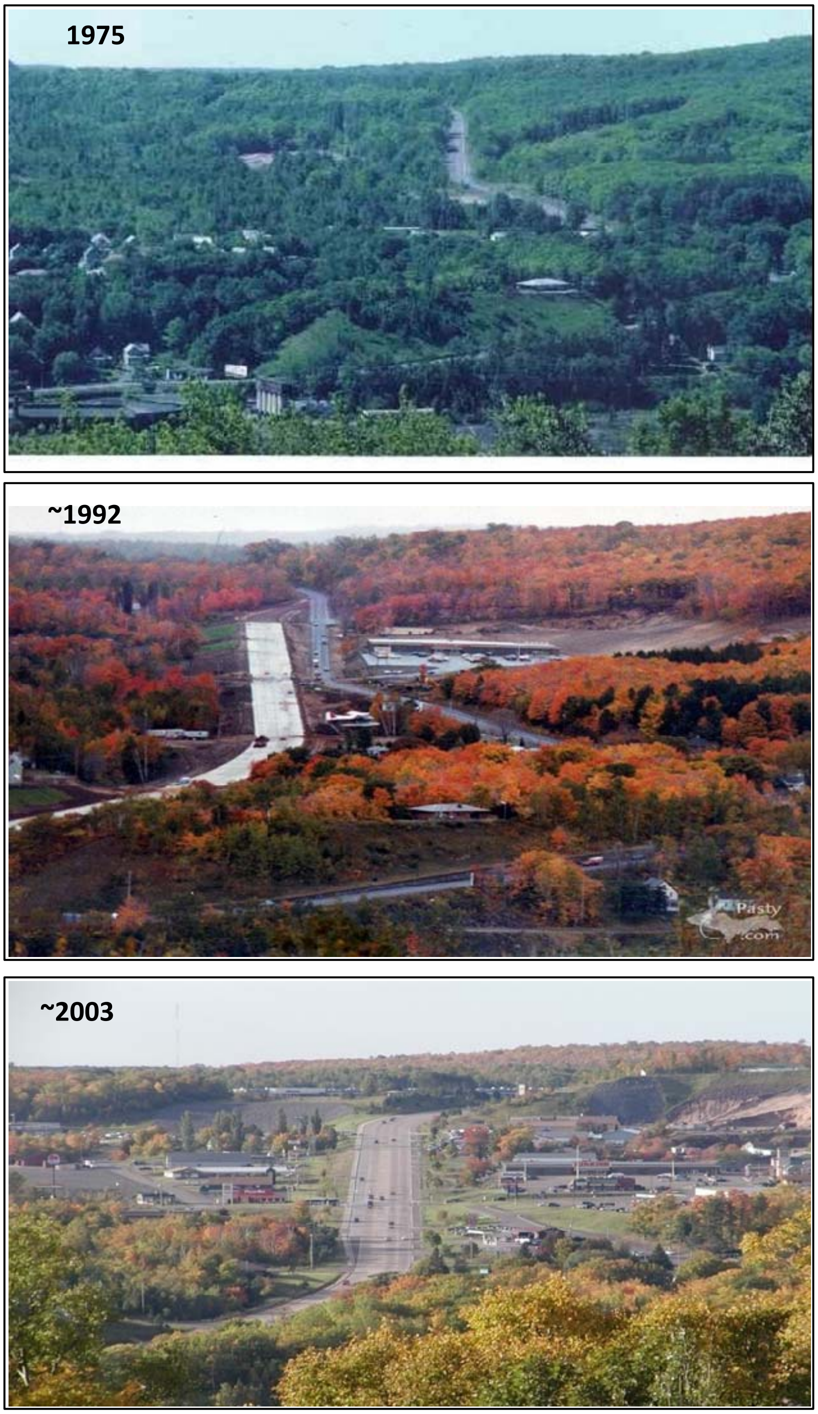


Figure 2.7 Photographs of M-26 corridor in Huron Creek watershed, 1975 (Photo courtesy of Dave Wisti via Greer, 2006), ~1992 (Photo from MTU GEM Center via Greer, 2006), and ~2003 (Photo from MTU GEM Center via Greer, 2006). Photographs taken facing south from Ripley overlook.

Near-future development areas in Portage Township include (Bingham, 2008):

- a commercial parcel slated for a large store or business directly to the south of the Copper Country Mall and
- two commercial parcels located on the north side of M-26 on the east and west sides of Janovsky Road (to the east of Snowmobile Club Road).

2.4. Topography, Geology and Soils

2.4.1. Ground Surface Topography

The ground surface topography of the Huron Creek watershed is displayed in Figure 2.9. From the southern watershed boundaries to near the former Huron Lake, the surface topography is nearly level to gently sloping. Elevations range from 1049 ft above mean sea level (AMSL) at the southern and southeastern boundaries of the watershed to 893 ft AMSL near the former Huron Lake. Ground surface slopes between these locations vary from 2 to 4 percent. The average slope of the creek bed in this location is approximately 1 percent. From the former Huron Lake north to the mouth of Huron Creek, surface slopes greatly increase as the width of the watershed decreases. Average ground surface slopes increase to a range of 6 to 10 percent on both sides of the creek and highway M-26. The surface elevation drops from around 890 ft AMSL to near 602 ft AMSL, which is the historical average water surface elevation of the Portage Canal. The average slope of the creek bed is approximately 4 to 5 percent between the canal and the former Huron Lake. The creek flows over several waterfalls in this portion of the watershed.

The steepest ground surface slopes in the watershed are located along the western boundary near from Festival Foods north to Econo Foods and Shopko. These slopes reach 14 to 17 percent, and were generally unprotected during the years immediately following commercial development. Today however, most of the slopes have been stabilized with terracing and vegetation due to slope stability and liability concerns. Another common way slopes have been stabilized in the watershed is with the placement of “mine rock” from mining operations or construction blasting.

2.4.2. Geology

Bedrock in the Huron Creek area consists of the Portage Lake Volcanics series, and is present across the entire watershed. The Portage Lake Volcanic Series is an extremely thick, Precambrian-aged, flood basalt deposit that filled up an ancient continental rift valley. The dominant rock type is vesicular basalt (basalt with vesicles or “pockets” from gas bubbles). Many of these vesicles are filled with minerals, which classifies it as amygdaloidal basalt. Houghton area amygdaloidal basalts have long had significant economic importance because native copper is one of the more common vesicle-filling and fracture-filling minerals. Numerous Houghton area copper mines have exploited these cupriferous amygdaloidal basalts through from the mid-1800’s to the mid-1900’s (St. John, unknown). Historical copper mining activities are discussed further in Section 2.7.

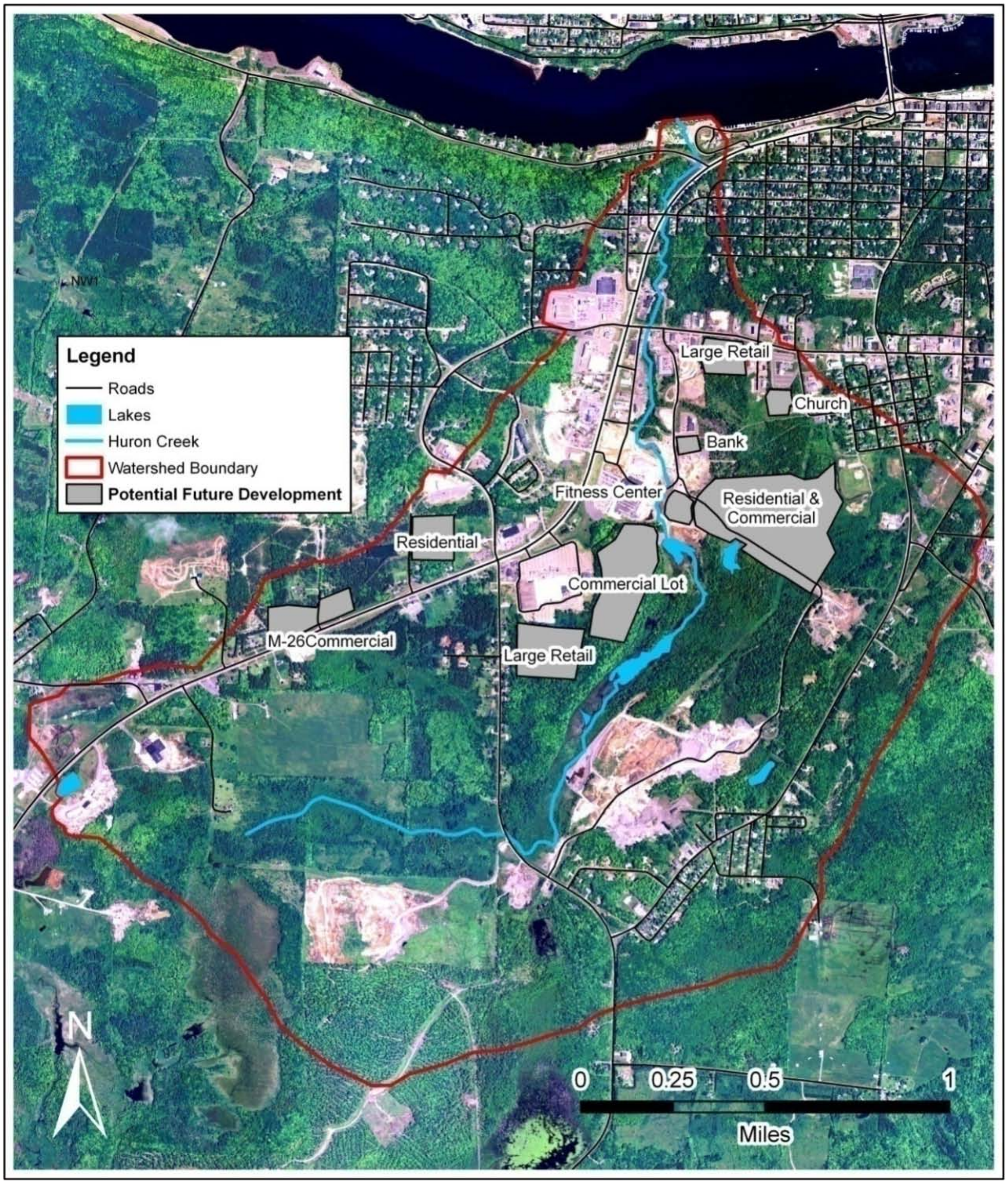


Figure 2.8 Potential near-future developments in Huron Creek watershed. Created by Linda Kersten, 4/10/08. Map projection: NAD 1927 UTM Zone 16N. Data sources: MI Geographic Database; 2005 NAIP 1-meter digital orthophoto.

Although the basalt formation is not generally considered "sulfur bearing" (and does not pose a significant sulfide/acid drainage threat), the waste rock and stamp sands produced from mining have introduced various metals into the environment over the years such as copper, silver and mercury

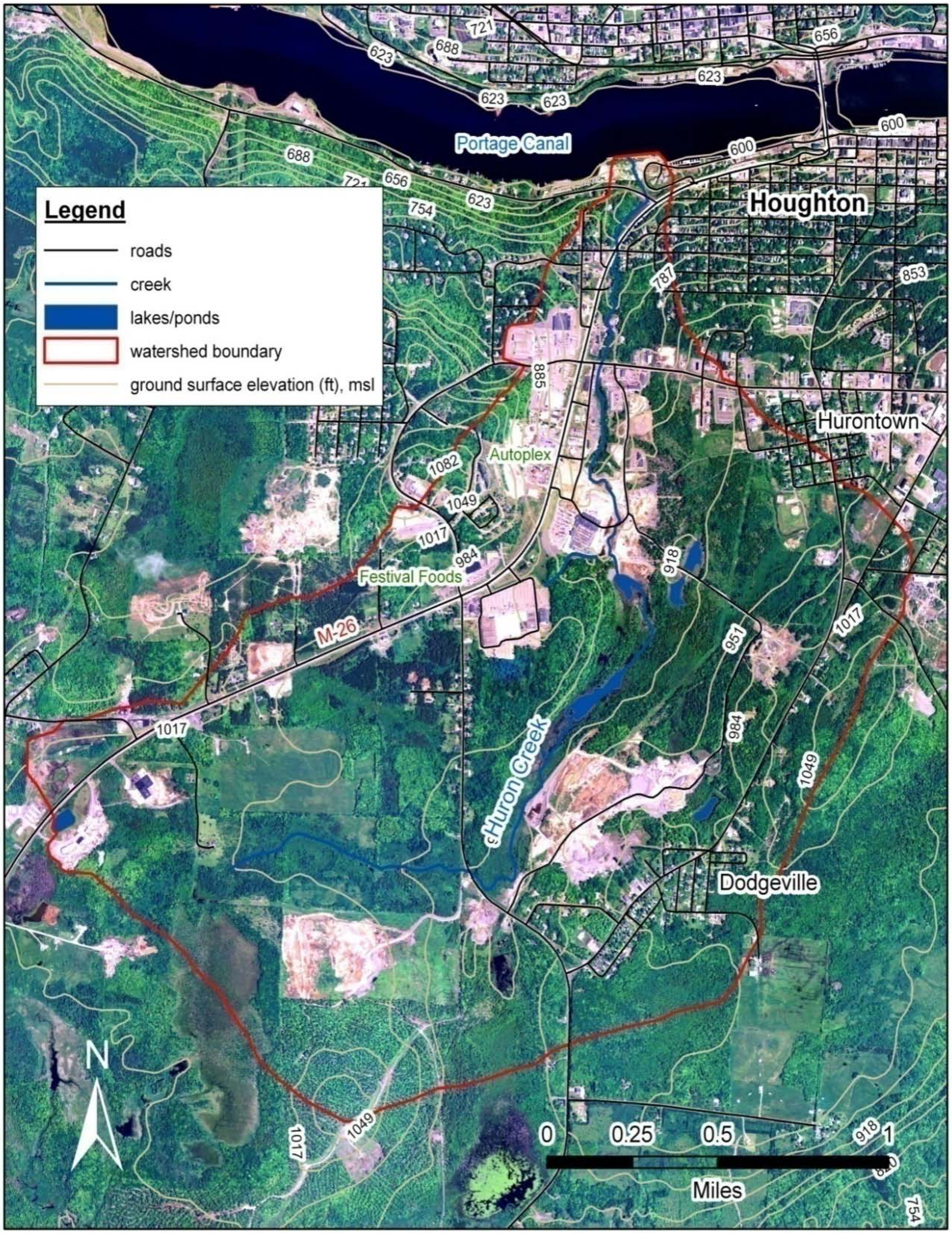


Figure 2.9 Ground surface topography in Huron Creek watershed. Created by Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data sources: MI Geographic Data Library; 2005 NAIP 1-meter digital orthophoto.

(W. Charles Kerfoot, S.L. Harting, Ronald Rossman, John A. Robbins, Unknown). Elevated levels of copper and iron have been documented in Huron Creek that may be attributable to mining activities.

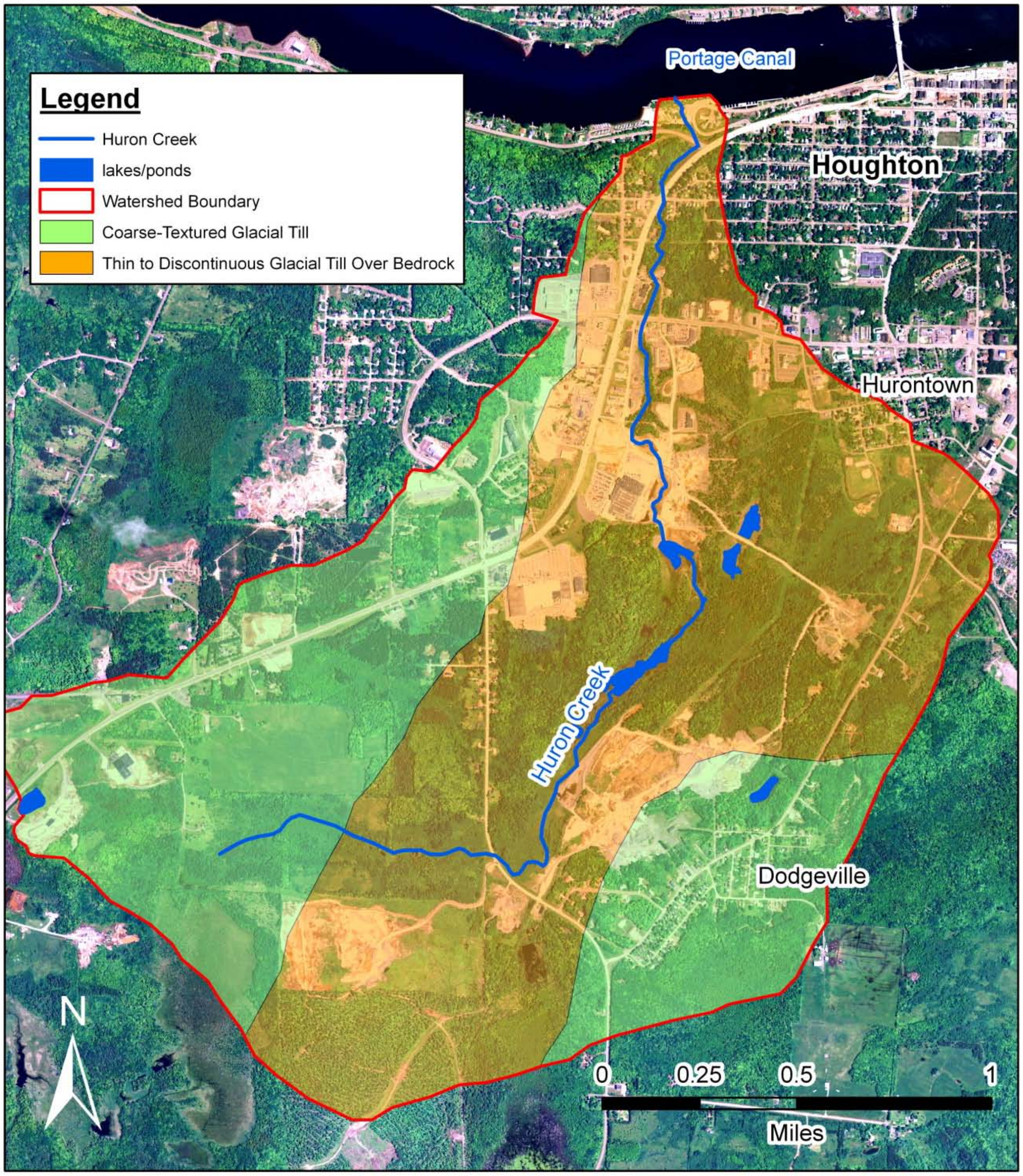


Figure 2.10 Quaternary geology in Huron Creek watershed. Created by Linda Kersten, 1/15/08. Map projection: NAD 1927 UTM Zone 16N. Data sources: 1998 MNFI & MDNR digital quaternary geology maps; 2005 NAIP 1-meter digital orthophoto.

The quaternary (or recent) geology of the Huron Creek watershed consists of glacial till over bedrock. A map showing the watershed's quaternary geology is provided in Figure 2.10. Much of the northern and central portions of the watershed have thin to discontinuous glacial till. Where the till is discontinuous, there are bedrock outcrops. In the southwestern and southeastern portions of the watershed, the glacial till is coarse-textured (meaning larger sands, gravels and cobbles) and is generally continuous.

Depth to groundwater varies from 0 feet below the surface in wetland and pond areas to 550 feet below the surface on the tops of hills and slopes (MDEQ Water Bureau, USGS- MI Water Science Center, 2005).

2.4.3. Soils

A soils map derived from the Natural Resources Conservation Service (NRCS) soil survey map is shown in Figure 2.11. Each colored polygon in Figure 2.11 represents a different soil map unit that is labeled with numbers and/or letters. These labels correspond to a specific map unit name that indicates soil texture, depth, slope and various other characteristics. Table 2.3 lists map unit labels, names, corresponding soil textures and hydrologic groups. The hydrologic group of a soil indicates its surface water runoff potential when thoroughly wet (NRCS). Full soil type descriptions can be found on the NRCS website at: http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi.

The predominant soil textures in the watershed are sand, sandy loam or gravelly sand. In a few areas, the soils have slightly more silt or cobbles, or are mucky such as in wetlands. Some areas, especially along the perimeter of the watershed, have thin soils among areas of rock outcrop (92B, 92D, 92E). Also indicated are locations of borrow pits (45) and mine dumps (55) which consist of stamp sand and/or mine rock. These locations are primarily in the southeastern portion of the watershed. Stamp sands were produced by stamping mills that were run by the copper mines. The stamping mills were locations where large mined rock was crushed and pulverized for easier extraction of the copper. Stamp sands are the residual materials that were usually deposited adjacent to the stamp mills

Two major sand and gravel quarries are found in the watershed. One is located just west of the town of Dodgeville, and occupies approximately 71 acres. The other quarry is located to the southwest, on the west side of Green Acres Road. It occupies approximately 40 acres. Both quarries are owned by Moyle, Inc., which is in the process of developing another quarry near the south-central border of the watershed. Moyle, Inc. is responsible for implementation and inspection of erosion control and stormwater management measures for these quarries. The company hires employees who are certified under the MDEQ's Stormwater Operator program to carry out the inspections (Moyle, 2006).

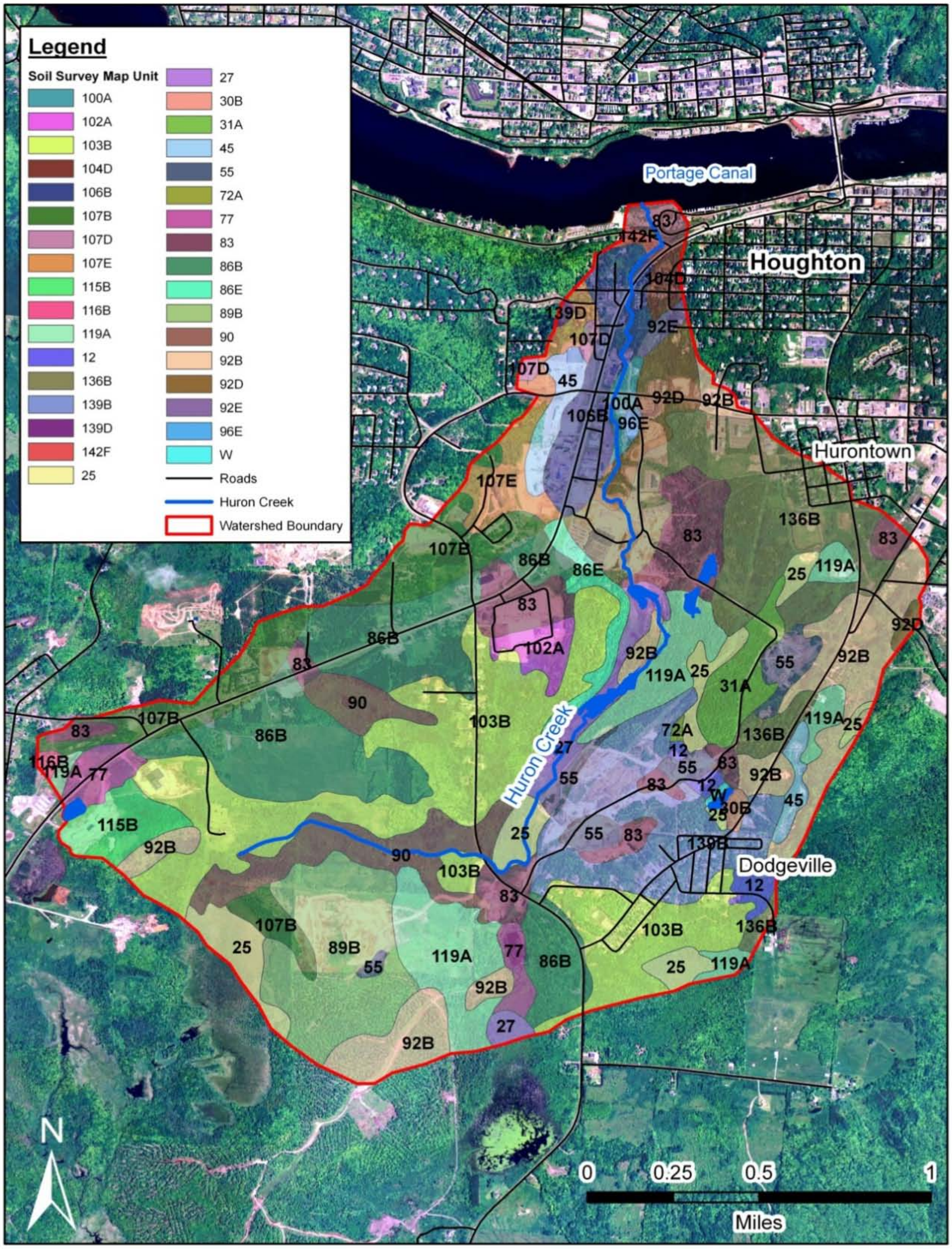


Figure 2.11 Natural Resources Conservation Service (NRCS) soil survey map for Huron Creek watershed. Created by Linda Kersten, 1/16/08. Map projection: NAD 1927 UTM Zone 16N. Data sources: 2000 NRCS Soil Survey of Houghton County; 2005 NAIP 1-meter digital orthophoto.

Table 2.3 NRCS Soil Survey Map Unit Descriptions

Map Unit Label	Map Unit Name	Soil Texture(s)	Hydrologic Group*
12	Gay muck	muck	B/D
25	Lupton and Cathro mucks	muck	A/D
27	Histosols and Aquents, ponded	muck, organics	D
30B	Munising-Skanee complex, 0 to 8 percent slopes	sandy loam, loamy sand	B, C
31A	Skanee-Gay complex, 0 to 3 percent slopes	sandy loam, muck	C, B/D, B
45	Pits, borrow	--	--
55	Dumps, mine	stamp sands and/or mine rock	--
72A	Halfaday sand, 0 to 3 percent slopes	sand	A
77	Tawas-Roscommon mucks	peat, muck, mucky sand	A/D
83	Udipsamments and Udorthents, nearly level	fill	A
86B	Trimountain cobbly fine sandy loam, 1 to 8 percent slopes	cobbly fine sandy loam	B
86E	Trimountain cobbly fine sandy loam, 15 to 35 percent slopes	cobbly fine sandy loam	B
89B	Trimountain-Paavola complex, 1 to 8 percent slopes	fine sandy loam, loamy sand, loamy coarse sand	B
90	Witbeck very stony muck	stony muck	B/D
92B	Arcadian-Michigamme-Rock outcrop complex, 1 to 8 percent slopes	gravelly fine sandy loam, silt loam, rock outcrop	D, C
92D	Arcadian-Michigamme-Rock outcrop complex, 8 to 15 percent slopes	gravelly fine sandy loam, silt loam, rock outcrop	D, C
92E	Arcadian-Michigamme-Rock outcrop complex, 15 to 35 percent slopes	gravelly fine sandy loam, silt loam, rock outcrop	D, C
96E	Liminga fine sand, 15 to 35 percent slopes	fine sand	A
100A	Au Gres-Roscommon complex, 0 to 3 percent slopes	sand, mucky sand	B, A/D
102A	Net-Witbeck complex, 0 to 3 percent slopes	silt loam, loam, sandy loam,	C, B/D
103B	Trimountain-Net complex, 0 to 8 percent slopes	fine sandy loam, silt loam, loam	B, C
104D	Urban land-Udorthents complex, strongly sloping	paved areas, fill soils	--
106B	Urban land-Udorthents-Udipsamments complex	paved areas, fill soils	--
107B	Kalkaska-Waiska sands, 0 to 8 percent slopes	sand, gravelly sand	A
107D	Kalkaska-Waiska sands, 8 to 15 percent slopes	sand, gravelly sand	A
107E	Kalkaska-Waiska sands, 15 to 35 percent slopes	sand, gravelly sand	A
115B	Trimountain-Paavola complex, 1 to 12 percent	fine sandy loam, loamy sand, loamy coarse sand	B
116B	Trimountain-Paavola-Michigamme complex,1 to 12 percent slopes	fine sandy loam, loamy sand, loamy coarse sand, silt loam	B, C
119A	Net-Witbeck complex, 0 to 3 percent slopes, rocky	silt loam, loam, sandy loam	C, B/D
136B	Michigamme-Net complex, 0 to 8 percent slopes, rocky	silt loam	C
139B	Trimountain-Paavola-Waiska complex, 1 to 8 percent slopes	fine sandy loam, loamy sand	B, A
139D	Trimountain-Paavola-Waiska complex, 8 to 15 percent slope	gravelly sand, loamy coarse sand, fine sandy loam	B, A/D
W	Water	water	--

* Group A = High infiltration rate (low runoff potential), Group B = Moderate infiltration rate, Group C = Slow Infiltration Rate, Group D = Very slow infiltration rate. Hydrologic groups are listed perspective to the order the soil names are listed in the complex name. If a soil has a dual hydrologic group (A/D), the first letter is for drained areas and the second letter is for undrained areas (NRCS).

2.5. Climate and Hydrology

2.5.1. Climate Data

Westerly prevailing winds and winters with prolonged periods of snow cover are characteristic of the Huron Creek watershed's regional climate. The Huron Creek watershed is a north-facing watershed located in a northern latitude and therefore does not receive as much sunlight as one that is south-facing or in a southern latitude. The annual average incidence of solar radiation on horizontal surfaces is 1130 BTU/ft^2/day. The greatest solar radiation occurs during the months of June and July (Contes, 2007).

Average temperature during the winter months (November through April) is 23° F. During the summer months, the average temperature is 56° F (Contes, 2007). On average, the area receives 33 inches of annual precipitation[6]. The highest amount of precipitation generally occurs in January in the form of snow with an average of 3.3 inches when measured in melted form (Contes, 2007). When measured in frozen form, the annual average snowfall is 215 inches (Contes, 2007) . Much of the snow is lake effect snow, which is prevalent in the area due to Houghton's location relative to Lake Superior. Since 1952, average on-the-ground snowpack has varied from 14 to 28 inches between December and March. Accordingly, runoff from snowmelt is a significant contributor to Huron Creek's flow in the spring months. In the summer months (June to September), average monthly rainfall varies between 2.8 and 3.3 inches (Contes, 2007). In recent years (2006, 2007) Houghton has received relatively intense rainstorms such as the storm on September 4, 2007 that produced 3.7 inches of rain in less than 10 hours (Weather Underground). Figure 2.12 and Figure 2.13 provide historical total annual precipitation data and monthly average precipitation data for the Houghton area, respectively. Climate trends are discussed further in Chapter 5.

[6] All climate data is taken from the National Climatic Data Center (NCDC) Hancock-Houghton County Airport weather station. This station is located approximately 8 miles from the center of the Huron Creek watershed. The station is located at an elevation of 1074 feet, which is approximately 300 ft higher than the average elevation in the Huron Creek watershed. Higher elevations typically receive more snow, such that the precipitations reported for the Huron Creek watershed here are likely biased high.

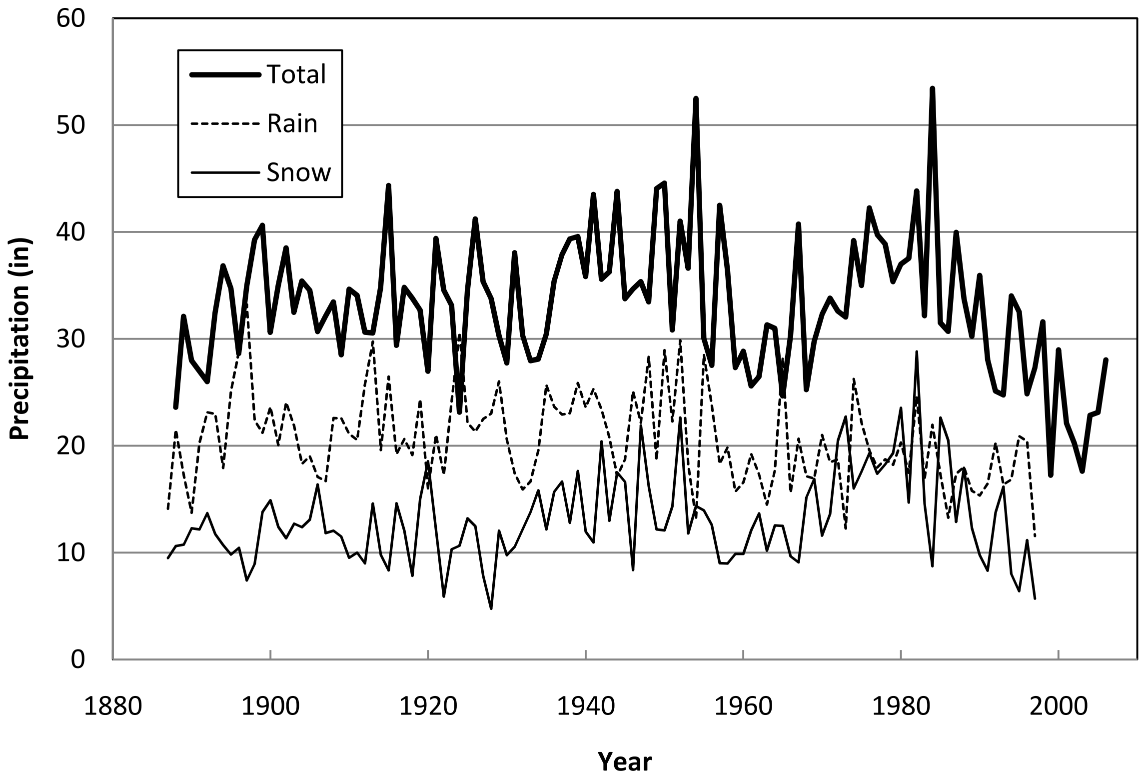


Figure 2.12 Annual precipitation for 1888-2007 (Contes, 2007). Separated rain and snow total data was not available from the NOAA/NCDC website from 1999 onward as of July 2007. Annual data is based on a precipitation year beginning 9/1 and ending 8/31, so that a precipitation year captures an entire winter.

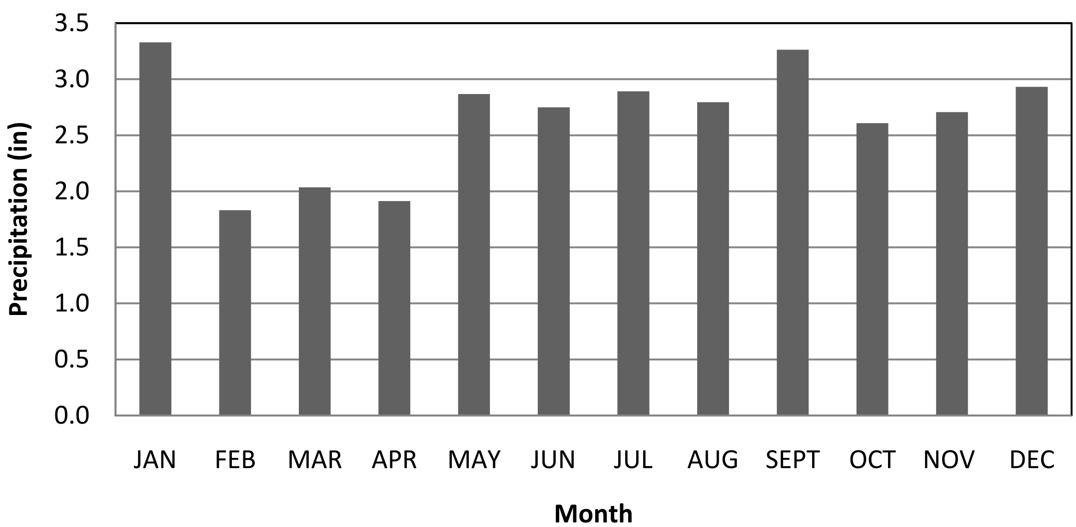


Figure 2.13 Average monthly precipitation over the period 1888-2007 (Contes, 2007).

2.5.2. Hydrology

Short term changes in the rate of flow in response to rainfall and snowmelt events are influenced by land cover and local slopes, among other factors. The upper (southern-most) two-thirds of the watershed (see Figure 2.14) is dominated by forested land and wetlands with relatively gentle slopes. In response to rainfall and snowmelt events, forested lands generally produce relatively small amounts of runoff volumes and relatively slow movement of water across the land surface towards the stream. Wetlands tend to attenuate runoff by collecting water from rainfall and snowmelt events and release the water at relatively slow rates. The prevalence of forested land and wetlands, combined with low slopes give rise to relatively small increases in flow rates in response to rainfall and snowmelt events in the upper portion of the watershed.

In contrast, the lower one-third (northern-most) is dominated by developed land cover and relatively steep slopes, both in the stream channel and the land draining to the stream. The developed land cover consists of relatively impervious materials, such as rooftops and parking lots, which tend to produce high volumes and rapid rates of runoff. The developed land cover includes drains that collect the runoff from rooftops and parking lots and direct the flow through ditches and culverts which eventually lead to the creek. These systems tend to increase rates of runoff to the creek even further. The combination of the relatively impervious materials; direction of flow through drains, ditches, culverts; and the relatively high slopes can generate relatively high increases in flow rates in response to rainfall and snowmelt events in the lower portion of the watershed. The increase in developed land over the past few decades has caused the rate of flow of the creek to increase significantly in response to rainfall and snowmelt events, also referred to “flashy” flow, over the years, which in turn has caused contributed to erosion problems such as those in the Shopping Cart Creek tributary and the Kestner Waterfront Park. The geomorphology survey results provided in Section 5.7 describe some of these erosion areas.

In between rain and snowmelt events, flow into the creek from groundwater seepage, also referred to as baseflow, controls the rate of flow of the creek. Baseflow is essentially rainfall or snowmelt that recharges the near-surface groundwater system and tends to flow from the point of recharge towards the creek. The volume and rate of baseflow is controlled by land cover and slopes. As the amount of less pervious surface increases, baseflow generally decreases, since less water infiltrates the subsurface. The volume and rate of baseflow is also controlled by the elevation of the local groundwater table relative to the stream channel. In most areas of the watershed, it is suspected that the water table is higher than the stream channel, leading to a positive gradient towards the stream. This situation is often referred to as a gaining stream. However, in other areas, most notably downstream of the wetlands in the area where Huron Lake use to be located and upstream of the “Frog Pool” area, it is suspected that the water table is lower than the stream channel. This portion of the stream is described as the “creek re-route area” in Section 2.6.2. This situation leads to what is referred to a losing stream, or, in other words, no baseflow is provided to the stream. It has been observed over the last few summers that the stream is dry in portions of this area in between rain and snowmelt events.

Limited data has been collected on flows in Huron Creek to date. As a substitute for observed flow rate data, flow rates of Huron Creek have been simulated using a rainfall-runoff model. Average and peak flow rates determined from these efforts are described in Section 5.4.

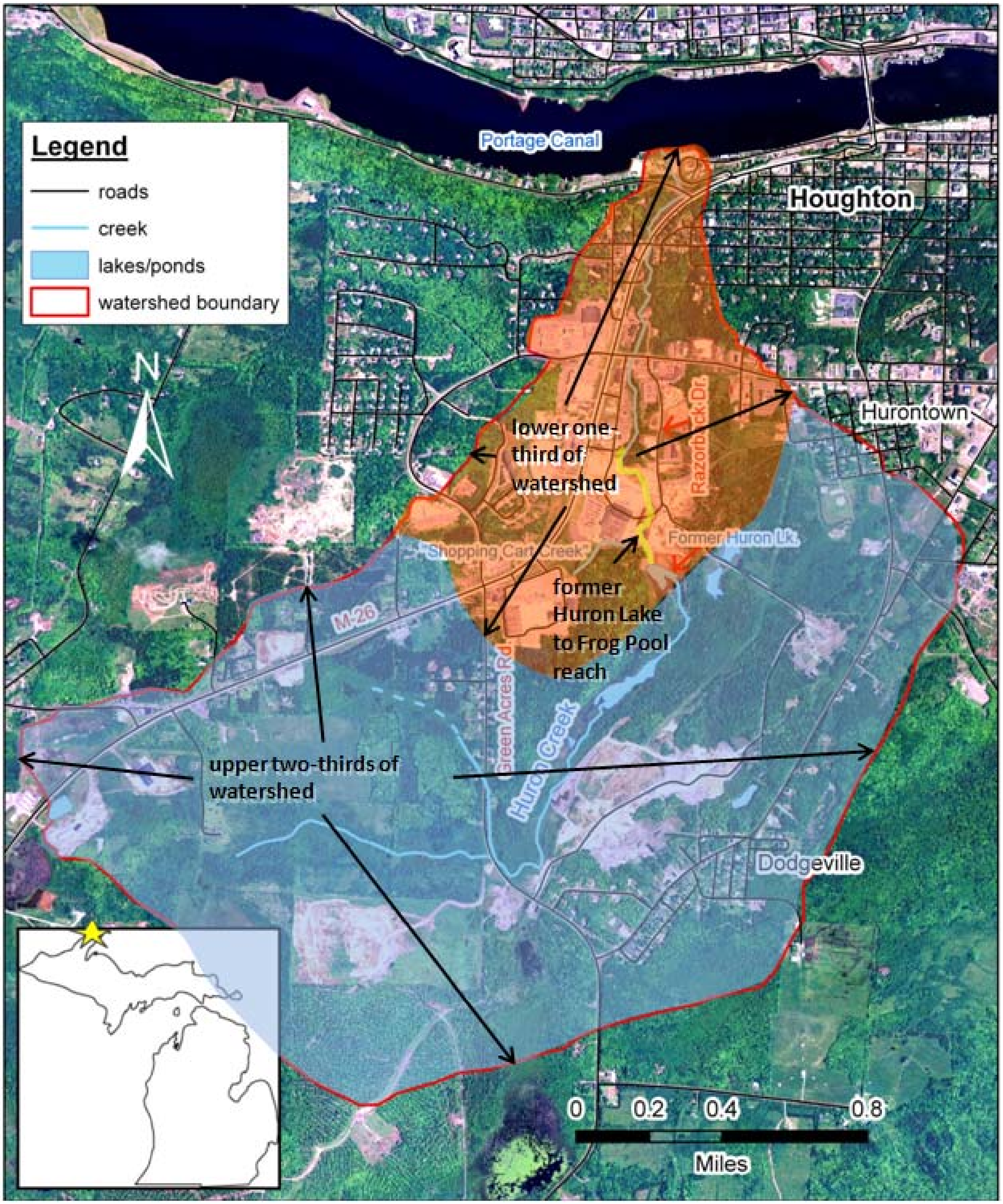


Figure 2.14 General features of Huron Creek watershed relevant to watershed hydrology. Created by Linda Kersten, 1/16/08; Alex Mayer 3/5/09. Map projection: NAD 1927 UTM Zone 16N. Data source: 2005 NAIP 1-meter digital orthophoto.

2.6. Habitats and Vegetation

2.6.1. Native Habitats

Pre-settlement era habitats of the Huron Creek watershed included sugar maple-hemlock forest, sugar maple-basswood forest, mixed conifer swamp and cedar swamp. These habitat types have changed or become fragmented due to clear-cutting that occurred at the turn of the century. Today, upland forests commonly consist of sugar and red maple (*Acer saccharum, Acer rubrum*), paper birch (*Betula papyrifera*), hemlock (*Tsuga canadensis)*, basswood (*Tilia americana*) and elm (*Ulmus americana).* Balsam fir (*Abies balsamea*) is especially common in the understory of these forests, along with several herbaceous plants such as bracken fern (*Pteridium aquilinum*), meadow horsetail (*Equisetum pretense*) and goldenrod (*Solidago spp.*). Red and white pine (*Pinus resinosa, Pinus strobus*) stands are prevalent in the high, sandy portions of the watershed. In mesic habitats (habitats that lie between uplands and wetlands), tree species such as cottonwood (*Populus deltoides*) and quaking aspen (*Populus tremuloides*) are dominant. The percent cover the canopies of these forests provide is generally high in areas without recent disturbance. Details on vegetation and percent cover can be found in the vegetation and riparian buffer survey found in Section 5.8.

Wetland areas occupy approximately 19% of the watershed's land cover (see Figure 2.4). These wetland types include forested wetlands, open-water wetlands and shrub-scrub areas. Shrub-scrub wetlands are especially predominant in riparian zones (areas adjacent to the stream) in the southern portion of the watershed where ground surface topography is relatively flat. Willow species (*Salix spp.)*, red-osier dogwood (*Cornus sericea*) and tag alder (*Alnus incana ssp. rugosa*) are common shrub species in these areas. Plant species commonly found in the watershed's open water wetlands include yellow waterlily (*Nuphar lutea*), floating pondweed (*Potamogetan natans*) and cattail species (*Typha spp*.). The edge of these open water areas often supports various sedge (*Carex spp.*) and rush (*Juncus spp.*) species among others.

The forested wetlands in the Huron Creek watershed are commonly dominated by white cedar (*Thuja occidentalis*), but support a variety of other tree, shrub and herbaceous plant species.

2.6.2. Wetland Mitigation and Creek Rerouting in 2004

In 2004, the Houghton Wal-Mart made plans to expand to a "Super-Center" and applied to the MDEQ for a permit to fill 5.5 acres of wetland and relocate a portion of Huron Creek[7]. Because the wetlands that were to be filled were considered contiguous (connected to other bodies of water), and due to the length of stream to be relocated, the U.S. Army Corps of Engineers and U.S. Environmental Protection Agency also had jurisdictional review of the permit application.

The designated wetland mitigation ratio for this site was 2:1, meaning that the mitigation site would have to be 11 acres in size. The selected mitigation site included the former Huron Lake area (to the southeast of the existing Wal-Mart), and areas of stream located to the east and northeast of the

[7] As a result of negotiations with the City of Houghton, the responsible party and permit holder for the wetland fill and mitigation is the City of Houghton.

existing store. Because part of the proposed mitigation plan was to rehabilitate the Huron Lake area (removal of stamp sands and establishment of vegetation), the City of Houghton negotiated to have the required mitigation area reduced by 10%. This resulted in the final mitigation area being approximately 10 acres. Figure 2.15 shows the creek re-route and mitigation site locations relative to the Wal-Mart expansion.

In addition to the permit application and mitigation site design plans, the City of Houghton was required to provide a wetland mitigation monitoring plan. This plan is required by MDEQ and lays out guidelines for monitoring of the wetland to provide for an established, vegetatively-diverse wetland. The minimum required monitoring period is five years. The proposed permit application and mitigation plan was approved by all regulatory agencies (date unknown) and mitigation monitoring is in progress by the city of Houghton.

Figure 2.15 Wal-Mart expansion wetland mitigation and creek re-routing.

2.6.3. Invasive Species

Various invasive plant species have been observed within the Huron Creek watershed. the more prevalent species include spotted knapweed (*Centaurea stoebe*) and white and yellow sweetclover (*Melilotus alba, Melilotus officinalis*). Species that are least commonly observed include reed canary grass (*Phalaris arundinacea*), glossy and European buckthorn (*Rhamnus frangula, Rhamnus cathartica*), and purple loosestrife (*Lythrum salicaria*). Of these invasive species, the sweetclovers, knapweed and reed canary grass are currently present in the Wal-Mart mitigation site and creek re-route area. The buckthorn species have been observed in various wooded areas, while purple loosestrife has been observed near the mouth of Huron Creek. The locations of these species are documented in the vegetation survey that is provided in Appendix L, and discussed in Section 5.8. The species described here have been identified as invasive in the state of Michigan according to the Michigan Department of Agriculture's Horticulture Fund 2005 Final Report (Michigan Department of Agriculture, 2005).

2.7. History of Human Activities

As mentioned earlier, mining activities have played a significant part in shaping the history of the area. The Huron Creek watershed (and much of Houghton and Keweenaw County) is positioned over what once was one of the richest deposits of native copper in the world. Copper mining began in the watershed in 1852 with the opening of the Isle Royale mine and one year later, the opening of the Huron mine. The Isle Royale mine was located approximately one-half mile north of present-day Dodgeville, and the Huron Mine was located slightly farther to the north in Section 2, T 54N, R 34W (Greer, 2007) (see Figure 2.16).

In most cases, the copper was separated from the host rock through a crushing or "stamping" process. In 1865, Huron Creek was dammed to utilize water power to run the Huron Stamp Mill, creating Huron Lake. The lake provided the mill with the power and filtration mechanism needed to process the copper and separate it from the waste rock (Greer, 2007). Both the Isle Royale and Huron mines operated independently until production slowed to the point where the operation was no longer profitable. The Isle Royale mine and the Huron mine temporarily ceased production in 1870 and 1893, respectively. However, in 1897 the Isle Royale Consolidated Mining Company (IRCMC) merged the Huron, Isle Royale and Portage mine (another local mine outside of the watershed) into one mining operation. Soon after, in 1899, IRCMC merged again with the Miners Mining Company, forming the Isle Royale Copper Company (IRCC). From 1897 until 1900, the IRCMC and the IRCC continued to use the Huron Stamp Mill for finishing operations. In 1900, the IRCC built a new stamping mill on the Portage canal at the mouth of the Pilgrim River, ceasing the production of stamp sands in the Huron Creek watershed (Greer, 2007).

Throughout this 100 -year-plus mining era, the Huron Creek watershed was impacted in many ways. In addition to the damming of the creek (creation of Huron Lake), the creek itself was often rerouted and moved to optimum locations for use in industrial or agricultural activities. Figure 2.17 shows the location of Huron Creek in 2007 compared to its originally surveyed location in the 1867 State of Michigan Land Office Plat. Also during this period, metals such as copper and mercury may have begun to be introduced into the watershed and creek from infiltration and surface water runoff from the stamp sands (W. Charles Kerfoot, S.L. Harting, Ronald Rossman, John A. Robbins, Unknown). Pulverization of the metal-bearing rock into the stamp sands greatly increased the surface area of the solid materials, potentially increasing the rate of release of contaminants from the solids into water flowing through the solids. Many areas of stamp sand deposits remain in the watershed (refer to the soils map, Figure 2.11), and still have the potential to carry these contaminants to the groundwater and creek.

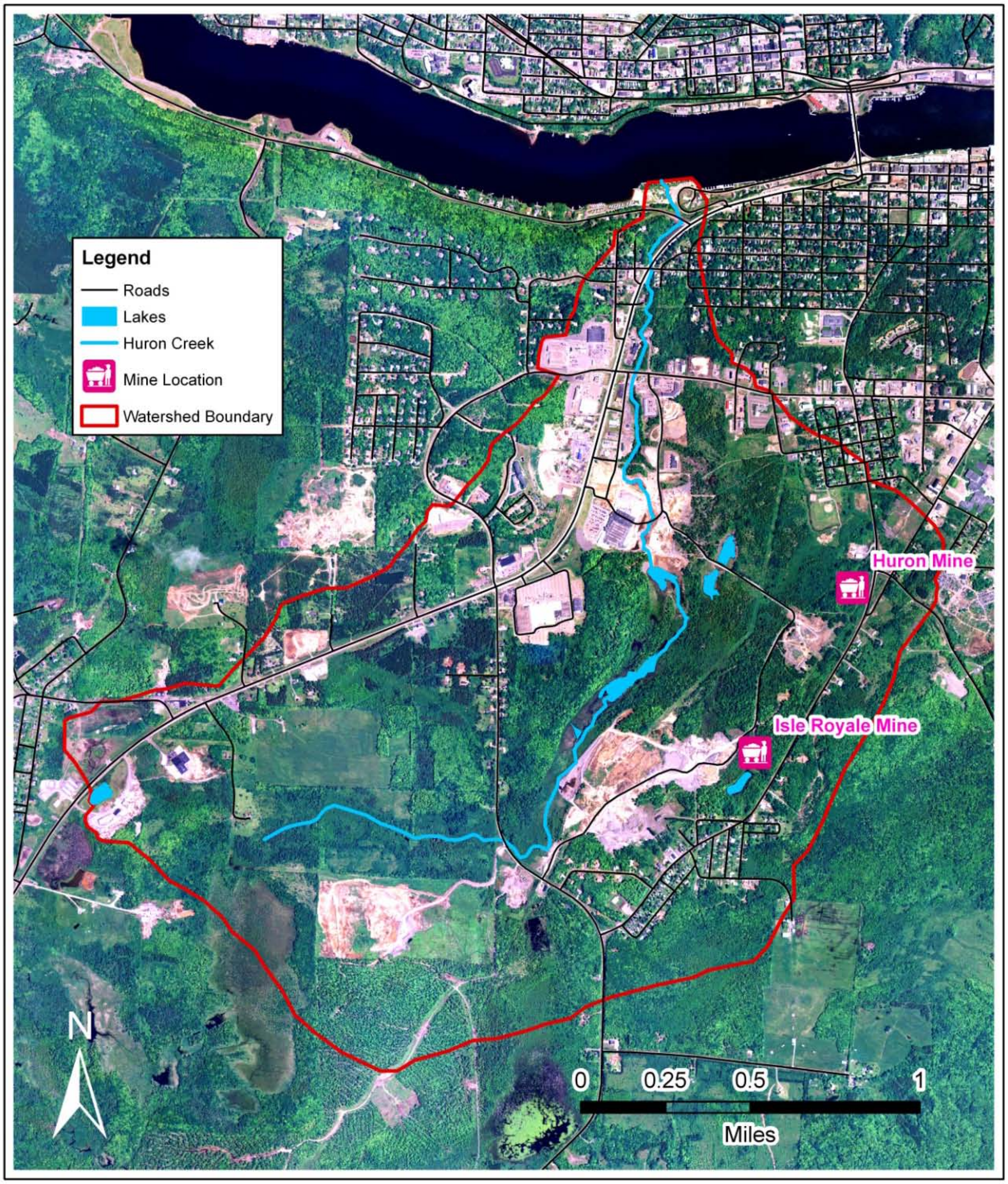


Figure 2.16 Isle Royale and Huron Mine locations (approximate). Created by Linda Kersten, 4/10/08. Map projection: NAD 1983 UTM Zone 16N. Data sources: Michigan Geographic Database; 2005 NAIP 1-meter digital orthophoto.

Deforestation also occurred at a rapid rate during the height of the mining era. The mining companies clear-cut areas near mine sites and stamping mills in order to make room for building construction and transport of mine rock. Clear cutting occurred not only to open up space, but also to provide timber for mine stability, fuel to produce steam power, material for miners to build homes, and tracks for trams and railroads (Greer, 2007). The rapid removal of vegetation and ground cover would have caused a

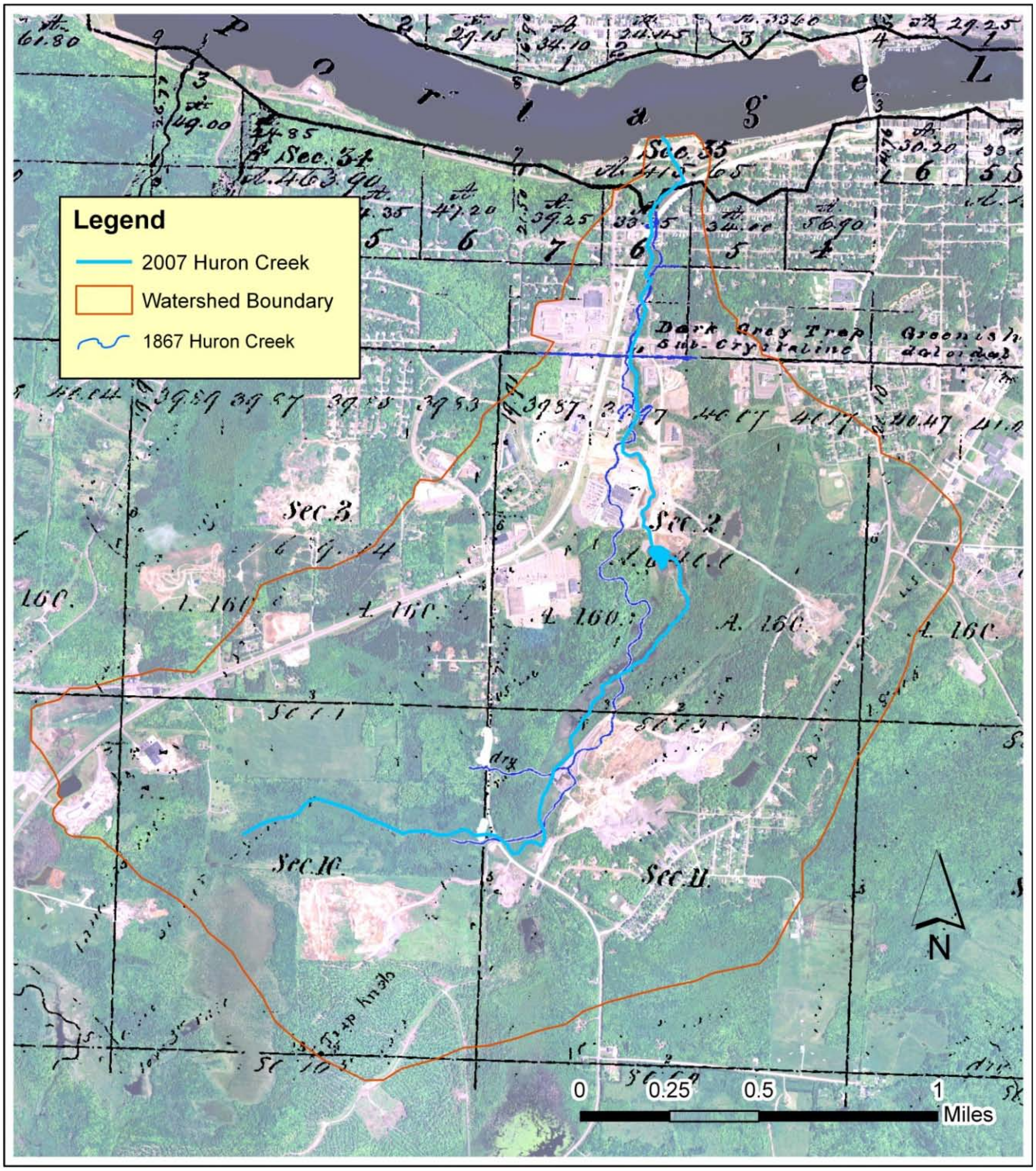


Figure 2.17 Locations of Huron Creek in 1867 and 2007. Geo-referencing of 1867 base map is approximate. Created by Linda Kersten, 10/23/07. Map projection: NAD 1927 UTM Zone 16N. Data sources: State of Michigan General Land Office Plats; 2005 NAIP 1-meter digital orthophoto.

steep increase in soil erosion, which in turn likely caused changes in the appearance and/or location of the creek as a result of bed or bank deposition. Deforested portions of the Huron Creek watershed are apparent in the 1938 aerial photo in Figure 2.18. These areas show recovery however, in the 1963 aerial photo (Figure 2.19), and the 2005 aerial photo (Figure 1.1).

Figure 2.18 Aerial photo of Huron Creek watershed, 1938. Created by Linda Kersten, 10/23/07. Map projection: NAD 1927 UTM Zone 16N. Data sources: Houghton-Keweenaw Conservation District, courtesy of Bruce Peterson.

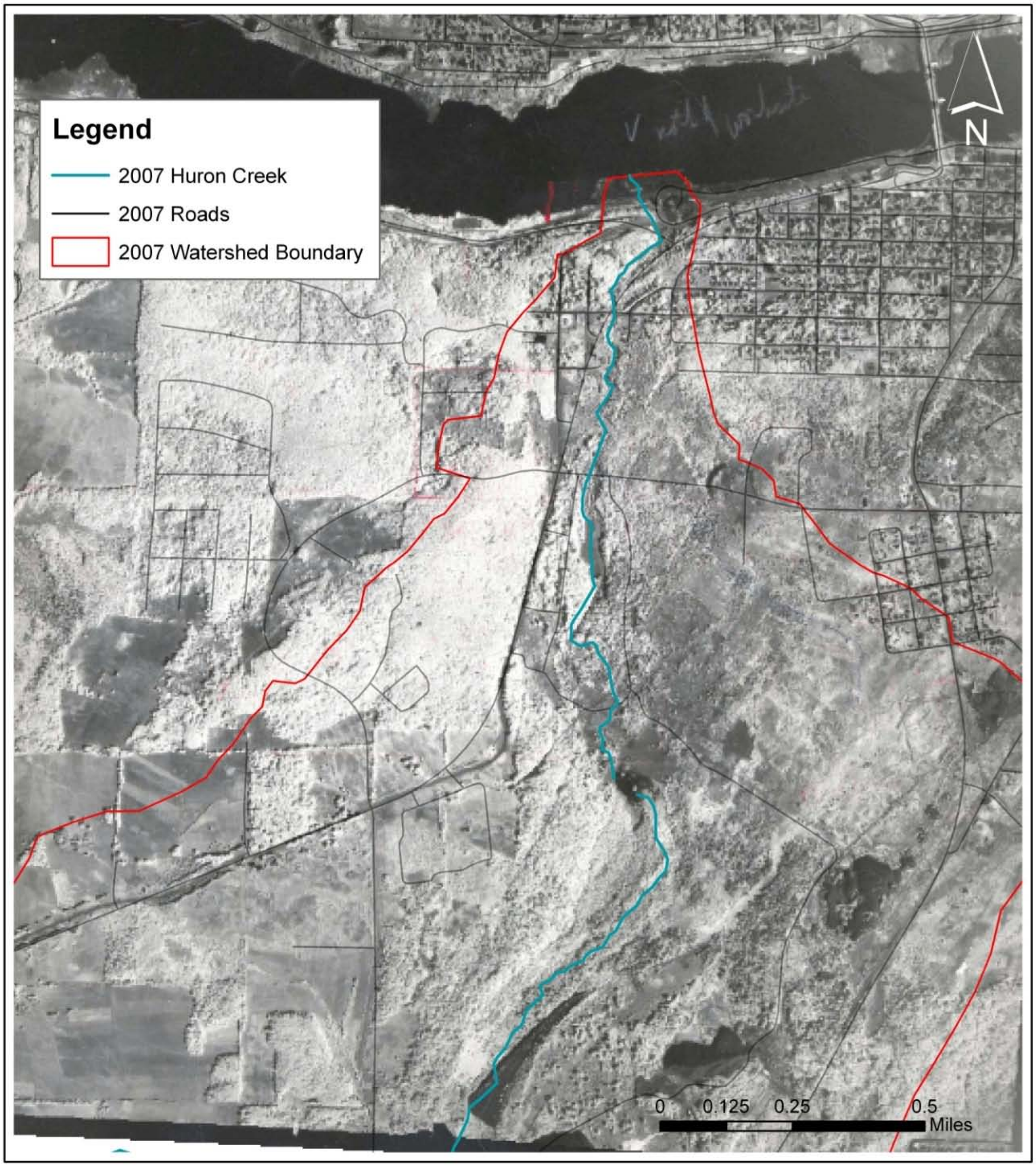


Figure 2.19 Aerial photo of Huron Creek watershed, 1963. Created by Linda Kersten, 10/24/07. Map projection: NAD 1927 UTM Zone 16N. Data sources: Houghton-Keweenaw Conservation District, courtesy of Bruce Peterson. Photo date: 9/13/63.

Despite copper mining's apparent negative impacts on the local environment, mining is an integral part of the region's cultural heritage. Mining brought immigrants from many countries to the area, underlying the cultural landscape that exists today. Many residents do the area have that at one time worked for a local mine, and would like to see the history and culture of the "Copper County" carried on for generations to come. The historical significance of the area has also been recognized by the United States federal government through the creation of the Keweenaw National Historic Park, owned and operated by the U.S. Department of Interior National Park Service (U.S. National Park Service, 2008).

3. Key Stakeholders & Public Participation in Plan Development

3.1. Initiation of the Watershed Management Plan

In the 20th century, Huron Creek and the surrounding watershed were recreational resources for local residents. Commercial development in the watershed during the period 1970 to the present has detracted from the attractiveness of the creek as a recreational and ecological resource. The Houghton Waterfront Park, located at the mouth of the creek is valued as a recreational area, but the local community has expressed a desire for improving the creek in the Waterfront Park. The City of Houghton Planning Commission is currently evaluating the current use of the commercial corridor on Highway M-26 as well as new residential expansion in the watershed. Specific water quality issues, such as leachate emanating from a landfill adjacent to the creek and potential contamination from decaying septic tanks near the creek, have raised concern in the community. The City of Houghton has implemented solutions to address the landfill leachate problem. Portage Township is considering expanding its sewer system to include the houses that presently utilize septic systems.

Particular attention to the creek was focused in summer 2003, when a local business (Wal-Mart) announced plans to expand its facilities. The expansion involved moving a portion of the creek channel and covering wetlands through which the creek flowed. The City of Houghton applied for and obtained approval for a wetlands fill permit, which allowed the expansion plans to move forward. The permit also contained measures for replacing the eliminated wetlands (mitigation). The expansion was completed in summer 2004.

The creek and watershed has been the center for a range of educational activities over the last decade. Students from the Houghton-Portage School District and Michigan Technological University have used the creek and the watershed as a “laboratory,” where approximately 200 secondary and 100 university students have studied land use impacts on water quality in the watershed. The Western Upper Peninsula Center for Science, Mathematics and Environmental Education has used the watershed as a training ground for over 50 secondary school teachers on integrating watersheds into natural and social science classroom activities.

The proposal to fund this management plan was formulated by students from Michigan Technological University, supervised by Professor Alex Mayer, director of Michigan Tech’s Center for Water & Society (CWS) over the period September 2005 to March 2006 (see Appendix A for a copy of the proposal). The proposal was submitted in March 2006 to the Michigan Environmental Quality’s Watershed Management Planning funding program. Community support for the proposal was secured by obtaining letters of support from several community organizations, as indicated in Table 3.1.

Table 3.1 Organizations Attaching Letters of Support to MDEQ Proposal

Organization	Role in Watershed
City of Houghton	Municipality encompassing ~ 33% of watershed and majority of residential-commercial activity
Moyle Construction, Inc.	Largest landowner and developer
B-H-K Child Development Board	Agency involved in childhood education and major landowner
Copper Country Chapter of Trout Unlimited	Organization dedicated to preserving habitat for fish
Copper Country Mental Health Services	Located directly on stream, user of stream for recreation
Friends of the Land of Keweenaw	Local non-governmental organization with environmental interests
Houghton Keweenaw Conservation District	Michigan conservation district encompassing watershed
Houghton Rotary Club	Organization with local representatives from business and community organizations, active in improving stream
Houghton-Portage Township Schools	Local school district, already use stream in science and social studies classes
Keweenaw Land Trust	Land conservancy organization
Keweenaw Memorial Fitness Center	Active in wide range of outdoor recreation in community, future site location next to stream
National Resource Conservation Service office	Local office responsible for resource management issues, including soil and water resource protection
Portage Township	Municipality encompassing ~67% of watershed
Wal-Mart	Largest business in watershed, located directly next to stream
Western UP Health Department	Agency responsible for protecting public health in area, including issues related to water quality

The proposal was funded in July 2007, with Professor Alex Mayer of Michigan Technological University Center for Water & Society as the principal investigator. The proposal included three primary project goals, given in the list below along with the objectives required to achieve each goal.

Goal 1: Monitor water quality to identify pollutants and critical areas in the Huron Creek Watershed:

- gather data and create maps of watershed bio-physical characteristics;
- identify critical areas and prioritize in terms of threat to water quality; and

- screen previous monitoring data, develop monitoring plan including an approved Quality Assurance Project Plan (QAPP), perform stream monitoring, and develop sustainable monitoring system

Goal 2: Improve water quality in the Huron Creek Watershed by addressing areas that are contributing pollutants to the creek:

- research Best Management Practices (BMPs) for improvement of water quality in critical areas need to be developed, including both physical improvements and policies for water quality protection;
- identify and describe alternative BMPs for improvement of water quality, including preliminary designs, costs, and descriptions of pros and cons for each alternative BMPs ; and
- complete watershed management plan for approval by DEQ.

Goal 3: Educate local citizens and landowners about water quality issues in the Huron Creek Watershed:

- form a self sustaining watershed advisory committee (WAC), and
- develop and implement watershed publicity program

3.2. Formation of Watershed Advisory Council

In anticipation of the development of a watershed management plan, Professor Hugh Gorman directed students in his spring 2006 Environmental Decision-Making course at Michigan Technological University to formulate a Watershed Advisory Council, in cooperation with Professor Alex Mayer. The students generated a list of critical stakeholder categories, e.g. businesses, government agencies, NGOs, and residents, and indentified relevant organizations and individuals in each category. As a result, about 50 individuals were invited to a public information meeting on the watershed on March 21, 2006. The public meeting was attended by 36 people, including a reporter from the local newspaper, the *Daily Mining Gazette*. Discussions and small group brainstorming sessions were held to generate ideas on the most important issues associated with the watershed. In the small groups at this meeting, the comments reflected a variety of different perspectives, such as:

- "One of the biggest concerns I have for the creek is the storm water runoff that is channeled from parking lots and streets."
- "Maintaining and protecting the natural landscapes that are left in Houghton is very important."
- "The greatest challenge facing Huron Creek is educating the community."

A second meeting was held on April 22, 2006. The meeting began with an interactive tour of the creek, with stops at locations of interest and discussions of different issues at each location. The meeting ended at the Houghton Waterfront Park, where attendees were divided into small groups, and asked the question "if you had a million dollars to improve the watershed, what would you spend it on?" The answers to this question can be grouped into the following categories.

- Improve creek at the waterfront park
- Improve water quality

- Improve the aesthetics of the creek
- Improve access to creek
- Improve use as habitat
- Educational opportunities

At the end of this meeting, the role of a Watershed Advisory Council (WAC) was discussed and attendees were asked if they were willing to be members of the Council. The general purpose of the WAC was described as guiding the Michigan Tech Center for Water & Society in the development of a Watershed Management Plan. This meeting was also covered by a reporter from the *Daily Mining Gazette*. As a result of this meeting, individuals volunteered to be members of the WAC. Table 3.2 indicates the WAC members and associated organizations. The list of members in Table 3.2 includes individuals who participated in the WAC at this meeting and over the next seven months.

Table 3.2 Watershed Advisory Council Members and Associated Organizations

Members	Organization
Glen Anderson	Western UP Health Department
Jim Baker	Copper Country Chapter of Trout Unlimited
Bruce Belmas	Houghton Middle School
Kristine Bradof	City of Houghton
Ron Cavallaro	Hitch Engineering
Joan Chadde	Western Upper Peninsula Center for Science, Mathematics & Environmental Education
Steve Delong	Keweenaw National Historic Park
Kevin Geschel	Moyle Real Estate and Development
Hugh Gorman	Michigan Tech Center for Water & Society
Don Kreher	Copper Country Chapter of Trout Unlimited
Katherine Kruse	Baraga-Houghton-Keweenaw Head Start
Jim Luoma	Houghton Middle School
Pete & Leslie Manderfield	Resident
Matt Manderfield	Resident
Alex Mayer	Michigan Tech Center for Water & Society
Jeff Moyle	Moyle Construction
Melanie Needham	U.P. Engineers and Architects
Ray Niemi	Houghton County Drain Commission
Bruce Peterson	Keweenaw Land Trust
Dave Rulison	Friends of the Land of Keweenaw
Jeremy Shannon	Copper Country Chapter of Trout Unlimited
Terry Smythe	Keweenaw Memorial Rehab and Fitness Center
Alice Soldan	Friends of the Land of Keweenaw
Ted Soldan	Friends of the Land of Keweenaw
Fred Zenner	Resident
Bob Zimmerman	Portage Township

A series of WAC meetings occurred over the next 12 months, with the purpose of identifying the critical areas and recommended measures for improvement to be included in the watershed management plan. Table 3.3 gives a list of the meetings and the principal topics of each meeting. The meetings included the development of a vision for the creek and watershed, discussions of geographically-distinguished stream segments with common environmental characteristics with respect to the vision, and discussions of relevant watershed planning topics. Each meeting was covered by the *Daily Mining Gazette*. The last meeting (4/28/07) was advertised to the public and involved presentations on the recommended measures for improvement to be included in the watershed management plan.

Table 3.3 Watershed Advisory Council Meetings

Date	Principal Topics
May 23, 2006	• purpose of watershed management plan • answers to “million dollar improvements “question • organize meetings
June 26, 2006	• vision statement • waterfront park interpretive sign
July 25, 2006	• state of the stream: Sharon Avenue to Frog Pool segment • landscape architecture
August 22, 2006	• state of the stream: Portage Canal to Canal Road segment • principles of macro-invertebrate community assessment
August 26, 2006	• field demonstrations of macro-invertebrate community assessment
September 11, 2006	• state of the stream: Canal Road to Sharon Avenue segment • stormwater management and low impact development
October 24, 2006	• state of the stream: Frog Pool to former Huron Lake segment • City of Houghton development plans • Moyle Inc. development principles and plans
November 14, 2006	• state of the stream: Huron Lake to Headwaters segment • categories of alternatives for watershed improvement — stormwater management — water quality — education and heritage — vegetation and wetlands and — improving the waterfront park
January 30, 2007	• formation of sub-committees to develop improvement alternatives
February 20, 2007	• development of improvement alternatives
March 20, 2007	• development of improvement alternatives
April 28, 2007	• public meeting on recommended actions

Several other public outreach activities have been organized and conducted through the Center for Water & Society, including the following

- 5/20/07: Storm drain stenciling with 20 adults and children.

- 6/1/07: Installation of watershed information sign at Houghton Waterfront Park by Bridge school teachers and students.
- 6/10/07: Sponsoring of two Houghton High School students to attend Lake Superior outreach conference.
- 8/20/07: Watershed litter pickup day with 12 adults and children.
- 4/26/08: Watershed litter pickup day with 8 adults and children.
- 7/7/08: Public meeting presenting a draft of the watershed management plan document.

3.3. Watershed Management Plan Development

The development of the Watershed Management Plan has been coordinated by Professor Alex Mayer. Linda Kersten, a Master's student in Environmental Engineering at Michigan Tech, is the principal writer of the plan. Ms. Kersten has also supervised students involved in the project. Bio-physical and socio-political information has been collected by more than 30 undergraduate and graduate students through the Engineering Senior Design, Environmental Decision-Making, and other classes at Michigan Tech from fall 2005 through fall 2008.

The development of the Watershed Management Plan culminated in a one-month public review period in which the public was invited to review and provide comment on the plan. The review period was announced in a press release in the local newspaper which described locations and dates a draft of the plan could be accessed. The draft was made available at the Houghton Public Library and on the web at from June 9th to June 30th 2008. Shortly after the public review period ended (July 7, 2008) a public meeting was held to present the main parts of the plan and to collect additional public comments. This document has been revised according to the comments received during this period. These comments are listed in Appendix U.

4. Designated Uses and Water Quality Summary

4.1. Designated and Desired Uses

The Michigan Environmental Protection Act (P.A. 451 of 1994, Part 31, Chapter 1) identifies eight[8] designated uses for Michigan's waterways:

- Agriculture – Surface water must be of the quality that it can be used for livestock watering, irrigation and spraying crops.
- Industrial water supply – Surface waters must be clean enough to be used for commercial or industrial applications or non-contact food processing.
- Public water supply at the point of intake – After conventional treatment, surface waters must provide a source of water that is safe for human consumption, food processing, and cooking.
- Navigation – Surface waters must be of the quality sufficient for passage of boat traffic.
- Warmwater fishery – Water bodies designated as warmwater fisheries should be able to sustain populations of fish species such as bass, pike, walleye and panfish.
- Habitat for other indigenous aquatic life and wildlife – Surface waters must support fish, other aquatic life and wildlife that use the water for any stage of their life cycle. This designated use also includes the protection of fish for human consumption.
- Partial body contact recreation – Residents of the state should be able to use surface waters for activities that involve direct contact with the water but does not involve the immersion of the head. Such partial body contact activities include fishing, wading, hunting and dry boating.
- Total body contact recreation between May 1 and October 31 – The waters of the state should allow for activities that involve complete submersion of the head such as swimming. Activities that have considerable risk of ingesting the water are also part of this designated use.

Designated uses are recognized uses of water established by state and federal water quality programs. In Michigan, the goal is to have all waters of the state meet all designated uses (Elaine Brown, Amy Peterson, Ruth Kline-Robach, Karol Smith, Lois Wolfson, 2000). Table 4.1 lists designated uses and their status for the Huron Creek watershed. If a designated use is not being met according to the State of Michigan's water quality standards, that use is impaired. Or more specifically, when the impairment is confirmed by state water quality testing, those portions of the water body are said to be in "non-attainment." An annually published listing of the bodies of water and stream reaches in the state of Michigan that are in non-attainment can be found in the MDEQ's Section 303(d) Report.

[8] A ninth designated use, "coldwater fishery," can also apply to certain water bodies that meet this designation. (R323.1100 of Part 4, Part 31 of PA 451.)

The MDEQ uses a rotating watershed cycle for surface water quality monitoring where each of the 58 major watersheds in the state is scheduled for monitoring at least once every five years (MDEQ Water Bureau, 2004). Huron Creek was monitored by MDEQ (as a portion of the Portage Lake watershed) in 2001 and 2006 at two locations between Sharon Avenue and Wal-Mart. In both monitoring events, concentrations of copper were in exceedance of the state aquatic life protection values (MDEQ Water Bureau, December 2007). Therefore, this portion of Huron Creek was identified as being in non-attainment of the water quality standards for aquatic life and wildlife, and was listed in the Michigan 2008 Sections 303(d), 305(b), and 314 Integrated Report (http://www.michigan.gov/documents/deq/wb-swas-ir-final-2008report_230026_7.pdf) as "Not Supporting Other Indigenous Aquatic Life and Wildlife" due to copper levels. A total maximum daily load (TMDL) is scheduled to be developed in 2013. In addition to the high copper levels, water quality testing during 2007-8 has indicated (see Section 5.1) that ammonia levels have exceeded water quality standards for aquatic life and wildlife.

Two other designated uses, Partial Body Contact Recreation and Total Body Contact Recreation are designated as impaired, due to concerns associated with contact with human wastes. As described in Section 2.2.1, homes in the Dakota Heights area are not connected to a municipal sewer system and rely on septic systems for treatment and disposal of household wastewater. These septic systems are a potential concern for the Huron Creek watershed because many of these septic systems are old, their condition is unknown, and, in several cases, the septic systems are within 100 feet of the creek. Use for partial body contact recreation occurs downstream of the Dakota Heights area, where the creek flows through the Kestner Waterfront Park. Furthermore, the creek empties into the Portage Canal approximately 700 feet east of a public swimming beach.

Table 4.1 Huron Creek Watershed Designated Uses

Designated Use	Status	Justification
Agriculture	Not threatened or impaired	- Currently, approximately 3% of the land use in the watershed is for agriculture. Land use for this purpose is not anticipated to increase in coming years. - Existing agricultural areas utilize rain for watering.
Industrial Water Supply	Not threatened or impaired	The average quantity of flow[1] is not sufficient to support industrial use.
Public Water Supply	Not threatened or impaired	- Huron Creek is not currently used as a public source of drinking water. - The average quantity of flow is not sufficient to support use as a public (or private) water supply, even if drinking water quality standards were attained. - Residents in the watershed use municipal systems or domestic groundwater wells for water supplies
Navigation	Not threatened or impaired	The average quantity of flow, size and depth are not sufficient to provide for floatation of a vessel, including canoes or kayaks.

Designated Use	Status	Justification
Warmwater Fishery	Not threatened or impaired	It is unknown if Huron Creek historically sustained fish populations. Currently no fish populations are sustained and it is not a goal to establish them.
Aquatic Life and Wildlife Habitat	Impaired	Per MDEQ report dated December 2007 and recent water quality testing[2].
Partial Body Contact Recreation	Threatened	-Dakota Heights septic systems -Use for partial body contact recreation occurs where the creek flows through the Houghton waterfront park.
Total Body Contact Recreation	Threatened	-Dakota Heights septic systems The creek empties into the Portage Canal approximately 700 feet east of a public swimming beach.
Coldwater Fishery	Not threatened or impaired	It is unknown if Huron Creek historically sustained fish populations. Currently no fish populations are sustained and it is not a goal to establish them.

1. The phrase "average quantity of flow" refers to typical flow rates in the creek based on ideal or "natural" conditions.
2. Water quality sampling results are provided in Section 5.1.

Desired uses of Huron Creek and its watershed have been determined by the Huron Creek watershed advisory committee. They are stated by the committee's vision statement:

> *"We see Huron Creek and its watershed as valuable to the residents of Houghton County in maintaining a sense of place compatible with the area's character. In particular, we desire a watershed and stream that:*
>
> 1. *Is visually attractive and includes a stream-side vegetation buffer that is visible on the landscape;*
> 2. *Provides habitat for a healthy ecosystem within an urban setting;*
> 3. *Provides opportunities for human interactions with the stream ecosystem, with the Houghton Waterfront park and the former Huron Lake being prime sites for interaction;*
> 4. *Has water quality that is consistent with the previous three goals;*
> 5. *Provides opportunities for community education (including schools, business owners, and the public in general) on the importance of healthy watersheds and in the historical uses of this particular watershed, with interpretive signs at sites of interaction being one possible form of education."*

4.2. Pollutants, Sources and Causes

Table 4.2 provides a summary of applicable designated uses and the pollutants of concern related to these uses. Also listed are potential sources of pollutants and their causes. This table provides the framework for the protection of water quality through the watershed management plan. Table 4.3 gives water quality standards for the parameters of concern in the watershed.

Table 4.2 Huron Creek Watershed Pollutants, Sources and Causes

Impaired/ Threatened Use[1]	Pollutant or Concern[2]	Sources of Pollutants	Causes of Pollutants
Aquatic Life & Wildlife Habitat (I)	Metals (Copper, k; Iron, s)	Stamp sands (k)	Historical mining activities (k)
		Landfill leachate (k)	Unlined and/or Uncapped Landfills (k)
	Sediments (k)	Bank erosion (k)	Flashy storm flows/impervious surfaces (k) Unvegetated banks (k) Steep banks (s)
		Construction (k)	Lack of erosion control/stabilization (k) Improper erosion control/installation (k) Improper construction techniques (s)
		Stormwater (k)	Sand spreading in winter (k) Lack of retention/detention, infiltration (k)
	"Flashy" Flow (k)	Impervious surfaces (k)	Lack of infiltration areas (k) Lack of stormwater retention/detention (k)
	Nutrients (s)	Old Houghton Landfill (s)	Materials disposed of in landfill (s)
		Septic systems (s)	High density/age of systems (k) Improper design/cesspools (k)
		Lack of Vegetative Buffer (k)	Lack of stream setback (k) Construction & disturbance (k)
		Stormwater (s)	Residential and commercial fertilizers (s) Lack of infiltration areas & buffers (s)
	Invasive Species (k)	"Source" vegetation seed/plant dispersal (k)	Disturbance/lack of establishment by native vegetation (k)
Partial Body Contact Recreation (T)	Bacteria (s)	Septic systems (s)	High density/age of systems (s) Improper design/cesspools (s)
Total Body Contact Recreation (T)	Bacteria (s)	Septic systems (s)	High density/age of systems (s) Improper design/cesspools (s)

[1] (I) = Impaired, (T) = Threatened.
[2] (k) = Known, (s) = Suspected.

Pollutants, sources and causes are designated as "known" if:

- Multiple water quality sampling events have documented the pollutant to be in exceedance of a state or federal standard.

- The pollutant, source or cause is readily observable under normal conditions and has been observed and/or documented.
- There is likely only one cause for the pollutant or source (i.e. historical mining activities created stamp sand piles that have been documented to leach metals such as copper and iron).

Pollutants, sources and causes are designated as "suspected" if:

- The pollutant has been documented to be in exceedance of a state or federal standard at least once.
- The pollutant, source or cause is not easily observable (i.e. nutrients entering a stream) but is likely, given conditions in the watershed (i.e. presence of commercial and residential lawn areas, and algal growth in creek).
- The pollutant, source or cause has potential to inhibit the designated use through aesthetic or physical means. An example of this would be iron flocculent reducing aesthetic value (appearance) and likely inhibiting periphyton growth due to flocculent settling and coating of the creek substrate.

Table 4.3 Water Quality Standards Relevant to Concerns in Huron Creek Watershed

Water Quality Parameter	Designated Use	Standard
Copper	FAV[1] for aquatic life protection	0.027 mg/L
	FCV[2] for aquatic life protection	0.009 mg/L
Ammonia-N	FAV[1] for aquatic life protection	0.32 mg/L
	FCV[2] for aquatic life protection	0.029 mg/L
Fecal Coliform	Total body contact recreation	130 E. coli/100 mL[3]
	Total body contact recreation	300 E. coli/100 mL[4]
	Partial body contact recreation	1,000 E. coli/100 mL[5]

[1] Final Acute Value
[2] Final Chronic Value
[3] based on 30-day geometric mean
[4] geometric mean of three or more samples taken during the same sampling event
[5] geometric mean of 3 or more samples

4.2.1. Metals: Copper and Iron

The two metals that are of concern in Huron Creek are copper and iron. Copper has been documented multiple times to be in exceedance of the Michigan Rule 57 aquatic life protection (see Table 4.3 for standards) through MDEQ and MTU water quality sampling[9] (MDEQ Water Bureau, December 2007). Because historical copper mining activities have occurred in the watershed resulting in deposited piles of stamp sand and mine rock, it lends itself as the most likely cause. Stamp sands have been shown to

[9] MTU water quality monitoring results are provided in Section 6.1.

leach various metals such as copper, silver and mercury (W. Charles Kerfoot, S.L. Harting, Ronald Rossman, John A. Robbins, Unknown).

Iron in Huron Creek is most noticeable just upstream of Sharon Avenue where plumes of yellow-orange flocculent-looking material are present year-round. Figure 4.1 shows photos from this location. This material is often referred to as "yellow-boy." Yellow boy is typically associated with elevated levels of iron that stimulate the growth of iron-loving bacteria, thereby creating a slime-like plume. As the plumes are located next to the site of the former Houghton landfill, it appears that the landfill is the source of iron for the bacteria. Yellow-orange seepage has been observed coming from the side slopes of the landfill, which is pictured in Figure 4.1. The landfill opened in the 1970's and was used for only a few years before it closed (Greer, 2007).

Although there is no Michigan aquatic life protection water quality standard for iron, the presence of plumes such as these affect the appearance and aesthetic value of the creek. The plumes also create a slime that covers the creek bottom substrate, thereby eliminating habitat for periphyton (organisms that live on the substrate) and altering the creek ecosystem. Iron concentrations in the creek and the landfill are discussed further in Chapter 5 and Chapter 7, respectively.

Figure 4.1 (a) Iron bacteria plume in Huron Creek and (b) leachate seepage from nearby bank

4.2.2. Sediments

Sediments are also a visible problem in Huron Creek. Bed deposition of sediment is visible at many locations, and is caused by a variety of factors.

In some cases, erosion has been caused by storm events washing away sandy bank areas that are not well vegetated. Sudden increases in the creek's water level from storm events can cause incision of the creek (creation of steep banks) which in turn can cause slumping or failing of the banks. This type of erosion is evident in Huron Creek's "tributary," Shopping Cart Creek which runs between the Copper Country Mall and the Wal-Mart storm ponds, as well as in the Houghton Waterfront Park. This is not to say that some sediment transport in a stream is abnormal. It is the excess amounts of sediment that are of concern. The amount of sediment coming down the creek is large enough to warrant the city of Houghton physically removing it from the creek bed each year in the waterfront park area.

Construction near the creek can also contribute to sediment deposition. Lack of proper erosion control can allow stormwater to wash sediments directly into the creek, or into ditches that reach the creek. Or, if the erosion control is not properly installed (for example putting stakes on the wrong side of a silt fence), it can become essentially useless. In addition to proper erosion control, construction sites need to ensure the site is properly stabilized after construction is completed. This generally includes establishment of some type of vegetation to stabilize and hold soils in place. The portion of the creek located adjacent to the landfill (just north of Sharon Avenue) is an example of a construction area that is in need of additional stabilization. Other sources of sediment in the watershed include sand from road spreading in the winter, and stormwater runoff from parking lots and other impervious areas (including the non road spreading season). Because of the relatively high amount of snow that the Houghton area receives each winter, a relatively large amount of sand is spread on roads and parking lots each year for automobile safety.

Deposition of sediment can result in covering of the creek bed substrate (rocks, gravel, woody debris) that results in loss of habitat, cover and reproduction areas for macro-invertebrates and other aquatic life such as amphibians and small fish. Sediment that remains suspended in the water also reduces visibility for predators of aquatic life. These factors can result in a total collapse of the aquatic ecosystem.

4.2.3. "Flashy" Flow

The term "flashy" flow refers to when a creek or river's water level increases then decreases more rapidly during a storm than it would under non-developed conditions. The reason why flows change more rapidly under developed conditions is because impervious surfaces (streets, roofs, parking lots) and storm sewers route rainwater to the creek much more rapidly than if the watershed was undeveloped (mostly vegetation). The peak flow rate (highest rate of flow during a storm) also tends to increase in developed watersheds. This and the rapid change of flow rate can contribute to additional erosion of stream banks. This is generally prevented through the use of stormwater management practices such as stormwater detention or retention basins and infiltration areas (bioswales, infiltration basins, rain gardens). Figure 4.2 demonstrates the differences between pre-development and post-development storm flows.

4.2.4. Nutrients

The term "nutrients" generally includes ammonia, nitrates and nitrites and phosphorus. These compounds can harm water quality by causing excessive algal growth. This excessive growth blocks sunlight for other aquatic plants leading to reduced dissolved oxygen levels, and can result in the deposition of foul-smelling algae mats when water levels are low. Algae mats can reduce aesthetic value and appearance, and prevent recreational use. Algae blooms have been most often noticed in Huron Creek in the Kestner waterfront park in the mid- to late summer months. Of the class compounds described as nutrients, only ammonia has a water quality concentration standard in Michigan (see Table 4.3 for standards).

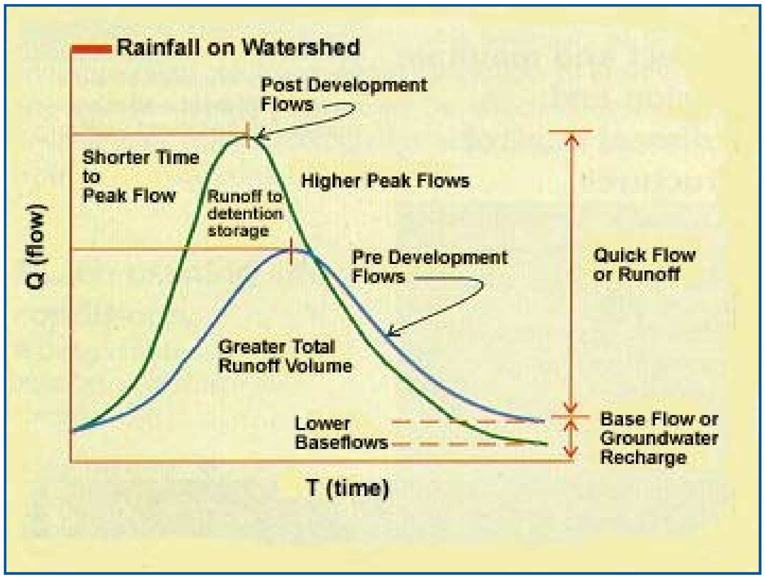


Figure 4.2 Pre- and Post-development Hydrograph Comparison[10]

Nutrients can have many sources within a watershed, especially those that have urban and residential areas. One of the most common sources is fertilizers. Fertilizers that are inappropriately applied can travel through stormwater runoff to nearby storm drains and water bodies. Examples of inappropriate application would include applying too much, applying at the wrong time of year, or too frequently. Nutrients from fertilizers can be prevented from reaching the creek by maintaining vegetative buffers or through use of stormwater infiltration areas. These areas infiltrate stormwater into the soil where natural microbial "treatment" can occur that removes the nutrients before the stormwater can reach the creek.

Aging or improperly constructed septic systems could also potentially contribute to the presence of nutrients in Huron Creek. There are residential areas in the watershed that are not connected to a municipal sewer and therefore use septic systems for sewage treatment. As mentioned in Chapter 2, the Dakota Heights neighborhood in Portage Township is suspected to have extremely old and/or inappropriately constructed septic systems. Human sewage is generally high in nutrients such as ammonia and nitrates, and depending on hydraulic interactions between the groundwater and Huron Creek, there is a potential for sewage to reach the creek (Bingham, MacInnes, & Tarbutton, 2008).

4.2.5. Invasive Species

Invasive plant species have been identified in the Huron Creek re-route mitigation area near Wal-Mart. These species include white sweet clover (*Melilotus alba*), yellow sweet clover (*Melilotus officinalis*) and spotted knapweed (*Centurea biebersteinii*), and are relatively dense in this area. Other invasive plant species have been identified within the watershed but are sparsely located compared to the creek re-route area. Invasive aquatic species (such as Eurasian milfoil) have not yet been identified in the Huron Creek watershed.

[10] http://www.env.gov.bc.ca/wat/wq/nps/NPS_Pollution/Stormwater_Runoff/SW_Main.htm

Invasive plant species generally have special physical adaptations that allow them to out-compete native species. This is detrimental to whatever habitat the species is invading (including riparian areas) as it results in the elimination of the mix of vegetation (and therefore the type of habitat) that is required by native insects, birds and other wildlife. Some invasive species have the ability to alter soil characteristics so that other plants can never re-establish.   Control of these species would help prevent their spread to other portions of the watershed where other native habitats might be affected or eliminated.

4.2.6. Bacteria

Coliform bacteria such as *E. coli* exist in human sewage. These bacteria can potentially reach Huron Creek by means of leaking from aging or improperly constructed septic systems within the watershed. Coliforms are a pathogen (a biological agent that can cause illness) and therefore are of concern for any water body that is used for partial or full body contact recreation (Tarbutton, 2008). Concentrations of the bacteria were found to be in exceedance of the Michigan coliform Human Body Contact standard (see Table 4.3 for standards) at one location[11] along the creek in August 2007. However, the August 2007 sampling event is the only one out of six recent sampling events to indicate a quantifiable concentration of coliforms. Also, concentrations of all parameters measured were higher than normal during that sampling event due to an extremely low amount of flow in Huron Creek (see water quality monitoring data in Section 5.1).

4.3. Water Quality and Other Watershed Goals

The watershed management plan goals described below are based on restoration and protection of the designated uses stated in Section 4.2. They are also based on achievement of the desired watershed uses as outlined by the Huron Creek watershed advisory committee's mission statement. These goals present a conceptual picture of the anticipated future state of the watershed. These goals can be modified as necessary to meet the changing needs and desires of the watershed stakeholders.

Table 4.4 Water Quality and Other Watershed Goals for Huron Creek

Designated or Desired Use	Goals
Aquatic Life & Wildlife Habitat (Impaired)	Improve and protect aquatic and terrestrial ecosystems by: - Reducing copper and iron, sediment and nutrient levels - Reducing the "flashiness" of flow through stormwater management techniques - Protecting and improving the vegetative buffer - Controlling the establishment of invasive species
Partial Body Contact Recreation (Threatened)	Protect recreational use by reducing copper and iron, bacteria and nutrient concentrations in the creek.
Total Body Contact Recreation (Threatened)	Same goal as partial body contact.
Have a visually attractive creek corridor that is visible on the landscape	Protect and improve the vegetative buffer

[11] The location of exceedance was the "Frog Pool" (FP) sampling location (see Figure 6.1).

Designated or Desired Use	Goals
Provide habitat for a healthy ecosystem in an urban setting	Same goals as Aquatic Life & Wildlife Habitat
Provide opportunities for interaction with the creek	- Improve and restore the creek areas in the Houghton waterfront park and maintain access to creek - Encourage use of the Wal-Mart wetland mitigation area for educational and outreach purposes
Ensure water quality that is consistent with visual attractiveness, ecosystem health and safe human interaction	Same goals as Aquatic Life & Wildlife Habitat
Provide opportunities for community education	Install interpretive signs on watershed health and historical heritage

5. Summaries of Studies and Data Collection

5.1. Water Quality Monitoring

Water quality sampling of the Huron Creek watershed has been completed in effort to characterize the overall water quality of the watershed, as well as to identify which parameters, if any, exceed existing standards. In this way, pollutants are identified and a platform is created from which further investigations and water-quality based improvement projects are launched.

5.1.1. Results from Previous Studies

The Michigan Department of Environmental Quality has conducted several water quality campaigns on Huron Creek since 2000, primarily in connection with water quality issues associated with the City of Houghton landfill. The results of these efforts are discussed in Chapter 6. Huron Creek has been monitored for water quality by several local educational institutions, including Houghton Middle School and Michigan Technological University over the last decade. The majority of these water quality sampling and analysis efforts has followed informal protocols and are not listed in this document. However, they have been compiled by the MTU Center for Water & Society (CWS) and can be examined by contacting the CWS Director (asmayer@mtu.edu).

5.1.2. Results from Quarterly Monitoring 2006-2008

Quarterly water quality monitoring of Huron Creek was completed by the MTU Center for Water & Society between November 2006 and May 2008. For each monitoring event, sampling was completed at five different locations, each chosen to reflect the water quality of a specific portion of the creek. These locations are indicated in Figure 5.1 and are described as follows, listed from upstream to downstream:

- Green Acres (GA) – This site is farthest upstream and is assumed to characterize water quality that has not been affected by development and disturbance.
- Downstream of Wetland (DWL) – This sampling site is downstream of the former Huron Lake, which is now a wetland mitigation site. This site is also downstream of residential areas that use septic systems and is the last location upstream of commercial development.
- Frog Pool (FP) – This site is the first downstream of commercial areas but is upstream of the former City of Houghton landfill.
- Landfill (LF) – This sampling location is immediately downstream of the former landfill that is located adjacent to Huron Creek. The placement of this site is intended to detect impacts the landfill may have on water quality.
- Houghton Waterfront Park (HWP) – This site is located near the mouth of Huron Creek in the Houghton Waterfront Park. This sampling location is utilized to characterize the aggregate water quality impacts of the entire watershed.

Figure 5.1 Water quality monitoring locations

At each of these locations, field data collection was completed as well as sample collection for laboratory analysis. A photo was also taken of the creek at each location to provide a record of flow conditions at that time. All details of sampling including parameters, analysis methods, sampling methods, equipment used and quality control are described in the Huron Creek Quality Assurance Project Plan (QAPP) for Water Quality Sampling that is provided as Appendix B. This QAPP was reviewed and approved by MDEQ to ensure that appropriate methods for sampling and data collection were utilized. All laboratory analysis was completed by White Water Associates, Inc. of Amasa, Michigan.

Water quality parameters were chosen to provide basic hydro-geochemical data and to detect potential impacts associated with the development activities that have taken place in the watershed including mining, residential development, and commercial development. These parameters are listed in Table 5.1.

Table 5.1 Water Quality Parameters Analyzed During Quarterly Sampling

Field-Analyzed Parameters
Air Temperature
Conductivity
Dissolved Oxygen
pH
Turbidity
Water Temperature
Laboratory-Analyzed Parameters
Alkalinity
Ammonia-N
Arsenic (total) [1]
Barium (total) [1]
Cadmium (total) [1]
Chromium (total) [1]
Copper (total) [a]
Hardness
Iron (total)
Lead (total) [1]
Manganese (total)
Mercury (total) [1]
Nitrate/Nitrite-N
Selenium (total) [1]
Silver (total) [1]
Total Kjeldahl Nitrogen
Total Phosphorus
Zinc (total) [1]

[1] These compounds are referred to the "Michigan 10 Metals"

The results of water quality sampling are provided in

Table 5.2. Samples labeled “FL” were duplicate samples collected at the landfill (LF) site for quality control purposes. Graphs of results for parameters yielding a significant number of data points (few to zero “no detects”) are provided in Figure 5.2 through Figure 5.15. Calculations related to quality assurance are provided as Appendix C. All water quality data has been supplied to MDEQ for inclusion into the U.S. Environmental Protection Agency’s Storage and Retrieval (STORET) Database. The Michigan Final Chronic Value (FCV), Aquatic Maximum Value (AMV) and Final Acute Value (FAV) are water quality standards based on the chronic (long-term) exposure threshold, maximum recommended threshold and acute (one-time) exposure threshold for aquatic life such as fish and macro-invertebrates, respectively. These standards are used for comparison to the collected data because Huron Creek’s parameter concentrations generally fall below or near them, and Huron Creek is not utilized as a drinking water source. The recommended parameter standards listed by MDEQ as Human Non-Cancer Values (HNVs) for drinking water or human body contact are generally significantly higher than those designated for protection of aquatic life. For example, the HNVs for copper are 0.47 mg/L (drinking water) and 38 mg/L (human body contact) compared to the aquatic thresholds which range from 0.009 to 0.027 mg/L[12].

[12] Based on an average hardness of 100 mg/L.

Table 5.2 Water Quality Monitoring Results for Huron Creek (11/16/06 – 5/9/08)

Event	Location	Alkalinity	Ammonia-N	Hardness	Iron (t)	Manganese (t)	Arsenic (t)	Barium (t)	Cadmium (t)	Chromium (t)	Copper (t)
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
11/1/06	GA	69	0.05 J-	79.2	--	--	ND	0.0205	ND	0.0010 J-	ND
	DWL	63	ND	88.5	--	--	ND	0.0095	ND	0.0007 J-	0.010 J-
	FP	82	ND	111	--	--	ND	0.0101	ND	0.0010 J-	0.015 J-
	LF	127	0.15	174	--	--	ND	0.0264	ND	0.0017 J-	0.065
	HWP	139	0.09 J-	193.6	--	--	ND	0.0252	ND	0.0011 J-	0.048
2/7/07	GA	63	0.1	71.3	1.04	0.228	ND	0.026	ND	0.0027	0.0064
	DWL	84	0.1	106	0.35	0.0682	ND	0.0106	ND	ND	0.0066
	FP	99	0.11	127	0.33	0.205	ND	0.0132	ND	0.0014	0.018
	LF	124	0.14	163	1.7	0.388	ND	0.022	ND	0.0012	0.0315
	HWP	130	0.16	175	1.05	0.318	ND	0.0232	ND	0.0018	0.0369
5/7/07	GA	60	0.1	65.3	0.15	0.0256	ND	0.0152	ND	ND	ND
	DWL	54	0.08	68	0.32	0.0307	ND	0.0068	ND	ND	0.008
	FP	43	0.08	82.1	0.2	0.0587	ND	0.008	ND	ND	0.022
	LF	75	0.11	124	0.99	0.212	ND	0.0163	ND	ND	0.034
	FL	76	ND	106	0.89	0.196	ND	0.0153	ND	ND	0.031
	HWP	71	0.09	141	0.77	0.164	ND	0.0183	ND	ND	0.04
8/7/07	GA	94	0.08	89	0.62	0.166	ND	0.045	ND	0.001	0.0034
	DWL	191	0.32	188	1.76	1.24	ND	0.036	ND	ND	0.0518
	FP	218	0.07	232	0.43	0.97	ND	0.0268	0.001	ND	0.074
	LF	181	0.34	279	3.28	1.04	ND	0.0543	ND	ND	0.0523
	FL	186	0.32	277	3.22	0.997	ND	0.0519	ND	ND	0.0516
	HWP	180	0.06	250	0.31	0.108	ND	0.0296	ND	ND	0.0261
12/5/07	GA	54	0.1	57.9	0.34	0.0628	ND	0.0155	ND	0.0012	0.004
	DWL	68	ND	76.5	0.23	0.0902	0.01	0.0083	ND	ND	0.0089
	FP	86	ND	91	0.19	0.0924	0.01	0.009	ND	0.0007	0.0185
	LF	100	0.07	116	0.71	0.203	ND	0.0146	ND	ND	0.0357
	FL	99	0.08	124	0.68	0.201	ND	0.0138	ND	0.0006	0.0322
	HWP	106	0.05	129	0.49	0.18	ND	0.0157	ND	ND	0.0354
2/27/08	GA	54	0.06 J-	63.6	0.48	0.087	ND	0.0179	ND	0.002	0.006
	DWL	80	ND	93.3	0.11	0.013	ND	0.0078	ND	0.001	0.014
	FP	88	ND	97.6	0.16	0.061	ND	0.0093	ND	0.001	0.017
	LF	104	0.09 J-	132	0.70	0.201	ND	0.016	ND	0.001	0.032
	FL	102	0.09 J-	125	0.68	0.201	ND	0.0155	ND	0.001	0.03
	HWP	110	0.08 J-	147	0.54	0.181	ND	0.0168	ND	0.002	0.035
5/9/08	GA	40	ND	45.4	0.129	0.017	ND	0.0129	ND	0.0007	0.003
	DWL	48	0.08	53.2	0.175	0.041	ND	0.0065	ND	ND	0.01
	FP	56	0.07	62.8	0.164	0.036	ND	0.0069	ND	0.0006	0.019
	LF	66	0.06	84.9	0.309	0.076	ND	0.0099	ND	0.0016	0.031
	FL	68	0.08	66.6	0.283	0.075	ND	0.0098	ND	0.0004	0.03
	HWP	71	0.07	101	0.277	0.064	ND	0.0114	ND	0.0008	0.034

MI Standard (mg/L)	FCV	N/A	0.029	N/A	N/A	1.258	0.15	0.472	0.003	0.074	0.009
	AMV	N/A	0.16	N/A	N/A	2.471	0.34	1.438	0.005	0.570	0.013
	FAV	N/A	0.32	N/A	N/A	4.543	0.68	3.004	0.005	1.140	0.027

Event	Location	Lead (t) mg/L	Mercury (t) mg/L	Selenium (t) mg/L	Silver (t) mg/L	Zinc (t) mg/L	Nitrate/Nitrite-N mg/L	Total Kjeldahl Nitrogen mg/L-N
11/1/06	GA	0.0006 J-	ND	0.002 J-	ND	0.005 J-	0.17	0.48
	DWL	0.0007 J-	ND	ND	ND	0.004 J-	ND	0.88
	FP	0.0006 J-	ND	ND	ND	0.006 J-	0.03 J-	0.92
	LF	0.0011 J-	ND	0.001 J-	ND	0.008 J-	0.25	0.47
	HWP	0.0010 J-	ND	0.001 J-	ND	0.012	0.08 J-	ND
2/7/07	GA	ND	ND	ND	ND	0.006	0.21	0.7
	DWL	ND	ND	ND	ND	ND	0.26	0.26
	FP	ND	ND	0.001 J-	ND	0.006	ND	0.32
	LF	ND	ND	ND	ND	ND	ND	0.31
	HWP	ND	ND	ND	ND	0.01	0.3	0.47
5/7/07	GA	ND	ND	ND	ND	ND	ND	ND
	DWL	0.006	ND	ND	ND	ND	ND	ND
	FP	ND	ND	ND	ND	ND	ND	ND
	LF	ND	ND	ND	ND	ND	0.14	ND
	FL	ND	ND	ND	ND	ND	0.09	ND
	HWP	ND	ND	ND	ND	ND	0.40	ND
8/7/07	GA	ND	ND	ND	ND	0.009	0.08	0.37
	DWL	ND	ND	ND	ND	0.006	17.0	2.4
	FP	ND	ND	ND	ND	0.008	0.07	0.41
	LF	ND	ND	ND	ND	0.007	0.67	0.55
	FL	ND	ND	ND	ND	0.007	0.16	0.55
	HWP	ND	ND	0.02 J-	ND	ND	0.87	0.31
12/5/07	GA	ND	ND	ND	ND	0.01 J-	0.25	0.71
	DWL	ND	ND	ND	ND	0.01 J-	0.24	0.61
	FP	ND	ND	ND	ND	0.01 J-	ND	0.62
	LF	ND	ND	ND	ND	0.01 J-	0.07 J-	0.38
	FL	ND	ND	0.02 J-	ND	0.02 J-	0.10 J-	0.62
	HWP	ND	ND	0.02 J-	0.0013 J-	0.02 J-	0.36	0.31
2/27/08	GA	ND	ND	ND	ND	ND	0.54 M+	1.3
	DWL	ND	ND	ND	ND	ND	ND M+	0.42
	FP	ND	ND	ND	ND	ND	0.06 J-	ND
	LF	ND	ND	ND	ND	0.01 J-	0.1 J-	0.34
	FL	ND	ND	ND	ND	0.01 J-	0.17	0.25
	HWP	ND	ND	ND	ND	0.01 J-	0.35	0.3
5/9/08	GA	ND	ND	ND	ND	ND	ND	0.89
	DWL	ND	ND	0.011	ND	0.006	ND	ND
	FP	ND	ND	0.018	ND	0.008	0.04	0.22
	LF	ND	ND	ND	ND	0.007	0.08	0.2
	FL	ND	ND	ND	ND	0.008	0.08	0.2
	HWP	ND	ND	ND	ND	0.01	0.07	ND

MI Standard (mg/L)		Lead (t)	Mercury (t)	Selenium (t)	Silver (t)	Zinc (t)	Nitrate/Nitrite-N	Total Kjeldahl Nitrogen
	FCV	**0.004**	0.00077	0.005	0.00006	**0.118**	N/A	N/A
	AMV	**0.068**	0.0014	0.062	0.00054	**0.117**	N/A	N/A
	FAV	**0.135**	0.0028	0.12	0.0011	**0.234**	N/A	N/A

Event	Location	Total Phosphorus mg/L	Fecal Coliform 10 - 10,000 Count cfu/100ml	Conductivity µS/cm	Turbidity NTU	pH --	Dissolved Oxygen mg/L	Temperature ºC
11/1/06	GA	ND	--	93.5	0.65	8.03	10.50	4.0
	DWL	ND	--	135.9	2.2	7.83	10.07	4.0
	FP	ND	--	170.6	2.75	7.87	11.92	4.1
	LF	ND	--	292	3.45	7.43	10.21	5.1
	HWP	0.04 J-	--	332	3.7	8.61	12.00	4.8
2/7/07	GA	0.08	10	158	4.75	6.84	11.30	1.1
	DWL	ND	<10	142.6	2.25	6.28	8.10	0.1
	FP	ND	<10	193.4	3	6.54	13.8	0.2
	LF	0.04	<10	257	2.2	6.56	13.5	1.2
	HWP	ND	10	361	4.2	6.86	15.1	0.0
5/7/07	GA	ND	<10	104	1	6.52	14.99	10.3
	DWL	0.06	40	152.9	1.1	6.63	15.52	15.2
	FP	0.05	<10	202.47	1	6.66	15.50	14.0
	LF	0.05	<10	280.67	1.4	6.69	14.76	13.5
	FL	ND	<10	280.67	1.4	6.69	14.76	13.5
	HWP	ND	<10	344.73	1.5	6.63	16.86	12.3
8/7/07	GA	ND	200	174	1	7.87	8.75	13.6
	DWL	0.38	30	491	1	6.55	7.06	18
	FP	ND	440	649	3.5	6.6	6.6	16
	LF	0.09	20	799	30	7.28	6.03	16.4
	FL	0.06	20	799	30	7.28	6.03	16.4
	HWP	ND	50	814	3.5	7.05	8.88	15.4
12/5/07	GA	0.06 M-	<10	112	1.6	7.49	10.4	0.1
	DWL	0.06 M-	10	144	3	7.39	7.87	0.1
	FP	0.06 M-	<10	166	1.2	7.34	10.71	0.1
	LF	ND	<10	262	1.4	7.1	10.2	0.1
	FL	0.06 M-	<10	262	1.4	7.1	10.2	0.1
	HWP	0.06 M-	<10	300	1.6	8.22	11.54	0.1
2/27/08	GA	ND	<10	101.5	4.09	6.69	13.48	0.2
	DWL	ND	<10	218	0.92	6.72	12.58	0.1
	FP	ND	<10	159	1.2	7.19	13.5	0.1
	LF	ND	<10	222	1.14	6.72	12.91	0.1
	FL	ND	<10	222	1.14	6.72	12.91	0.1
	HWP	ND	<10	269	1.97	6.88	14.13	0.1
5/9/08	GA	0.1	<10	71	6	6.62	10.66	8.1
	DWL	ND	<10	116.5	2	6.7	9.25	10.4
	FP	ND	<10	149	2	6.72	10.31	11.4
	LF	ND	<10	211	2	7.08	10.36	11.1
	FL	ND	<10	211	2	7.08	10.36	11.1
	HWP	ND	<10	266	2	6.86	10.8	10.1

MI Standard (mg/L)	FCV	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	AMV	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	FAV	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	MI Col. HBC		300					
	MI Col. F&B		1000					

<u>Notes for</u>

Table 5.2:

1. "MI Standard" values represent the Michigan Rule 57 Water Quality Standards for Aquatic Life Protection for each parameter.
2. "FCV" = Final Chronic Value, "AMV" = Aquatic Maximum Value and "FAV" = Final Acute Value. Additional information can be found at: http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-11383--,00.html.
3. Michigan water quality standards indicated in **bold** are calculated based on an average hardness of 100 mg/L.
4. "MI Col. HBC" = Michigan Coliform Human Body Contact Standard. "MI Col. F&B" = Michigan Coliform Fishing and Boating Standard. More information at: http://www.deq.state.mi.us/documents/deq-wb-swas-rules-part4.pdf.
5. "N/A" = Not Applicable. Either there are no Michigan standards for this parameter or, a standard is site-specific and requires a Total Maximum Daily Load calculation, such as with nutrients (nitrate/nitrite, phosphorus, TKN).
6. "ND" = None Detected.
7. "(t)" = Total (i.e. Total Iron vs. only Fe^{3+} or Fe^{2+})
8. White Water & Associates Results Flags: "J-" = The quantitation is an estimated value because the result is less than the sample quantitation limit, but greater than the detection limit; "M+" = A matrix effect was present with a high bias; "M-" a matrix effect was present with a low bias.
9. cfu = colony forming unit

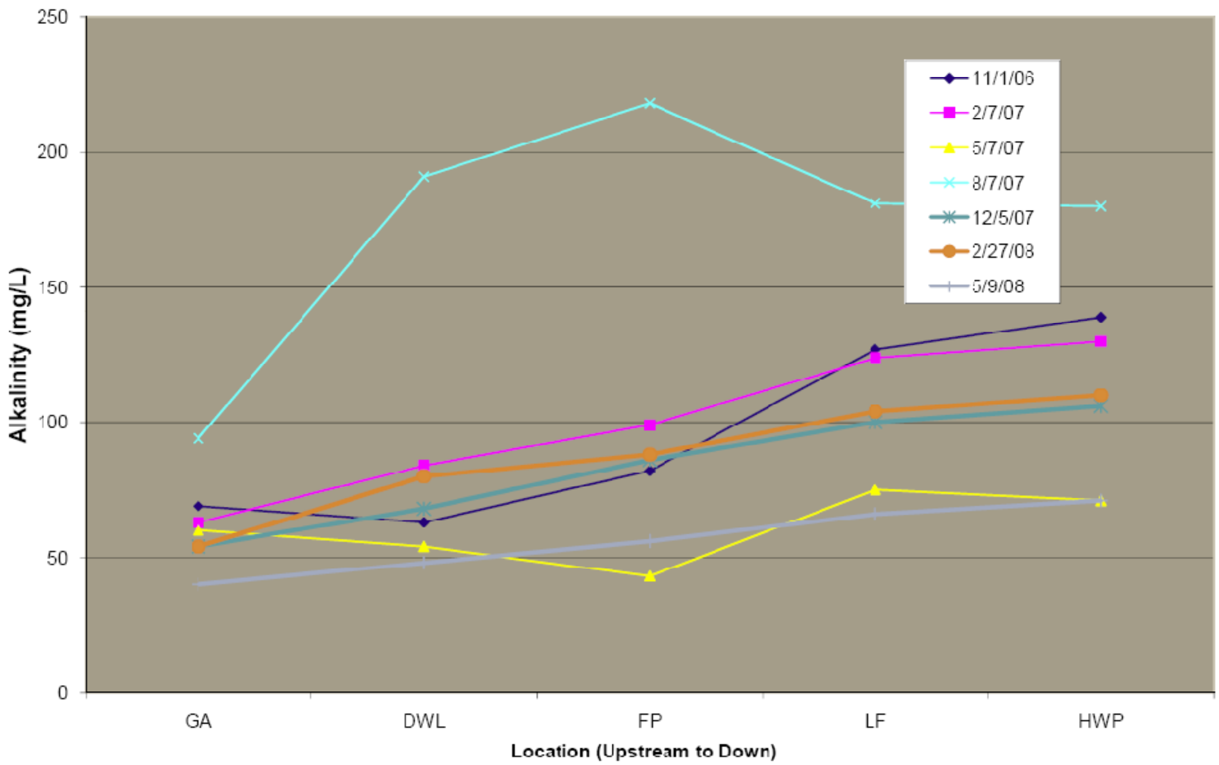


Figure 5.2 Alkalinity concentrations as a function of sample location and date.

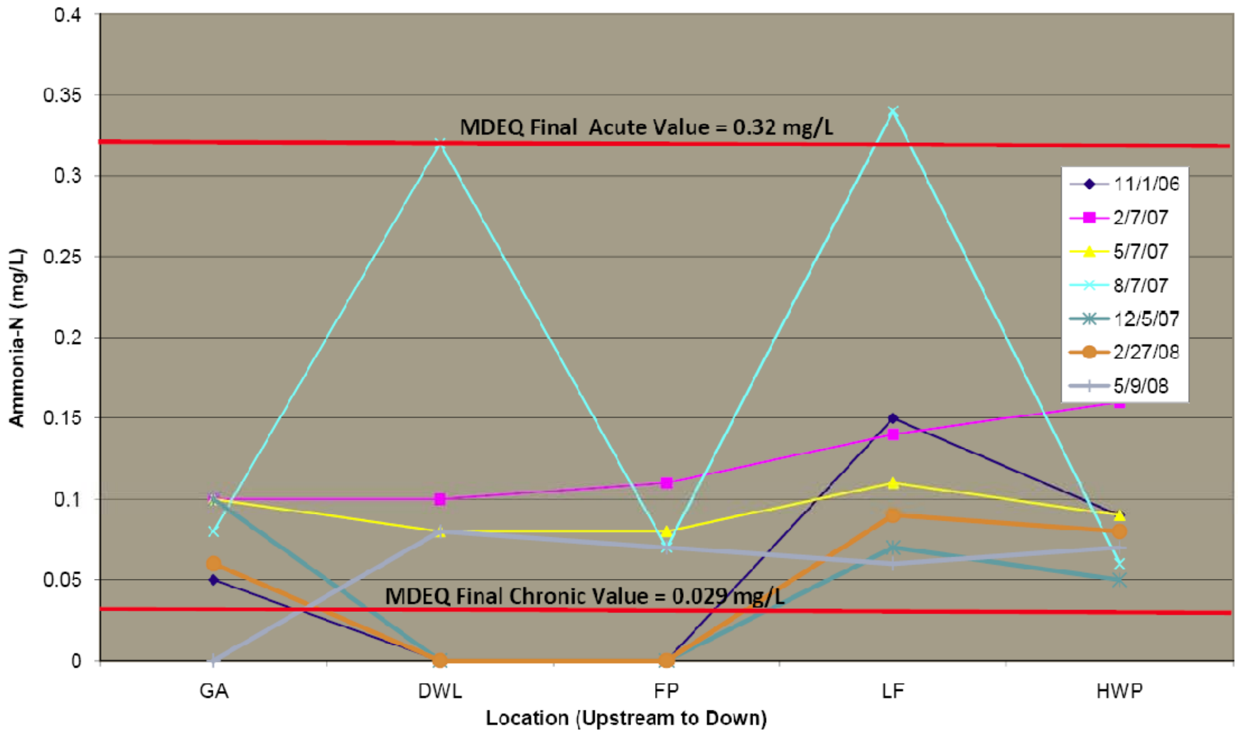


Figure 5.3 Ammonia (as mg N/L) concentrations as a function of sample location and date.

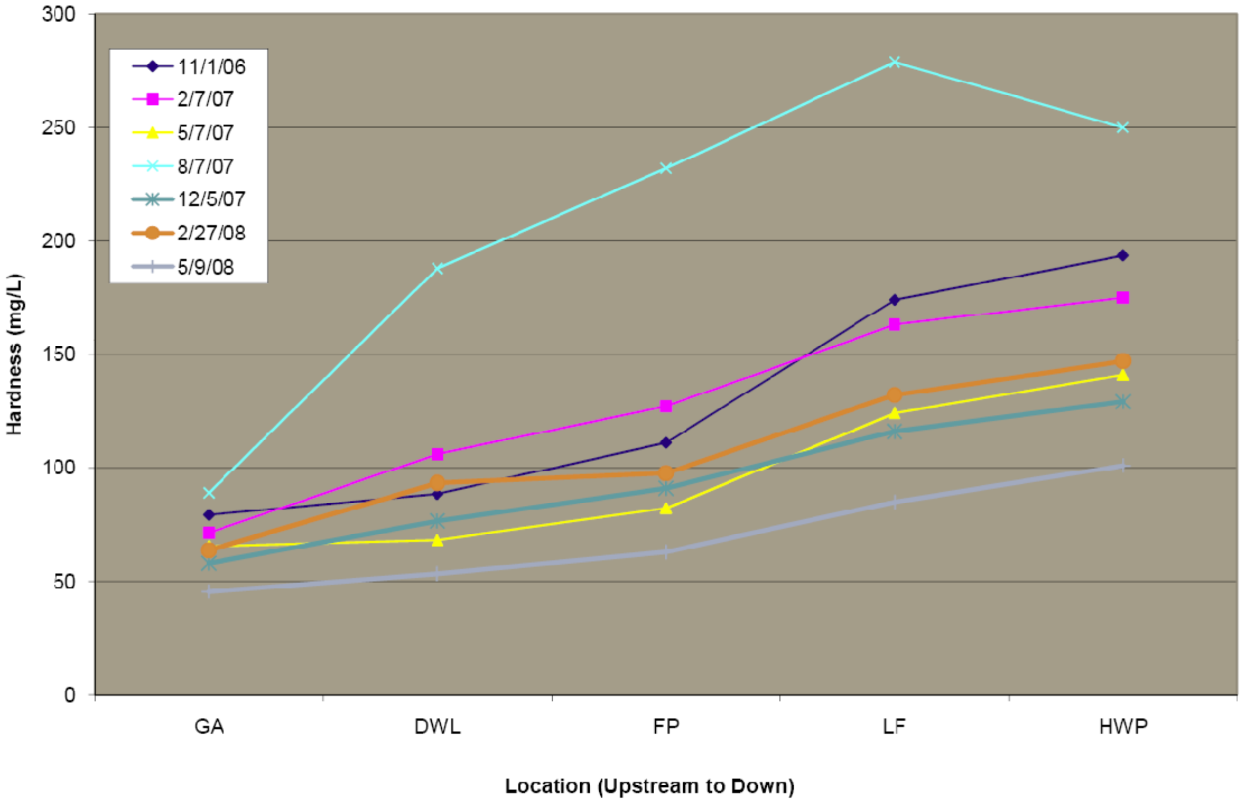


Figure 5.4 Hardness as a function of sample location and date.

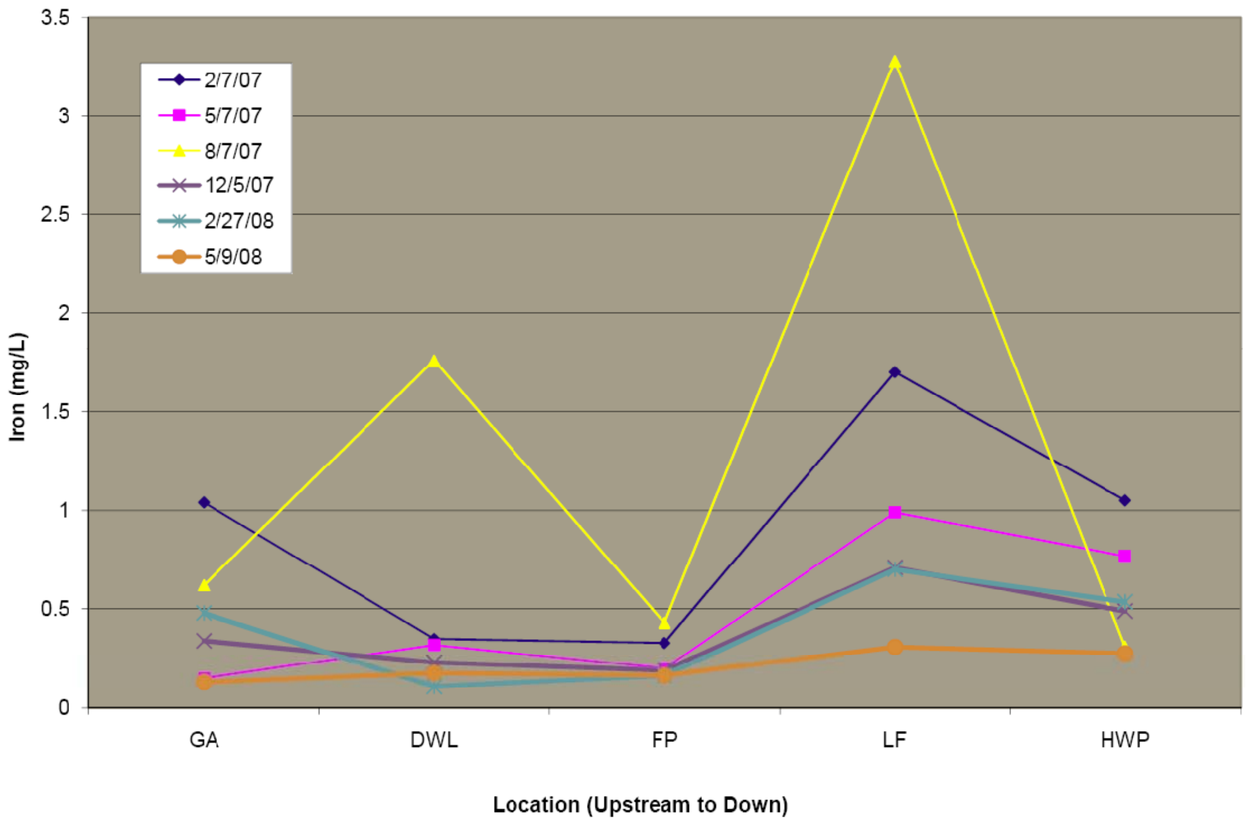


Figure 5.5 Total iron concentrations as a function of sample location and date.

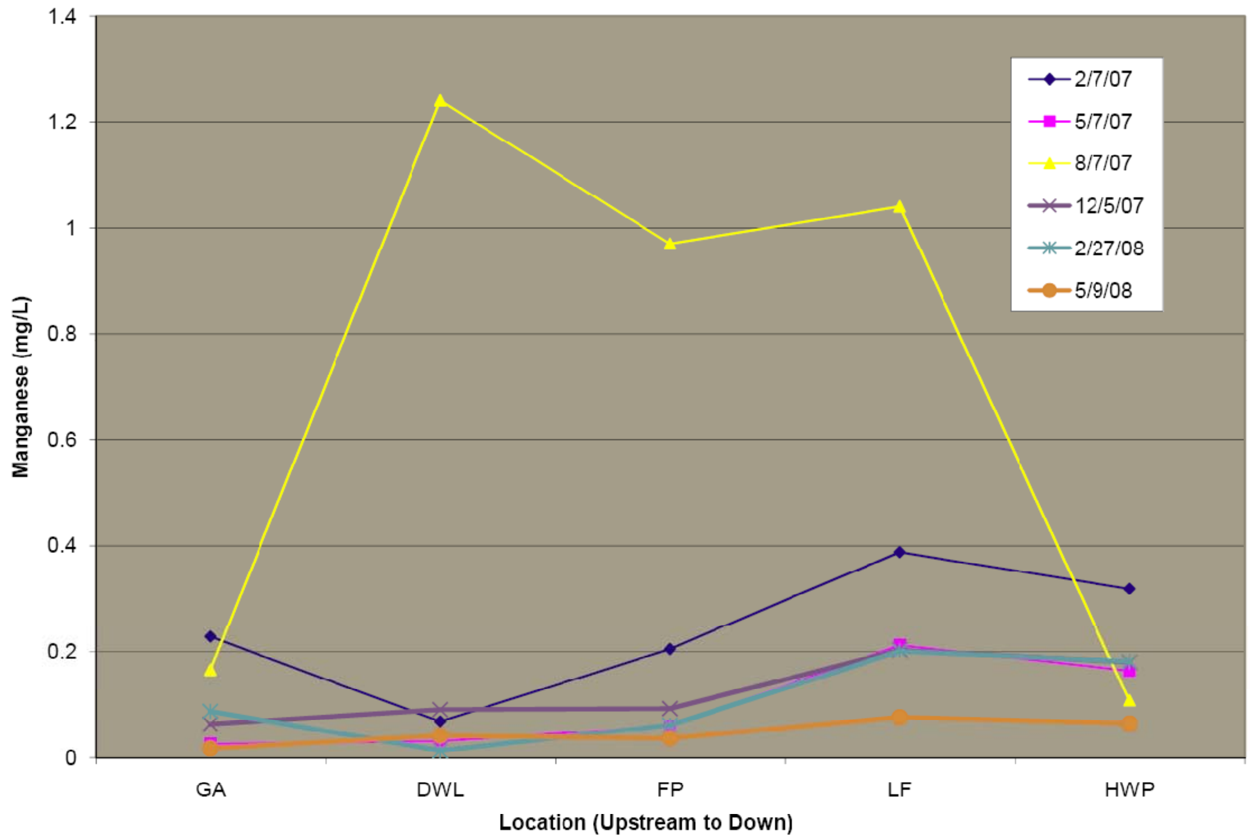


Figure 5.6 Total manganese concentrations as a function of sample location and date.

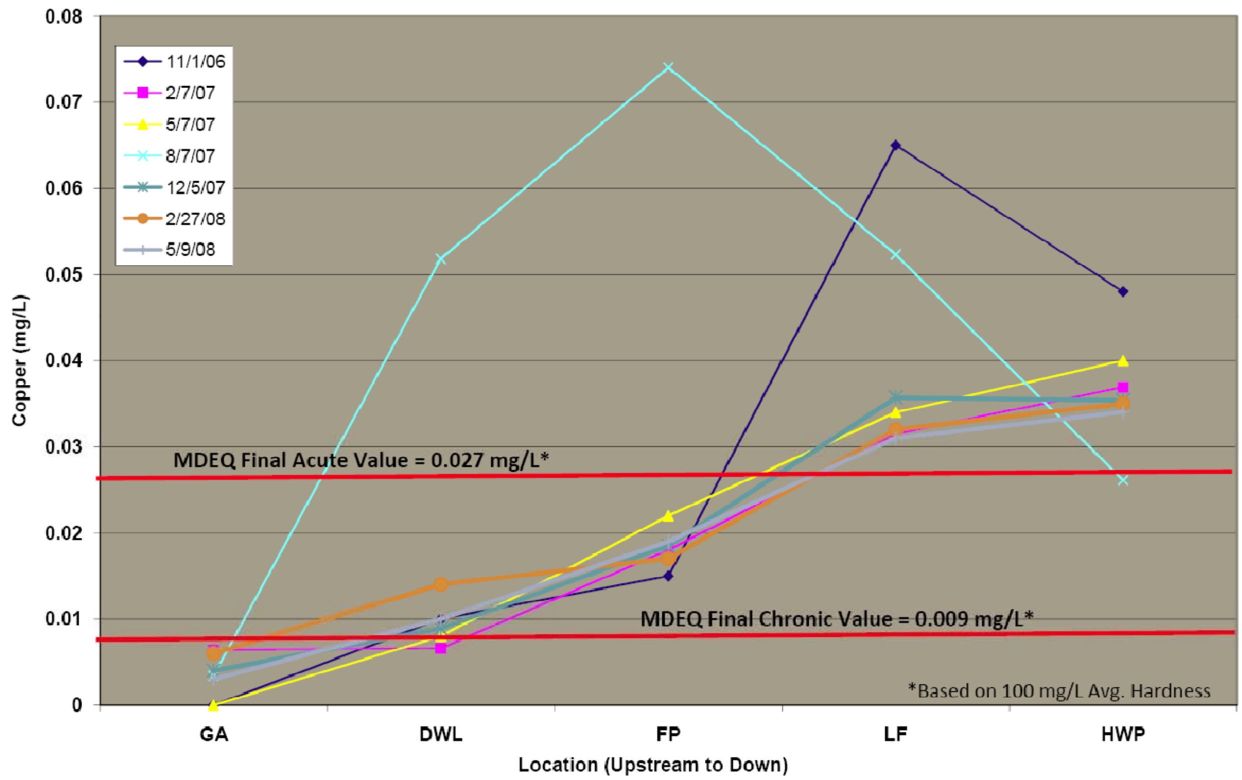


Figure 5.7 Total copper concentrations as a function of sample location and date.

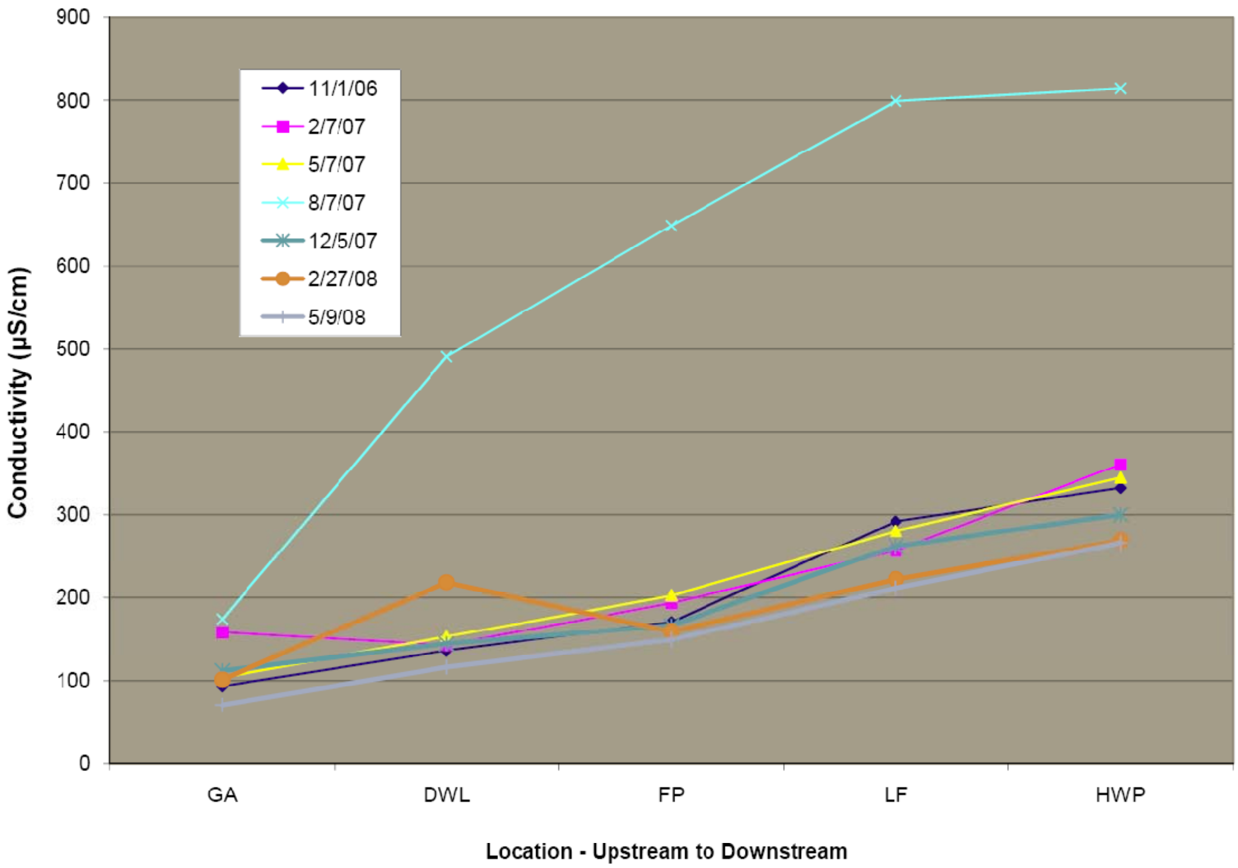


Figure 5.8 Conductivity as a function of sample location and date.

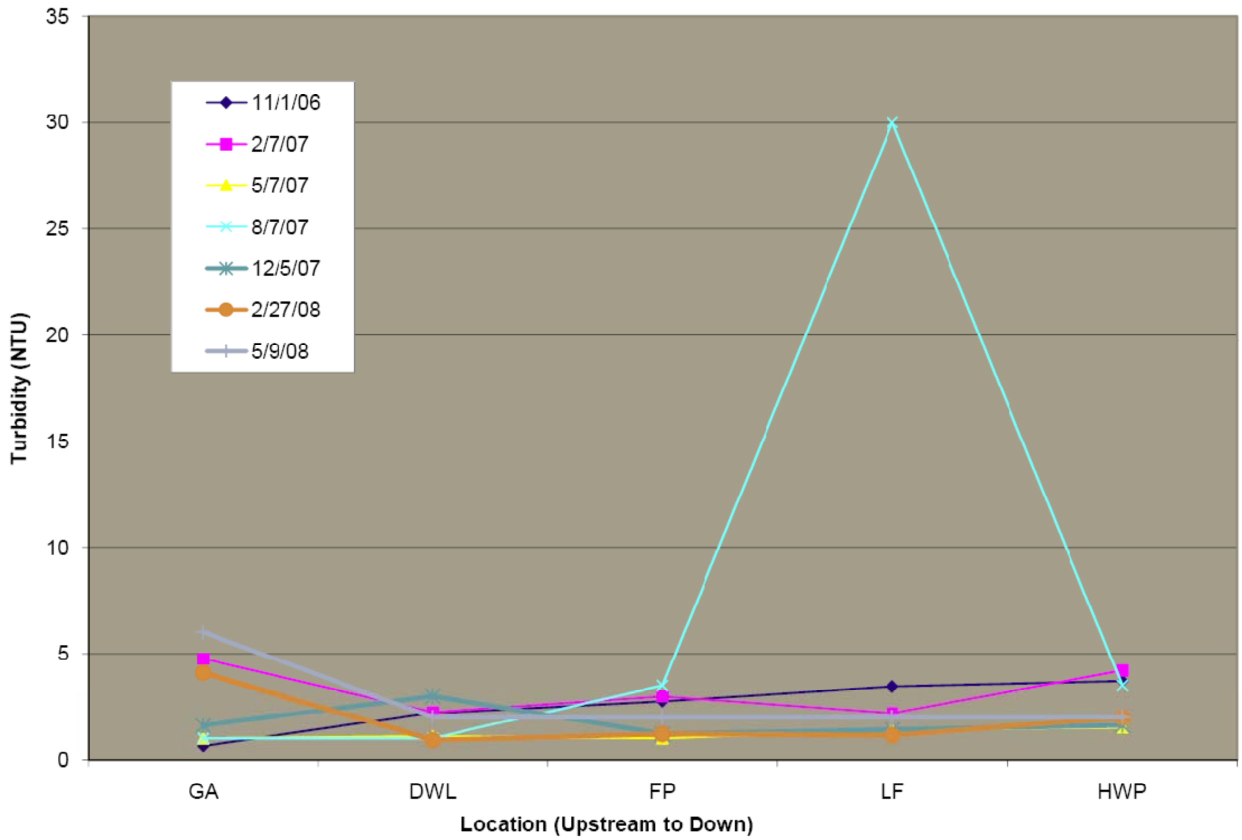


Figure 5.9 Turbidity as a function of sample location and date.

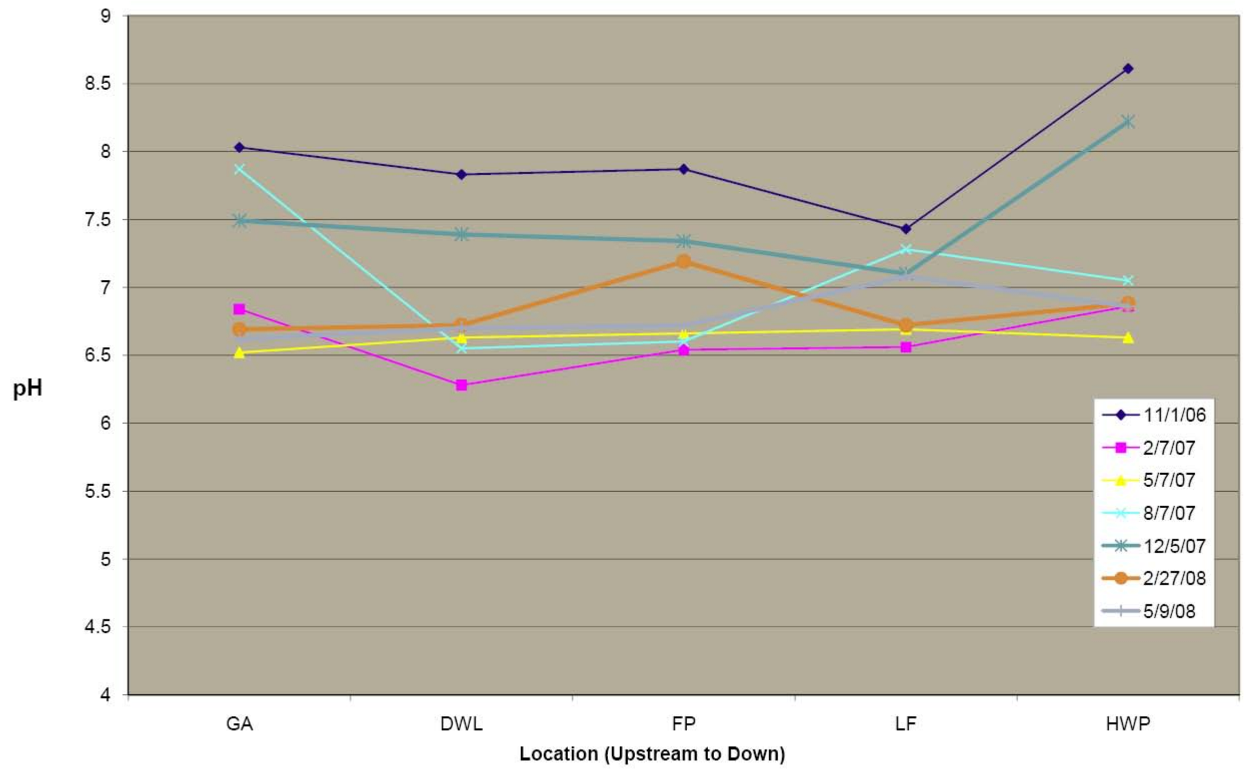


Figure 5.10 pH as a function of sample location and date.

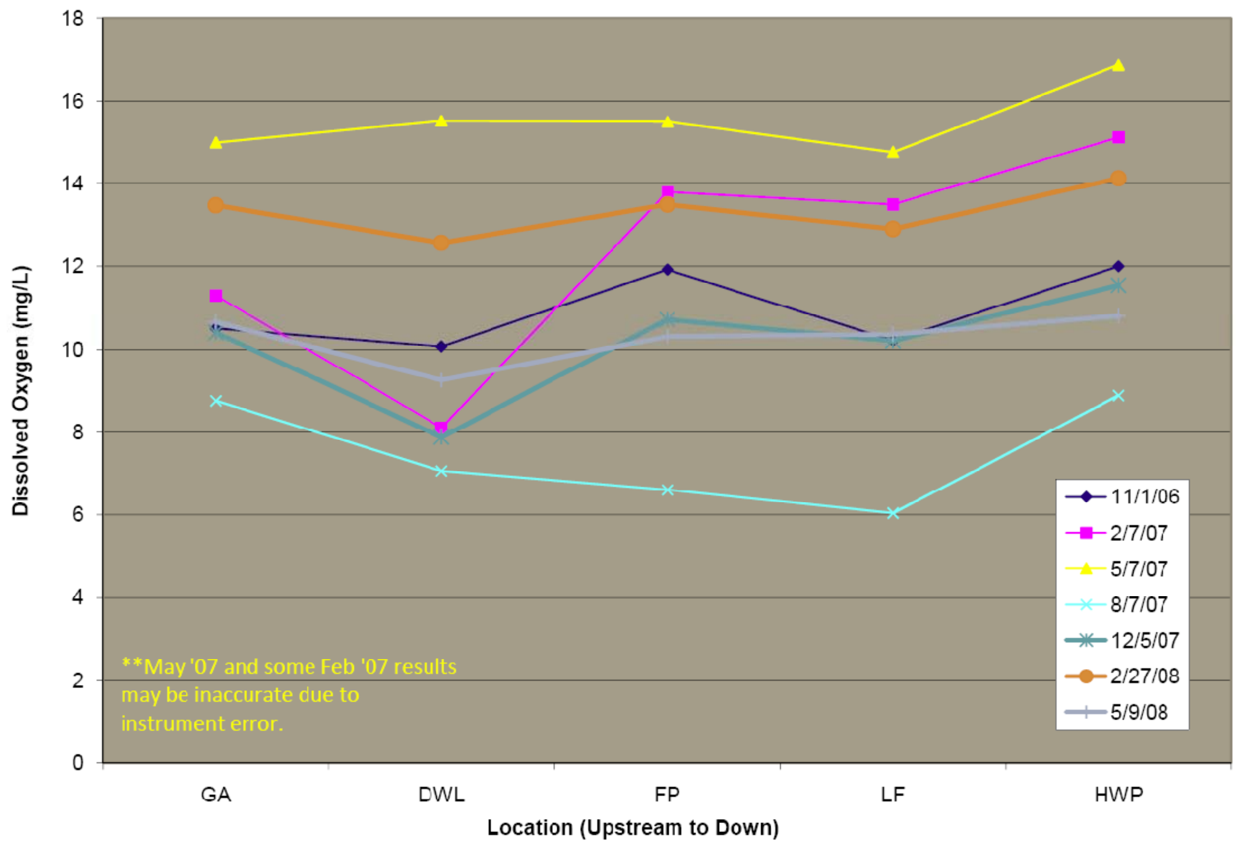


Figure 5.11 Dissolved oxygen concentrations as a function of sample location and date.

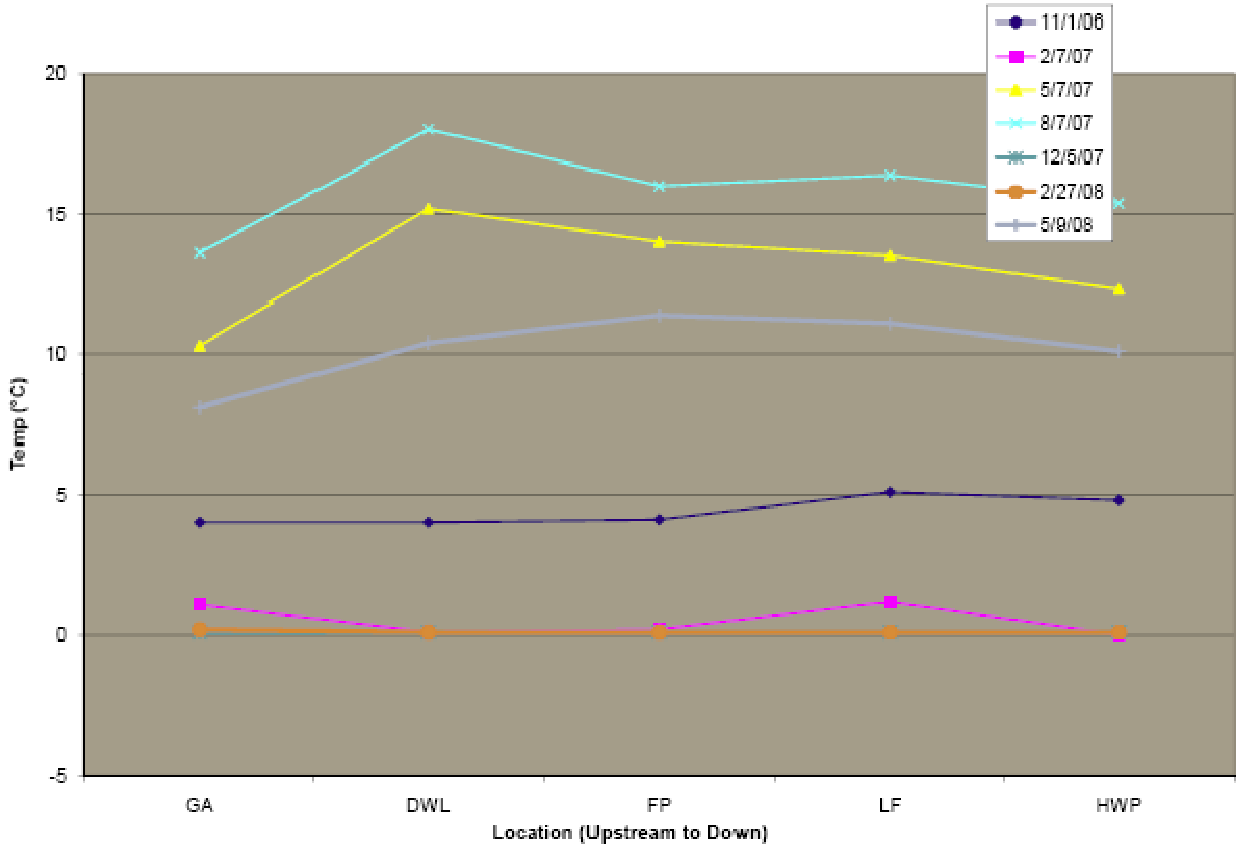


Figure 5.12 Temperature as a function of sample location and date.

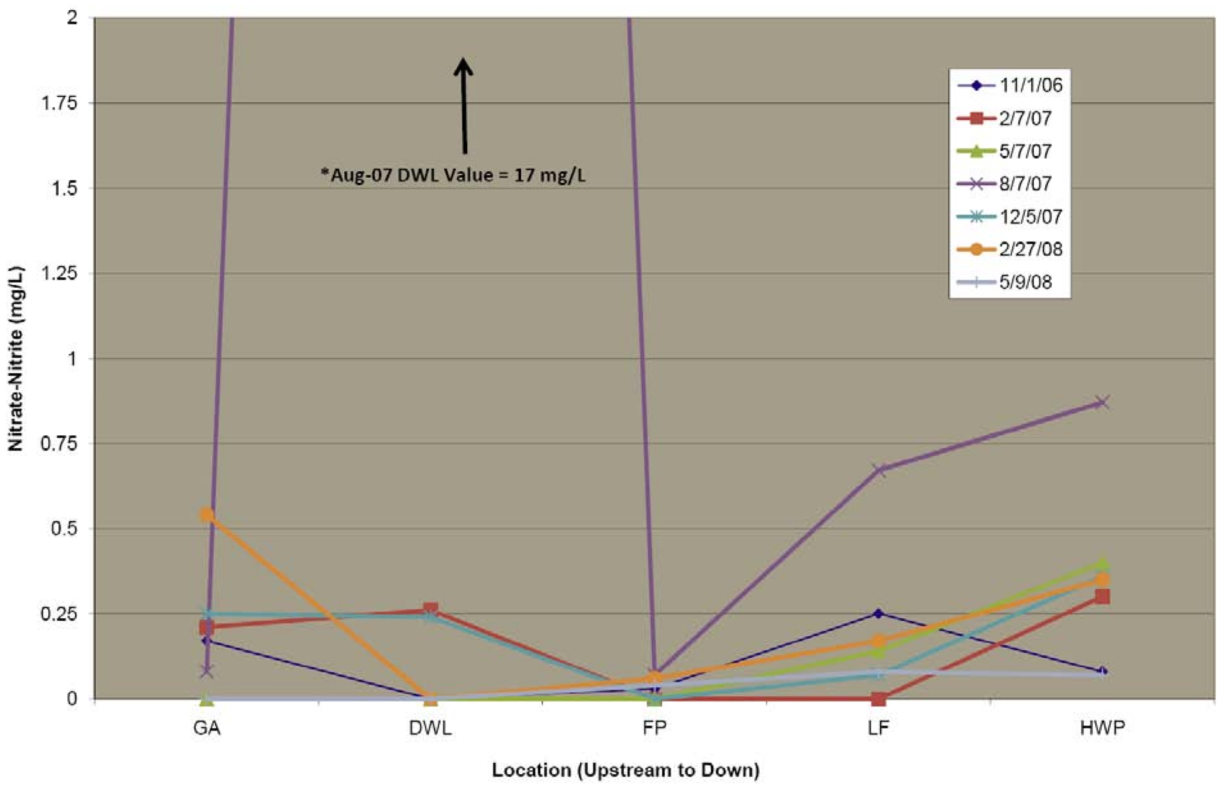


Figure 5.13 Nitrate-nitrite concentrations as a function of sample location and date.

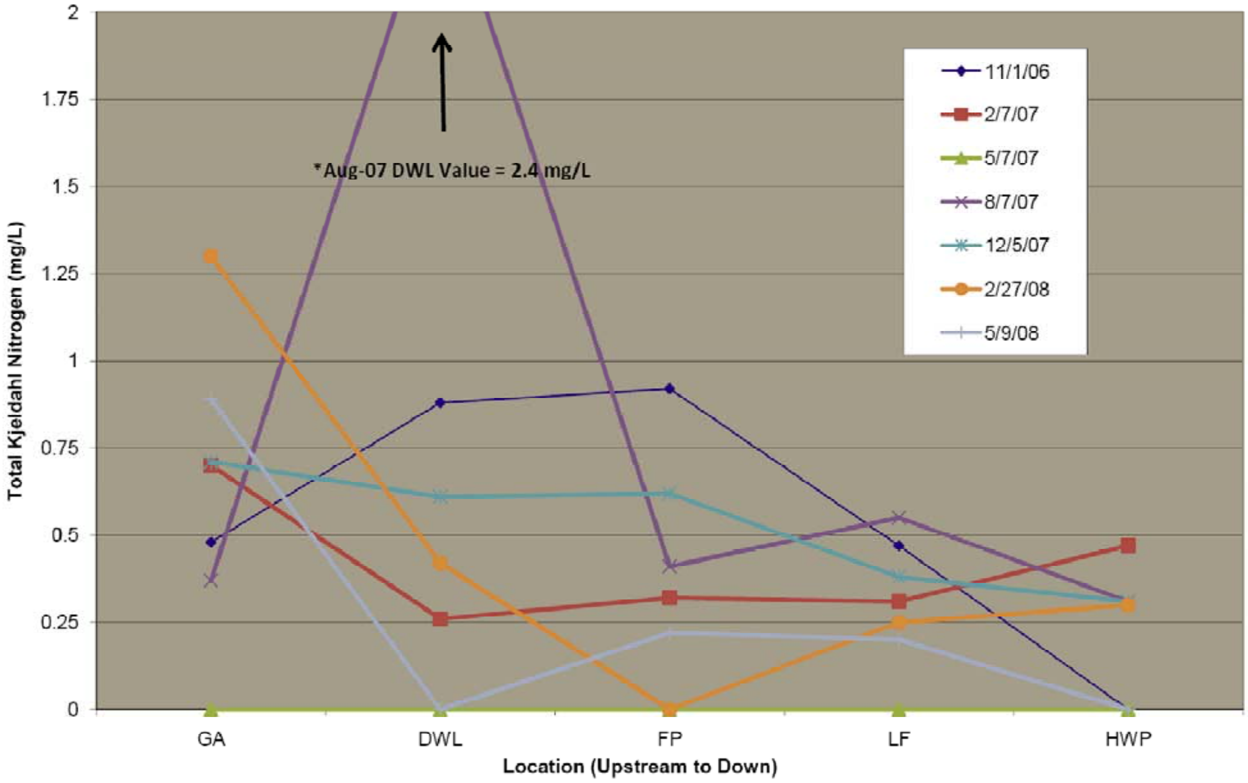


Figure 5.14 Total Kjeldahl nitrogen concentrations as a function of sample location and date.

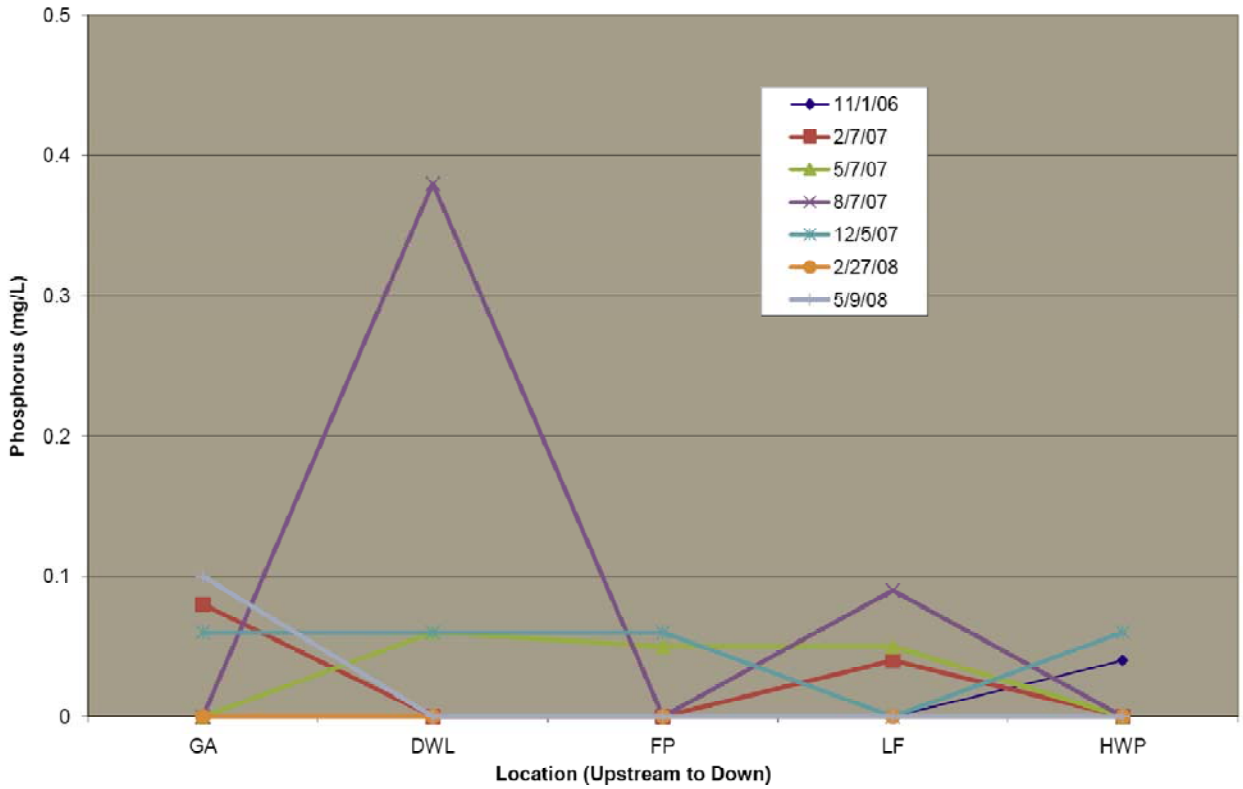


Figure 5.15 Total phosphorus concentrations as a function of sample location and date.

5.1.3. Identified Standards Exceedances in Quarterly Monitoring 2006-2008

Ammonia (NH_3) concentrations commonly exceeded the FCV, with a few occasions of the AMV and FAV being exceeded. Exceedances of the FCV in this case, may be considered “potential exceedances” as many of these values are flagged with a “J-” by the analytical laboratory. This means that they fall below the level at which the laboratory can accurately quantify the concentration, but they are above the level at which they can detect any concentration. Ammonia concentrations in Huron Creek exceeded the FAV at three locations in August 2007. This result may have been attributable to the extremely low amount of flow at that time, as several other parameter concentrations were elevated compared to other sampling events.

Total copper (Cu) concentrations regularly exceeded the AMV and FAV at all sampling locations except for the most upstream sampling site, Green Acres (GA). These results are not surprising considering the history of copper mining within the watershed and the presence of several stamp sand deposits. As mentioned in Chapter 4, this exceedance of the water quality standards qualifies the designated use of “Habitat for Aquatic Life and Wildlife” as “impaired.”

Ammonia and total copper were the only measured parameters that consistently exceeded MDEQ aquatic protection standards. A few of the other metals including total lead (Pb), total selenium (Se) and total silver (Ag) occasionally exceeded the FCV (including silver exceeding the FAV once), however all but one of these results were flagged with a “J-“ by the analytical laboratory, and may be inaccurate.

The August 2007 sampling event also identified levels of coliform bacteria in excess of the Michigan Human Body Contact (HBC) standard. This result occurred at only one sampling locations out of five, and only for the August 2007 sampling event. For all other locations and sampling events, lead, silver, selenium and coliform testing generally has resulted in a “no detect” (ND) or “< 10 CFU” for coliforms.

5.1.4. General Parameter Trends in Quarterly Monitoring 2006-2008

- Alkalinity – Alkalinity is the measure of the water’s ability to buffer the addition of acids such as acidic rainfall. Typical streams have alkalinities of less than 200 mg/L. Studies have determined that streams with alkalinities from 100-200 mg/L support the highest diversity (Brooks, K.N., P.F. Folliot, H.M. Gregersen, and L.F. DeBano., 1997). The alkalinity of Huron Creek has generally measured between 50 and 150 mg/L, with concentrations increasing downstream.

- Hardness - Hardness is the measurement of the amount of certain minerals in water such as calcium and magnesium. Hardness is often expressed as a total amount of minerals equivalent to mg/L of calcium carbonate ($CaCO_3$) (as they are presented in Table 5.1). Concentrations of magnesium greater than 100-400 mg/L can be toxic to some fish. Total hardness in Huron Creek has generally varied between 50 and 200 mg/L, with concentrations increasing downstream.

- Iron and Manganese – Iron (Fe) and manganese (Mn) are commonly found in igneous rocks and are leached through soils. Iron is a specific concern in Huron Creek near an old landfill where “iron bacteria” blooms are present that create an orange slime of ferrous iron precipitate. Iron concentrations in the creek generally range between 0 and 1.5 mg/L, with a few sampling events yielding higher average concentrations. A consistent "spike" in iron concentration is evident in Figure 5.5 at the landfill (LF) sampling location. A similar increase is also evident in the graph of manganese concentrations (Figure 5.6) which generally indicates concentrations between 0 and 0.4 mg/L. According to Brooks, et. al., natural stream concentrations of manganese are generally less than 1.0 mg/L.

- Michigan 10 Metals – A set of ten dissolved metals known as the "Michigan 10 Metals" were sampled for and analyzed, for all sampling events. The Michigan 10 Metals are often monitored in surface waters of the state as they can be toxic or have negative health effects. These metals include arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), selenium (Se), silver (Ag) and zinc (Zn). Of these metals, analysis of arsenic, cadmium, lead, mercury, selenium and silver typically resulted in a no detect. Low levels of barium were detected at each sampling point and during each sampling event, but never exceeded standards. Measurements of chromium and zinc also yielded low levels (often below the quantitation limit) mixed with "no detect" results. As mentioned above, copper regularly exceeded at least one of the water quality standard thresholds, and generally increased in concentration further downstream.

- Nutrients – The term "nutrients" when referring to water quality generally includes phosphorus (P) and nitrogen (N). Organic nitrogen, nitrates (NO_3^-), nitrites (NO_2^-), ammonia and ammonium (NH_4^+) are different forms in which nitrogen is present in the environment. Total Kjeldahl nitrogen (TKN) is the measure of the sum of organic nitrogen, ammonia and ammonium. High concentrations of nitrate-N in surface waters can stimulate growth of algae and other aquatic plants, but if phosphorus is present, only about 0.3 mg/L of nitrate-N is needed for algal blooms (Brooks, K.N., P.F. Folliot, H.M. Gregersen, and L.F. DeBano., 1997). Some fish life can be affected when nitrate-N exceeds 4.2 mg/L (Brooks, K.N., P.F. Folliot, H.M. Gregersen, and L.F. DeBano., 1997).

  As mentioned above, ammonia consistently exceeds the FCV, AMV or FAV through all sampling events. A notable "spike" in ammonia concentration was repeatedly observed at the landfill (LF) sampling site. Nitrate/nitrite concentrations typically ranged between 0 and 0.5 mg/L, while the range of TKN values was typically 0 to 1.0 mg/L. Higher concentrations of TKN may be attributable to the elevated concentrations of ammonia and/or organic nitrogen. Phosphorus concentrations generally varied between 0 and 0.1 mg/L, with approximately 50 percent of measurements resulting in a "no detect." Another concentration "spike" of note is that levels of ammonia, nitrate-nitrite, TKN and phosphorus all were elevated at the DWL (downstream of wetland) sampling location during the August 2007 sampling event. This occurrence can be attributed to the flow of Huron Creek being extremely low during that sampling event, and possibly to nitrogen fixation (changing gaseous N_2 into NO_3^- and NH_4^+) and export by wetland plants.

- Dissolved Oxygen (DO) – Most fish require 4.0 to 5.0 mg/L DO minimum (California Water Quality Resources Board, 1963). DO levels in Huron Creek ranged between 6.0 mg/L and 14 mg/L, with levels around 14 mg/L occurring during the winter months. There are no apparent trends in pH or DO levels along the length of the creek.

- pH – Most fish can tolerate pH values between 5.0 and 9.0 (California Water Quality Resources Board, 1963). The pH levels in Huron Creek varied between 6.0 and 9.0.

- Conductivity – Conductivity in Huron Creek typically ranged between 100 µS/cm and 400 µS/cm, which repeatedly increased in the downstream direction. Conductivity is the measure of the amount of dissolved ions in water (salts, metals, etc.), and commonly increases further downstream in a watershed. It is considered natural for stream water if the average conductivity measured at a site is 800 microSiemens (µS/cm) or less (The Watershed Center, 2005).

- Turbidity – Turbidity is a measure of the amount of suspended solids (clarity) of the water. Measurements of Huron Creek consistently yielded levels between 0 and 5 NTU (Nephelometric Turbidity Units), with no apparent trends in the upstream/downstream directions. The American Public Health Association turbidity standard for drinking water is 0.5 NTU or less (California Water Quality Resources Board, 1963).

- Temperature – The temperature of Huron Creek varies from 0° to 5.0° C in the winter months and 10° to 20° C in summer months. Rainbow trout, a fish requiring generally pristine water quality, lives in an optimum water temperature of 13° C. Warm-water species of fish such as carp however, can tolerate temperatures up to 32°C.

- Coliform Bbacteria – Coliform bacteria are bacteria that live in the digestive systems of mammals, including humans. Fecal coliform assays are intended to be an indicator of fecal contamination, or more specifically *E. coli* which is an indicator microorganism for other pathogens that may be present in feces. Fecal coliform can be associated with waste from mammals and birds, from agricultural and storm runoff, and from untreated human sewage. Coliform testing is often included in water quality monitoring as a method of detecting if sewage is reaching the water body (such as might occur with a leaking septic system).

  Most sampling events and locations have yielded results of <10 colony forming units (cfu), with 10 being the laboratory detection limit. However, as stated above, the August 2007 sampling event resulted in the Frogpool (FP) site having coliform levels higher than the Michigan standard for human body contact. Again, the flow rate of Huron Creek was low during this sampling event, which most likely caused elevated concentrations for many measured parameters (versus having high concentrations during high or average-flows).

5.2. Climate Data Study

Climate data was downloaded from the National Climatic Data Center (NCDC)[13] website for weather stations nearest Houghton, MI. Downloaded data included daily total precipitation, rainfall, snowfall, and temperature data between July 1887 and April 2007. Data from July 1887 to July 1952 was recorded at a weather station that was located near the Portage Canal (Co-op ID # 210213). In August 1952, the weather station was moved to the current location of the Houghton County airport, which is where the weather station is located today (Co-op ID# 203908).

[13] http://www.ncdc.noaa.gov/oa/ncdc.html

A graph of annual total precipitation, rainfall and snowfall for 1890 to 2007 is shown in Figure 2.12. The nearly 120 years of data indicates that total precipitation has regularly fluctuated, but has been steadily decreasing since the late 1970's. Historically, rainfall has contributed most to the total precipitation amount. However, the amount of snowfall (measured in inches of melted snow) became nearly equal to or exceeded the amount of rainfall from the late 1970's to the late 1990's. Figure 2.13 provides monthly average total precipitation data for the Houghton area for 1890 to 2007[14]. Historically, the months with the highest amounts of total precipitation have been January and September, with 3.33 and 3.26 inches of precipitation, respectively.

As mentioned in Chapter 10, the Houghton area has experienced some relatively intense rain storms in recent years that have caused flooding and severe erosion of bank areas along Huron Creek. The most recent intense storm occurred on September 4, 2007, and produced 3.66 inches of rain in less than 10 hours. Another intense storm occurred on July 16, 2006 which produced 2.99 inches of rain in less than 10 hours. This storm produced approximately the same amount of precipitation as the average 5-year, 24 hour storm (Menerey, 1999), in less than half the time. Figure 5.16 shows a graph of hourly precipitation for the 2006 and 2007 storms mentioned here.

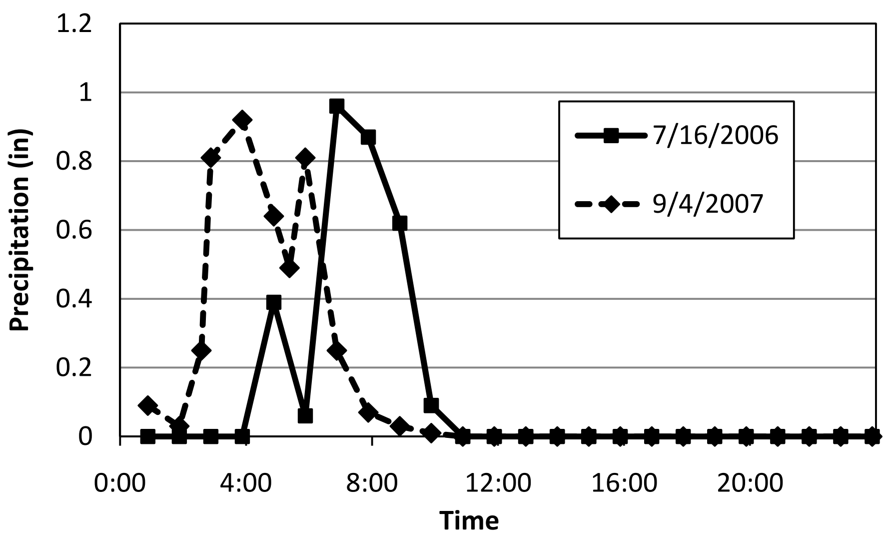


Figure 5.16 Recent Intense Rainstorms of the Houghton, MI Area

Figure 5.17 and Figure 5.18 present average annual and average monthly temperature data for the Houghton area from 1887 to 2006. As can be seen in Figure 5.17, the annual average temperature has generally ranged between 38°F and 42°F with some extreme years dropping near 36°F and increasing up to 46°F. No major trend in average temperature increase or decrease is event from this graph. However, further investigation might be completed to identify trends on a finer level. According to the data presented in Figure 5.18, the average monthly temperature of the Houghton, Michigan area varies from approximately 15°F in January to approximately 65°F in July. The raw data associated with graphs

[14] Snowfall precipitation contributing to the total is measured in inches of melted snow.

presented in this chapter is available on the NCDC website or by contacting Alex Mayer at the MTU Center for Water & Society (e-mail: asmayer@mtu.edu).

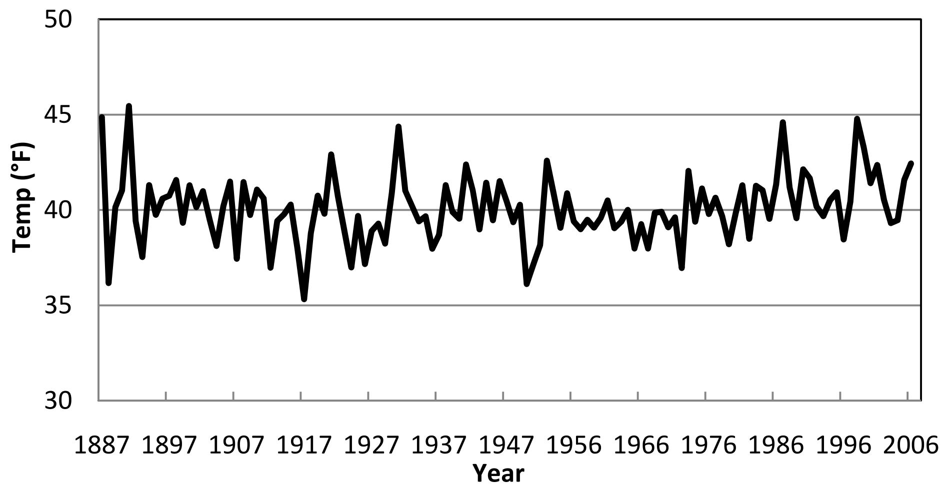


Figure 5.17 Average Annual Temperature for Houghton, MI, 1887-2006

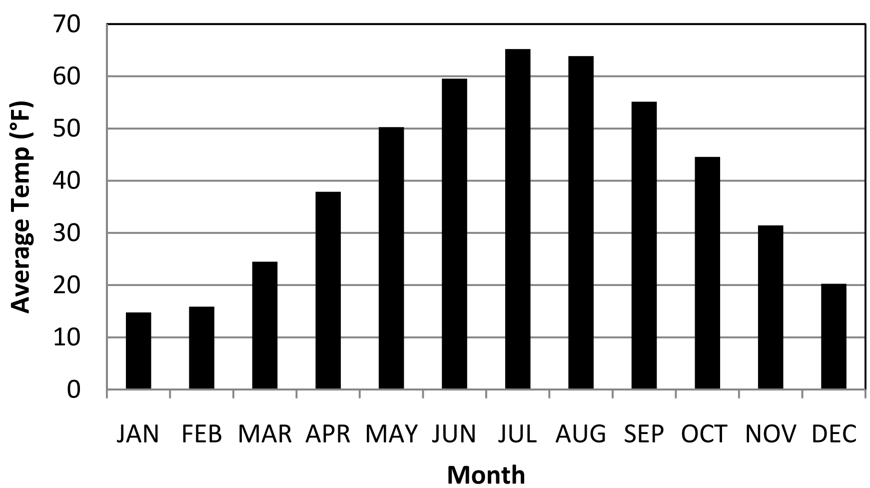


Figure 5.18 Average Monthly Temperatures for Houghton, MI, 1887-2006

5.3. Land Use Study

In fall 2006, a land use study of the Huron Creek watershed was completed using a geographical information system (GIS). The study resulted in the production of a land use map based on the most recently available aerial photo of the watershed (2005 NAIP[15] aerial photo), as well as analysis of

[15] National Agriculture Imagery Program

changes in land use between 1978 and 2005. These results are included in this report as Figure 2.4(2005 Land Use Map), Figure 2.5 (2005 Huron Creek Watershed Land Use Distribution) and Figure 2.6 (Percent Change in Land Use, 1978-2005). The data presented in these figures is discussed in Section 2.3. The complete land use study is attached to this report as Appendix D. The report describes data sources and methods, as well as provides further discussion of results and recommendations for future investigation.

5.4. Hydrologic Modeling

Two different approaches were used to estimate runoff in Huron Creek. First, a water balance approach as used to estimate average monthly and average annual flows. Second, a rainfall-runoff model was used to estimate runoff in response to discrete storm events.

5.4.1. Average Annual Streamflow

The Thornthwaite water balance equation (e.g., (Dingman, 2002)) provides a means for accounting for the amount of water stored in each component of the hydrological cycle. Local meteorological data for temperature, precipitation, daylength, humidity, etc. are input into simple empirical formulae that estimate the values in this form of the Thornthwaite-type water balance model. The model consists of several subcomponents that are combined to simulate values of watershed or regional water inputs, including precipitation (as rain and snow) and output via evapotranspiration. Water can be stored as soil moisture and snowpack. All hydrological quantities are expressed as depth of water over an assumed area (region or drainage basin). Monthly climatic averages of temperature and precipitation are used as inputs to the model. The model divides precipitation inputs into rain or snow depending on a surface air temperature melt factor. This factor is also used to determine the monthly melt component of the snow pack. From these quantities, the resulting monthly water runoff can be determined.

Calculations using the Thornthwaite water balance equation were made using a spreadsheet (see Appendix N). The results of the calculations are given in Figure 5.19. If it is assumed that all recharge reaches the stream, integration under the Runoff and Recharge curve in Figure 5.19 gives an annual total streamflow of or 357 mm or 14.1 inches. Multiplying by the area of the watershed (3.4 square miles) gives an annual volumetric streamflow of 3.5 cubic feet per second (cfs) or 0.01 in cubic meters per second.

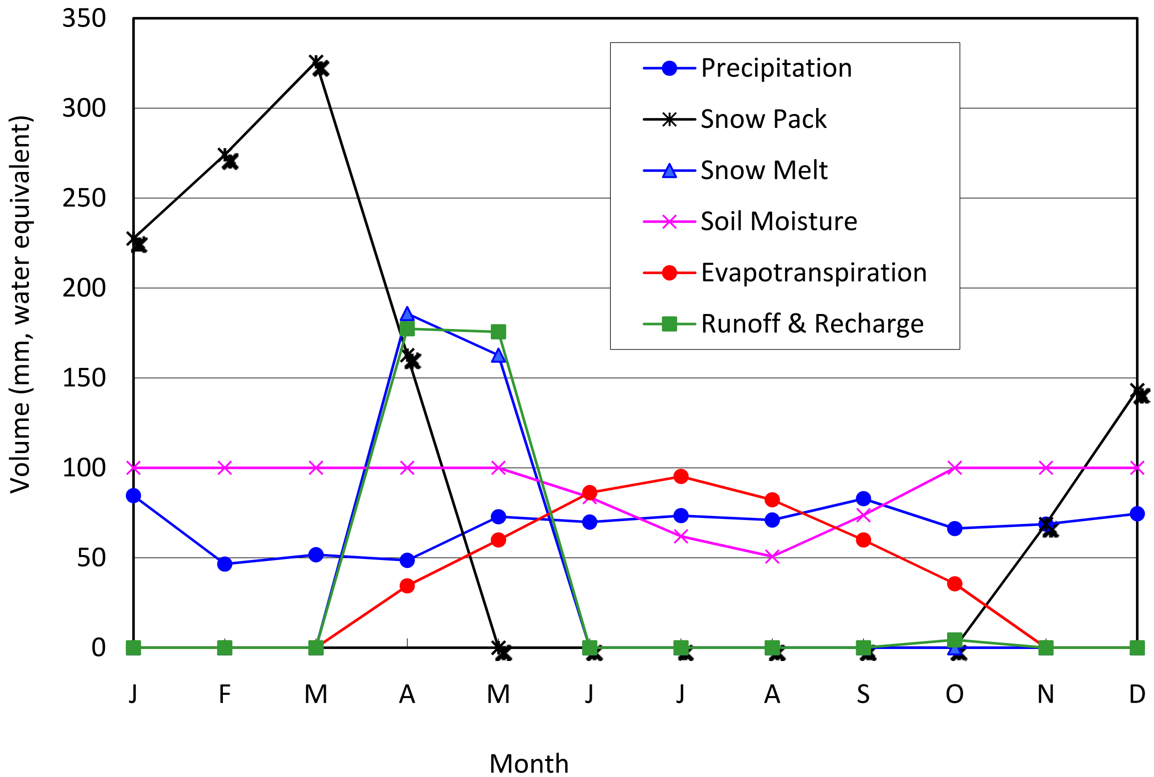


Figure 5.19 Monthly water balance calculations using the Thornthwaite water balance equation.

5.4.2. Peak Streamflow

A hydrologic model of the Huron Creek watershed was developed using rainfall-runoff modeling software (HydroCAD®) in order to estimate runoff in response to discrete storm events. HydroCAD® uses the Natural Resource Conservation Service (NRCS) TR-20 method to calculate rainfall-runoff. Spatial data used as input to the software included land use/land cover, ground surface slopes, soil types, catchment areas and reach lengths. This information was determined from GIS coverages and entered into HydroCAD® for the following three development scenarios:

- Pre-Development –approximates conditions before any disturbance or development of the Huron Creek watershed.

- Current Development – represents conditions of today's Huron Creek watershed. The main difference between this model and the pre-development model are the increases in less permeable land cover (currently existing residential and commercial areas, roads, quarries, etc.).

- Future Development – represents potential future increases in commercial and residential development (see Figure 2.8).

For purposes of modeling rainfall-runoff responses, the watershed was divided into 12 sub-watersheds and five stream reaches, as shown in Figure 5.20. The sub-watersheds are further divided into areas with different land cover and soil types. The land cover-soil type combinations are assigned curve numbers (CN). The CN is an empirical parameter used to estimate runoff resulting from rainfall excess (rainfall that exceeds the capacity of the land area to infiltrate the rainfall). A higher CN indicates higher amounts of runoff, with a CN = 100 indicating a completely impervious surface. For example, CN = 90 would correspond to commercial and business developments in urban areas, indicating significant amounts of rooftops and paved area, and CN = 30 to 80 would be indicative of vegetated cover.

The output for each modeling scenario is a hydrograph, which depicts flow rate of the creek as a function of time, in response to a model storm event. Two model storm events were considered: a 2-year, 24-hour storm event with a total rainfall of 2.39 inches and a 25-year, 24-hour storm event of with a total rainfall of 4.17 inches (Sorrell, 2008). These storms represent events that are likely to occur in the Houghton area, on average, once every 2 or 25 years, respectively. Three antecedent moisture conditions (AMC) were considered. AMC refers to the state of saturation of the soils in a watershed before a modeled storm event occurs. AMC-I has the lowest runoff potential and the watershed soils are dry. AMC-II represents normal soil moisture conditions. AMC-III has the highest runoff potential as the watershed is practically saturated from antecedent rainfall or snowmelt. The purpose of using three difference AMCs is to represent the envelope of possible soil moisture conditions and resulting runoff behavior.

Figure 5.21 and Figure 5.22 show the hydrographs for the 2-year and 25-year storms, respectively, and represent the flow at the outlet of the watershed. The results show that runoff and consequent flow rates at the outlet of the watershed apparently have increased from prior development to current development conditions and will further increase with future development. The degree of increase is sensitive to the magnitude of the storm (2-year vs. 25-year) and the AMC. Table 5.3 shows the peak discharges for all of the combinations of development scenarios, storm recurrence probabilities, and antecedent moisture conditions. The results in Figure 5.21, Figure 5.22, and Table 5.3 show that the increase in flows from prior to current development is lower for the larger storm and higher AMC since these conditions generally produce more excess runoff, no matter what the land cover conditions are.

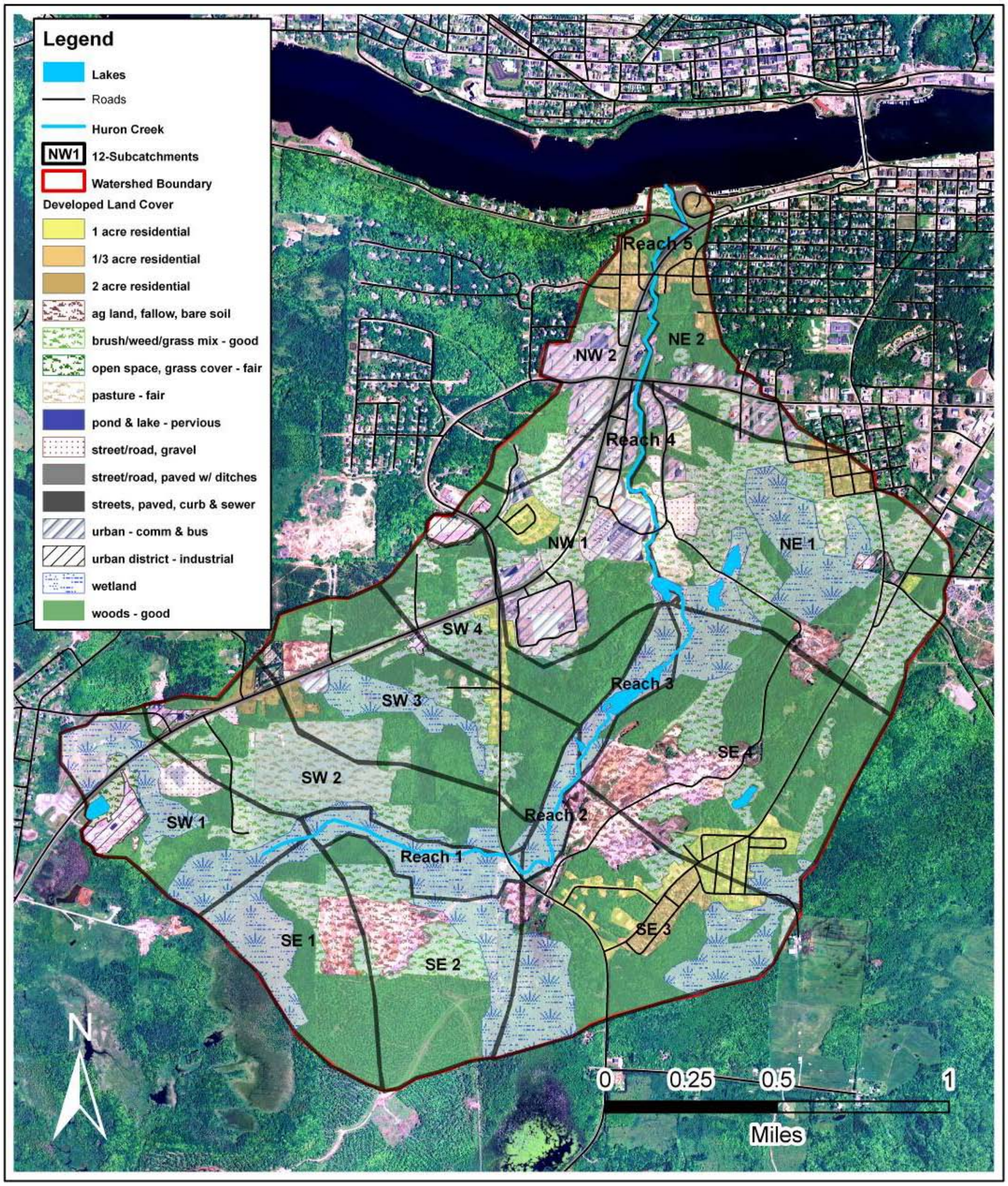


Figure 5.20 Division of watershed into sub-watersheds and reaches Created by Linda Kersten, 4/10/08. Map projection: NAD 1983 UTM Zone 16N.

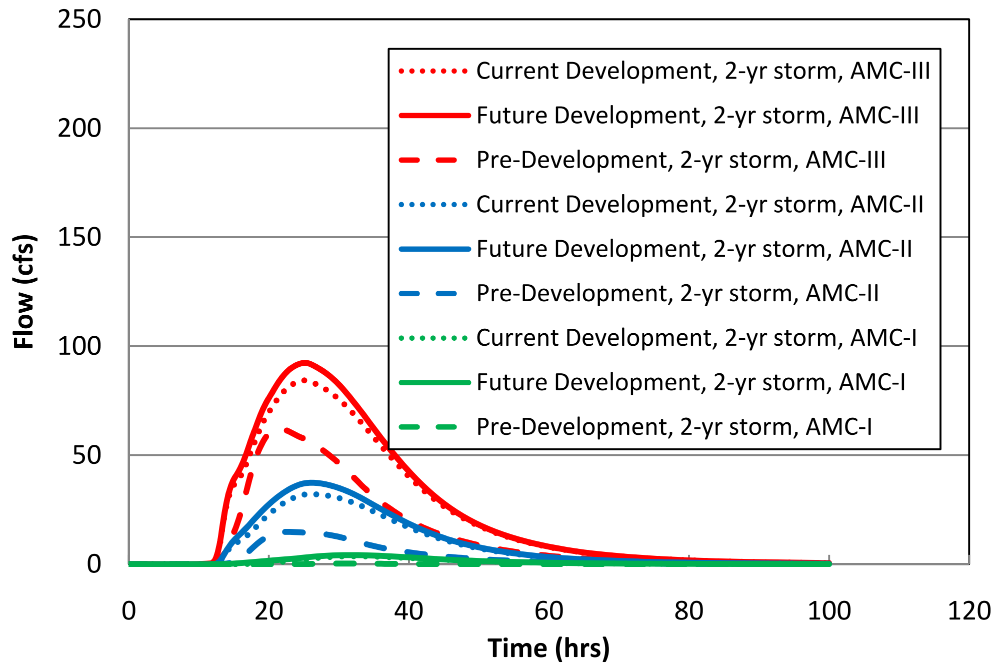


Figure 5.21 2-year storm hydrograph comparison of pre-development, current development and future development models for various antecedent moisture conditions.

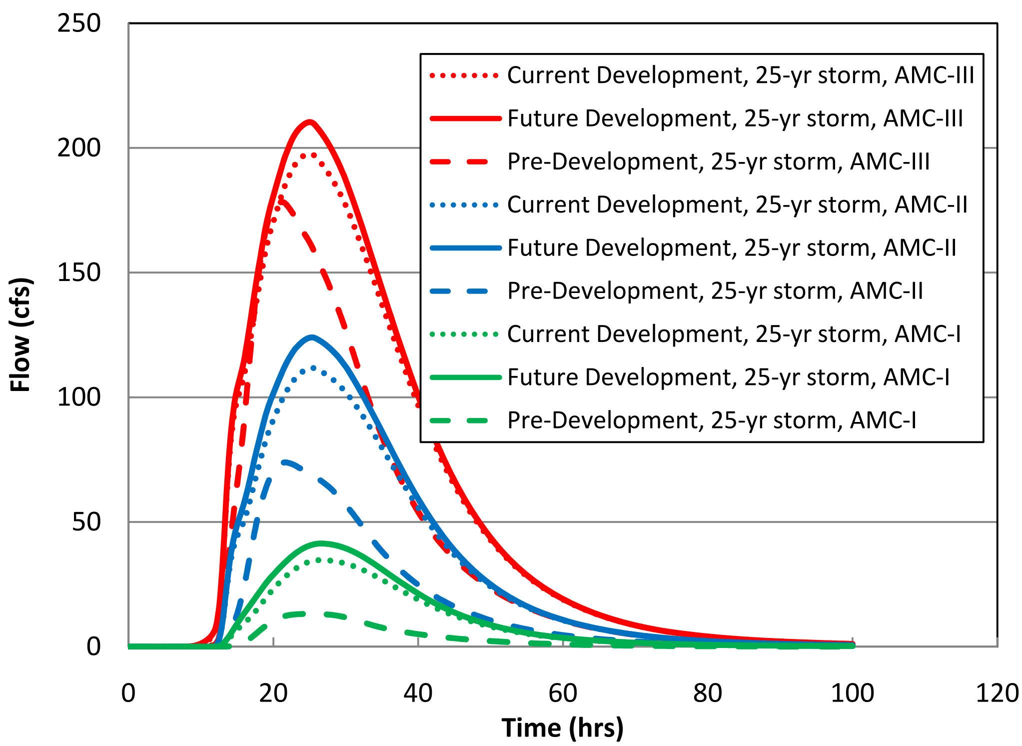


Figure 5.22 25-year storm hydrograph comparison of pre-development, current development and future development models for various antecedent moisture conditions.

Table 5.3 Peak flows for combinations of development scenarios, storm recurrence probabilities, and antecedent moisture conditions

	Peak Flow (cfs)		
	Pre-Development	Current Development	Future Development
2-yr Storm, AMC-I	<1	4	4
2-yr Storm, AMC-II	15	32	37
2-yr Storm, AMC-III	62	84	92
25-yr Storm, AMC-I	13	35	41
25-yr Storm, AMC-II	74	112	124

In Table 5.4, the fractions of the watershed corresponding to surface cover with curve numbers (CN) greater than 80 and 90 are given for each development scenario, using the 2-year storm and AMC=II as example conditions. A CN = 90 is indicative of commercial and business developments in urban areas, indicating significant amounts of rooftops and paved area, and a CN = 80 is indicative of high-density residential areas (average lot sizes of 1/8 of an acre or less). The results in Table 5.4 indicate that the significant increase of in area with CN > 80 and CN > 90 from pre-development to current development explains the large increase in the amount of simulated peak flow.

Table 5.4 Hydrologic characteristics for 2-year storm event and antecedent moisture characteristic II

Scenario	Peak Flow (cfs)	Runoff Volume (acre-feet)	Fraction of Watershed Area Corresponding to Given Curve Number (CN) *		% Increase in Peak Flow Over Pre-Development
			CN > 80	CN > 90	
Pre-Development	15	29	13%	13%	--
Current Development	32	67	35%	25%	113%
Future Development	37	78	39%	31%	134%

Several important assumptions used in the rainfall-runoff modeling need to be considered when interpreting the results in Figure 5.21 and Figure 5.22 and Table 5.3 and Table 5.4, described as follows.

- Much of the stormwater in the commercial and residential areas of the watershed is routed through storm sewers. The stormwater runoff in the Copper Country Mall, Wal-Mart, Shopko and Econo Foods areas is routed to detention ponds. More sophisticated modeling is needed to account for these stormwater management measures, but the overall impact of these measures is likely to result in even higher peak flows.

- The storm events modeled here are used to model runoff associated with conventional rain storm events. However, since a significant snowpack typically develop in the watershed over the winter, rain-on-snow events can occur, where rain and snowmelt simultaneously contribute to runoff and can produce high flows. The runoff from the rain and snowmelt also is likely to occur with saturated or frozen soil conditions, where the ground can absorb or store less water, resulting in even higher flows than those simulated here.

5.5. Storm Drain, Ditch and Road Crossing Surveys

In fall 2006, a road crossing survey and storm drain survey was completed. The road crossing survey included taking photos of road crossings and visually assessing their condition using MDEQ's Watershed Survey Data Sheet for single site stream crossings and corresponding procedures. The purpose of this survey is to identify problematic sites and those that may be appropriate for biological surveys. Data collected to evaluate the crossings included substrate material, the presence or abundance of aquatic plants, algae, turbidity, foam, oil, trash and bacterial sheen/slime. Other information recorded included width of riparian vegetation, important stream habitat, percentage of stream shading, adjacent land uses and potential sources of pollution. Eight road crossings along the stream were identified to be in generally good shape. The most common problems noted were excessive turbidity, the presence of trash and lack of aquatic vegetation. Data collection locations, completed data sheets and photos from this survey are included in Appendix F.

The storm drain survey identified and documented locations of approximately 94 storm drain inlets, outlets and culverts. Their construction, condition and size were also documented, with locations of each identified on an aerial photo of the watershed. Observations were also made of culvert and storm drain flow paths and routing, which was also documented on an aerial photo. Spreadsheets containing collected data and maps showing locations and routing are provided in Appendix G.

Another survey was completed in September 2007, this time documenting conditions of specific culverts and ditches during rain events. The purpose of this survey was to identify which culverts and ditches were contributing significant amounts of flow during a storm. Locations, descriptions and comments on the relative amount of flow were recorded in a spreadsheet. Photos were also taken and are referenced by location within the spreadsheet. Data and photos compiled from this survey can be found in Appendix G.

5.6. Property Ownership Survey

Property ownership along Huron Creek was investigated in fall 2006. This information was gathered so that the possibility of adding public access sites and/or a nature trail along the creek could be better addressed by the watershed advisory committee.

Property line information was overlain on aerial photos and labeled so that each parcel's owner could be listed in a separate spreadsheet according to the parcel label. Sources of parcel and property data included the 2006 Houghton County plat book and the City of Houghton and Portage Township. The information pertaining to Portage Township may not be up to date as it predates the addition of M-26 and the associated changes in property lines.

The figures and spreadsheet provided in Appendix H summarize riparian property owner information along Huron Creek from its source north to the Keweenaw Foot Care Clinic on M-26. This data may not be completely accurate due to the methods used to create the maps and the publishing date of the information.

5.7. Geomorphology Survey

In fall 2007, a multi-part geomorphology and stream habitat survey was completed. The primary goals of the survey included:

- Provide a baseline of geomorphologic conditions for future comparison.
- Provide data for use in relating geomorphology with land use, hydrology and condition of stream re-route areas.
- Provide data for use in recommending BMPs for the Huron Creek watershed management plan.
- Provide preliminary recommendations for stream improvements as they relate to stream stability.

These goals were achieved by completing the following components of the overall geomorphology survey:

- Modified BEHI (Bank Erosion Hazard Index) – This is a method for assessing stream bank condition and erosion potential. This includes observing physical characteristics of the stream banks, assigning individual scores, and calculating an overall score that indicates risk of bank erosion.
- Stream Habitat Survey – This is a survey that identifies channel bottom materials, streamside vegetation and channel characteristics and uses them to calculate an overall stream habitat score.
- Sediment Monitoring – This survey characterizes sediment size distributions (<1" in diameter) and establishes sediment monitoring locations in the bed of the creek. These locations have been designed for monitoring aggradation and degradation of the creek bed.
- Cross Section and Slope Measurement – Physical cross-section and slope measurements have been completed at designated locations along Huron Creek.
- Other Erosion Monitoring – This is a visual survey that documents erosion within 200 feet of the stream banks. Locations have been recorded along with a photo.
- Photos – Photos have been taken at designated locations for comparative purposes. Photo locations correspond with specific survey locations indicated in the geomorphology survey report.

These survey types were selected based on discussions with Joe Rathbun of the MDEQ's Water Bureau (Rathbun, 2007). The geomorphology survey methods, locations, data forms and quality assurance procedures are summarized in the Huron Creek Geomorphology Survey QAPP that is provided in Appendix I. This QAPP was reviewed and approved by MDEQ prior to beginning the survey[16].

Results of the individual surveys are as follows:

[16] Changes were made to the approved QAPP that are included in Appendix I. These changes were also approved by MDEQ.

- Modified BEHI – For the nine survey locations:
  - 1 location has a “very low” hazard index
  - 4 locations have a “low” hazard index
  - 1 location has a “low to moderate” hazard index
  - 2 locations have a “moderate” hazard index
  - 1 location has a “very high” hazard index

- Stream Habitat Survey – For the nine survey locations:
  - 4 locations rated “fair”
  - 4 locations rated “good”
  - 1 location rated “excellent”

- Sediment Monitoring – A rebar pin was driven into the creek bed at 3 locations where sediment deposition had previously been observed. A measurement from the top of the stream bed substrate to the top of the pin was collected at each location. These measurements will be compared with future measurements to identify if sediment is collecting at (aggrading) or being transported away from (degrading) that location. At the sediment pin locations and one additional location, grab samples of bed sediment were also collected for use in a sieve analysis. It was determined that each sample classified as a poorly graded sand (SP) per the Unified Soil Classification System.

- Cross-Section and Slope Monitoring – Cross-section and longitudinal creek bed slopes were measured using surveying techniques at each of the locations designated in the QAPP. The generated results included figures depicting the physical shape of each cross-section, and a table providing slope data for each location.

- Other Erosion Monitoring – Locations of concern were identified, photographed and incorporated into the future monitoring recommendations as needed.

The Huron Creek Geomorphology Survey final report is attached as Appendix J. The report includes a map of survey locations, detailed explanations of results, cross-section and grain size graphs, slope data and photos.

Recommendations for stormwater management, stream bank stabilization and future monitoring can also be found in the report. The specifics of these include:

- A design for a stormwater detention pond, recommendations for bank stabilization, and future monitoring of a head cut in order to solve severe erosion problems in “Shopping Cart Creek,” a man-made tributary to Huron Creek. (The stormwater detention pond was designed by modeling flows with HydroCAD®).
- Recommendations for repair of damaged creek banks in the Houghton Waterfront Park (Ray Kestner Park).
- A schedule for future monitoring that includes completion of the surveys mentioned above.

Portions of the geomorphology survey were not completed in 2007 due to weather and time constraints. The remaining data collection was then completed in spring 2008, and is supplied as an addendum to the geomorphology report in Appendix J.

5.8. Vegetation and Buffer Survey

In September 2007, a buffer and vegetation survey of riparian zones along Huron Creek was completed. The overall goals of the surveys were to:

- Provide a baseline of vegetation data for future comparison.
- Provide data for use in relating vegetative conditions with other characteristics such as geomorphology, land use, or water quality.
- Provide data for use in recommending BMPs for the Huron Creek watershed management plan.
- Identify locations of invasive plant species, if any.

Survey locations, methods and quality assurance standards are provided in the Huron Creek Vegetation Survey QAPP, attached as Appendix K. This QAPP was reviewed and approved by MDEQ prior to initiation of the survey.

The buffer survey of Huron Creek was completed using GIS and the most recent (2005) aerial photo of the watershed. The riparian buffer used in the survey was created by delineating all areas within 200 feet perpendicular to the creek, creating a 400-foot wide zone (see Figure 2, Appendix K). Each side of the creek within this zone was then categorized based on the amount of contiguous vegetation extending in an outward direction. Next, the total area that each categorized buffer distance covered was calculated. This resulted in the determination of how much of the total buffer zone each vegetated buffer category covered. The categories and results are provided in Table 5.5, as well as in Figure 5.23.

Table 5.5 Fraction of Total Buffer Area Corresponding to Different Buffer Widths

Buffer Width Category (*BW*)	Fraction of Total Buffer Area Corresponding to Category
BW > 400 ft	53%
200 ft < *BW* < 400 ft	15%
100 ft < *BW* < 200 ft	8%
0 ft < *BW* < 100 ft	<1%
No buffer	23%

The second survey completed was a physical, on-the-ground survey of vegetation types within the buffer zone, and is referred to in the QAPP as the “Vegetation Transect Survey.” Nine separate transect location were selected along Huron Creek based on having consistent vegetation and habitat characteristics (see Figure 3, Appendix K). Vegetation species and percent cover information was collected at anywhere between 1 and 3 “data plot” locations along each transect. A spreadsheet is provided in Appendix L that describes the location of each plot (GPS coordinates), a photo of each plot location, common and scientific names of identified species, and percent cover based on stratum (herbaceous, shrub, tree). Invasive species locations are indicated on Figure 5.24 and highlighted in the spreadsheet for easy identification. No general conclusions are easily made from the collected data as habitat type (therefore vegetation type) and percent cover vary randomly along Huron Creek. This information will be used in combination with other survey results to identify Areas of Concern that are described in Chapter 6. The vegetation species data will also be used as a reference for native plant species and a baseline for invasive species management.

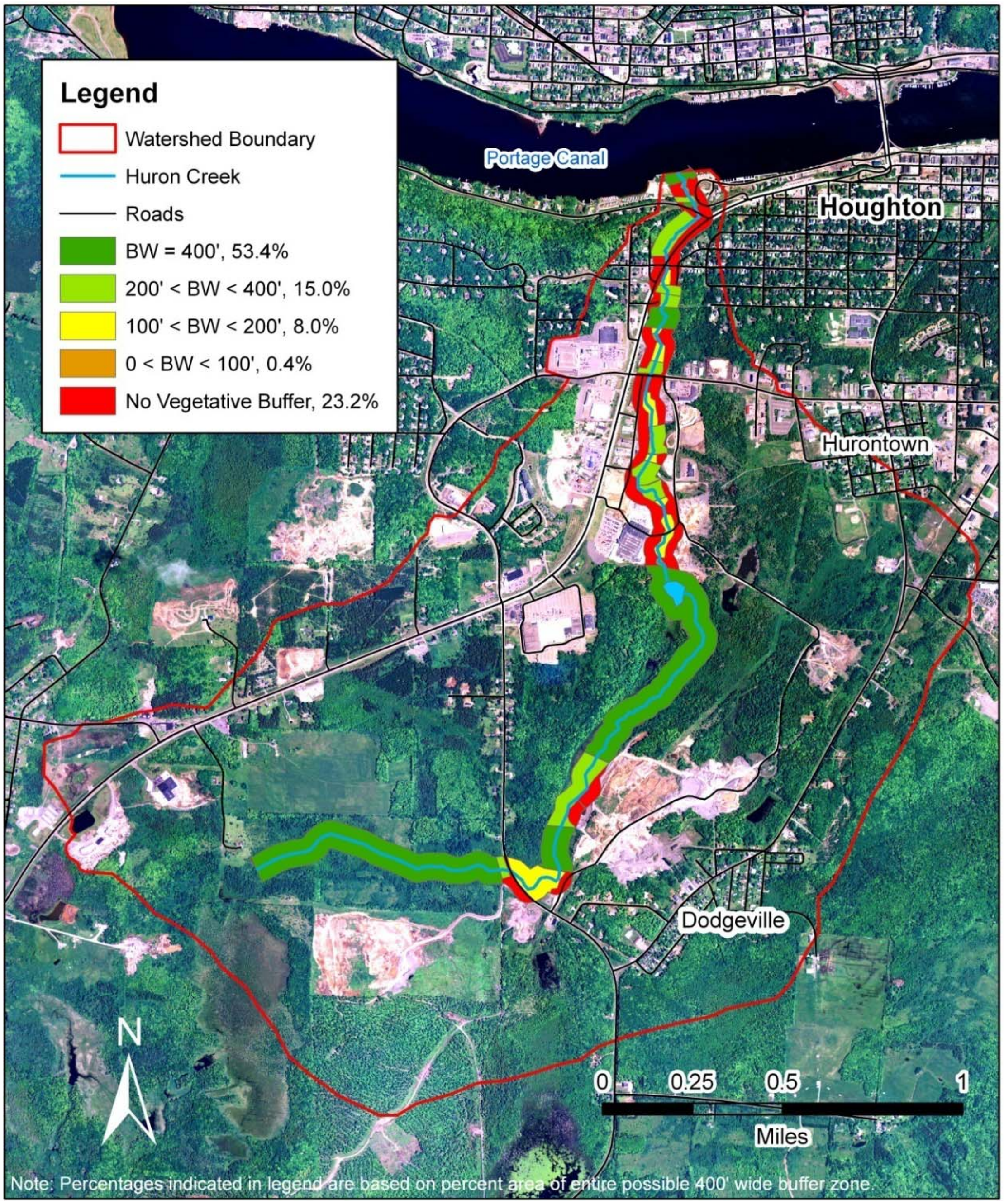


Figure 5.23 Vegetative buffer zones of Huron Creek categorized by buffer width (BW). Created by: Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data source: 2005 NAIP 1-meter digital orthophoto.

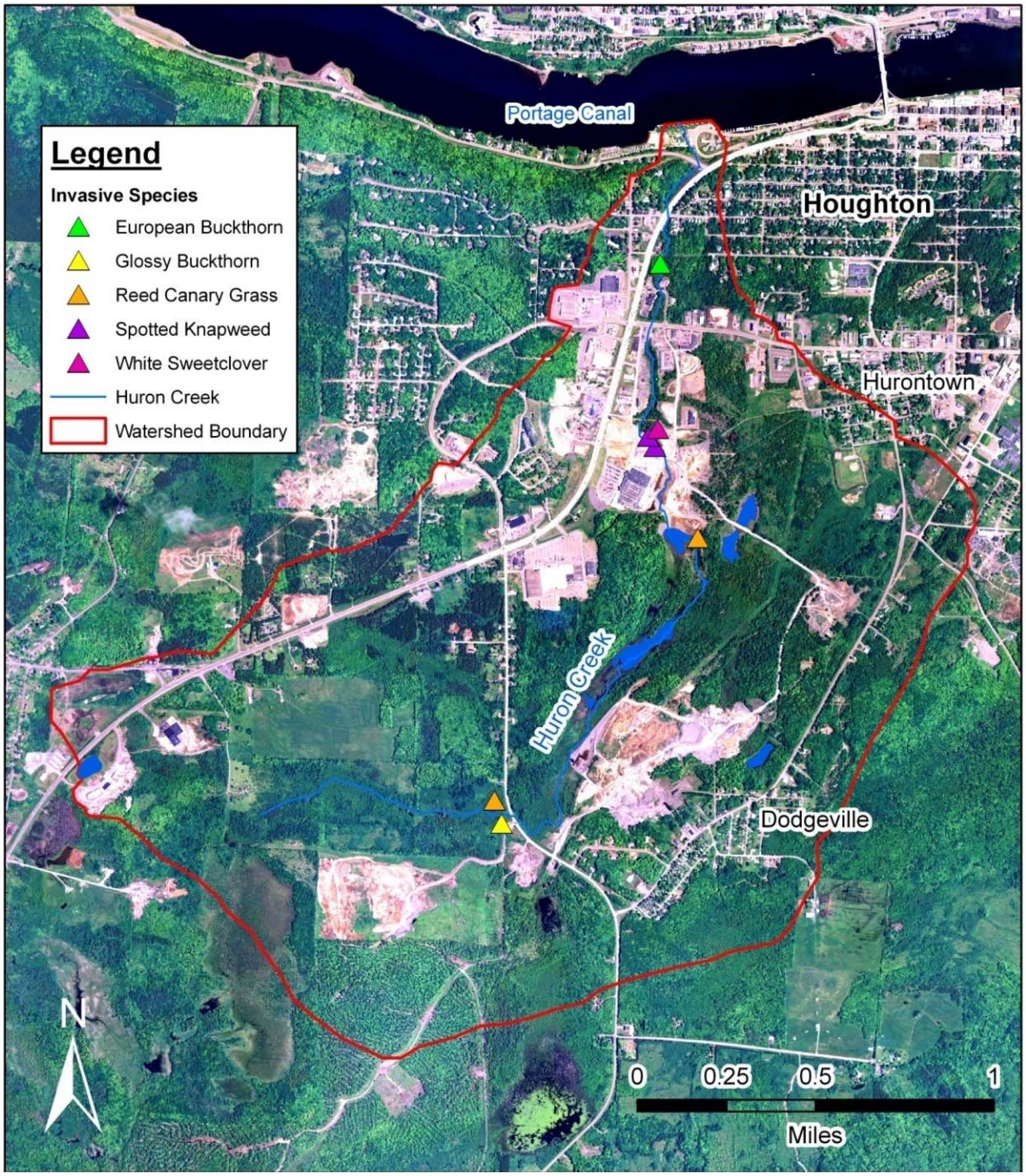


Figure 5.24 Locations and types of invasive plant species found on transects. Created by: Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data source: 2005 NAIP 1-meter digital orthophoto.

5.9. Wetland Restoration Analysis

A simple analysis of potential wetland restoration areas was conducted for the Huron Creek Watershed through the use of a publicly available GIS data layer. This layer is simply referred to as a "potential wetland restoration layer," and is available for most of the state of Michigan on the Michigan

Geographic Data Library website[17]. The information the layer provides to the user is probable locations of former wetland areas that are prioritized by the likelihood they could be restored. In order to give some insight into the interpretation of this data, it is best to first understand how it was created:

- A layer showing historical wetlands data from the 1800's is overlain on today's wetland locations that are from the National Wetland Inventory (NWI) or other similar sources. The current wetland locations are then "erased" from the 1800's data, leaving only locations of where wetlands "used to be" due to changes in land use.

- Next, a layer showing today's locations of hydric soils (soils associated with wetlands) is overlain on top of the same NWI (or similar) layer. The current wetland locations are again "erased" from the hydric soils layer leaving only locations where there are currently hydric soils, but no wetlands.

- Next, the resulting layers from #1 and #2 are overlapped resulting in a layer indicating areas where there used to be wetlands (but currently are not), yet currently have hydric soils. An example of this might be a wetland that was drained for agricultural use.

- Finally, information from #1, #2 and #3 are compiled into one final data layer, with each type of layer categorized by restoration potential according to the following (Chad Kotke MDEQ, 2008):
    - Areas that used to be wetlands (in the 1800's), but currently are not (#1) = *Low Restoration Potential*
    - Areas that currently have hydric soils but are not wetlands (#2) = *Moderate Restoration Potential*
    - Areas that used to be wetlands and currently have hydric soils (#3) = *High Restoration Potential*

Prioritized areas of wetland restoration potential for the Huron Creek watershed are indicated in Figure 5.25, along with areas of existing wetlands. As can be seen on Figure 5.25, the majority of potential restoration areas are of moderate potential, meaning they have been documented as having hydric soils. The largest high potential area, located in the southwestern part of the watershed, is currently a pond. The rest of the high potential areas are relatively small "slivers" that are adjacent to other moderate or low potential areas. It should be noted that the layers used to create the results have not all been verified on the ground, and so field confirmation of existing conditions may be necessary prior to carrying out any action based on this data.

[17] http://www.mcgi.state.mi.us/mgdl/

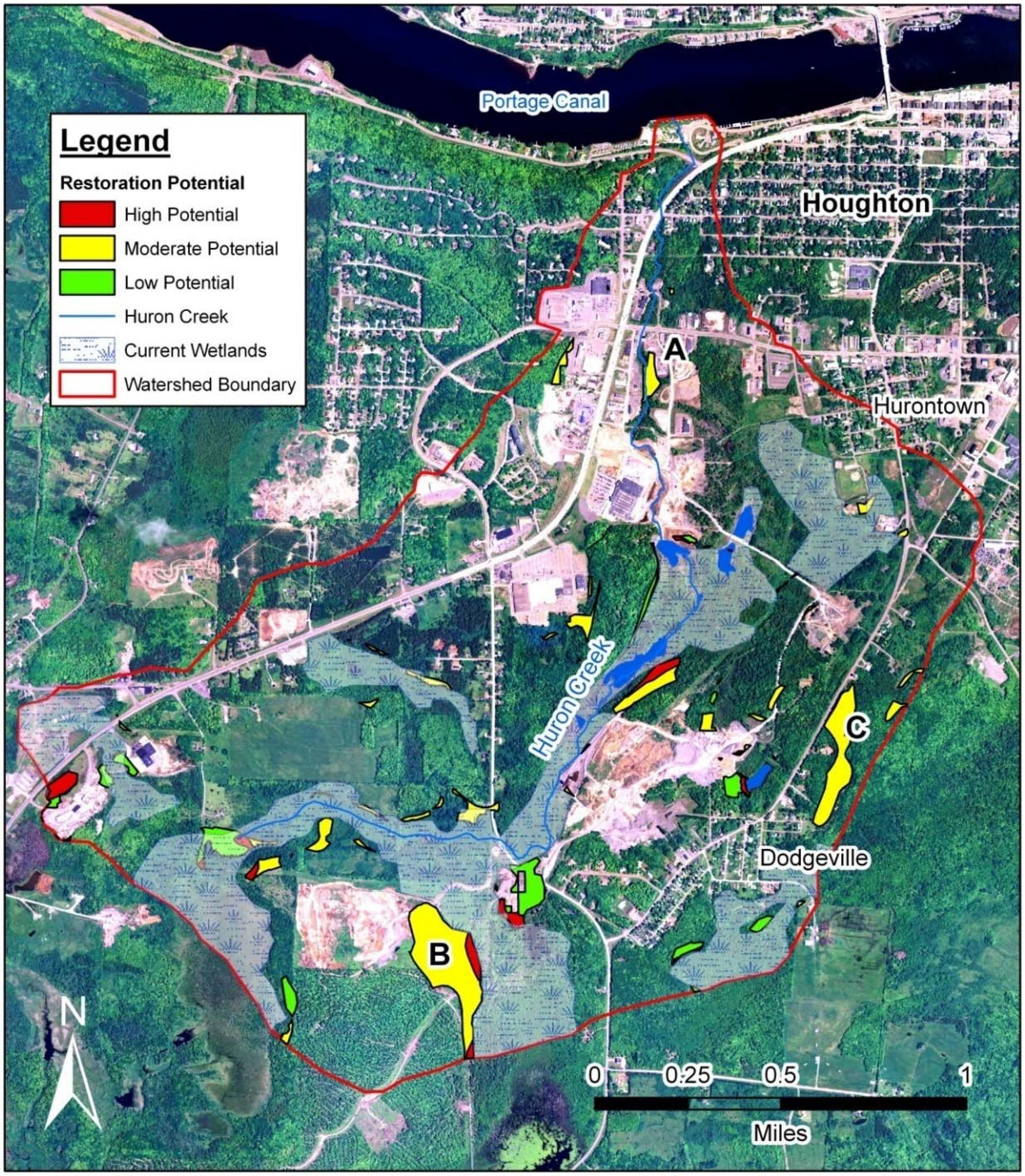


Figure 5.25 Potential wetland restoration areas and current wetland areas. Created by: Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data source: 2005 NAIP 1-meter digital orthophoto.

Three areas of moderate potential in particular stand out as feasible sites for wetland restoration, and are labeled as areas A, B and C on Figure 5.25:

- Area A is located on the east side of Huron Creek immediately south of Sharon Avenue between Razorback Drive and Ridge Road). This area currently exhibits some wetland characteristics such as hydrophytic vegetation and generally saturated soils. In recent years the area has been disturbed due to construction and could be improved through soil stabilization and re-establishment of vegetation.

- Area B is the largest area of moderate potential located near the southern watershed boundary, immediately southeast of the western gravel pit. This area is located between a high, sandy area and a large area of existing wetland. Evidence of excavated drainage ditches is apparent in the aerial photo (Figure 5.25) which may have been created to drain water away from the gravel pit area. If that is the case, then restoration may only rely on returning natural hydrologic conditions to this area (plugging the ditches). However, the benefits of restoration would have to be weighed against the impact it would have on the operation of the gravel pit. Restoration might best be attempted once operations in the southeast portion of the pit cease or in combination with land reclamation performed once all operations cease.

- Area C is the restoration area to northeast of Dodgeville off the east side of Superior Road Based on "drive-by" observation and review of the aerial photo, the majority of this area appears to be existing wetland that has had trails cut through it. (The area is not included in the "current wetlands" most likely because the NWI is not field verified and is not always inclusive of every wetland present.) If this area is confirmed as wetland in the future, it may be a good site for restoration involving either removal or consolidation of trails using proper trail construction techniques so as not to alter hydrology and minimize erosion. These actions, combined with re-vegetation, may be the best first steps at restoration.

5.10. Threatened and Endangered Species Investigation

The Michigan Natural Features Inventory (MNFI) is an organization operated by Michigan State University Extension that maintains databases of the numbers and locations of endangered species, threatened species, species of concern and some natural communities in the state of Michigan[18]. MNFI provides this data to the public in the form of GIS layers that are often used for land use planning. The data is supplied in the form of models that are geared to provide adequate information on rare and endangered species locations, while maintaining the sensitive nature of this data so the resource can remain protected.

An MNFI probability model of sensitive species information was obtained for the Huron Creek watershed. This model indicates the likelihood of finding a rare (threatened or endangered) species or natural community in a given area, in this case, by Public Land Survey System (PLSS) quarter section. Despite its name, the model is not probabilistic in the sense that it provides a statistical probability of an occurrence. The underlying assumption is that the more recent an occurrence has been observed, the more likely it is to still exist. Factors considered in the model are the spatial extent of the occurrences, the presence of potential habitat within the known spatial extent of the occurrence, and the last observed date of the occurrence. The age of each record is then used to determine the likelihood of the species still being present, with recent sightings given a higher likelihood of still existing (Ed Schools,

[18] http://web4.msue.msu.edu/mnfi/

Helen Enander, and John Paskus). Specifically, records prior to 1970 are given a “low” probability of still existing, records between 1970 and 1982 are given a “moderate” probability of still existing, and records after 1982 are given a “high” likelihood of still existing.

The results of this investigation are provided in Figure 5.26. Seventeen sections in the Huron Creek watershed were ranked as having a “low” probability of having a rare species or natural community. All other areas are listed as “no status,” meaning that no rare species or communities have been documented there. Again, the “low” or “no status” designations given do not eliminate those areas from the possibility of having rare species. It only provides an indication of the likelihood a species might be encountered.

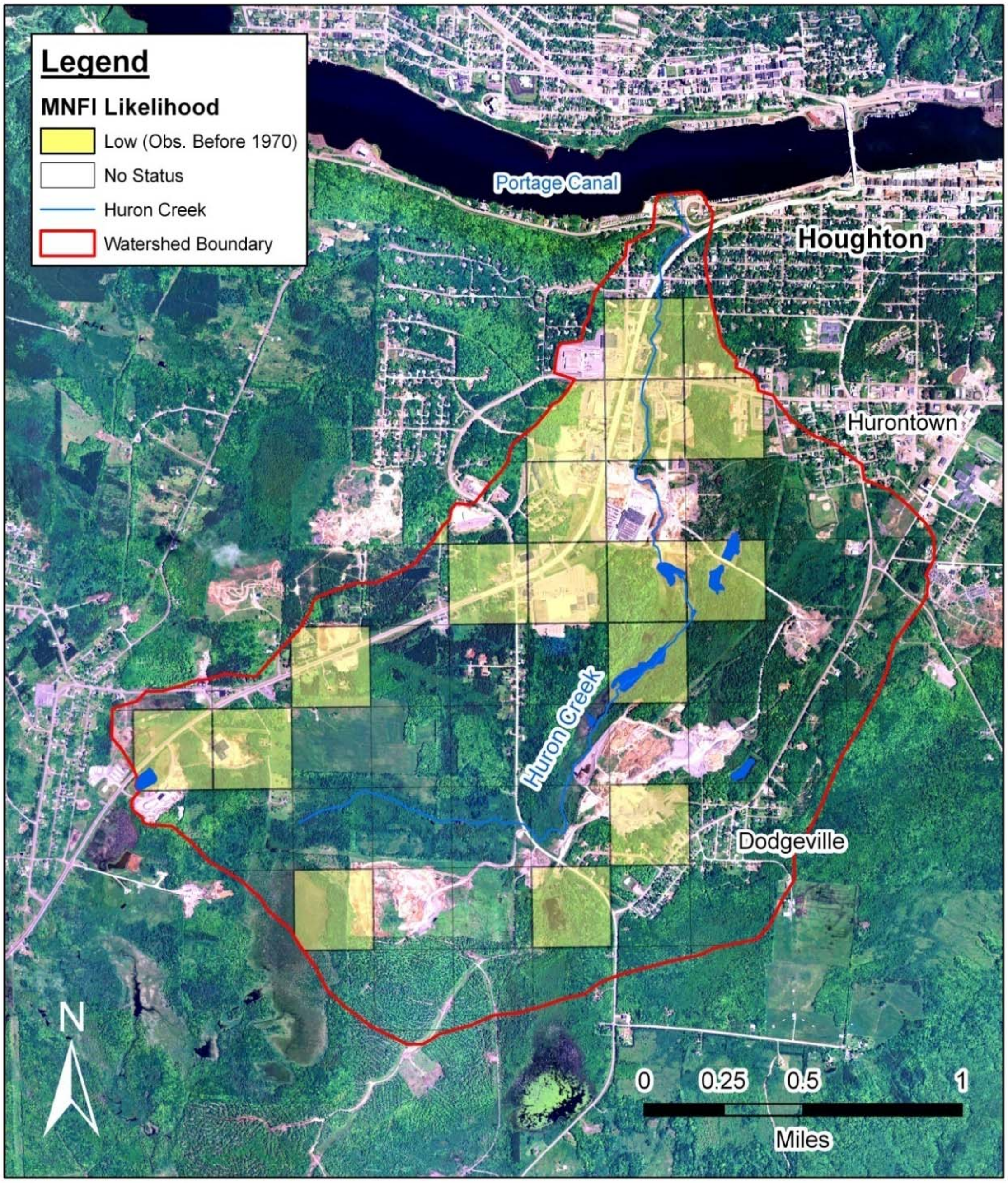


Figure 5.26 MNFI Rare species or natural feature occurrence likelihood. Created by: Linda Kersten, 12/20/06. Map projection: NAD 1927 UTM Zone 16N. Data sources: 2005 NAIP 1-meter digital orthophoto; MNFI Biological Rarity Index and Probability Value.

6. Priority Pollutants and Critical Areas

6.1. Priority Pollutants

The results of field monitoring and data collection presented in Chapter 5 were used along with input from the Huron Creek Watershed Advisory Council (WAC) to compile a prioritized list of pollutants (or characteristics) and sources. This list, provided in Table 6.1, provides a framework for future implementation of improvements that will be targeted first by pollutant, and secondly by sources of each pollutant. In general, each pollutant or characteristic and source or cause was prioritized based on its potential threat to water quality and the designated uses and goals established by the WAC. A more detailed description of prioritization follows.

Table 6.1 Priority Pollutants for Huron Creek Watershed

Pollutant or Characteristic	Pollutant or Characteristic Ranking[1]	Sources or Causes	Sources or Causes Ranking[1]
Metals: Copper, Iron	1	landfill leachate	1
		stamp sands	2
"Flashy" Flow	2	less pervious surfaces/lack of stormwater management	-
Sediments	3	stormwater	1
		construction	2
		bank erosion	3
Pathogens	4	septic systems	-
Nutrients	5	stormwater	1
		landfill leachate	2
		lack of vegetative buffer	3
		septic systems	4
Invasive Species	6	presence of source vegetation	-

[1]Ranking of 1 = "High Priority," with priority decreasing to 5 = "Low Priority"

6.1.1. Metals

Metals (copper and iron) are listed first due to the listing of Huron Creek as being in non-attainment status for copper in the MDEQ's Section 303(d) and exceedance of the Final Acute water quality value for copper (see Figure 5.7). In addition, high iron concentrations are likely responsible for bacteria blooms in a portion of Huron Creek. In Figure 5.5, a consistent "spike" can be seen in iron concentration. The closed landfill located south of Sharon Avenue and adjacent to Huron Creek is listed as the first priority source, as it may be contributing both copper and iron to the creek. It is also listed first as the City of Houghton has taken measures to collect leachate from the landfill before it reaches the creek. Stamp sands are listed second as these materials are likely secondary contributors to copper in surface water runoff.

6.1.2. "Flashy" Flow

The term "flashy" refers to flows with high peak discharges and rapid times of concentration relative to the onset of a storm. As can be seen by the pre-and post-development hydrographs illustrated in Figure 5.21 and Figure 5.22, the runoff response to a storm has a much higher peak flow rate, and reaches that flow rate in a shorter time when portions of the watershed are developed. The pre-development creek morphology (channel shape, bank slope, vegetation, etc.) developed in equilibrium with the pre-development rates of discharge that occurred in response to precipitation events. When the creek is exposed to post-development flashy flows, the creek channel can be disturbed as evidenced by bed incision, bank erosion and deposition of the disturbed sediment when flow rates drop after storm events. Flashy flows and the corresponding channel disturbance also can be exacerbated by re-arrangement of the creek channel. Flashy flows can cause erosion, generate excess sediment, and compromise aquatic habitat. Each of these problems has been identified as critical by the Huron Creek Advisory Council, which explains why it is ranked as the first pollutant/characteristic after metals.

6.1.3. Sediments

Erosion and excessive sediment deposition is prevalent in Huron Creek. Sediment is by far the most observable and prevalent pollutant currently affecting water quality. This pollutant has been ranked above metals and nutrients because the impairment of biological function and visual quality of a stream can occur from excess sedimentation. The sources or causes of sediments have been ranked with stormwater runoff first, since the impervious surfaces that cause excessive stormwater runoff constitute an extensive portion of the watershed. Sediment from construction is ranked second because it can be a large contributor to erosion and excess sediment, but occurs only temporarily (after the land has been cleared and before it is developed). Bank erosion is listed third as it can be caused by flashy flows and stormwater runoff, and can occur as a result of improperly stabilized construction areas in or near the creek.

6.1.4. Nutrients

Nutrients are ranked third because levels of ammonia have been detected that are in exceedance of the Michigan water quality standards (Final Chronic Value). The primary contributors of nutrients are thought to be stormwater runoff and the closed City of Houghton landfill. This is because a) levels of nutrients generally increase traveling downstream in Huron Creek, and b) ammonia levels sharply increase at the landfill monitoring site (see Figure 5.3). The first priority source listed is stormwater, as control and treatment of stormwater can prevent or reduce the amount of nutrients reaching the creek. Lack of a vegetative buffer is listed next as it is a specific type of "treatment" zone where nutrients can be taken up by vegetation. Residential & commercial fertilizers are listed third, as addressing their use can reduce nutrients at the source. However, it is hard to control the use of fertilizers watershed-wide, which is why buffers and stormwater treatment come in as important "safety measures." Septic systems are listed last as identification and replacement of inappropriate systems requires local government action and significant costs.

6.1.5. Bacteria

Bacteria are listed fifth as they potentially threaten the Designated Use of Partial Body Contact Recreation. Although only a few exceedances of coliform bacteria have been measured, there is general agreement by the Huron Creek Watershed Advisory Council, the City of Houghton, Portage Township, and the local district Health Department that the aging septic systems in the Dakota Heights neighborhood pose a potential threat to water quality. However, the amount of effort and funds required to eliminate this potential threat through abandonment of non-code systems and connection to the existing City of Houghton sewer system would be considerable.

6.1.6. Invasive Species

Invasive vegetative species have been listed fourth as they pose a threat to all ecosystems in the watershed, including riparian ecosystems. However, their control can require intensive management and their effects on water quality are more indirect than other pollutants.

6.2. Critical Areas

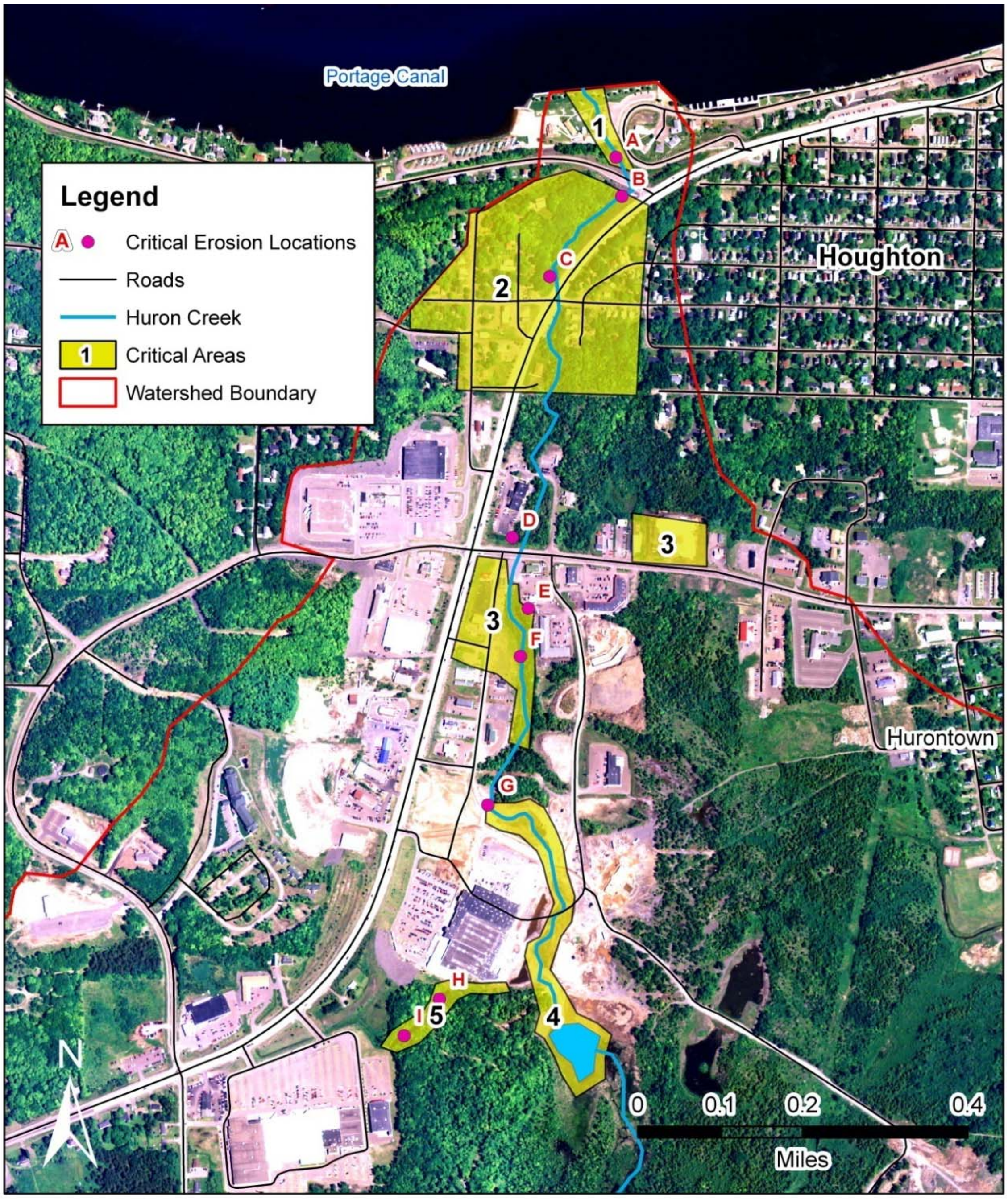
A critical area is the geographic portion of the watershed that is contributing a majority of the pollutants and is having a significant impact on the water body. The concept behind identifying a critical area is to reduce the geographic scope of the overall watershed project, and focus attention on the areas that are in greatest need of improvement. During the implementation phase, the critical areas where the greatest gains in water quality can be obtained relative to the money invested will be targeted for improvement (Elaine Brown, Amy Peterson, Ruth Kline-Robach, Karol Smith, Lois Wolfson, 2000).

Critical areas were identified through meetings of the Huron Creek Watershed Advisory Council and through results of data collection via the water quality, geomorphology and vegetation surveys. Figure 6.1 illustrates the locations and extents of the critical areas, each of which is labeled with a number. In addition, "critical erosion locations" are also identified on Figure 6.1, and are labeled with letters. The "critical erosion locations" are relatively small areas outside of the critical areas where erosion is occurring. Each critical area and erosion location is described below.

6.2.1. Critical Area #1 - Kestner Waterfront Park

The Kestner Waterfront Park (also referred to in this document as the Houghton Waterfront Park) is located within the City of Houghton limits along the Portage Canal. Due to its scenic location and ample facilities, the park is one of the most popular recreation areas in the city. Facilities include a swimming beach, launch site for kayaks and sailboats, an extensive playground area, picnic tables and a walking path. The park also has a pavilion and band shell, making it a prime location for many outdoor events and gatherings. Huron Creek flows through the Kestner waterfront park for approximately 350 feet before emptying into the Portage waterway through a culvert beneath a concrete walkway. The creek channel was excavated when the park was built in 1988. The creek channel in the park consists primarily of straight segments with steep, un-stabilized banks. Historically there have been repeated problems with the banks of Huron Creek washing out from erosion during storms. A severe storm in September

Figure 6.1 Critical areas and erosion locations.



2007 caused several bank areas to completely fail (Figure 6.2) resulting in steep, undercut and unprotected slopes. Various methods have been used to attempt to stabilize the banks over the years including rip-rap, herbaceous plantings and erosion matting with lawn grass. Each method has eventually given way to severe bank erosion.

Figure 6.2 Eroded banks in the Kestner Waterfront Park

The priorities for this area are (a) the repair and stabilization of the creek banks, (b) planting of vegetation along the creeks banks to provide a more natural setting, and (c) replacing the sidewalk-culvert outlet with a bridge. The improvement of the creek in the Waterfront Park is recognized as a high priority by the Huron Creek WAC, since the park is practically the only location where the public interacts with the creek, and so it is especially important to present the creek as a natural amenity here. The thought is that, if the public enjoys the creek as a natural amenity in the park, they are more likely to support he protection and restoration of the remainder of the creek and its watershed.

6.2.2. Critical Area #2 - Dakota Heights

Dakota Heights is the name used to describe the portion of Portage Township that lies within the larger boundaries of the City of Houghton along M-26. The Dakota Heights area is roughly contained in Critical Area #2. As mentioned in Chapters 2 and 4, homes in this area are not connected to a municipal sewer system and rely on septic systems for treatment and disposal of household wastewater. These septic systems are a potential environmental concern for the Huron Creek watershed because many of these septic systems are old and their condition is unknown. Some of the septic systems are cesspools (tanks or holes filled with rock), undersized, have more than one house on a system or are leaking and in need of repair. Some homes with septic systems are on lots that are visibly too small to support the offset and other requirements of modern septic systems (Bingham, 2008).

However, the sanitary sewer system for City of Houghton is no more than a few hundreds of feet from the homes in Dakota Heights. Sewage collected by the City of Houghton sanitary system is sent to the Portage Lake Water-Sewer Authority Treatment Plant. The City of Houghton has the capacity to handle the sewerage from the homes in Dakota Heights. Thus, collaboration between the City of Houghton and Portage Township to connect the Dakota Heights homes to the Houghton sanitary sewer system could eliminate the potential threat of these septic tanks. However, an agreement on a funding scheme for the initial sewer connections and monthly sewerage charges has yet to be worked out between the two governments.

6.2.3. Critical Area #3 - Former Houghton Landfills & Leachate Collection Area

Two closed landfills are located within the Huron Creek watershed. The first of these landfills operated for approximately 15 years beginning in the 1950's and was located just north of Sharon Avenue, extending between the current Quizno's and Huron Creek. This landfill was a "burning dump" where garbage was burned on a regular basis. This landfill was closed in the 1970's during a push towards the removal of burning dumps, and was replaced with a state registered landfill nearby. No apparent water quality impacts have been associated with this landfill. It is assumed that the distance between the materials in this landfill and the creek is large enough to preclude water quality impacts on Huron Creek. However, no assessment of the potential hazards associated with this landfill has been performed.

This second landfill was opened shortly after the close of the first, and is located under Ridge Road, extending south from Sharon Avenue to approximately the location of the current Miner's State Bank. The locations of the landfills are indicated on Figure 6.1. This second landfill was only operated for a few years before it was closed (Greer, 2006). Neither landfill was constructed by today's environmental standards, which would include having impervious liners, caps and leachate and methane collection systems. Therefore there has been concern regarding the environmental impact they are having on soil, groundwater and surface waters.

Figure 6.3 Ridge Road Landfill in the mid-1980's.

In 2000, blooms of iron bacteria were observed seeping from banks and in the bed of Huron Creek immediately next to the Ridge Road landfill. These blooms create an orange and brown slime that covers the creek bottom substrate, which could impact aquatic habitat, as well as reduce the creek's visual appeal (see Figure 4.1). These observations were responded to by MDEQ with water quality monitoring of Huron Creek beginning in 2001, and again in 2006. MDEQ employees confirmed that the "slime" was iron bacteria blooms, and observed it originating from the banks of the creek next to the landfill. Water quality test results indicated levels of dissolved copper in exceedance of the Michigan Rule 57 Aquatic Life protection value at multiple locations (including the landfill site) in both 2001 and 2006. These water quality results are listed on page 12 of the MDEQ Water Bureau December 2007 Staff Report provided in Appendix M.

In July 2005, the MDEQ Water Bureau also collected samples of the material seeping from the landfill area at two locations (seep #1 and seep #2). The seep samples were tested for a variety of parameters including some field parameters (conductivity, pH), metals, nutrients, total dissolved solids, hardness, alkalinity, pesticides and PCBs, volatile compounds (benzene, xylene, etc.) and base-neutral acid compounds.

The results of testing both seeps resulted in exceedances of the Final Chronic Value (FCV) for total dissolved solids, dissolved manganese and dissolved silver. Copper and ammonia concentrations exceeded the Final Acute Value (FAV) by one to two orders of magnitude. No pesticides, PCBs or base-neutral acid compounds were identified in either of the seep samples. The only volatile compound identified in either of the samples was benzene, which was found in seep #2 only. The measured concentration was 4.7 µg/L which is relatively low compared to the FAV for benzene which is 1,800 µg/L. Acute toxicity testing was also completed on the samples. This involves exposing macro-invertebrates (usually *Daphnia magna*) to the collected sample and observing their mortality compared to a control sample. The results of this testing indicated that the material from seep #1 was not acutely toxic to *Daphnia* as it did not exceed the standard of 1.0 Acute Toxicity Units (TUa). However, the material from seep #2 was determined to be acutely toxic to *Daphnia* with a level of toxicity of >3.1 TUa. The report for seep #2 states that seeping groundwater from the landfill may be contributing to the biological impairment of Huron Creek. These results and data summaries by MDEQ are also included in Appendix M.

In fall 2005, MDEQ approached the City of Houghton about completing a remediation project to prevent the seeping groundwater (leachate) from reaching Huron Creek. In response, the city installed a leachate collection system at the toe of the slope of the landfill so that the leachate is intercepted before it reaches the creek. This system includes a perforated pipe that has been installed in a gravel trench lined with impervious geo-membrane. The pipe and trench are sloped so that leachate entering them runs to a sump, where it is then pumped into the city's municipal sewer system for treatment at the wastewater treatment plant. The system began operating in fall 2006.

Although the installation of the leachate collection system is potentially solving the problem of leachate impacting the creek's water quality, the construction during installation of the system resulted in disturbance of soils and vegetation along that portion of Huron Creek. The City of Houghton took measures to control erosion and stabilize the site, but some are in need of repair, or additional stabilization should be completed. For example, the steep side slope of the old landfill that was disturbed during construction is showing rill and gully erosion despite installation of erosion matting and attempts at planting grass seed. Grass is only sparsely filling in on erosion mat at the base of the slope due to a thin or non-existent soil layer. Other locations remain with bare soil and would best be stabilized through planting native riparian vegetation. Figure 6.4 shows the creek and construction area as viewed from the current Arby's parking lot. In addition, as seen in Figure 6.4, the dense shrub and tree vegetation that existed before installation of the leachate collection system has not been replaced.

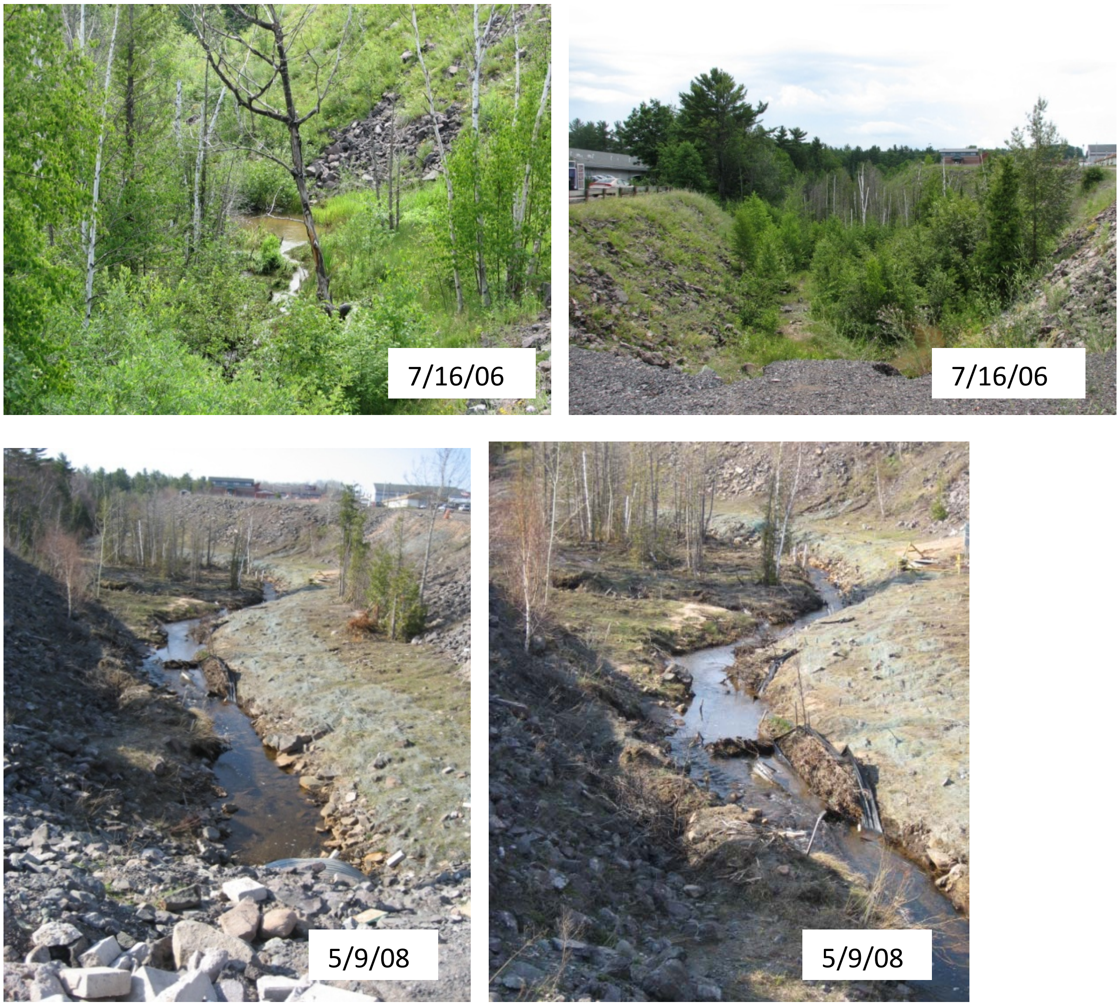


Figure 6.4 Huron Creek and leachate collection system installation area

A final concern associated with the landfills is the emission of methane gas. Because degrading materials within a landfill are buried and therefore in a low oxygen environment, anaerobic (non-oxygen using) bacteria complete a majority of the breakdown of the organic material in the landfill. These bacteria produce methane from their respiration process which then collects and tends to diffuse from the source area, including towards the ground surface. Because methane is combustible, having concentrations in the air above certain levels can pose a safety threat to buildings and people located on or near the landfill. Currently, all of the businesses located on top of the landfill on Ridge Road are aware of this issue and have had methane monitors installed in their buildings by the City of Houghton. The city also contracted out an independent consulting firm to install and operate a methane collection system that has been in operation for several years. The operation of the methane capture system combined with regular monitoring of methane levels in local buildings has thus far prevented any major health concerns or incidents. The landfill located north of Sharon Avenue is not known to be releasing measureable levels of methane.

As mentioned earlier, rill and gully erosion is present on the steep side-slope of the landfill on the west side of Huron Creek. This steep side-slope is at an angle of approximately 60 to 70 degrees relative to horizontal, and continues south along the west side of Huron Creek through Critical Area #3 to the “Frog Pool.” Although much of the slope near Frog Pool has been stabilized through the use of mine rock rip-rap, there are several areas where the rock has been disturbed and more rills and gullies have developed. An example of this is discussed in the critical erosion locations section below.

The last item of concern in Critical Area #3 is a pile of stamp sands that is located on the east side of the creek across from the old Ming restaurant. The pile is approximately 20’x30’ and has an unknown depth. It also remains entirely un-vegetated as the coarseness of these sands tends to prohibit establishment of topsoil and therefore vegetation. The proximity of this pile of stamp sands to Huron Creek is of concern as it may be adding to levels of dissolved copper or iron in the creek. This is especially likely for dissolved copper, for which the water of Huron Creek currently exceeds a Rule 57 aquatic protection value.

6.2.4. Critical Area #4 - Huron Creek Re-Route and Wetland Mitigation Areas

As mentioned in Chapter 2, 5.5 acres of wetlands were filled and a portion of Huron Creek was relocated when the existing Wal-Mart expanded to a Super Wal-Mart in 2004. The state and federal permits that were obtained for completing these tasks required creation of mitigation areas, which includes the re-routed portion of Huron Creek and the former Huron Lake area.

The former Huron Lake area has been rehabilitated and enhanced as part of the mitigation. In the creek re-route area, the vegetation survey and general observations have indicated that much of the vegetation planted there has not survived or has been out-competed by invasive species such as spotted knapweed (*Centaurea stoebe*) and white and yellow sweetclover (*Melilotus alba, Melilotus officinalis*).

Figure 6.5 Huron Creek Re-route and former Huron Lake mitigation areas

Currently the creek re-route area is open and does not have a variety of tree and shrub species that might provide shade and thereby reduce the warming of the creek water. Invasive species such as spotted knapweed can prevent establishment of any other vegetation through altering the biological or chemical characteristics of the soil, as well as by out-competing them through reproductive or other adaptive means. Therefore, a main concern for this area is to eliminate invasive species and establish a more diverse, preferably native riparian habitat.

The former Huron Lake area is in generally better condition than the re-route area, and has open-water as well as emergent wetland areas. Several small areas of wet meadow fringe the open water areas, and support native herbaceous species such as sedges, rushes and flowering plants such as joe-pye weed and blue vervain. The southern end of the open water area then transitions into a shrub-scrub type wetland. Establishment of invasive species is also a threat to these habitats as reed canary grass (Phalaris arundinacea), a prominent invasive, has been documented there. Future management objectives for the former Huron Lake area might include control of invasive species and enhancement of habitat for wildlife.

Lastly, as mentioned in Chapter 2, the rehabilitation of the former Huron Lake area included removal of several areas of stamp sands that existed around the edge of the lake. Stamp sands are no longer present in most of the mitigation site, except for a small area located on the northwest side of the open-water wetland. This area of stamp sands is located on the side of a relatively small slope that has trees and other vegetation on top. Similar to the pile located in Critical Area #3, this pile could be a source of copper and/or iron and poses a potential threat due to its close proximity to the open-water wetland that Huron Creek flows in and out of.

6.2.5. Critical Area #5 - “Shopping Cart Creek"

“Shopping Cart Creek” is the name given to the man-made tributary to Huron Creek that begins at the northeast corner of the Copper Country Mall parking lot and discharges into the Wal-Mart stormwater detention ponds (which in turn discharge into Huron Creek). Stormwater runoff from the Copper Country Mall (via culvert) and the Festival Foods area (via ditch) provide most of the flow to Shopping Cart Creek. This “tributary” has been designated as a critical area due to the severe erosion that has occurred at multiple locations along its length. The two areas of most concern are a headcut and an exposed, eroded bank that is approximately 6-8 feet high. Both of these locations are designated as critical erosion locations and are described in length in Section 6.2.6. It is likely that these severe areas of erosion have been caused by the high flows associated with runoff from impervious surfaces in the Copper Country Mall and the Festival Foods area.

6.2.6. Critical Erosion Locations

Each of the areas described below is an individual location of documented significant erosion. These areas were identified in the erosion portion of the geomorphology survey (see Section 5.7), which included any observable erosion within a 200-foot buffer of Huron Creek. These areas have been identified as critical as they are contributing to, or have potential to contribute to excessive sediment concentrations in Huron Creek. They also represent possibilities for small future improvement projects that can be completed incrementally, while potentially having a significant impact on water quality.

Location "A": At this location, Huron Creek flows through a man-made rectangular rock channel that was constructed during historical mining operations. It is located immediately south of the Kestner Waterfront Park, north of Canal Road. As shown in Figure 6.6, portions of the channel have collapsed causing soil to erode on the bank above, and the creek to undercut the rock wall.

Figure 6.6 Critical Erosion Location "A."

Location "B": This area of erosion is located immediately south of where Huron Creek passes under Canal Road. In this location, concrete was used to stabilize the creek bank. However, as shown in Figure 6.7, the creek has managed to undercut the concrete and is now flowing underneath it.

Figure 6.7 Critical Erosion Location "B."

Critical Erosion Location “C”: This site (see Figure 6.8) is located immediately downstream (north) of where Huron Creek passes under Highway M-26. At this location, a gully has formed adjacent to the culvert sidewall and extends up-slope to M-26.

Figure 6.8 Critical Erosion Location “C”

Critical Erosion Location “D”: This site (see Figure 6.9) is a ditch that drains to Huron Creek from a culvert that passes under M-26. The culvert conveys stormwater runoff from the Shopko and Econo Foods areas, and possibly from the Perkins/Kirkish Furniture/Holiday Inn Express development area. The ditch runs between Sharon Avenue and the parking lot of the Rice Memorial Mental Health clinic. It is showing signs of erosion on the parking lot side and undercutting of the banks of the ditch.

Figure 6.9 Critical Erosion Location “D”

Figure 6.10 Critical Erosion Location "E"

Critical Erosion Location "E": This site (see Figure 6.10) is located on the west side of the parking area between the Taco Bell and Dairy Queen restaurants. A culvert discharges stormwater at the edge of the pavement which runs down a slope and combines with Huron Creek. The discharge, as well as the steepness of the slope has carved an approximately 2 to 3-foot deep channel. The banks of the channel are undercut and slope failure is apparent. Sediment from erosion of the bank deposits at the base of the slope near where the stormwater enters Huron Creek.

Critical Erosion Location "F": As mentioned in the description of Critical Area #3, there are several locations of erosion along the steep slopes of this area, predominantly on the west side of Huron Creek. The photo in Figure 6.11 shows a location near Keweenaw Gem & Gift where slope stabilization methods have failed. The photo in Figure 6.12 shows a similar location on the same slope near the Ming Restaurant.

Figure 6.11 Critical Erosion Location "F"

Figure 6.12 Critical Erosion Location "F"

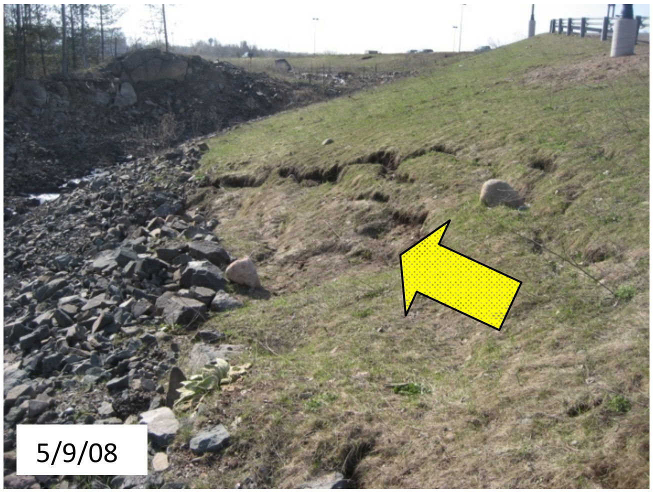


Figure 6.13 Critical Erosion Location "G"

Critical Erosion Location "G": This site is located on the east side of Ridge Road in the creek corridor below Applebee's Restaurant. Here (see Figure 6.13), the soil is showing signs of slope failure. It is evident that the grass planted on this slope is not providing enough stability to hold the soil in place. Although this location is separated from Huron Creek by a zone of rip-rap, it has the potential to create a large area of slope failure and erosion, and may eventually cause sediment to reach the creek.

Figure 6.14 Critical Erosion Location "H"

Critical Erosion Location "H": This site is an erosional feature called a headcut, and is one of the most prominent erosion locations in Critical Area 4. A headcut occurs when flow in an earthen channel or gully encounters a weak point (or "knickpoint") and soil is severely eroded downstream resulting in a sudden elevation decrease of the channel bottom (Hanson, 2008). This elevation decrease creates a small waterfall which, through scour occurring at its base, continues movement of the headcut in an upstream direction. As can be seen in Figure 6.14, the entire portion of Shopping Cart Creek that passes through a hill downstream of the headcut is a large eroded gully. After the gully, the flow follows a smaller channel that passes behind Wal-Mart and then enters the Wal-Mart stormwater ponds prior to discharging to Huron Creek. The headcut poses at least two problems. First, visual observation of the Wal-Mart stormwater ponds indicates that the inlet and outlet culverts are at the same elevation as the bottom of the ponds. If this is the case, sediment entering the ponds is free to pass through them and into Huron Creek. If this is not the case, sediment washing into the storm ponds from Shopping Cart Creek presents a maintenance issue. Sediments collecting in the bottom of the ponds would have to be removed in order to preserve the volume of stormwater the detention ponds were designed for.

Second, The continual movement of the headcut in an upstream direction would eventually lead to the large gully extending all the way to the Copper Country Mall parking lot and culverts. This would result in a large amount of land loss and soil erosion, and may pose a threat to ground stability in the parking lot area.

Figure 6.15 Critical Erosion Location "I"

Critical Erosion Location "I": This site is another prominent area of erosion in Critical Area 4. It is located only a few hundred feet downstream of the Copper Country Mall culverts and the Festival Foods area ditch. As shown in Figure 6.15, the bank of the creek has been eroded away leaving a bare soil and rock face that is approximately 6 to 8 feet high. If this area is not stabilized, it may continue to erode in an outward direction as it is located on the outside of a curve in the creek. As mentioned earlier, this erosion is most likely attributable to the increased peak flow rates and volumes that are generated by runoff from impervious surfaces such as the parking lots of the Copper Country Mall and the development area around Festival Foods.

6.2.7. Other Areas to Note

There are a few areas that have similar environmental concerns as the Critical Areas listed above, but have not been designated as Critical Areas (Figure 6.16 shows these areas).

First, there are several deposits of stamp sands in the Huron Creek watershed that have not been indicated as Critical Areas for the following reasons:

- The stamp sand locations are located relatively far from Huron Creek (on the order of thousands of feet from the creek) and/or do not appear to be eroding. The exception, in terms of distance from the creek, is the area shown in Figure 6.16 indicated with a star. However, the size of the majority of the materials in this area is relatively large (diameter on the order of several inches). The large size of these materials should preclude significant leaching of metals such as copper.
- Due to their significant extent (on the order of tens to hundreds of thousands of square feet), removal or remediation would require large-scale efforts, financing and multiple-property owner collaboration.

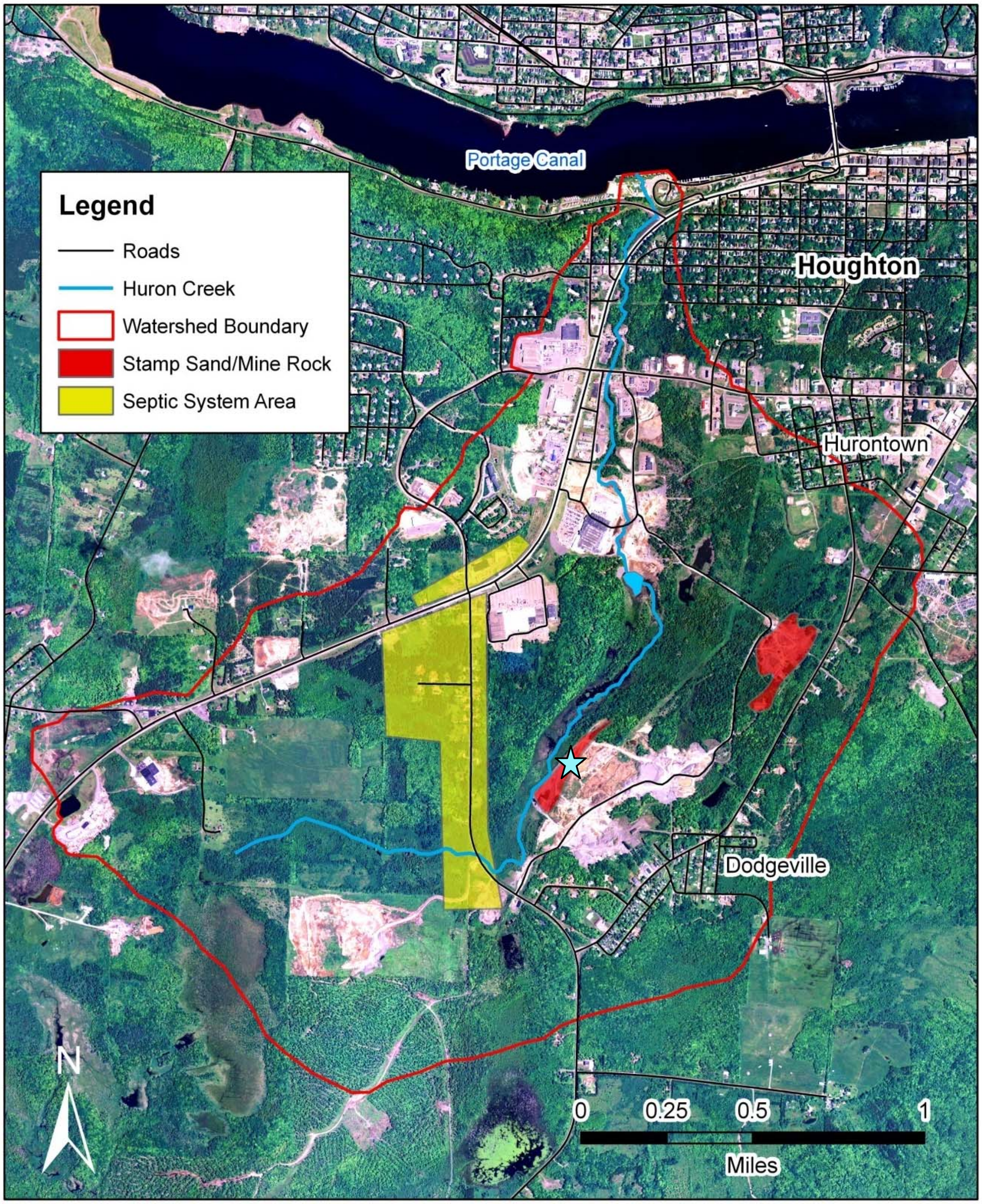


Figure 6.16 Non-critical septic system and stamp sand areas

- These stamp sand locations are associated with old mines, which may have archeological or historical value as cultural resources, and might require management and preservation in addition to remediation.

Excluding these stamp sand locations from designation as Critical Areas is not meant to imply that the perception of environmental impact of these stamp sands should be minimized, as they could be significant sources of dissolved metals. Their presence and impacts should remain as a concern for the watershed, even if their management lies outside of the scope of the Huron Creek watershed management plan.

Second, there are other areas where septic systems are in use in Portage Township besides Dakota Heights, namely on Green Acres road from the intersection with M-26 east to the boundaries of Dodgeville, that have not been included as Critical Areas for the following reasons:

- It is not as obvious if the density of housing and sizes of lots are in conflict with today's state septic system rules as in Dakota Heights. Lot sizes are generally larger and less densely spaced.
- Many of the homes are newer than in Dakota Heights, implying that the age and/or design of their septic systems may not be as old as those in Dakota Heights.

7. Watershed Objectives and Recommended Actions

In this chapter, the objectives for protecting and restoring the Huron Creek Watershed are listed (Section 7.1). Next, recommended actions for protecting and restoring the Huron Creek Watershed are described in detail (Section 7.2). The recommended actions are presented under the categories of physical improvements, monitoring plans, and ordinances (Sections 7.3, 0, and 7.5). Along with the descriptions, potential partners, implementation timelines and milestones, and estimated costs for each action are given. Following the recommended actions, sources for best management practices (BMPs) are given, which provide guidance on how best to implement the recommended actions (Section 7.6). Next, potential funding sources for implementing the recommended actions are listed (Section 7.7). Finally, pollutant reductions associated with the recommended actions are estimated (Section 7.8).

7.1. Goals and Objectives

In Table 7.1, the watershed goals listed in Chapter 4 are associated with specific objectives to be completed. These objectives have been designed to address priority pollutants and critical areas. The objectives are expanded into recommended actions in Section 7.2 and into information/education plans in Chapter 8.

Table 7.1 Goals and Objectives for the Huron Creek Watershed

Goals	Objectives
Improve and protect aquatic and terrestrial ecosystems	***Manage copper and iron pollution through:*** - Reclamation or removal of stamp sand areas near the creek - Continued operation of the leachate collection system by City of Houghton - Continued monitoring of copper and iron concentrations in Huron Creek ***Manage the "flashiness" of stormwater flows through:*** - Installation or improvement of stormwater detention ponds - Implementation of stormwater management and buffer ordinances - Establishment of flow monitoring system and calibration of flow model ***Manage sediment pollution through:*** - Installation of or improvement stormwater detention ponds - Stabilization of creek banks and channel in the Kestner Waterfront Park, landfill leachate system area, "Shopping Cart Creek," and the Critical Erosion Locations - Implementation of stormwater management and buffer ordinances - Education about proper construction techniques and stabilization practices for minimizing erosion - Continued monitoring of erosion and sediment deposition sites in Huron Creek ***Protect and improve the vegetative buffer through:*** - Implementation of a buffer ordinance - Enhancement of buffer vegetation in the Kestner Waterfront Park, landfill leachate system area, and the creek re-route/mitigation area ***Control the establishment of invasive vegetative species through:*** - Continued monitoring of establishing species - Removal of invasive plants combined with re-establishment of native vegetation ***Protect and improve biodiversity through:*** - Completing a biodiversity study or studies in the wetland mitigation and potential wetland restoration areas. - Recommending improvements to habitat areas that are designed to increase biodiversity.

Goals	Objectives
Protect recreational use by reducing copper and iron, bacteria and nutrient concentrations in the creek	***Manage copper and iron pollution through*** - Reclamation or removal of manageably-sized stamp sand areas near creek - Continued operation of the leachate collection system by City of Houghton - Continued monitoring of copper and iron concentrations in Huron Creek ***Manage bacterial pollution through:*** - Connection of Dakota Heights and/or other areas to public sewers - Continued monitoring of coliform bacteria in Huron Creek ***Manage nutrient concentrations through:*** - Connection of Dakota Heights and/or other areas to public sewers - Continued monitoring of nutrient concentrations in Huron Creek - Education about use of residential & commercial fertilizers - Implementation of a buffer ordinance - Implementation of a stormwater ordinance (infiltration practices)
Protect and improve the vegetative buffer	***Protect and improve the vegetative buffer through*** - Implementation of a buffer ordinance - Enhancement of buffer vegetation in the Kestner Waterfront Park, landfill leachate system area, and the creek re-route/mitigation area
Improve and restore the creek areas in the Kestner waterfront park and maintain access to creek	***Restore the creek in the waterfront park by:*** - Leveling out steep bank areas - Stabilization of the toe of the bank to protect against future erosion - Planting the banks with native vegetation while leaving areas open for access & viewing - Repair or replace the walkway near the mouth with a bridge
Encourage use of the Wal-Mart wetland mitigation area for educational and outreach purposes	***Use the wetland mitigation area for education and outreach by:*** - Working with City of Houghton for permission and access - Educating about wetland and watershed health at the site - Creating signage and/or an "education station" for use by classes and/or organizations
Install interpretive signs on watershed health and historical heritage	***Install interpretive and educational signage through:*** - Working with WAC & historical experts to determine appropriate locations and topics - Identifying funding sources and technical assistance

7.2. Summary of Recommended Actions

Recommended actions include physical improvements, monitoring plans, ordinances, and an information and education strategy (described in Chapter 8 and summarized in Table 8.1). Table 7.2, Table 7.3, and Table 7.4 provide a summaries of recommended actions and their corresponding potential partners, estimated costs, potential funding sources and milestones. Implementation timelines are presented on a 10-year timeline, with short-term (0-3 years), mid-term (3-7 years) and long term (7-10 years) proposed schedules. Continuously implemented items are expressed as 0-10 years.

The recommended actions are presented in order of their recommended priority (highest to lowest). The order of priority is based on several factors including the (a) the priority of the associated pollutant or characteristic (see Section 6.1), (b) potential availability of funding for the action, (c) anticipated interest in the action by the local community.

In Sections 7.3, 7.4 and 7.5, each recommended action is described in more detail, as well as the following information:

- related objectives (from Table 7.1)
- potential partners
- implementation timeline
- milestones
- estimated cost

The potential partners are suggested groups and organizations that could potentially provide financial and/or technical assistance associated with the recommended action. Simple milestones have also been suggested as interim targets for project completion. Associated costs are provided in the form of a cost range as some actions may vary in scope or are difficult to target. These quantities and costs are rough estimates and should be verified and/or recalculated prior to grant application or implementation[19]. All costs are based on 2008 prices. Detailed calculations of estimated costs are provided in Appendix O.

[19] The quantities and costs estimated for the Kestner waterfront park improvements were completed as part of a detailed estimate (included in Appendix P) and have been reviewed by the City of Houghton. All other costs are summarized in Table 8.5 and Appendix O.

Table 7.2 Summary of Recommended Actions: Physical Improvements

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.3.1. Reduce Metals and Ammonia Loads to Huron Creek	City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	1. Mitigate stamp sand area next to Huron Creek in vicinity of Ridge Road Landfill	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	\$800 to \$1,200	MDEQ-NPS
	City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	2. Mitigate stamp sand in wetlands mitigation area	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	\$1,000 to \$3,800	MDEQ-NPS
	City of Houghton, MDEQ, CWS	Long-term (0-10 yr)	3. Evaluate performance of landfill leachate collection system	10/09 to as needed: Monitor leachate collection system performance	\$500 to 1,000/yr	
7.3.2. Further Study of Stormwater Management Issues	HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short-term (0-3 yr)	Conduct survey of stormwater systems and stormwater modeling; assess best management alternatives for reducing the flashy flows.	5/10: Develop outline of stormwater management study and hire consulting firm or other organization to perform study 5/11: Complete study	\$50,000	MDEQ-NPS, MDEQ-Revolving Fund
7.3.3. Improve Huron Creek in Kestner Waterfront Park	City of Houghton, HKCD, MDEQ, Master Gardeners	Short-term (0-3 yr)	Stabilize banks and establish vegetative buffer	10/09: Banks stabilized 06/10: Vegetation planted 06/11: Vegetation stabilized	\$70,000 to \$85,000	CZM, EPA GLNP
7.3.4. Septic System and Sanitary Sewer Improvements	City of Houghton, Portage Township	Short-term (0-3 yr)	Connect Dakota Heights to sanitary sewer	10/09: Bid contract 6/10: Complete construction	Approximately \$1 million, with a USDA grant covering \$724,000	City of Houghton, Portage Township, Property Owners, USDA

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.3.5. Improve "Shopping Cart Creek" Area	HKCD, MDEQ, Copper Country Mall, Wal-Mart of Houghton	Short term (0-3 yr)	1. Install stormwater detention pond at the source of Shopping Cart Creek.	12/10: Develop plans for detention pond 6/11: Begin construction of detention pond 10/11: Complete construction of detention pond	$200,000	EPA GLNP, NPS, Private
	HKCD, MDEQ, NRCS, Houghton County Drain Commissioner	Mid-term (3-7 years)	2. Stabilize erosion areas	6/11: Develop plans for stabilizing erosion areas 6/12: Begin stabilization efforts 10/12: Complete stabilization efforts	$10,000 to $36,000	EPA GLNP, MDEQ-NPS, Private
	HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short to Long-term (0-10 yr)	3. Establish baseline data for headcut and continue to monitor.	10/09: Collect baseline data and develop monitoring program 10/09 to indefinite: Continue monitoring	$0 to $1,900/yr	City of Houghton, CWS
7.3.6. Improve Wetland Mitigation and Creek Re-route Areas	City of Houghton, SWS, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	1. Remove invasive species and establish native plant species	10/10: Establish plan for reducing existing invasive species 5/11: Begin removal of invasive species 7/11: Complete removal of invasive species and begin planting of native species 10/11: Complete removal of invasive species and begin planting of native species 10/11 to indefinite: Monitor vegetation	$22,500 to $45,000	Private, NPS, U & CF, NAWCA
	City of Houghton, CCTU	Short to Long-term (0-10 yr)	2. Physical Improvements	10/10: Establish plans for physical improvements 5/11: Begin construction- create pools, place coarse woody debris and boulders 10/11: Complete physical improvements 10/11 to indefinite: Monitor improvements	$2,000 to $3,000	City of Houghton, TU

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.3.7 Mitigate Erosion Areas	City of Houghton, HKCD, MDEQ, MSUE, Adjacent Businesses	Short-term (0-3 yr)	1. Improve Ridge Road Landfill Area	10/10: Erosion control replaced 10/11: Vegetation planted 10/12: Vegetation established	$13,000 to $18,000	NPS, U & CF
	HKCD, MDEQ, Landowners	Mid-term (3-5 yr)	2. Mitigate Critical Erosion Locations (A, B, C, D, E, G)	10/10: Plans for mitigation established 5/11: Begin mitigation construction 10/11: Complete mitigation construction	$100 to $3,000 for each location	EPA GLNP, NPS, Private
7.3.8 Wetland Restoration	City of Houghton, Portage Twp., SWS, HKCD, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	Plan and implement wetland restoration	10/10: Establish plan for wetland restoration and prioritize sites 10/11 to indefinite: Implement and monitor at least one wetland restoration project each year	$3,500-$140,000	Private, NPS, U & CF, NAWCA

[1]Potential Partners
HKCD = Houghton-Keweenaw Conservation District
MDEQ = Michigan Department of Environmental Quality
MSUE = Michigan State University Extension
CWS = MTU Center for Water and Society
SWS = MTU Chapter of the Society of Wetland Scientists
MG = Houghton Area Master Gardeners
MTU C&E = MTU Civil & Environmental Engineering Department (Courses)
MTU Micro = MTU Microbiology Club
HAS = Houghton Area Schools
WUP Center = Western Upper Peninsula Center for Science, Mathematics and Environmental Education
CCTU = Copper Country Trout Unlimited

[2]Potential Funding Sources
CZM = MDEQ Coastal Zone Management Grant
EPA GLNP = US Environmental Protection Agency Great Lakes National Program Office Grant
U & CF = Urban and Community Forestry Grant
NPS = MDEQ Nonpoint Source Grant
Private = Private Funding/Landowners
NAWCA = North American Wetlands Conservation Act Grant
USDA = Rural Development Housing & Community Facilities
TU = Trout Unlimited Embrace-A-Stream Program.

Table 7.3 Summary of Recommended Actions: Monitoring Plans

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.4.1. Water Quality Monitoring	MTU C&E, MTU Micro, HAS, WUP Center	Long-Term (0-10+ yr)	Evaluate changes and/or trends in water quality	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	$1,200 to $1,400/yr	NPS
7.4.2. Erosion and Geomorphologic Monitoring	MTU C&E	Long-Term (0-10+ yr)	Evaluate changes and/or trends erosion & sediment	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	NPS
7.4.3. Invasive Vegetative Species Monitoring	SWS	Long-Term (0-10+ yr)	Create watershed-wide invasive species management plan and monitor invasive species	5/10: Create monitoring plan and gain commitment of organization(s) to carry out monitoring 10/11 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	Club Funds

[1] Potential Partners
HKCD = Houghton-Keweenaw Conservation District
MDEQ = Michigan Department of Environmental Quality
MSUE = Michigan State University Extension
CWS = MTU Center for Water and Society
SWS = MTU Chapter of the Society of Wetland Scientists
MG = Houghton Area Master Gardeners
MTU C&E = MTU Civil & Environmental Engineering Department (Courses)
MTU Micro = MTU Microbiology Club
HAS = Houghton Area Schools
WUP Center = Western Upper Peninsula Center for Science, Mathematics and Environmental Education
CCTU = Copper Country Trout Unlimited
[2] Potential Funding Sources
CZM = MDEQ Coastal Zone Management Grant
EPA GLNP = US Environmental Protection Agency Great Lakes National Program Office Grant
U & CF = Urban and Community Forestry Grant
NPS = MDEQ Nonpoint Source Grant
Private = Private Funding/Landowners
NAWCA = North American Wetlands Conservation Act Grant
USDA = Rural Development Housing & Community Facilities
TU = Trout Unlimited Embrace-A-Stream Program.

Table 7.4 Summary of Recommended Actions: Ordinances

Recommended Action	Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
7.5.1 Develop and Implement Stormwater Management Ordinance	City of Houghton, Portage Township, CWS	Short-term (0-3 yr)	Create and implement stormwater ordinance	7/09: Begin working with municipalities on ordinance 10/09: Approve final version of ordinance Identify regulatory structure 11/09: Begin enforcing ordinance	Dependent on time required by government officials to pass/enforce.	City of Houghton, Portage Township

[1]Potential Partners
HKCD = Houghton-Keweenaw Conservation District
MDEQ = Michigan Department of Environmental Quality
MSUE = Michigan State University Extension
CWS = MTU Center for Water and Society
SWS = MTU Chapter of the Society of Wetland Scientists
MG = Houghton Area Master Gardeners
MTU C&E = MTU Civil & Environmental Engineering Department (Courses)
MTU Micro = MTU Microbiology Club
HAS = Houghton Area Schools
WUP Center = Western Upper Peninsula Center for Science, Mathematics and Environmental Education
CCTU = Copper Country Trout Unlimited
[2]Potential Funding Sources
CZM = MDEQ Coastal Zone Management Grant
EPA GLNP = US Environmental Protection Agency Great Lakes National Program Office Grant
U & CF = Urban and Community Forestry Grant
NPS = MDEQ Nonpoint Source Grant
Private = Private Funding/Landowners
NAWCA = North American Wetlands Conservation Act Grant
USDA = Rural Development Housing & Community Facilities
TU = Trout Unlimited Embrace-A-Stream Program.

7.3. Physical Improvements

7.3.1. Reduce Metals and Ammonia Loads to Huron Creek

Related objective(s) from Table 7.1:
Manage copper and iron pollution
Manage nutrient concentrations

Potential Partners[1]	Proposed Timeline	Task/ BMP/ Action	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	1. Mitigate stamp sand area next to Huron Creek in vicinity of Ridge Road Landfill	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	\$800- \$1,200*	MDEQ-NPS
City of Houghton, HKCD, NRCS MDEQ, CWS	Short-term (0-3 yr)	2. Mitigate stamp sand in wetlands mitigation area	10/09: Soil and vegetation cover plan established 10/10: Soil and vegetation cover placed 10/11: Vegetation established	\$1,000- \$3,800	MDEQ-NPS
City of Houghton, MDEQ, CWS	Long-term (0-10 yr)	3. Evaluate performan ce of landfill leachate collection system	10/09 to as needed: Monitor leachate collection system performance	\$500- 1,000/yr	

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

Task 1: Mitigate stamp sand areas next to Ridge Road Landfill . As mentioned in Chapter 6, stamp sands near Huron Creek pose a potential threat to water quality, especially with regard to copper, if they are eroded and subsequently transported into the creek. To remedy this, the area of stamp sands located within Critical Area 3 (see Figure 7.1) can be mitigated in a similar fashion as other local stamp sand areas. This procedure includes covering the stamp sand with a minimum of 6 inches of soil and planting various grasses and forbs for vegetative cover and soil stabilization. This stabilization method is

the same method used by the US Environmental Protection Agency to stabilize stamp sands in the Torch Lake Superfund site. Planting of shrubs and trees was not recommended (Jones, 2002).

Figure 7.1 Location of recommended actions for landfill area

Mitigating the stamp sand area in this manner reduces the amount of disturbance to nearby existing vegetation and soils, while stabilizing and therefore preventing the stamp sands from being transported to the creek. A native grass and/or forb seed mix is recommended for planting. As recommended for seeding in the landfill area, seed mix should be planted in a 50/50 mix with an annual nurse plant such as oats. Also, recommendations of the seeding supplier should be followed for proper seeding rate, mulching and fertilization.

Task 2: Mitigate stamp sand areas next to mitigation wetland. The suggested stabilization plan for the stamp sand area next to the mitigation wetland (see Figure 7.2) is the same as that recommended for the stamp sand area near the Ridge Road landfill. This includes covering with soil and planting with herbaceous vegetation. This stamp sand area is on a moderate slope however, so the high-end cost estimate provided above includes costs for erosion matting.

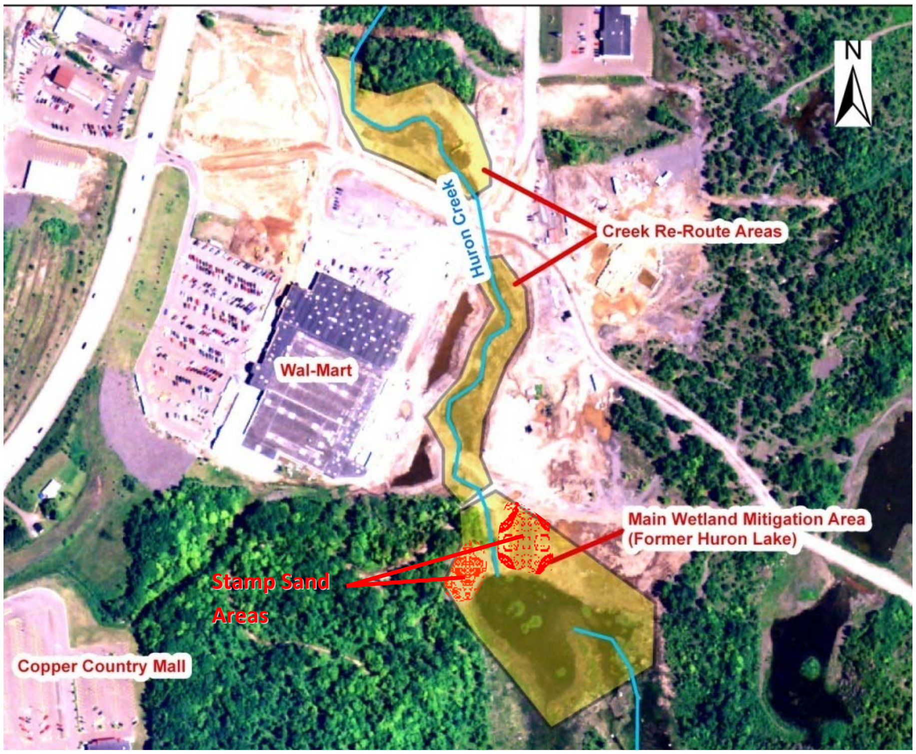


Figure 7.2 Huron Creek re-route and wetland mitigation area

Task 3: Evaluate performance of landfill leachate collection system. Since 2006, the City of Houghton has operated a leachate collection system that was installed at the base of the Ridge Road landfill on the west side of Huron Creek. This collection system was installed to prevent leachate from reaching Huron Creek that was documented by MDEQ[20] to contain levels of dissolved copper and ammonia that were in exceedance of the Final Acute Value (FAV). Water quality monitoring completed by the MTU Center for Water & Society has consistently indicated levels of dissolved copper downstream of the landfill in exceedance of the FAV (See Figure 5.7) from November 2006 to May 2008. Also during this time period, ammonia concentrations in exceedance of the Final Chronic Value (FCV) have been documented at the landfill monitoring site and downstream, with some sites upstream in occasional exceedance (See Figure 5.3). Iron bacteria blooms are also still observed along the landfill side (western banks) of the creek in the vicinity of the landfill. Based on this information, it may appear that landfill leachate is still entering the stream. However, as upstream concentrations of copper and ammonia sometimes also exceed MDEQ Aquatic Life Protection values, it is difficult to determine how much "background" or watershed-wide contributions are affecting concentrations.

Therefore, it is recommended that further studies are completed to evaluate the performance of the landfill leachate collection system, and to identify, if any, the effect leachate is having on ammonia and copper concentrations in Huron Creek. Once a study is formulated and completed, results can be used to identify any treatment, monitoring or recommended action alternatives that may be needed. In the

[20] Landfill seep analysis completed in July 2005. See Appendix M.

mean time, it is recommended that operation of the leachate collection system continues along with water quality sampling of Huron Creek at the landfill (LF) monitoring site. A long-term water quality monitoring plan is presented in Section 7.4.1. Ideally, these actions combined with mitigating stamp sand areas will ultimately reduce copper (and ammonia) concentrations below the Aquatic Protection Standards (FAV/FCV) and result in Huron Creek being removed from the MDEQ 303(d) Impaired Waters List.

7.3.2. Further Study of Stormwater Management Issues

Related objective(s) from Table 7.1:
Manage sediment pollution
Manage "flashy flows" of urban stormwater runoff

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short-term (0-3 yr)	Conduct survey of stormwater systems and stormwater modeling; assess best management alternatives for reducing the flashy flows.	5/10: Develop outline of stormwater management study and hire consulting firm or other organization to perform study 5/11: Complete study	$50,000	MDEQ-NPS, MDEQ-Revolving Fund

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

In Section 5.4.2, results from hydrologic modeling efforts indicated that development in the Huron Creek watershed may be contributing to the increase in magnitude of "flashy" flow events, as evidenced by to more than 100% increases in peak flow rates in response to storm events. Increases in the magnitude of flows can results in channel erosion, generation of excess sediment, and compromising of aquatic habitat. These results imply that measures to reduce the magnitude of "flashy" flow events. The proposed detention pond to be installed at the head of Shopping Cart Creek described in Section 7.3.5 will partially address this issue of flashy flows in the watershed. The proposed stormwater ordinance described in Section 7.5 should help to reduce the possibility of future developments contributing even more towards flashy flows.

However, there are other, developed portions of the watershed that are likely to continue to contribute to flashy flows. The studies described in this management plan provide useful, but still limited information on which areas are contributing most towards the flashy flows. Before recommended specific measures for ameliorating flashy flows in these areas, a detailed survey of stormwater systems and a detailed stormwater modeling effort should be conducted to determine which sites are contributing most towards the flashy flows. The survey and modeling effort can then be used to assess best management alternatives (e.g. detention ponds) for reducing the flashy flows at these sites.

7.3.3. Improve Kestner Waterfront Park (Critical Area #1)

Related objective(s) from Table 7.1:
Restore the creek in the Kestner Waterfront Park
Manage sediment pollution (from eroded banks)
Protect and improve the vegetative buffer

Potential Partners[1]	**Proposed Timeline**	**Task[3]**	**Milestones[3]**	**Estimated Cost(s) [3]**	**Potential Funding Sources[2]**
City of Houghton, HKCD, MDEQ, Master Gardeners	Short-term (0-3 yr)	Stabilize banks and establish vegetative buffer	10/09: Banks stabilized 06/10: Vegetation planted 06/11: Vegetation stabilized	\$70,000-\$85,000	CZM, EPA GLNP

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations
[3]Does not address replacement or repair of concrete walkway that crosses the mouth of the creek adjacent to the Portage Canal

Figure 7.3 shows the general location of proposed improvements of Huron Creek in the Kestner Waterfront Park, which focus on stabilization of the creek banks and producing a more natural creek channel. In spring 2009, funds were awarded to the City of Houghton to complete this work by the MDEQ Coastal Zone Management grant application, which was submitted in April 2008. The Coastal Zone Management grant program provides funds to protect coastal water quality and reduce nonpoint source pollution in coastal watersheds, among other similar project types. The grant program requires a 1:1 funding match which can include in-kind services, donations or cash. The City of Houghton has already allotted funds for the match as part of the city's adopted recreation plan, which was approved by the Houghton planning commission in March 2008. The grant application is also included in Appendix P.

The main components of the proposed improvements are as follows:

- Excavate slopes back to a shallower angle; 3H:1V where possible, otherwise 2H:1V given a buffer strip width of 12 to 18 feet.
- Install coir logs at the toe of the slope to provide protection against undercutting. Plant native shrubs into coir logs to provide additional toe and bank stabilization.
- Plant a mixture of native grasses, shrubs and trees within a 12 to 18-foot buffer strip along biotechnical stabilization areas. This will contribute to bank stabilization, help cover and prevent access to the gabions, and help create a more natural creek corridor.

Figure 7.3 Stabilization area in the Kestner Waterfront Park

Some areas of the buffer zone are to be left open without trees or shrubs for maintaining access to the creek, and also to preserve the viewscape. Detailed drawings, notes, suggested seed mixes and other materials information provided to the city of Houghton are included in Appendix P.

An additional concern in the waterfront park area is the condition of the concrete walkway that crosses the mouth of the creek adjacent to the Portage Canal. Portions of the walkway are slumping due to soil wash-outs near and under the walkway. It has been suggested in Huron Creek Watershed Advisory Committee (WAC) meetings that the walkway be repaired or removed and replaced with an open-span type bridge that would provide a more open connection between the creek and the portage. At this time, no specific recommendations, designs or cost estimates are provided for repair or replacement of the walkway, as bridge repair and design is outside of the scope of this plan. However, it is encouraged that this issue is addressed in the future by the WAC and the City of Houghton.

7.3.4. Septic System and Sanitary Sewer Improvements (Critical Area #2)

Related objective(s) from Table 7.1:
Manage/prevent nutrient pollution
Manage bacterial pollution

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
City of Houghton, Portage Township	Short-term (0-3 yr)	Connect Dakota Heights to sanitary sewer	10/09: Bid contract 6/10: Complete construction	Approximately $1 million, with a USDA grant covering $724,000	City of Houghton, Portage Township, USDA

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

Portage Township recognizes the inadequacy of many septic systems in the Dakota Heights area, and recognizes the challenges created by having non-sewered residences and development areas. Therefore, Portage Township would like to move forward with a plan to first connect Dakota Heights to the city sanitary sewer system, and later connect other non-sewered portions of the Township. In April 2009, Portage Township received a 75 percent U.S. Department of Agriculture Rural Development grant to install a sewer line in Dakota Heights. The project will cost approximately $1 million, with the grant covering $724,000. The project will likely be bid out in fall 2009 and start in spring 2010.

This project has been made possible by a Spring 2008, agreement between the City of Hancock and Franklin Township with the City of Houghton to connect their sanitary sewer systems to a new sewer line that is to be constructed under the Portage Canal from Ripley to the This lift station pumps sewage through a main sewer line to the Portage Lake Water & Sewage Authority (PLWSA) Wastewater Treatment Plant (WWTP). Since sewage from City of Hancock and Franklin Township currently flows to the in northwest Houghton lift station, construction of the new sewer line has freed capacity in the lift station located in northwest Houghton. This new capacity will then be available for sewage from Portage Township, including the Dakota Heights area. In addition, sanitary sewer lines already exist on each side of Highway M-26 as it passes through Dakota Heights, which means that the highway will not need to be disturbed or directionally drilled under in order to connect all of Dakota Heights.

7.3.5. Improve "Shopping Cart Creek" (Critical Area #5)

Related objective(s) from Table 7.1:
Manage sediment pollution
Manage "flashy flows" of urban stormwater runoff

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)**	**Potential Funding Sources[2]**
HKCD, MDEQ, Copper Country Mall, Wal-Mart of Houghton	Short term (0-3 yr)	1. Install stormwater detention pond at the source of Shopping Cart Creek.	12/10: Develop plans for detention pond 6/11: Begin construction of detention pond 10/11: Complete construction of detention pond	$200,000	EPA GLNP, NPS, Private
HKCD, MDEQ, NRCS, Houghton County Drain Commissioner	Mid-term (3-7 years)	2. Stabilize erosion areas	6/11: Develop plans for stabilizing erosion areas 6/12: Begin stabilization efforts 10/12: Complete stabilization efforts	$10,000 to $36,000	EPA GLNP, MDEQ-NPS, Private
HKCD, MDEQ, CWS, NRCS, Houghton County Drain Commissioner	Short to Long-term (0-10 yr)	3. Establish baseline data for headcut and continue to monitor.	10/09: Collect baseline data and develop monitoring program 10/09 to indefinite: Continue monitoring	$0-$1,900/yr	City of Houghton, CWS

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

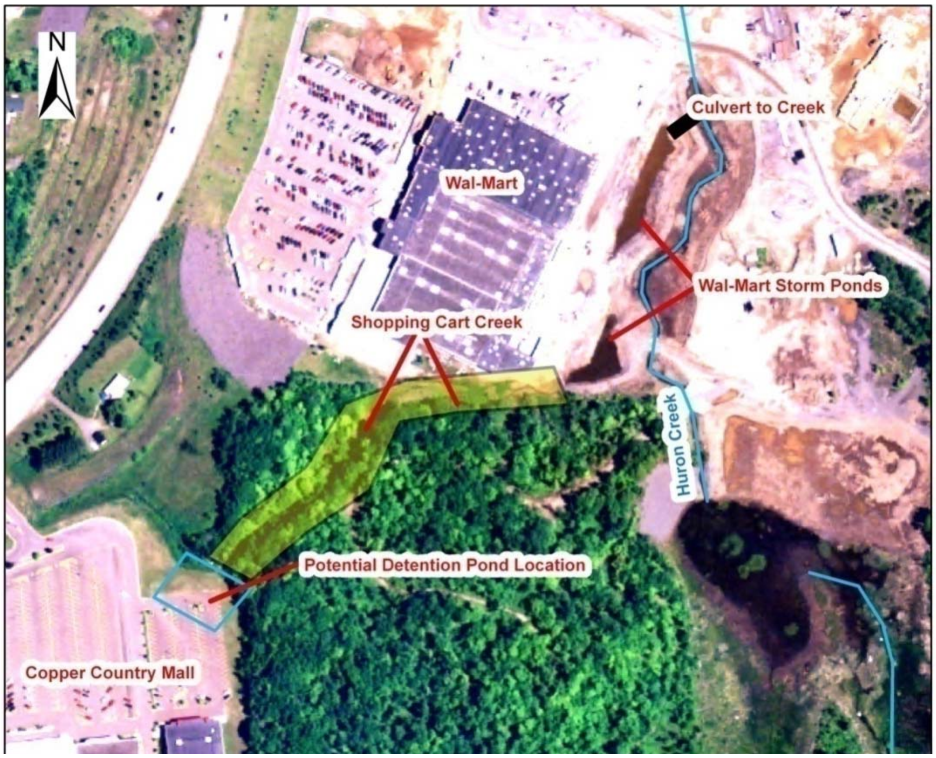


Figure 7.4 Recommended action areas for Shopping Cart Creek

Task 1: Install stormwater detention pond at the source of Shopping Cart Creek. As mentioned in Chapter 6, increased peak flows have caused severe erosion at multiple locations in Shopping Cart creek. Hydrologic modeling of Shopping Cart creek completed as part of the Huron Creek geomorphology survey (see Appendix J) indicates a current (post-development) peak flow of 140 cubic feet per second (cfs) as a result of a 25-year, 24-hour storm event. This peak flow rate is approximately 14 times higher than the modeled pre-development flow rate of approximately 10 cfs for the same storm event.

Therefore, the first logical step towards bank stabilization in the creek would be controlling and reducing the peak flow rates of the creek, ideally, down to pre-development levels. Controlling and reducing the peak flow rates of the creek can be accomplished through construction of a stormwater detention pond where the Festival Foods ditch and Copper Country Mall culverts discharge at the “head” of the creek. The pond would then hold and slowly discharge the runoff at controlled rate that again, is ideally close to the pre-development flow rate of the creek. A potential construction location for the pond is indicated in Figure 7.4. This location was suggested as it is located where both runoff sources discharge to the creek and disturbance of the existing mall parking area would be minimal. The square indicating the pond location is not drawn to scale and does not necessarily reflect its actual footprint area.

An example stormwater detention pond for the head of Shopping Cart creek was designed as part of the Huron Creek geomorphology study. This pond was designed to detain runoff from the local 100-year, 24-hour storm event and release it at the pre-development flow rate of Shopping Cart Creek (10 cfs). Methods, calculations and HydroCAD® models for this design are included in Appendix J. As the size of a pond required to detain runoff from a 100-year storm from both the Copper Country Mall and Festival Foods development areas would be quite large and costly to construct (see cost calculations, Appendix O), it is recommended that a pond be constructed as large as practicably possible given existing site and cost constraints. For example, a pond designed to detain a 2-year, 24-hour storm event would cost approximately $200,000.

Task 2: Stabilize severe erosion areas. The severe erosion areas described in the Shopping Cart Creek area in Chapter 6 include a steep, eroded bank area near the head of the creek and a headcut area downstream near Wal-Mart. These two locations were identified as "Critical Erosion Areas." It is recommended that current peak flow rates be reduced (through methods such as Task #1) prior to implementation of any bank stabilization projects or improvements, as such improvements may not be capable of withstanding velocities associated with the current peak flows.

Because of the depth and extent of erosion created by the headcut, it is recommended that assistance is obtained from regulatory agencies (MDEQ, NRCS) and/or professional consultants when designing a stabilization plan for this area. The following is a list of BMPs and other items that may be used individually or in combination with each other to re-stabilize the Shopping Cart creek headcut area:

- re-working the banks to decrease slopes;
- re-working the creek channel longitudinally to remove the headcut and create a slope rather than a small waterfall;
- rip-rap or gabions for stabilizing toe of bank slope;
- vegetated coir logs, live fascines or brush mattresses; and
- native plantings of forbs, grasses, shrubs and trees in newly re-worked areas, including installation of erosion blanket in newly seeded areas.

Stabilization of this part of Shopping Cart creek might be accomplished with methods similar to those proposed for the Kestner Waterfront Park. However, the type of stabilization materials and methods utilized will be dictated by whether or not a storm pond is installed upstream to first decrease peak flow rates.

Task 3: Establish baseline data for headcut and continue to monitor. The headcut is expected to continue to migrate upstream and may eventually reach the Copper Country Mall parking lot, creating a large gully at the storm sewer discharge location. The headcut also is expected to continue to cause sediment to be transported downstream into the Wal-Mart storm ponds, creating a maintenance issue. Until the point in time when the headcut area can be physically improved and stabilized, it is recommended that its location and size be determined under current conditions and then be monitored on an annual basis. The headcut location and size can be measured by surveying longitudinal profiles of the centerline of the creek from upstream of the headcut to downstream of the headcut. This involves use of a surveyor's tape, hand-held GPS unit to record location data, and a surveying level and rod for collecting elevation data. A more detailed description of methods can be found in the Huron Creek geomorphology survey report found in Appendix J.

7.3.6. Improve Wetland Mitigation and Creek Re-route Areas (Critical Area #4)

Related objective(s) from Table 7.1:
Protect and improve the vegetative buffer
Prevent establishment of invasive plant species
Protect and improve biodiversity

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)[3]**	**Potential Funding Sources[2]**
City of Houghton, SWS, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	1. Remove invasive species and establish native plant species	10/10: Establish plan for reducing existing invasive species 5/11: Begin removal of invasive species 7/11: Complete removal of invasive species and begin planting of native species 10/11: Complete removal of invasive species and begin planting of native species 10/11 to indefinite: Monitor vegetation	\$22,500 to \$45,000	Private, NPS, U & CF, NAWCA
City of Houghton, CCTU	Short to Long-term (0-10 yr)	2. Physical improvements	10/10: Establish plans for physical improvements 5/11: Begin construction-create pools, place coarse woody debris and boulders 10/11: Complete physical improvements 10/11 to indefinite: Monitor improvements	\$2,000 to \$3,000	City of Houghton, TU

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations
[3]Lowest price in range indicates cost with volunteer labor/manual labor, etc.

Remediation of stamp sands in the wetland mitigation area is covered in Section 7.3.1.

The City of Houghton currently owns and monitors the creek re-route and wetland mitigation areas near the Houghton Wal-Mart (see Figure 7.2). Monitoring includes documentation of establishment of vegetation, presence of wildlife and the general condition of the site. This monitoring is a requirement of the wetland mitigation permit that was obtained by the city, and it will continue until vegetation is sufficiently established according to MDEQ requirements. The success of the re-vegetation effort includes having the appropriate type (native species versus invasive species) and amount of vegetation, and creating a generally healthy wetland and riparian habitat.

As mentioned in Chapter 6, the creek re-route area, in particular, currently has sparse native vegetation mixed with relatively dense areas of invasive plant species such as spotted knapweed and white sweet clover. Trees that were planted to eventually provide shade over Huron creek appear to have not taken hold or were affected by the drought of summer 2007. In contrast, the main wetland mitigation area supports a variety of native mesic, emergent and submergent vegetation. Wildlife from waterfowl to small mammals have also been observed in this area. However, invasive species are encroaching on the main mitigation site, especially from the northern side where the soil is not as saturated as the main open-water area. A few patches of reed canary grass, a particularly problematic invasive, have established along the western side of the wetland. With these issues in mind, the following tasks are recommended to manage invasive species, establish more native vegetation, and generally improve habitat.

Task 1: Remove invasive species and establish native plant species. It is recommended that removal of existing invasive species be completed to the maximum extent practicable in the Huron creek re-route and wetland mitigation area. Removal can include manual pulling, burning, herbicide treatments and other methods depending on the type of plant species. Information regarding removal of invasive species can be found in many published and on-line resources. For example, the *Global Invasive Species Team* website (http://tncweeds.ucdavis.edu) provides photos, descriptions and fact sheets by species. The websites listed below are links to main species websites and recommended removal methods sheets for each species that has been documented in the Huron Creek re-route and wetland mitigation area. These sheets can also be found in Appendix Q.

- Spotted Knapweed Main Website - http://tncweeds.ucdavis.edu/esadocs/centmacu.html
- Spotted Knapweed Removal Methods - http://tncweeds.ucdavis.edu/moredocs/cenmac02.pdf
- Sweet Clover Main Website - http://tncweeds.ucdavis.edu/esadocs/melioffi.html
- Sweet Clover Removal Methods - http://tncweeds.ucdavis.edu/esadocs/documnts/melioff.pdf
- Reed Canary Grass Main Website – http://tncweeds.ucdavis.edu/esadocs/phalarun.html
- Reed Canary Grass Removal Methods – http://tncweeds.ucdavis.edu/esadocs/documnts/phalaru.pdf

These or similar guidance documents should be referred to when implementing an invasive species removal project. Removal of these species should ideally be completed prior to planting additional native species. This is important as any remaining invasive plants may still out-compete the natives that are trying to establish. Additional guidance on invasive species can be found in the BMP manuals that are discussed in Section 7.6.

The next logical step after addressing invasive species and improving the physical habitat would be to establish additional native plant species where necessary. Some suggestions for choosing and planting vegetation in the creek re-route and wetland mitigation areas are:

- The vegetation selected should be native and similar to what exists in nearby habitats. A good reference habitat is the portion of Huron Creek downstream of the creek re-route area. Species identified in this area are listed in the vegetation survey in Appendix L.
- The areas currently without much native vegetation are exposed and sunny. The first types of vegetation established might best be those that are sunlight-tolerant. Later other species that require little to some shade may be planted.
- The soil moisture and hydrology should also be considered when choosing types of plants and choosing their placement. Vegetation planted next to or in areas where the creek might flood should be wetland or mesic species that can tolerate saturated soil conditions. Vegetation planted in regularly dry soils should be more of the upland variety.
- A variety of grasses, forbs, shrubs and trees should be planted to create as much vegetative diversity as possible. Balled-stock (root ball in place) shrubs and trees might be best for planting near Huron Creek as storm event flow velocities could wash away seeds or herbaceous "plug" type planting. Trees and shrubs planted as live stakes may also be a good choice. Preferably trees should be planted along the creek to provide shade to the water (reduce water temperatures).
- The selection of, grouping and placement of vegetation should be designed to increase and maintain biodiversity of mammals, amphibians, reptiles and various avian species. For example, trees or shrubs could be placed in groups to provide shelter for song birds, or various flowering plants could be utilized to attract butterflies and other pollinators. Ideally, a baseline biodiversity study and future biodiversity studies could be completed to monitor the effectiveness of these efforts.
- When planting seed, spread in 50/50 mix with an annual "nurse plant" such as oats to prevent establishment of invasive species[21].
- If planted species are not proliferating after a year or two, it may be necessary to revise the planting scheme and try different species at that location.
- Some nurseries and seed suppliers that sell native plants and can provide recommendations for planting include:
    - Lake Superior Tree Farm, Chassell,MI, 906-523-6200
    - Borealis Seed Co., Marquette, MI 906-226-8507
    - Great Lakes Nursery, Watervliet, MI, 269-468-3323, www.greatlakesnurseryco.com/
    - Cold Stream Nursery, Free Soil, MI, 231-464-5809, www.coldstreamfarm.net/
    - Engels Nursery, Fennville, MI, 296-543-4123, www.engelsnursery.com/

Task 2: Physical Improvements. A few simple physical improvements to the ground surface at various locations in the mitigation area can help establishment of plant species and improve habitat:

[21] Planting instructions per Borealis Seed Company, Marquette, Michigan.

- Create pools in the creek re-route area – Reducing Huron creek's rate of flow and pool at various locations will allow for slow, shallow water where aquatic vegetation can more easily establish without being washed away. Pooling also provides for a more slow transition from inundated soil to saturated soil to upland areas, allowing a greater diversity of species to establish. Existing rock, soil or woody debris could be used to "dam" or constrict portions of the creek to create pools.

- Place course woody debris and/or boulders in the riparian zone – The term course woody debris (CWD) in this case, is being used to refer to dead and down trees and their branches. CWD serves many functions in woodland and riparian habitats. These functions include providing a source of carbon and organics for soil via decomposition, providing habitat for many plant and animal species, and most importantly, providing habitat for fungi and mosses that serve critical functions in ecosystem health (The Dead Wood Cycle, 1998). These fungi and mosses help cycle and transport nutrients into the soil for use by vegetation, and serve as "launching platforms" for bacterial growth that is also necessary for growth of many plants (Stamets, 2007).

  In the Huron Creek re-route area this additional fungal growth may be especially necessary as spotted knapweed (present in the area) is known to out-compete other plants by reducing their necessary supply of mycorrhiza, a fungus that many native species rely on for uptake of nutrients (Spero News, 2007). Therefore, it is recommended that CWD and/or boulders are placed randomly throughout the creek re-route area, and in open areas around the mitigation wetland.

7.3.7. Improve Erosion Areas

Related objective(s) from Table 7.1:
Manage sediment pollution
Protect and improve the vegetative buffer

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)[3]**	**Potential Funding Sources[2]**
City of Houghton, HKCD, MDEQ, MSUE, Adjacent Businesses	Short-term (0-3 yr)	1. Improve Ridge Road Landfill Area	10/10: Erosion control replaced 10/11: Vegetation planted 10/12: Vegetation established	$13,000 to $18,000	NPS, U & CF
HKCD, MDEQ, Landowners	Mid-term (3-5 yr)	2. Mitigate Critical Erosion Locations (A, B, C, D, E, G)	10/10: Plans for mitigation established 5/11: Begin mitigation construction 10/11: Complete mitigation construction	$100 to $3,000 for each location	EPA GLNP, NPS, Private

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations
[3]Costs presented don't include labor for planting. Ideally, volunteer or in-kind labor would be available

Task 1: Ridge Road Landfill Area (Critical Area #3): Remove & replace failing erosion control materials, stabilize slopes and re-establish vegetation. Figure 7.1 shows the location of this area. In order to accomplish stabilization of currently exposed and/or unstabilized soil areas, slopes and banks in the Ridge Road landfill area, the following steps should be taken:

- Remove silt fencing and other construction debris that is in creek channel and on banks.
- Review areas of existing erosion matting. If erosion matting has washed out, shifted, or is overlain on bare rock, complete the following steps as appropriate:
    - Compare specifications for existing erosion matting with location of original installation. Ensure the type of matting is appropriate for the slope it has been placed on. Replace with appropriate type if necessary.
    - Prior to re-installation, ensure that a minimum of 12 inches of soil (3-6 inches of topsoil) exists under the erosion matting so that a grass and/or forb seed mix can be seeded and take hold. If soil needs to be brought in and spread, it should not be compacted.
    - After establishment/addition of topsoil layer apply a seed mix and fertilizer according to the application rates specified by the seed provider and fertilizer manufacturer.
    - Install erosion matting over seed and soil. Ensure it is staked down according to the appropriate staking pattern for the type of erosion mat and slope it is to be installed on.
    - Additional planting of native shrubs and trees will add to soil stabilization in areas where soils are deep/thick enough to support them.

      An expert should be consulted regarding the species of shrubs and trees (as well as for the grass/forb mix) to be used, and also for planting densities, fertilization, etc.

    - Initial planting of grass/forb seed mixes should be planted in a 50/50 mix with a "nurse crop" such as annual oats to assist in establishment. Preferably all seeds and seed mixes are certified weed free.
- For areas where rill and/or gully erosion has occurred on steep slopes adjacent to the creek:
    - In many locations, the steepness of the slope requires stabilization using rip-rap rather than erosion matting and seed. Choose the appropriate type of stabilization based on slope and soil conditions and install per the instructions above.
    - Where the rill or gully extends down to the creek underneath existing matting, repair this area after the upstream slope has been stabilized.
- For near level areas that remain unstabilized and/or unvegetated:
    - Planting of native grasses, forbs, shrubs and trees should be completed in bare areas. It is recommended that planted species are similar to those already found in that portion of the creek corridor (see vegetation survey in Appendix L).
    - As mentioned above, planting density/seed application rate, fertilizer and/or mulch application should be completed per supplier recommendations.

- The creek channel should be inspected for areas of bank failure (collapse). The application of "soft" bank stabilization materials such as coir logs, vegetative mats or wattles should be considered if necessary.
- Topography, soil and runoff velocity conditions vary in the Ridge Road landfill area. Professionals, academic experts, and/or state and federal agency representatives should be consulted prior to design and implementation of any stabilization or revegetation plan.

Figure 7.5 Critical erosion locations

Task 2: Mitigate Critical Erosion Locations (A, B, C, D, E, G)

Erosion problems that have been observed at each critical erosion location are described in detail in Chapter 6. Figure 7.5 shows the location of each critical erosion location. The following recommendations are suggestions for implementation. All improvements should be reviewed by the appropriate technical or regulatory expert. Also, property owners at each location should be contacted to gain access and approval for stabilization projects. Property owner information is provided in Appendix H. Mitigation for Erosion Location F is included in Task 1 of this Section. Mitigation for Erosion Locations H and I are included in Section 7.3.5.

Erosion Location A – Collapsed Rock Channel Wall. Assuming that the rock channel wall is preserved for its historical value and it is not removed in the future, the following steps should be taken to prevent continued erosion into the bank behind the wall:

- Remove vegetation that has established in wall collapse area.
- Repair the wall by mortaring in natural rock that is similar to the rock in the existing wall.
- Fill in soil behind the wall repair area and plant with forbs and grasses.

Erosion Location B – Undercut Concrete Bank. As the concrete "bank" that was previously installed has become complete undercut by the creek, it is only a matter of time until all of the soil underneath it is eroded, causing it to fall into the creek. Therefore it is recommended that the concrete is broken up and removed completely from the area. If bare soil remains after removal of the concrete, the area can be stabilized through placement of nearby creek stones and cobbles as a sort of "rip rap." If the area is large enough, cobble-sized stones can be brought in and placed in the area. Erosion location B is a rocky area, and it is not anticipated that an exposed soil area will be left that is large enough to warrant re-vegetation.

Erosion Location C – Gully Next to Culvert Entrance. At this location, water traveling down through rip-rap on the adjacent road slope appears to have caused slope erosion where the runoff travels over a non-rip-rapped area. Recommendations to repair this location include:

- Add a wider "apron" of rip-rap to the bottom end of the existing rip-rap area so that runoff is spread out down the slope and is less channelized.
- Fill in the gully with soil and either continue the rip-rap apron down slope to the culvert wing wall, or plant native shrubs to stabilize the soil.

Erosion Location D – Ditch on Northeast Corner of Sharon Avenue and M-26. At this location, undercut channel sides and sediment deposition are indicators of possible future erosion problems and a source of sediment load for Huron Creek (this ditch discharges directly to Huron Creek). It is likely that peak flow rates of runoff from the culvert under M-26 are cutting into the "banks" of the ditch, and that road-spread sand and sediment are depositing in its bottom. These two items can be addressed through use of check dams placed along the length of the creek. Check dams are piles of stone or hay bales that are placed across a channel to reduce flow and trap sediment before it reaches the creek. Recommendations for installation and maintenance of check dams can be found in the Best Management Practice (BMP) manuals that are referenced in Section 7.6.

Erosion Location E – Gully Below Culvert Between Taco Bell and Dairy Queen. This gully extends down slope from the parking lot culvert to Huron Creek where it forms a channelized "tributary" within a sediment deposition area. The gully ranges in width from 2 to 5 feet, and in depth from 6 inches to 2 feet. As with other erosion areas on slopes, it is best to stabilize from up-slope to down-slope. It is recommended that the channel be re-worked to be shallower and wider (rather than narrow and deep) and that check dams are installed at appropriate intervals down the slope. After the check dams are installed and have been monitored to ensure they are stable and reducing the culvert discharge, the lower areas of the channel should be planted with vegetation, as well as those areas disturbed on the slope from re-shaping of the channel.

Erosion Location G – Slope Failure Area on Razorback Drive. Erosion Location G is a slope location where non-rip-rapped soils adjacent to rip-rapped areas are shifting. In this case, the slope failure is a grassy area located above a rip-rap zone. It appears that the rip-rap had shifted down slope since its installation and therefore made the soil it was supporting above it shift. Because the grassed soil area above the rip-rap has not yet had major failure/erosion, the best remedy may be to plant shrubs and trees to stabilize the topsoil in that area. Balled stock (plants with root ball attached) is recommended as they take hold quickly. Native, sunlight-tolerant species are recommended as this is an unshaded area.

7.3.8. Wetland Restoration

Related objective(s) from Table 7.1:
Protect and improve the vegetative buffer
Protect and improve wetlands in the watershed (not listed in Table 7.1***, but general goal of WAC)***

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)**	**Potential Funding Sources**[2]
City of Houghton, Portage Twp., SWS, HKCD, MDEQ, MSUE, MG, Landowners	Short to Long-term (0-10 yr)	Plan and implement wetland restoration	10/10: Establish plan for wetland restoration and prioritize sites 10/11 to indefinite: Implement and monitor at least one wetland restoration project each year	\$3,500-\$140,000	Private, NPS, U & CF, NAWCA

[1]See footnotes in Table 7.2 for explanation of abbreviations
[2]See footnotes in Table 7.2 for explanation of abbreviations

Wetland restoration projects can provide a variety of benefits and opportunities to a watershed and community. Restoration of wetlands improves wildlife habitat and increases biodiversity. Also, wetlands retain and slowly release surface water runoff, which is important for reducing runoff during high rainfall events and for allowing groundwater recharge to occur.
These capabilities are particularly important in the Huron Creek watershed where existing impervious surfaces reduce infiltration and therefore the amount of base flow in Huron Creek. Wetland restoration projects can also serve as environmental education opportunities, and provide a chance for community members to become involved.

As discussed in Chapter 5 and indicated in Figure 5.25, various locations exist in the Huron Creek watershed that may provide opportunities for wetland restoration activities. Locations A, B and C in Figure 5.25 were highlighted as potential wetland restoration locations based on apparent disturbance activities, adjacency of existing wetlands and other factors. Note that Location A is part of the Ridge Road landfill recommended action area.

For any location at which a wetland restoration project is proposed, it is recommended that the following actions be taken prior to initiation of the project:

- Identify a potential restoration location and identify a clear set of restoration goals.
- Contact property owner(s), ensure their permission is obtained for restoration on their property, and create a plan that fits the owner's needs as well as the restoration goals.
- Examine site topography, delineate existing wetlands, determine locations of hydric soils and characterize hydrologic conditions and other pertinent site characteristics.
- Investigate the amount of funding and technical support required, including the amount of volunteer hours potentially available.
- After gathering relative field data and quantifying funding resources, construct a plan of action that is designed to achieve the established goals. At this point it may be best to consult someone knowledgeable in the fields of restoration and wetland sciences in order to create an appropriate restoration plan. Ideally, each restoration plan should have a monitoring component so that progress can be monitored and the plan of action can be adapted as necessary ("adaptive management").
- Implement the project.

Various resources can be referred to for guidance on implementation and funding of wetland restoration projects. A few of these resources are listed in Section 7.6 (BMPs). Additional resources include:

- An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement developed by the Interagency Workgroup on Wetland Restoration (US Army Corps of Engineers, US Environmental Protection Agency, NOAA, US Fish and Wildlife Service, NRCS, 1993): http://www.epa.gov/owow/wetlands/pdf/restdocfinal.pdf
- Michigan Department of Natural Resources Wetland Restoration Techniques Webpage: http://www.dnr.state.mi.us/publications/pdfs/huntingwildlifehabitat/landowners_guide/Habitat_Mgmt/Wetland/Wetland_Restoration_Techniques.htm

7.4. Monitoring Plans

7.4.1. Water Quality Monitoring

Related objective(s) from Table 7.1:
Manage sediment pollution
Manage copper and iron pollution
Manage nutrient pollution
Manage bacterial pollution

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)[3]	Potential Funding Sources[2]
MTU C&E, MTU Micro, HAS, WUP Center	Long-Term (0-10+ yr)	Evaluate changes and/or trends in water quality	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	\$1,200 to \$1,400/yr	NPS

[1]See footnotes in Table 7.3 for explanation of abbreviations
[2]See footnotes in Table 7.3 for explanation of abbreviations
[3]without equipment costs

As stated in Section 4, water quality monitoring of Huron Creek was completed in an effort to identify pollutants and create a platform for action towards improvement watershed-wide. Just as this monitoring provided a baseline of Huron Creek water quality, further monitoring can be utilized to identify if actions completed as part of this plan are meeting the goal of improving water quality and related goals such as habitat improvement. Continued monitoring can also help to identify any new water quality issues that arise. Furthermore, monitoring is a useful way to engage the public to interact with the creek. Table 7.5 lists recommended parameters, their associated pollutants and sampling frequencies for continued monitoring of Huron Creek.

Table 7.5 Recommended Water Quality Monitoring for Huron Creek

Parameter	Field or Laboratory Sample Analysis	Frequency
Alkalinity	Lab	Two times/yr: Apr., Sept.
Ammonia	Lab	Two times/yr: Apr.
Copper	Lab	Two times/yr: Apr.
Iron	Lab	Two times/yr: Apr.
Coliform Bacteria	Lab	Two times/yr: Apr.
Turbidity	Field	Two times/yr: Apr.
Temperature	Field	Two times/yr: Apr.
pH	Field	Two times/yr: Apr.
Dissolved Oxygen	Field	Two times/yr: Apr.
Conductivity	Field	Two times/yr: Apr.
Bio-Assessment	Field	Two times/yr: Apr.

These samples should be collected at the same monitoring locations that were utilized during recent monitoring events for consistency. These locations include the Green Acres (GA), Downstream of Wetland (DWL), Frog Pool (FP), Landfill (LF) and Houghton Waterfront Park (HWP) sites. The location of the sites is indicated in Figure 5.1.

The locations of these sites, and recommended procedures and equipment are provided in the Huron Creek Water Quality Monitoring Quality Assurance Project Plan (QAPP) in Appendix B. The bio-assessment listed refers to an aquatic macroinvertebrate survey, completed using such methods as the MDEQ Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers (http://www.dnr.state.mi.us/PUBLICATIONS/PDFS/ifr/manual/SMII%20Chapter25A.pdf), or the Izaak Walton League Survey Method (http://www.iwla.org/index.php?id=398).

Monitoring months and frequencies were selected based on the following:

- The frequency of two times per year is designed to provide enough data for drawing conclusions and observing trends while keeping the monitoring budget to a minimum. If budget allows, more monitoring events can be completed, with quarterly sampling being the next suggested step up.
- The months of April and September were selected so that water quality data could be obtained during both high-flow (April) and low-flow (September) seasons.

Costs provided above include costs for materials and sending alkalinity, ammonia, copper, iron and coliform samples to professional labs for analysis. The costs do not include equipment costs, since it is assumed that field equipment can be provided by MTU through courses. If MTU cannot provide equipment, an additional $1,500 to $2,000 should be added as an initial purchase cost. It is also assumed that MTU will be able to complete coliform analysis.

7.4.2. Erosion and Geomorphologic Monitoring

Related objective(s) from Table 7.1:
Manage sediment pollution

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)**[3]	**Potential Funding Sources**[2]
MTU C&E	Long-Term (0-10+ yr)	Evaluate changes and/or trends erosion & sediment	5/09: Gain commitment of organization(s) to carry out monitoring 10/09 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	NPS

[1]See footnotes in Table 7.3 for explanation of abbreviations
[2]See footnotes in Table 7.3 for explanation of abbreviations
[3]One time cost of ~$2000 only if new survey equipment needs to be purchased

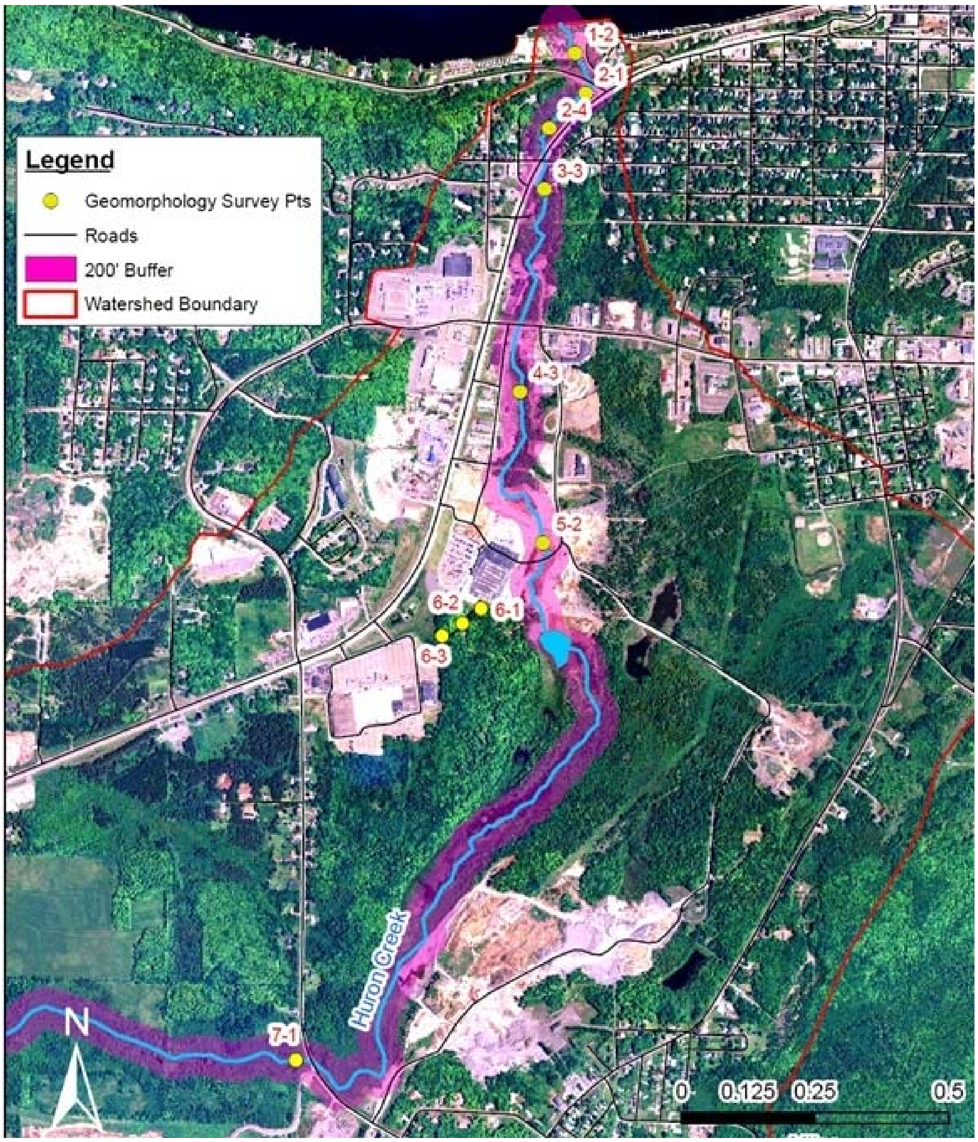
Geomorphologic and erosion monitoring was completed by the MTU Center for Water and Society in fall 2007. This monitoring resulted in the identification of the critical erosion areas listed in Chapter 6, and provided a basis for future monitoring so that more can be learned about sediment conditions in Huron Creek. Therefore, it is recommended that this monitoring be continued into the future according to the monitoring schedule presented in Table 7.6. Monitoring frequencies were chosen based on the estimated time required in order to observe a measurable change in the monitoring parameters. For example, it is likely that changes in cross-section and slope would occur at some time during a ten year period, but may not occur during a shorter time period.

Table 7.6 Recommended Erosion and Geomorphologic Monitoring for the Huron Creek Watershed

Location Name	Survey Type(s)[1]	Frequency (yrs)
1-2	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2
2-1	Sediment (sieve only)	5
2-4	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
3-3	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
4-3	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
5-2	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
6-1	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
6-2	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
6-3	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3
7-1	BEHI	5
	Habitat	5
	X-section & slope	10
	Sediment	2-3

[1]BEHI = Bank erosion hazard index; HABITAT = Stream habitat evaluation; X-SECTION & SLOPE = Cross-section and longitudinal slope measurements; SEDIMENT = Monitoring using sediment pin and sieve analysis of sample

Following the schedule above, the condition and progress of improvement of the critical erosion locations can be monitored, and monitoring can be continued at already established sites for comparison. Critical erosion locations A-I are shown in Figure 7.5. All other monitoring locations are indicated in Figure 7.6 below.



It is recommended that methods and equipment used to complete monitoring follows that stated in the Huron Creek Geomorphology Survey Quality Assurance Project Plan (QAPP) provided in Appendix I. The costs listed above are based on MTU classes completing the monitoring. Factors contributing to the range in costs include materials if needed, and purchase of equipment if existing MTU equipment is not available.

7.4.3. Invasive Vegetative Species Monitoring

Figure 7.6 Geomorphology survey locations

Related objective(s) from Table 7.1:

Control the establishment of invasive species
Protect and improve the vegetative buffer

Potential Partners[1]	Proposed Timeline	Task	Milestones	Estimated Cost(s)	Potential Funding Sources[2]
SWS	Long-Term (0-10+ yr)	Create watershed-wide invasive species management plan and monitor invasive species	5/10: Create monitoring plan and gain commitment of organization(s) to carry out monitoring 10/11 to indefinite: Complete monitoring on regular basis	$0 to $100/yr	Club Funds

[1]See footnotes in Table 7.3 for explanation of abbreviations
[2]See footnotes in Table 7.3 for explanation of abbreviations

It is recommended that numbers and locations of invasive vegetative species are monitored into the future. It is further recommended that the monitoring effort is utilized to create a watershed-wide invasive species management plan, as simply monitoring the spread of invasive species will not slow their spread. As many of the identified invasive species have not yet densely colonized (except for in the creek re-route area), the Huron Creek watershed is at a critical juncture for control of these plants. The more quickly that control measures are implemented, the better chance they can be managed into the future. These measures are also recommended as a supplementary action to invasive species removal in the Huron Creek re-route and mitigation areas. Removing invasive species in one small area while allowing seed sources from surrounding areas to proliferate will prove to make control efforts difficult. Costs listed above are generally based on volunteers completing monitoring. Some annual or one-time costs may need to be incurred for equipment purchase or rental.

Monitoring methods utilized should be similar to those used in the vegetation/invasive species survey already completed. These methods are described in the Vegetation Survey Quality Assurance Project Plan (QAPP) that is included in Appendix K. Other resources that can assist in the creation of an invasive species management plan include the *Global Invasive Species Team* website (http://tncweeds.ucdavis.edu), and the U.S. Department of Agriculture's invasive species website (http://www.csrees.usda.gov/invasivespecies.cfm).

7.5. Develop and Implement Stormwater Management Ordinance

Related objective(s) from Table 7.1:
Manage the "flashiness" of stormwater flows
Manage sediment pollution
Manage nutrient pollution

Potential Partners[1]	**Proposed Timeline**	**Task**	**Milestones**	**Estimated Cost(s)**	**Potential Funding Sources**[2]
City of Houghton, Portage Township, CWS	Short-term (0-3 yr)	Create and implement stormwater ordinance	7/09: Begin working with municipalities on ordinance 10/09: Approve final version of ordinance Identify regulatory structure 11/09: Begin enforcing ordinance	Dependent on time required by government officials to pass/enforce.	City of Houghton, Portage Township

[1]See footnotes in Table 7.4 for explanation of abbreviations
[2]See footnotes in Table 7.4 for explanation of abbreviations

The most commonly used and effective action that can be taken to reduce non-point source pollution and improve surface water quality in a watershed is to implement and enforce a stormwater ordinance. In general, stormwater ordinances are designed to achieve water quality improvements through controlling runoff rates and encouraging use of stormwater infiltration and detention. Ideally these measures are implemented to the extent that post-development runoff is as close to pre-development runoff conditions as possible. Infiltration (retention) basins, detention basins, infiltration swales and bioretention structures are commonly suggested on-site treatment mechanisms used to accomplish this. Specific benefits of implementing these measures can include reduction in flooding and erosion, removal of sediment, reduced water temperature and reduced nutrient concentrations.

Currently, stormwater management is only required by law in the State of Michigan in municipalities with separate storm sewer systems that service populations greater than 100,000. These municipalities are referred to in Michigan as "MS4" municipalities[22]. This law was federally enacted through Phase II of the National Pollutant Discharge Elimination System (NPDES) under the U.S. Clean Water Act, and is enforced in the State of Michigan through Part 21 of the Natural Resources and Environmental Protection Act (Act 451).

As the current populations of the City of Houghton and Portage Township do not exceed 100,000, they are not required to follow the MS4 rules. However, a desire has been expressed by both City of Houghton and Portage Township officials to create and implement a local stormwater ordinance. Reasons cited for this include recent disputes over property damages from excess stormwater runoff

[22] More information can be found at http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-24366--,00.html.

and inadequacy of some existing stormwater management facilities (Bingham & MacInnes, Personal Interviews, 2008).

To this end, a draft stormwater ordinance for the city of Houghton has been included in Appendix R. This ordinance has been constructed using the Kent County, Michigan and City of DeWitt, Michigan[23] ordinances as guidance. The main components of the ordinance include stormwater permit and management plan requirements, design and construction standards, enforcement and maintenance. This ordinance is being provided in draft form only, and should be edited as desired by the adopting municipality. However, it is recommended that a stormwater professional or expert be consulted when finalizing the ordinance. Some items to consider when finalizing this document should include:

- Who will complete review and approval of permit applications?
- What review is needed when stormwater is routed to an existing storm sewer?
- Should construction site erosion control requirements beyond the existing state rules be included?
- What are appropriate application fees and financial guarantees?
- Are special requirements needed for development of easements?
- What is the appropriate minimum storm event for which detention ponds should be sized? Or should the language, "maximum extent practicable" be used?

These items are addressed in the draft stormwater ordinance, but may need specialization according to the needs or existing rules of the adopting municipality.

Although this ordinance was written for the City of Houghton, it can readily be modified for use by Portage Township. Primarily, Section 1.1 - Statement of Authority, should be modified for applicability to Charter Township jurisdiction. An example of this modification is:

> "This ordinance is adopted in accordance with the Charter Township Act, as amended, being MCL 42.1, et seq.; the Township and Village Public Improvement Act, as amended, being MCL 41.721, et seq.; the Drain Code of 1956, as amended, being MCL 280.1, et seq.; the Land Division Act, as amended, being MCL 560.1, et seq.; the Revenue Bond Act, as amended, being MCL 141.101, et seq.; and the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101, et seq.; Section 401(p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124; and other applicable state and federal laws."

The types of stormwater facilities required by the draft ordinance, in order of preference, are stormwater infiltration facilities followed by stormwater detention facilities. The reason for preference being given to infiltration is because these types of facilities control both peak runoff discharge rate and total runoff volume. Detention facilities such as storm ponds (ones that do not infiltrate) only control

[23] City of DeWitt: http://www.dewittmi.org/Watershed.asp. Kent County: http://www.accesskent.com/YourGovernment/DrainCommisioner/drain_stormwater.htm.

discharge rate. Infiltration is desirable as it allows recharge of the groundwater table thereby supplying water bodies such as Huron Creek with flow when storm event runoff is not a major contributor to flow.

It also provides for natural uptake of nutrients, removal of sediment, and cooling of runoff that has passed over warming impervious surfaces. Design guidelines and recommendations for a variety of stormwater infiltration and detention facilities are available in the BMP manuals that are discussed in Section 7.6.

Use of infiltration-based stormwater management techniques is a part of what is known as "low-impact development" or "LID." LID emphasizes protection and use of on-site natural features integrated with engineered, small-scale stormwater controls to manage stormwater and maintain or restore pre-development watershed hydrologic functions. Low impact development strategies focus on evaporating, transpiring and infiltrating stormwater on site through native soils, vegetation and bioengineering applications, rather than conveying stormwater at increased volumes through large structural systems to streams and wetlands (Hinman, 2001). Use of LID techniques is recommended for the Huron Creek watershed. More information on LID can be found at:

- US Environmental Protection Agency: http://www.epa.gov/owow/nps/lid/.
- Prince George's County, Maryland: http://www.co.pg.md.us/Government/AgencyIndex/DER/ESD/low-impact.asp.
- Southeast Michigan Council of Governments (SEMCOG): http://www.semcog.org/LowImpactDevelopment.aspx. SEMCOG is currently in the process of creating the Michigan Low-Impact Development Statewide Manual.
- Low-Impact Development Center, Inc.: http://www.lowimpactdevelopment.org/.

The proposed stormwater ordinance includes language related to vegetation buffers. The term "vegetation buffer," in the context of water quality management, generally refers to zones or strips of vegetation that are left between development areas (impervious surfaces) and waterways or wetlands. The primary purposes of vegetative buffer zones are to:

- Reduce runoff by increasing stormwater infiltration into soil. Less runoff means lower amounts of nutrients and other pollutants directly entering the water. Less runoff also means more water entering the waterway or wetland as baseflow (subsurface flow).
- Stabilize soils with plant root systems.
- Reduce stream bank and wetland erosion from high velocity runoff.
- Improve wildlife and fish habitat by providing food, shelter, and shade (Univesity of Minnesota Sustainable Urban Landscape Information Series, 2006).

The main legal mechanism through which vegetative buffer zones are required and protected is a buffer ordinance. These ordinances are implemented in the same manner as stormwater ordinances, and are sometimes combined with stormwater ordinances into one ordinance.

Currently, vegetative buffers are not required by federal or state of Michigan law. However, many counties, municipalities and states (Wisconsin, Minnesota, and several eastern states) have implemented them as either a local ordinance or state-wide rule. Currently, Portage Township has a buffer zone rule for lakes and streams as part of the township zoning code:

> "Section 3.0 (Zoning Districts) – For RUR, RER, LAR, R-1, R-2, R-3 and R-4[24] zones, no dwelling can be located closer than 50 feet to the edge of a lake or stream. In cases of high banks 10 feet or higher, dwellings may be allowed to be closer." (The portion of the watershed that is in Portage Township falls into one of these zoning classifications. Figure 2.3 shows a zoning map for Portage Township.)

A stream buffer is also included for the length of Huron Creek that is in Portage Township in the Houghton County Land Use Plan that was approved in July 2006 (http://www.houghtoncounty.net/docs/LandUsePlanText.pdf).

At this time the City of Houghton does not require a vegetative buffer for either waterways or wetlands.

The draft stormwater ordinance provided in Appendix R includes a simple buffer zone rule that can be enforced as part of the ordinance (Article 3.4):

"3.4 Buffer Zones

> 1) No building or impervious surface shall be constructed within 50 feet of the ordinary high water mark of a lake, pond or stream. The definition of ordinary high water mark is as presented in article 1.5.
>
> 2) No building or impervious surface shall be constructed within 50 feet of the delineated boundary of a wetland as defined in article 1.5."

The distance of 50 feet was chosen for the following reasons because a 50-foot distance is already used by Portage Township, which establishes a precedent and 50 feet is often used as a maximum buffer distance in several other states' and counties' buffer ordinances. This example rule is a simplified version of the many buffer ordinances that currently exist. More thorough versions can include:

- buffer setbacks specified in the site plan requirements;
- buffer distances varied by quality and/or type of wetland or water body;
- permitted and prohibited uses and activities in buffer zones;
- vegetation type, permitted and prohibited uses dictated within the zone by distance from water body; and
- variances and related procedures.

Resources providing more information on writing waterway and wetland buffer ordinances include:

- Lower Dead River Model Buffer Ordinance (Provided by the Superior Watershed Partnership, Marquette, MI): www.superiorwatersheds.org/file.php?file=riparianbufferreportnew.pdf.
- Planning and Zoning Strategies for Water Quality Protection (St. Louis County, MI): http://www.cityofbn.com/downloads/PZManualFinalDraft.pdf.
- Stormwater Manager's Resource Center: http://www.stormwatercenter.net/.

[24] RUR = Rural Residential, RER = Resort Residential, LAR = Lakeshore Residential, R-1 = Low Density Single-Family Residential, R-2 = Medium Density Single-Family Residential, R-3 = High Density Single-Family Residential, R-4 = Medium Density Multi-Family Residential District

Generally speaking, the more thought-out and thorough the ordinance, the more effective the ordinance will be at providing the environmental and water quality control functions that buffer zones are designed for. However, the extent of the ordinance implemented will depend on the resources and funds available to the enforcing municipality.

7.6. Best Management Practices (BMPs)

Best Management Practices or BMPs, are any structural, vegetative or managerial practice used to treat, prevent or reduce water pollution. Such practices include temporary seeding on exposed soils, detention and retention basins for stormwater control, and scheduling the implementation of all BMPs to ensure their effectiveness (Peterson, Reznick, Hedin, Hendges, & Dunlap, 1998). The summary and descriptions of recommended physical improvements found in Table 7.2 and Section 7.3 indicate BMPs that would be applied in the recommended improvements. References and resources that can be used for specific guidance on BMP procedures and design include

- Michigan Natural Resource Conservation Service (NRCS) Field Office Technical Guide
- Michigan Department of Environmental Quality (MDEQ) Best Management Practices Design Manual
- Great Lakes Better Backroads Guidebook

Table 7.7 lists the BMPs from these guides that apply to the recommended actions and/or critical areas discussed in this chapter. These guidebooks include specifications which will provide the user with information to help design and implement the BMP. Each of these guidebooks presents BMPs that were developed for use in Michigan. These BMPs are provided in the guidebooks because have been proven to work when designed, installed and maintenance correctly. It is important to follow all specifications when designing and installing BMPs and it is also important that BMP projects be maintained. Maintenance is most often the largest shortcoming of BMP performance. It is highly recommended that these resources are consulted and utilized prior to implementation of the applicable recommended actions listed in this chapter.

Table 7.7 Best Management Practices for Critical Areas and/or Recommended Actions

	Related Critical Areas and/or Recommended Action[4]							
Best Management Practice	**HWP**	**LF**	**SCC**	**WET-MIT**	**CRIT**	**WET-REST**	**STORM**	**BUFF**
Michigan NRCS Field Office Technical Guide[1]								
channel stabilization	**X**		**X**		**X**			
conservation planning								
critical area planting	**X**	**X**	**X**		**X**			
MI riparian forest buffer								**X**
recreation trail and walkway				**X**				
seeding/sodding/spreading topsoil	**X**	**X**		**X**	**X**	**X**		
shrub plantings for wildlife				**X**		**X**		

	Related Critical Areas and/or Recommended Action[4]							
Best Management Practice	**HWP**	**LF**	**SCC**	**WET-MIT**	**CRIT**	**WET-REST**	**STORM**	**BUFF**
stream crossing								
stream habitat improvement & management		**X**	**X**	**X**				
streambank & shoreline protection	**X**	**X**	**X**		**X**			
tree/shrub establishment	**X**	**X**	**X**		**X**	**X**		
water & sediment control basin, O&M plan			**X**				**X**	
wetland enhancement		**X**		**X**		**X**		
wetland restoration		**X**		**X**		**X**		
MDEQ Best Management Practices Design Manual[2]								
construction - access roads, grading practices, land clearing, spoil piles, staging and scheduling, tree protection	**X**							
critical area stabilization	**X**	**X**	**X**		**X**			
lawn maintenance	**X**							
pond construction & management	**X**		**X**				**X**	
slope/shoreline stabilization	**X**	**X**	**X**		**X**			
stream bank stabilization	**X**	**X**	**X**		**X**			
check dams								
grassed waterways								
stabilized outlets					**X**			
detention basins			**X**				**X**	
modular pavement, porous asphalt pavement								
infiltration trenches and basins								
buffer/filter strips								**X**
seeding/sodding	**X**	**X**	**X**	**X**	**X**	**X**		
tree/shrubs & ground cover	**X**	**X**	**X**	**X**	**X**	**X**		
Great Lakes Better Backroads Guidebook[3]								
ditch velocity controls & energy dissipators								
stream crossings - bridge spans, culverts, ditch culverts								
outlet structures - rock aprons, riprap conveyance channels, plunge pools		**X**	**X**					
bank stabilization - seeding	**X**	**X**	**X**	**X**	**X**	**X**		
bank stabilization - shrubs & trees	**X**	**X**	**X**	**X**	**X**	**X**		
stabilization structures - gabions, timber cribs, riprap, revetments	**X**	**X**	**X**		**X**			
combination "hard" & vegetative stabilization	**X**	**X**	**X**		**X**			
stabilization mats, blankets & geotextiles	**X**	**X**	**X**		**X**			
sediment controls & traps								
storage & borrow areas								

	Related Critical Areas and/or Recommended Action[4]							
Best Management Practice	**HWP**	**LF**	**SCC**	**WET-MIT**	**CRIT**	**WET-REST**	**STORM**	**BUFF**

[1]: http://efotg.nrcs.usda.gov/treemenuFS.aspx, Click on Section IV - Conservation Practices
[2]: http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714-118554--,00.html)
[3]: http://www.huronpines.org/project/23
[3] Key:
HWP = Houghton Waterfront Park
WET-REST = Wetland Restoration Areas
LF = Landfill Area
STORM = Stormwater Ordinance
SCC = Shopping Cart Creek
BUFF = Buffer Ordinance
WET-MIT = Wetland Mitigation Area and Creek Re-route
CONS-DEV = Conservation Development
CRIT = Critical Erosion Locations
CONSTR = Construction Practices

7.7. Funding Sources

The following is a list of potential funding sources for the recommended actions listed in this chapter. This list is not all-inclusive as funding sources are continually changing and becoming available.

MDEQ Nonpoint Source Grants

These grants distribute funds from Section 319(h) of the federal Clean Water Act, and from the Clean Michigan Initiative Nonpoint Source Pollution Control Grants and Clean Water Fund. Approximately $3.2 million from federal funding and approximately $2.0 million of CMI funding was made available for the 2008 grant cycle. This program is the funding source through which this watershed management plan was created. Funds are also available for implementation of watershed management plans (see http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714-175889--,00.html).

Federal Targeted Watershed Grants Program

Implemented through the US Environmental Protection Agency, the Targeted Watersheds Grant (TWG) program encourages the protection and restoration of the country's water resources through cooperative conservation.

The program supports collaborative watershed partnerships that are ready to implement on-the-ground restoration and protection activities designed to achieve quick, measurable environmental results. In 2007, US Environmental Protection Agency awarded $12.4 million in implementation grants for 2006/2007. These grants are awarded through a competitive process, and all proposals must include a nomination letter from the Michigan Office of the Governor (see http://www.epa.gov/twg/implementation.html).

Urban and Community Forestry Program

This federal funding program is implemented through state forestry agencies, in Michigan's case, the Michigan DNR. These funds are made available for local government program development, education and technology transfer projects, library and nature center reference material acquisition, and tree planting projects. This program is a reimbursement program, meaning the proposed project must be completed prior to distribution of funds (see http://www.michigan.gov/dnr/0,1607,7-153-10366_37984_38165-126153--,00.html).

MDEQ Coastal Zone Management Program

The MDEQ Coastal Zone Management grant program provides funds for:

- Creation and enhancement of coastal public access
- Protection, management and/or restoration of coastal resources, habitats, and watersheds
- Control of development in erosion or flood hazard areas
- Preservation and restoration of historic and cultural coastal structures

The City of Houghton has a grant application in for 2009 funding for improvements to Huron Creek in the Kestner waterfront park. See http://www.michigan.gov/deq/0,1607,7-135-3313_3677_3696-11198--,00.html for details.

North American Wetlands Conservation Act Small Grants Program

This grant, administered through the U.S. Fish & Wildlife Service, provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands conservation projects in the United States, Canada, and Mexico for the benefit of wetlands-associated migratory birds and other wildlife. The Small Grants Program in particular funds project activities are usually smaller in scope and involve fewer project dollars.
Grant requests may not exceed $75,000, and funding priority is given to grantees or partners new to the Act's Grants Program.

Michigan Natural Resources Trust Fund

The Michigan Natural Resources Trust Fund provides financial assistance to local governments to purchase land or rights in land for public recreation or protection of land because of its environmental importance or its scenic beauty. It also assists in the appropriate development of land for public outdoor recreation. Applicants must include their community's adopted recreation plan along with their submission. The deadline for application is April 1 of each year (see http://www.michigan.gov/dnr/0,1607,7-153-10366_37984_37985-124961--,00.html).

Rural Development Housing & Community Facilities Program

This grant and loan program implemented by the U.S. Department of Agriculture (USDA) provides funds to communities and individuals for improvements and modernizations to homes and community facilities, including sewer and water improvements. The program is need-based. See http://www.rurdev.usda.gov/rhs/common/program_info.htm#SFH for details.

Great Lakes Protection Fund

The Great Lakes Protection Fund is a private, nonprofit corporation formed in 1989 by the Governors of the Great Lakes States. It is a permanent environmental endowment that supports collaborative actions to improve the health of the Great Lakes ecosystem. To date, the Fund had made 217 grants and program related investments representing more than $53 million in regional projects to improve the health of the Great Lakes ecosystem. To be successful, tying the project work into a larger, basin-wide effort would therefore be necessary. Projects should anticipate and prevent impacts to the Great Lakes ecosystem or the specific component (like a developed watershed) of the Great Lakes ecosystem rather than attempt to correct areas already impacted. Applications are accepted at any time (see http://www.glpf.org/).

US Environmental Protection Agency Great Lakes National Program Office Grant Program

US Environmental Protection Agency's Great Lakes National Program Office provides funding for the achievement of the goals in the Great Lakes Water Quality Agreement, the principal goal of that Agreement being the restoration and maintenance of the chemical, physical, and biological integrity of the Great Lakes basin. This program includes funding for sediment, monitoring, habitat and pollution prevention projects (see http://www.epa.gov/glnpo/fund/glf.html).

7.8. Estimate of Pollutant Discharge Reductions

The purpose of this section is to present calculations for demonstrating pollutant load reductions that are projected to occur through implementation of the recommended actions.

7.8.1. Sediment (Total Suspended Solids), Nitrogen & Phosphorus

The recommended actions that address streambank erosion include the Kestner Waterfront Park improvements, improvements to Shopping Cart Creek upstream of the headcut (Critical Erosion Location I), and Critical Erosion Locations B and D. The landfill area also has some channel erosion. The formula presented in the MDEQ guidance document for streambank erosion is (MDEQ, 1999):

Sediment from Channel Erosion (CE) = Length (ft) x Height (ft) x Lateral Recession Rate (LRR, ft/yr) x soil weight (tons/ft^3)

Recommended LRRs are found in Table 7.8.

Table 7.8 Recommended Lateral recession rates (LLRs)

Lateral Recession Rate (ft./yr.)	Category	Description
0.01 - 0.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
0.06 - 0.2	Moderate	Bank is predominantly bare with some rills and vegetative overhang.
0.3 - 0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U-shaped and streamcourse or gully may be meandering.

Source: Steffen, L.J., 1982.

A soil weight of 0.055 tons/ft^3 is used for sands and loamy sands as they are the most common soil textures found in watershed.

- Kestner Waterfront Park Sediment Reduction = 615 ft x 4 ft x 0.5 ft/yr x 0.055 tons/ft^3 = 68 tons/yr
- Shopping Cart Creek (Erosion Location I) Sediment Reduction = 50 ft x 6 ft x 0.5 ft/yr x 0.055 tons/ft^3 = 8 tons/yr
- Landfill Creek Channel Sediment Reduction = 60 ft x 0.5 ft x 0.1 ft/yr x 0.055 tons/ft^3 = 0.2 tons/yr
- Erosion Location B Sediment Reduction = 20 ft x 1 ft x 0.2 ft/yr x 0.055 tons/ft^3 = 0.2 tons/yr
- Erosion Location D Sediment Reduction = 100 ft x 0.5 ft x 0.05 ft/yr x 0.055 tons/ft^3 = 0.1 tons/yr

The majority of erosion in the landfill area and critical erosion locations A, C, E and H can be described as small to large gully erosion. Location G is not included as it has not yet eroded and is a preventative measure. The formula presented in the MDEQ guidance document for gully erosion is (MDEQ, 1999):

Sediment from Gully Erosion (GE) = [(Top Width + Bottom Width(ft))/2] x Depth (ft) x Length (ft) x Soil Weight (tons/ft^3)/(Estimated # of Years it Took to Erode)

- Landfill Area Sediment Reduction - approximately 3 significant slope gullies, on average 2-3 ft wide (top & bottom), 0.5 to 1 ft deep and approximately 30 ft long:

$$= \frac{(2.5\text{ ft}) \times (0.75\text{ ft}) \times (30\text{ ft}) \times (0.055\text{ tons/ft}^3) \times 3\text{ gullies}}{2\text{ years}} = \boxed{5\text{ tons/yr}}$$

- Erosion Location A Sediment Reduction:

$$= \frac{[(3\text{ ft} + 0.5\text{ ft})/2] \times (1.5\text{ ft}) \times (3\text{ ft}) \times (0.055\text{ tons/ ft}^3)}{4\text{ years}} = \boxed{0.1\text{ tons/yr}}$$

- Erosion Location C Sediment Reduction:

$$= \frac{[(3\text{ ft} + 0.5\text{ ft})/2] \times (1\text{ ft}) \times (5\text{ ft}) \times (0.055\text{ tons/ ft}^3)}{4\text{ years}} = \boxed{0.1\text{ tons/yr}}$$

- Erosion Location E Sediment Reduction:

$$= \frac{[(5\text{ ft} + 2\text{ ft})/2] \times (3\text{ ft}) \times (30\text{ ft}) \times (0.055\text{ tons/ft}^3)}{8\text{ years}} = \boxed{2\text{ tons/yr}}$$

- Erosion Location H (Shopping Cart Creek Headcut) Sediment Reduction:

$$= \frac{[(8\text{ ft} + 4\text{ ft})/2] \times (5\text{ ft}) \times (80\text{ ft}) \times (0.055\text{ tons/ft}^3)}{20\text{ ears}} = \boxed{7\text{ tons/yr}}$$

Combining the estimated sediment reduction from streambank and gully erosion sites gives $\boxed{90.7\text{ tons}}$.

This value can then be used to calculate an estimated amount of total phosphorus and nitrogen reductions using the following formula (MDEQ, 1999):

> Nutrient load (lb/yr) = Sediment load (tons/yr) x Nutrient Concentration (lb/lb soil) x 2000 lb/ton x soil type correction factor

Where the average nitrogen concentration in soil = 0.001 lb N/ lb soil,and the average phosphorus concentration in soil = 0.0005 lb P/ lb soil. Using this formula, total estimated nitrogen and phosphorus reductions are:

Total Annual Nitrogen Reduction = (90.7 tons/yr) x (0.001 lb N/ lb soil) x (2000 lb/ton) x 0.85

$$= 154\text{ lb/yr} = \boxed{0.08\text{ tons/yr}}$$

Total Annual Phosphorus Reduction = (90.7 tons/yr) x (0.0005 lb P/ lb soil) x (2000 lb/ton) x 0.85

$$= 77\text{ lb/yr} = \boxed{0.04\text{ tons/yr}}$$

7.8.2. Copper

Table 5.1 and Figure 5.7 indicate that the Green Acres (GA) water quality monitoring site has not had levels of total dissolved copper in exceedance of the Final Chronic Value (FCV) or Final Acute Value (FAV) for any of the monitoring events completed between November 2006 and May 2008. It can also be seen that exceedances generally begin at the next monitoring site downstream (DWL), continue downstream, and spike at the landfill (LF) monitoring site. Based on this information, it can be concluded that the GA location characterizes background water quality that is not influenced by copper-contributing runoff from stamp sands or the Ridge Road landfill, as they are both in downstream/down-gradient locations relative to the GA site. Therefore, the assumption is made that if recommended actions for the landfill and stamp sand locations are completed, dissolved copper levels in Huron Creek would be reduced to the approximate concentrations found at the GA site. Below, copper load reduction calculations are presented for:

1. Stamp sand stabilization in the wetland mitigation area using the average copper concentration of the DWL monitoring site (nearest downstream monitoring site), referred to as $\mathbf{L_{DWL}}$.
2. Stamp sand stabilization in the Ridge Road landfill area, and prevention of leachate from reaching Huron Creek using the average copper concentration of the FL monitoring site (nearest downstream monitoring site), referred to as $\mathbf{L_{LF}}$.

The general method used to complete the calculations is the "Simple Method" (Shaver, 2007). The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration as

$$L = QC$$

where L = annual load, Q = annual runoff and C = pollutant concentration. The average annual runoff volume, or streamflow, was reported in Section 5.4.1 as 3.5 cfs.

Because separate load calculations are being completed for two monitoring locations (representing separate recommended actions), the runoff contributing to creek flow at each location (Q_{DWL}, Q_{LF}) must be calculated to determine an associated load reduction for each location. These runoff values are estimated by using a ratio of that monitoring location's influencing catchment area (A_{DWL}, A_{LF}) to the total watershed area (A_{TOT}), and multiplying it by the total runoff (Q), as in

$$Q_{DWL} = (A_{DWL}/A_{TOT})Q = (1634 \text{ ac}/2112 \text{ ac})\ 3.5 \text{ cfs} = 2.1 \text{ cfs}$$

$$Q_{LF} = (A_{LF}/A_{TOT})\ Q = (2009 \text{ ac}/2112 \text{ ac})\ 3.5 \text{ cfs} = 3.3 \text{ cfs}$$

The desired copper concentration reduction is calculated by subtracting the background copper concentration, taken as the average copper concentration at the Green Acres (C_{GA}) sampling site, from the average copper concentration at the monitoring locations (C_{DWL}, C_{LF}). Given C_{GA} = 0.0027 mg/L, C_{DWL} = 0.017 mg/L and C_{LF} = 0.036 mg/L, the concentration reductions are:

$$C_{DWL*} = (0.017 \text{ mg/L} - 0.0027 \text{ mg/L}) = 0.0143 \text{ mg/L}$$
$$C_{LF*} = (0.036 \text{ mg/L} - 0.0027 \text{ mg/L}) = 0.033 \text{ mg/L}$$

Next, the Simple Method can be used to calculate the load reduction associated with each monitoring location and therefore each recommended action. The results of these calculations are given in

Table 7.9 .

Table 7.9 Estimated Total Annual Copper Load Reductions

Location	Runoff, cfs (Q_{DWL}, Q_{LF})	Copper Concentration Reduction, mg/L (C_{DWL}, C_{LF})	Estimated Total Load Reduction (tons/yr)
DWL	2.7	0.014	0.04
LF	3.3	0.033	0.11

These load reductions would result in concentrations at DWL and LF (and downstream locations) being reduced to the target average concentration of the Green Acres site, which is below both the typical FCV of 0.009 mg/L, and the typical FAV of 0.027 mg/L.

7.8.3. Ammonia

As can be seen in Figure 5.3, for every monitoring event, the average concentration of ammonia significantly increases at the LF site compared to the next upstream monitoring point, "Frog Pool," (FP). Similar to the calculations for copper, it is assumed that if leachate from the Ridge Road landfill is prevented entirely from reaching Huron Creek, the average concentration would drop to that of the upstream site, FP. Calculations follow for an estimated ammonia reduction following completion of the recommended action for the landfill leachate collection system:

- Q_{LF} = 3.5 cfs
- C_{LF} for ammonia = 0.15 mg/L
- C_{FP} = 0.0825 mg/L
- $C_{LF*} = C_{LF} - C_{FP}$ = 0.15 mg/L – 0.0825 mg/L = 0.0675 mg/L

Using the Simple Method, the estimated annual ammonia load reduction, L_R is 0.23 tons/yr. Completion of the recommended action to ensure that leachate is not entering Huron Creek from the former landfill will reduce ammonia concentrations at the LF monitoring site and downstream, to the average concentration of the FP site, which is 0.0825 mg/L.

7.9. Target Criteria and Associated Actions for Eliminating Impairments and Threats

In Section 4.1, the designated use, "Aquatic Life and Wildlife Habitat," was identified as being impaired, due to excessive levels of copper and ammonia that have been measured in Huron Creek. Two designated uses, "Partial Body Contact Recreation" and "Total Body Contact Recreation," were identified as threatened. These designated uses were identified as threatened due to concerns over potential contact with human wastes in the Kestner Waterfront Park and a nearby swimming beach, downstream of the Dakota Heights area. In this area, it is suspected that septic systems nearby the creek are not operating sufficiently.

The recommended actions described in Section 7.3 are expected to remove these impairments and threats to designated uses. Table 7.10 lists the water quality contaminants associated with these impairments and threats, the targets to be met to remove the impairments and threats, and the recommended actions expected to remove the impairments and threats. Each of the contaminants is addressed in the monitoring plans in Section 7.4, such that the success of meeting the targets and removal of the impairments and threats will be assessed.

Table 7.10 Target Criteria for Removal of Designated Use Impairments and Threats

Contaminant	**Target**	**Associated Recommended Actions**
Copper	Reduce concentrations to below Final Acute Value for copper: 0.027 mg/L	7.3.1 Reduce Metals and Ammonia Loads to Huron Creek
Ammonia	Reduce concentrations to below Acute Value Value: 0.32 mg/L	7.3.1 Reduce Metals and Ammonia Loads to Huron Creek
Fecal Coliform	Ensure that concentrations are below total body contact recreation standard: 130 E. coli/100 ml [1]	7.3.4 Septic System and Sanitary Sewer

[1] based on 30-day geometric mean

8. Information and Education (I/E) Strategy

Educating and involving the public are two key elements to the success of any watershed management plan. Public education draws interest, reinforces the importance of water quality management and informs stakeholders about decisions in which they will have a say. Involving the public throughout the planning and implementation process allows stakeholders, volunteers and other interested parties to take ownership of the planning and actions that take place. This aspect of "ownership" reinforces community partnerships as well as the level of commitment people have to their environment.

Chapter 3 describes key stakeholders and public participation in the development of the Huron Creek watershed management plan, including formation of the Huron Creek Watershed Advisory Committee (WAC), presentations on various watershed topics at the WAC meetings, and creation of the WAC's mission statement (watershed goals). In addition to the WAC activities, several other information and education (I/E) events have taken place, as described in Section 8.1. Recommendations for future I/E strategies are described in Section 8.2.

8.1. Information and Education Activities Conducted 2001-2008

8.1.1. Watershed Plan Development Website

In spring 2007, MTU graduate students and Professor Hugh Gorman of the MTU Department of Social Sciences created a website to present proposed components of the watershed management plan. The website development was a product of the MTU Department of Social Sciences course "Environmental Decision Making." The purpose of the website was to provide information to the public during the development of the watershed management plan for the Huron Creek watershed. Topics covered on the website include:

- A general description of the watershed
- Stormwater management issues
- Water quality management issues
- Proposed improvements to the Kestner Waterfront Park
- Conditions and features of Huron Creek
- Watershed vegetation and wetlands issues
- Cultural and historical preservation issues

This website can be found at: http://www.social.mtu.edu/GORMAN/HuronCreek/HuronCreek.htm.

8.1.2. Public Comment Period

After completion of the first draft of the final watershed management plan text, a one-month public review period was held in which the public was invited to review and provide comment on the plan. The review period was announced in a press release in the local newspaper. The press release described how and when the draft plan could be accessed.

The draft was made available at the Houghton Public Library and on the web from June 9th to June 30th 2008. Shortly after the public review period ended (July 7, 2008) a public meeting was held to present the main parts of the plan and to collect additional public comments. This watershed management plan has been revised according to the comments received during this period. These comments are listed in Appendix U.

8.1.3. Huron Creek Day

On April 28th, 2007, a multi-topic educational event called "Huron Creek Day" was held by MTU graduate students at the Kestner Waterfront Park in Houghton. This event was a product of the MTU Department of Social Sciences course "Environmental Decision-making." Poster presentations were made on subjects such as wetland values and functions, stormwater management and the watershed's historical heritage. The event also included guided bus tours of the watershed so that participants could visit areas of concern and make a visual connection with the creek. Tour locations included the Wal-Mart wetland mitigation and creek re-route area, the former Houghton landfill site and leachate collection system, and of course, the Kestner waterfront park.

The event was advertised in the Houghton Daily Mining Gazette, as well as on local radio stations and through flyers posted at local businesses. The target audience was the general public, including City of Houghton and Portage Township officials and planning commissioners. Approximately 30 people attended this event, and a lengthy article was published in the Mining Gazette. Flyers and articles covering this and other completed I/E events are provided in Appendix S.

Figure 8.1 Participants viewing an educational poster at Huron Creek Day

8.1.4. Litter Clean-Up Days

Litter clean-up days were held along Huron Creek in May 2007 and May 2008. The first was organized by the MTU Center for Water & Society (CWS) and was attended by Girl Scout troops and students and teachers from a home school group. Approximately 15 people attended.

This event began with a brief educational session about the watershed and water quality. The second clean-up day was organized by CWS and the MTU Society of Wetland Scientists (SWS). This event was attended by members of other community organizations such as Trout Unlimited and Friends of the Land of the Keweenaw (FOLK). Approximately 15 people attended. The Daily Mining Gazette provided a front-page article on the clean-up and the Huron Creek watershed management plan (see Appendix S). Materials and disposal costs were paid for by the Superior Watershed Partnership of Marquette, Michigan.

Figure 8.2 Participants at a Huron Creek Clean-Up Day

8.1.5. Storm Drain Stenciling

In May 2007, CWS organized a storm drain stenciling event. At this event, participants learned about stormwater and its relationship to water quality, and how storm drain stenciling can help spread awareness. Afterwards, several watershed storm drains were stenciled with the words "Drains to Lake, Do Not Dump," and flyers were distributed to local businesses (for distribution to the public) that contained information about local waste disposal and recycling facilities.

Figure 8.3 Storm drain stenciling

8.1.6. Educational Sign in Kestner Waterfront Park

In fall 2006, the BRIDGE alternative school in Hancock created and installed a sign describing the Huron Creek watershed in the Kestner Waterfront Park (see Figure 8.4). The content of the sign was reviewed and approved by the Huron Creek WAC. This sign was placed adjacent to the creek and shows the reader their location relative to the watershed boundaries. The sign also discusses why watershed management is important, and what can be done protect water quality in a watershed.

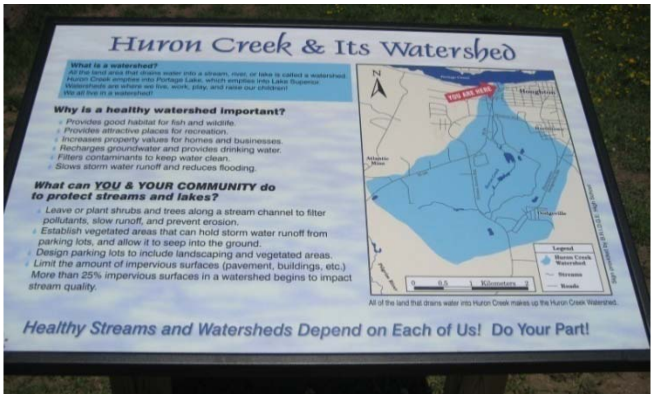


Figure 8.4 BRIDGE School sign at Kestner Waterfront Park

8.1.7. Publications in Local Media

Various publications have also assisted in spreading awareness of environmental issues in the Huron Creek watershed. These have included the Copper Country Trout Unlimited chapter newsletter, the MTU Geological and Mining Engineering and Sciences (GMES) department newsletter and several *Daily Mining Gazette* Articles. These articles have described the Huron Creek watershed, the management planning process, specific environmental concerns, and the need for public awareness. The GMES publication in particular discussed contributions of MTU undergraduate students to the formation of the management plan. As mentioned above, the *Daily Mining Gazette* published articles covering events such as Huron Creek Day and litter clean-up days. Other articles published described events of WAC meetings, methane monitoring of the former Houghton landfill, aesthetics of the creek in the Kestner waterfront park, and letters to the editor regarding the various aspects of the creek. These articles and publications can be found in Appendix S. Also, another Huron Creek article is planned for publication in the MTU Alumni newsletter in Fall 2008, which is sent to all graduates of Michigan Tech.

8.1.8. Local School Activities

From 2001 to the present, Houghton Middle School science teachers and students have used Huron Creek as a laboratory for learning about water quality. Activities have included water chemistry sampling and benthic macro-invertebrate assessments. In 2007 and 2008, representatives from the MTU Center for Water and Society (CWS) have made presentations in these classes on general aspects of the Huron Creek watershed, land use history in the watershed, current water quality issues, and the importance of citizen involvement in watershed management. The activities have involved more than 300 middle school students.

8.1.9. Community Workshops and Courses

From 2000 to the present, Joan Chadde, Education & Outreach Program Coordinator at the Western U.P. Center for Science, Mathematics and Environmental Education (WUPCSME) has used Huron Creek for educational workshops for high school teachers, school-aged children and other grant-funded activities. Workshop activities have included water quality monitoring, macroinvertebrate sampling, watershed hydrology, wetlands, and stormwater runoff, and surveys of public knowledge of the watershed. Approximately 100 students and teachers have attended the workshops. Figure 8.5 shows teachers completing flow monitoring at the Kestner waterfront park.

Figure 8.5 Graduate student teachers monitoring the Flow of Huron Creek

8.2. Proposed Information and Education Strategy

Increasing awareness and understanding how actions on the land can impact water quality is a critical step toward protecting and improving water quality in the Huron Creek Watershed. The purpose of the proposed information and education strategy is to support the goals, objectives, and recommended actions proposed in this watershed management plan. Table 8.1 identifies key recommended actions for the proposed I/E strategy. Explanations of selected portions of the proposed actions are given in Sections 8.2.1., 8.2.2., 8.2.3., and 8.2.4.

Table 8.1 Recommended Actions: Information and Education

Recommended Action	Target Audiences	Frequency	Medium or Method	Potential Partners[1]	Timeline (years out)	Estimated Cost/year	Potential Funding Sources2
Develop and distribute information on important functions of wetlands; construct Wetland Education Station (see Section 8.2.1)	General public, K-12, tourists	Develop information, annual distribution of information, construction of education station	Brochure, newsletter, newspaper, website, permanent education site	City of Houghton, Wal-Mart of Houghton, WUP Center, HKCD, NRCS	information: 0-2 station: 0-4	Cost of information development, printing, and mailing; Education Station (deck), Path, Interpretive Sign = $4,000 to $5,000	Wal-Mart of Houghton, Private
Develop and distribute information about the location of scenic vistas, historical sites; install educational and historical signage (see Section 8.2.2)	General public, K-12, tourists	Develop information, annual distribution of information, development and installation of signs	Brochure, newsletter, newspaper, website, permanent signs	Houghton-Portage Township Schools, BRIDGE School, WUP Center, MTU Industrial Archeology Department	information: 0-2 signs: 0-4	Cost of information development, printing, and mailing; $200 to $350 per sign	NPS, Private
Conduct training and implement volunteer water quality (see Section 8.2.3) and invasive species monitoring programs	Riparian landowners, general public, K-12, local governments	Develop, implement, repeat as necessary	Training packet, newsletter, workshop	Houghton-Portage Township Schools, WUP Center	0-2	Cost of packet development and reproduction, workshops	NPS
Inform public of Implementation of recommended actions (see section 8.2.4)	General public	Hold meetings, news events as necessary	Meetings, news events	City of Houghton, Portage Township	0-4	Minimal	

Recommended Action	**Target Audiences**	**Frequency**	**Medium or Method**	**Potential Partners[1]**	**Timeline (years out)**	**Estimated Cost/year**	**Potential Funding Sources2**
Hold watershed tours to promote protection and improvement of water quality	General public, K-12, local governments	Yearly	Tours	City of Houghton, Portage Township, CWS	0-4	Cost of transportation	City of Houghton, Portage Township
Educate about proper construction techniques and stabilization practices to minimize erosion	Developers, landowners, local governments	Develop information, annual distribution of information, workshops	Brochure, newsletter, newspaper, website, workshops	HKCD, NRCS	0-2	Cost of information development, printing, and mailing, workshops	NPS
Develop and distribute information on limiting nutrient loadings to surface water through limited use of fertilizers or low phosphorus fertilizers	Landowners, businesses, general public, local governments	Develop information, annual distribution of information, workshops	Brochure, newsletter, newspaper, website, workshops	HKCD, NRCS	0-2	Cost of information development, printing, and mailing, workshops	NPS
Educate about low impact development techniques for managing stormwater runoff	Landowners, businesses, general public, local governments	Develop information, annual distribution of information, workshops	Brochure, newsletter, newspaper, website, workshops	City of Houghton, Portage Township, HKCD, NRCS, Houghton County Drain Commissioner, WUP Center	2-4	Cost of information development, printing, and mailing, workshops	NPS

Recommended Action	Target Audiences	Frequency	Medium or Method	Potential Partners[1]	Timeline (years out)	Estimated Cost/year	Potential Funding Sources2

[1]Potential Partners
HKCD = Houghton-Keweenaw Conservation District
MDEQ = Michigan Department of Environmental Quality
MSUE = Michigan State University Extension
CWS = MTU Center for Water and Society
SWS = MTU Chapter of the Society of Wetland Scientists
MG = Houghton Area Master Gardeners
MTU C&E = MTU Civil & Environmental Engineering Department (Courses)
MTU Micro = MTU Microbiology Club
HAS = Houghton Area Schools
WUP Center = Western Upper Peninsula Center for Science, Mathematics and Environmental Education
CCTU = Copper Country Trout Unlimited
[2]Potential Funding Sources
CZM = MDEQ Coastal Zone Management Grant
EPA GLNP = US Environmental Protection Agency Great Lakes National Program Office Grant
U & CF = Urban and Community Forestry Grant
NPS = MDEQ Nonpoint Source Grant
Private = Private Funding/Landowners
NAWCA = North American Wetlands Conservation Act Grant
USDA = Rural Development Housing & Community Facilities
TU = Trout Unlimited Embrace-A-Stream Program.

8.2.1. Wetland Education Station

The Houghton Wal-Mart wetland mitigation area has been recognized by the Huron Creek WAC as a potentially valuable resource for on-site wetlands and water quality education.

An "education station" is proposed to be constructed near Huron Creek in the main wetland mitigation area. The education station would consist of a handicapped-accessible elevated deck and an interpretive sign. Topics discussed on the sign would include:

- History of the site in the context of mining activities.
- Values and functions of wetlands in watersheds.
- The wetland mitigation process and restoration completed at the site.

The education station would be an ideal location for use by local schools, MTU courses and community workshops, such as those discussed earlier in this chapter. The site readily combines historical and environmental education aspects, and provides a location for access to the creek for water quality or macro-invertebrate sampling. It is also proposed that a path be created from Razorback Drive leading out to the education station.

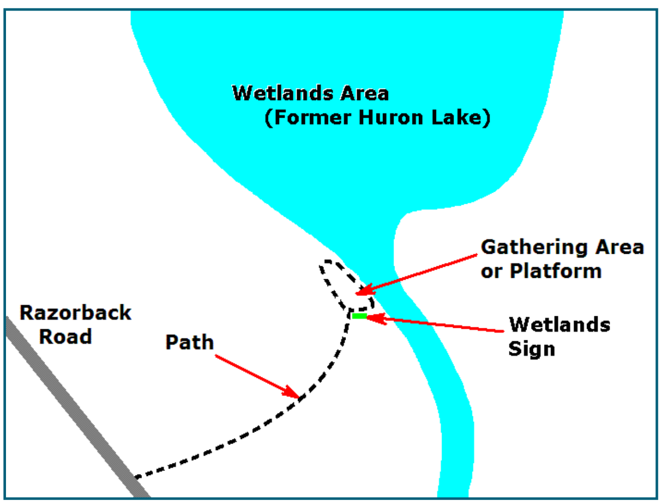


Figure 8.6 Conceptual Sketch of Path and Education Station

Currently, the City of Houghton owns and manages the wetland mitigation site and creek re-route area. Permission would have to be obtained from the city before any implementation activities begin. Also, it may be necessary to contact MDEQ as modifications to, and activities in wetland mitigation areas are limited based on state regulations for wetland mitigation sites. However, it is likely that additional use of the area for educational purposes would be considered favorable.

8.2.2. Educational and Historical Signage

Another goal identified by the Huron Creek WAC was to install interpretive signs on watershed health and historical heritage. The existing sign in the Kestner Waterfront Park and the proposed sign for the wetland education station both address this goal. Some additional suggestions for signage in the watershed might include:

- Signs identifying Huron Creek where it crosses Sharon Avenue and Razorback Drive (see Figure 8.7).
- A historical sign in the Kestner Waterfront Park describing the history of the location, including the Copper Range roundhouse and coal dock.
- A separate sign and/or trail at the Wal-Mart wetland mitigation site describing the history of the former Huron Lake and the Huron Mine and stamp mill.

Figure 8.7 Example Sign for Creek Crossings

8.2.3. Volunteer Water Quality Monitoring

Volunteer water quality monitoring programs can provide a unique opportunity to engage citizens in watershed protection and enhancement efforts. Through monitoring, volunteers learn how the quality of surface water and groundwater is affected by human actions on the land and how to protect water resources. In turn, monitors can help to educate the local community on water quality issues. It is proposed that the MTU Center for Water and Society develop a volunteer monitoring program for the Huron Creek watershed. The program will include some or all of the water quality parameters identified in Section 7.4.1. The goal of the program will be to engage the public in ongoing monitoring and in the evaluation of the recommended actions proposed in this plan.

8.2.4. Informing the Public of Implementation of Recommended Actions

Chapter 7 identifies a series of recommended actions for improving and protecting the watershed. As each action proceeeds towards implementation, a public education activity will be developed and conducted. The purpose of these activities will be to inform the public of the need for the action, the details concerning the action, and the expected outcome of the actions, in order to engage the public before and during the implementation of the action. For example, partners responsible for implementing the proposed improvements to Huron Creek in the Kestner Waterfront Park will announce through the media the purpose of the improvements and that funds are being sought for the improvements.

While the improvements are being put in place, the public will be invited to view the activities. Finally, whenthe improvments are finished, a public dedication will take place. In addition to engaging the public in a particular recommended action, it is expected that these activities will help to continue public support for remaining activities.

9. Watershed Management Plan Evaluation Strategy

Watershed management planning is generally considered an iterative process due to the fact that over the course of any long-term plan, various factors can change that might affect proposed actions or direction. For example, funding sources might change, new developments may cause a shift of task priority, or a proposed improvement may not be achieving the desired effect. Measuring effectiveness is one of the most important reasons to regularly evaluate progress, as it can help re-direct resources to achieve a more productive end. Also, more support can be gained for the management plan if it can be demonstrated that goals were achieved and improvements were made.

It is recommended that the Huron Creek watershed management plan be annually evaluated in order to measure progress (are goals and objectives being completed?) and identify any needed changes (do proposed tasks need to be modified?). A form is provided in Appendix T that can be used as a guide at WAC meetings or by individuals to evaluate the progress of the plan.

Part 1 of the form addresses recommended monitoring plans (See Chapter 7) and identifies

- If monitoring has been completed.
- If any new trends have been identified, and if subsequent changes need to be made to the plans.
- If previously suggested changes have been made.

Part 2 of the form addresses recommended actions and improvements and includes the following questions.

- Which recommended actions and/or tasks have been addressed during the last year? Have any been completed?
- Are these actions being completed according to suggested plan priority and timeline? If not, do project priorities and timelines need to be changed?
- What methods are being used to measure progress?
- Are current efforts still in line with the goals of the WAC? If not, do the goals need to be modified? Should any additional goals be addressed?
- Have previously suggested changes to goals, objectives or recommended actions been made?

Part 3 of the form addresses information and education (I/E) efforts and includes the following questions.

- Which I/E actions and/or tasks have been addressed during the last year? Have any been completed?
- Are these actions being completed according to suggested timeline? If not, do project timelines need to be changed?
- What methods are being used to measure progress?

Suggested methods to measure progress can include:

- Identifying completed steps or tasks towards a recommended action (for example, identifying funding or gaining commitment of project partners).
- Evaluating results of monitoring plans.
- Taking photos of critical areas over the implementation process.
- Monitoring WAC member and volunteer participation (is more outreach needed?).

Completed forms can then provide a “look back” that will allow long-term plan evaluation and provide documentation of progress over the implementation process. Making these forms available to the public, such as by posting them on a website, will help keep the community aware of progress, and add accountability to the plan.

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