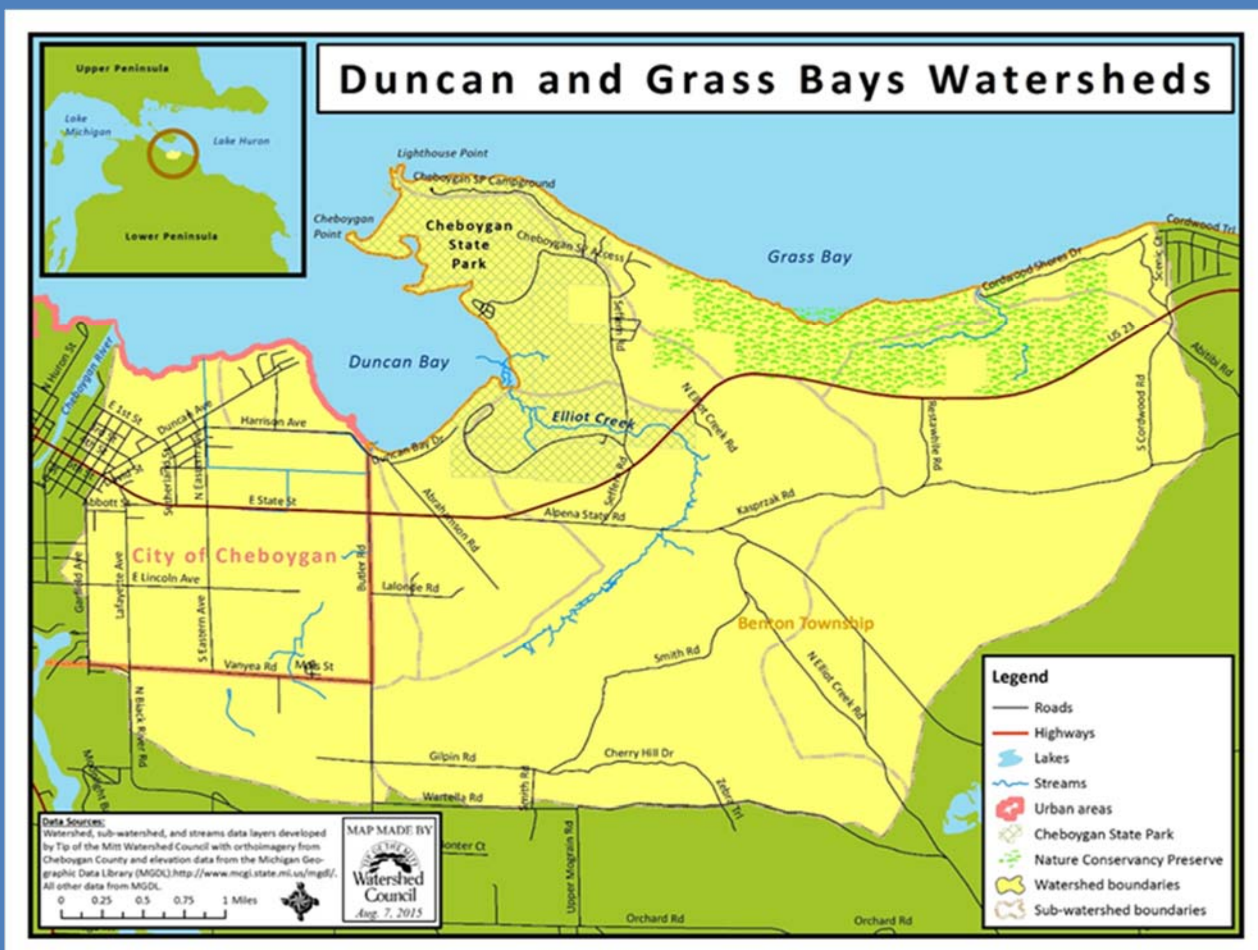
Duncan and Grass Bays Watershed

Management Plan



October 2016

Acknowledgements

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MDEQ/EPA Approved

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A watershed is an area of land that feeds all the water running under it and draining off it into a body of water. It combines with other watersheds to form a network of rivers and streams that progressively drain into larger water areas.

Homes, farms, ranches, forests, small towns, big cities, and more can make up watersheds. Some cross county, state, and even international borders. Watersheds come in all shapes and sizes. Some are millions of square miles; others are just a few acres. Wherever you are and wherever you go, you are in a watershed.

What Is the Watershed Approach?

A watershed approach is an analytical process that considers the abundance, locations, and conditions of aquatic resources in a watershed. It further considers how those attributes support landscape functions and attainment of watershed goals (Sumner 2004). Rather than identifying and protecting individual water resources, a watershed approach involves developing a framework for management of an area defined by drainage instead of political or land ownership boundaries (USEPA 2005).

Watershed management is a widely used and effective approach to managing water resources. The Environmental Protection Agency (EPA), the agency responsible for meeting the requirements set forth in the Clean Water Act (1973), describes the watershed approach as:

> "…a flexible framework for managing water resources quality and quantity within specified drainage areas, or watershed. This approach includes stakeholder involvement and management actions supported by sound science and appropriate technology. The watershed planning process works within this framework by using a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement and adapt selected actions as necessary. The outcomes of this process are documented or referenced in a watershed plan. A watershed plan is a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, action, participants, and resources related to developing and implementing the plan." *EPA's Handbook for Developing Watershed Plans to Restore and Protect Our Water (October, 2005)*

The **Duncan and Grass Bays Watershed Protection Plan** (Plan) is the result of applying the watershed approach to managing water resources within the Duncan and Grass Bays Watershed (Watershed). The Plan takes into account the known sources and causes of the priority nonpoint source pollutants, the areas within the Watershed most impacted by these pollutants, and the measures necessary to protect or enhance water quality throughout the Watershed. The Plan is a tool and a guide to future management efforts based on the needs of the Watershed and capacity of its stakeholders.

And why are these efforts so critical to water quality protection? Moreover, why so important in a watershed with so few impairments, such as the Duncan and Grass Bays Watershed?

According to the EPA, nonpoint source pollution is considered the greatest threat to water quality and is the most significant source of water quality impairment in the nation.

Therefore, the development and implementation of watershed plans for waters that are *not* impaired by nonpoint source pollution is, perhaps, the best way to ensure they remain unimpaired.

The EPA notes that "of particular concern are *high-quality waters that are threatened by changing land uses when unique and valuable aquatic resources (e.g. habitat for salmon migration, spawning and rearing) are at serious risk of irreparable harm."*

Why the Duncan and Grass Bay Watershed?

The Michigan Department of Environmental Quality's 2012 Integrated Report identified the Duncan and Grass Bays Watershed (HUC 040700030103) as:

"The most significant priority area to protect along the Lake Huron coast in the Northeast Michigan Coastal Stewardship Project (2009). The area is a state-designated environmentally sensitive area with high biological rarity, and includes shoreline ridge swale habitats, dune swale complexes, large tracts of public land, and extensive wetlands. Protecting adjacent land is a priority considering the high rate of population growth and development in the area, which contributes to sedimentation from construction site erosion as well as habitat loss and fragmentation. There is not a CMI or Section 319 approved watershed management plan that covers this area, but there is local interest in developing one and funding is currently being sought."

In 2012, Tip of the Mitt Watershed Council received a grant through the Clean Water Act Section 205j with the Michigan Department of Environmental Quality (MDEQ) to implement the Duncan and Grass Bay Watershed Management project, including the development of this Watershed Management Plan. This is the first formal effort toward bringing together watershed stakeholders under the auspices of developing and implementing a watershed management plan (Figure 1).

The Plan contains the actions and steps necessary to protect the water resources; implementation of these steps, however, must follow. Implementation of the Plan will be ongoing over the next ten years. At that point, the Plan will once again be updated to reflect current water quality and resource conditions, as well as accomplishments toward water quality protection. New recommended actions and steps for watershed protection will be made and the process will continue. Watershed management is an ongoing effort, but essential for protecting water quality for today and tomorrow.

The Environmental Protection Agency's Nine Minimum Elements

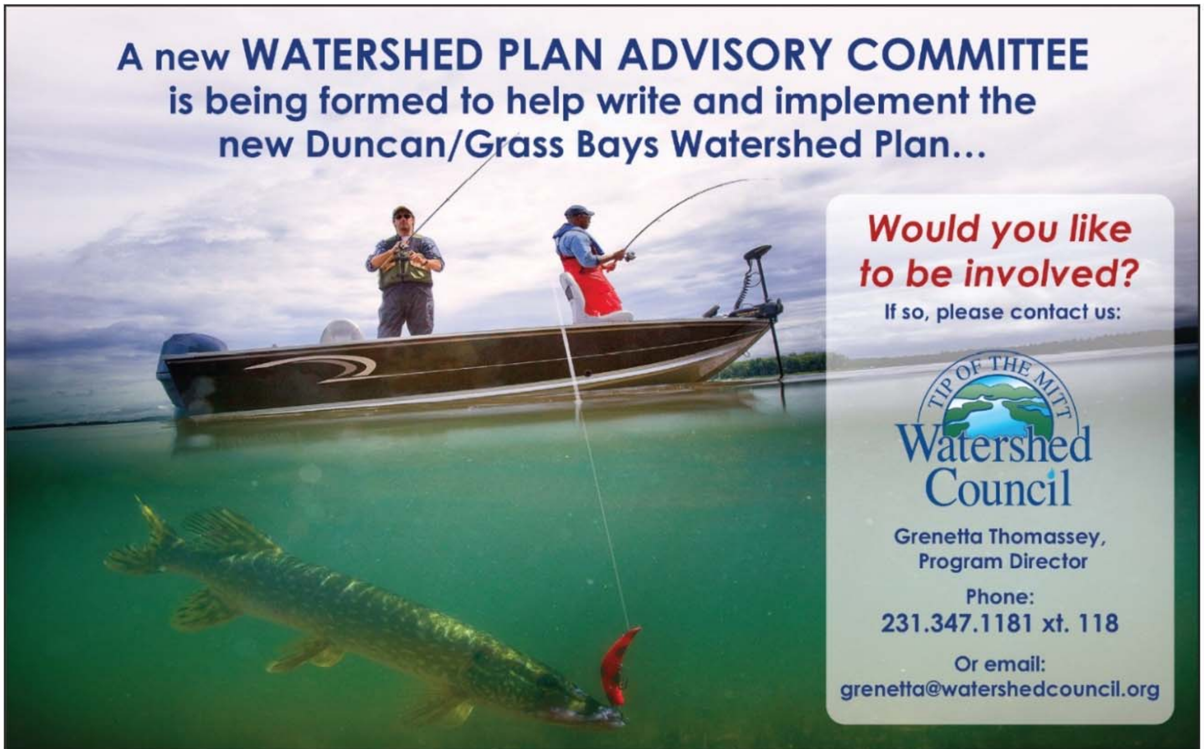
From: Handbook for Developing Watershed Plans to Restore and Protect Our Waters

The Environmental Protection Agency (EPA) recognizes that not all watersheds are threatened or impaired and that in many cases watershed stakeholders want to develop and implement watershed plans to continue protecting high-quality watersheds. The watershed planning and implementation steps are similar for healthy and impaired watersheds, but the overall watershed plan goals and management strategies will vary depending on local and regional priorities, conservation programs, and regulatory requirements or other approaches used to achieve them.

EPA developed the *nine minimum elements* to help watershed managers address some of the most common pitfalls seen in watershed plans, particularly those for impaired waters. Watershed plans often lack quantified estimates of current and projected pollutant loads and the reductions needed to achieve water quality standards and other watershed goals. These loading estimates and estimates of load reductions from proposed pollution control measures provide the analytic link between actions on the ground and attainment of water quality standards. In the absence of such a framework, it is difficult to develop and implement a watershed plan that can be expected to achieve water quality standards or other environmental goals.

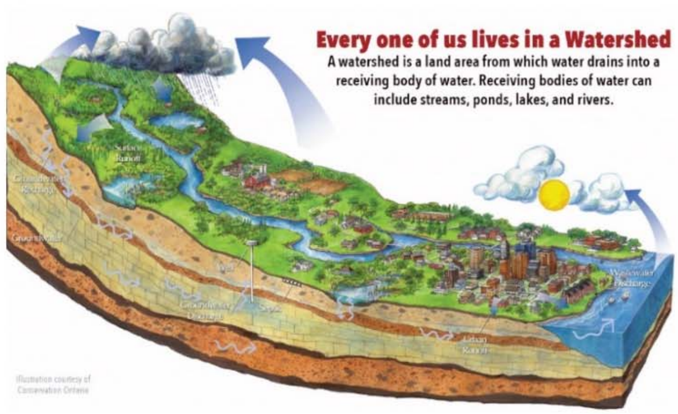
EPA-approved watershed management plans, therefore, must contain the following nine minimum elements:

a. Identify causes and sources of pollution
b. Estimate pollutant loading into the watershed and the expected load reductions
c. Describe management measures that will achieve load reductions and targeted critical areas
d. Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan
e. Develop an information/education component
f. Develop a project schedule
g. Describe the interim, measurable milestones
h. Identify indicators to measure progress
i. Develop a monitoring component



WHAT IS A WATERSHED PLAN?

No matter where you are, you are in a watershed. When rain falls and snow melts, that water goes somewhere. A watershed is defined by where that water goes, and the boundaries of the Duncan and Grass Bays Watershed are defined by the surrounding land areas draining into the Bays. A watershed management plan identifies problems and threats to local water resources, and develops a framework to address those issues. The Duncan-Grass Bays Plan will be the product of a collaborative effort among multiple local organizations, state and local agencies, as well as local neighbors and businesses, coordinated by the Watershed Council.



WHO WILL PARTICIPATE?

Invitations to participate are going to:

- County and City governments
- Benton Township
- DEQ/DNR staff
- Road Commission
- Conservation District
- Drain Commissioner
- Little Traverse Conservancy
- Little Traverse Bay Bands of Odawa Indians
- MSU Extension
- North Central Michigan College
- Northern Lakes Economic Alliance
- Chamber of Commerce
- Health Department
- NEMCOG
- Huron Pines
- USDA
- Trout Unlimited
- Top of Michigan Trails Council
- Straits Area Community Foundation
- Straits Area Concerned Citizens for Peace, Justice, and the Environment
- Straits Area Audubon Society
- Sturgeon for Tomorrow
- Concerned Citizens of Cheboygan & Emmet Counties
- The Nature Conservancy
- Local neighborhood citizens and businesses.

Figure 1: Invitation to Participate on Watershed Plan Advisory Committee

Chapter 1: Duncan and Grass Bays Watershed

Duncan and Grass Bays are located on Lake Huron in Cheboygan County in the northern tip of the Lower Peninsula of Michigan (Figure 2). The shorelines of the Bays fall within Benton Township and the City of Cheboygan. Duncan Bay extends eastward from the Cheboygan River outlet in the City of Cheboygan to the tip of the peninsula jutting forth on the east side of Cheboygan State Park. The straight-line distance from the river to the peninsula tip is approximately two miles, whereas the more pronounced foot of the Bay, near the Duncan Bay Club and the State Park, measures less than a mile across. Grass Bay is broad, stretching five miles from the tip of the Cheboygan State Park Peninsula east to just past Cordwood Road. Based upon digitization of aerial orthophotographs (Cheboygan County 2008), the Duncan Bay shoreline measures approximately 6 miles and Grass Bay just over 5 miles of shoreline. The majority of Duncan and Grass Bays are shallow with depths of less than 20 feet.

The largest inlet stream on Duncan Bay is Elliot Creek, a high quality trout stream that flows approximately 4-5 miles through Cheboygan County and empties directly into Lake Huron in Duncan Bay, near Cheboygan. The creek flows through a significant amount of state land and has multiple road crossings.

Another small tributary enters Duncan Bay near the intersection of Elliot Street and Butler Road. The only sizable tributary of Grass Bay is Grass Bay Creek, which is located at the west end of Cordwood Shores Drive.

Climate

Based on data for Cheboygan County, the general climate of the Watershed is as follows:

- The average warmest month is July.
- The highest recorded temperature was 98°F in 1988.
- The average coolest month is February.
- The lowest recorded temperature was -28°F in 1985.
- The maximum average precipitation occurs in August.
- The average precipitation is 30.42 inches.
- The average snowfall is 88.26 inches.

Table 1: Cheboygan County Climate

Demographics

The following demographic information is for Cheboygan County as detailed information for the Grass and Duncan Bays Watersheds is not available.

As of 2010, the total population of Cheboygan County is 26,152. The Cheboygan population density is 36.5 people per square mile, which is much lower than both the state average density of 102.20 people per square mile and the national average density of 81.32 people per square mile. The most prevalent race in Cheboygan is white, which represents nearly 95% of the total population. The average Cheboygan education level is lower than the state average and is lower than the national average. The median income for a household in the county was $33,417, and the median income for a family was $38,390.

Geology, Soils and Groundwater

The Duncan and Grass Bays Watershed includes sand lake plains and dune sand deposits created by glacial and postglacial activity. As glaciers retreated nearly 12,000 years ago, chunks of ice were broken off, forming lacustrine sand and gravel. Old shorelines, both rocky and sandy can be found in the coastal area. Dune and swale complexes are a series of alternating old beach ridges and linear depressions that parallel the Lake Huron shoreline.

The Watershed's soils are part of the Roscommon-Charity-Au-Gres Association (Figure 3). They are located on lake plains, and are deep, nearly level, very poorly to somewhat poorly drained, mucky, loamy, and sandy soils. These formed in sandy and lacustrine deposits (www.nrcs.usda.gov). Roscommon series are deep and poorly drained. They are rapidly permeable soils on outwash plains, lake plains and in glacial drainage ways. In this county series, there is more organic material than is typical for the series. A variety of types of soils are found here, including Tawas peat, Rubicon sand, East Lake sand, Wallace sand, loamy sand, loam, sand, Roscommon muck, and fine sandy loam.

In the United States, soils are assigned to four hydrologic soil groups: A, B, C, and D. This describes their rate of water infiltration when the soils are not protected from vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The hydrologic soil groups in the Duncan and Grass Bays Watershed include mostly A groups, followed by C and D. Group A consists of soils that have high infiltration rates even when thoroughly wet because of sandy or gravelly, well-draining soils. Groups C and D have respectively slower infiltration rates when thoroughly wet, due to fine texture or clayey soils (Figure 4).

Groundwater is critically important for water quality and ecosystem integrity of lakes, streams, and wetlands. Rain, melting snow, and other forms of precipitation move quickly into and through the ground throughout much of the watershed due to highly permeable (sandy) soils. Gravity causes vertical migration of groundwater through soils until it reaches a depth where the ground is filled, or saturated, with water. This saturated zone in the ground is called the water table and can vary greatly in depth. In watershed areas with steep slopes, hillsides intersect the water table, resulting in groundwater expelling at the land surface. The exposed water table causes horizontal groundwater movement, which releases to create seeps and springs that then form or contribute water to streams and wetlands. The degree of groundwater contributions to surface waters in the watershed is illustrated by the Darcy map developed by the University of Michigan and Michigan Department of Natural Resources (Figure 5).

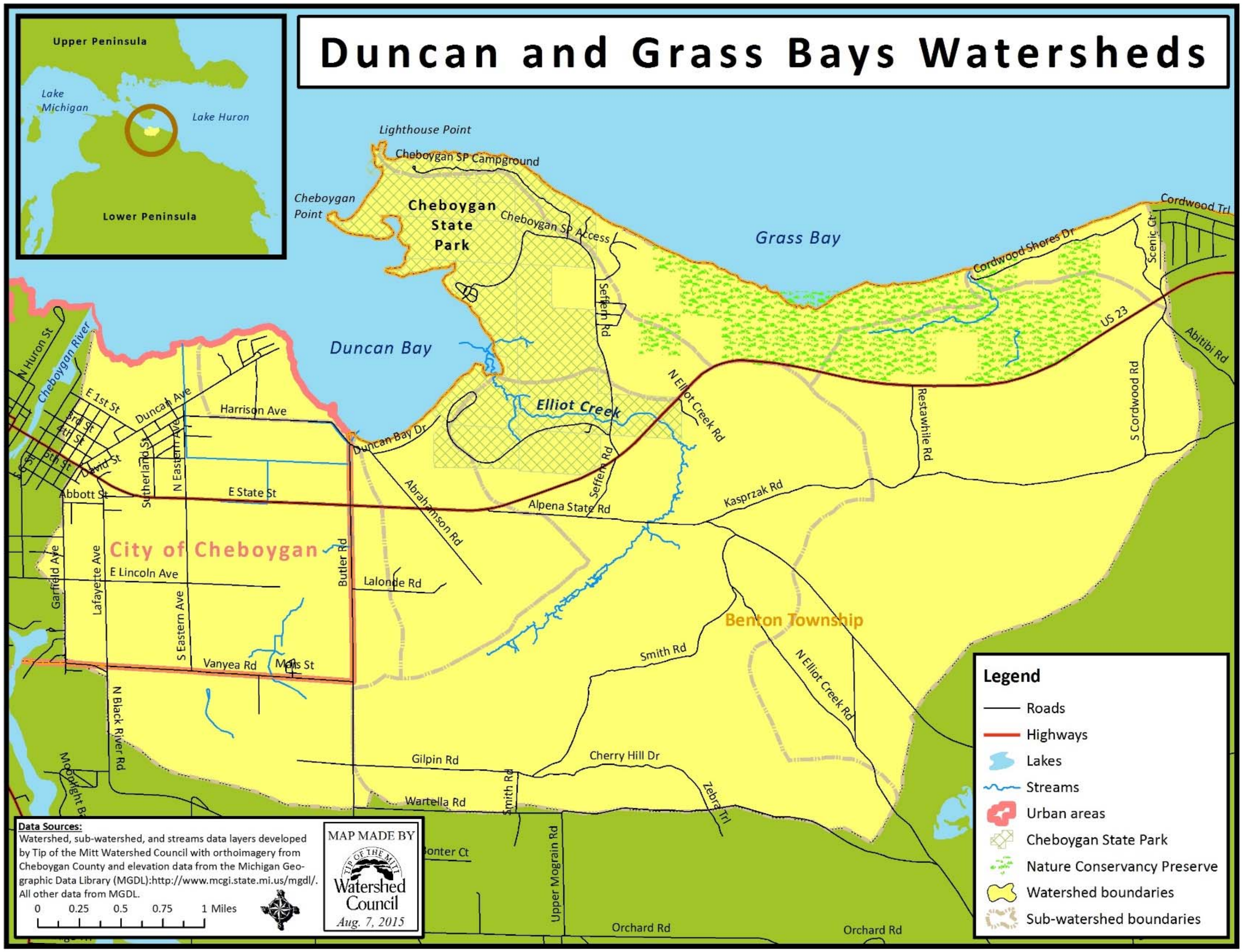


Figure 2: Duncan and Grass Bays Watersheds

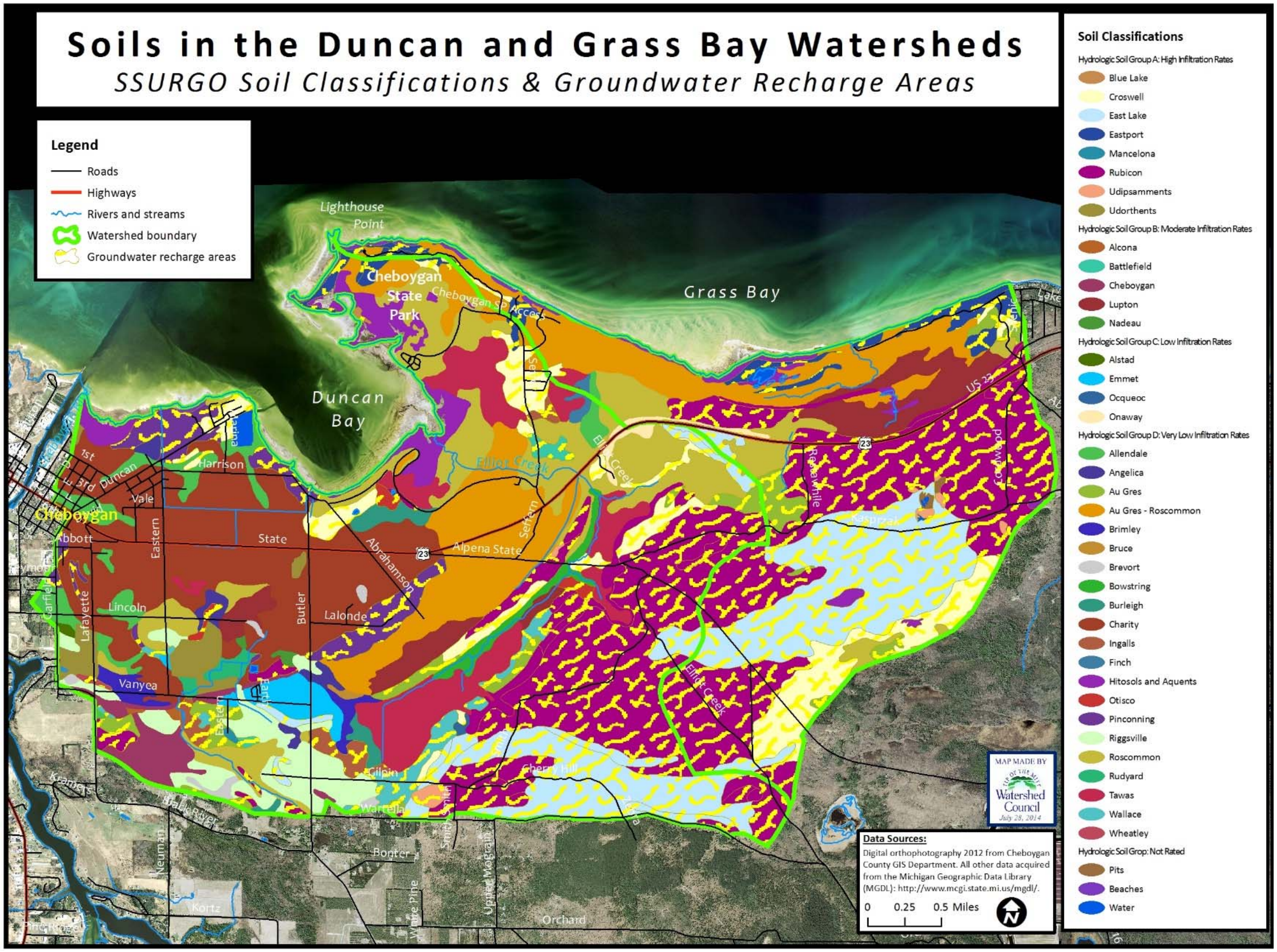


Figure 3: Soils in the Duncan and Grass Bay Watersheds

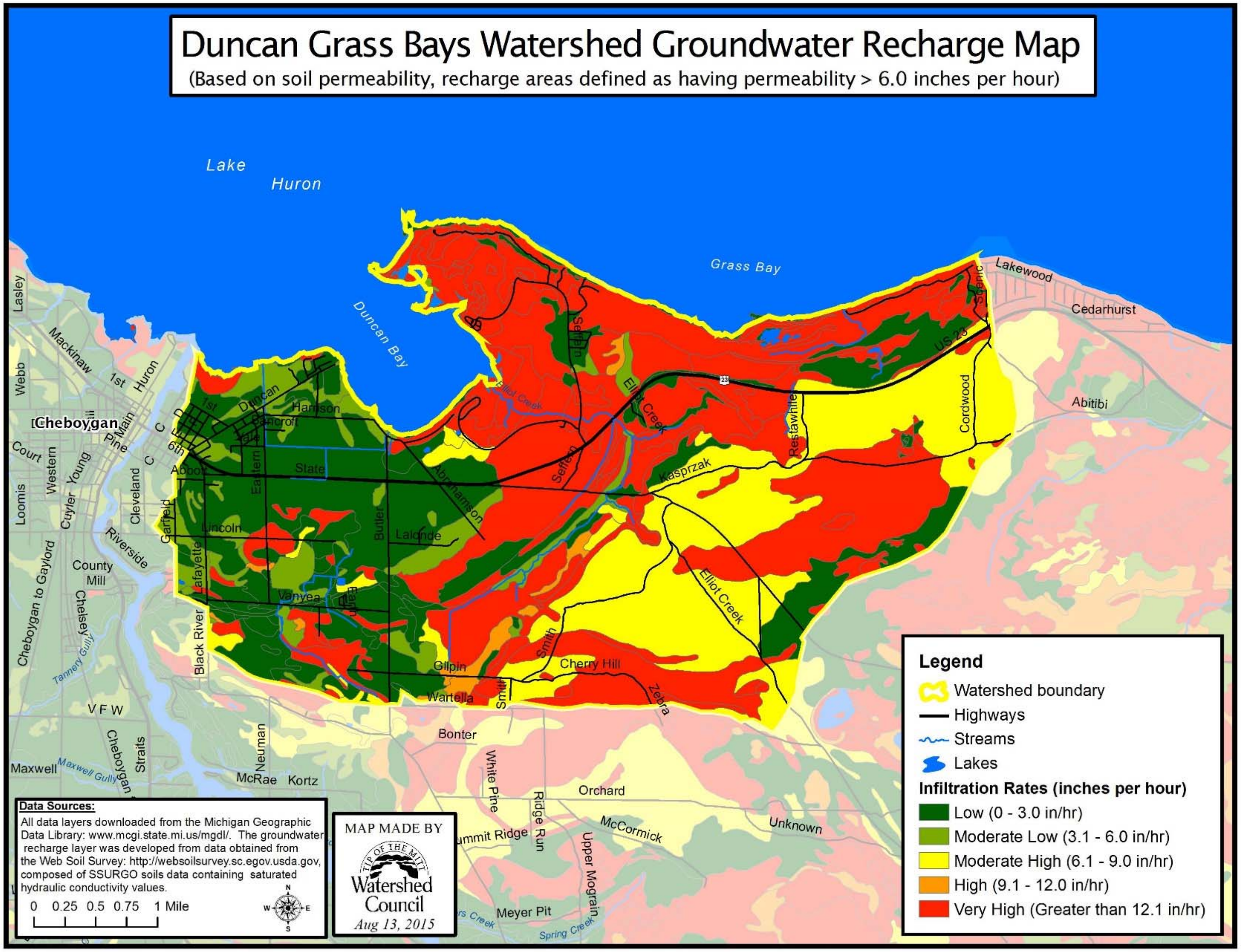


Figure 4: Duncan and Grass Bays Watershed Groundwater Recharge Map

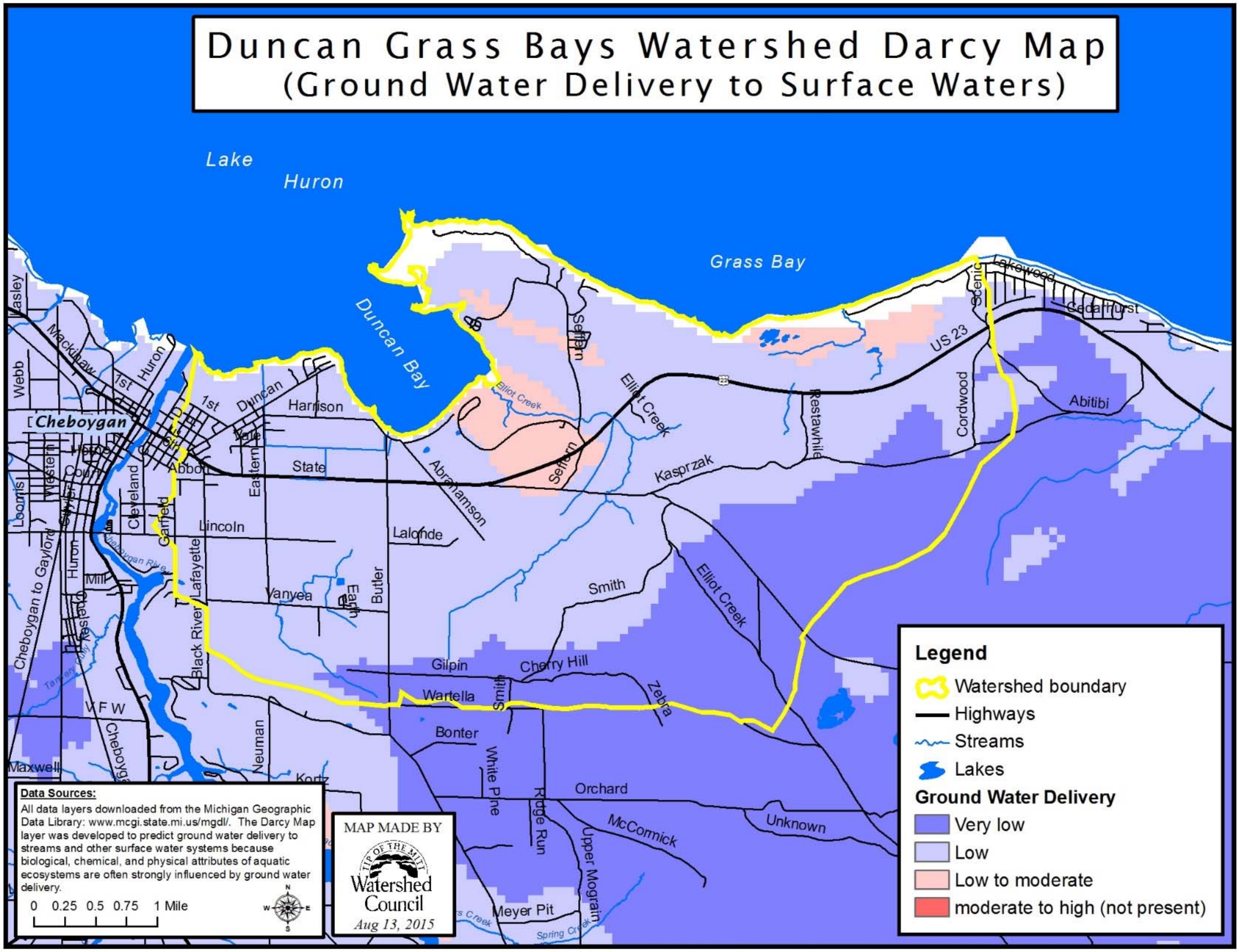


Figure 5: Duncan and Grass Bays Watershed Darcy Map

Natural Communities

One of the most valuable characteristics of Duncan and Grass Bays Watershed is its natural resources.

A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances. Source: MNFI

More specifically, the Watershed includes a variety of natural communities that are considered either imperiled or vulnerable within the State of Michigan. They include:

- Great Lakes Marsh
- Interdunal Wetland
- Intermittent Wetland
- Open Dunes
- Rich Conifer Swamp

It is critical to put into place conservation goals aimed at protecting, monitoring, and managing these natural communities in order to conserve the diversity of native plants and animals that represent Michigan's natural heritage.

The following state ranking system applies, as noted, to the natural communities identified with the Duncan and Grass Bays Watershed.

> S2: Imperiled in the state because of rarity due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state.
>
> S3: Vulnerable in the state due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

The following descriptions are from Michigan Natural Features Inventory. Additional information pertaining to these natural communities can be found at:

http://mnfi.anr.msu.edu/communities/

Great Lakes Marsh

State Rank: S3

Great Lakes marsh is an herbaceous wetland community occurring statewide along the shoreline of the Great Lakes and their major connecting rivers. Vegetational patterns are strongly influenced by water level fluctuations and type of coastal feature, but generally include the following: a deep marsh with submerged plants; an emergent marsh of mostly narrow-leaved species; and a sedge-dominated wet meadow that is inundated by storms. Great Lakes marsh provides important habitat for migrating and breeding waterfowl, shore birds, spawning fish, and medium-sized mammals.

Over 50 species of fish, including several game fish, have been documented to utilize the coastal wetlands of northern Lake Huron. Fish utilize coastal wetlands in all parts of their life cycle, including egg, larval, immature, and adult stages. A broad range of invertebrates occupy this habitat, providing food for fish, birds, herptiles, and small mammals. Coastal wetlands have long been recognized as critical habitat for the migration, feeding, and nesting of waterfowl and shorebirds. The Great Lakes and connecting rivers are parts of several major flyways. During spring migration, when few alternative sources of nutrients are available, terrestrial migratory songbirds feed on midges from the Great Lakes marshes. Mammals utilizing coastal wetlands include beaver, muskrat, river otter, and mink.

Biodiversity Management Considerations

Water-level control has altered natural wetland dynamics. All the connecting channels (river connections between the Great Lakes) have been modified to accommodate shipping, resulting in increased shoreline erosion. Agricultural drainage has eliminated large areas of marshes, and agricultural sedimentation has greatly increased turbidity, eliminating submergent species that require clear water. The resulting deposition of rich organic sediments in the wet meadow zone and along the shoreline favors early-successional species. Nutrient loading has locally reduced oxygen levels, prompted algal blooms, and led to the dominance of high-nutrient tolerant species such as cattails.

Urban development degrades and eliminates coastal marshes through pollution, land management, and ecosystem alteration. Armoring shoreline and dredging of harbors eliminate marshes. Dumping of waste materials such as sawdust, sewage, and chemicals alters shallow-water marsh environments, increasing turbidity, reducing oxygen levels, and altering the pH. Shipping traffic erodes shoreline vegetation through excessive wave action. Introductions of invasive plants and animals have altered community structure and species composition. Many invasive species arrive in shipping ballast, while others are purposefully introduced. Some of the invasive plants that threaten the diversity and community structure of Great Lakes marshes include reed (*Phragmites australis subsp. australis*), narrow-leaved cat-tail (*Typha angustifolia*), hybrid cat-tail (*Typha xglauca*), reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*), frogbit (*Hydrocharis morsus-ranae*), hydrilla (*Hydrilla verticillata*),

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Maintaining hydrologic regimes, in addition to eliminating off-road vehicle (ORV) traffic, nutrient and sediment inputs, and invasive species populations, is integral to protecting the ecological integrity of high quality Great Lakes marshes.

Interdunal Wetland

State Rank: S2

Interdunal wetland is a rush-, sedge-, and shrub-dominated wetland situated in depressions within open dunes or between beach ridges along the Great Lakes, experiencing a fluctuating water table seasonally and yearly in synchrony with lake level changes.

This natural community is typically found in long troughs or swales between dune ridges, in wind-formed depressions at the base of blowouts, in hollows of dune fields, and in abandoned river channels that once flowed parallel to the lakeshore behind a foredune. Interdunal wetlands occur on all of the Laurentian Great Lakes.

These quickly warming wetlands provide important feeding areas for migrating shorebirds, waterfowl, and songbirds in the spring. They are also important foraging areas for waterfowl in the fall. Spotted sandpipers (*Actitis macularia*) breed along the margins of interdunal wetlands, and piping plovers (*Charadrius melodus*) forage at the edges of these wetlands. Great blue herons (*Ardea herodias*) regularly feed on invertebrates in the swales. Among the invertebrates occupying interdunal wetlands are dragonflies (Suborder *Anisoptera*), damselflies (Suborder *Zygoptera*), midges (Family *Chionomidae*), and probably many others. Leeches (Family *Hirundinae*) are commonly observed invertebrates in the warm, shallow waters of interdunal swales along Lakes Michigan and Huron.

Off-road vehicles can damage or destroy the vegetation and habitat of interdunal wetlands, as documented at several sites along the northern Lake Michigan and Lake Huron shorelines. Heavy human usage of the adjacent beach can also threaten associated fauna, such as piping plover and other shorebirds.

Monitoring and control efforts to detect and remove invasive species are critical to the long-term viability of interdunal wetland. Invasive species that may threaten diversity and community structure include reed (*Phragmites australis subsp*. *australis*), reed canary grass (*Phalaris arundinacea*), narrow-leaved cat-tail (*Typha angustifolia*), hybrid cat-tail (*Typha xglauca*), purple loosestrife (*Lythrum salicaria*), spotted knapweed (*Centaurea stoebe*), baby's breath (*Gypsophila paniculata*), common St. John's-wort (*Hypericum perforatum*), ox-eye daisy (*Leucanthemum vulgare*), bull thistle (*Cirsium vulgare*), white sweet clover (*Melilotus alba*), Japanese knotweed (*Fallopia japonica*), hoary alyssum (*Berteroa incana*), Kentucky bluegrass (*Poa pratensis*), Canada bluegrass (P. *compressa*), quack grass (*Elymus repens*), hawkweeds (*Hieracium spp*.), sheep sorrel (*Rumex acetosella*), black locust (*Robinia pseudoacacia*), white poplar (*Populus alba*), Lombardy poplar (*P*. *nigra var*. *italica*), common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), autumn olive (*Elaeagnus umbellata*), Eurasian honeysuckles (especially *Lonicera morrowii*, *L. tatarica*, and *L. xbella*), and multiflora rose (*Rosa multiflora*).

Intermittent Wetland

State Rank: S3

Intermittent wetland is a sedge- and herb-dominated wetland found along lakeshores or in depressions and characterized by fluctuating water levels, both seasonally and interannually. Intermittent wetlands exhibit traits of both peatlands and marshes, with characteristic vegetation including sedges (*Carex spp*.), rushes (*Juncus spp*.), sphagnum mosses, and ericaceous shrubs. The community occurs statewide.

Intermittent wetlands occur throughout Michigan on poorly drained flat areas or mild depressions of sandy glacial outwash and sandy glacial lakeplain and in kettle depressions on pitted outwash. The community is found in isolated depressions and along the shores of softwater, seepage lakes, and ponds where water levels fluctuate both seasonally and yearly. Intermittent wetlands may be bordered by several other wetland communities and may encircle floating bog mats. The sandy, well-drained uplands surrounding intermittent wetlands typically support fire-dependent pine and oak communities.

Protection of the regional and local hydrologic regime is critical to the preservation of intermittent wetlands.

Stabilization of water levels can allow for the establishment of perennials and woody species, which can displace less competitive annuals. Increased surface flow and alteration of groundwater recharge can be prevented by avoiding road construction and complete canopy removal in adjacent stands. A serious threat to intermittent wetland hydrology and species diversity is posed by ORV traffic, which can significantly alter the hydrology through rutting and erosion. Soil erosion resulting from ORV use within the wetland or surrounding uplands may greatly disturb the seed bank, reducing plant density and diversity. Reduction of access to wetland systems will help decrease detrimental impacts from ORVs.

Where shrub and tree encroachment threatens to convert open wetlands to shrub-dominated systems or forested swamps, prescribed fire can be employed to maintain open conditions. Prescribed fires are best employed in intermittent wetlands during droughts or in the late summer and fall when water levels are lowest. In addition to controlling woody invasion, fire promotes seed bank expression and rejuvenation and thus helps maintain species diversity. Intermittent wetlands are common natural features within a variety of droughty, fire-dependent, upland pine and oak matrix communities, and would likely have experienced surface fires along with the surrounding uplands when conditions were favorable. When feasible, prescribed fires conducted in the adjacent uplands should be allowed to carry into intermittent wetlands.

Monitoring and control efforts to detect and remove invasive species are critical to the long-term viability of intermittent wetlands. Invasive species that threaten the diversity and community structure of intermittent wetlands include reed (*Phragmites australis subsp*. *australis*), reed canary grass (*Phalaris arundinacea*), narrow-leaved cat-tail (*Typha angustifolia*), hybrid cat-tail (*Typha xglauca*), purple loosestrife (*Lythrum salicaria*), glossy buckthorn (*Frangula alnus*), and multiflora rose (*Rosa multiflora*).

Open Dunes

State Rank: S3

Open dunes is a grass- and shrub-dominated multi-seral community located on wind-deposited sand formations near the shorelines of the Great Lakes. Dune formation and the patterning of vegetation are strongly affected by lake-driven winds.

Dune vegetation is adapted to constant sand burial and abrasion. As plants are buried by sand, they continue to form new growth above the sand while their roots and rhizomes continue to grow and stabilize the sand. As vegetation of the dunes is stabilized, herb and shrub diversity increases, and there is a gradual accumulation of organic soils and eventual transition to forest. At the forest edge, colonizers include oak in the southern part of the state and pine in both the north and south. When lake levels recede, beach and dune areas increase, permitting lakeward expansion of savanna and forest, but when lake levels rise, blowouts expand into the forest. The open, dry conditions of the sand dunes provided ideal conditions for the establishment of fire-dependent oaks and pines. Lightning fires ignited patches of dune grasses and leaf litter, allowing these fire-dependent savanna and forest communities to persist at the borders of the open dune.

Major threats to open dunes include off-road vehicles, recreational overuse, residential development, sand mining, and invasive plants and animals.

While blowouts are a natural occurrence, their frequency is greatly exacerbated by human activities that erode vegetation cover. Off-road vehicles and recreational overuse can destroy plants that stabilize dunes, leading to large blowouts during heavy storms and significantly reducing vegetation cover from both massive wind erosion and burial of existing flora and fauna. Eliminating illegal off-road vehicle activity is a primary means of protecting the ecological integrity of open dunes and associated shoreline communities. Residential development destroys dune habitat, results in introductions of invasive plants, and prevents natural dune movement, which many dune plants require. In addition, roaming pets disrupt ground-nesting birds, some of which are globally rare. Sand mining directly destroys dunes. Invasive plants can eliminate native dune plants through competition for resources and by stabilizing dunes, which results in the loss of plants that rely on shifting sand and facilitates conversion to closed-canopy forest. Invasive plants that threaten the diversity and community structure in open dunes include spotted knapweed (*Centaurea stoebe*), baby's breath (*Gypsophila paniculata*), common St. John's-wort (*Hypericum perforatum*), ox-eye daisy (*Leucanthemum vulgare*), bull thistle (*Cirsium vulgare*), white sweet clover (*Melilotus alba*), common mullein (*Verbascum thapsus*), black swallow-wort (*Vincetoxicum nigrum*), white swallow-wort (*Vincetoxicum rossicum*), hoary alyssum (*Berteroa incana*), Kentucky bluegrass (*Poa pratensis*), Canada bluegrass (*P. compressa*), quack grass (*Elymus repens*), timothy (*Phleum pratense*), hawkweeds (*Hieracium spp*.), sheep sorrel (*Rumex acetosella*), black locust (*Robinia pseudoacacia*), white poplar (*Populus alba*), Lombardy poplar (*P. nigra var. italica*), common buckthorn (*Rhamnus cathartica*), autumn olive (*Elaeagnus umbellata*), Eurasian honeysuckles (especially *Lonicera morrowii, L. tatarica,* and *L. xbella*), and multiflora rose (*Rosa multiflora*). Monitoring and control efforts to detect and remove invasive species are critical to the long-term viability of open dunes.

Rich Conifer Swamp

State Rank: S3

Rich conifer swamp is a groundwater-influenced, minerotrophic, forested wetland dominated by northern white-cedar (*Thuja occidentalis*) that occurs on organic soils (i.e., peat) primarily north of the climatic tension zone in the northern Lower and Upper Peninsulas. The community is also referred to as a cedar swamp.

Rich conifer swamp occurs in outwash channels, outwash plains, glacial lakeplains, and in depressions on coarse- to medium-textured ground moraines. It is common in outwash channels of drumlin fields and where groundwater seeps occur at the bases of moraines. Rich conifer swamps typically occur in association with lakes and cold, groundwater-fed streams. They also occur along the Great Lakes shoreline in old abandoned embayments and in swales between former beach ridges where it may be part of a wooded dune and swale complex.

Biodiversity Management Considerations

Rich conifer swamp is a self-maintaining, stable community that relies on gap-phase dynamics to regenerate long-lived, shade-tolerant, northern white-cedar. A major threat to natural regeneration of cedar in northern rich conifer swamps is high density of deer, which rely on cedar as a main winter-staple. Logging rich conifer swamps can facilitate its conversion to hardwood-conifer swamps, hardwood swamps, aspen, and alder thickets. Long-term conservation of rich conifer swamps will require reducing deer densities across the landscape and allowing natural disturbances such as wind throw to create the complex structure that creates habitat for late-successional species.

Invasive species that threaten the diversity and community structure of rich conifer swamp include glossy buckthorn (*Frangula alnus*), purple loosestrife (*Lythrum salicaria*), narrow-leaved cat-tail (*Typha angustifolia*), hybrid cat-tail (*Typha xglauca*), reed (*Phragmites australis subsp*. *australis*), reed canary grass (*Phalaris arundinacea*), and European marsh thistle (*Cirsium palustre*). Regular monitoring for these and other invasive species followed by prompt and sustained control efforts will help protect the ecological integrity of rich conifer swamp and adjacent natural communities.

Wetlands

Wetlands are the link between land and water. They are transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils, and vegetation, making these areas very important features of a watershed (USEPA 2004).

It is important to include wetlands in watershed plans because of the important role they play in ecosystem function and watershed dynamics. Wetlands are a product of and have an influence on watershed hydrology and water quality. Wetlands contribute to healthy watersheds by influencing important ecological processes.

The Duncan and Grass Bays Watershed includes a variety of wetland types (refer to Natural Communities discussion). These wetlands are, perhaps, the ecological highlight of the Watershed. In general, wetlands provide many ecological, economic, and social values. Without intact, healthy wetlands, the following services are compromised:

Ecological Values:

- Source of biodiversity
- Recycle nutrients
- Filter pollutants
- Provide food, water, and shelter for migrating and breeding species
- Provide habitat for endangered or threatened species
- Play a role in climatic processes by absorbing and storing elements such as carbon and Sulphur
- Recharge groundwater

Economic Values:

- Commercial fishing and shellfishing
- Commercial timber
- Habitat for animals used in fur and pelt production
- Reduce peak flows and flood damage
- Commercial production of cranberries, wild rice, and mint
- Medicines produced from wetland plants
- Removal of pollutants and water quality maintenance
- Water storage
- Protect erodible shorelines
- Water filtration and particulate removal
- Recreational opportunities

Social Values:

- Scenic beauty
- Recreational opportunities
- Nature-based tourism
- Historical and heritage value
- Educational opportunities

Sources: Novitzki et al. 1997; Kusler 2004; and USEPA 2008b. and Schuyet and Brander 2004; USEPA 2005; Cappiella et al. 2006

In a 1990 report to Congress, the Michigan Department of Natural Resources (MDNR) and the U.S. Department of the Interior estimated that Michigan had lost approximately 50% of its original wetland resource base. In the Duncan and Grass Bays Watershed, pre-settlement conditions included an estimated 5,039 acres of wetlands, as compared to 3,924 acres remaining as of 2005 (a loss of 1,115 acres of wetlands).

Duncan and Grass Bays Watershed:
77% of Original Wetland Acreage Remains
23% Loss of Total Wetland Resource

Given the extensive functions and values associated with wetlands, it is no longer adequate to simply quantify wetland loss in terms of acreage. As a result, there have been recent, statewide efforts to interpret loss of wetland function on a landscape level and incorporate that information into watershed management plans.

In a non-regulatory sense, this landscape level analysis can help to pinpoint potential restoration, enhancement, and protection activities to appropriate areas of the watershed that are most in need of a particular wetland function. From a regulatory perspective, wetlands should be inventoried, assessed, monitored, and managed in the context of the entire watershed to supplement the site-by-site regulatory-based assessments, which are often necessary for addressing direct impacts such as dredging, filling, and draining. A watershed approach can also integrate indirect wetland impacts that are caused by land use practices that require a broader understanding of how wetlands function on the landscape and the benefits that they provide. For this reason, watershed planning allows communities to make better choices on preserving the highest quality wetlands by protecting the most vulnerable wetlands and for prioritizing sites for restoration (Cappiella et al. 2006). Given the recent push to incorporate and understand the ‘watershed context’ of a wetland resource in Clean Water Act guidance involving mitigation efforts, landscape level assessment of this type will continue to play an increasingly large role in wetland regulatory actions. *From: LANDSCAPE LEVEL WETLAND FUNCTIONAL ASSESSEMENT (LLWFA), Version 1.0, Methodology Report, Updated October 1, 2013, Michigan Department of Environmental Quality.*

In Michigan, wetlands are just beginning to be considered in the context of watershed management planning and the creation of municipal master plans. Wetland restoration and enhancement are increasingly becoming popular tools, in lieu of traditional best management practices, to enhance the overall ecological health and surface water quality of a watershed. Understanding the overall historic impact of wetland loss and degradation can assist local planners and resource managers in sighting future development as it lends new importance to the wetlands that remain.

> Watershed groups and local governments should consider using landscape assessments to identify priority areas, probable stressors, and wetland restoration and conservation opportunities (Apfelbeck, 2006).

Landscape Level Wetlands Functional Analysis

The landscape level wetland functional assessment (LLWFA) tool was developed by staff of the Michigan Department of Environmental Quality (MDEQ) in conjunction with cooperating state and local agencies, universities, and nongovernmental organizations. It enables users to identify existing wetlands and the functions those wetlands currently perform. The LLWFA tool also enables the user to identify historical or former wetlands (i.e., areas of hydric soils that are not currently wetlands) and the functions they would likely perform if restored.

The LLWFA is, in essence, a screening tool for identifying wetland types and their functions.

- Flood Water Storage
- Streamflow Maintenance
- Nutrient Transformation
- Sediment and Other Particulate Retention
- Shoreline Stabilization
- Stream Shading
- Conservation of Rare and Imperiled Wetlands
- Ground Water Influence
- Fish Habitat
- Waterfowl/Water bird Habitat
- Shorebird Habitat
- Interior Forest Bird Habitat
- Amphibian Habitat
- Carbon Sequestration
- Pathogen Retention

Flood Water Storage:
This function is important for reducing the downstream flooding and lowering flood heights, both of which aid in minimizing property damage and personal injury from such events.

Streamflow Maintenance:

Wetlands that are sources of groundwater discharge that sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. All wetlands classified as headwater wetlands are important for streamflow

Nutrient Transformation:
Wetlands that have a fluctuating water table are best able to recycle nutrients. Natural wetlands performing this function help improve local water quality of streams and other watercourses.
Sediment and Other Particulate Retention:
This function supports water quality maintenance by capturing sediments with bonded nutrients or heavy metals. Vegetated wetlands will perform this function at higher levels than those of non-vegetated wetlands.

Shoreline Stabilization:
Vegetated wetland along all waterbodies (e.g. estuaries, lakes, rivers, and streams) provide this function. Vegetation stabilizes the soil or substrate and diminished wave action, thereby reducing shoreline erosion potential.

Stream Shading:
Wetlands that perform water temperature control due to the proximity to streams and waterways. These wetlands generally are Palustrine Forested or Scrub-Shrub.

Conservation of Rare and Imperiled Wetlands:
Wetlands that are considered rare either globally or at the state level. They are likely to contain a wide variety of flora and fauna, or contain threatened or endangered species.

Groundwater Influence:
Wetlands categorized as High or Moderate for groundwater influence are areas that receive some or all of their hydrologic input from groundwater reflected at the surface. The Darcy model was the data source utilized to determine this wetland/groundwater connection, which is based upon soil transmissivity and topography. Wetlands rated for this function are important for maintaining streamflows and temperature control in waterbodies.

Fish Habitat:
Wetlands that are considered essential to one or more parts of fish life cycles. Wetlands designated as important for fish are generally those used for reproduction, or feeding.

Waterfowl/Waterbird Habitat:
Wetlands designated as important for waterfowl and waterbirds are generally those used for nesting, reproduction, or feeding. The emphasis is on the wetter wetlands and ones that are frequently flooded for long periods.

Shorebird Habitat:
Shorebirds generally inhabit open areas of beaches, grasslands, wetlands, and tundra and undertake some of the longest migrations known. Along their migration pathway, many shorebirds feed in coastal and inland wetlands where they accumulate fat reserves needed to continue their flight. Common species include plovers, oystercatchers, avocets, stilts, and sandpipers. This function attempts to capture wetland types most likely to provide habitat for these species.

Interior Forest Bird Habitat:
Interior Forest Birds require large forested areas to breed successfully and maintain viable populations. This diverse group includes colorful songbirds such as; tanagers, warblers, and vireos that breed in North America and winter in the Caribbean, Central and South America, as well as residents and short-distance migrants such as; woodpeckers, hawks, and owls. They depend on large forested tracts, including streamside and floodplain forests. It is important to note that adjacent upland forest to these riparian areas are critical habitat for these species as well. This function attempts to capture wetland types most likely to provide habitat for these species.

Amphibian Habitat:
Amphibians share several characteristics in common including wet skin that functions in respiration and gelatinous eggs that require water or moist soil for development. Most amphibians have an aquatic stage and a terrestrial stage and thus live in both aquatic and terrestrial habitats. Aquatic stages of these organisms are often eaten by fish and so for certain species, successful reproduction may occur only in fish-free ponds. Common sub-groups of amphibians are salamanders, frogs, and toads. This function attempts to capture wetland types most likely to provide habitat for these species.

Carbon Sequestration:
Wetlands are different from other biomes in their ability to sequester large amounts of carbon, as a consequence of high primary production and then deposition of decaying matter in the anaerobic areas of their inundated soils.

Pathogen Retention:
Wetlands can improve water quality through natural processes of filtration for sedimentation, nutrients and Escherichia coli (E. coli). E. coli is a sub-set of fecal coli forms whose presence in water indicates fecal contamination from warm-blooded animals. The presence of E. coli indicates that contamination has occurred, and other harmful pathogens may also be present.

Application of the LLWFA indicates that this study found that wetland resources in the Duncan and Grass Bays Watershed have changed drastically since pre-settlement, with both wetland acreage and function decreasing significantly.

Table 2: Wetland Functional Acres Comparison (Source: LLWFA/DEQ)

Function	Pre-European Settlement Functional Acres	2005 Functional Acres	Predicted % of Original Capacity Left	Predicted % Change in Functional Capacity
Flood Water Storage	6,015.93	4,391.78	73	-27
Streamflow Maintenance	8,256.26	6,217.45	75	-25
Nutrient Transformation	7,206.98	7,471.84	104	4*
Sediment and Other Particulate Retention	3,987.65	4,800.73	120	20*
Shoreline Stabilization	4,846.37	4,081.54	84	-16
Fish Habitat	8,671.33	6,015.53	69	-31
Stream Shading	1,833.08	1,320.33	72	-28
Waterfowl and Waterbird Habitat	1,545.48	1,747.33	113	13*
Shorebird Habitat	5,038.93	3,883.01	77	-23
Interior Forest Bird Habitat	5,124.01	3,874.79	76	-24
Amphibian Habitat	5,054.79	3,825.66	76	-24
Carbon Sequestration	2,035.69	3,393.45	167	67*
Ground Water Influence	4,051.87	2,638.72	65	-35
Conservation of Rare & Imperiled Wetlands & Species	0	5,832.31	100	100

*Increases in the predicted percent change functional capacity in the functions above can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.

Wetland restoration activities could possibly lead to water quality improvements in the watershed (Figure 6). It is important to remember that the LLWFA is intended as a first-level or coarse-scale assessment of wetland location, condition, and function. A subsequent step in the watershed planning process is to ground-truth the data from the LLWFA through other level 1 or 2 analyses. The LLWFA provides a general picture of wetland extent and function within a watershed that can be used to identify trends in wetland condition and function, identify initial restoration locations, and form the basis of a wetland inventory.

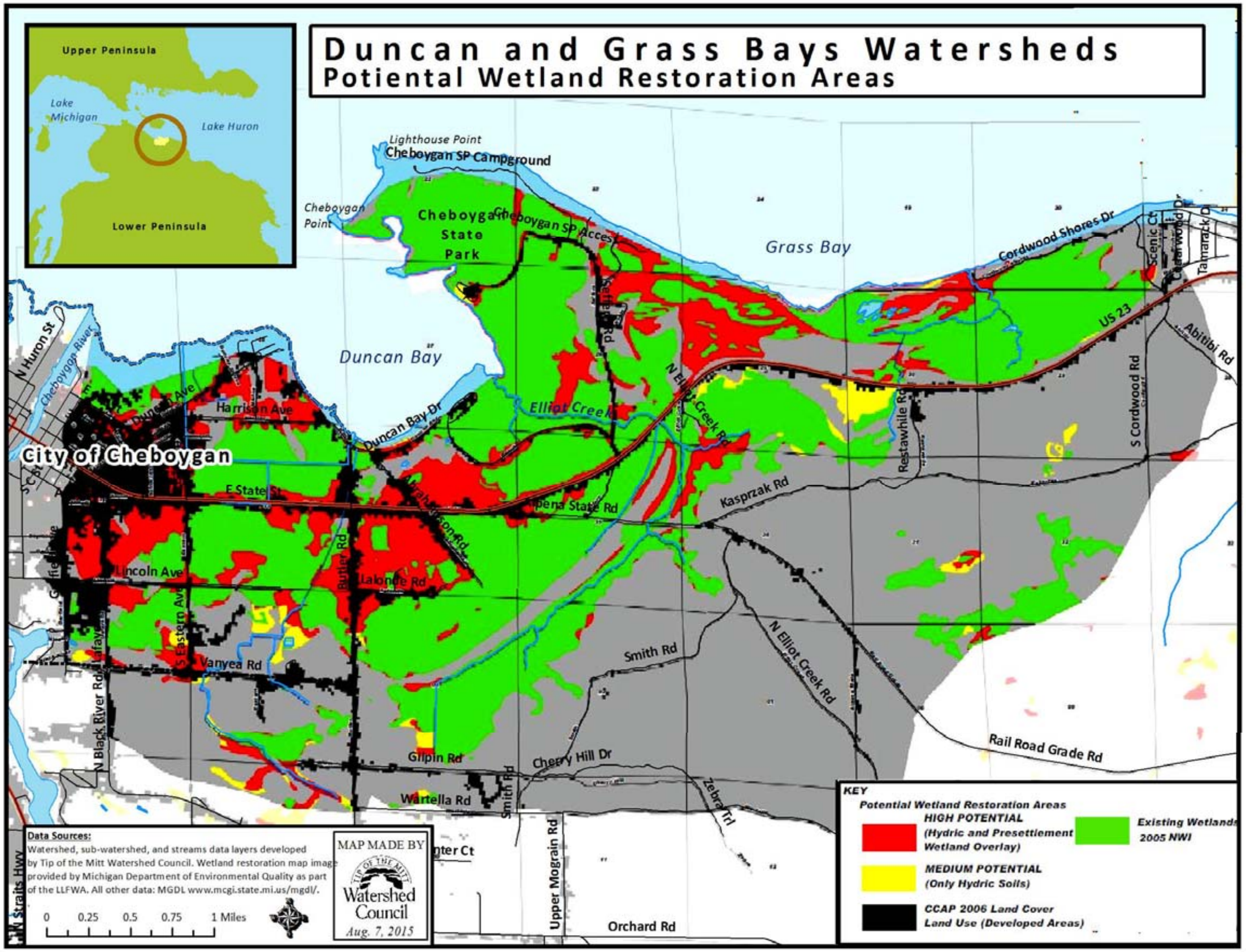


Figure 6: Potential Wetland Restoration Areas in the Duncan and Grass Bays Watershed (Michigan Department of Environmental Quality)

Threatened, Endangered, and Species of Special Concern

Endangered species *are any species of fish, plant life, or wildlife that is in danger of extinction throughout all or a significant part of its range, other than a species of insecta determined by the Department, or the Secretary, of the United States Department of the Interior to constitute a pest whose protection under this part would present an overwhelming and overriding risk to humans.*

Threatened species *are any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.*

Species of Special Concern*, while not afforded legal protection under the Act, are of concern because of declining or relict populations in the state. Should these species continue to decline, they would be recommended for Threatened or Endangered status. Protection of Special Concern species now, before they reach dangerously low population levels, would prevent the need to list them in the future by maintaining adequate numbers of self-sustaining populations within Michigan. Some other potentially rare species are listed as Special Concern pending more precise information on their status in the state; when such information becomes available; they could be moved to Threatened or Endangered status or deleted from the list.*

Many threatened, endangered, and species of special concern within the Duncan and Grass Bays Watershed are associated with the Watershed's wetland complexes. Preservation and restoration of wetlands will invariably provide greater protection of these species.

All known occurrences of threatened (T), endangered (E), and special concern (SC) species within the greater Lone Lake-Ocqueoc Watershed, of which the Duncan and Grass Bays Watershed is included, are listed in Table 3. The species and community information is derived from the Michigan Natural Features Inventory database. T and E species are protected under the Endangered Species Act of the State of Michigan (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act). The current list became effective on April 9, 2009, after extensive review by technical advisors to the Michigan Department of Natural Resources and the citizenry of the state.

Figure 7: Dwarf Lake Iris (Photo by Susan R. Crispin)

Figure 8: Pitcher's Thistle (Photo by Susan R. Crispin)

Table 3: Known Occurrences of Threated, Endangered, and Special Concern Species within Lone Lake-Ocqueoc Watershed (MNFI).

Watershed Name: Lone Lake-Ocqueoc		
HUC ID: 4070003020030, 4070003020020, 4070003020010		
Scientific Name	**Common Name**	**State Status**
Botaurus lentiginosus	American bittern	SC
Calypso bulbosa	Calypso or fairy-slipper	T
Charadrius melodus	Piping plover	E
Cirsium pitcheri	Pitcher's thistle	T
Cypripedium arietinum	Ram's head lady's-slipper	SC
Dendroica discolor	Prairie warbler	E
Drosera anglica	English sundew	SC
Haliaeetus leucocephalus	Bald eagle	SC
Helianthus hirsutus	Whiskered sunflower	SC
Huperzia selago	Fir clubmoss	SC
Iris lacustris	Dwarf lake iris	T
Juncus militaris	Bayonet rush	T
Oncocnemis piffardi	3-striped oncocnemis	SC
Potamogeton hillii	Hill's pondweed	T
Pterospora andromedea	Pine-drops	T
Sistrurus catenatus catenatus	Eastern massasauga	SC
Solidago houghtonii	Houghton's goldenrod	T
Sterna caspia	Caspian tern	T
Tanacetum huronense	Lake Huron tansy	T
Trimerotropis huroniana	Lake Huron locust	T

The listing is based on the polygon representation of the occurrences. Consequently, any single occurrence may span watershed boundaries and be listed in more than one watershed. This list is based on known and verified sightings of threatened, endangered, and special concern species and represents the most complete data set available. It should not be considered a comprehensive listing of every potential species found within a watershed. Because of the inherent difficulties in surveying for threatened, endangered, and special concern species and inconsistencies of inventory effort across the State, species may be present in a watershed and not appear on this list.

Fisheries

Surveys by Michigan Department of Natural Resources show that Duncan and Grass Bays support a mix of fish species typical for lakes of Northern Michigan. Fish species collected during a 2001 survey include alewife, black bullhead, black crappie, bluegill, bowfin, brown bullhead, brown trout, burbot, common carp, largemouth bass, longnose gar, northern pike, pumpkinseed, rainbow trout, rock bass, smallmouth bass, walleyes, white sucker, yellow bullhead, and yellow perch (Hanchin et. al., 2005). Additional forage fish collected with seine nets in a 1954 survey include a number of shiners, darters, and other species. Walleye and pike populations are generally characterized as having slow growth rates, which may be the result of inadequate forage.

Elliot Creek

Elliot Creek is a high quality Type 1 designated trout stream managed by MDNR. It was classified as a trout stream by MDNR in 1967. The following stock and survey history information was provided by Tim Cwalinski, DNR Fisheries.

Stocking History

Brook trout fall fingerlings or adults: 1937-38, 1940-42, 1947-65

Survey History

1957 – inspected by MDNR, thought to hold brook trout, low amount of angling pressure, stable flow

1967 – eletrofishing by MDNR in April at two stations, in sections 35 and 26 (near highway); 50 brook trout collected ranging from 2-9 inches in size; reclassified as a designated trout stream

1977 – MDNR surveys of stream to check for coho salmon reproduction; stations included Alpena State Road and both upstream and downstream of Seffern Road; sea lamprey observed in creek; brook trout were abundant at all three stations; juvenile coho salmon were also collected at all three stations

1978 – MDNR survey at two stations sampled in 1977; both brook trout and coho salmon common

1979 – MDNR survey at Alpena State Road, station length 600 feet; 295 brook trout collected ranging in length from 2-18 inches; only 5 coho salmon collected

1998 – electrofished by U.S. Fish and Wildlife Service (USFWS) in August and November while attempting to identify streams along Lake Huron appropriate for "coaster" brook trout management; considered an ideal stream for coaster brook trout management following shocking; contained a healthy brook trout population with some juvenile rainbow trout present

The following information details the most recent survey data from July 22, 2014 (MDNR Fisheries):

Survey location: Downstream of Seffern Road but not starting at the culvert, total of 239 feet
Sampling efficiency: fair
Gear: 1 Backpack shocking unit, 1 probe
Bottom substrate: sand and gravel, swift current, ample large woody debris
Riparian: Cedar and spruce, some pine
Water Temperature: 60F
Average width: 10 feet
Note: Likely more age-0 trout missed

Note: some larger brook trout (less than 10 in) and one decent sized brown trout also collected in the culvert hole outside the station
Note: an electrofishing station was attempted at Alpena State Road, but creek was very high and nearly flowing over the road, a likely product of downstream beaver dams

Brook trout collected in the 239 foot station.

Length Group (in)	Number Collected	Ages
3-3.9	1	1
4-4.9	3	1
5-5.9	5	1
6-6.9	1	1
7-7.9	0	1
8-8.9	0	1
9-9.9	1	1

Rainbow trout collected in the 239 foot station.

Length Group (in)	Number Collected	Ages
1-1.9	1	0
2-2.9		
3-3.9		
4-4.9	3	1
5-5.9	6	1
6-6.9	6	1

Other species observed: blacknose dace, brown trout, brook stickleback, creek chub, common shiner, northern redbelly dace, white sucker, central mudminnow, pumpkinseed

Management Implications:

1. This is a healthy small trout stream that holds some legal size brook trout, and likely, an occasionally larger brook trout. A recent angler report suggests it gets some fishing pressure.
2. Beaver dams on such a small tributary to Lake Huron can be problematic for migrating fish, particularly during spawning season. Work with conservation officers (as in the past) to ensure this stream is trapped, and possibly remove problematic dams through the local sportsmen's club.
3. This stream does have an anadromous run of fish, including salmon, steelhead, and suckers. Though no salmon were captured in the recent surveyed reach, it is likely still used by occasional salmon, but mostly steelhead. Wild juvenile steelhead in this stream contribute to the Lake Huron fishery.
4. Sedimentation to the stream is evident at Alpena State Road (July 2014) and the inside of the east culvert appeared crushed. This entire road crossing needs replacement for the betterment of the creek.

Land Use

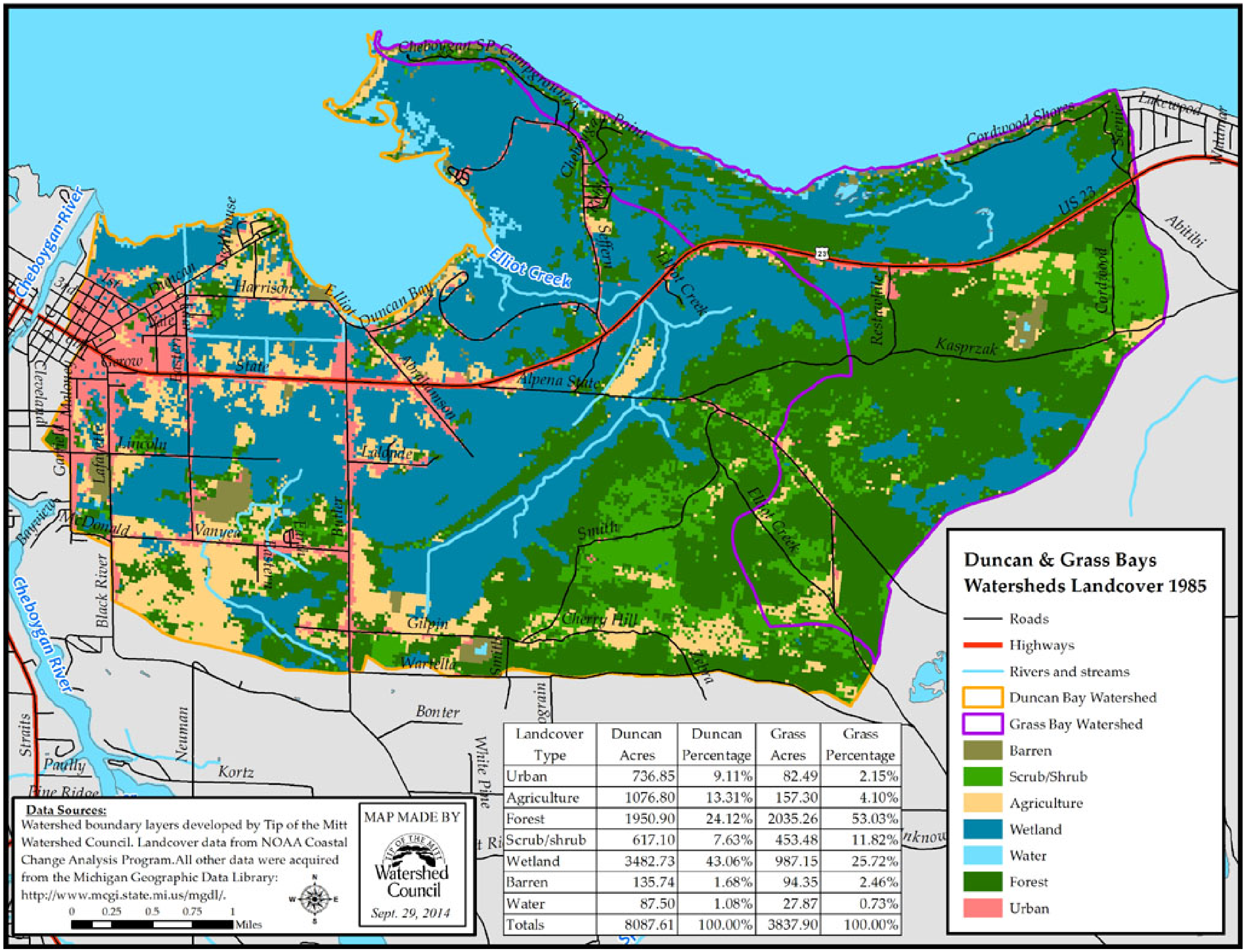
Based on GIS files developed by the Watershed Council using existing watershed boundary and elevation data from the State of Michigan, the Duncan Bay Watershed encompasses 8,088 acres and the Grass Bay Watershed covers 3,838 acres. Land cover statistics for the Duncan and Grass Bays Watershed were generated using remotely sensed data from the Coastal Great Lakes Land Cover project (Table 4 and Table 5). Based on the 2010 data, there is little agricultural landcover within the Duncan Bay Watershed (~5%), but a relatively high amount of urban land cover for Northern Michigan watersheds (11%). The Grass Bay Watershed has less than 3% of agricultural and urban land cover types combined. The majority of land cover in both watersheds consists of forests and wetlands.

Table 4: Watershed land cover statistics for Duncan Bay Watershed (1985 and 2010)

	1985		2010		% Change
Land Cover Type	Duncan Bay (acres)	Duncan Bay	Duncan Bay (acres)	Duncan Bay	
Agriculture	405.80	5.02%	366.56	4.53%	-.49%
Barren	135.74	1.68%	117.18	1.45%	-.23%
Forested	1950.90	24.12%	2061.55	25.49%	1.37%
Grassland	671.00	8.3%	516.44	6.39%	-1.91%
Scrub/Shrub	617.1	7.63%	563.15	6.96%	-.67%
Urban	736.85	9.11%	888.93	10.99%	1.88%
Water	87.5	1.08%	16.82	.21%	-.87%
Wetland	3482.73	43.06%	3556.98	43.98%	.92%
TOTAL	8087.61	100%	8087.61	100%	

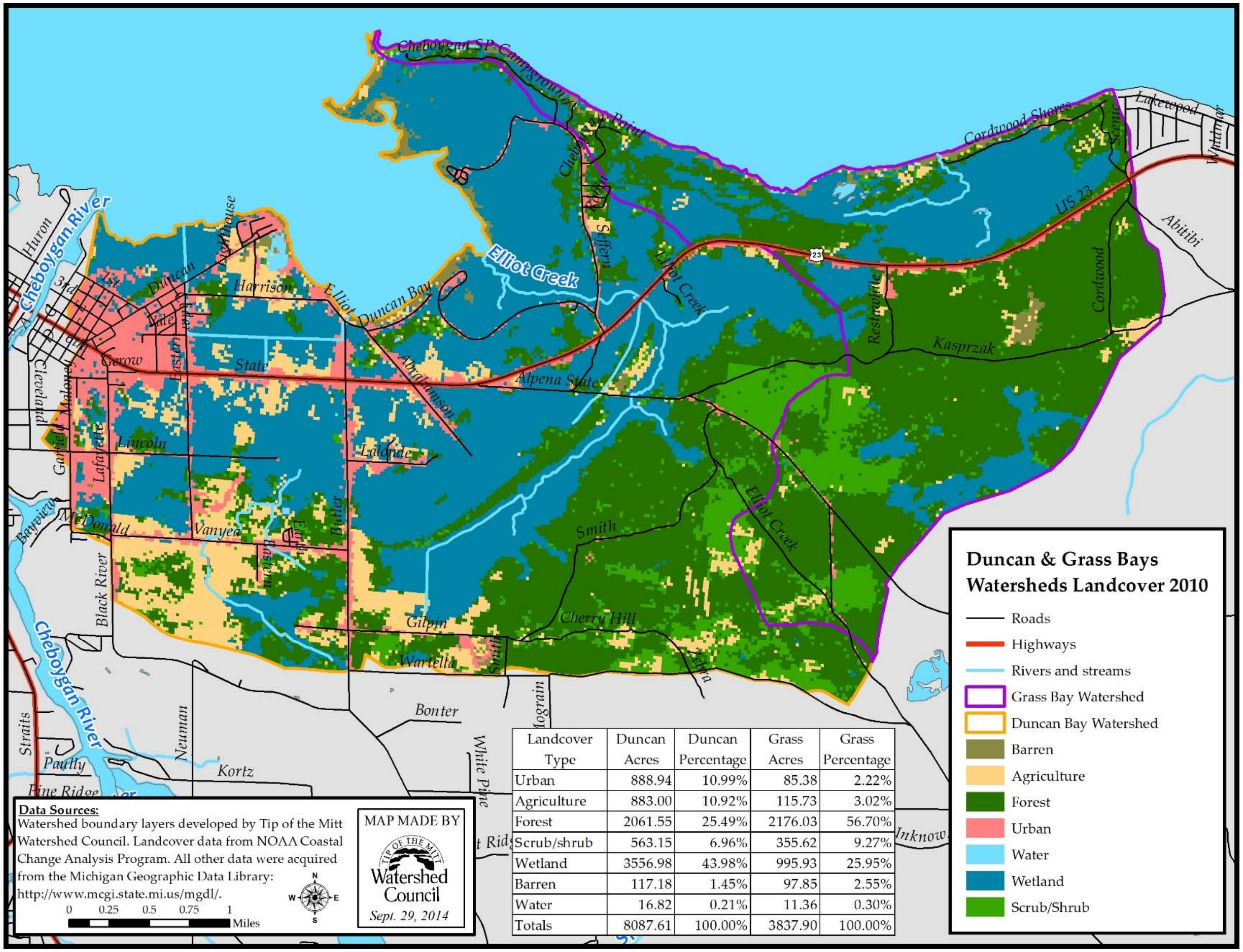
Table 5: Watershed land cover statistics for Grass Bay Watershed (1985 and 2010)

	1985		2010		% Change
Land Cover Type	Grass Bay (acres)	Grass Bay (percent)	Grass Bay (acres)	Grass Bay (percent)	
Agriculture	1.11	.03%	1.44	.04%	.01%
Barren	94.26	2.46%	97.76	2.55%	.09%
Forested	2035.26	53.03%	2176.03	56.70%	3.67%
Grassland	156.19	4.07%	114.30	2.98%	-1.09%
Scrub/Shrub	453.48	11.82%	355.62	9.27%	-2.55%
Urban	82.49	2.15%	85.38	2.22%	.08%
Water	27.87	.73%	11.36	.30%	-.43%
Wetland	987.15	25.72%	995.93	25.95%	.23%
TOTAL	3837.81	100%	3837.81	100%	



Landcover Type	Duncan Acres	Duncan Percentage	Grass Acres	Grass Percentage
Urban	736.85	9.11%	82.49	2.15%
Agriculture	1076.80	13.31%	157.30	4.10%
Forest	1950.90	24.12%	2035.26	53.03%
Scrub/shrub	617.10	7.63%	453.48	11.82%
Wetland	3482.73	43.06%	987.15	25.72%
Barren	135.74	1.68%	94.35	2.46%
Water	87.50	1.08%	27.87	0.73%
Totals	8087.61	100.00%	3837.90	100.00%

Figure 9: Duncan and Grass Bays Watersheds Land Cover (1985)



Landcover Type	Duncan Acres	Duncan Percentage	Grass Acres	Grass Percentage
Urban	888.94	10.99%	85.38	2.22%
Agriculture	883.00	10.92%	115.73	3.02%
Forest	2061.55	25.49%	2176.03	56.70%
Scrub/shrub	563.15	6.96%	355.62	9.27%
Wetland	3556.98	43.98%	995.93	25.95%
Barren	117.18	1.45%	97.85	2.55%
Water	16.82	0.21%	11.36	0.30%
Totals	8087.61	100.00%	3837.90	100.00%

Figure 10: Duncan and Grass Bays Watersheds Land Cover (2010)

Recreation

Duncan and Grass Bays Watershed includes several exceptional parks and preserves, which allow recreationists opportunities for exploration of some of the state's most interesting natural areas.

The Nature Conservancy's Grass Bay Nature Preserve:

Grass Bay Preserve extends along two miles of Lake Huron shoreline and includes over 300 plant species. Three species of wildflowers found at Grass Bay are endemic to the Great Lakes—the dwarf lake iris (blooming in purple or white), Pitcher's thistle, and Houghton's goldenrod. Neotropical migrants such as the black-throated blue warbler and the prairie warbler can also be observed at the Preserve. The Preserve includes sandy and cobble shorelines wither emergent wetlands, open dunes, interdunal wetlands, coniferous swamps and forests, and home to twelve of Michigan's thirteen coniferous species.

The Nature Conservancy first became aware of Grass Bay's diverse flora in 1978. When the original 80-acre parcel went on the market in 1979, the Conservancy secured an option to purchase it. Because the Federated Garden Clubs of Michigan treasured this site and also wanted to see it protected, they launched a very successful multi-year campaign to raise money to assist the Conservancy in purchasing the original parcel, plus approximately 100 more acres soon after. Since its initial purchase, several land donations and purchases have expanded the Grass Bay Preserve to its current 956.2 acres. In order to protect the site from inadvertent ecological damage due to overuse, access is limited to Conservancy field trips and research opportunities. (Source: www.nature.org)

Figure 11: Grass Bay Nature Preserve (source: The Nature Conservancy/Ron Leonetti)

Figure 12: The Nature Conservancy's Grass Bay Nature Preserve (2013)

Cheboygan State Park

Source: Michigan Department of Natural Resources

Cheboygan State Park is approximately three miles east of the City of Cheboygan. The park has seven miles of Great Lakes frontage and includes coastal marshes, cobblestone and sand beaches, open sand dunes, and interdunal wetlands. A small boat launch provides access to Duncan Bay. Some of the best fishing in the area, with northern pike, small and large mouth bass, and several types of pan fish can be found in Duncan Bay. Elliot Creek, also known as Little Billy Elliot Creek, is well known for its speckled brook trout.

Figure 13: Cheboygan State Park (photo credit CheboyganStatePark.com)

Enbridge Line 5 Pipeline

There are only two major crude oil pipelines in Northern Michigan and one of them is of special interest to Duncan and Grass Bays – Line 5, owned and operated by Enbridge Energy, Limited Partnership.

Enbridge Line 5 is notable for Duncan and Grass Bays because it crosses the Straits of Mackinac, which is a jewel in the crown of Michigan's tourist industry and located just a few miles away. Line 5 is a 645-mile hazardous liquid pipeline that runs from Superior, Wisconsin across Michigan's Upper Peninsula, through Northern Michigan, down to the thumb region, and over to Sarnia, Ontario, Canada. This pipeline is 30 inches in diameter, except when crossing the Straits of Mackinac, where it divides into two 20-inch diameter pipes. Line 5 became operational in 1953 and carries up to 450,000 barrels, or 22.7 million gallons of light crude oil, synthetic crude, and natural gas liquids (propane) per day.

A spill or release of products carried through this pipeline could impact the environment and may even result in injuries or fatalities, as well as property damage. Crude oil spills can result in harm to human health and the environment, including fish and wildlife, and contamination of drinking water supplies. Waterfowl populations often experience direct mortality or significant injury from oil spills. For example, oil will coat bird feathers, reducing their buoyancy, and when birds groom themselves they ingest the oil, which will wreak havoc on their internal organs. Additionally, oil on the surface of water blocks sunlight, damages fish eggs, and impacts plankton, a primary food source for numerous fish and wildlife species. Oil can linger in the environment for many years, even after a cleanup, continuing to affect fish, wildlife, and humans. In addition to the environmental impacts of a spill, the potential economic impact of an oil spill in Duncan and Grass Bays – from property damage to a decrease in tourism – would be substantial.

From January 1, 2009 until December 31, 2013, the following product types and quantities were transported through Line 5:

Average (barrels per day)	2009	2010	2011	2012	2013
Natural Gas Liquids	76,269	73,924	71,532	74,373	67,871
Condensates	520	0	0	0	0
Light	351,453	388,755	389,277	383,208	397,010
Medium	0	575	0	0	0

The pipeline in the Straits of Mackinac was authorized under Public Act 10 by the Michigan Department of Conservation, which predated both the Michigan Department of Environmental Quality (MDEQ) and the Michigan Department of Natural Resources (MDNR). An easement was granted to Lakehead Pipeline Company, Inc. in 1953 for the pipeline. Currently, the MDNR holds the easement, which contains requirements related to the design, material specifications, construction, and operation of the Straits pipelines.

Line 5 was constructed of steel and installed with corrosion protection measures, including a coal-tar enamel coating on the outside of the pipeline, as well as cathodic protection. Cathodic protection is a technology that uses direct electrical current to counteract the normal external corrosion of a metal pipeline. The 20 inch diameter pipes in the Straits of Mackinac have a wall thickness of 0.812 inches.

The pipelines in the Straits are buried 15 feet deep until a depth of 65 feet of water. Deeper than 65 feet, the pipes were laid on the lake bottom.

In 2002, Enbridge began installing screw anchor pipe supports. The anchors are ten-foot long steel screws that are augured into the lake bed on each side of the pipeline and hold a steel saddle mount that supports the pipelines. The easement with the State of Michigan requires that the pipeline be supported at least every 75 feet, to ensure the stability of the pipelines running along the lake bed. Recent work was conducted on the support structures in 2014, installing additional anchors, providing an average unsupported span length of less than 50 feet.

Pipelines are considered to be the safest and most efficient way to transport oil and gas commodities. An incident or failure on the portion of Line 5 located in the Straits of Mackinac is considered to be a low-probability, high-consequence event. That means it does not have a high likelihood of occurring, but if it does occur, the impact can be catastrophic. Unfortunately, at this time, the structural integrity of Line 5 cannot be confirmed, due to the lack of access to information, particularly inline inspection report data. In addition, there is limited capability to effectively respond to a failure on Line 5 in Northern Michigan, due to a lack of resources such as emergency response equipment and personnel, and situational conditions such as being located in remote areas or the open waters of the Great Lakes.

As a result, Tip of the Mitt Watershed Council recommends that Line 5 should be decommissioned (policy position on oil transportation in the Great Lakes, adopted by the Watershed Council Board of Directors March 18, 2016).

Until this occurs, it is imperative to work on measures to prevent an oil spill and enhance preparedness capabilities, to be able to effectively respond in case of an accident. Tip of the Mitt Watershed Council advocates for the following measures:

- An independent analysis of inline inspection data to assess structural integrity of the pipeline;
- Conducting a comprehensive and independent risk assessment and alternative analysis for the portion of Line 5 in the Straits of Mackinac;
- Implementation of recommendations made in the Michigan Petroleum Task Force Report;
- Increasing emergency response capabilities in Northern Michigan, including stockpiling of equipment, training, and personnel; and
- Increasing inspection frequencies, requiring annual or biannual internal/external inspections of the pipeline.

Zoning Assessment

Jurisdictional zoning plays an important role in watershed protection. In 2014, Tip of the Mitt Watershed Council published the Cheboygan County volume of the Local Ordinance Gaps Analysis Project. This is a four-volume series Zoning Assessment produced for Antrim, Charlevoix, Cheboygan and Emmet Counties. The project consisted of an extensive review of all the water-related ordinances within the county. The purpose was to evaluate them against what should be in place to best protect water resources, and offer recommendations and suggested actions to help local government officials understand and strengthen any areas that need improvement. It covers ordinances at not only the county level, but also for all cities, townships, and villages in the county.

The Gaps Analysis was conducted with the underlying assumption that specific Critical Elements are considered vital to address, if a local government wants to create strong protections for local water resources. These Critical Elements are:

- Master Plan Components
- Basic Zoning Components
- Shorelines
- Impervious Surfaces and Stormwater Management
- Soil Erosion and Sediment Control
- Sewer/Septic
- Wetlands
- Groundwater and Wellhead Protection
- Other: Floodplains, Steep Slopes, and Critical Dunes

The rationale for creating this particular list was detailed in the Gaps Analysis in a formal academic Literature Review, documenting the current relevant research literature for each of these items. It explains why the Critical Elements were considered important enough to include in this work.

An Evaluation Checklist was created to focus on the Critical Elements listed above, in accordance with the Literature Review. The checklist was compared to each jurisdiction's Master Plan and all ordinances in place. The checklist question was asked and the answer was found and noted. If the answer was "yes," the question earned 3 points. If the answer was "yes, partially" the question earned 2 points. If the answer was "yes, minimally" the question earned 1 point. If the answer was "no," the question earned 0 points and that item is considered to be missing. The score for each question was assigned and then the next question was asked, until the entire checklist was complete.

It is important to note that the scoring system used with the Evaluation Checklist does not penalize a jurisdiction for missing ordinances that are not appropriate for their area, because of geographic or other circumstances. Upon completion of a checklist section, the points were totaled and the section was ranked.

The summary of the Ranking System is as follows:

STRONG: The section of the ordinance being reviewed can be identified as more protective or better than most ordinances in the state, for reasons that can be clearly articulated. For example, the section replicates a model ordinance on the same topic, or minimum standards are exceeded.

ADEQUATE: The section of the ordinance being reviewed is on par with other ordinances in the state; it is at least as protective as ordinances for areas with similar water resource features.

WEAK: The section of the ordinance being reviewed is deemed weaker than similar ordinances in the state, for a specific reason that can be clearly articulated. For example, a model ordinance is changed to delete some protection that should have remained intact.

MISSING: The topic is not included in the jurisdiction's ordinance.

An analysis of the results was done when each checklist was finished, including Recommendations and Suggested Actions. Those are covered in the Gaps Analysis, with a chapter devoted to each jurisdiction.

As part of the grant through the Clean Water Act Section 205j with the MDEQ to implement the Duncan and Grass Bay Watershed Management project, Tip of the Mitt Watershed Council, in partnership with Northeast Michigan Council of Governments (NEMCOG), conducted two-hour workshops to unveil the Gaps Analysis to local government officials in all of Cheboygan County. Working in conjunction with another grant, a total of seven workshops were held in October and November 2014. The first two were held at Benton Township and Munro Township, followed by Burt Township, Nunda Township, City of Cheboygan, and two for Cheboygan County. Copies of the Gaps Analysis were provided to every member of the County Planning Commission and Board of Commissioners; all township Supervisors, Trustees, and Planning Commissioners; city Mayors, Councils, and Planning Commissioners; and copies were also made available to Zoning Administrators and staff. The workshops stepped participants through the guides, explaining the purpose and how to use the information included in them. Follow up work is currently underway to do presentations to any jurisdiction that missed the workshops, or any that want other kinds of help with implementation.

The Duncan and Grass Bays Watershed includes three jurisdictions: Cheboygan County, the City of Cheboygan, and Benton Township. **Table 6** summarizes the ranking of the two zoned jurisdictions within the Duncan and Grass Bays Watershed. Because Benton Township falls under Cheboygan County zoning, it was not ranked separately.

Table 6: Gaps Analysis Ranking Results for Duncan and Grass Bays Watershed Jurisdictions

Elements	**Cheboygan County**	**City of Cheboygan**
Master Plan Components	Adequate: A new Master Plan had just been completed. Suggested adding: maps of groundwater recharge areas; call to minimize new impervious surfaces; acknowledge importance of road stream crossings	Adequate: Suggested including a specific goal to protect water resources and identify that the city is located in two watersheds: Lake Huron and the Cheboygan River. Acknowledge importance of road stream crossings; identify stormwater management as a community goal
Basic Zoning Components	Strong	Strong
Shorelines	Adequate: Suggested requiring native vegetation and prohibit invasive species in greenbelts; add marina BMPs; and address *Phragmites*	Weak: Suggested requiring waterfront setbacks and natural vegetation strips for waterfront properties; adding marina BMPs

Elements	Cheboygan County	City of Cheboygan
Impervious Surfaces	Weak: Suggested conducting an Impervious Surface Assessment for the County; make recommendations based upon it to guide stormwater management in the County	Weak: Suggested using incentives to encourage Low Impact Development techniques; encouraged flexibility on parking space requirements parking lot BMPs
Stormwater Management	Strong	Strong
Soil Erosion and Sediment Control	Strong	Strong
Sewer/Septic	Adequate: Suggested education and outreach to better inform citizens about how to maintain septic systems; encouraged consideration of a Time of Transfer Septic Inspection Ordinance	Strong
Wetlands	Weak: Suggested establishing a wetland setback of at least 25'; adopting minimum shoreline frontage requirements to prevent creation of unbuildable lot splits; and citizen education	Missing: Suggested education of citizens on importance of wetlands; establish a wetland setback of at least 25'; ensure all state and federal permits are in place before granting local permits
Groundwater and Wellhead Protection	Adequate: Suggested requiring Pollution Incident Prevention Plans in coordination with Local Emergency Planning Committees for storage of hazardous materials; conduct inventory of potential threats to groundwater; provide citizen education	Adequate
Other: Floodplains, Steep Slopes, and Critical Dunes	Strong	Strong

Duncan and Grass Bay Watershed Management Project implementation steps include recommendations from the Gaps Analysis. Finally, all four Gaps Analysis volumes are available online in a user-friendly format. Simply go to the Tip of the Mitt Watershed Council website, at the Publications link: www.watershedcouncil.org.

Environmental Areas

Source: www.michigan.gov/deq

The Michigan Department of Environmental Quality includes McLeod Bay (aka Duncan Bay)(Area #05-08) as one of the State's 118 environmental areas . This designation affords additional protection of habitat deemed necessary for the preservation and maintenance of fish and wildlife. Many environmental areas contain coastal wetlands but other important habitats, such as upland ridges and islands are also included. Designation of these sensitive coastal shorelands assures an increased level of protection over these valuable resources. Studies and surveys conducted by the Department and others have recorded over 25 fish species, 12 mammal species, and 131 bird species utilizing these valuable coastal habitats. In addition, typically unseen and overlooked species which are equally essential for maintaining healthy fish and wildlife populations are also provided protection under this coastal designation.

Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 Public Act 451, provides for the designation of environmental areas up to 1000 feet landward of the ordinary high water mark of a Great Lake or 1000 feet landward of the ordinary high water mark of lands adjacent to waters affected by levels of the Great Lakes. Environmental area designation sets up a review program where the affected property owner must make application to the Department for any dredging, filling, grading, or other alteration of the soil, natural drainage or vegetation, or placement of permanent structures.

Approximately 275 linear miles of essential habitat exists along Michigan's Great Lakes shorelands representing about 8.5% of the Great Lakes shoreline. About 607 parcels of land were designated as environmental areas from 1976 to 1985. Of the approximately 118 environmental areas, each containing one to several parcels of land, less than 6% utilize the full 1000 foot setback. Most of the parcels containing environmental areas extending inland 1000 feet are State and/or federally owned.

Focus Groups within the Duncan and Grass Bays Watershed

Michigan State University Extension (MSUE), as part of the DEQ-funded Duncan and Grass Bay Watershed Management project, hosted two focus group sessions during late 2013 and mid-2014. The focus groups were conducted to determine overall values and perceptions about water quality awareness and risks, governmental challenges, and ways to engage local leaders and residents in water quality protection efforts.

Method

Two 90-minute focus groups were conducted, one with local elected and appointed officials serving the Grass and Duncan Bays Watershed (seven participants), the other with residents of the two watersheds (12 participants). The intent was to conduct a third focus group with business leaders, but we were unsuccessful in recruiting the minimum number of participants.

Two sets of questions were asked to gain the unique perspectives of each group. During our analysis, we looked for common themes in the discussions for each question.

Questions were designed to gather perceptions about:

- Overall perceptions about best attributes of the watershed

- Perspectives on water sources and risks to the watershed
- Initial impressions of the Emmet County Gaps Analysis report that will be used as a model for the Cheboygan County document (local officials)
- Suggestions for ways to engage others in watershed protection planning efforts

The local officials were randomly selected for invitation to the session in a way that encouraged representation from townships, cities, and county governments. Residents were recruited by phone call based on land owner lists and suggestions from other residents invited to participate.

Findings

When asked what they liked most about the area, participants highlighted three major themes:

- The beauty and clarity of the water
- Unique natural habitats
- Peace and quiet afforded by low population and fewer recreational visitors, as compared to other parts of Northern Michigan.

Residents used terms like “isolated,” “pristine,” and “serene” to describe Duncan and Grass Bays. For most, it is truly a special area. “That’s why it is so hard to take a vacation,” said one participant. “Because we took off this spring…and we got home and I say ‘Why do we ever leave this place?’”

Duncan and Grass Bay attributes

Participants described the bays as largely undeveloped with long stretches protected by state park or Nature Conservancy holdings. Only a small percentage of shoreline areas are currently available for development, or would likely be in the future. Likewise, said local officials, who described the only developable areas as being immediately adjacent to the city along US-23, with most of the rest of the watersheds in public ownership or otherwise unlikely to change from current uses.

Participants in the residents group were asked to identify on a map areas where water flows into the bay, and exceptional areas within the watersheds. From their perspectives, water enters the bay primarily from Elliot Creek, the ditch that exits at the south end of Duncan Bay by Butler Road, and many seeps, especially along Grass Bay. Pretty much the whole shoreline, perhaps excepting the area from the state park to the marina, was identified as exceptional. Also highlighted were the wetlands immediately east of the Cheboygan River mouth and Elliot Creek.

The residents group tended to focus their comments on attributes and issues associated with the immediate shoreline, where most lived, while local officials expressed a broader perspective.

Watershed Threat

Participants in both groups viewed external sources, those originating outside of the watershed, as the most significant threats.

Both groups identified outflows from the Cheboygan River as potentially impacting the watersheds by virtue of the area's predominantly northwest winds. Dredging, sewer overflows, legacy paper mill waste, and the possibility of establishing a deep water port were also mentioned in this context. The residents group discussed the potential for leaks from the Enbridge pipeline at the Straits as the most critical threat. (Interestingly, the local official's group did not mention this issue at all, perhaps because the issue was not as intensively discussed in communities and media until after the local officials focus group was convened in December 2013.)

Within Duncan Bay, both groups brought up the abandoned tug boat issue (Figure 14); some residents also mentioned legacy submerged sawdust from the lumbering era that washes up yearly along some portions of the bay near the state park.

The stormwater drain in the city that enters Duncan Bay at Butler Road was also frequently mentioned. Both groups identified this source. Local officials also talked about the challenges with flooding and high water table on the east side of the city of Cheboygan, and the need to drain those areas.

Except for cold water temperatures, occasional algae build-up during low water periods, and sharp zebra mussel shells, participants identified few impairments to the use and enjoyment of water in Duncan and Grass Bays.

Development and the future of the Watersheds

Both groups expressed that the bays are well-protected and not under threat from residential or commercial development. Local officials identified the US 27 corridor as where development was most likely to occur. Although there are long-term plans to extend city water and sewer east to the city limits, none of the participants expected increased development in that area any time soon.

Governmental roles and the Gaps Analysis study

Participants in the local government group commented that they try to coordinate between the city and county, but it could be better, perhaps with better communication.

These focus groups were conducted before the Cheboygan County volume of the Local Ordinance Gaps Analysis was completed. The group viewed a sample excerpt prior to the focus group meeting, and saw a copy of the entire Emmet County Gaps Analysis during the session. Overall, participants appreciated the effort and expressed that the guide was well done, and the Cheboygan County report would be a useful reference document. However, with only the county and a few other governmental units doing planning and zoning, some doubted that there were many gaps. The county master plan, for instance, was just recently updated.

The officials also wondered if zoning or regulatory changes recommended in the report could be implemented in their community, due to resistance by residents. By example, several reflected on resistance to a proposed zoning ordinance amendment related to vegetative strips around lakes.

Local officials suggested that the gaps analysis needs to be marketed with brief summaries and in a format that can be easily distributed to avoid the report sitting on shelves. This recommendation was specifically why the Watershed Council teamed up with NEMCOG to do the workshops, mentioned earlier, to release and distribute the report.

There was also general concern about outside advice, either as part of a watershed plan or other reports.

Comments

Residents and local officials alike value Duncan and Grass Bays. The Watershed is very small with few perceived threats. Since perceived threats are external, it may be worth considering an approach that incorporates these watersheds in an overall plan for the Cheboygan River Watershed, not treat as a separate unit. Even though not part of the Cheboygan River hydrologic unit, local residents and leaders view the river as one of the main influences on the bays. It was also notably difficult to recruit a minimal number of stakeholders in this lightly populated area just to conduct these focus groups, never mind the effort to develop and implement a watershed plan.

The comments provided during the focus group sessions reinforced that although natural resource protection is highly valued, increased regulation to restrict land use and activity are not as well supported.

A plan approach that places primary emphasis on goals and individual practices, secondary emphasis on regulation, may be more readily accepted by community leaders and residents.

Local engagement in plan development and implementation will be very important to counter perception of outsiders trying to influence community decisions.

As noted in the methods section, we were unsuccessful in two attempts to recruit enough business representatives to conduct a focus group session. One of the issues might have been that there are simply not many businesses, in total, located within the watershed, and an even fewer number with a direct stake or interest in water quality issues – another justification for combining discussions about the bays with those associated with the lower Cheboygan River Watershed.

Figure 14: Tugboat Removal (2013) Photo credit: Mike Fornes/Cheboygan Tribune

Chapter 2: Water Quality Standards and Designated Uses of the State of Michigan

The EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* describes water quality standards and designated uses as follows:

- Water quality standards set the goals, pollution limits, and protection requirements for each waterbody. Meeting these limits helps to ensure that waters will remain useful to both humans and aquatic life. Standards also drive water quality restoration activities because they help to determine which waterbodies must be addressed, what level or restoration is required, and which activities need to be modified to ensure that the waterbody meets its minimum standards.
- Standards are developed by designating one or more beneficial uses for each waterbody, establishing a set of measurable criteria that protect those uses and implementing policies and procedures that keep higher-quality waters from degrading.
- Designated or beneficial uses are descriptions of water quality expectations or water quality goals. A designated use is a legally recognized description of a desired use of the waterbody, such as aquatic life support, body contact recreation, fish consumption, or public drinking water supply. State and tribal governments are primarily responsible for designating uses of waterbodies within their jurisdictions.
- Two types of criteria are used to measure whether standards are being met. Numeric criteria set numeric limits for water quality parameters while narrative criteria are nonnumeric descriptions of desirable or undesirable water quality conditions.
- The MDEQ monitors the waters of the State on a five-year rotating watershed cycle to facilitate effective watershed management. Michigan has 57 major watersheds based on the USGS's 8-digit Hydrologic Unit Codes (HUC). Water quality assessment efforts focus on a subset (approximately 20%) of these major watersheds each year. The Duncan and Grass Bays Watershed is scheduled to be monitored in 2020.

The Water Resources Commission Act (P.A. 451 of 1994, Part 31, Chapter 1) requires all surface waters in the State of Michigan are designated for and shall be protected for all of the following uses:

1. **Agriculture:** Surface water must be of the quality that it can be used for livestock watering, irrigation, and spraying crops.
2. **Industrial water supply:** Surface waters must be clean enough to be used for commercial or industrial applications or non-contact food processing.
3. **Navigation:** Applies to water bodies that were historically used to float commercially-harvested logs.
4. **Warmwater fishery:** Water bodies designated as warmwater fisheries should be able to sustain populations of fish species such as bass, pike, walleye, and panfish.
5. **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.
6. **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.
7. **Total body contact recreation (May 1-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.
8. **Fish consumption:** There is a state-wide, mercury-based fish consumption advisory that applies to all of Michigan's inland lakes.

In addition to the abovementioned designated uses, the coldwater fishery designated use applies to Elliot Creek (T38N, R1W, S27).

The coldwater fishery designation differs from the warmwater fishery because there are different water quality standard levels for dissolved oxygen, water temperature, and other chemical, physical, and biological parameters.

Table 7: State of Michigan Water Quality Standards

(as required by sections 3103 and 3106 of 1994 PA 451, MCL 324.3103 and 324.3106)

Pollutant	State-required level	Designated Uses Affected
Dissolved Solids	500 mg/L monthly average or 750 mg/L at any time as a result of controllable point sources	All
Chlorides	125 mg/L monthly average	Public Water Supply
pH	6.5 to 9/0	
Taste or odor producing substances	Any concentration	Public Water Supply Industrial Water Supply Agricultural Water Supply Fish Consumption
Toxic substances (selected shown here; see rule for complete listing)	DDT and metabolites: 0.00011 ug/L Mercury, including methylmercury: 0.0013 ug/L PCBs (class): 0.00012 ug/L 2,3,7,8 - TCDD: 0.0000000031 ug/L	All but navigation
Radioactive substances	Pursuant to U.S nuclear regulatory commission and EPA standards	All but navigation
Plant nutrients	Phosphorus: 1 mg/L monthly average for permitted point-source discharges	All
Microorganisms	130 *Escherichia* coli per 100 ml 30-day mean of 5 or more sampling events 300 E.coli per 100 ml 30-day 1,000 E.coli per 100 ml 30-day mean Human sewage discharges (treated or untreated) 200 fecal coliform per 100 ml 30-day mean or 400 fecal coliform per 100 ml in 7 days or less	Total body contact Total body contact Partial body contact Total body contact
Dissolved oxygen	Minimum 7 mg/L for coldwater designated streams, inland lakes, and Great Lakes/connecting waters; minimum 5 mg/L for all other waters Minimum 5 mg/L daily average	Cold water fishery Warm water fishery
Temperature	Natural daily and seasonal temperature fluctuations shall be preserved: Monthly averages for inland lakes: J F M A M J J A S 0 N D 45 45 50 60 70 75 80 85 80 70 60 50 Monthly averages for warm water inland streams in this watershed: J F M A M J J A S 0 N D 38 38 41 56 70 80 83 81 74 64 49 39 Monthly averages for cold water inland streams in this watershed: J F M A M J J A S 0 N D 38 38 43 54 65 68 68 68 63 56 48 40	Cold water fishery Other indigenous aquatic life and wildlife Warm water fishery Cold water fishery

If a body of water or stream reach is not meeting the water quality standards set for a specific designated use, then it is said to be in 'nonattainment.'

The Clean Water Act (CWA) requires Michigan to prepare a biennial report on the quality of its water resources as the principal means of conveying water quality protection/monitoring information to the United States Environmental Protection Agency (USEPA) and the United States Congress. The *Water Quality and Pollution Control in Michigan, 2014, Sections 303(d), 305 (b), and 314 Integrated Report (Integrated Report)* satisfies the listing requirements of Section 303(d) and the reporting requirements of Section 305(b) and 314 of the CWA. The Section 303(d) list includes Michigan water bodies that are not attaining one or more designated uses and require the establishment of Total Maximum Daily Loads (TMDLs) to meet and maintain Water Quality Standards.

At this time, no water bodies in the Grass and Duncan Bays Watershed are included on the 303(D) list.

According to the 2012 *Integrated Report* (Michigan Department of Natural Resources and Environment Water Bureau, April 2012, page 43):

Lake Huron Coast - Duncan and Grass Bays (HUC 040700030103)

> Located just east of the city of Cheboygan (Cheboygan County), the Duncan and Grass Bays area was identified as the most significant priority area to protect along the Lake Huron coast in the Northeast Michigan Coastal Stewardship Project completed in 2009. The area is a state designated environmentally sensitive area with high biological rarity, and includes shoreline ridge swale habitats, dune swale complexes, large tracts of public land, and extensive wetlands. Protecting adjacent land is a priority considering the high rate of population growth and development in the area, which contributes to sedimentation from construction site erosion as well as habitat loss and fragmentation.

Although the Duncan and Grass Bays Watershed is currently meeting all of the designated uses of the State, it remains vulnerable to nonpoint source pollution. Existing and future activities may put some or all of the designated uses at risk; therefore, it is critical to remain vigilant.

The designated uses that may be considered most at risk by nonpoint source pollution include 1) other indigenous aquatic life and wildlife 2) cold water fishery and 3) total body contact recreation. Implementation of the Duncan and Grass Bays Watershed Protection Plan recommendations will work to support *all* designated uses, but will have the greatest impact on the abovementioned uses.

Review of Existing Monitoring Data for the Grass and Duncan Bays Watersheds

Due to the small size of the Duncan and Grass Bays Watershed (19 sq. miles total) and the limited number of water bodies contained within, relatively little water quality data are available. Tip of the Mitt Watershed Council, the United States Fish and Wildlife Service (USFWS), and District Health Department #4 of Alpena (DHD#4) have monitored water quality in Duncan Bay, Grass Bay, and tributaries draining into these bays. Tip of the Mitt Watershed Council data are from the Comprehensive Water Quality Monitoring Program (CWQM), Volunteer Lake Monitoring Program (VLM), and the DEQ-funded Clean Water Act Section 205j watershed management planning grant (project #2012-0026). USFWS data are from the Sea Lamprey Control Program, while DHD#4 data are from their beach monitoring program.

Water quality data from the Bays and tributaries include the following parameters: water temperature, dissolved oxygen, specific conductance, pH, alkalinity, total phosphorus, total nitrogen, nitrate nitrogen, chloride, total suspended solids, water transparency, chlorophyll-a, and *Escherichia coli (E. coli)*. Tributary monitoring also included discharge measurements.

Duncan Bay

Duncan Bay includes the nearshore area of Lake Huron that extends from the east side of the Cheboygan River outlet to the tip of Lighthouse Point on the Cheboygan State Park peninsula (Figure 15). The Bay is relatively shallow, with an average depth of about 20'. The nearshore areas are particularly shallow and extend well into the Bay. Depending on currents and prevailing winds, discharge from the Cheboygan River could affect the quality of Duncan Bay. This is particularly true for the Outer Bay, which extends north from a line between Lofgren Shore Drive on the west side to Cheboygan Point on the east. Elliot Creek and the Butler Ditch, which flow into the south side of Duncan Bay, also influence the water quality, particularly in the Inner Bay. Duncan Bay water quality data include the following: CWQM from 2007 to 2013, DEQ 205j-funded monitoring during 2013 and 2014, VLM from 2002 to 2004, and DHD#4 from 2002 to 2013.

Averaged CWQM and DEQ 205j monitoring data show high water quality in Duncan Bay (Table 8). Dissolved oxygen concentrations were consistently above the State of Michigan Water Quality Standards' (WQS) minimum of 7 milligrams per liter (mg/L) for waters capable of sustaining cold-water fisheries. Chloride concentrations were far below the USEPA recommended limit of 230 mg/L for chronic toxicity and 860 mg/L for acute toxicity (USEPA, 2012). Suspended solids were also low and in the range of what is generally considered to be clear (<=20 mg/L). Nutrient levels for nitrogen and phosphorus were also quite low and, on average, below USEPA reference conditions of 9.7 micrograms per liter (µg/L) for total phosphorus and 323 µg/L for total nitrogen. The USEPA established these nutrient reference conditions for lakes in the Northern Michigan ecoregion because they are "likely associated with minimally impacted conditions, will be protective of designated uses, and provides management flexibility" (USEPA, 2001).

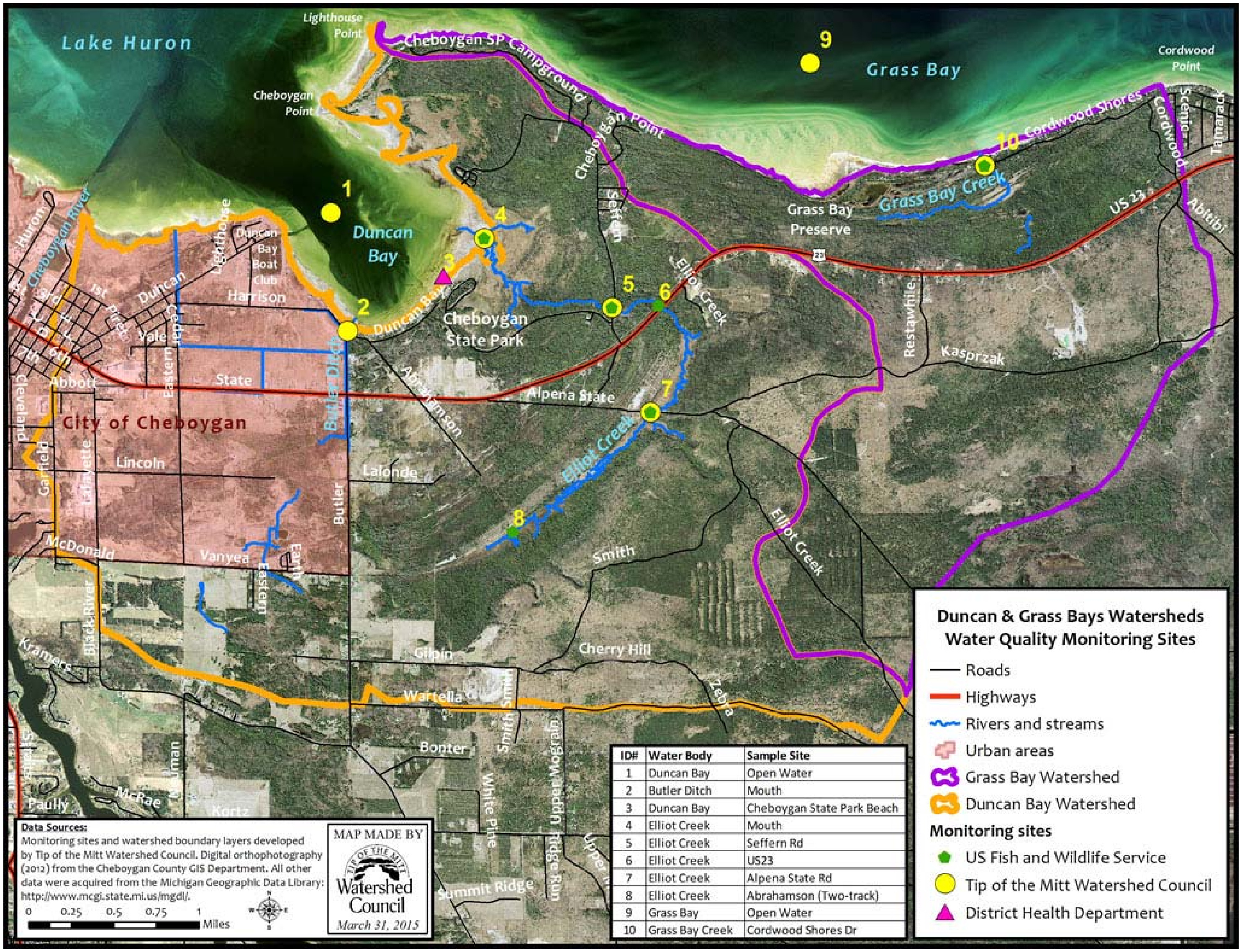


Figure 15. Water quality monitoring sites in Duncan Bay, Grass Bay, and tributaries.

Table 8. Water quality data for Duncan Bay.

PARAMETER	Low Value	Low Date	High Value	High Date	Average
Dissolved Oxygen (mg/L)	9.74	10/8/2013	13.16	11/15/2013	11.45
Conductivity (µS/cm)	188.5	5/8/2007	279.5	4/22/2010	248.3
pH	8.1	10/24/2014	8.9	6/30/2014	8.4
Nitrate-Nitrogen (µg/L)	47.3	8/1/2013	233.0	5/8/2007	119.3
Total Nitrogen (µg/L)	190.0	8/1/2013	487.0	10/24/2014	284.6
Total Phosphorus (µg/L)	1.1	5/17/2013	71.0	10/24/2014	6.4
Chloride (mg/L)	7.4	11/3/2014	11.6	11/15/2013	9.8
Suspended Solids (mg/L)	0.3	8/1/2013	23.0	11/3/2014	4.0

Volunteers monitored water transparency and chlorophyll-a in Duncan Bay from 2002 to 2004. However, only the chlorophyll-a data were used in this assessment because the bay is quite shallow, such that most Secchi disc (water transparency) readings likely reflect the maximum depth at the sample site. The chlorophyll- a data that passed quality control checks show Duncan Bay to be oligotrophic; averaged seasonal trophic status index scores ranged from 24 to 26 (Table 9).

Table 9. Volunteer monitoring data for Duncan Bay.

Monitoring Year	Water Transparency (feet)	TSI* (Based on Water Transparency)	Chlorophyll-a (µg/L)	TSI* (Based on Chlorophyll-a)
2002	16.75	36.51	0.49	19.50
2003	16.83	36.50	0.96	25.80†
2004	16.92	36.43	0.51	23.74†

** TSI = Trophic Status Index. Lower values (0-38) indicate an oligotrophic or low productive system, medium values (39-49) indicate a mesotrophic or moderately productive system, and higher values (50+) indicate a eutrophic or highly productive system.*
† data passed quality control check.

DHD#4 of Alpena has monitored bacteria in Duncan Bay on a weekly basis during summer months since 2002. A total of 132 water samples from the Cheboygan State Park beach have been analyzed to determine the number of *Escherichia coli* (*E. coli*) bacteria per 100 milliliters. Results ranged from 0 to 1178 *E. coli*/100mL. Only four samples were above Michigan WQS (Table 10). A maximum of 300 *E. coli*/100mL was established by WQS Rule 62: “At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 milliliters.”

Table 10. High bacteria concentrations in Duncan Bay.

Sample Date	Sample Type	Result Value*
8/13/2007	Daily Mean	309.9
8/20/2007	Daily Mean	677.1
7/12/2011	Daily Mean	388.9
7/19/2011	Daily Mean	1178.4

*Results reported in the number of *E. coli*/100mL.

Duncan Bay Tributaries

Elliot Creek

USFWS has monitored Elliot Creek since 1970 and TOMWC monitored the creek during 2013 and 2014. Parameters monitored by USFWS include total alkalinity, dissolved oxygen, water temperature, and pH. TOMWC monitored these same parameters, as well as specific conductivity, total phosphorus, total nitrogen, nitrate-nitrogen, suspended solid concentration, and chloride. Discharge data were also collected by both entities. Monitoring data from USFWS used in this assessment are from five sampling sites (Figure 15) that have been regularly monitored through time (at least once every four years). TOMWC monitored at three locations.

Water quality data demonstrate that the Elliot Creek ecosystem is healthy and consistently attains Michigan WQS. Of the 60 dissolved oxygen measurements among all Elliot Creek sample sites, only one was below the WQS of 7 mg/L for sustaining a cold-water fishery (Table 11). Specific conductivity readings at all sites were typical or low for Northern Michigan streams as compared to CWQM data (

Table 12).

All pH readings fell within the range of 6.5 to 9.0 required for all Michigan surface waters according to WQS Rule 53. Averaged total phosphorus concentrations in Elliot Creek were below the USEPA reference condition of 12 µg/L for streams in this ecoregion, while averaged total nitrogen levels were far below the USEPA reference condition of 440 µg/L. On average, suspended solids were well below 20 mg/L and therefore, in the range of what is generally considered to be clear. Alkalinity data show that Elliot Creek is a moderately alkaline stream with a high buffering (i.e., acid neutralizing) capacity.

Figure 16: Elliot Creek at Alpena State Road (DG 21)

Table 11. Water quality data from tributaries of Duncan and Grass Bays.

Monitoring Parameter	Elliot Creek Mouth (Site 4)	Elliot Creek Seffern Rd. (Site 5)	Elliot Creek US23 (Site 6)	Elliot Creek Alpena State Rd. (Site 7)	Elliot Creek Two Track (Site 8)	Butler Ditch Mouth (Site 2)	Grass Bay Creek Cordwood Shores (Site 10)
Dissolved Oxygen: Low	7.5	6.7	8.6	8.4	ND	2.9	7.0
Dissolved Oxygen: High	12.1	12.0	10.8	11.9	ND	11.2	10.9
Dissolved Oxygen: Average	10.6	9.8	10.3	10.2	ND	8.4	9.4
Water Temperature: Low	5.6	4.4	16.0	4.5	19.0	3.3	5.5
Water Temperature: High	28.5	24.6	20.0	23.0	23.0	20.6	23.3
Water Temperature: Average	15.8	14.7	18.0	15.0	20.3	11.8	11.8
Conductivity, Spec.: Low	211.7	201.2	ND	232.5	ND	376.1	236.0
Conductivity, Spec.: High	316.7	296.7	ND	293.1	ND	638.5	394.8
Conductivity, Spec.: Average	269.0	253.5	ND	263.0	ND	514.7	324.2
pH: Low	7.7	7.8	7.8	7.8	7.6	7.7	7.8
pH: High	8.5	8.4	8.3	8.3	7.8	8.1	8.2
pH: Average	7.7	8.1	8.1	8.1	7.7	7.9	8.0
Alkalinity, Total: Low	100.0	112.0	109.0	142.0	165.0	ND	167.0
Alkalinity, Total: High	164.0	160.0	160.0	174.0	166.0	ND	178.0
Alkalinity, Total: Average	146.6	149.9	147.6	156.0	165.1	ND	174.3
Phosphorus, Total: Low	1.4	1.4	ND	1.0	ND	5.1	0.6
Phosphorus, Total: High	29.0	40.0	ND	76.0	ND	53.0	73.0
Phosphorus, Total: Average	6.9	9.1	ND	11.6	ND	19.6	12.6
Nitrogen, Total: Low	75.0	13.7	ND	42.0	ND	248.0	59.0
Nitrogen, Total: High	414.0	397.0	ND	348.0	ND	4,120.0	1,781.0
Nitrogen, Total: Average	223.3	158.8	ND	151.4	ND	996.8	271.4
Nitrate-Nitrogen: Low	1.1	1.6	ND	1.3	ND	0.8	3.0
Nitrate-Nitrogen: High	23.1	16.0	ND	33.4	ND	56.4	42.6
Nitrate-Nitrogen: Average	5.7	6.9	ND	13.2	ND	15.6	15.6
Suspended Solids: Low	0.1	0.7	ND	0.4	ND	1.2	0.4
Suspended Solids: High	7.4	19.7	ND	55.7	ND	47.3	29.0
Suspended Solids: Average	3.2	4.4	ND	5.9	ND	10.9	5.1
Chloride: Low	3.8	1.8	ND	1.0	ND	21.0	7.6
Chloride: High	17.3	4.7	ND	2.5	ND	96.0	11.0
Chloride: Average	3.2	3.6	ND	1.7	ND	35.6	9.3

**Units: dissolved oxygen, alkalinity, suspended solids, and chloride are mg/L, phosphorus, nitrogen, and nitrate in µg/L, conductivity in µS/cm, and temperature in ◦C. ND=no data.*

Table 12. Averaged water quality data for streams in the CWQM program.

River Name	Total Phosphorus (µg/l)	Nitrate-Nitrogen (µg/l)	Total Nitrogen (µg/l)	Chloride (mg/l)	Specific Conductivity (µS/cm)
Bear River	9.7	158	381	13.7	297.3
Black River	5.8	28	302	5.3	277.2
Boyne River	4.3	366	520	9.8	369.2
Cheboygan River	4.8	47	315	7.4	293.3
Crooked River	4.6	191	366	9.3	299.5
Elk River	4.5	224	342	8.4	272.1
Indian River	2.9	107	299	11.6	304.1
Jordan River	6.2	843	1052	8.4	341.3
Little Sturgeon River	5.9	63	241	12.5	309.4
Maple River	5.6	234	483	5.5	262.0
Pigeon River	7.1	51	298	6.0	311.8
Pine River	1.9	284	383	10.1	265.3
Sturgeon River	4.0	195	345	12.5	345.1
AVERAGE (all rivers)	**5.2**	**215**	**410**	**9.3**	**303.7**

These monitoring results are not surprising considering that Elliot Creek drains a largely undeveloped, pristine watershed. However, water temperature data show that the creek does not always attain standards established for streams capable of supporting a cold-water fishery. Approximately 43% of measurements at the two-track site in the headwaters, 6% at Alpena State Rd., 13% at Seffern Rd., and 42% at the mouth, were above the maximum water temperatures established in Michigan WQS (Table 13). Additional water temperature data from a fish population assessment at Seffern Rd. and Alpena State Rd. in 2008 show that monthly averages for summer months were less than 16º Celsius and therefore, meeting WQS (DNR 2008).

Table 13. DEQ maximum stream water temperatures by month.

Month/Temperature	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cold Water Fish Maximum Temperature (Fahrenheit)	38.0	38.0	43.0	54.0	65.0	68.0	68.0	68.0	63.0	56.0	48.0	40.0
Cold Water Fish Maximum Temperature (Celsius)	3.3	3.3	6.1	12.2	18.3	20.0	20.0	20.0	17.2	13.3	8.9	4.4
Warm Water Fish Maximum Temperature (Fahrenheit)	38.0	38.0	41.0	56.0	70.0	80.0	83.0	81.0	74.0	64.0	49.0	39.0
Warm Water Fish Maximum Temperature (Celsius)	3.3	3.3	5.0	13.3	21.1	26.7	28.3	27.2	23.3	17.8	9.4	3.9

The high water temperatures in exceedance of WQS are attributed to the local topography. A very gradual drop in elevation throughout the course of the creek (Figure 17) has led to the formation of extensive riparian wetlands. The wetlands do not support tall tree species that would shade the creek channel, but rather are populated with a mix of shrubs and herbaceous plant species. Aerial imagery show the lack of trees in the immediate riparian zone, which occurs in the lower section of the creek near the mouth and upstream of US 23. The slow-moving and sun-exposed water in these stream sections are thought to be responsible for the elevated water temperatures at the two-track and mouth sites. Interestingly, water temperatures are cooler at the Alpena State Rd. crossing in spite of slow flow and exposure. Groundwater could be emanating from the high slopes surrounding a small tributary of Elliot Creek just upstream of Alpena State Rd. and to the east, which would explain the lower temperatures (Figure 17). In spite of elevated water temperatures in the upper and lower sections, a recent survey at Seffern Road indicates that Elliot Creek supports acceptable trout populations (MDNR 2014).

To supplement physico-chemical monitoring, TOMWC used the DEQ p51 procedure to assess macroinvertebrate communities and habitat. The biological and habitat monitoring were performed two times at three sites on Elliot Creek by TOMWC staff in 2013 and 2014. Macroinvertebrate communities received an excellent score at Seffern Rd., acceptable at Alpena State Rd., and both acceptable and poor at the creek mouth (Table 14). The high scores at Seffern Rd. are attributed to the complexity of in-stream habitat found at the site coupled with cooler water temperatures. Habitat at Alpena State Road site on Elliot Creek and at the Butler Ditch site received a “good” rating, whereas all other sites were rated as “excellent”.

Table 14. Biological and habitat monitoring results for tributaries.

Biological and Habitat Monitoring	Elliot Creek Mouth	Elliot Creek Seffern Rd.	Elliot Creek Alpena State Rd.	Butler Ditch Mouth	Grass Bay Creek Cordwood Shores
Macroinvertebrates 2013	acceptable	excellent	acceptable	poor	acceptable
Macroinvertebrates 2014	poor	excellent	acceptable	poor	acceptable
Habitat 2013 & 2014	excellent	excellent	good	good	excellent

Averaged discharge and loading data reveals some interesting patterns in Elliot Creek. As expected, discharge increases in a downstream direction in Elliot Creek (Table 15). Total nitrogen load also increases in a downstream direction. Total phosphorus and suspended solids however, increase from upstream to mid-stream and then, drop considerably at the mouth. Sediments washing in from road-stream crossings may contribute to the high phosphorus and solid loads in the upper stream sections. Decaying vegetation in the abundant riparian wetlands in the upper watershed may also contribute to the total phosphorus load. The reduction in the phosphorus load in the lower section may be the result of biological uptake, whereas solids probably fall out in the flat areas the creek passes through as it approaches Lake Huron.

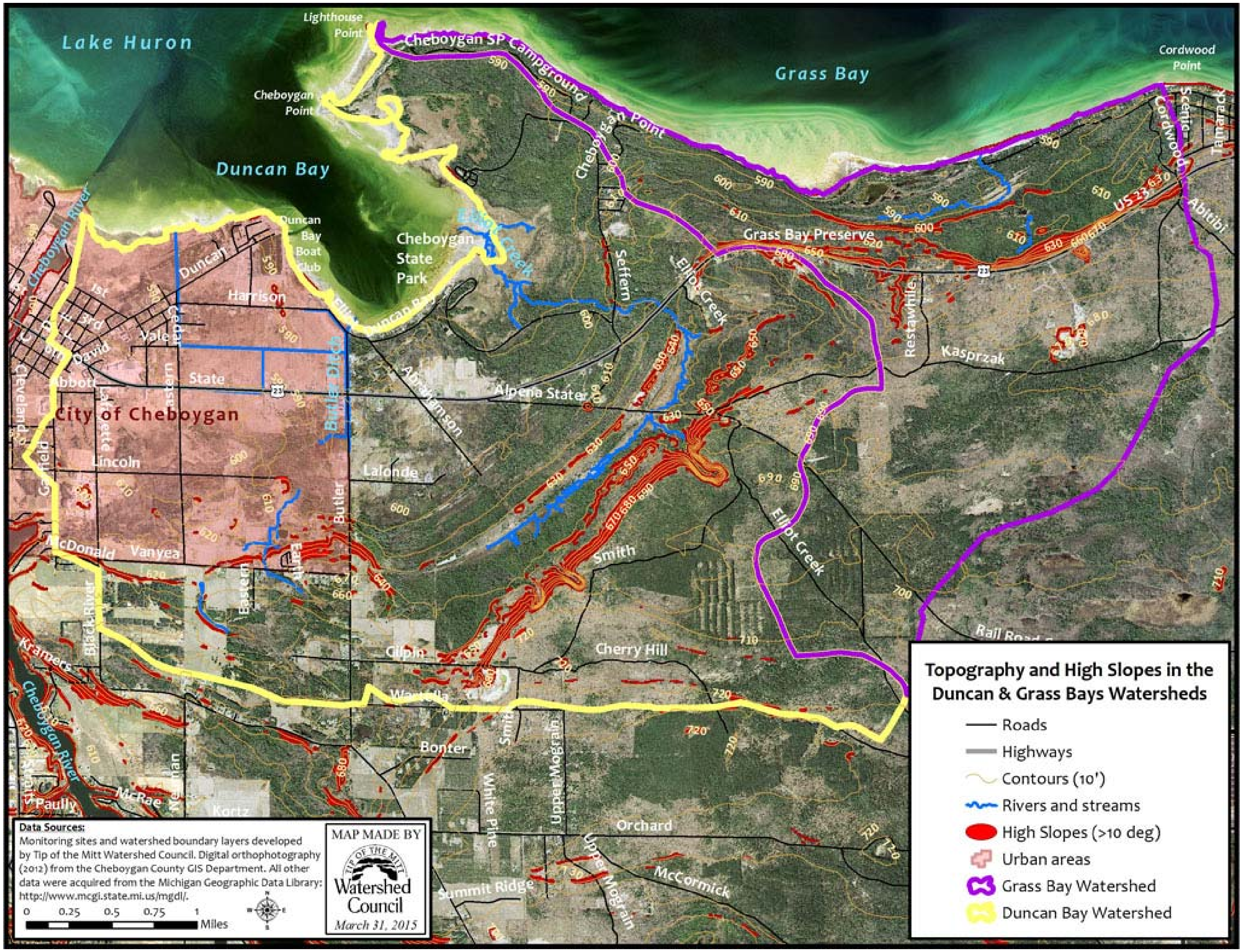


Figure 17: Topography and High Slopes in the Duncan and Grass Bay Watershed

Table 15. Discharge and pollutant loads in the tributaries.

Discharge and Loads*	Elliot Creek Mouth	Elliot Creek Seffern Rd.	Elliot Creek US23	Elliot Creek Alpena State Rd.	Elliot Creek Two Track	Butler Ditch Mouth	Grass Bay Creek Cordwood Shores
Discharge: Low	0.9	4.6	4.6	1.5	ND	0.1	0.9
Discharge: High	23.6	14.4	7.1	5.9	ND	9.5	5.6
Discharge: Average	9.3	6.5	5.9	4.7	ND	2.7	2.4
Phosphorus, Total: Low	8.2	18.3	ND	3.0	ND	2.4	3.1
Phosphorus, Total: High	334.8	423.9	ND	530.3	ND	199.3	217.3
Phosphorus, Total: Average	91.7	129.3	ND	97.9	ND	96.9	47.2
Nitrogen, Total: Low	371.7	138.3	ND	261.6	ND	102.9	173.1
Nitrogen, Total: High	16,541.4	4,207.4	ND	3,326.7	ND	6,187.1	6,067.6
Nitrogen, Total: Average	4,982.7	2,000.5	ND	1,419.6	ND	2,809.3	1,032.1
Suspended Solids: Low	1,418.6	9,378.0	ND	2,915.3	ND	915.2	1,190.9
Suspended Solids: High	79,056.2	256,609.6	ND	532,464.5	ND	344,486.7	98,798.4
Suspended Solids: Average	31,903.4	72,297.8	ND	60,160.1	ND	77,840.5	20,853.6

Units: discharge in cubic feet per second and loads in pounds per year. ND=no data.

Butler Ditch

The Butler Ditch drains a large area on the east side of the City of Cheboygan that includes residential, commercial, industrial, agricultural, and undeveloped areas. Stormwater runoff from these areas invariably picks up pollutants from the landscape, such as sediments and nutrients. The polluted runoff is conveyed via ditches to the channelized outlet at the intersection of Butler Rd. and Elliot St., which flows into Lake Huron to the west of Cheboygan State Park.

The monitoring data from Butler Ditch clearly demonstrate the negative impacts associated with polluted runoff. Averaged data show that Butler Ditch had the lowest dissolved oxygen concentrations, while having the highest conductivity, total phosphorus, total nitrogen, suspended solid, and chloride levels among all sites monitored in the Duncan and Grass Bay Watersheds (Table 11). Dissolved oxygen measurements were below the WQS minimum of 7 mg/L for cold-water fisheries during 3 of 11 monitoring events and even below the warm-water minimum of 5 mg/L during two of these events. Averaged total phosphorus and total nitrogen concentrations were well above USEPA reference conditions. In addition, conductivity and chloride levels in Butler Ditch were found at very high levels relative to other streams in Northern Michigan (Table 11,

Table 12).

Research shows that conductivity and chloride are good indicators of human disturbance in a watershed, particularly from urban landuse (Jones and Clark 1987, Lenat and CrawfoRd. 1994, Herlihy et al. 1998).

The discharge and pollutant loading data also illustrate the degree of pollution occurring in Butler Ditch. In spite of contributing less than one third the amount of discharge to Duncan Bay, compared with Elliot Creek, on average Butler Ditch contributes a greater load of suspended solids and total phosphorus to the Bay (Table 15). Furthermore, the ditch contributes more total nitrogen to the Bay than Elliot Creek, relative to discharge.

There are many potential impacts to Duncan Bay resulting from the polluted discharge from Butler Ditch. It has been estimated that one pound of phosphorus could stimulate 500 or more pounds of algae growth. Therefore, heavy phosphorus inputs into Duncan Bay could result in nuisance algae and plant growth, which could, in turn, degrade water quality and alter the natural lake ecosystem. Although not the limiting nutrient, excessive nitrogen in the ecosystem could cause shifts in the aquatic food web, beginning with changes in algal communities. In addition, there is evidence that high nitrogen levels drive invasion by non-native species, such as *Phragmites australis* and *Typha angustifolia* (Currie et. al., 2014). Excessive sediments clog fish gills, injure aquatic life by abrasion, degrade habitat by filling interstitial spaces, and elevate water temperatures by absorbing sunlight energy. Furthermore, pollution in the creek may have contributed to the high bacteria counts at Cheboygan State Park beach.

Figure 18: Butler Ditch

Grass Bay and Tributaries

Grass Bay includes the nearshore area of Lake Huron that extends east to west from Lighthouse Point on the Cheboygan State Park peninsula to Cordwood Point (Figure 15). The shoreline and the watershed afford Grass Bay a great deal of protection. Several minute streams flow into Grass Bay, the largest of which is located at the west end of Cordwood Shores Drive and is referred to in this report as Grass Bay Creek. DEQ 205j-funded monitoring during 2013 and 2014 provide the water quality data to assess Grass Bay and Grass Bay Creek. The only other data available are limited to just a handful of measurements on Grass Bay Creek recorded by USFWS between 1970 to 1978.

Mirroring Duncan Bay, averaged DEQ 205j-funded monitoring data show high water quality in Grass Bay (Table 16). Dissolved oxygen concentrations were consistently above the Michigan WQS minimum of 7 milligrams per liter (mg/L) for waters capable of sustaining cold-water fisheries. Chloride concentrations were far below the USEPA recommended limit of 230 mg/L for chronic toxicity and 860 mg/L for acute toxicity (USEPA, 2012). Suspended solids were also low and in the range of what is generally considered to be clear (<=20 mg/L). Total phosphorus levels were also quite low and, on average, below USEPA reference conditions of 9.7 micrograms per liter (µg/L). Averaged total nitrogen concentrations was slightly above the USEPA reference condition of 323 µg/L. Data show that pH levels in Grass Bay consistently meet Michigan WQS requiring surface waters to maintain a pH in the range of 6.5 to 9.0.

Table 16. Water quality data for Grass Bay.

PARAMETER	Low Value	Low Date	High Value	High Date	Average
Dissolved Oxygen (mg/L)	9.6	8/1/2013	13.4	5/20/2014	11.3
Conductivity (µS/cm)	194.7	11/3/2014	261.5	8/30/2013	218.2
pH	8.2	10/24/2014	8.9	6/30/2014	8.5
Nitrate-Nitrogen (µg/L)	120.0	11/3/2014	233.0	5/8/2007	119.3
Total Nitrogen (µg/L)	237.0	8/1/2013	577.0	10/24/2014	328.5
Total Phosphorus (µg/L)	0.2	10/29/2013	57.0	10/24/2014	6.4
Chloride (mg/L)	7.6	11/3/2014	11.4	11/15/2013	9.4
Suspended Solids (mg/L)	0.3	8/1/2013	10.7	11/3/2014	1.7

Monitoring data also show high water quality in Grass Bay Creek. Dissolved oxygen concentrations were consistently above the Michigan WQS of 7 milligrams per liter (mg/L) for cold-water fisheries (Table 11). Chloride concentrations were far below the USEPA recommended limit of 230 mg/L for chronic toxicity and 860 mg/L for acute toxicity (USEPA, 2012). Relative to CWQM data, averaged specific conductivity levels were typical for Northern Michigan streams (

Table 12).

All pH readings fell within the range of 6.5 to 9.0 required for all Michigan surface waters according to WQS Rule 53. The majority of total phosphorus and total nitrogen concentrations in Grass Bay Creek were below USEPA reference conditions of 12 µg/L and 440 µg/L respectively. On average, suspended solids were well below 20 mg/L, indicating clear waters. Furthermore, biological monitoring data showed acceptable aquatic macroinvertebrate diversity and excellent in-stream habitat (Table 14).

Nonpoint source pollution can originate from a variety of sources within the landscape. In order to identify those sources within the Duncan and Grass Bays Watershed, the following resource inventories were conducted as part of the DEQ-funded Duncan and Grass Bays Watershed Management Project. They include:

- Road/stream crossing inventory
- Streambank erosion
- Shore survey
- Stormwater

It is important to note, that while most watershed management plans include agricultural and forestry inventories, as both practices can contribute to nonpoint source pollution, the Duncan and Grass Bays Watershed does not. It was determined that neither forestry nor agricultural practices are significant enough within the Watershed to pose a very substantial threat to water quality. It is important to note that one or both practices may become more prevalent in the future and should be included, or at least considered, in future watershed management plan projects and updates.

Road/stream Crossing Inventory

Road/stream crossings that are improperly designed or installed, structurally failing, or no longer accommodate current stream conditions affect stream health. They can affect stream hydrology, prevent fish and other aquatic organisms from reaching up-and downstream reaches, increase water temperatures, and are sources of nutrients, sediments, bacteria, heavy metals, and other nonpoint source pollutants.

In Northern Michigan, sediments pose the greatest threat to rivers and streams. Sedimentation can adversely impact fish and aquatic organisms by degrading their habitat and reducing water quality.

Road/stream crossing inventories serve as a useful watershed management tool. They help to identify sediment pollution entering surface waters from poorly designed, maintained, or aging infrastructure; fish passage barriers due to perched culverts or velocity barriers; and altered stream hydrology due to inadequately designed or installed crossings. Therefore, identifying failing or deficient road/stream crossings is critical to resource management. Regular inventorying of road/stream crossings allows road commissions and resource managers to note changes in stream and structure conditions over time. Furthermore, road/stream crossings can be ranked as minor, moderate, or severe as a means of prioritizing them for improvements or replacement.

During the summer of 2013, Tip of the Mitt Watershed Council performed a road/stream crossing inventory for the Duncan and Grass Bays Watershed. The inventory followed the Great Lakes

Road/Stream Crossing Inventory protocol established (2011) by the U.S. Forest Service, U.S. Fish and Wildlife Service, Michigan Department of Natural Resources, Wisconsin Department of Natural Resources, Huron Pines, Conservation Resource Alliance, Michigan Technological University, and road commissions. See Appendix 5 for the inventory form used in the field to record data. Data was later entered into an Access Database and uploaded to www.northernmichiganstreams.org in collaboration with Land Information and Access Network (LIAA). In total, six road/stream crossings were inventoried (

Table 17; Figure 19; Figure 16; Figure 20; Figure 21).

Table 17: Road/stream Crossing Inventory Results

Site ID	Stream Name	Location	Extent of Erosion	Fish Passage	Severity	Erosion (tons/year)
DG 24	Elliot Creek	Seffren Rd.	Stabilized	0	Severe	0.1542
DG 23	Elliot Creek	U.S. 23	Stabilized	0.9	Minor	NA
DG 26	Grass Bay Creek	Cordwood Shores West	Stabilized	0.9	Minor	0.0592
DG 35	Eastern Ave. ditch	Eastern and Duncan Rd.	Minor	0.5	Moderate	0.3373
DG 01	Butler Ditch	Butler Rd.	Stabilized	0.5	Moderate	0.0027
DG 21	Elliot Creek	Alpena State Rd.	Severe	0.9	Severe	6.7913

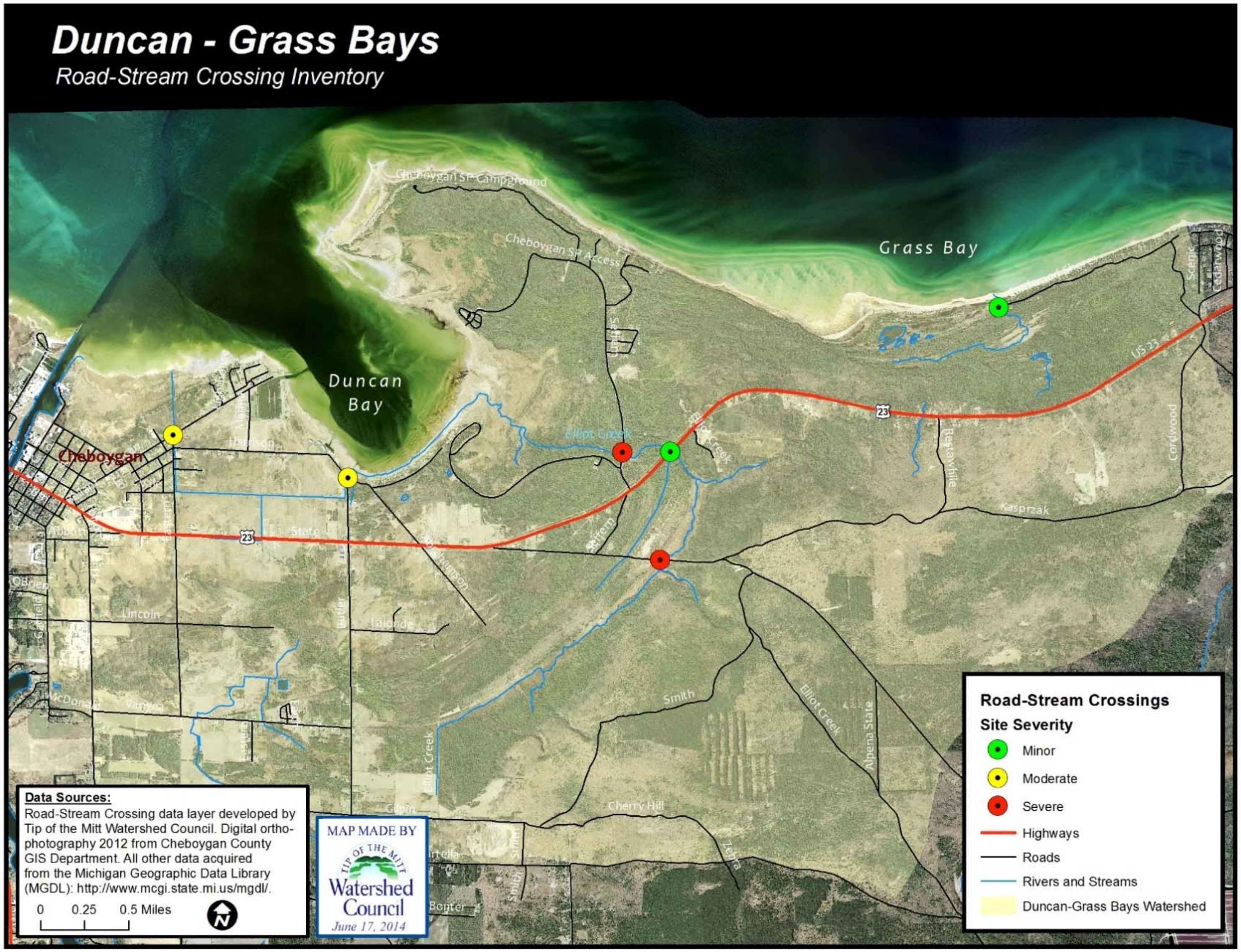


Figure 19: Duncan and Grass Bays Road/Stream Crossing Inventory

Figure 20: Butler Ditch culvert under Butler Rd. (DG 01)

Figure 21: Elliot Creek at Alpena State Road (DG 21)

Pollutant load reductions were calculated for Elliot Creek (

Table 18). Pollutant reduction refers to the annual amount of pollutants that would be saved if these sites were repaired. Estimates were calculated using both the formulas that accompany the Great Lakes Road/Stream Crossing Inventory (Microsoft Access database) and the the Spreadsheet Tool for Estimating Pollutant Load (STEPL). STEPL employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs).

Table 18: Duncan and Grass Bays Watershed Road/Stream Crossing Pollutant Load Reduction

Pollutant	Elliot Creek
Sediment Reduction	7.35 tons/year
Reduction in phosphorus	7.35 lbs./year
Reduction in nitrogen	15 lbs./year

Streambank Erosion Inventory

A streambank inventory of Elliot Creek was conducted during the summer of 2013. Tip of the Mitt Watershed Council walked 2.5 miles from the stream's mouth at Duncan Bay to Alpena State Road. The streambank was not inventoried above Alpena State Road as beaver activity immediately above the road/stream crossing has affected the stream channel to a point where it is not walkable. See Appendix for the Streambank Erosion Assessment Field Form used to document field conditions.

Only four locations (Figure 22) were noted as having erosion. Erosion at two of the locations (DGB 01 and DGB 02) was noted as being natural and not an immediate concern for water quality. Erosion at the other two locations is likely the result of pedestrian access that has compromised the streambank (DGB 03) and because of the road/stream crossing conditions at Alpena State Road (DGB 04). In total, approximately 230 linear feet are experiencing erosion.

Applying the Pollutants Controlled Calculation and Documentation for Section 319 Watersheds (Michigan Department of Environmental Quality, June 1999) workbook, correcting these erosion sites would yield the pollutant load reductions shown in Table 19. Pollutant reduction refers to the annual amount of pollutants that would be saved if these sites were repaired.

Table 19: Duncan and Grass Bays Watershed Streambank Pollutant Load Reductions

Cumulative length of streambank	230 feet
Sediment reduction	5.3 tons/year
Reduction in phosphorus	4.4 lbs/year
Reduction in nitrogen	8.8 lbs/year

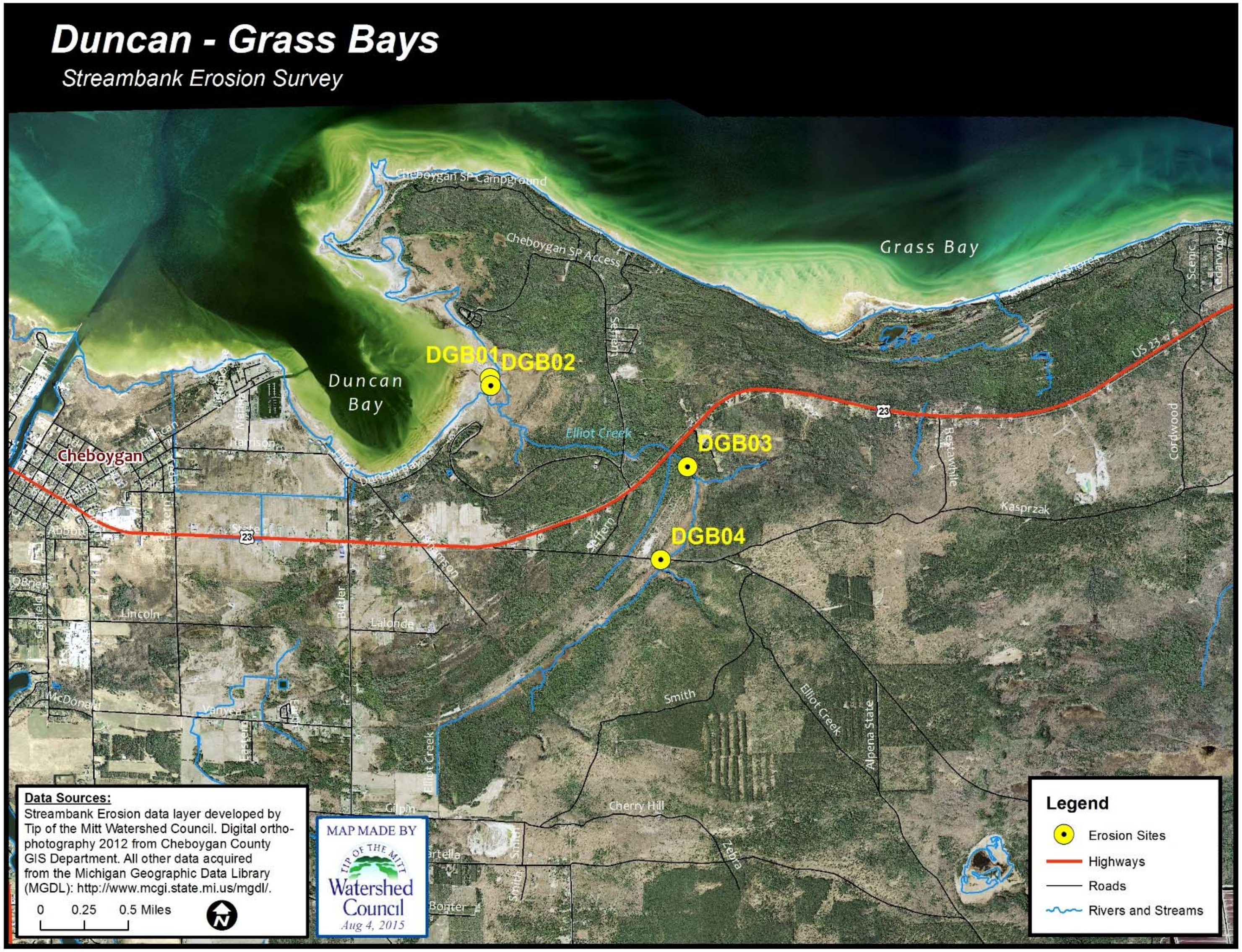


Figure 22: Duncan and Grass Bays Streambank Erosion

Figure 23: Erosion on Elliot Creek (DGB 02)

Figure 24: Erosion on Elliot Creek (DGB 03)

Shore Survey

During the late spring of 2013, a shoreline survey was conducted on Duncan and Grass Bays by Tip of the Mitt Watershed Council to document shoreline conditions that potentially impact water quality. All shoreline properties were surveyed to document the following: *Cladophora* algae growth as a nutrient pollution indicator, erosion, alterations, greenbelts, bottomland vegetation, and streams. No prior shoreline surveys had been performed on Duncan and Grass Bays.

The 2013 assessment of shoreline conditions on Duncan and Grass Bays provides a valuable dataset that can be used to improve shoreline management. Through follow-up activities, such as on-site consultations, problems in shoreline areas that threaten the water quality can be identified and corrected. These solutions are often simple and low cost, such as regular septic system maintenance, shoreline plantings, proper lawn care practices, and low impact development along the shoreline. Problems in shoreline areas can be prevented by promoting education and awareness of the survey and ecologically friendly approaches to shoreline property management. Periodic repetition of shoreline surveys is important for identifying new and chronic problem sites, determining long-term trends in near-shore nutrient inputs, greenbelts, erosion, and shoreline alterations associated with land-use changes, and for monitoring and assessing the success of remedial actions.

Shoreline Development Impacts

Lake shorelines are the critical interface between land and water, where human activity has the greatest potential for degrading water quality. Developing shoreline properties for residential, commercial, or other uses invariably has negative impacts on the lake ecosystem. During the development process, the natural landscape is altered in a variety of ways: vegetation is removed, the terrain is graded, utilities are installed, structures are built, and areas are paved. These changes to the landscape and subsequent human activity in the shoreline area have consequences on the aquatic ecosystem. Nutrients from wastes, contaminants from cars and roads, and eroded soils are among some of the pollutants that reach and negatively impact the lake following shoreline development.

Nutrient pollution can create a recreational nuisance, adversely impact aquatic ecosystems, and lead to conditions that pose a danger to human health. Although nutrients are necessary to sustain a healthy aquatic ecosystem, excess can result in nuisance and potentially harmful algal and aquatic plant growth. Excessive aquatic macrophyte growth (i.e., vascular aquatic plants) and heavy algal blooms that form mats and scum at the lake's surface can become a recreational nuisance. Algal blooms also pose a public health risk as some species produce toxins, including hepatotoxins (toxins that cause liver damage) and neurotoxins (toxins that affect the nervous system). Furthermore, excess algal and aquatic plant growth can degrade water quality by depleting the ecosystem's dissolved oxygen stores. Decomposition of dead algae and plant material reduces dissolved oxygen supplies due to the aerobic activity of decomposers, which is particularly problematic in the deeper waters of stratified lakes. The problem becomes particularly acute during nighttime respiration, when plants compete with other organisms for a limited oxygen supply.

Large, deep lakes, such as Lake Huron, are more resilient to water quality impacts caused by nutrient pollution than smaller inland lakes because they have greater water volume and therefore, greater capacity for diluting pollutants and storing dissolved oxygen. In addition, Lake Huron is a drainage lake with inflows and outflows, which provide the means to flush excess nutrients out of the system. In spite of Lake Huron's resilience to nutrient pollution due to lake size and flushing, unnaturally high nutrient concentrations can cause problems in localized areas, particularly near sources along the shoreline.

Surface waters receive nutrients through a variety of natural and cultural (human) sources. Natural sources of nutrients include stream inflows, groundwater inputs, surface runoff, organic inputs from riparian (shoreline) areas, and atmospheric deposition. Springs, streams, and artesian wells are often naturally high in nutrients due to the geologic strata they encounter and wetland seepages may discharge nutrients at certain times of the year. Cultural sources include septic and sewer systems, fertilizer application, and stormwater runoff from roads, driveways, parking lots, roofs, and other impervious surfaces. Poor agricultural practices, soil erosion, and wetland destruction also contribute to nutrient pollution. Furthermore, some cultural sources (e.g., malfunctioning septic systems and animal wastes) pose a potential health risk due to exposure to bacteria and viruses.

Severe nutrient pollution is detectable through chemical analyses of water samples, physical water measurements, and the utilization of biological indicators (a.k.a., bio-indicators). Chemical analyses of water samples can be effective, though costlier and more labor intensive than other methods. Typically, water samples are analyzed to determine nutrient concentrations (usually forms of phosphorus and nitrogen), but other chemical constituent concentrations can be measured, such as chloride, which are related to human activity and often elevated in areas impacted by malfunctioning septic or sewer systems. Physical measurements are primarily used to detect leachate from these systems, which can cause localized increases in water temperature and conductivity (i.e., the water's ability to conduct an electric current). Biologically, nutrient pollution can be detected along the lakeshore by noting the presence of *Cladophora* algae.

Cladophora is a branched, filamentous green algal species that occurs naturally in small amounts in Northern Michigan lakes. Its occurrence is governed by specific environmental requirements for temperature, substrate, nutrients, and other factors. *Cladophora* is found most commonly in the wave splash zone and shallow shoreline areas of lakes and can also be found in streams. It grows best on stable substrates such as rocks and logs, though artificial substrates such as concrete or wood seawalls are also suitable. *Cladophora* prefers water temperatures of 50 to 70 degrees Fahrenheit. Consequently, the optimal time for its growth and detection in Northern Michigan lakes is generally during the months of May, June, September, and October.

The nutrient requirements for *Cladophora* to achieve large, dense growths are typically greater than the nutrient availability in the lakes of Northern Michigan. Therefore, shoreline locations where relatively high concentrations of nutrients, particularly phosphorus, are entering a lake can be identified by noting the presence of *Cladophora*. Documenting the size and density of *Cladophora* helps interpret causal factors on an individual basis. However, the description has limited value when making year to year comparisons at a single location or estimating the relative amount of shoreline nutrient inputs because growth features are greatly influenced by current patterns, shoreline topography, size and distribution of substrate, and the amount of wave action on the shoreline. Rather, the presence of any significant growth at a single site over several years is the most indicative of elevated nutrient concentrations in shoreline areas. It can reveal the existence of chronic nutrient loading problems, help interpret the cause of the problems, and assess the effectiveness of any remedial actions. Comparisons of the total number of algal growths can reveal trends in nutrient inputs due to changes in land use or land management practices.

Erosion along the shoreline has the potential to degrade a lake's water quality. Stormwater runoff through eroded areas and wave action along the shoreline contribute sediments to the lake, which negatively impacts the lake ecosystem. Sediments clog the gills of fish, aquatic insects, and other aquatic organisms. Excessive sediments smother fish spawning beds and fill interstitial spaces that provide habitat for a variety of aquatic organisms. While moving through the water column, sediments absorb sunlight energy and increase water temperatures. In addition, nutrients adhere to sediments that wash in from eroded areas.

Shoreline greenbelts are essential for maintaining a healthy aquatic ecosystem. A greenbelt consisting of a variety of native woody and herbaceous plant species provides habitat for near-shore aquatic organisms as well as terrestrial animals. Greenbelts naturally function to control erosion by stabilizing the shoreline with plant root structures that protect against wave action and ice. The canopy of the greenbelt provides shade to near-shore areas, which helps to maintain cooler water temperatures and higher dissolved oxygen levels. In addition, greenbelts provide a mechanism to reduce overland surface flow and absorb pollutants carried by stormwater from rain events and snowmelt.

Tributaries have great potential for influencing a lake's water quality as they are one of the primary conduits through which water is delivered to a lake from its watershed. Inlet streams may provide exceptionally high quality waters that benefit the lake ecosystem, but conversely have the potential to deliver polluted waters that degrade the lake's water quality. Outlet streams flush water out of the lake, providing the means to remove contaminants that have accumulated in the lake ecosystem. With regards to shore surveys, noting the location of inlet tributaries is beneficial when evaluating shoreline algae conditions because nutrient concentrations are generally higher in streams than in lakes. The relatively higher nutrient levels delivered from streams often lead to heavier *Cladophora* and other algae growth in nearby shoreline areas.

Responsible, low-impact, shoreline property development and best management practices are paramount for protecting water quality. Maintaining a healthy greenbelt, regular septic tank pumping, treating stormwater with rain gardens, correcting erosion sites, and eliminating fertilizer, herbicide, and pesticide application are among many low-cost best management practices that minimize the impact of shoreline properties on lake water quality. Living in harmony with the lake and practicing responsible stewardship are vitally important for sustaining a healthy and thriving lake ecosystem.

Results

This survey documented shoreline conditions at 180 parcels on Duncan and Grass Bays, (105 parcels on Duncan Bay and 75 on Grass Bay). The length of shoreline per parcel varied from less than 30 feet to more than a mile. Approximately 72% (129 parcels) of shoreline properties on Duncan and Grass Bays were considered to be developed.

Survey results indicate that human activity along the Duncan and Grass Bays shoreline probably has negative impacts to the lake ecosystem and water quality of Lake Huron.

- Habitat generally considered suitable for *Cladophora* growth was present along at least part of the shoreline of 81 properties (77%) in Duncan Bay and 27 properties (36%) in Grass Bay (Table 20). Noticeable growths of *Cladophora* or other filamentous green algae were found along the shoreline *only in Duncan Bay at 43 parcels (41%)*, which represents 53% of properties with suitable habitat. Only one property had *Cladophora* growth that was considered to be heavy. *Cladophora* was not noted on any parcel within Grass Bay (Figure 25).
- Approximately 45% of greenbelts in Duncan Bay were found to be in poor condition, while over 50% were in good or excellent condition. Nearly all greenbelts in Grass Bay were in good or excellent condition.
- Erosion was documented at 13% of properties in Duncan Bay and 4% in Grass Bay.
- Approximately 41% of properties in both Bays had altered shorelines.
- Relative to other surveys conducted on lakes in the region, Duncan Bay had a high percentage of properties with *Cladophora* algae growth, poor greenbelts, erosion, and altered shorelines while Grass Bay had less than the average.

Maps were developed to display and examine patterns in the occurrence of *Cladophora* growths, poor greenbelts, and shoreline erosion on the shorelines of Duncan and Grass Bays. The only shoreline area where *Cladophora* was observed was the southwest side of Duncan Bay, including within the Duncan Bay Boat Club Marina (Figure 25). Poor greenbelts were also only documented in Duncan Bay. Clusters of properties with poor greenbelts occurred within the Duncan Bay Boat Club Marina and extended north and west for one-third mile, as well as along a one-quarter mile shoreline section in the southern end of the Bay (Figure 26). Incidentally, shoreline erosion was documented in the same shoreline area as poor greenbelts, extending northwest from the Duncan Bay Boat Club approximately one-half mile.

Table 20: *Cladophora* density results

***Cladophora* Density**	**Duncan Bay Properties (Number)**	**Duncan Bay Properties (%)**	**Grass Bay Properties (Number)**	**Grass Bay Properties (%)**
Very Heavy	1	1	0	0
Heavy	0	0	0	0
Moderate to Heavy	0	0	0	0
Moderate	0	0	0	0
Light to Moderate	0	0	0	0
Light	36	34	0	0
Very light	6	6	0	0
None	62	59	75	100
TOTAL	105	100	75	100

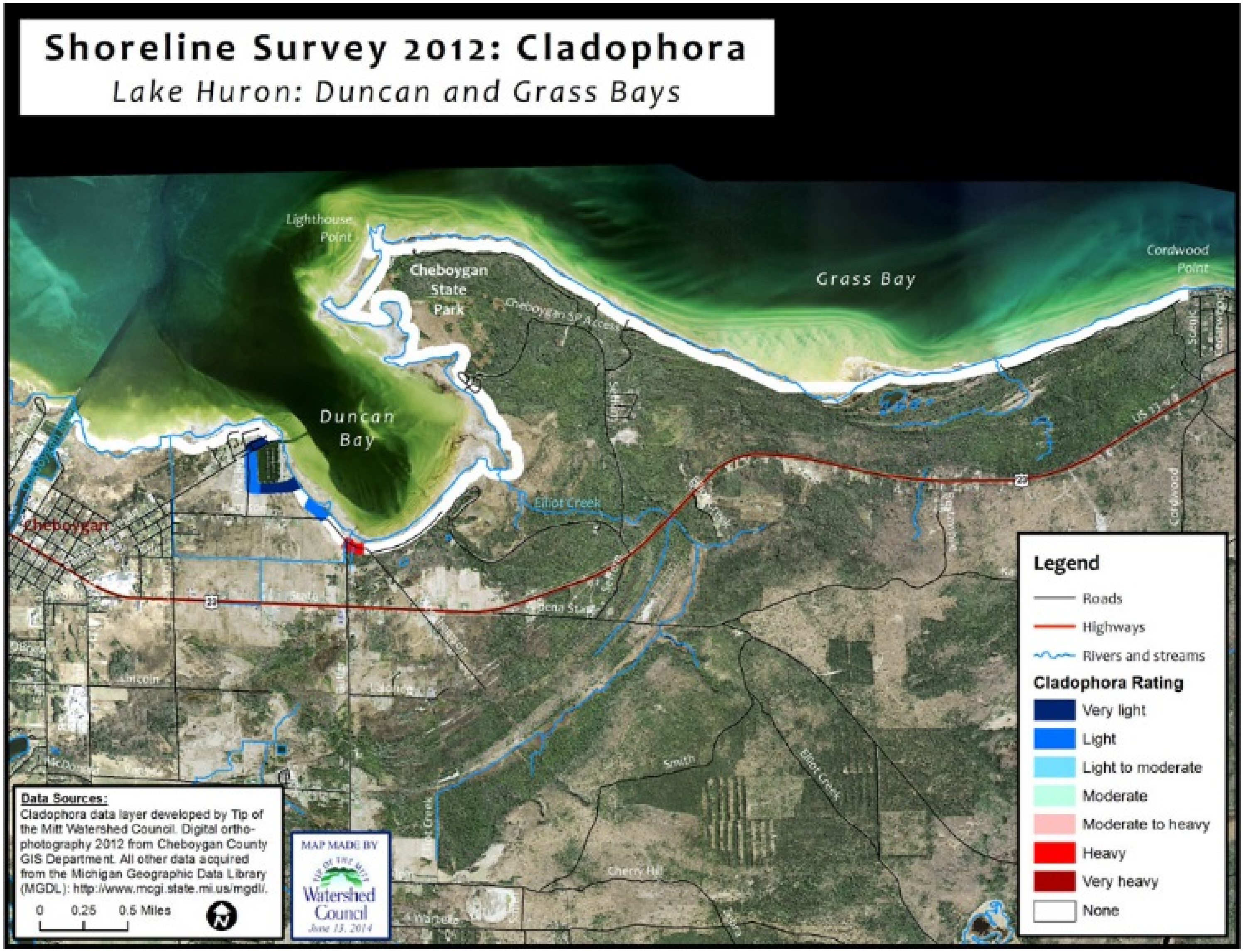


Figure 25: Nutrient Pollution (*Cladophora* algae) Results

Greenbelt scores ranged from 0 (little to no greenbelt) to 7 (exemplary greenbelt). Over half of the greenbelts in Duncan Bay were found to be in good or excellent condition, while 45% received a greenbelt rating in the poor or very poor categories (Table 21). Nearly all shoreline properties in Grass Bay were found to be in good or excellent condition (Figure 26).

Some form of shoreline alteration was noted at 74 shoreline properties (41%) on Duncan and Grass Bays (Table 22). The majority of alterations consisted of riprap (32%), while seawalls accounted for approximately 9%. Seawalls and riprap both present at the same property accounted for another 28% of shoreline alterations (Figure 27; Figure 28).

Table 21: Greenbelt Rating Results

Greenbelt Rating	Duncan Bay Properties (Number)	Duncan Bay Properties (%)	Grass Bay Properties (Number)	Grass Bay Properties (%)
0 = Very Poor*	22	21	0	0
1-2 = Poor	25	24	0	0
3-4 = Moderate	4	4	1	1
5-6 = Good	35	33	15	20
7 = Excellent	19	18	59	79
TOTAL	105	100	75	100

**Very poor= indicative of a property with no vegetation beyond mowed turf grass at the lake edge.*

Table 22: Shoreline Alteration Results

Alteration Type	Both Bays # of parcels	Both Bays % of parcels
Riprap (small)	2	2
Riprap (boulder)	22	30
Seawalls	7	9
Mixed*	21	28
Beach Sand	15	21
Other†	7	10
TOTAL	74	100

**Mixed means both riprap and seawall present.*

†Other includes rock groins, boat ramps, or boat houses.

Erosion was noted at 20 parcels (~13%) on the Duncan Bay shoreline and three parcels (4%) in Grass Bay (Table 23). Over 60% of shoreline properties with erosion were classified as moderate in terms of severity, but not one property was found to be experiencing severe erosion.

Table 23: Shoreline Erosion Results

Erosion Category	Duncan Bay Properties (Number)	Duncan Bay Properties (%)	Grass Bay Properties (Number)	Grass Bay Properties (%)
Minor	6	30	3	100
Moderate	14	70	0	0
Severe	0	0	0	0
TOTAL	20	100	3	100

Tributaries (e.g., streams, creeks) were documented at 24 properties. The actual number could be lower because occasionally tributaries located between land parcels are tallied for both properties.

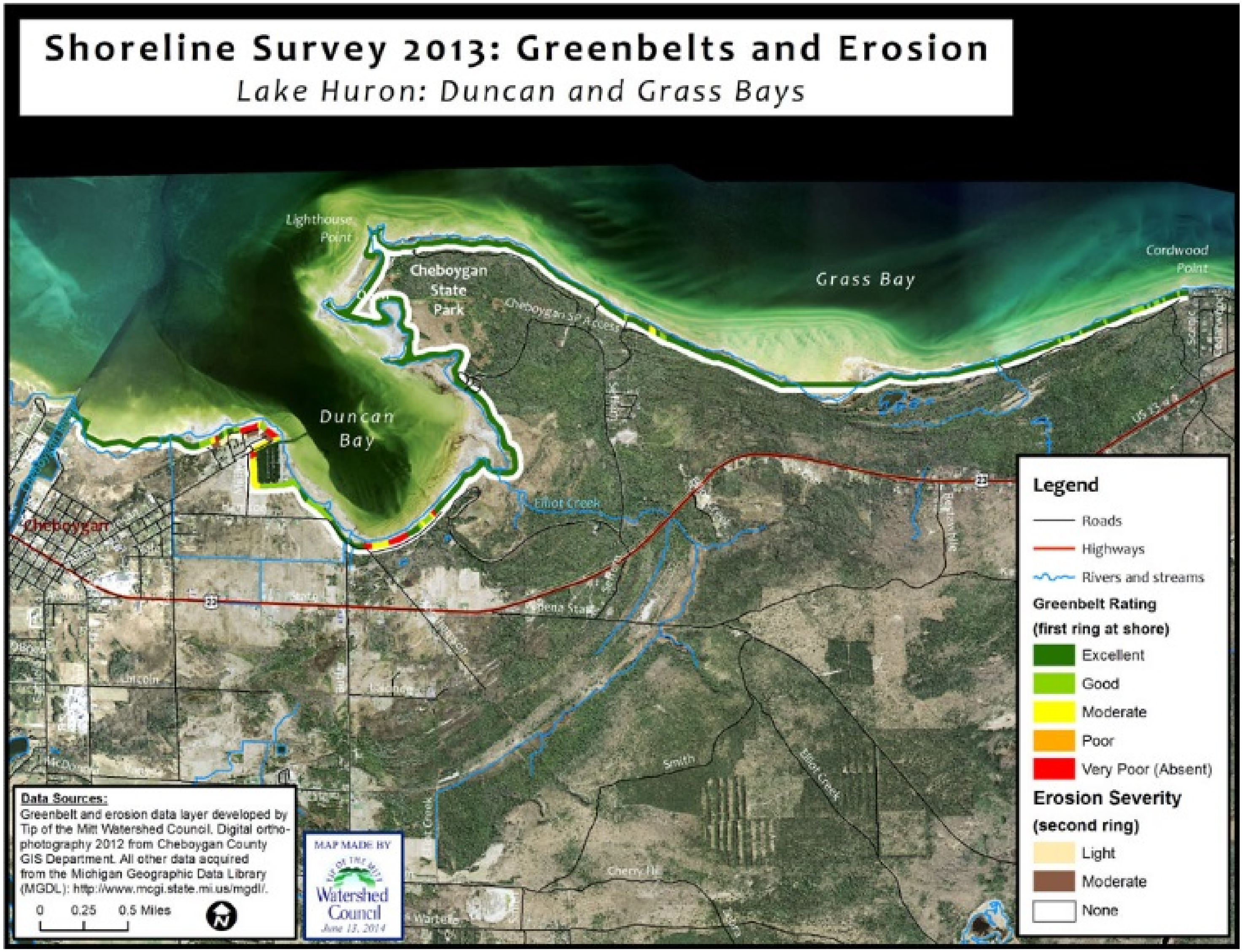


Figure 26: Greenbelt and Erosion Results

Figure 27: Beach Grooming (2013)

Figure 28: Condominium complex on Duncan Bay

The shore survey results serve as an excellent tool to begin discussions with shoreline property owners regarding shoreline maintenance. Unlike inland lake shorelines and streambank erosion assessments, these results do not yield data that can be used to determine accurate pollutant loading calculations. Although erosion was noted as part of the survey, specific information (i.e. dimensions, severity) was not noted. Erosion along Duncan and Grass Bays is not considered a significant source of nonpoint source pollution within the Watershed.

Invasives Species

In addition to inventorying the shoreline conditions previously discussed, Tip of the Mitt Watershed Council also documented occurrences of both native and invasive *Phragmites* along the Duncan and Grass Bays shoreline. In total, 45 stands were noted, with 38 consisting of native *Phragmites* and seven stands of the invasive varieties. The total area of the 45 stands comprises 1.87 acres. Invasive *Phragmites* totaled .35 acres, with native *Phragmites* comprising the remaining 1.52 acres. No other invasive species were included as part of the survey, but other species (e.g. purple loosestrife) are invariably present. *Phragmites* was surveyed due to its highly invasive nature and the potential impact it can have on Great Lakes coastal areas.

In addition, the Northeast Michigan Cooperative Weed Management Area (CWMA) works within Iosco, Alcona, Alpena, Presque Isle, Cheboygan, Otsego, Montmorency, Crawford, Oscoda, Roscommon and Ogemaw Counties. Their goal is to stop the introduction, spread, and distribution of invasive weed species in the ecosystems along the Lake Huron shoreline and adjacent ecosystems to which it connects. The Northeast Michigan CWMA focuses on the fight against invasive species along the Lake Huron shoreline in Northeast Michigan, but also includes inland invaders as well.

Figure 29: Native *Phragmites* at Seffren Road in Cheboygan State Park

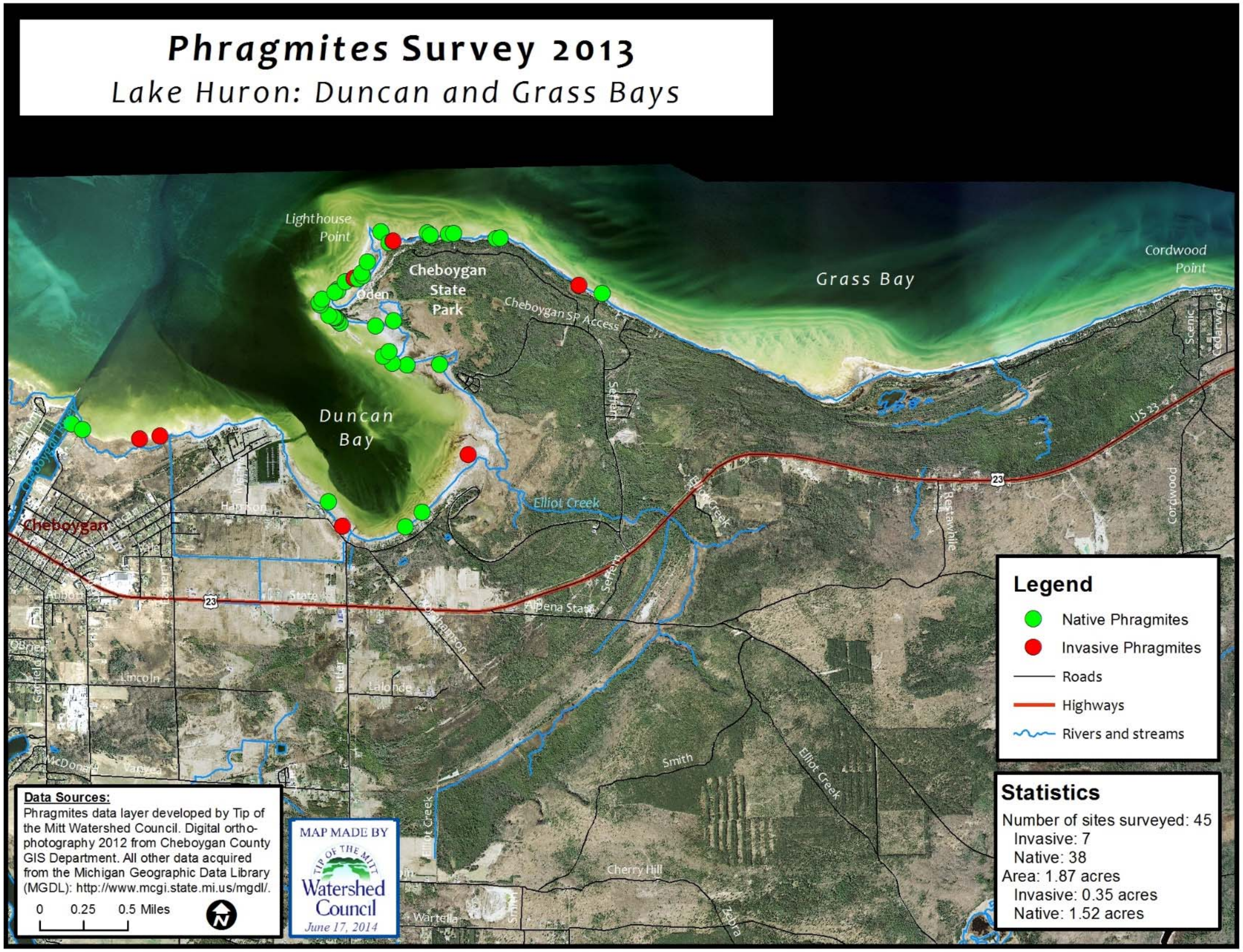


Figure 30: Phragmites Survey 2013

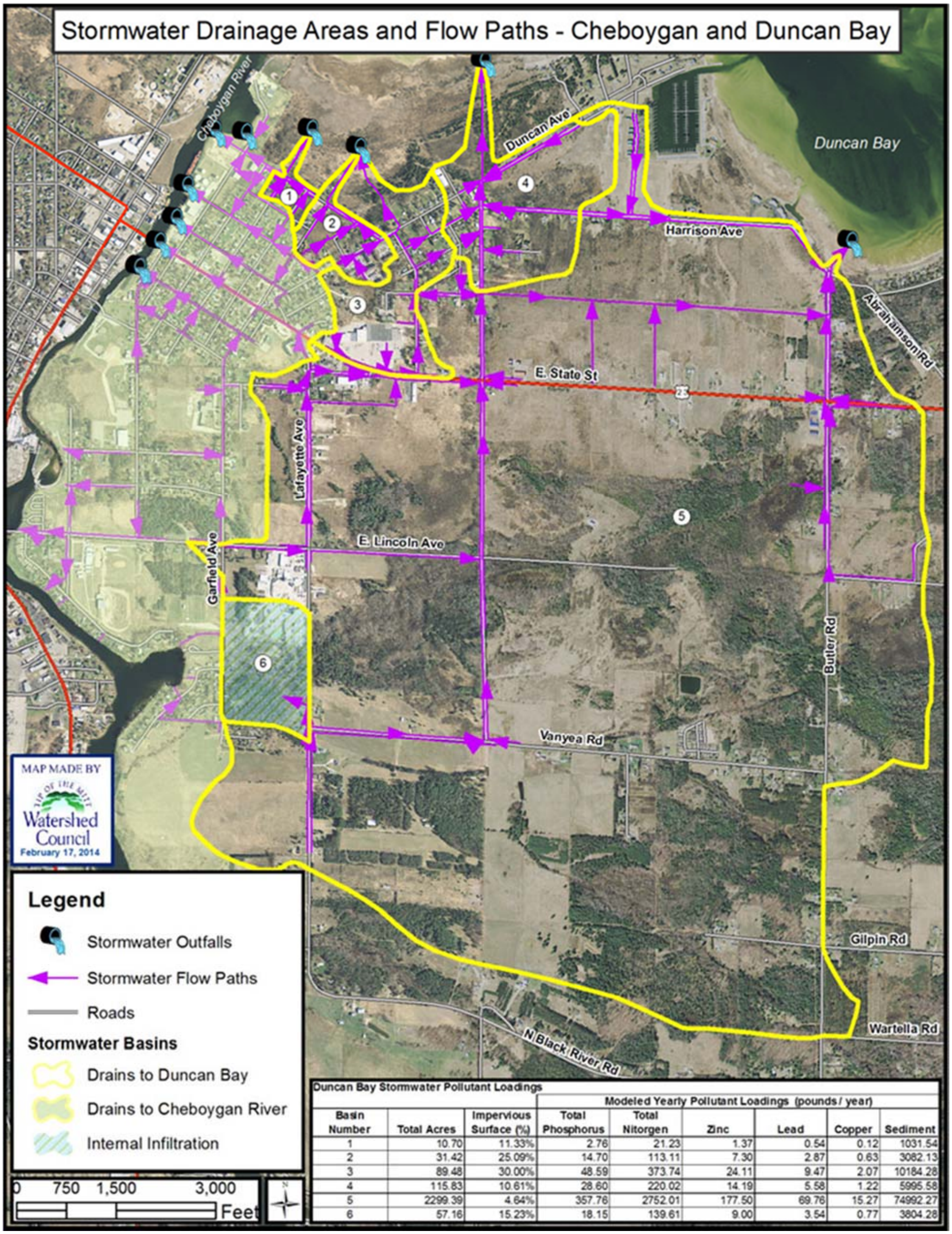
Stormwater Inventory

Stormwater runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not infiltrate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates pollutants that can adversely affect water quality if the runoff is discharged untreated. Nutrients used in fertilizers applied to lawns and gardens, pet waste, and sediments from soil particles that are washed away from bare spots in lawns and gardens, roadways, and other areas of exposed soils are just a few examples of nonpoint source pollutants.

During the spring of 2014, Tip of the Mitt Watershed Council conducted a Stormwater assessment. Watershed Council staff met with officials from the City of Cheboygan Department of Public Works who provided information about storm sewer infrastructure and drainage patterns. Staff utilized the information provided by the City, along with aerial imagery and topographic maps, to perform field reconnaissance and locate storm sewer outfalls, identify stormwater infrastructure (e.g., detention basins), and delineate stormwater drainage areas. All information was used to develop a GIS data layer that represents storm drainage areas in the developed area of Duncan Bay. In addition, another map layer for impervious surfaces, such as buildings, roads, and sidewalks was developed in a GIS using 2012 orthophotographs obtained from Cheboygan County.

Stormwater drainage areas were mapped and pollutant loadings estimated for the developed area surrounding Duncan Bay, which includes the City of Cheboygan east of the Cheboygan River. To determine the full extent of stormwater impacts, drainage areas were delineated to the most detailed extent possible. The majority of basins delineated occurred within the urbanized area of Cheboygan. Development within this 930-acre area includes single-family homes, multiple family condominium complexes, individual businesses, a commercial downtown area, and industrial complexes.

The Duncan Bay stormwater assessment identified six distinct drainage areas: five areas with conduits that transport stormwater (e.g., pipe, ditch) into the Bay, and one area where stormwater infiltrates into the ground directly (Figure 31). Of the 3200 acres included in this stormwater assessment, 581 acres were found to drain directly to the Cheboygan River. Nearly all of this area, along with drainage basins one through four and six of Duncan Bay, were considered to be heavily urbanized. Drainage basin five was found to be largely rural, feeding the Butler Ditch, a tributary to Duncan Bay (Figure 18).



Duncan Bay Stormwater Pollutant Loadings

Basin Number	Total Acres	Impervious Surface (%)	Modeled Yearly Pollutant Loadings (pounds / year) Total Phosphorus	Total Nitorgen	Zinc	Lead	Copper	Sediment
1	10.70	11.33%	2.76	21.23	1.37	0.54	0.12	1031.54
2	31.42	25.09%	14.70	113.11	7.30	2.87	0.63	3082.13
3	89.48	30.00%	48.59	373.74	24.11	9.47	2.07	10184.28
4	115.83	10.61%	28.60	220.02	14.19	5.58	1.22	5995.58
5	2299.39	4.64%	357.76	2752.01	177.50	69.76	15.27	74992.27
6	57.16	15.23%	18.15	139.61	9.00	3.54	0.77	3804.28

Figure 31: Stormwater Drainage Areas and Flow Paths-Cheboygan and Duncan Bay

A simple, empirical method developed by the Washington Metropolitan Water Resource Planning board in 1987 was used to estimate pollutant loadings for four important pollutants: sediment, phosphorus, copper, and zinc. The empirical methods utilize stormwater drainage area and impervious surface data to estimate pollutant exports. Although very general in nature, this method is considered precise enough to make reasonable and reliable nonpoint source pollution management decisions at the site-planning level.

Estimates from the empirical model indicate that runoff from the five drainage areas that flow into the Bay collectively contribute large quantities of pollutants on an annual basis (e.g. >450 lbs. of phosphorus and nearly 48 tons of sediment (Table 24)). Infiltration allows for the containment and environmental degradation of nearly 2 tons of sediment and 18 pounds of phosphorus (

Table 25).

Table 24: Duncan Bay Stormwater Pollutant Loading

Duncan Bay Stormwater: Modeled Pollutant Loadings (pounds / year)								
Basin Number	**Total Acres**	**Impervious Surface (%)**	**Total Phosphorus**	**Total Nitrogen**	**Zinc**	**Lead**	**Copper**	**Sediment**
1	10.7	11	3	21	1	<1	<1	1032
2	31.4	25	15	113	7	3	<1	3082
3	89.5	30	49	374	24	10	2	10184
4	115.8	11	29	220	14	6	1	5996
5	2299.4	5	358	2752	176	70	15	74992
Total	2546.8	--	454	3480	222	90	20	95286

Table 25: Duncan Bay Stormwater Pollutant Infiltration

Duncan Bay Stormwater: Modeled Pollutant Loadings (pounds / year)								
Basin Number	**Total Acres**	**Impervious Surface (%)**	**Total Phosphorus**	**Total Nitrogen**	**Zinc**	**Lead**	**Copper**	**Sediment**
6	57.2	15	18	140	9	4	<1	3804

In addition to nutrient and sediment loading of the Bay, stormwater is contributing to thermal pollution. As water flows across the land's surface it is naturally warmed. This effect is increased on pavement and other unnatural surfaces, which absorb more solar energy and reach higher temperatures than natural surfaces. Once the overland flow reaches the receiving water body, unnaturally high temperatures have the potential to negatively impact aquatic flora and fauna.

Table 26: Total Pollutant Loading by Assessment Category

Category	Phosphorus	Nitrogen	Sediment
RSX	7.35 lbs/yr	15 lbs/yr	7.35 tons/yr
Streambank Erosion	4.4 lbs/yr	8.8 lbs/yr	5.3 tons/yr
Shore Survey	NA	NA	NA
Stormwater	472 lbs/yr	3620 lbs/yr	49.5 tons/yr
Total	**+/- 484 lbs/yr**	**+/- 3644 lbs/yr**	**+/- 62.15 tons/yr**

Land Use

Evaluation of nonpoint source (NPS) pollutants for the Duncan and Grass Bays Watershed was carried out using Purdue University's Long Term Hydrologic Impact Analysis (L-THIA) tool. L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. L-THIA is useful for determining impacts of overland runoff within a watershed to the receiving waters. Historic precipitation data for Cheboygan County, soil permeability and land use types, as well as event mean concentration (EMC) pollution coefficients are used by the model to predict NPS loadings at the outlet of a watershed. Although originally intended to evaluate smaller, urban watersheds, L-THIA utilizes key soil permeability properties that benefit an analysis for larger rural watersheds. This means that L-THIA takes into account rain "soaking in" to the ground, failing to create runoff, and yielding less NPS pollution.

Identification of pollutant sources is based on land use types within the watershed. NPS loadings resultant of the following land cover types are calculated: forest, agricultural, grass/pasture, high and low density residential, industrial, and commercial (Table 27). This is useful for identifying the largest contributors of nonpoint source pollutants within the watershed. Annual loads are calculated for the following pollutants: phosphorus, nitrogen, suspended solids, lead, copper, zinc, and oil/grease. Biological Oxygen Demand and Fecal Coliform are also calculated. This is useful for identifying key pollutants that may impact the Duncan and Grass Bays Watershed.

Table 27: Total Pollutant Loading for Duncan and Grass Bays Watershed (L-THIA Model)

	Total Modeled Pollutant Loading (lbs/yr)								
Land Use Type	Phosphorus	Nitrogen	Suspended Solids	Lead	Copper	Zinc	BOD	Oil and Grease	Fecal Coilform*
Forest	1	113	162	0.82	1.30	0.981	80	0	147
Agricultural	267	907	22126	0.31	0.31	3.283	825	0	24439
Grass/Pasture	1	90	129	0.65	1.23	0.78	64	0	117
High Density Residential	80	258	5859	1.26	1.26	11.014	3643	241	12994
Low Density Residential	181	583	13155	2.60	2.60	25.07	8182	544	29171
Industrial	8	33	1653	0.41	0.41	6.54	381	81	1204
Commercial	11	49	2052	0.48	0.54	5.821	850	331	1159
TOTAL	549	2033	45136	6.53	7.65	53.489	14025	1197	69231

* Bacterial Loading in millions of coliform per year

Nutrient pollution resultant from agriculture was modeled to be relatively high. Although agriculture is somewhat limited in the Duncan and Grass Bays Watershed, it is generally located on muck or organic soils that have low permeability. With less potential for infiltration, farm runoff is more readily created from rain events with the potential to carry fertilizer, manure, or other organic material into a nearby water body. Sediment is another pollutant associated with agriculture. Suspended solids loads from agricultural land cover were also disproportionately high, likely due to the reasons described above.

Moderately high concentrations of toxic metals (lead, copper, and zinc) were shown to be resultant from residential development. Automobiles, pesticides, and waste products accumulate in the urban environment and are washed into nearby waters when rain generates stormwater runoff. Model results highlight urban stormwater as being a concern for the Duncan Bay Watershed. Low infiltration rates in the organic soils surrounding the Cheboygan River result in large volumes of runoff. Without the filtration capacity of porous soils, toxics such as lead, copper, and zinc flow more freely into Duncan Bay.

As detailed in previous chapters, different land uses (sources) and activities (causes) have the potential to impact water quality, and subsequently, threaten the designated uses of a water body. It is critical to identify and understand the link between the source of nonpoint source pollutants and the potential cause. It is this understanding that forms the framework for developing the goals and action strategies of the Watershed Management Plan.

Sediment Sources and Causes

Sediment pollution comes from a variety of sources and causes.

Sources of sediment can include lakeshores and streambanks, road/stream crossings, agricultural practices, construction, logging, and others.

Causes of sediment pollution range and frequently include:

- Lakeshore and streambank erosion is often a result of the removal of shoreline vegetation.
- Improperly sized culverts and lack of runoff diversions are the main reason for erosion and sedimentation associated with road/stream crossings.
- Livestock access to streams for a watering source can destroy the bank and cause erosion and sedimentation.
- New construction in the shoreline area can also contribute sediment, particularly if inadequate erosion controls are used.
- Not maintaining buffer strips during logging can also contribute to erosion and sedimentation.

Nutrient Sources and Causes

Nutrient pollution may also be derived from a variety of sources, and oftentimes is linked with sediment pollution because nutrients regularly attach to sediment particles. Consequently, shoreline, streambank, and road/stream crossing erosion contribute sediment *and* nutrient pollution.

Sources of nutrient pollution include shoreline and streambank erosion, road crossings, turf management, failing septic systems, agricultural practices, stormwater discharges in urban areas, manure application and management, golf courses, and new construction.

Causes of nutrient pollution oftentimes mirror that of sediment pollution. They may include:

- Lakeshore and streambank erosion is often a result of the removal of shoreline vegetation.
- Improperly sized culverts and lack of runoff diversions are the main reason for erosion and sedimentation associated with road/stream crossings.
- Livestock access to streams for a watering source can destroy the bank and cause erosion and sedimentation. In addition, manure may be directly entering stream.
- Outdated, poorly maintained, and improperly designed septic systems discharge nutrients
- Improper (overuse, wrong formulation, etc.) application of fertilizers on agricultural fields, golf courses, and residential lawns.

- Urban stormwater carries pet waste and other nutrient sources and is discharged to a lake or stream without treatment.

Sources and Causes of Other Pollutants

Sources of oils, grease, and heavy metals include stormwater discharges in urban areas and road/stream crossings.

Sources of pesticides include agricultural fields and residential, commercial and municipal turf management.

Sources of bacteria include stormwater discharges in urban areas, manure application and storage, and livestock access to streams.

Causes may include:

- Outdated, poorly maintained, and improperly designed septic systems discharge bacteria and other pathogens.
- Urban stormwater carries bacteria, oils, grease and heavy metals and is then discharged to a lake or stream without treatment.
- Unrestricted livestock access to a stream allows waste to enter the stream directly.
- Over application of pesticides on residential, commercial, and municipal properties, as well as agricultural fields.

Reducing and preventing the nonpoint source pollutants relies upon addressing the priority pollutants' sources and causes, which have been identified and ranked for the Duncan and Grass Bays Watershed (Table 28). The pollutants are ranked according to their potential impact on water quality. Sources are ranked for each pollutant according to their prevalence. Causes are ranked according to their priority by source.

Table 28: Duncan and Grass Bays Watershed Pollutant Sources and Causes

Duncan and Grass Bays Watershed Pollutant Sources and Causes				
Rank	Pollutants	Pollutant Source (k: known; s: suspected)	Rank	Cause (listed in priority order by source)
1	Nutrients *Phosphorus and Nitrogen*	Urban stormwater (k)	1	Inadequate treatment of stormwater that may contain oils, grease, heavy metals, pet waste, etc. (s)
		Shoreline alterations & property management (k)	2	Over-application of fertilizers (s)
				Removal of native shoreline vegetation (k)
		Road/stream crossings (k)	3	Undersized and short culverts (k)
				Lack of runoff diversions (k)
				Inadequate fill on road surface (k)
				Lack of vegetation (k)
		Septic systems (s)	4	Outdated, poorly maintained, and improperly designed systems (s)
1	Sediment (k)	Road/stream crossings (k)	1	Undersized and short culverts (k)
				Lack of runoff diversions (k)
				Inadequate fill on road surface (k)
				Lack of vegetation (k)
		Lakeshore and streambank use (k)	2	Pedestrian access (k)
				Lack of buffer strips in riparian areas (s)
		Urban stormwater (k)	3	Sand used in winter for traffic safety, construction, and general runoff (s)
		New development and construction	4	Lack of proper erosion control and stormwater management measures (s)
				Shoreline development and removal of shoreline vegetation (k)
				Inadequate buffer strips near streams (s)
2	Oils, grease, and heavy metals (k)	Urban stormwater (k)	1	Inadequate treatment of stormwater that may contain oils, grease, heavy metals (s)
		Road/stream crossings (k)	2	Undersized and short culverts (k)
				Lack of runoff diversions (k)
				Inadequate fill on road surface (k)
				Lack of vegetation (k)
3	Pathogens (k)	Urban stormwater (k)	1	Pet waste, wildlife (k)
		Septic systems (s)	2	Outdated, poorly maintained, and improperly designed systems (s)
3	Pesticides	Shoreline alterations & property management (k)	1	Misuse and over use of pesticides (s)

Critical Areas

Critical areas have been identified to help prioritize and target management efforts within the Duncan and Grass Bays Watershed (Figure 32). Critical areas are where the pollutant sources and their causes are potentially causing the most damage within the Watershed. Subsequently, implementation steps, have been developed in response to the critical areas. Implementation steps allow stakeholders to address where management steps are needed most for watershed protection.

- Urban stormwater: The City of Cheboygan is included because it contributes to urban stormwater. Although the majority of the city's stormwater is directed into the Cheboygan River, several outfalls are located directly on Duncan Bay. The proximity of the River to the Bay undoubtedly presents additional stormwater impacts. Therefore, the entirety of the City of Cheboygan is included as a critical area.

- Shoreline degradation:
    - Duncan Bay Boat Club
    - Duncan Bay Drive

- Stream channelization: Butler Ditch

- Road/stream Crossings:
    - Alpena State Road
    - Seffern Road
    - Butler Road

- Streambank erosion: Alpena State Road

In addition, the Line 5 pipeline, while it does not cross through the Watershed, is a concern because of its proximity to Duncan and Grass Bays. A spill or release of products carried through this pipeline could impact the environment and may even result in injuries or fatalities, as well as property damage.

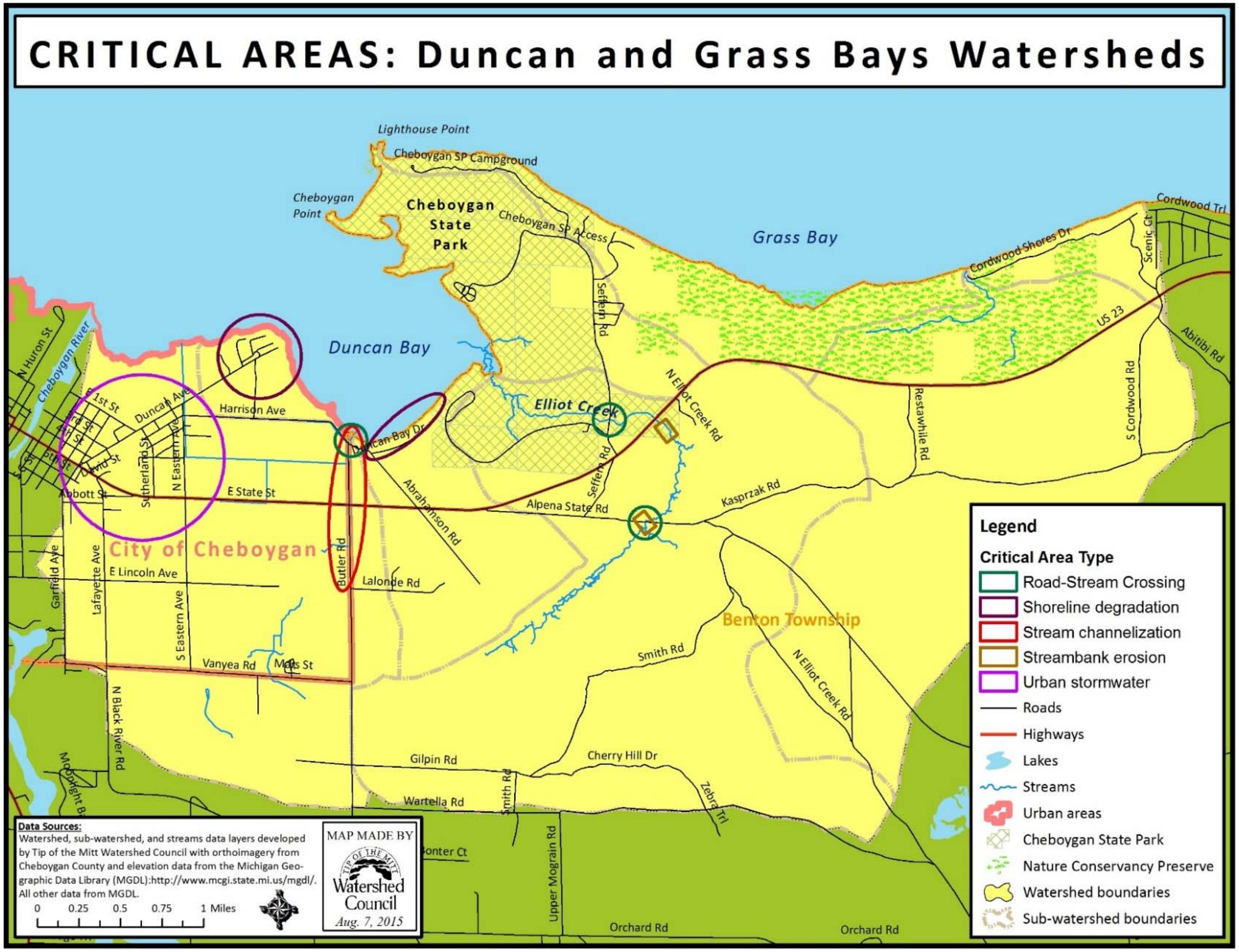


Figure 32: Duncan and Grass Bays Watershed Critical Areas

Priority Areas

Priority areas are considered the areas within the Watershed with features that are most vulnerable to development and other land uses. Protecting these features will provide long-term protection of water quality within the Watershed. Figure 33 illustrates the priority areas by types and are as follows:

- Stormwater abatement wetlands
- Streams and riparian wetlands
- Undeveloped shoreline and wetlands

It is important to note that other wetlands of these types exist elsewhere in the Watershed, but are not shown in Figure 33 because they are considered protected lands due to their ownership.

Protected Lands

The total acreage of protected lands within the Watershed comprises over 55% of the Watershed's land area (Table 29), which includes nearly 5% (11943.32 acres) of the Watershed's parcels. Protected lands include land owned by a land conservancy, the State of Michigan, Cheboygan County, the City of Cheboygan, or have a conservation easement.

It is important to note, that although these lands are considered protected, the degree of protection offered varies with land ownership. The State of Michigan, for example, manages their lands for not only conservation, but also recreation and resource extraction. Recreational impacts, particularly from motorized vehicles, can affect water resources. Off-road vehicles can cause erosion, spread invasive species, and disturb wildlife. Similarly, some forestry practices can have the same result. Managing state lands where resources are most vulnerable to these types of impacts is critical to water quality protection and conservation of ecosystem values.

Privately owned land protected by a conservation easement held by a non-profit land trust or governmental organization protects conservation values by limiting certain development rights and land uses agreed upon by the landowner and the holder of the easement. The restrictions are legally binding for perpetuity and compliance is monitored by the easement holder.

Table 29: Protected Lands within Duncan and Grass Bays Watershed

Ownership	ACRES	% of Total
Little Traverse Conservancy	34	<1
Privately owned land with conservation easements	73	<1
The Nature Conservancy	870	7
Cheboygan State Park	1171	10
State Forest	4291	36
Cheboygan County	<1	<1
City of Cheboygan	143	1
TOTAL Protected	**6583**	**55**

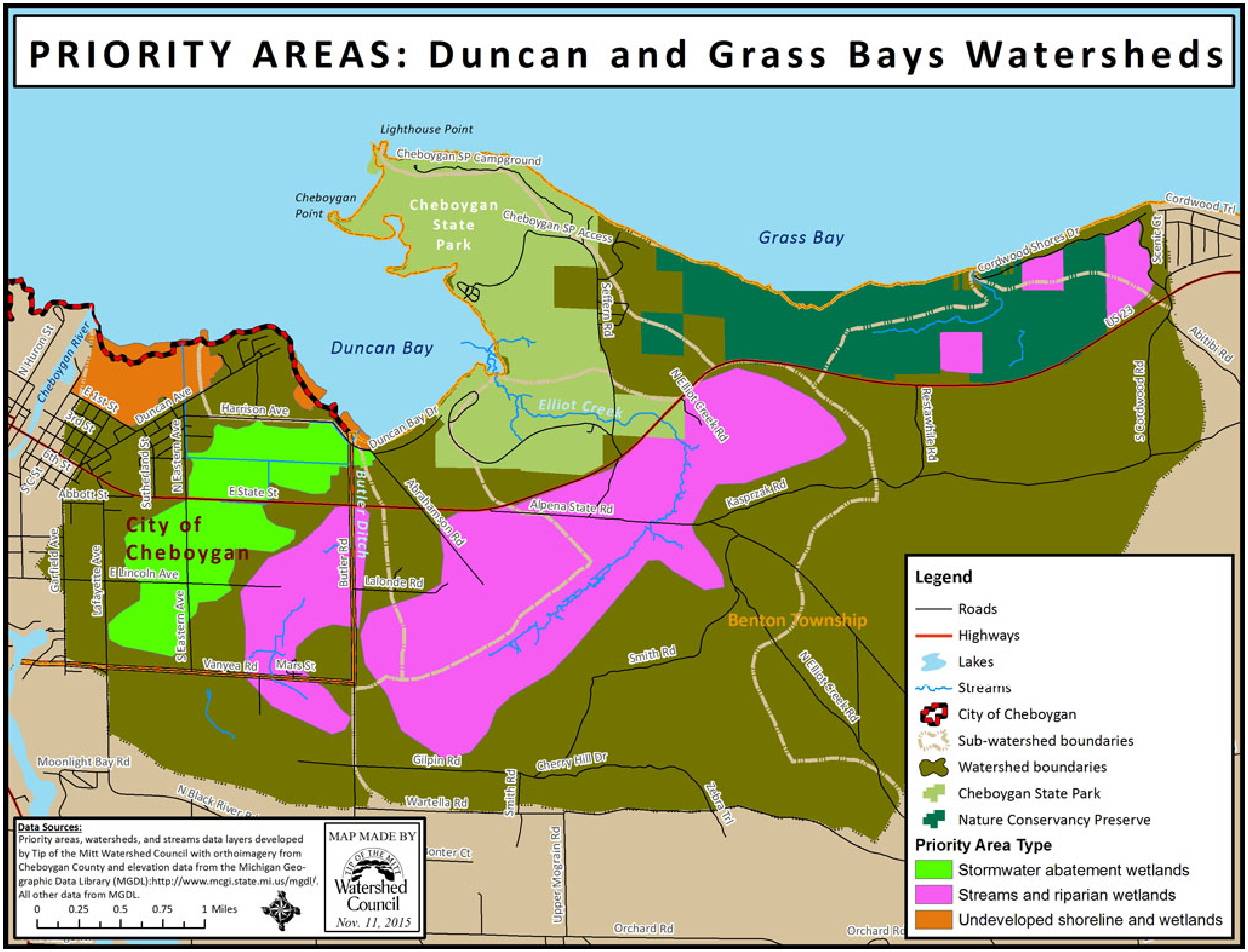


Figure 33: Priority Areas

Properly managing high-quality water resources requires addressing known sources of pollution and reducing future sources. Although effective regulation and strong stewardship ethics reduce the adverse impacts of development and land management to our surface waters, the permanent protection of sensitive lands is potentially the most effective tools for long-term water quality and aquatic ecosystem protection. Permanent protection of sensitive areas helps maintain the ecological integrity of our lakes, streams, and wetlands, and arguably provides the most positive impact per conservation effort. Permanent protection is best achieved through purchase, donation, or conservation easement.

Priority Parcels Process

In addition to identifying priority areas, Tip of the Mitt Watershed Council's Priority Parcel Analysis comprehensively ranks individual land parcels using a quantitative scoring system that reflects each parcel's ecological value. While the process is a holistic approach to ecological evaluation, special emphasis is placed on the protection of water resources. Anthropogenic variables pertaining to development are also used in the criteria to frame the rankings from a land acquisition and preservation standpoint. The Analysis is done entirely in a Geographic Information System (GIS), using commonly available spatial data. Many of the data layers used in the analysis were obtained from the Michigan Geographic Data Library. A portion of the data is supplied by partner organizations and government agencies, including parcel datasets from county GIS or equalization departments, and protected lands from local conservancies.

Parcels within the Duncan and Grass Bays Watershed were analyzed and ranked based on variables considered important for protecting and improving the quality and ecologic integrity of the Watershed's aquatic ecosystems, and to some extent terrestrial ecosystems. Descriptions of scoring criteria and the point system used to assign priority rankings to parcels are described below. The scores for each criterion were summed to produce a total score for each land parcel.

Parcel Size: Larger blocks of contiguous land typically have higher ecological value due to their potential to harbor a greater diversity of species and habitat types. Permanent protection of large parcels is also more time and cost effective than protecting small parcels. The selection threshold for parcel size criteria during this process was 10 acres. The larger the parcel, the more points it received.

Groundwater Recharge Potential: Groundwater discharge is essential for the maintenance of the cold-water fisheries that prevail in watersheds of the Northern Lower Peninsula. Land with highly permeable soils allows precipitation to percolate through the soils and recharge groundwater supplies. Predominant soil type and associated permeability were determined for each parcel using the physical properties found in county soil surveys (Natural Resource Conservation Service, Emmet and Charlevoix Counties). Parcels were scored based on the extent (acreage) of soils conducive to groundwater recharge.

Wetlands: Wetlands provide a variety of important functions that contribute to the health of the watershed, including fish and wildlife habitat, water quality protection, flood and erosion control, and recreational opportunities. National Wetlands Inventory data were utilized to determine the acreage of wetlands on individual properties and assign scores.

Lake and Stream Riparian Ecosystems: Activities on land immediately adjacent to a waterbody are critically important to maintaining water quality and ecological health. Properties with lake or stream shorelines were given scores based on total shoreline distance contained within the parcel.

Steep Slopes: Steep, highly erodible slopes are particularly vulnerable to improper use. Large amounts of erosion can degrade terrestrial habitat and impact water quality through sedimentation. Parcels with slopes greater than 20% scored points in this category.

Protected Land Adjacency: Properties adjacent to protected lands, such as state forests or conservancy lands, have a high ecological value because they provide a buffer to preexisting protected lands. They also increase the contiguous protected area, which essentially expands the biological corridor for species migration and interaction. Parcels bordering local or state government land and conservancy properties were identified and scored based upon the number of sides on the parcel adjacent to protected lands. Properties that linked two separate protected land parcels, or doubled the size of an existing parcel, received additional points.

Threatened or Endangered Species (state or federally listed): The protection of threatened and endangered species is important because many species are indicators of environmental quality and other dependent species could be affected. The Biological Rarity (Biorarity) Index model, developed by the Michigan Natural Features Inventory, provides an estimate of occurrence based on known sightings of threatened, endangered, or special concern species and high quality natural communities. Priority scores were based on model predictions for occurrence of threatened and endangered species or habitat types on the parcel.

Proximity to Development: Properties near urban areas have a high conservation value due to the imminent threat of development. Because these properties are near population centers, they have the greatest potential for public use and provide the most gain in terms of ecosystem preservation. NOAA CCAP (Coastal Change Analysis Program) land cover data and MGDL municipal boundary data were used to identify urban areas and growth corridors. Parcels were scored based on proximity to these areas.

Natural Land Cover Types: Land in its natural state is more ecologically valuable than altered land because natural land cover tends to contain a greater diversity of habitat and species, and is more resilient to invasion by non-native species. NOAA's CCAP land cover dataset was used to determine a percent coverage of natural land cover types for each parcel. Parcels with greater than 50% natural land cover received points.

Drinking Water Protection Areas: Wellhead protection areas are critical recharge zones that maintain aquifer water supplies and sustain local municipal drinking water systems. Development within these areas can jeopardize water sources by contaminating water supplies or inhibiting the infiltration of rain water. Points were assigned to parcels that lie within wellhead protection areas and based on the percentage of the parcel within the area.

Exceptional Resources: This criterion provides a fixed, two point score increase to any parcel adjacent to an exceptional resource. Exceptional resources are locally occurring conditions that are rare, vulnerable to degradation, and have high intrinsic value. The following were identified as critical resources for this analysis: critical dunes, blue-ribbon trout streams, forests with an average age of greater than 90 years, and undeveloped lakes.

Road Visibility via Roadway: This scoring system places value on access for the public. While it is not an ecological criterion, it evaluates the potential for use by the public. It also helps quantify the gains associated with roadside improvements such as interpretive signs and parks.

Results from the Priority Parcels Analysis are shown in Table 30. Of 1,608 parcels, 75 parcels (nearly 5%) ranked high (score=16-20) or very high (score= 21-27)

Table 30: Priority Parcels Analysis Results

Priority Score	Number of Parcels	Percent of Parcels
0-5	409	26
6-10	835	52
11-15	216	13
16-20	53	3
21-27	22	1
Protected	73	5
TOTAL	**1608**	**100.00**

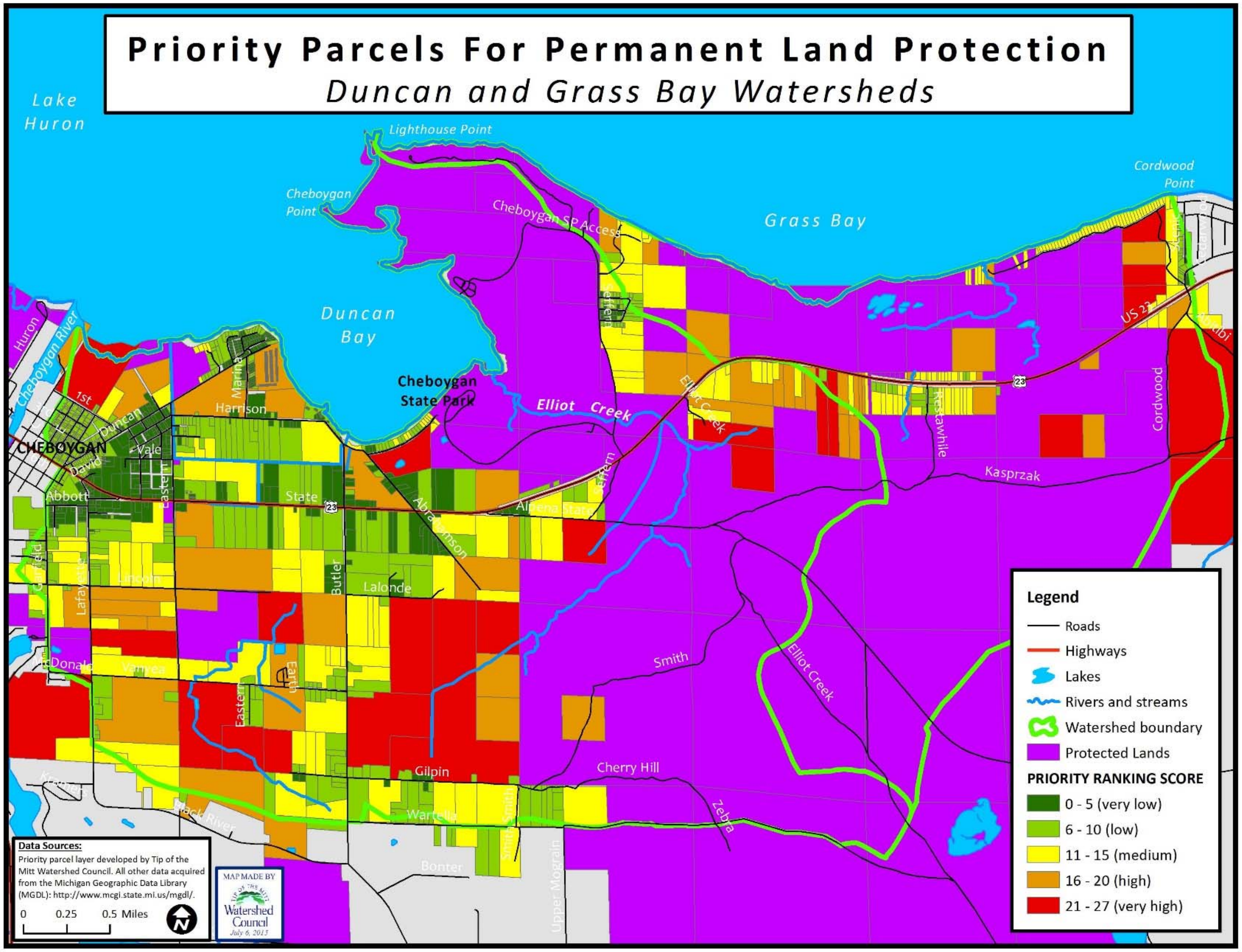


Figure 34: Priority Parcels for Permanent Land Protection

The following goals and their corresponding objectives have been developed for purposes of creating the framework for which the implementation, or action, steps are based. These goals and objectives reflect the desires of the community, requirements of regulatory agencies, and needs of the physical watershed.

Goal 1: Protect regional and local hydrology

Objectives:

1.1 Limit impacts to wetlands and groundwater recharge areas
1.2 Manage stormwater throughout the Watershed
1.3 Restore areas where local hydrology has been altered
1.4 Restore or enhance wetland functions

Goal 2: Protect natural communities

Objectives:

2.1 Increase permanent land protection on lands containing or adjoining natural communities
2.2 Manage recreational impacts to natural communities
2.3 Manage invasive species throughout the Watershed

Goal 3: Sustain tourism and recreational opportunities in a manner consistent with water quality protection

Objectives:

3.1 Expand low-impact recreational opportunities
3.2 Collaborate with resource managers on recreational planning efforts

Goal 4: Protect water quality of Duncan and Grass Bays and their tributaries

Objectives:

4.1 Restore eroding or otherwise altered shorelines and streambanks
4.2 Improve priority road/stream crossings throughout the Watershed
4.3 Manage stormwater throughout the Watershed
4.4 Implement new and enforce existing zoning ordinances designed to protect water quality
4.5 Conduct resource inventories and monitor water quality on a regular basis to assess conditions that may be affecting water quality.

Information and Education Goal:

Goal 5: Develop Effective Educational And Communication Efforts And Programs That Support And Promote Watershed Protection Activities.

Objectives:

5.1 Promote clean boating practices at marinas, events and other public venues

5.2 Promote low-impact recreation throughout the Watershed, particularly state lands

5.3 Provide information and educational programs within the community about aquatic and terrestrial invasive species

5.4 Provide information, educational opportunities, and incentives to riparians regarding best management practices

5.5 Provide information, educational opportunities, and incentives to businesses and residents regarding stormwater management

5.6 Provide information, educational opportunities, and forums to local government officials to strengthen water quality protection regulations and enforcement

5.7 Provide information and incentives to land owners to increase permanent land protection

5.8 Engage with all audiences within the Watershed to bring greater awareness and information about emerging issues through educational opportunities, events, media, watershed advisory committee meetings, and other formats.

Overview of Implementation Tasks and Actions

The Duncan and Grass Bays Watershed Management Plan Advisory Committee seek an integrative approach to reduce existing sources of nonpoint source pollution and prevent future contributions. Effective watershed management must rely upon an integrative approach that includes 1) best management practices (BMPs); 2) partnerships, community consensus building, and work with local governments; and 3) information and education components.

In an era when grant opportunities are very competitive, the Advisory Committee recognizes the importance of not only prioritizing the needs of the watershed, but also the value in building partnerships with stakeholders and leveraging funds. The recommended implementation tasks and actions represent the best management practices and initiatives identified by the Advisory Committee as being the most critical for water quality protection within the Watershed.

Proposed Best Management Practices (BMPs)

BMPs are techniques, measures, or structural controls designed to minimize or eliminate runoff and pollutants from entering surface and ground waters. Non-structural BMPs are preventative actions that involve management and source controls. These include policies and ordinances that provide requirements and standards to direct growth of identified areas, protection of sensitive areas such as wetlands and riparian areas, and maintaining and/or increasing open space. Other examples include providing buffers along sensitive water bodies, limiting impervious surfaces, and minimizing disturbance of soils and vegetation. Additional non-structural BMPs can be education programs for homeowners, students, businesses, developers, and local officials about everyday actions that protect water quality. Educational efforts are expounded upon in the Information and Education Strategy.

Structural BMPs are physical systems that are constructed to reduce the impact of development and stormwater on water quality. They can include stormwater facilities such as stormwater wetlands; filtration practices such as grassed swales and filter strips; and infiltration practices such as bioretention areas and infiltration trenches.
Structural and non-structural BMPs will be used in combination in the Watershed to obtain the maximum reduction or elimination NPS pollutants. BMPs should be selected according to their potential to reduce the targeted NPS pollutant, as well as budget, maintenance requirements, available space, and other factors. Some examples of possible BMPs for the most common sources of nonpoint source pollutants are listed in Table 31. Specific BMP recommendations for the Watershed are located in the Recommended Implementation Tasks table.

Table 31: Best Management Practices to Address Nonpoint Source Pollution

Source	Potential Systems of BMPs
Road/Stream Crossings	Extend or enlarge culverts, install runoff diversions to direct runoff, install box culverts or elliptical culverts, install clear-span bridges
Streambanks/ Lakeshores	Biotechnical erosion control, vegetative buffer strips, rock riprap, tree revetments, land conservation easements
Stormwater	Rain gardens (bioretention), runoff diversions, infiltration basins or trenches, sand filters, oil/grit separators, pervious pavers
Recreation	Runoff diversions, walkways/stairways, parking lot barriers, canoe landings, biotechnical erosion control, rock riprap, tree revetments
Lawn/Shoreline Care	Zero-phosphorus fertilizers, soil testing, vegetative buffer strips
Agriculture-Livestock	Fencing, alternative watering devices, vegetative buffer strips, land conservation easements
Agriculture-Manure	Nutrient management, animal waste storage, manure application plan
Septic	Regular maintenance
Golf Courses	Soil testing, fertilizer and pesticide management, vegetative buffer strips

BMP Effectiveness

The actual effectiveness or efficiency of a BMP is determined by the size of the BMP implemented (e.g., feet of vegetated buffer or acres of stormwater detention ponds), and how much pollution was initially coming from the source. **Table 32** (Huron River Watershed Council, 2003) lists estimates of pollutant removal efficiencies for stormwater BMPs that may be used in the Watershed.

Table 32: Pollutant Removal Efficiencies of Stormwater BMPs

	Pollutant Removal Efficiencies					
Management Practice	Total Phosphorus	Total Nitrogen	TSS	Metals	Bacteria	Oil & Grease
High-powered street sweeping	30-90%		45-90%			
Riparian buffers Forested: 20-40 m width Grass: 4-9 m width	Forested: 23-42%; Grass: 39-78%	Forested: 85%; Grass: 17-99%	Grass: 63-89%			
Vegetated roofs	70-100% runoff reduction, 40-50% of snow/rainfall. 60% temperature reduction. Structural addition of plants over a traditional roof system.					
Vegetated filter strips 7.5 m length 45 m width	40-80%	20-80%	40-90%			
Bioretention	65-98%	49%	81%	51-71%	90%	
Wet extended detention pond	48-90%	31-90%	50-99%	29-73%	38-100%	66%
Constructed wetland	39-83%	56%	69%	(-80)-63%	76%	
Infiltration trench	50-100%	42-100%	50-100%			
Infiltration basin	60-100%	50-100%	50-100%	85-90%	90%	
Grassed swales	15-77%	15-45%	65-95%	14-71%	(-50)-(-25)%	
Catch basin inlet devices		30-40% sand filter	30-90%			
Sand and organic filter	41-84%	22-54%	63-109%	26-100%	(-23)-98%	
Soil stabilization on construction sites			80-90%			
Sediment basins or traps at construction sites			65%			
Porous pavement	65%	80-85%	82-95%	98-99%		

Information regarding pollutant removal efficiency, designs of BMPs, and costs are continually evolving and improving. As a result, it is critical to research the latest technologies, design, and methodologies before implementing BMPs within the Watershed.

Location of BMPs in the Watershed

The location of structural BMPs depends on the site and site conditions. **Table 33** lists general guidelines for the placement of structural BMPs that have been adapted from the rapid assessment protocol of the Center for Watershed Protection (Huron River Watershed Council, 2003).

Table 33: General Guidelines for Locating Structural BMPs

	Undeveloped	Developing	Developed
Philosophy	Preserve	Protect	Retrofit
Amount of impervious surface	<10%	11-26%	>26%
Water quality	Good	Fair	Fair-Poor
Stream biodiversity	Good-Excellent	Fair-Good	Poor
Channel stability	Stable	Unstable	Highly unstable
Stream protection objectives	Preserve biodiversity and channel stability	Maintain key elements of stream quality	Min. pollutant loads delivered to downstream waters
Water quality objectives	Sediment and temperature	Nutrients and metals	Bacteria
BMP selection and design criteria	Maintain pre-development hydrology		Max. pollutant removal and quantity control
	Minimize stream warming and sediment	Maximize pollutant removal, remove nutrients	Remove nutrients, metals, and toxics
	Emphasize filtering systems		

Low-Impact Development

Of particular importance are the more innovative stormwater BMPs known collectively as Low-Impact Development (LID) techniques. LID is a stormwater management practice or approach, based on natural systems. The emphasis of LID is on managing stormwater locally rather than conveying it through costly infrastructure to an “end-of-pipe” facility. LID is applicable to new and existing development and can be integrated into virtually any site, from the residential scale to larger sites, such as commercial areas. The range of techniques continues to expand and new advances in design provide greater water quality benefits.

Promoting LID throughout the Watershed is an increasingly important component of watershed management efforts. No longer must engineers be the only stormwater practioners, but laypeople can have their hand in stormwater management as well. Encouraging Watershed residents to take ownership in “their” stormwater through implementing LID projects will ultimately result in increased water quality and watershed protection.

Green Infrastructure

Effective watershed management must take into consideration the watershed’s green infrastructure. Green infrastructure is an ecological framework needed for environmental, social, and economic sustainability, and refers to an interconnected network of open space, woodlands, wildlife habitat, parks and other natural areas that sustains clean air, water, and natural resources and enriches our quality of life. Green infrastructure is a scientific and community-based approach to identify land best suited for conservation and recreation. It differs from conventional approaches to open space planning because it looks at conservation values and actions in concert with land development, growth management, and built infrastructure planning.

According to the New Designs for Growth manual *Planning for Green Infrastructure: An implementation Resource of the New Designs for Growth Guidebook (20*10):

> Green Infrastructure planning helps to maintain or repair natural systems and defines a framework for future development patterns. It encompasses a wide variety of natural and restored native ecosystems and landscape features that make up a system of “hubs” and “links.”

The abovementioned manual also describes the numerous techniques and tools available for implementing Green Infrastructure projects, including the following:

Voluntary Implementation Strategies such as tax incentives, conservation practices by property oweners, smart growth techniques, Low Impact Development, and LEED (Leadership in Energy and Environmental Design).

Land Protection through fee simple purchase, conservation easements, purchase of development rights (PDR), and transfer of development rights (TDR).

Regulatory Approaches through master plans, zoning ordinances, planned unit development, conservation design, site design and development review, service districts and growth boundaries.

Implementation Steps

The following implementation steps tables include a comprehensive list of proposed tasks and actions that, if implemented, will result in water quality protection or improvements. Tasks and actions are organized by category to facilitate easy reference. The recommendations are based on a 10 year timeline (2016-2025), a standard duration of time for a watershed management plan. Each task and action identifies the following:

Priority Level: Each task and action has been assigned a priority level based on one or more of the following factors: urgency to correct or reduce an existing problem; need to enact a specific task or action before a problem develops; availability of funds, partner(s) or program(s) ready to implement; and the overall need to balance low, medium, and high priorities over the course of ten years.

Unit Cost/Total Cost estimate: An estimated unit cost is provided when applicable. An estimated total cost is provided when applicable and calculable.

Milestones: Milestone(s) are identified, when possible, to establish an interim, measurable benchmark for determining progress of a specific task or action.

Timeline: Based on the ten-year span of the watershed management plan, the year in which the task or action is to begin or end is noted. When a task or action is ongoing, it is noted as spanning the ten years.

Potential Partners: The potential partners specified are those who have the interest or capacity to implement the task or action. They are not obligated to fulfill the task or action. It is expected that they will consider pursuing funds to implement the task or action, work with other identified potential partners, and communicate any progress with the Duncan-Grass Bays Watershed Advisory Committee.

Partner:	Abbreviation:
Benton Township	BNT
Cheboygan Area Chamber of Commerce	CAC
Cheboygan Conservation District	CCD
Cheboygan County	CHC
Cheboygan County Drain Commissioner	CDC
Cheboygan County Economic Development Group	CCEG
Cheboygan County Road Commission	CCR
City of Cheboygan	CCH
Concerned Citizens of Cheboygan and Emmet Counties	CCCE
District Health Department 4	DHD
Huron Pines	HP
Little Traverse Bay Bands of Odawa Indians	LTBB
Little Traverse Conservancy	LTC
MI Dept. of Environmental Quality	MDEQ
MI Dept. of Natural Resources	MDNR
MI State University Extension	MSUE
Mullett Lake Areas Preservation Society	MAPS
North Central Michigan College	NCMC

Northeast MI Council of Governments	NEMCOG
Northern Lakes Economic Alliance	NLEA
Straits Area Audubon Society	SAA
Straits Area Community Foundation	SACF
Straits Area Concerned Citizens for Justice, Peace, and the Environment	SACC
Sturgeon for Tomorrow	SFT
The Nature Conservancy	TNC
Tip of the Mitt Watershed Council	TOMWC

Potential Funding Sources: Potential funding sources for each task or action include, but are not limited to: private foundation (PF); state grant (SG); federal grant (FG); local government (LG); partner organization (PO); revenue generated (RG); private cost-share (CS); and local businesses (LB).

Objectives Addressed: Each task and action supports one or more of the objectives in Chapter 6.

Steps shown in **bold** are considered priorities actions undertaken within the first years of plan implementation.

Italicized Potential Project Partners indicates the anticipated project lead.

Table 34: Shoreline and Streambank Protection Implementation Steps

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
SP	Shoreline and Streambank Protection																		
SP.1	Conduct shore survey on Bays every 5 to 10 years	H	$5,000	$5,000	Secure funding to conduct survey	Completion of survey and results summary								Funding		Survey/summarize	TOMWC	PF, SG, FG, PO	4.5
SP.2	Conduct streambank inventory every 5 to 10 years on Elliot Creek	M	$1,000	$1,000	Secure funding to conduct survey	Completion of inventory and results summary								Funding		Survey	TOMWC	PF, SG, FG, PO	4.5
SP.3	**Restore streambank erosion sites on Elliot Creek (DG 03/DG04)**	**H**	**NA**	**$10,000**	**Secure funding to implement projects**	**Two repaired streambanks**		**Funding**	**Restore**								***HP, TOMWC***		**4.1**

SP.4	Implement best management practices (BMPs) on moderate and severe shoreline erosion sites on Duncan and Grass Bays in conjunction with property owner outreach	H	NA	$25,000	Secure funding to implement outreach program	Implement 5 erosion control projects by year 10							Funding	Implement			CCD, *HP,* MSUE, *TOMWC*	PF, SG, FG, LG, PO, CS	4.1
SP.5	Conduct streambank inventory on Grass Creek	L	$2,000	$2,000	Secure funding to conduct survey	Baseline assessment of erosion sites									Funding	Assess	CCD, HP, *TOMWC*	PF, SG, FG, PO	4.5

Table 35: Stormwater Implementation Steps

	Categories	Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
SW	Stormwater																		
SW.1	Support adoption of stormwater ordinances	M	NA	$10,000	Engage with stakeholders to gain support for stormwater ordinance adoption	Stormwater ordinance adopted by year 10										Adopt	All	PO, LG	4.4
SW.2	Update stormwater infrastructure and impervious surface maps for Cheboygan	M	NA	$4,500	Secure funding to conduct survey	Distribution of updated maps								Funding		Distribute	*CCH,* TOMWC	PO, LG	4.3
SW.3	Monitor stormwater discharge from basins 1-4 to establish baseline data	H	NA	$2,500	Identify outfalls and monitoring parameters; secure funding; monitor	Distribution of monitoring report						Identify	Monitor	Monitor	Distribute		Municipalities, *TOMWC*	PF, SG, FG, LG	4.5

Table 36: Planning, Zoning, and Land Use Implementation Steps

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
PZ	Planning, Zoning and Land Use																		
PZ.1	Utilize the recommendations of the Cheboygan County Gaps Analysis (2014) to encourage adoption of model standards in zoning ordinances to protect water quality.	H	NA	$60,000	3 model standards adopted by year 7	Improved water protection measures in place							Adopt				BNT, CHC, CDC, CCH, MSUE, *NEMCOG,* TOMWC	PF, LG, PO	4.4, 5.6
PZ.2	**Work with the County to require a Natural Vegetation Strip in the Lake and Stream Protection District**	**H**	**NA**	**$20,000**	**Majority support established from citizens and local officials by year 3**	**Vegetation Strip required by year 5**					**Adopt**						**CHC, BNT, CCH, *TOMWC,* SACC**	**PF, SG, FG**	**4.4**
PZ.3	**Establish requirement that state permits must be issued for regulated wetlands before a County Zoning permit is issued.**	**H**	**NA**	**$5,000**	**Majority support established from citizens and local officials by year 5**	**State permit approval required by year 7**							**Adopt**				***CHC,* BNT, CCH, TOMWC, SACC**	**PF, SG, FG**	**4.4**

PZ.4	**Work with the County to adopt a wetland setback of at least 25', similar to shoreline setbacks.**	**H**	**NA**	**$10,000**	**Majority support established from citizens and local officials by year 6**	**Setback established to protect wetlands by year 7**							**Adopt**				**CHC, BNT, CCH, *TOMWC,* SACC**	**PF, SG, FG**	**4.4**
PZ.5	**Work with local governments to adopt minimum shoreline lot frontage to help prevent the creation of unbuildable lots that consist of mostly wetlands.**	**M**	**NA**	**$10,000**	**Majority support established from citizens and local officials by year 6**	**Avoidance of unbuildable lot splits, protecting wetlands**						**Adopt**					***CHC,* BNT, CCH, TOMWC, SACC**	**PF, SG, FG**	**4.4**
PZ.6	Require groundwater protection steps to be specified for mining operations in the County.	L	NA	$1,500	Stakeholders in agreement and supporting change by year 10	Mining BMPs in place to protect groundwater resources										Adopt	*CHC,* TOMWC, SACC	PF, SG	4.4
PZ.7	Provide incentives for using low-impact development techniques in the City, to mitigate the impacts of impervious surfaces.	H	NA	$8,000	Stakeholders in agreement and supporting change by year 7	Healthy local surface waters protected from NPS							Adopt				*CCH,* TOMWC, SACC	PF, SG	4.4
PZ.8	Incorporate more flexibility into the City's zoning ordinance to reduce the number of parking spaces	M	NA	$5,000	stakeholders in agreement and supporting	Healthy local surface waters protected from NPS							Adopt				*CCH,* TOMWC, SACC	PF, SG	4.4

	constructed, if warranted by the proposed development.				change by year 7														
PZ.9	**Complete research, including local statistics, and create a Septic System Local Report for all local officials in Cheboygan County**	**H**	**NA**	**$5,000**	**Report completed**	**Report presented to all local government entities**		**Distributed**									**DHD, *TOMWC***	**SG, FG, PF**	**4.4, 5.6**
PZ.10	**Include a specific goal to protect water resources in update of the City's Master Plan.**	**M**	**NA**	**$1,000**	**Stakeholders agree during Master Plan update**	**Master Plan update includes additional water protection measures**	**Adopt**										**CCH**	**LG**	**5.8**

Table 37: Road/Stream Crossings Implementation Steps

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
RSX	Road/Stream Crossings																		
RX.1	Repeat road stream crossing inventory every 10 years to determine if priorites are the same, and to document newly installed BMPs or improvements	H	$5,000	$5,000	Secure funding to conduct survey	Completion of inventory and results summary				Complete Inventory							*HP, TOMWC*	PF, SG, FG, LG, PO	4.5
RX.2	**Implement priority RSX projects for improved hyrdology, erosion control, and fish passage**	**H**	**$40,000**	**$120,000**	**Secure funding to implement RSX projects**	**Completion of three priority RSX projects**		**Funding**		**Implement**							***HP, TOMWC***	**LG, PO**	**1.3, 4.2**

Table 38: Land Protection and Management Implementation Steps

	Categories	Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
LP	Land Protection and Management																		
LP.1	Conduct priority parcel process (PPP) every 5 to 10 years to identify additional priority parcels	H	NA	$3,000	Evaluate criteria used for PPP; obtain updated data	Completion of priority parcel process				Evaluate	Conduct						LTC, *TOMWC*	PF, LG, PO,	2.1
LP.2	Engage with land owners of High and Medium priority parcels to encourage land protection	M	NA	$5,000	Conduct workshops	Two workshops					Workshop					Workshop	*LTC*, TNC, TOMWC	PF, LG, PO	2.1
LP.3	Permanently protect 300 acres or more of high and very high priority parcels as well as lands containing natural communities with state rank of critically imperiled, imperfiled, or vulnerable (S1, S2, or S3).	H	NA	$300,000	Identify parcels for acquisition, conservation easement, or other permanent land protection means; secure funding and agreements	Protect 300 acres				Identify			Secure			Protect	*LTC,* TNC	PF, SG, FG, LG, PO	2.1

LP.4	Assess changes in land use using remotely sensed GIS land cover data.	M	NA	$2,000	Obtain updated GIS data layers	Distribution of summary report to Advisory Committee									Update	Distribute	Cheboygan County, *NEMCOG,* TOMWC	PF, SG, FG, LG, PO	2.1

Table 39: Ecosystem Health Implementation Steps

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
EH	Ecosystem Health																		
EH.1	Restrict ORV access to public lands containing natural communities with a state rank of critically imperiled, imperiled, or vulnerable (S1, S2 or S3)	H	NA	$30,000	Identify areas where restrictions are needed	Enact measures to restrict access			Identify					Enact			LTC, *MDNR,* TNC		2.2
EH.2	Conduct habitat monitoring on Elliot Creek to establish baseline data	M	NA	$5,000	Secure funding to conduct survey	Baseline data collected				Secure			Conduct				HP, MDNR, TOMWC, *USGS*	SG, FG, PO	4.5

Table 40: Recreation, Safety, and Human Health Implementation Steps

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
RSH	Recreation, Safety, and Human Health																		
RH.1	Monitor public beaches annually for potential health hazards, report advisories and beach closings	H	$250/per beach/sample =$44,000/yr	$440,000	Secure funding to implement program annually		Monitor										DHD#4	SG, FG, LG, PO	4.5
RH.2	Require fueling stations to have spill containment equipment that is stored in a clearly marked location.	H	NA	$5,000	Install at least one set of equipment						Install						*MDEQ*, TOMWC, other stakeholders	PF, LG, PO	2.2

Table 41: Hydrology and Groundwater Implementation Steps

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
HG	Hydrology and Groundwater																		
HG.1	Compile all existing groundwater information, identify problems, determine data gaps, and develop a strategy for long-term monitoring.	H	NA	$10,000	Complete compilation and assessment of existing data							Assess					DHD#4, MDEQ, NEMCOG, TOMWC, *USGS*	SG, FG, PO	1.1
HG.2	Assess changes (net gain or loss) in permanently protected lands in areas with high groundwater recharge rates	H	NA	$2,500	Complete assessment concurrent with watershed management plan update											Assess	DHD#4, MDEQ, *NEMCOG,* TOMWC, USGS	PF, PO	1.1
HG.3	Employ Landscape Hydrology Model to assess pollutant loadings and sources concurrent with watershed management plan update	M	NA	$10,000	Incorporate model results into plan update											Model	Michigan State University, *TOMWC*	SG, FG	4.5

Table 42: Water Quality Monitoring Implementation Steps

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
WQ	Water Quality Monitoring																		
WQ.1	**Continue implementing Comprehensive Water Quality Monitoring (CWQM) program every 3 years on Duncan Bay**	**H**	**$1,500**	**$6,000**	**Complete 4 CWQM cycles by year 10**	**Four monitoring cycles of data**	**Monitor**			**Monitor**			**Monitor**			**Monitor**	**TOMWC**	**PF, LG, PO**	**4.5**
WQ.2	Begin Comprehensive Water Quality Monitoring (CWQM) program on Grass Bay	M	$1,500	$3,000	Complete 2 CWQM by year 10	Two monitoring cycles of data							Monitor			Monitor	TOMWC	PF, LG, PO	4.5
WQ.3	**Incorporate Elliot Creek into TOMWC's Volunteer Stream Monitoring (VSM) program**	**H**	**$1,000/year**	**$9,000**	**Recruit and maintain VSM team by year 2**	**Nine years of VSM data**		**Monitor**									**TOMWC**	**PF, LG, PO**	**4.5**

WQ.4	Monitor tributaries (Elliot Creek and other) during both high and low flows (at least twice per year) to determine pollutant loading to Duncan and Grass Bays.	M	$3,000	$9,000	Begin annual monitoring by year 3				Monitor			Monitor			Monitor		TOMWC	PF, SG, FG, LG, PO	4.5

Table 43: Wetlands Implementation Steps

	Categories	Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
WL	Wetlands																		
WL.1	Identify potentially restorable wetlands, develop restoration plans, seek funding, and restore	M	$25,000 for planning, $125,000 restoration	$150,000	Complete restoration plans for one wetland (>1 acre) by year 8	Restore 10 acres by year 10								Complete Plans		Restore	TOMWC	PF, SG, FG, LG, PO	1.4
WL.2	Groundtruth wetlands identified through Landscape Level Wetlands Functional Analysis to confirm high-value wetland status	H	NA	$20,000	Complete groundtruthing by year 10											Groundtruth	*HP*, LTBB, TOMWC	PF, SG, FG, LG, PO	1.4

Table 44: Aquatic Invasive Species Implementation Steps

	Categories	Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone(s)	Product	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
AI	Aquatic Invasive Species																		
AI.1	Develop volunteer-based aquatic invasive species monitoring program	H	NA	$15,000	Develop program and begin implementation by year 5	Continue program through year 10				Begin	Ongoing						TOMWC	PF, SG, FG, LG, PO	2.3
AI.2	**Control invasive Phragmites on Duncan and Grass Bays**	**H**	**$5,000**	**$50,000**	**Repeat shore survey by year 3 to monitor previously documented and new stands**	**Treat invasive stands, as needed, over 10 year timeframe**			**Survey**							**Treat**	***HP*, TNC, TOMWC**	**PF, SG, FG, LG, PO**	**2.3**
AI.3	Control invasive Phragmites and other priority species on private, inland properties	H	NA	$25,000	Treat invasives on at least 10 properties by year 10											Treat	*HP,* CCD, MDNR, NRCS	PF, SG, FG, LG, PO	2.3
AI.4	Control invasive Phragmites and other priority species on land with natural communities with state rank of critically imperiled, imperfiled, or vulnerable (S1, S2, or S3)	H	NA	$25,000	Treat invasives on at least 10 properties by year 10											Treat	*HP,* LTC, TNC, TOMWC	PF, SG, FG, LG, PO	2.3

AI.5	**Report introductions and spread of invasive species to at least one tracking database (USGS, MISIN, etc.)**	**H**	**NA**	**$5,000**	**Report introductions annually beginning year 1**		**Report**										**HP, LTC, *Northeast Michigan CWMA***	**PF, SG, FG, LG, PO**	**2.3**
AI.6	**Work with Northeast Michigan Cooperative Weed Management Area to stop the introduction, spread, and distribution of invasive weed species in the ecosystems along the lake Huron shoreline and adjacent ecosystems to which it connects.**	**H**	**NA**	**$50,000**	**Implement at least one on-the-ground management project by year 5**	**Implement 5 on-the-ground management projects by year 10**			**Implement**							**Implement**	**All, Northeast Michigan CWMA**	**SG, FG, LG, PO**	**2.3**

Table 45: Implementation Tasks and Actions Cost Summary

Recommended Tasks and Actions Cost Summary		
	Category	Cost
SP	Shoreline and Streambank Protection	$43,000
SW	Stormwater	$17,000
PZ	Planning, Zoning, and Land Use	$125,500
RX	Road/stream Crossings	$125,000
LP	Land Protection and Management	$310,000
EH	Ecosystem Health	35,000
RH	Recreation, Safety and Human Health	$445,000
HG	Hydrology and Groundwater	$22,500
WQ	Water Quality Monitoring	$27,000
WL	Wetlands	$170,000
AI	Aquatic Invasive Species	$170,000
	Total	**$1,490,000**

Implementation of the Information and Education (I/E) Strategy will support the following goal (included in Chapter 6 as Goal #5) and objectives:

Goal 5: Develop and Implement Effective Educational and Communication Efforts that Support And Promote Watershed Protection Activities.
Objectives:

5.1	Promote clean boating practices at marinas, events, and other public venues
5.2	Promote low-impact recreation throughout the Watershed, particularly state lands
5.3	Provide information and educational programs within the community about aquatic and terrestrial invasive species
5.4	Provide information, educational opportunities, and incentives to riparians regarding best management practices
5.5	Provide information, educational opportunities, and incentives to businesses and residents regarding stormwater management
5.6	Provide information, educational opportunities, and forums to local government officials to strengthen water quality protection regulations and enforcement
5.7	Provide information and incentives to land owners to increase permanent land protection
5.8	Engage with all audiences within the Watershed to bring greater awareness and information about emerging issues through educational opportunities, events, media, watershed advisory committee meetings, and other formats

The I/E activities include a variety of approaches including installing demonstration sites, building partnerships, sponsoring seminars and workshops, and developing new and informative educational materials. The cumulative impact of these efforts will result in the support of not only the I/E Strategy goal and objectives, but also the first four goals of the Watershed Protection Plan (Chapter 6).

The following I/E Tasks tables include proposed tasks and actions that, if implemented, will result in water quality protection or improvements. Tasks and actions are organized by category to facilitate easy reference. The recommendations are based on a 10 year timeline (2016-2025), a standard duration of time for a watershed management plan. Each task and action identifies the following:

Priority Level: Each task and action has been assigned a priority level based on one or more of the following factors: urgency to correct or reduce an existing problem; need to enact a specific task or action before a problem develops; availability of funds, partner(s) or program(s) ready to implement; and the overall need to balance low (L), medium(M), and high (H) priorities over the course of ten years.

Unit Cost/Total Cost estimate: An estimated unit cost is provided when applicable. An estimated total cost is provided when applicable and calculable.

Milestones: Milestone(s) are identified, when possible, to establish an interim, measurable benchmark for determining progress of a specific task or action.

Timeline: Based on the ten year span of the watershed management plan, the year in which the task or action is to begin or end is noted. When a task or action is ongoing, it is noted as spanning the ten years.

Potential Partners: The potential partners specified are those who have the interest or capacity to implement the task or action. They are not obligated to fulfill the task or action. It is expected that they will consider pursuing funds to implement the task or action, work with other identified potential partners, and communicate any progress with the Duncan and Grass Bays Watershed Advisory Committee.

Partner:	**Abbreviation:**
Benton Township	BNT
Cheboygan Area Chamber of Commerce	CAC
Cheboygan Conservation District	CCD
Cheboygan County	CHC
Cheboygan County Drain Commissioner	CDC
Cheboygan County Economic Development Group	CCEG
Cheboygan County Road Commission	CCR
City of Cheboygan	CCH
Concerned Citizens of Cheboygan and Emmet Counties	CCCE
District Health Department 4	DHD
Huron Pines	HP
Little Traverse Bay Bands of Odawa Indians	LTBB
Little Traverse Conservancy	LTC
MI Dept. of Environmental Quality	MDEQ
MI Dept. of Natural Resources	MDNR
MI State University Extension	MSUE
Mullett Lake Areas Preservation Society	MAPS
North Central Michigan College	NCMC
Northeast MI Council of Governments	NEMCOG
Northern Lakes Economic Alliance	NLEA
Straits Area Audubon Society	SAA
Straits Area Community Foundation	SACF
Straits Area Concerned Citizens for Justice, Peace, and the Environment	SACC
Sturgeon for Tomorrow	SFT
The Nature Conservancy	TNC
Tip of the Mitt Watershed Council	TOMWC

Potential Funding Sources: Potential funding sources for each task or action include, but are not limited to: private foundation (PF); state grant (SG); federal grant (FG); local government (LG); partner organization (PO); revenue generated (RG); private cost-share (CS); and local businesses (LB).

Objectives Addressed: Each task and action supports one or more of the eight I/E objectives.

Steps shown in **bold** are considered priorities actions undertaken within the first years of plan implementation.

Italicized Potential Project Partners indicates the anticipated project lead.

Table 46: General I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
G	General																		
GEN.A	**Continue to bring attention to the Duncan and Grass Bays Watershed through partners' newsletters, e-news, websites, and other published updates.**	**H**	**$5,000/yr**	**$50,000**	**Ongoing**		**Ongoing**										**All**	**PO**	**5.8**
GEN.B	Provide regular press releases to local media featuring watershed management efforts	H	$1,000/yr	$10,000	Ongoing		Ongoing										All	PO	5.8

GEN.C	Offer field trips (paddling, hiking, LTC EcoStewards Program) to community to explore and learn about local natural resources.	M	$4,000/yr	$40,000	Ongoing		Ongoing										HP, *LTC,* MAPS, SAA, SFT, TNC, TOMWC, TOMTC	PO, RG	5.2, 5.8
GEN.D	**Coordinate and implement regular Duncan and Grass Bays Watershed Advisory Committee meetings**	**H**	**$5,000/yr**	**$50,000**	**Ongoing**		**Ongoing**										**TOMWC**	**PF, SG, FG, LG, PO**	**5.8**
GEN.E	Evaluate plan implementation progress, via Stocktaking Strategy with Advisory Committee every five years	H	$2,500	$5,000	Perform stocktaking in year 5	Perform stocktaking in year 10					Evaluate					Evaluate	ALL	PF, SG, FG, LG, PO	5.8

Table 47: Shoreline and Streambank Protection I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
SSP	Shoreline and Streambank Protection																		
SSP.A	**Install demonstration riparian buffers on publicly-owned properties**	**H**	**$10/SF**	**$20,000**	**Install 2,000 SF by year 7**								**Install**				**BNT, CCD, CHC, CCH, *HP,* MDNR, MAPS, MSUE, NRCS, NEMWCOG, *TOMWC***	**PF, SG, FG, LG, PO, CS**	**5.4**
SSP.B	Develop incentive program for riparian buffers that may include tax credit, awards, vouchers, discounts on landscape supplies and services, etc.	L	NA	$10,000	Develop program by year 7 and present to appropriate authorities, agencies, and vendors; include details of proposed economics								Develop Program				CCD, CHC, CCH, *HP,* MAPS, MSUE, *TOMWC*	PF, LG, PO, RG, LB	5.4

SSP.C	**Distribute printed resources to riparians that detail best management practices for shorelines, shoreline ecology, as well as geological and human histories of Duncan and Grass Bays, as well as Lake Huron; include information on local resource groups and agencies**	**M**	**NA**	**$5,000**	**Produce booklet and distribute by year 5**						**Distribute**						**CHC, CCH, *HP,* LTBB, MSUE, NRCS, *TOMWC***	**PF, PO, RG, LB**	**5.4**

Table 48: Stormwater I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
SWR	Stormwater																		
SWR.A	**Work with local govts., area businesses, and property owners to install stormwater BMPs; sponsor an annual installation of demonstration rain garden at 1 residence, business, or public land**	**M**	**$5,000**	**$25,000**	**Begin sponsorship by year 5**	**Sponsor 5 rain gardens by year 10 (average rain garden of 300 SF)**					**Begin Sponsorship**					**5 Rain Gardens**	**BNT, CAC, CCD, CHC, CDC, CCH, CCCE, *HP*, NRCS, NEMCOG, *TOMWC***	**PF, SG, FG, LG, PO, RG, CS, LB**	**5.5**
SWR.B	Using updated stormwater infrastucture maps, identify storm drains in need of "Drains to Lake" marking	L	NA	$2,500	Mark all drains in need by year 6							Mark Drains					CCCE, CDC, CCH, HP, *SACC*, *TOMWC*	PF, LG, PO, LB	5.5, 5.8

	and implement program to re-mark or mark new drains on a regular basis																		

Table 49: Planning, Zoning, and Land Use I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
PZL	Planning, Zoning, and Land Use																		
PZL. A	**Utilize the recommendations of the Cheboygan County Gaps Analysis (2014) to encourage adoption of model standards in zoning ordinances to protect water quality.**	**H**	**NA**	**$100,000**	**3 model standards adopted by year 3**				**Adopt**								**BNT, CHC, CDC, CCH, MSUE, *NEMCOG* *TOMWC***	**PF, LG, PO**	**5.6**

PZL.B	Develop and implement ongoing education program for local governments on land use planning tools and principles, such as Smart Growth and Green Infrastructure, that protect water quality and encourage better coordination between communities	H	$10,000/yr	$80,000	Implement first program by year 3	Implement on an annual basis; 8 programs by year 10			Implement Program	Implement							*MSUE, NEMCOG*, TOMWC	PF, LG, PO	5.6
PZL.C	Promote the use of Green Infrastructure to local govts, developers and others through workshops and publications	M	NA	$20,000	Develop and print Duncan and Grass Bays Watershed publication by year 5	Hold one workshop by year 10					Print					Workshop	CCEG, HP, MSUE, *NEMCOG*, NLEA, TOMWC	PF, LG, PO, LB	5.6

Table 50: Road/Stream Crossings I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
RSX	Road/Stream Crossings																		
RSX.A	Maintain road/stream crossing database through LIAA for common access to current information	M	$1,000/update	$2,000	Update database by year 5	Update database by year 10	Ongoing										CCR, *HP, TOMWC*	PF, PO	5.8

Table 51: Land Protection and Management I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
LPM	Land Protection and Management																		
LPM.A	Distribute information to land owners of High and Medium priority parcels to encourage land protection	M	NA	$5,000	Distribute information by year 2			Distribute									BNT, CCD, CHC, *LTC, TOMWC*	PF, LG, PO	5.7

Table 52: Ecosystem Health I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
ECH	Ecosystem Health																		
ECH.A	Develop and distribute outreach packets to shoreline property owners about natural communities and other watershed protection topics	H	$5,000	$5,000	Distribute packets by year 4					Distribute							TOMWC	PF, SG, FG, PO	5.3, 5.4, 5.7

Table 53: Recreation, Safety, and Human Health I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
RSH	Recreation, Safety and Human Health																		
RSH.A	**Promote Clean Marinas**	**M**	**NA**	**$5,000**	**Certification of at least one additional marina by year 5**						**Certification**						**CAC, CCCE, LTBB, MSUE, NEMCOG, SACC, *TOMWC***	**PF, SG, FG, PO, LB**	**5.1**
RSH.B	**Promote Michigan's "Clean Boats, Clean Waters" program**	**H**	**NA**	**$10,000**	**Recruit and train volunteer base by year 3**	**Host at least one community boater education event during peak boating times each year**			**Recruit**	**Host**	**Host**	**Host**	**Host**	**Host**	**Host**	**Host**	**CAC, CCCE, LTBB, *MSUE,* NEMCOG, SACC, TOMWC**	**SG, LB, PO**	**5.1**

RSH.C	Install signage at public boat launches and other public sites to bring awareness to invasive species and other issues	M	NA	$10,000	Install 5 signs by year 6							Install					CCCE, LTBB, MSUE, *NEMCOG,* SACC, TOMWC	PF, SG, FG, PO, LB	5.3
RSH.D	Develop and implement educational campaign to encourage ORV users to minimize their impact to resources	M	NA	$20,000	Distribute informational packets to businesses, sporting clubs, and public lands regarding impacts by year 10											Distribute	CAC, CHC, CCH, CCCE, HP, LTBB, *MDNR,* MSUE, NEMCOG, SACC, TOMWC	PF, SG, FG, PO, LB	5.2

Table 54: Hydrology and Groundwater I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
HGW	Hydrology and Groundwater																		
HGW.A	Develop and promote outreach and education materials (press release, mailing, etc. to inform public of results of groundwater protection efforts	L	NA	$1,000	Publicize upon completion of HG.1 through local news outlets, websites, etc.								Publicize				All	PF, SG, FG, PO	5.4, 5.6

Table 55: Water Quality Monitoring I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
WQM	Water Quality Monitoring																		
WQM.A	**Promote Volunteer Lake Monitoring program on both Duncan and Grass Bays**	**H**	**NA**	**$1,000**	**Recruit at least one volunteer for one of the two Bays by year 2**	**Recruit at least a second volunteer for other Bay by year 5**		**Recruit**			**Recruit**						**TOMWC**	**PF, SG, PO**	**5.8**

Table 56: Wetlands I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
WLS	Wetlands																		
WLS.A	Develop and distribute outreach packets to property owners who have been identified as having restorable wetlands on their properties	M	NA	$2,500	Distribute packets by year 4					Distribute							TOMWC	PF, SG, FG, PO	5.7

Table 57: Aquatic Invasive Species I/E Tasks

Categories		Priority: High (H), Med. (M), Low (L)	Unit Cost	Estimated Total Cost	Milestone	Milestone	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Potential Project Partners	Potential Funding Sources	Objectives Addressed
AIS	Aquatic Invasive Species																		
AIS.A	Develop volunteer-based aquatic invasive species monitoring program	H	NA	$15,000	Develop program and begin implementation by year 5	Continue program through year 10					Begin	Ongoing					HP, TOMWC	PF, SG, FG, LG, PO	5.3

Table 58: Information and Education Strategy Tasks and Actions Cost Summary

I/E Strategy Recommended Tasks and Actions Cost Summary		
	Category	**Cost**
GEN	General	$155,000
SSP	Shoreline and Streambank Protection	$35,000
SWR	Stormwater	$27,500
PZL	Planning, Zoning, and Land Use	$200,000
RSX	Road/stream Crossings	$2,000
LPM	Land Protection and Management	$5,000
ECH	Habitat, Fish and Wildlife	$5,000
RSH	Recreation, Safety and Human Health	$45,000
HGW	Hydrology and Groundwater	$1,000
WQM	Water Quality Monitoring	$1,000
WLS	Wetlands	$2,500
AIS	Aquatic Invasive Species	$15,000
	Total	**$494,000**

Implementation tasks and actions include many different types of monitoring activities. Monitoring is essential in order to evaluate effectiveness of the collective watershed efforts or individual actions. The following narrative details many of the Recommended Implementation Actions and Tasks.

Surface Water Quality Monitoring

Surface water quality monitoring will be used to evaluate the overall effectiveness of the nonpoint source watershed management plan and assess changes resulting from specific implementation activities. Water quality data collected by MDEQ, USGS, TOMWC, academic institutions, and other sources will be used to assess changes over time in Duncan and Grass Bays, Elliot Creek and other tributaries where data is available.

Physical and chemical parameters to be monitored include, but are not limited to: dissolved oxygen, pH, temperature, conductivity, chemical oxygen demand, biological oxygen demand, suspended solids, dissolved solids, water clarity, turbidity, light, carbon, phosphorus, nitrogen, chloride, zinc, copper, lead, cadmium, nickel, mercury, and arsenic. Biological monitoring of bacteria, algae, aquatic macrophytes, aquatic macroinvertebrates, fish, and other aquatic organisms will supplement physicochemical data. Discharge will be measured at sites on any lotic systems that are monitored. Additional physical, chemical, or biological parameters will be included in monitoring efforts in response to emerging water quality threats.

At a minimum, tributaries will be monitored annually. The primary pollutants of concern that will be monitored in the tributaries are sediments and nutrients, but will also include other parameters such as chloride. Discharge measurements will be made to determine pollutant loads and make comparisons among tributaries in terms of pollutant loads relative to discharge.

Shoreline and Streambank Surveys

Shoreline protection will be achieved by surveying the Duncan and Grass Bays shorelines every five to ten years. Parameters to be surveyed include indicators of nutrient pollution, erosion, greenbelt health, and shoreline alterations. A streambank survey will be conducted every five to ten years on Elliot Creek to document erosion. The results of surveys will be used to conduct follow-up activities directed toward riparian property owners, which will identify specific problems and encourage corrective actions. Survey results will also be used for trend analyses to determine if riparian areas are improving or deteriorating over time.

Stormwater Monitoring

Pollutants associated with cars and roads, including metals, chlorides, and Polycyclic Aromatic Hydrocarbons (PAHs), are also commonly found in urban stormwater and warrant monitoring. The USEPA lists metals and salts as pollutants associated with urban runoff that “can harm fish and wildlife populations, kill native vegetation, foul drinking water, and make recreational areas unsafe and unpleasant." PAHs are not water-soluble and persist in the environment for long periods, although they can breakdown from UV light exposure.

Stormwater discharge from basins 1-4 will be monitored to determine negative impacts to surface waters and to evaluate changes in the quality and quantity of stormwater runoff. Considering that stormwater has only been monitored at a handful of sites in the Watershed, the first priority is to collect baseline water quality data from all stormwater outfalls that discharge into Duncan Bay by year seven. Baseline data will be used to identify serious water quality problems, investigate problem sources, and determine and implement corrective actions. In addition to identifying and correcting problems, subsequent monitoring will provide the means to evaluate future BMP implementation projects.

Land Use monitoring

Land use change and landscape alterations caused by humans will be monitored because of the strong potential to influence nonpoint source pollution. Although primarily done using remotely sensed data in a GIS, field surveys may also be required. Landcover data will be used to assess changes in land use every 10 years. Increases or decreases in landcover associated with development (e.g., agricultural or urban) will be examined in context of changes in water quality and aquatic ecosystem health.

Road/Stream Crossing Monitoring

Road/stream crossings throughout the watershed will be surveyed approximately every 10 years to document current conditions, update prioritization, and to evaluate improvements or BMP installations. As is the practice with road/stream crossings, most are not given attention until they are failing and resulting in a significant problem. Therefore, monitoring should also include informal discussion with resource managers and other partners to ascertain whether any road/stream crossings need more immediate attention.

Land Protection and Management Monitoring

The priority parcel process is a tool that reduces nonpoint source pollution impacts to water resources by identifying parcels that are high priority for permanent protection based on ecological value and other criteria. This prioritization process will be carried out approximately every five years to monitor land protection efforts; reevaluating all parcels in the watershed and assigning updated rankings. Progress in land protection will be evaluated by determining change over time in the number of parcels and the total land area in the watershed considered to be protected from development. Updated prioritization information will be shared with land conservancies that are active in the watershed to assist with land protection efforts.

Habitat Monitoring

Habitat diversity is important for maintaining healthy, vibrant aquatic ecosystems, particularly in small streams and the littoral zone of lakes. Nonpoint source pollution can reduce the variety of available habitat in an aquatic ecosystem through excessive sedimentation and cultural eutrophication. Therefore, monitoring habitat conditions throughout the watershed is an important component for evaluating the effectiveness of nonpoint source pollution management plans.

Habitat monitoring data for Elliot Creek is limited; therefore the first step will be to collect baseline data followed by a subsequent survey approximately ten years afterward. Field surveys will be conducted with a particular emphasis on large woody debris, gravel, and cobble, all important aquatic habitat features.

Recreation, Human Health, and Safety Monitoring

Monitoring of recreation, human health, and safety can be measured by the health alerts issued by local health agencies. Oftentimes, health alerts are issued when water-related recreation, such as swimming, is prohibited due to a detected pathogen or other health threat. Beach closings are the most common alert; they are usually due to elevated *E. coli* levels. Other threats include avian botulism and swimmer's itch. Monitoring of mercury is also important. Mercury accumulates in fish tissue. Fish consumption, therefore, results in ingestion of mercury. Although the most significant source of mercury in the Duncan and Grass Bays Watershed is air deposition (which is outside the scope of Watershed Management efforts), monitoring of mercury levels in local fish should be a priority for the MDEQ.

Groundwater Monitoring

Groundwater is susceptible to contamination by nonpoint source pollution. In addition, landscape development and groundwater withdrawals (e.g., agricultural irrigation and drinking water) have the potential to reduce the amount of available groundwater. Therefore, groundwater monitoring is needed to assess the effectiveness of the nonpoint source management plan.

The status of the quality and quantity of groundwater in the Duncan and Grass Bays Watershed is currently unknown. The first step is to compile all existing groundwater information, identify problems, determine data gaps, and develop a strategy for feasible, effective, and long-term groundwater monitoring. This assessment of existing information and development of a monitoring plan will be completed in 10 years.

High groundwater recharge areas are determined by the presence of permeable soils that allow for relatively rapid recharge of groundwater stores. They have been delineated for the Duncan and Grass Bays Watershed because groundwater in these areas is particularly vulnerable to landscape development and nonpoint source pollution. The same permeability that lends itself to high groundwater recharge rates can also result in nonpoint source pollution passing relatively quickly through the soils and contaminating groundwater stores. Furthermore, increased impervious surface area as a result of landscape development leads to relatively greater decreases in groundwater recharge in areas with highly permeable soils (versus areas with lower soil permeability).

One approach for protecting high groundwater recharge areas is to limit impervious surface coverage. This can be accomplished through various means, such as implementing ordinances that limit the amount of impervious surface area on a parcel or limiting build-out potential through permanent land conservation. Efforts focused on protecting high groundwater recharge areas will be evaluated every ten years by determining changes (net gain or loss) in the extent of permanently protected lands in areas with high groundwater recharge rates.

Wetland Monitoring

Wetland restoration and protection efforts will be monitored by performing land cover change analyses in a GIS. A watershed-level analysis will be performed every 10 years using remote sensing data to determine increases or decreases in wetland acreage throughout the Watershed.

High-value wetlands will be identified and mapped out by assessing wetlands throughout the watershed in terms of ecological and environmental values (e.g., habitat value, water quality benefits, and flood control contributions). Following identification and mapping, the areas containing high value wetlands will be calculated every 10 years to determine any net change.

Aquatic Invasive Species

Several invasive species have become well established within the Duncan and Grass Bays Watershed, including invasive *Phragmites*, purple loosestrife, Eurasian watermilfoil, zebra mussels, quagga mussels, and round gobies. The mussels and gobies are pervasive throughout Lake Huron and the other Great Lakes. Controlling their spread within the Watershed is, therefore, beyond achievable. However, invasive *Phragmites,* which has been documented on both the Duncan and Grass Bays' shorelines, is at a more manageable level. Using databases maintained by TOWMC and USGS, both the introduction of additional aquatic invasive species and the spread of documented aquatic nuisance species within the Watershed will be tracked.

Low Impact Development (LID) Monitoring

Implementation of LID practices is an important aspect of the recommended tasks and actions. As more LID projects are implemented, public interest, awareness, and familiarity with LID practices will increase. Tracking the number of implemented projects through Information/Education (I/E) efforts, as well as public interest and awareness, will be ongoing.

Socio-economic Monitoring

Many projects carried out as a result of the watershed plan will have social and economic impacts. For example, nonpoint source pollution education of watershed residents may affect behavior and result in a reduction of nonpoint source pollution, or nonpoint source pollution reductions in surface waters may increase local tourism revenues and boost the economy. Therefore, monitoring activities should also include social and economic elements.

There are many methods for monitoring social and economic changes as a result of the management plan. Some of the primary tools for conducting this type of monitoring include surveys and demographic/economic change analyses. To establish relationships between socio-economic factors and nonpoint source pollution, data from other monitoring activities (e.g. surface water quality monitoring) will be incorporated into this monitoring effort.

To ensure that the recommended actions are meeting the goals of the watershed plan, an evaluation will be required to determine the progress and effectiveness of the proposed activities. The evaluation step is an important part of any watershed planning effort in that it provides feedback on the success of an activity or the project's goals. It also provides communities with important information about how to conduct future efforts, or how to change the approach to a specific problem in order to be more successful the next time. If activities are successful, this will gain more support for future activities amongst decision makers.

The Duncan and Grass Bays Watershed Management Plan will be evaluated by:

- Progress in completing the recommended actions and tasks (plan implementation)
- Effectiveness in protecting water quality

Evaluation Strategy for Plan Implementation

Tip of the Mitt Watershed Council will act as the lead organization and will oversee both the coordination of the Advisory Committee and the evaluation strategy for plan implementation. The evaluation strategy will be used to determine progress in completing the recommended actions and tasks identified in the plan. The Advisory Committee will review the recommended tasks and actions every five years at one of the regularly scheduled meetings and identify what has been accomplished during the previous five years.

A more thorough assessment every ten years will also identify what actions and tasks have been completed, as well as review the priority ranking of individual actions. As priority actions are accomplished, lower priority actions may be reassigned to be medium or high priority. In addition, new recommendations may be added in response to new issues and concerns, methodologies, data, and as other information is learned. The ten-year assessment will include an advisory committee "stocktaking" based on an effective evaluation strategy developed for the Little Traverse Bay Watershed Management Plan in 2011. The Little Traverse Bay Advisory Committee decided to "take stock of the progress that had been made on the actions recommended in the Plan; to identify the highest priorities for action today, given developments over the past five years; and to get input from partners on how to improve implementation of the LTB Watershed Protection Plan." The evaluation was based on soliciting opinions of the Advisory Committee on a one-on-one basis. A series of interview questions were used to elicit responses that would gauge the interviewee's sense of the effectiveness of the plan, its strengths and weaknesses, areas in need of change, usefulness, etc. Interviewee responses were compiled into a report of key findings and suggestions. The stocktaking effort was considered very insightful and will influence the future success of the Advisory Committee through implementing change, such as meeting structure and agendas. As an example, one key finding includes:

The scope of the Plan and, thus, the agendas for many of the Committee's meetings, is too broad for many partner organizations and their representatives, and may have contributed to lower participation at Committee meetings. To address this, one suggestion was to convene smaller working group meetings around a few priority topics and hold general meetings less frequently (e.g., once a year). Another was to focus each meeting on a different aspect of the plan and target speakers, field visits, and participation accordingly.

Based upon the informative result of this evaluation method, the Duncan and Grass Bays Watershed Advisory Committee will undergo a similar stocktaking strategy every ten years. Although an intensive process, the results will be very valuable to the success of the overall watershed management effort.

Evaluation Strategy for the Overall Protection Plan

The evaluation strategy for the overall Protection Plan in protecting water quality is based on comparing criteria with monitoring results. The Monitoring Strategy in Chapter 8 provides the framework in which to collect the appropriate data. For the Duncan and Grass Bays Watershed, the following criteria have been identified in order to determine whether water quality protection efforts are yielding results. Both quantitative and qualitative measurements are used in the evaluation.

Criteria used to determine effectiveness of water quality protection efforts

A set of criteria were developed to determine if the proposed pollutant reductions in the Duncan and Grass Bays Watershed are being achieved and that water quality is being maintained or improved. The water quality criteria for parameters that reflect nutrient and sediment pollution are as follows:

1. **Total phosphorus concentrations in Duncan and Grass Bays remain below 5 ppb (parts per billion).**
   Total phosphorus concentrations in large, deep, oligotrophic lakes are typically less than 10 ppb, which is the case for Duncan and Grass Bays whose phosphorus has been about 1 to 3 ppb in recent years.

2. **Total phosphorus concentrations in tributaries to Duncan and Grass Bays remain below 20 ppb.**
   Phosphorus concentrations in surface waters are not regulated by the State of Michigan or the USEPA. However, the USEPA recommends that total phosphorus concentrations in streams discharging into lakes not exceed 50 ppb.

3. **Total Nitrogen concentration in Duncan and Grass Bays and their tributaries should remain below 1 ppm (parts per million).**
   Nitrogen concentrations in surface waters are also not regulated by the State of Michigan or the USEPA.

4. **Maintain high dissolved oxygen levels in Duncan and Grass Bays and their tributaries.**
   Dissolved oxygen concentrations in Duncan and Grass Bays and its tributaries are typically above the 7 ppm standard that is required by the State of Michigan for water bodies that support cold-water fisheries.

5. **Reduce nutrient inputs from stormwater in urban areas.**
Depending on numerous factors, such as drainage area, land cover type, and period between rain events, nutrient loads in stormwater can vary widely. More data is needed to generate a comprehensive baseline data set and accurately assess stormwater impacts, particularly to Duncan Bay. Once baseline data are available, implementation projects that aim to reduce nutrient loads from stormwater in urban areas can be assessed through future stormwater monitoring. It is important to note that implementing stormwater management projects prior to baseline data collection will still achieve pollutant reductions; however, site-specific data will result in more targeted efforts.

6. **Maintain or reduce sediment loads in tributaries and stormwater draining into Duncan and Grass Bays and their tributaries.**
Similar to nutrient inputs in stormwater, additional sediment data is needed to generate a comprehensive baseline data set for stormwater impacts. In addition, sediment load data are limited for tributaries flowing into Duncan and Grass Bays. Once baseline data are generated, comparisons can be made to determine changes in time as related to implementation projects.

7. **Maintain pH levels within range of 6.5 to 9.0 in Duncan and Grass Bays and their tributaries as required by the State of Michigan.**
Data from the TOMWC Comprehensive Water Quality Monitoring (CWQM) program show that pH levels consistently fall within this range.

8. **Maintain or reduce the level of conductivity in Duncan and Grass Bays and their tributaries.**
Conductivity levels have been monitored in Duncan Bay as part of the TOMWC CWQM program and typically ranged from 200 to 300 µS/cm. Therefore, conductivity levels should consistently be less than 500 µS/cm and generally be less than 300 µS/cm in surface waters of the Duncan and Grass Bays Watershed.

9. **Maintain low water temperatures Elliot Creek (designated or capable of sustaining cold-water fisheries).**
Maintain low water temperatures in Elliot Creek to sustain the cold-water fishery. Water temperatures should generally not exceed 18° Celsius throughout summer months.

10. **Prevent beach closings on Duncan and Grass Bays due to bacteriological contamination.**
Prevent beach closings on Duncan and Grass Bays due to E. coli levels that exceed the State of Michigan water quality standard for single day (>300 E. coli per 100 ml of water). Prevent extended beach closings (there have been none to date) on Duncan and Grass Bays that result from a 30-day geometric mean measurement that exceeds State standards (>130 E. coli per 100 ml of water in 5 samples over 30 days).

11. **Maintain or improve aquatic macroinvertebrate community diversity in Elliot Creek.**
Aquatic macroinvertebrate diversity in a stream varies depending on many variables, including stream size, stream flow, habitat diversity, water temperature, riparian vegetation, land use, and more. Therefore, aquatic macroinvertebrate diversity at a given location on a stream must be viewed through a lens that accounts for such variables and is best compared with similar stream sites to accurately gauge stream ecosystem health. Reliable baseline data requires monitoring a site for a minimum of three years, after which the site can be compared to others using diversity indices to determine if the site and stream are normal and healthy. Thereafter, future monitoring can be conducted to assess the benefits of implementation projects to stream ecosystem health.

12. **Reduce *Cladophora* algae growth on the Duncan and Grass Bays shoreline that is caused by nutrient pollution.**
    Cladophora algae occurs naturally in small amounts along the shorelines of Northern Michigan lakes, but grows more extensively and densely as nutrient availability increases. The shoreline survey conducted on Duncan and Grass Bays documented the occurrence of *Cladophora* on the shoreline, as well as the density of growth. Results tallied from the survey provide statistics for the number of shoreline properties where *Cladophora* was observed, and more importantly, the number of properties where heavy-density growth occurred. Thus, the same information generated during future surveys can be used to determine if there were reductions in the number of properties with *Cladophora* growth or the number with heavy-density growth because of implementation projects.

13. **Maintain low chloride concentrations in surface waters**
    Data from the TOMWC CWQM program show that chloride concentrations have increased significantly over the last 20 years in most lakes and streams monitored in Northern Michigan. Chloride levels in Duncan and Grass Bays average ~10 ppm, while Butler ditch has much higher chloride levels (average ~36 ppm).Chloride is monitored because it is a good indicator of human activity in a watershed, i.e., as human population increases and urban and agricultural landuses increase, chloride levels tend to increase. In addition, monitoring chloride is valuable because it indicates that more damaging pollutants associated with chloride, such as leaking fluids and metals from automobiles that accumulate on roads along with deicing salts, are washing into and negatively impacting adjacent surface waters. Although most aquatic life is not affected by chloride reaches very high concentrations (>1000 ppm), some sensitive organisms may be lost at lower levels over the long-term. Chloride concentrations in the watershed's surface waters should not surpass 50 ppm and remedial actions should be taken if levels reach 100 ppm.

In addition to applying the abovementioned criteria, more qualitative evaluation methods will be used. Field assessments of BMPs, such as LID or streambank or shoreline bioengineering projects, will determine effectiveness by taking photographs, gathering physical, chemical, and/or biological data. We will also document projects with photographs to evaluate their effectiveness or need for improvement or modification. For example, shoreline and streambank restoration projects will be photographed before any restoration begins, during project installation, and after project completion. Other project types that may also warrant photographic documentation include road/stream crossings, stormwater and agricultural best management practices (BMPs), recreational access sites, etc.

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Appendix 1: Procedure for Prioritization of Parcels for Permanent Land Protection

Procedure for Prioritization of Parcels for Permanent Land Protection

Duncan and Grass Bays Watershed Management Plan

Tip of the Mitt Watershed Council, February 2013

Conservation Drivers and Scoring:

1. **Parcel Size (acreage)**
    1) Acres < 20 — 1 pts
    2) Acres >= 20 AND acres < 40 — 2 pts
    3) Acres >= 40 AND acres < 80 — 3 pts
    4) Acres >= 80 — 4 pts
2. **Groundwater Recharge Potential**
    1) Groundwater Recharge Acres > 0 AND < 5 — 1 pts
    2) Groundwater Recharge Acres >= 5 AND < 10 — 2 pts
    3) Groundwater Recharge Acres >= 10 AND < 20 — 3 pts
    4) Groundwater Recharge Acres >= 20+ — 4 pts
3. **Wetland Preservation**
    1) Wetland Acres > 0 AND < 2 — 1 pts
    2) Wetland Acres >= 2 AND < 5 — 2 pts
    3) Wetland Acres >= 5 AND < 10 — 3 pts
    4) Wetland Acres >= 10+ — 4 pts
4. **Lake Shoreline/Riparian Protection**
    1) Lake Shore Distance > 0' AND < 50' — 1 pts
    2) Lake Shore Distance >= 50' AND < 100' — 2 pts
    3) Lake Shore Distance >= 100' AND < 200' — 3 pts
    4) Lake Shore Distance >= 200' — 4 pts
5. **Undeveloped Lake Shoreline Protection**
    1) Undeveloped Shore Distance > 0' AND <= 50' — 1 pts
    2) Undeveloped Shore Distance > 50' AND <= 100' — 2 pts
    3) Undeveloped Shore Distance > 100' AND < 200' — 3 pts
    4) Undeveloped Shore Distance >= 200' — 4 pts
6. **River and Stream Shoreline/Riparian Protection**
    1) Stream Distance > 0' AND < 100' — 1 pts
    2) Stream Distance >= 100' AND < 200' — 2 pts
    3) Stream Distance >= 200' AND < 400' — 3 pts
    4) Stream Distance >= 400' — 4 pts
7. **Steep Slopes for Erosion Prevention**
    1) Slopes >= 20 and < 30% — 1 pts
    2) Slopes >= 30 and < 35% — 2 pts
    3) Slopes >= 35 and < 40% — 3 pts
    4) Slopes > 40% — 4 pts
8. **Adjacency to Protected Lands (Wildlife Corridors)**
    1) Adjacent to public lands — 1 pts
    2) Adjacent to public lands and doubles size — 2 pts
    3) Adjacent to conservancy lands — 3 pts
    4) Adjacent to conservancy lands and doubles size — 4 pts
9. **Threatened/Endangered Species (using MNFI model)**
    1) Probability = 'Low' AND "RI" >= 3 AND "RI" < 4 — 1 pts

2) Probability = 'Low' AND "RI" >=4 2 pts
3) Probability = 'Moderate' AND "RI" >=0 3 pts
4) Probability = 'High' AND "RI" >=0 4 pts

Appendix 2: Cheboygan County Local Ordinance Gaps Analysis Workshop Registration

NEMCOG
PO Box 457
Gaylord, MI 49734

Cheboygan County Local Ordinance Gaps Analysis

An essential guide for water protection

Sponsored by:
Tip of the Mitt Watershed Council
NEMCOG
Michigan DEQ

This project is intended to help you protect the watershed that encompasses your jurisdiction, and work with watershed partners who do so.

Cheboygan County
Local Ordinance Gaps Analysis
An essential guide for water protection

The Cheboygan County Local Ordinance Gaps Analysis is a review of all the water-related ordinances in Cheboygan County.

Purpose

The purpose of this project is to give you, the local government official, a comprehensive picture of:

- The water resource protections now in place at the county and township levels, including your jurisdiction;
- our recommended local approaches to protect waters; and
- our suggestions to better protect your water resources.

Join us at one of the 5 - two hour long workshops being held to discuss the Cheboygan County Gap Analysis. Copies of the report will be handed out at the workshops

You are invited to attend a workshop to explain the Cheboygan County Gap Analysis. Copies of the report will be handed out at the workshops.

Critical Elements of this Project

This project was done with the underlying assumption that specific **Critical Elements** are considered vital to address, if a local government wants to create strong protections for local water resources.

These **Critical Elements** are:

- Master Plan Components
- Basic Zoning Components
- Shorelines
- Impervious Surfaces and Stormwater Management
- Soil Erosion and Sediment Control
- Sewer/Septic
- Wetlands
- Groundwater and Wellhead Protection
- Other: Floodplains, Steep Slopes, and Critical Dunes

Agenda

6:30 – Introductions

6:45– Presentation by Richard Deuell, NEMCOG
Regional Local Officials and Citizens Resource Conservation Survey, understanding local official's and citizen's interest and commitment to natural resource conservation and protection.

7:15 – Presentation by Grenetta Thomassey, Tip of the Mitt Watershed Council
Cheboygan County Local Ordinance Gaps Analysis

8:30 – Wrap-up

Copies of the Gaps Analysis report will be distributed at the workshops. The report can be viewed at http://watershedcouncil.org under publications.

Meeting dates and locations
October 15, 2014 - Munro Township Hall
October 20, 2014 - Benton Township Hall
October 27, 2014 - Burt Township Hall
October 29, 2014 - Nunda Township Hall
November 5, 2014 – Cheboygan Library

PLEASE COMPLETE THE FORM, TEAR OFF THIS PANEL AND RETURN TO NEMCOG

Select the workshop you'll be attending:

_____ **October 15, 2014**
_____ **October 20, 2014**
_____ **October 27, 2014**
_____ **October 29, 2014**
_____ **November 5, 2014**

Number attending _____

Name: ____________________________

Community: ________________________

Address: __________________________

____

Phone: ____________________________

Email: ____________________________

Please mail, fax or email the registration to:

NEMCOG
PO Box 457
Gaylord, MI 49734

Phone: (989) 705-3733)
Fax: (989) 7705-3729
Email: thuff@nemcog.org

Appendix 3: Road/Stream Crossing Data Sheet

Stream Crossing Data Sheet — **Site ID:** ________

General Information

Stream Name: ________ **Road Name:** ________

Name of Observer(s): ________ **Date:** ________

GPS Waypoint: ________ **GPS Lat/Long:** ________

County: ________ **Township:** ________ **Range:** ________ **Sec:** ________

Adjacent Landowner Information: ________ **Additional Comments:** ________

Crossing Information

Crossing Type: Culvert(s) no.: ____ Bridge Ford Dam Other: ________

Structure Shape: Round Square/Rectangle Open Bottom Square/Rectangle Pipe Arch Open Bottom Arch Ellipse

Inlet Type: Projecting Mitered Headwall Apron Wingwall 10-30° or 30-70° Trash Rack Other

Outlet Type: At Stream Grade Cascade over Riprap Freefall into Pool Freefall onto Riprap Outlet Apron Other

Structure Material: Metal Concrete Plastic Wood

Substrate in Structure: None Sand Gravel Rock Mixture

General Condition: New Good Fair Poor

Plugged: ____ % Inlet Outlet In Pipe

Crushed: ____ % Inlet Outlet In Pipe

Rusted Through? Yes No **Structure Interior:** Smooth Corrugated

Multiple Culverts/Spans

Number the culverts/spans left to right, facing downstream. Include #s in site sketch on back page

Culvert/ Span #	Width (ft)	Length (ft)	Height (ft)	Material

Structure Length (ft): [1] ________ **Structure Width (ft):** [1] ________ **Structure Height (ft):** [1] ________

Structure Water Depth (ft): [1] **inlet** ________ **outlet** ________ **Perch Height (ft):** [1] ________ or NA

Embedded Depth of Structure (ft): [1] **inlet** ________ **outlet** ________

Structure Water Velocity (ft/sec): [1] **inlet** ________ **outlet** ________

Structure Water Velocity Measured: At Surface or ____ **ft Below Surface** **Measured With:** Meter or Float Test

Stream Information

Stream Flow: None < ½ Bankfull < Bankfull = Bankfull > Bankfull

Scour Pool (if present) Length: ____ **Width:** ____ **Depth:** ____ **Upstream Pond (if present) Length:** ____ **Width:** ____

Riffle Information (measured in a riffle outside of zone of influence of crossing)

Water Depth (ft): ________ **Bankfull Width (ft):** ________ **Wetted Width (ft):** ________ **Water Velocity (ft/sec):** ________

Dominant Substrate: Cobble Gravel Sand Organics Clay Bedrock Silt **Measured With:** Meter or Float Test

Road Information

Type: Federal State County Town Tribal Private Other:

Road Surface: Paved Gravel Sand Native Surface **Condition:** Good Fair Poor

Road Width at Culvert (ft): ________ **Location of Low Point:** At Stream Other **Runoff Path:** Roadway Ditch

Embankment: **Upstream** **Fill Depth (ft):** ________ **Slope:** Vertical 1:1.5 1:2 >1:2

Downstream **Fill Depth (ft):** ________ **Slope:** Vertical 1:1.5 1:2 >1:2

Left Approach: **Length (ft):** ________ **Slope:** 0% 1-5% 6-10% >10% **Ditch Vegetation:** None Partial Heavy

Right Approach: **Length (ft):** ________ **Slope:** 0% 1-5% 6-10% >10% **Ditch Vegetation:** None Partial Heavy

[1] - Fill out for primary culvert (culvert #1). If multiple culverts are used, number each and use embedded table.

Form Date: February 28, 2011

Erosion Information

Use a new row for each distinct gully/erosion location. Note prominent streambank erosion within 50 feet of crossing.

Location of Erosion Ditch, approach, or streambank Left or right facing downstream	**Erosion Dimensions (ft)**			**Eroded Material Reaching Stream?**		**Material Eroded** Sand, Silt, Clay, Gravel, Loam, Sandy Loam or Gravelly Loam.
	Length	**Width**	**Depth**			
				Yes	**No**	
				Yes	**No**	
				Yes	**No**	
				Yes	**No**	
				Yes	**No**	

If there is erosion occurring, can corrective actions, such as road drainage measures, be installed to address the problem? **Y N**

Extent of Erosion: Minor Moderate Severe Stabilized

Erosion Notes:

Photos – enter photo number in blank corresponding to location

❑ Site ID _____ ❑ Upstream Conditions _____ ❑ Downstream Conditions _____

❑ Inlet _____ ❑ Outlet _____ ❑ Road Approach – Left _____ ❑ Road Approach – Right _____

Summary Information

Would you consider this a priority site? Fish Passage Erosion Why?

Would you recommend a future visit to this site? Yes No **Why?**

Were any non-native invasive species observed at the site? Yes No **If yes, what species were observed?**

Site Sketch

Draw an overhead sketch of crossing. Be sure to mark North on the map and to indicate the direction of flow. Include major features documented on form, such as erosion sites, multiple culverts, scour pool, impounded water, etc.

Form Date: February 28, 2011

Appendix 4: Streambank Erosion and Alterations Assessment Form

STREAMBANK EROSION AND ALTERATIONS ASSESSMENT FORM Site ID: ________________

Stream Name: __________________________ Date: _________________ Severity: _________________

Recorder's Name(s): _____________________________________ Picture #s: ______________________

SITE INFORMATION:

Bank-as designated while looking downstream (circle one) RIGHT LEFT (Also mark the appropriate side of the site on the map)

Is the site accessible by road? (circle one) YES NO UNSURE Nearest RSX: ____________________

Other location information: ____

CONDITION OF THE BANK (circle A, B, or C):

A. Toe is undercutting B. Toe is stable; upper bank eroding C. Toe and upper bank are eroding

D. The percent of vegetative cover on the bank is (circle one): 0-10% 11-50% 51-100%

E. Problem trend (circle one): INCREASING DECREASING COMBINATION STABLE

F. Other (describe): ____

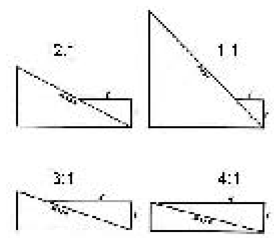
APPARENT CAUSE OF BANK EROSION (circle all that apply):

A. Obstruction in river B. Bank seepage C. Gullying of bank from side channels

D. Bend in river E. Road/stream crossing runoff F. Access traffic (type): ____________________

Other: ____

AMOUNT OF EROSION AND SLOPE RATIO:



A. Length of eroded bank (estimated or measured): __________ feet

B. Average height of eroded bank: __________ feet

C. Slope of bank-vertical (circle one): 1:1 2:1 3:1 4:1 or flatter

RIVER CONDITIONS:

A. Approximate width of river where erosion occurs (feet): ________________

B. Approximate depth of river: ________ at ________ feet from the bank. (Preferably get estimate 4' from the bank)

C. Current (circle one): FAST MODERATE SLOW

D. Soil Texture (circle all that apply): SAND CLAY LOAM GRAVEL STRATIFIED SAND OVER CLAY

Other Textures:

STREAMBANK STRUCTURES (circle all that apply):

A. Hardened seawall (describe): ____________________________________ B. Dock C. Launch/ramp

D. Stairway E. Riprap F. Other: ____________________________________

RIPARIAN VEGETATION: Has native vegetation been removed? YES NO

Linear footage of disturbance: ________ Average depth of disturbance (feet): ________

Has native vegetation been replaced with other vegetation? YES NO If yes: TURF OTHER

Remaining vegetation types (circle all that apply): TREES SHRUBS HERBACEOUS NONE

TYPE OF TREATMENT RECOMMENDED (CIRCLE): A. Rock Riprap B. Obstruction Removal D. Bank Regrading

E. Dedicated Access F. Bank Planting G. Fencing I. Other (explain):

USE BACK OF FIELD FORM TO SKETCH SITE

Notes:

____

____

____

Watershed Council

SYMBOL OPTIONS

→	Direction of flow
	Pool
	Undercut banks
	Streambank vegetation
LWD	Large woody debris
	Gully/rill erosion
	Erosion