Section VII.
Management Strategy Implementation

Watershed residents learn shoreline stabilization techniques using plant materials, or "bioengineering". credit: HRWC

This section outlines considerations in the implementation and evaluation of the Portage Creek Watershed Management Plan, as well as the interplay between evaluation and implementation, which shapes the revision process. A successful watershed plan is ultimately defined not by what is written on the pages of the plan, but by how the recommended plans and programs are put into action. A successful plan for implementation also recognizes that the state of the watershed changes over time. As such, evaluating the effectiveness and appropriateness of the actions taken to implement the plan, as well as the ability to adapt these actions to the changing conditions of the watershed, is critical.

A. Management Activities, Schedule and Costs

These activities are presented in Table VII-F.

Management Activities (#1-13)

Each of the recommended best practices presented in Table VI-N at the end of Section VI are summarized on the following pages with details on management activity, activity goal, estimated costs, estimated pollutant reduction when available, responsible agent, and potential funding sources.

1. Restore Vegetated Stream Buffers

Vegetated stream buffers are important permanent measures for water quality and habitat enhancement in the watershed. To most fully reap the benefits of these buffers, they should be at least 100 feet wide on either side of a stream – both intermittent and perennial. A stream buffer zone is a strip of undisturbed native vegetation, either original or reestablished, bordering a stream or river, or

wetland. These buffer zones also are known as riparian buffer zones, referring to the zone along a waterway or waterbody where the water meets the shore. The trees, shrubs and plants, and grasses in the buffer provide a natural and gradual transition from terrestrial to aquatic environments.

These areas are critical for wildlife habitat, storing water during periods of high water flow, and protecting lakes and rivers from physical and chemical pollutants. In fact, riparian areas are more productive than other ecosystems on a unit area basis[i]. Establishing buffers that protect the remaining riparian corridors, especially floodplains, wetlands, and steep slopes, is critical to protecting the aquatic system against increasing development pressures throughout the watershed and maintaining Portage Creek's physical, biological, and chemical integrity. In addition to the field data collected to characterize stream and lake buffer conditions, a spatial analysis of buffers was conducted based on subwatersheds and is shown in Figure VII-A.

Restoring natural shoreline vegetation in bacteria hot spots, such as designated swimming areas, will discourage Canadian geese populations from congregating. Planting and maintaining native grasses and sedges at swimming areas to replace some of the turfgrass will help reduce *E. coli* counts. The public beach at Halfmoon Lake is one example where this activity is recommended.

The Portage Creek Watershed Advisory Group further recommends that, through outreach efforts including a pilot program, property owners be encouraged to seek Wildlife Habitat Incentive Program (WHIP) contracts through the through Natural Resource Conservation Service (NRCS). The Conservation Reserve Enhancement Program (CREP) offers additional incentives to encourage landowners to implement practices that will help reduce sediment and nutrients and will improve wildlife habitat. Like the original conservation reserve program (CRP), land must be owned or leased for at least one year before it can be enrolled in CREP. Land must also meet cropping history and/or other eligibility requirements. Enrollment is on a continuous basis, allowing landowners to join the program at any time rather than waiting for specific signup periods.

The USDA Farm Service Agency (FSA) provides an annual land rental payment, including a CREP special incentive payment, plus cost-share of up to 50 percent of the eligible costs to plant grasses or trees on highly erodible cropland, establish vegetated buffers along streams, restore wetlands, provide shallow water areas for wildlife, and restore habitat for rare and declining species.

The goal of this activity is to add 82 acres in the Portage Creek watershed @$500/acre for 15 years (sign-up). Above that, we include staffing costs for $34,000. Appropriate grant opportunities to fund this initiative include section 319 nonpoint source pollution grants, Great Lakes Basin Program for Soil Erosion and Sediment Control, and the Great Lakes Restoration Initiative. In addition, supplemental budget requests to the State legislature are recommended. The Portage Creek Watershed Advisory Group has expressed in the Goals and Objectives that it would like to restore a minimum of 18,000 lineal feet of stream buffers, or 82 acres. Implementing this recommended activity at that level of effort would result in restoration of 82 acres, for an estimated cost of $75,000, and estimated pollutant reduction of 177,039 lbs/yr of TSS, 1,543 lbs/yr of TN and 200 lbs/yr of TP based on calculations of the U.S. EPA Region 5 Pollutant Reduction Manual (1999). Full implementation of this recommended activity would

result in restoration of 824 acres in the priority subwatersheds, for an estimated cost of $750,000, and estimated pollutant reduction of 1,770,391 lbs/yr of TSS, 15,431 lbs/yr of TN and 2,004 lbs/yr of TP.

Table VII-A. Estimated pollutant reduction for full stream buffer restoration in the Portage Creek watershed

	TSS			TN			TP		
	load before practice (lbs/yr)	**load after practice (lbs/yr)**	**load reduction (lbs/yr)**	**load before practice (lbs/yr)**	**load after practice (lbs/yr)**	**load reduction (lbs/yr)**	**load before practice (lbs/yr)**	**load after practice (lbs/yr)**	**load reduction (lbs/yr)**
Subwatershed									
5	284,311	76,764	207,547	4,500	2,700	1,800	594	325	269
7	281,080	75,892	205,188	4,444	2,666	1,777	471	258	213
8	151,518	40,910	110,608	2,269	1,361	908	256	140	116
9	57,483	15,520	41,693	901	540	360	88	48	40
11	482,680	130,324	352,356	7,643	4,586	3,057	825	452	374
12	377,487	101,921	275,566	5,707	3,424	2,283	537	294	243
13	749,964	202,490	547,474	12,429	7,458	4,972	1,570	860	711
14	41,040	11,081	29,959	684	410	274	84	46	38
Total	2,425,563	654,902	1,770,391	38,577	23,145	15,431	4,425	2,423	2,004

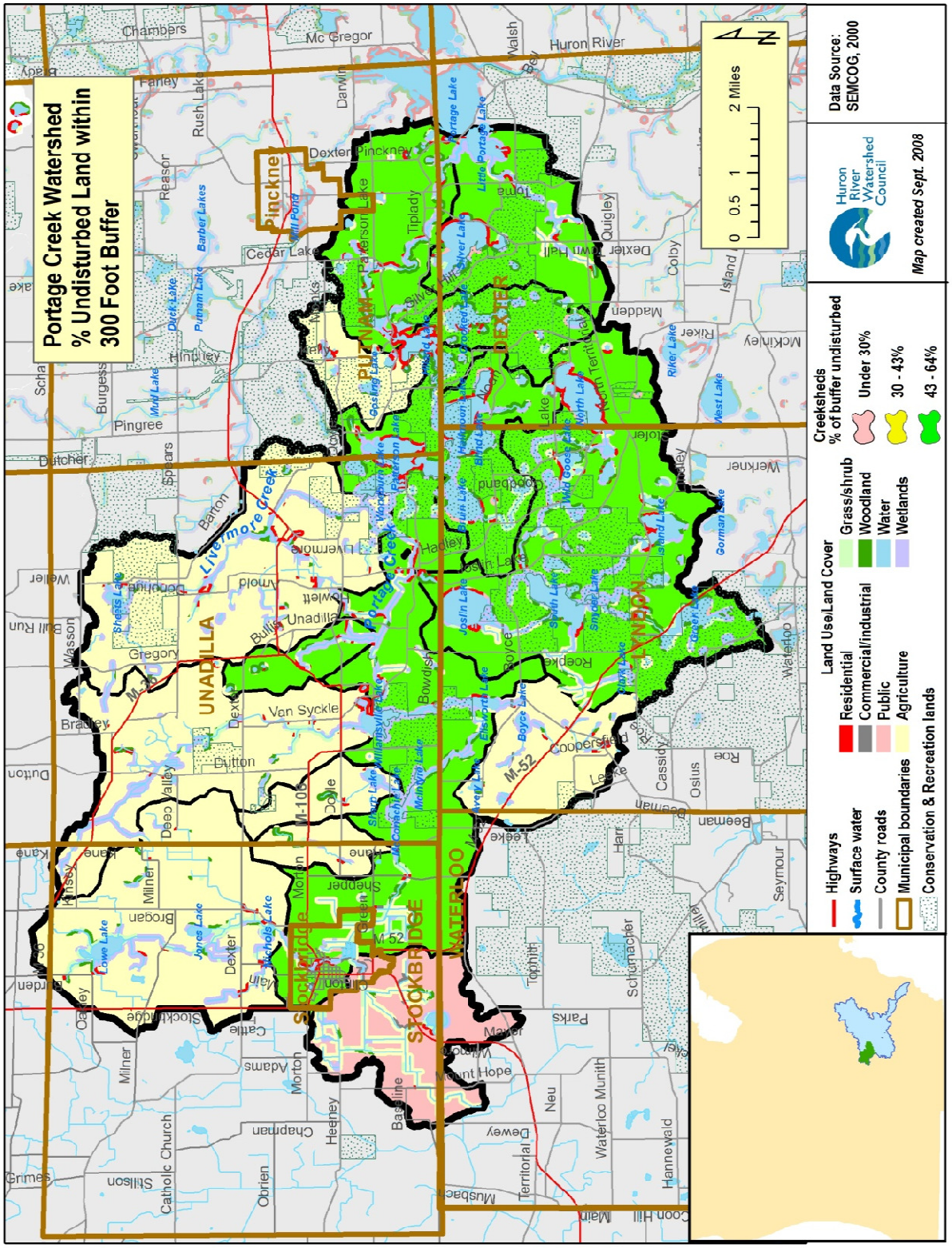
Based on 2000 Land Use/Land Cover from SEMCOG, and US EPA Region 5 Pollutant Reduction Manual (1999)

As part of the effort to restore vegetative stream buffers, **a Natural Shoreline Demonstration project** will be undertaken that is based on the recommended practices of the Michigan Natural Shoreline Partnership.

This project relies on volunteers to participate in the restoration, or makeover, of 3 public sites to demonstrate the value of lake- and river-friendly landscaping. This project includes an education and outreach component (media coverage and on-site educational materials). The demonstration will be led by a representative from the Michigan Natural Shoreline Partnership, such as the MSU-Extension staff at the Kellogg Biological Station. Success measured by number of acres successfully installed, # of citizen participants and tracking of subsequent referrals to landscape consultants. Estimated cost = $100,000. The townships and MDNRE will designate public lands for this project. The project is entirely dependent on grant funding such as section 319 grants and in-kind time and resources. Anticipated acreage of "makeover" sites = 3 acres.

Milestones: 2 months after funds received, site identified; 3 months after grant received, participants recruited, media alerted and site design begun; 4 months after grant received (and/or during appropriate planting period) plants ordered and planted; 6 months after grant received follow-up with participants to encourage home projects. Educational component: citizens will learn how to reduce pollution by using native plants which require fewer chemicals, and will understand the role of native plants in retaining and filtering stormwater runoff, and preventing shoreline erosion.

Figure VII-1. % Undisturbed Land within 300 Foot Buffer



2. Restore Wetlands

A restored wetland is the rehabilitation of a drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the natural conditions to the greatest extent possible. A constructed wetland is a man-made wetland with more than 50% of its surface area covered by wetland vegetation. It is ideal for large, regional tributary areas (10 to 300 acres) where there is a need to achieve high levels of particulate and nutrient removal. Wetland size and configuration, hydrologic sources, and vegetation selection must be considered during the design phase. Constructed wetlands provide a suspended solid removal of approximately 70%, while nutrient removal capabilities vary widely (between 40% and 80%) because no standard design criteria exist. These wetlands also benefit the area by providing fish and wildlife habitat and aesthetic benefits.

The Portage Creek Watershed Advisory Group has identified the need to restore hydric soils to their original pre-settlement wetland condition in order to improve pollutant removal from runoff and capture runoff for infiltration to groundwater. USDA NRCS, Conservation Districts, and HRWC in partnership with townships will seek wetlands restoration sites based on the Wetlands Trends Analysis and Landscape Functional Assessment prepared by MDNRE, and engage up to 100 citizens in planting and restoration.

The goal of this activity is to restore 500 acres in the Portage Creek watershed @$2,000/acre. Above that, we include staffing and O&M costs for $240,000. Appropriate grant opportunities to fund this initiative include section 319 nonpoint source pollution grants, Great Lakes Basin Program for Soil Erosion and Sediment Control, and the Great Lakes Restoration Initiative. In addition, supplemental budget requests to the State legislature are recommended.

Full implementation of this recommended activity would result in restoration of approximately 4,900 acres in the priority subwatersheds, for an estimated cost of $8,000,000 and estimated pollutant reduction of 1,323,488 lbs/yr of TSS, 5,462 lbs/yr of TN and 1,357 lbs/yr of TP. The Portage Creek Watershed Advisory Group has expressed in the Goals and Objectives that it would like to restore a minimum of 10% of previously converted wetlands. Implementing this recommended activity at that level of effort would result in restoration of 500 acres, for an estimated cost of $1,000,000, and estimated pollutant reduction of 132,349 lbs/yr of TSS, 546 lbs/yr of TN and 136 lbs/yr of TP.

Milestones: 2 months after grant received, sites identified; 4 months after grant received, participants recruited and plants ordered; 6 months after grant received (or appropriate planting season) marsh plantings occur; 12 months after grant received wetland condition assessed.

The restoration of wetland habitat in the watershed is recognized as an important attribute in restoring water quality. The Portage Creek watershed is estimated to have a historic wetland loss of 4,900 acres. The Wetland Functional Assessment Report (Appendix C) provides details on the geographic extant of wetlands in the watershed, assessment of functions provided by the wetlands, and locations of potential restoration projects. Most of this historic loss occurred in the upper headwater tributaries in the Lowe

Lake Drain, what is present day Stockbridge and Unadilla Township. Conversion of wetlands was a common agricultural practice in the region. Today those converted wetlands are valuable high production cropland. A network of lateral collectors (farm channels) and grass swales has altered the pre-settlement landscape and watershed hydrology.

As part of the action strategy to restore water quality to the Portage Creek watershed, it is recognized that restoration of upper headwater prior converted wetlands can play an important role in sequestering nutrients and sediments. Most of the opportunities for wetland restoration are on agricultural lands and farmland converted to low density development. Furthermore, the cost of conversion of agricultural land to wetland is a loss to the farmer in terms of the economic value of the land. Agricultural programs that promote best practices can offset the cost of converting drained hydric soils back to wetland through rental agreements. It is recognized that the restoration of wetlands should be done on a voluntary basis and that there are other conservation practices that may achieve similar results.

Table VII-B. Estimated pollutant reduction for full wetlands restoration in Portage Creek watershed

	TSS			TN			TP		
	load before practice (lbs/yr)	**load after practice (lbs/yr)**	**load reduction (lbs/yr)**	**load before practice (lbs/yr)**	**load after practice (lbs/yr)**	**load reduction (lbs/yr)**	**load before practice (lbs/yr)**	**load after practice (lbs/yr)**	**load reduction (lbs/yr)**
Subwatershed									
9	57,483	12,934	44,459	901	720	180	88	49	39
10	40,230	9,052	31,178	630	504	126	64	36	28
11	482,680	108,603	374,077	7,643	6,114	1,529	825	462	363
12	377,487	84,935	292,552	5,707	4,565	1,141	537	300	236
13	749,964	168,742	581,222	12,429	9,943	2,486	1,570	879	691
Total	1,707,844	384,266	1,323,488	27,310	21,846	5,462	3,084	1,726	1,357

Based on 2000 Land Use/Land Cover from SEMCOG, and US EPA Region 5 Pollutant Reduction Manual (1999)

3. Develop Environmental Flow Recommendations

While the activities recommended in #1 and #2 will benefit stream flows in the watershed by maintaining and improving the hydrology, understanding the flow regime required by the ecosystem is an important foundation to making management decisions. River ecosystem health deteriorates when natural flows of water, sediment and organic materials through a river or creek system are substantially disrupted or modified by human activities. Alterations such as damming, agricultural drains and storm sewer outlets impact how water flows through the creek.

In developing environmental flow recommendations, the water needs of the creek ecosystem are investigated during a process that involves water managers, scientists, and other parties involved in protecting and restoring the creek. Richter et al[ii] describe a process used by the Nature Conservancy to

develop flow recommendations based on a 5-step process: 1) Orientation Meeting for scientists, water managers, agency staff, local elected officials, and other interested parties ; 2) Literature Review and Summary Report of existing knowledge about flow-dependent biota and ecological processes of concern; 3) Flow Recommendations Workshop to develop ecological objectives and initial flow recommendations, and identify key information gaps; 4) Implementation of the flow recommendations on a trial basis to test hypotheses and reduce uncertainties; and 5) Monitoring System Response and conducting further research as warranted. A scientifically-defensible suite of recommendations and improved coordination and cooperation among water managers would result.

Primarily, staffing is needed to coordinate the process and is estimated at $25,000 for a 12-month period based on previous projects by the Nature Conservancy on other river systems.

4. Farm Best Practices and Farmer Outreach

The goal of this project is to secure 5 locations where farmers pursue best practices through the USDA NRCS cost-incentive programs. As presented in Section VI, the best practices identified as most beneficial and appropriate for the Portage Creek watershed are:

- Stream Buffer Strips
- Wetlands Restoration
- Conservation Tillage
- Comprehensive Nutrient Management
- Drain Naturalization with 2-Stage Channels

Stream Buffer Strips: Corridors or strips of land in permanent vegetation, designed to intercept pollution and manage other environmental concerns. Strategically placed buffer strips can effectively mitigate the movement of sediment, nutrients and pesticides within and from farm fields.

Wetlands Restoration: Wetlands that have been filled or drained retain their characteristic soil and hydrology, allowing their natural functions to be reclaimed. Restoration involves renewing historical wetlands that have been converted or degraded, and reclaiming their functions, such as sediment retention, nutrient uptake and assimilation and floodwater attenuation.

Conservation Tillage: Tillage that leaves 30% of the residue in the soil is conservation tillage. This practice decreases water and wind erosion and may be one of the most effective best practices for farmed parts of the watershed.

Comprehensive Nutrient Management Plan: These plans document practices and strategies adopted by livestock operations to address natural resource concerns related to soil erosion, livestock manure and disposal of organic by-products. The planning process begins with a comprehensive engineering and conservation planning resource assessment of current site conditions. Management options and structural alternatives are developed to address resource concerns identified during the assessment.

Ditch/Drain Naturalization: Modifying trapezoidal ditch design to 2-stage ditch design, which will develop pools and riffles in the channel, can benefit both drain function and maintenance and wildlife habitat by increasing stability and improving the channel's ability to transport sediment during high flows[iii]. Fish habitat may also be enhanced.

Interested farmers would be identified through an **agricultural outreach effort** lead by the Conservation Districts. Efforts will be focused on subwatersheds that include a large amount of cropland and farm operations (e.g., 5, 7, 8, 9, 10, 11, 12, 13 and 14). Conservation Districts in each County could be the party responsible for implementing this effort, with assistance from the USDA Natural Resources Conservation Service (NRCS).

Specific tasks for the activity could include: develop a targeted mailing/contact list of agricultural producers in each County by subwatershed; prepare a general watershed fact sheet that highlights watershed threats, causes, possible reduction alternatives, and information on available USDA Farm Bill programs that could help address watershed threats; host community meetings to include speakers and/or discussion on sub-watershed specific threats and causes, and how farmers can help address these threats with conservation practice installation; provide opportunity for interested agricultural producers to request a site visit to their farms by NRCS staff; follow-up with contact list via letter and phone to answer questions and remind agricultural producers about the community or neighborhood meetings; make list of site visits requested at meetings, to discuss site-specific alternatives to address threats using available USDA Farm Bill programs; and submit site visit list to NRCS for development of conservation plan(s) for interested farmers and assist with USDA Farm Bill program sign-ups. As appropriate, NRCS to provide technical, engineering or other assistance for practice implementation. Finally, progress reports could be prepared to include:

- # of agricultural producers participating in the watershed effort by sub-watershed
- # of agricultural producers participating in USDA Farm Bill programs by sub-watershed
- Amount of conservation practices installed or implemented by sub-watershed:
    - # of acres of conservation tillage
    - # of & # of acres of comprehensive nutrient management plans
    - # of acres of buffer strips
    - # of wetland restorations
    - # of 2-stage channels
    - # of other related practices

The approximate percent of total watershed acres identified above by Conservation District is:

CONSERVATION DISTRICT	% OF TOTAL WATERSHED ACRES
Ingham County	23.4
Jackson County	3.1
Livingston County	45.9
Washtenaw County	27.6
TOTAL:	**100.0**

BUDGET

Below is an estimated budget for implementation of an agricultural outreach effort:

TASK	EST. HOURS	HOURLY RATE	TOTAL STAFF COSTS	OTHER EXPENSES	TOTAL
Mailing Lists	80	$35	$2,800.00		$2,800.00
Fact Sheet	15	$35	525.00	Paper, copies, misc.: $300	825.00
Meetings	40	$35	1,400.00	Rental fees, Snacks: $300	1,700.00
Letter Mailing	50	$35	1,750.00	Postage: $550 Paper, copies, misc.: $350	2,650.00
Follow-up Calls	20	$35	700.00		700.00
Site Visits List	10	$35	350.00		350.00
Assist NRCS	100	$35	3,500.00		3,500.00
Additional Follow-up	20	$35	700.00		700.00
Progress Reporting	40	$35	1,400.00		1,400.00
TOTALS:	**375**		**$13,125.00**	**$1,500.00**	**$14,625.00**

Depending on staff availability in each of the four Conservation Districts, the outreach tasks could be conducted by each District individually; two Districts could complete tasks in two counties each (i.e. Ingham and Livingston, Jackson and Washtenaw, or some other combination); or one District could complete the entire agricultural outreach effort in all four counties.

Representatives from the four Conservation Districts could work out the best method for accomplishing the outreach effort, and how tasks and budgeted hours and dollars would be divided between participating Districts. A more detailed review of the estimated hours, hourly rates and other expenses to complete the outreach effort by the Conservation Districts may determine that adjustments to the hours and budget allocation amounts is necessary.

In addition to the staffing expenses, the best practices are estimated at $25,000 per site at 5 sites for a total of $139,625 to implement this activity to this extent. This level of effort is expected to yield pollutant reductions of 382 lbs. TSS, 765 lbs. Nitrogen, and 382 lbs. Phosphorus, as estimated using the Excel-based tool to estimate pollutant load reductions for agricultural and urban BMPs produced by U.S. EPA Region V.

5. Environmentally Sensitive Dirt and Gravel Roads Maintenance and Design

The majority of roads in the Portage Creek Watershed are unpaved. Many of these roads will remain unpaved due to very low traffic volume and/or lack of funds to adequately improve the subgrade and base before applying pavement layer(s). Unpaved road-stream crossings increase sediment in streams

and alter channel shape and stability. Erosion from unpaved roads can lead to high maintenance costs, increased roadway flooding, impaired waterways and degraded aquatic ecosystems.

Solve gully erosion on Tiplady Road at Portage Creek with Environmentally Sensitive Management Practices (ESMPs) to eliminate this source of sedimentation in the stream. Tiplady Road is an entrenched road with few outlets for drainage to leave the road area. Water is concentrated in parallel channels and directed 350 ft downhill into Portage Creek. Water entering the road area has nowhere to go but down the channels, gaining velocity and erosive force.

Objectives of the project are to:

1. Restore natural drainage by raising the road to achieve sheet flow
2. Reduce stream impact by providing additional inlet basins, with sumps, to collect road water in the ditch; periodically vacuum clean inlets
3. Reduce erosion by installing a flared culvert end structure with the slope lined with rip-rap and a plunge pool at the toe of the slope

This project would serve as a demonstration using ESMPs as a tie-in to the trainings. Estimated cost based on similar projects in Green Oak Township, MI, and Adams County, PA: $15,000 – $18,000 (not including cost of maintenance of inlets and plunge pool).

Train crews from county road commissions in Environmentally Sensitive Maintenance Practices (ESMPs) for dirt and gravel roads maintenance and design. Provide 2 professional training opportunities for road crews using instructors from the Pennsylvania State University's Center for Dirt and Gravel Roads. Suggested ESMPs covered in the training could include the following:

- ESMP #1 Insloping
- EMSP #2 Outsloping
- EMSP #3 Ditch Turnouts and Vegetative Filter Strips
- EMSP #5 Grade Breaks
- EMSP #6 Driveways
- ESMP #7 Culvert End Structures
- ESMP #8 Aprons at Culvert Outlets
- ESMP #10 Through Drains
- ESMP #11 Stream Saver System
- ESMP #12 Raising the Entrenched Road

These practices reduce or eliminate erosion and sediment flow into streams, provide filtering of pollutants, add to roadside safety, can reduce maintenance costs, and improve road conditions. Technical Information Sheets for the ESMPs listed above are included in the appendices and can be downloaded at http://www.epa.gov/owow/nps/sensitive/sheets.pdf. Estimated cost to sponsor the two trainings is $10,000.

Resources:
The Guidebook on Environmentally Sensitive Maintenance for Dirt and Gravel Roads
http://www.epa.gov/owow/nps/sensitive/sensitive.html

The Pennsylvania State University, Center for Dirt and Gravel Road Studies
http://www.dirtandgravel.psu.edu/

6. Stabilize Eroding Stream-Road Crossings and Other Eroding Sites

The goal of this project is to repair the eroding sites identified during the stream corridor assessment, as described in Section VI, and remove these sources of sedimentation from Portage Creek. Repairs to these sites will reduce or eliminate downstream scour and sediment deposition in Portage Creek.

The gravel and sand/gravel composite used for road surface can be the source of sediment pollution to surface waters when precipitation washes it into the stream or when road grading builds piles of the surface along the sides of the road. Stabilization of the eroding road and bridge surfaces at the sites identified in the field inventory may involve structural techniques such as retrofitting the bridge to prevent runoff from entering the stream or managerial techniques such as altering grading practices and selecting a different road and bridge surface.

This activity is estimated to cost $303,280 to restore all 7,582 lineal ft at $40/lineal ft + staff time at full implementation. To focus this activity on only the more severely eroded sites, about 250 lineal ft, then cost is estimated at $25,000 + staff time. Estimated pollutant reduction for this level of effort is 166 tons of TSS, 333 lbs of Nitrogen, and 166 lbs of Phosphorus.

Local units of government, specifically the townships, will need to work through the county governments to implement this practice. Appropriate funding sources include County Road Commission budgets, Michigan's Clean Michigan Initiative grants program, and federal s. 319 nonpoint source pollution program grants.

7. Remove Fish Barriers

The goal of this activity is to remove fish barriers from the 10 locations described in Section VI. The activity entails repair and replacement of culverts that are not flow-aligned, conduct stream repair, and work toward removal of two remnant dam structures near Williamsville Rd and downstream of Toma Rd. In addition, an alternatives analysis for Hi-Land Dam should be completed to determine if and how the dam and its operation could be altered to reduce its impact on Portage Creek.

The cost to conduct this activity is $1.6 million, or $1.4 million for just the culvert work alone. Culvert replacements/repair estimated at $150,000-200,000 per site at eight sites. Remnant dam removals and Hi-Land Dam alternatives analysis estimated at $200,000.

Local units of government, specifically the townships, will need to work through the county governments to implement this practice. Appropriate funding sources include County Road Commission budgets, and many state, federal and private grant sources that make a priority of river and freshwater fisheries restoration.

8. Detect and Correct Failed and High Risk Septic Systems

Potentially the highest concentrations of phosphorus entering Portage Creek are from failed septic systems. The dye testing programs in Washtenaw and Wayne County has shown that around 20% of septic systems are noncompliant, including failures. The rate of noncompliance can reasonably be extended to other counties in southeastern Michigan including Ingham, Livingston and Jackson County.

The goal of this activity is to use new technology to detect failed septic systems as piloted by Washtenaw County and HRWC during 2010-2013 (proposal submitted to MDNRE for EPA section 319 funding in fall 2009).

Tell tale signs prior to failure can be seen on the surface of the vegetation. Digital image analysis in conjunction with spatial analysis can identify signatures of failure. These signatures vary depending on soil and weather conditions, but relate to the impact on vegetation of saturation of soil with nutrients and water. The estimated pollutant reduction is 10% in Total Phosphorus and *E. coli* but the pilot program will yield field-based data.

First, the project will demonstrate how technology can be used to focus the activities of County Health Departments, so they can be more effective in identifying failed systems using fewer resources to act on the worst offenders who are probably not being picked up by the testing at time of sale regulations. Second, the project will remove the highest concentration and least well quantified of inputs of phosphorus and bacteria to streams.

County governments would be the responsible agent for this activity. The activity is expected to cost $35,000 once the pilot program has been established in Washtenaw County: $6,400 to collect GIS data and acquire imagery; $9,800 to field check results; $4,800 to identify high probability failures; $6,400 to follow-up on high probability failures for correction; and $6,400 for project management and handling results. Appropriate funding sources include County budgets, Michigan's Clean Michigan Initiative grants program, and federal s. 319 nonpoint source pollution program grants.

In addition, while some of the county governments in the Portage Creek watershed administer programs that regulate septic system inspections at time of property transfer to find problem systems, other county governments do not. Until a more sophisticated detect and correct program is in place, such as the one prescribed here, county governments can be identifying high risk and failed systems with a time of transfer program. The regulation used by Washtenaw County is in included in Appendix P.

9. Establish a Coordinated Monitoring System of Portage Creek

Water quality monitoring is crucial to our understanding of both existing conditions and the anticipated improvements in water quality as Portage Creek watershed plan implementation activities mature. It is imperative that monitoring be permanent, that the findings be scientifically unassailable, and that such progress in water quality improvements be heralded. Data collection is key to this strategy. Sufficient funding is crucial to the success of this strategy.

A consistent dataset of water quality parameters, biotic indicators and stream flow is needed for a better understanding of conditions in the Portage Creek watershed and to use as baseline when measuring conditions following implementation of recommended best practices. Further, pollutant removal efficiencies should be measured as part of any implementation project since the grey and peer-reviewed literature remains incomplete. Monitoring should include dry and wet weather events and seasonal variation over multiple years. Some of the monitoring could be conducted by trained volunteers affiliated with the HRWC's Adopt-A-Stream program.

HRWC is eager to work in partnership with MDNRE, county and local governments, and other partners to develop a water quality monitoring program that will integrate continuous monitoring technology with citizen monitoring. Cost estimate for first two years = $75,000. Project funding would be a combination of leveraging the resources of the Adopt-A-Stream monitoring at 2 sites in addition to adding at least one site to have a representative number of monitoring locations on this system. In addition to the Adopt program, additional funds would be needed from the communities in the Portage Creek watershed and/or from grant funding. Appropriate funding sources include the federal section 319 nonpoint source pollution program grants, Michigan water quality monitoring grants, among others.

Milestones: 1 month after funds received – recruit participants; 3 months after funds received, train participants, citizen monitoring ongoing for months 3 – 24. Educational component: citizens will observe changes (improvements) to water quality over time and be able to relate this to Portage Creek watershed plan implementation.

A 5-year monitoring strategy for Portage Creek watershed is presented in Table VII-C.

Table VII-C. Five-year monitoring plan outline (2011-2015) for Portage Creek watershed

Five-Year Monitoring Plan Outline (2011-2015)
Portage Creek Watershed Communities, Huron River Watershed

Monitoring Activity	Proposed Responsible Party	Sites/Frequency/Season	Year Performed				
			2011	2012	2013	2014	2015
Public Education and Involvement							
Public Survey	SEMCOG/HRWC	not applicable					
Summary of Volunteer Restoration Efforts	HRWC/County Conservation Districts	not applicable					
Biological Monitoring: Streams							
Aquatic Macroinvertebrates	Adopt-A-Stream (HRWC)	Jan/Apr/Sept at 3 sites	x	x	x	x	x
Stream Habitat Assessment	Adopt-A-Stream (HRWC)	3 sites (once every 4-5 years)	x				x
Fish and Habitat	MDNR/MDEQ	as selected by MDNR/ MDEQ		x			
Freshwater Mussels	MDNR/MDEQ	as selected by MDNR/ MDEQ					
Biological Monitoring: Lakes							
Fish, Herpetiles and Habitat	MDNR/MDEQ[x]	as selected by MDNR/ MDEQ		x			
Aquatic Plants	MDNR/MDEQ	as selected by MDNR/ MDEQ		x			
Physical Monitoring: Streams							
Flow	TBD	Year round at 2 sites (real-time)	x	x	x	x	x
Precipitation	TBD		x	x	x	x	x
Temperature	HRWC/County Conservation Districts		x	x	x	x	x
Geomorphology/ stream classification	HRWC/County Conservation Districts						
Sediment	TBD						
Water Quality: Streams							
Total Suspended Solids (TSS)	TBD	Apr - Sept at 3 sites 12 times	x	x	x	x	x
Dissolved Oxygen (D.O.)	TBD	Apr - Sept at 3 sites 12 times	x	x	x	x	x
Total Phosphorus (TP)	TBD	Apr - Sept at 3 sites 12 times	x	x	x	x	x
E. coli	TBD	Apr - Sept at 3 sites 12 times	x	x	x	x	x
Water Quality: Lakes							
Transparency	TBD	11 locations[y]	x	x	x	x	x
Total Phosphorus (TP)	TBD	11 locations[y]	x	x	x	x	x
Dissolved Oxygen (D.O.)	TBD						
Chlorophyll	TBD						
E. coli	MDEQ/ Livingston Co/ Washtenaw Co	May-Sept at 11 sites	x	x	x	x	x
Pollution Prevention							
Illicit Discharges Identified & Eliminated	Ingham Co/Livingston Co/Washtenaw Co	on-going	x	x	x	x	x
Planning and Reporting							
Watershed Group refines monitoring plan	Watershed Group/HRWC/MDEQ	not applicable	x	x	x	x	x
Data Handling, Data Management and Analysis	TBD	not applicable		x	x	x	x
Prepare Monitoring Report/ Brochure/Press Release	TBD	not applicable	x	x	x	x	x

TBD = To be determined
HRWC = Huron River Watershed Council
USGS = United States Geological Survey
MDEQ = Michigan Department of Environmental Quality
SEMCOG = Southeast Michigan Council of Governments
MDNR = Michigan Department of Natural Resources
CVT = Cities, Villages, Townships
[x] as part of 5-year monitoring of the Huron River Watershed
[y] 7 in-line lakes: Ellsworth, Williamsville, Patterson, Bruin, Blind, Halfmoon, and HiLand + Joslin, North, Island, Silver

10. Educate and inform public about good stewardship for stream and lake resources

The goal of this activity is to create an aware and involved public that protects local freshwater resources and change behaviors among watershed residents to increase stewardship for Portage Creek and its streams, lakes, wetlands, and floodplains. An estimated 75% of the nonpoint source pollutants in the Huron River watershed, and the Portage Creek watershed, are the result of individual practices. Audiences for this activity include homeowners, all levels of government, waterfront landowners, lake and home associations, commercial lawn care businesses, and general businesses and services. It is critical that these target audiences understand and respond to their impacts on the creek system. Preventing pollutants from reaching the river is far more cost effective than waiting until restoration is required.

This activity will target nonpoint source pollution prevention through traditional marketing outlets including print advertising, direct mail and retail promotions. Behaviors addressed by the campaign should include the following: responsible boating; invasive aquatic plant and animal species; shoreline stewardship for residential sites; septic system maintenance; and high quality/rare species and habitat requirements (e.g., cisco, herpetiles). Additionally, the campaign could address home toxics disposal, water conservation, land use, and watershed and stream crossing road signage.

Market research would be used to determine core behavioral motivations and how to use these motivations to inspire behavior change. Messages would focus on items of interest to the homeowner, such as savings in time and money, with water quality protection positioned as an "added benefit." Individual impacts should be stressed to empower homeowners with the message that "their actions do make a difference." Consistency of messages across the watershed and repetition will be crucial to success of the campaign.

A coordinated public information and education campaign will cost approximately $136,000 to reach these audiences on the priority topics listed above over five years. HRWC could be the lead agent for this activity building on its successful mass media public information and education for the Huron River watershed. The campaign would be based on the Information and Education Plan.

Information and Education Plan

The Information and Education Plan for the Portage Creek watershed follows the model laid out in *Developing a Communications Plan: a Roadmap to Success*[iv], which was developed for communities in the Huron River watershed through funding provided by the MDNRE and U.S. EPA. The Portage Creek Plan relies on market research conducted for an Information and Education Plan developed previously for the Huron River watershed.

Goal of the Information and Education Plan

The goal of the plan is to create an awareness of water quality and watershed issues that will promote positive actions to protect and enhance the integrity of the Portage Creek watershed.

Measurable Objectives

The objectives of the plan are to

1. Increase activities that result in preservation, restoration and protection of the watershed system;
2. Reduce pollution that impacts the Portage Creek watershed by providing practical knowledge to key audiences;
3. Increase the general public's awareness and knowledge of the watershed and the interconnectedness of the system; and
4. Increase participation in watershed stewardship and recreation.

Audience and Message Priorities

Target audiences were selected based on the goals and objectives for the Information and Education Plan. In general, most communities in the watershed can be characterized as rural townships or small villages with a mix of land uses, namely the Village of Stockbridge. Socio-economic variability between communities will also be taken into account when determining messages. The land uses and land ownership within these communities determine how to tailor the message to watershed audiences.

An estimated 75% of the nonpoint source pollution in the Huron River watershed is the result of individual practices. That percentage is higher still in the Portage Creek watershed since no permitted entities of significant size, such as a municipal publicly-owned wastewater treatment plant, are sending treated effluent to the creek. A multi-pronged outreach strategy that reaches the multiple audiences in the watershed will be required to meet the goals and objectives of the watershed management plan.

The following groups were selected: households, with waterfront landowners (creek and lakes) being an important sub-group; the farming community; local government decision makers; businesses, with the development community being an important sub-group; and partner organizations.

With the target audiences identified, water resource-related behaviors associated with the audiences were identified and prioritized according to which behaviors will have the most impact on the goal and objectives of the Information and Education Plan. Concurrently, the plan integrates community interest in what is most important to accomplish and what is feasible to accomplish given organizational resources.

The messages by target audience, based on current knowledge of audiences' behaviors, are the following:

Waterfront (creek and lakes) Landowners

1. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources and flow alteration (e.g., dams, lake level control)
2. Shoreline land management including importance of vegetated buffers
3. Responsible boating practices
4. Water-friendly lawn and garden practices: mowing habits; fertilizer/pesticide use; yard waste disposal; erosion control; landscaping with native plants; water conservation

5. Invasive aquatic plant and animal species identification, causes of introduction and options for mitigation and prevention
6. Septic system maintenance
7. Housekeeping practices and toxics disposal
8. Importance of being actively engaged in community watershed planning and protection, including participation in waterway stewardship efforts including HRWC's Adopt-A-Stream program and the Michigan Lakes Cooperative Monitoring Program.

Households

1. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources
2. Identification and protection of key habitats and features: aquatic buffers, woodland, wetlands, steep slopes, high quality/rare species and habitat requirements
3. Water-friendly lawn and garden practices: mowing habits; fertilizer/pesticide use; yard waste disposal; erosion control; landscaping with native plants; water conservation
4. Housekeeping practices and toxics disposal
5. Septic system maintenance
6. Stewardship opportunities to study and protect the Portage Creek watershed including lakes and creek monitoring

Participation in the RiverSafe Homes Program, through Washtenaw County Water Resource Commissioner's Office, provides homeowners with information on many of these messages.

Local Government Decision Makers

1. Importance of participating in ongoing regular watershed public education and of leveraging public education efforts being coordinated at the wider watershed level
2. Identification and protection of key habitats and features: aquatic buffers, woodland, wetlands, steep slopes, high quality/rare species and habitat requirements
3. Invasive aquatic plant and animal species identification, causes of introduction and options for mitigation and prevention
4. Coordinate master plans and planning issues with neighboring communities
5. Ensure use of Low Impact Development in development oversight (in support of Management activity #14)
6. Ensure use of innovative stormwater best practices (in support of Management activity #14)

Farming Community

1. Advantages of and opportunities for vegetated buffers and filter strips
2. Advantages of and opportunities for wetlands restoration
3. Impact of tillage methods/Importance of farming soil erosion & sedimentation control practices
4. Advantages of and opportunities for comprehensive nutrient management plans
5. Advantages of and opportunities for two-stage channel restoration over traditional channel maintenance
6. Opportunities for farmland conservation partnerships and cost-share funding incentives through the Farm Bill to implement #1-5

Management activity #3 Farm Best Practices and Farmer Outreach provides more detail on methods for reaching this audience.

Businesses

1. Water-friendly lawn and garden practices: mowing habits; fertilizer/pesticide use; yard waste disposal; erosion control; landscaping with native plants; water conservation
2. Proper toxic chemical use, storage & disposal
3. Responsible boating practices for customers, including invasive aquatic plant and animal species identification, causes of introduction and options for mitigation and prevention
4. Advantages of and opportunities for innovative stormwater management
5. Storm drain use and awareness

Participation in the Community Partners for Clean Streams Program, through the Washtenaw County Water Resources Commissioner's Office, provides businesses with information on these messages.

Development Community

1. Advantages of and opportunities for open space protection & financial incentives for conservation
2. Advantages of and opportunities for Low Impact Development
3. Impact of earth moving activities/Importance of soil erosion & sedimentation control practices
4. Identification and protection of key habitats and features: aquatic buffers, woodland, wetlands, steep slopes, high quality/rare species and habitat requirements
5. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources

Partner Organizations

1. Creekshed awareness: sense of place within watershed, water cycle and how we impact it, including key pollutant sources
2. Active participation in creekshed activities and stewardship projects
3. Communicate creekshed issues to members and residents
4. Participate in public communications plan network

Limited resources make it necessary to prioritize the audiences and messages in terms of the level of effort to be directed toward each audience. By asking "Which audience will be most important for our education program so as to restore and protect water quality and quantity?" a prioritization of audiences was determined. The audience priorities for this plan are:

1. Shoreline Landowners
2. Households
3. Local Government Decision Makers
4. Farming Community
5. Partner Organizations
6. Businesses
7. Development Community

To establish a methodology for reaching the target audiences, a two-part strategy was developed and projected for five consecutive years.

One part of the strategy involves passive mechanisms to reach target audiences via multiple mass media outlets. This strategy can include print, radio, television advertising, and direct mail, marketing, door hangers, or point of sale literature. These methods and many more are described in HRWC's *Marketing the Environment – Achieving Sustainable Behavior Change through Marketing* (J. Wolf, 2002), a guidebook to understanding and using commercial marketing techniques to create lasting behavior change. The audiences appropriate for the strategy are (1) households, (2) development community, and (3) businesses.

The second part of the strategy requires a more active and tailored approach to reach audiences about targeted behaviors that affect watershed quality and what audiences can do to alter their behavior for the better. The focus of this effort should be on (1) shoreline landowners, (2) local government decision makers, (3) farming community, and (4) partner organizations, via presentations and other face-to-face interaction/communication. Table VII-D illustrates the suggested breakdown of communications strategy per target audience.

Table VII-D. Prioritized Target Audiences per Communications Strategy

Communications Strategy	
1. Mass Media	2. Personal Communication and Interaction
Households Businesses Development Community	Shoreline Landowners Local Government Decision Makers Farming Community Partner Organizations Primary and Secondary School Educators

Information and Education Strategy

The main focus of years 1 and 2 will be on communicating with households, with a concerted effort to reach shoreline residents, local government decision makers and farmers. Approximately one-third of the effort will be directed toward households, one-third of the effort directed to local government decision makers, and one-third directed to farmers. In year 3, efforts focused on businesses and the development community will pick up with one-third of the effort focused on these groups, with corresponding decreases in the groups targeted in the first two years. In years 4 and 5 efforts will continue at a level to sustain results gained in years 1 through 3. Low level, but consistent outreach to partner organizations will run throughout all five years.

The primary goal of years 1 and 2 will be to develop awareness within the communities in the watershed of the water cycle and how we impact it, including key pollutant sources, and a sense of place within the watershed. Educating residents on practices and behaviors they can implement in their lives which will

result in improvement and protection of the watershed will be an emphasis as well. In years 3-5, messages will build on those developed in the preceding years.

Effectiveness of the media campaign and the personal communication strategy should be evaluated annually. Results from the evaluation should be used to assess the previous year's efforts and be a guide to shape the work in the coming year. Expect the level of effort to change as success is achieved and positive behavioral changes occur in the coming years. A full review of the Information and Education Plan should be conducted upon completion of years 3 and 5.

HRWC's *Developing a Communications Plan* will be combined with the few pre-existing information and education plans created by communities with Phase II public education plans and SWPPIs to guide the process of determining appropriate materials, media, budgets and timeframes, and measurements of progress. However, the following recommended educational message and initiatives can provide the framework for further development of the public communications efforts:

- Acceptable application and disposal of pesticides and fertilizers and simple lawn water quality-friendly maintenance alternatives
- Availability, location and requirements of facilities for disposal or drop-off of household hazardous wastes, travel trailer sanitary wastes, chemicals, grass clippings, leaf litter, animal wastes, and motor vehicle fluids
- Public responsibility for and stewardship of the watershed, and promote awareness of and participation in existing stewardship and monitoring programs
- Management of riparian corridors to protect water quality
- Awareness of stormwater runoff, simple mitigation activities, and the importance of imperviousness and forest cover to water quality
- Impact of impaired septic systems on water quality and knowledge of maintenance guidelines
- Awareness of the watershed concept, sense of place within the watershed, and the benefits of a healthy watershed
- Importance of proper erosion and soil control measures and existence of current oversight programs
- Benefits of landscaping and lakescaping with native plants and bioengineering techniques
- Promote education of local government employees on water quality-related good housekeeping/pollution prevention
- Alternatives to current development and land use practices within the watershed
- Build knowledge, awareness, and support of the Portage Creek Watershed Management Plan and its recommendations
- Encourage watershed-friendly business practices and site development (e.g., Washtenaw County's Community Partners for Clean Streams)
- Benefits of proper pet waste and livestock waste handling
- Benefits of water conservation measures for households

Several programs and initiatives are recommended for initiation in this Watershed Management Plan. Below is a list of programs for implementation across the watershed.

1. Watershed wide direct mail outreach consisting of tip cards, brochures or watershed community calendar. Topics and messaging will be targeted to households. Evaluative feedback through web-based survey. Timing of calendar production and distribution dependent upon HRWC's community calendar or tip card program. Cost estimate for production and mailing to 6,000-8,000 households $10-12,000 per year in years 2 and 4. ($24,000 TOTAL)

2. Regular, targeted advertising in local media in the Portage Creek watershed. Likely topics include yard, garden and shoreline maintenance best practices, watershed awareness, septic system maintenance and shoreline stewardship program opportunities. Appropriate print media to be researched and identified, but could include: The Sun Times, Livingston County Daily Press & Argus, Chelsea Standard, and Dexter Leader. Cost estimate based on publication mix and frequency, $10-12,000 per year over 5 years. ($60,000 TOTAL)

3. Develop content for websites and newsletters that support key messages for targeted audiences, in particular shoreline residents and farming community. $10-12,000 first year, $5,000 per year maintenance after that. ($22,000 TOTAL)

4. Develop, print and distribute fliers or brochures for use at key retail, entertainment and recreational venues that educate and inform lakeside residents about shoreline stewardship: including Waterway Stewardship Programs for citizen participation (HRWC Adopt-A-Stream and MiCorps/Cooperative Lakes Monitoring Program). Work with organizations like HRWC member governments, partner organizations, state recreation areas and parks, libraries, local chambers of commerce or economic development groups to distribute. $5,000 to develop print and distribute 7,000 fliers through years 1-3. ($5,000 TOTAL)

5. Develop and conduct presentations for existing civic groups, government decision makers, lake associations and other community groups. Engage in strategic partnerships with organizations that reach target audiences. Cost estimate: staff and travel $5,000 per year ($25,000 TOTAL)

6. HRWC's Adopt-A-Stream Program river monitoring and stewardship program. Program involved 400 volunteers per year monitoring ~75 sites per year. Cost estimate: included in Management Activity #9.

7. Promote participation in Washtenaw County's RiverSafe Homes Program. The RiverSafe Homes program enables Washtenaw County residents to identify water quality protection activities they currently practice around their homes, and to commit to additional pollution prevention practices that they may not have considered before. Work with the Washtenaw County Water Resources Commissioner's (WCWRC) office and incorporate into above activities.

8. Promote participation in Washtenaw County's Community Partners for Clean Streams Program, a voluntary, no cost to participants, cooperative water quality protection program between the WCWRC and Washtenaw County businesses, institutions, and multi-complex land owners. Work with WCWRC and incorporate into above activities.

11. Develop a Tourism Campaign

The watershed advisory group recommends the development of a tourism campaign to attract more visitors to the area by highlighting the natural assets of the Portage Creek watershed. The advisory group identified among its Goals and Objectives for the watershed to "Make Portage Creek watershed a recreation destination in Michigan's Lower Peninsula" by increasing visitors to state and county parkland emphasizing the off-peak times of winter and spring and weekdays during the year.

Interest in and availability of local "ecotours" is growing. One example of ecotours that have been offered in the watershed is canoe field trips that have attracted participants from a wide geographic area. Field trips, some for as long as one week, featuring some of the watershed's more rare inhabitants, such as reptiles and amphibians have demonstrated interest. Ecotours could be a main aspect of a campaign for the Portage Creek watershed.

A tourism campaign would need to be coordinated with efforts lead by the State of Michigan and any local convention and visitors bureaus. The estimated cost for this activity is $60,000 for a two-year initiative.

12. Preserve High Priority Natural Areas

The goal of this activity is the conservation of 1,525 acres of high-priority natural areas in the Portage Creek watershed through the purchase of conservation easements to expand contiguous protected land. An Easements Incentive Program for acquisition of development rights within the watershed is recommended that would boost the rate of conservancy in the watershed. A conservation easement is a legal agreement between a landowner and a land trust (a private, nonprofit conservation organization) or government agency that permanently limits a property's uses in order to protect its conservation values. A conservation easement can be an attractive tool to land owners looking to preserve their land legacy since it leaves the land in private ownership, and can result in an income tax deduction and reduced property and estate taxes.

Several land conservancies operate in the Portage Creek watershed that can serve as the responsible agents for implementing this activity. The approximate cost for this activity is $150,000 to purchase easements on 1,525 acres at $3,250 per 50 acre easement on average plus staff time. This level of effort represents protecting 10% of the 15,257 acres in the watershed identified as highest priority for protection.

Pollutant reductions associated with this activity are estimated to be 147,979 tons TSS, 7,018 lbs N, and 1,099 lbs P based on the assumption that this land otherwise would be developed as low-density single family residential that would contribute nonpoint sources of pollution to the Portage Creek watershed.

More information on conservation easements can be obtained at www.landtrustalliance.org, www.legacylandconservancy.org, and www.livingstonlandconservancy.org.

13. Maintain and Improve Habitat for Reptiles and Amphibians

The goal of this activity is to protect and improve habitat for native reptiles and amphibians in the Portage Creek watershed by addressing the top threats to their survival. These animals play a critical role in freshwater ecosystems in this region and, as such, serve as a bellwether for the quality of our wetlands, ponds, lakes and streams.

The Waterloo-Pinckney Recreation Area, within the Portage Creek watershed, is rich in reptile and amphibian species diversity. In order to preserve the integrity and connectivity within this region, active management needs to be conducted. Necessary management includes the removal and control of invasive plants, most notably buckthorn, honeysuckle, autumn-olive, multiflora rose, and garlic mustard. These invasive plants grow in the forest understory and wetland fringe creating dense shaded areas, eliminating necessary patches of sunlight for basking by reptiles and amphibians, and altering wetland hydrology. In addition, common buckthorn leaf litter in vernal pools has been found to have a toxic effect on salamander larvae. Furthermore, garlic mustard has been shown to alter soil chemistry and reduce available food sources for native mole salamander species such as Spotted and Blue-spotted Salamanders resulting in local extirpation.

Direct threats to reptiles and amphibians from humans are relatively rare in the Waterloo-Pinckney Recreation Area although several threats are present on adjacent lands. First, property owners on nearby lakes, wetlands and streams often convert natural riparian vegetation to manicured lawns and armored shorelines thereby eliminating nesting habitat for turtles. Increasing nesting opportunities for turtles adjacent to water bodies is a necessary management practice in order to counter the nests lost to habitat conversion in nearby residential areas. Second, road related mortality is a significant threat to turtles during nesting season and in early spring. Locations need to be identified for the placement of culverts in areas where high traffic volumes overlap with herpetofauna* travel corridors.

Invasive plant species control and monitoring to assess the success of the restoration effort needs to be conducted. Invasive species control should be conducted in fall and early winter to allow for sufficient pre-restoration monitoring and to minimize negative impact to wildlife. Eradication would include pulling, cutting, targeted herbicide application, and use of prescribed fire.

A coordinated public education and outreach program targeted to key constituencies can reduce direct threats from humans. Direct mail for property owners adjacent to the Waterloo-Pinckney Recreation Area would describe the exceptional species and communities in their backyard, the threats to them, and specific opportunities to reduce those threats on their own properties. Property owners adjacent to

the Waterloo-Pinckney Recreation Area, motorists, and park visitors would be the focus of educational outreach for the project.

The level of effort recommended for this activity is 12-15 public land survey blocks in the Pinckney State Recreation Area identified previously through a 2009 scientific survey of the Waterloo-Pinckney State Recreation Area. Approximate cost to implement this activity at this level is $75,000. Potential funding sources are the Great Lakes Restoration Initiative, National Fish and Wildlife Foundation, and MDNRE. Lead agents for this activity could be MDNRE, Washtenaw County Parks and Recreation, and HRWC.

**Herpetofauna refers to the reptiles and amphibians of a particular area or region, in this case the Waterloo-Pinckney Recreation Area*

Recommendations for Programmatic Change (#14-17)

Programmatic changes are perhaps the single most potent outcome of the Portage Creek Watershed Management Plan. It is through these management activities that the seven local communities and four counties can enter into a unique joint stewardship that transcends politics and puts action behind intent to “protect the environment”.

14. Adopt New Standards and Policies for Natural Features Protection

The goal of this activity is to enact the recommended policies presented to each local government through the Local Government Codes & Ordinances Review for Water Quality. The responsible agents for this activity are Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Township and Village of Stockbridge.

Given the emphasis on “home rule” in Michigan that vests significant governing authority to the local unit of government, adhering to a fairly consistent set of policies for protecting natural features is as critical as it is challenging in order to meet the goals for the Portage Creek watershed. If the watershed communities want to protect water quality and the character of the landscape into the future, then local governments, developers, and site designers alike must fundamentally change the way land is developed. Deciding where to allow or encourage development, promote redevelopment, or protect natural resources are difficult issues communities have to balance. While effective zoning and comprehensive planning are critical, communities should also be exploring ways to minimize the impact of impervious cover, maintain natural hydrology, and preserve contiguous open space on development sites.

The review of local government codes and ordinance as described in Section V resulted in the following recommended best practices. Every community can alter some part of its subdivision and development codes to foster development that better protects environmental resources and is not economically disadvantageous. Table VII-E calls this point out showing that each local government can make changes in its codes and ordinances to protect natural features.

Table VII-E. Policy Recommendations for Local Governments in the Portage Creek Watershed

	Dexter Township	Lyndon Township	Putnam Township	Stockbridge Township	Village of Stockbridge	Unadilla Township	Waterloo Township
Recommended Policy							
Stream Buffer Ordinance	X	X		X	X	X	X
Wetlands Ordinance	X	X		X		X	X
Stormwater Ordinance	X	X		X	X	X	X
Tree Conservation	X	X	X	X		X	X
Reduce Impervious Surface							
Cul-de-Sacs	X			X	X		
Street Widths and ROWs			X				
Setbacks			X				
Natural Areas Management		X					
Reduce Excessive Clearing and Grading		X		X		X	X
Increase Infiltration							
Open Vegetated Channels			X				
Bioretention Islands					X		
Parking Ratios					X		
Farmland Preservation Zoning				X		X	

Enact a Stream Buffer Ordinance: Forested buffers alongside the Huron River, streams and lakes are critical for wildlife habitat, storing water during periods of high water flow, and protecting lakes and rivers from pollutants. With projected increases in flood and drought events from a changing climate, these buffers will become even more important. Functional stream buffer systems have tremendous potential to reduce the effects of climate change by enhancing ecosystem resilience[v]. The protection and restoration of stream buffers becomes more important than ever as we seek strategies and practices that buffer climate change impacts. Restoring stream buffers on private lands and protecting buffers through local policies are two ways to modify practices to enhance resilience of stream buffers. A model stream buffer ordinance is available through the HRWC, which has been adapted and implemented by two local governments to date. Appendices Q and R provide sample buffer ordinances from communities in the Huron River watershed.

Enact a Wetlands Ordinance: Wetlands filter pollutants from water as it flows into Portage Creek, its tributaries, and lakes. They also absorb excess water, preventing flooding. The importance of buffers and critical zones around wetlands for water quality and habitat for wetland-dependant wildlife is documented extensively. A model wetlands ordinance is available through the HRWC, which has been adapted and implemented by local governments; 14 communities have enacted ordinances, including Scio, Ann Arbor, Brighton, and West Bloomfield Townships. The model wetlands ordinance in Michigan is provided in Appendix O.

Enact a Stormwater Ordinance: Regulations that can guide land development with regard to protecting the water quality, water quantity and biological integrity of the receiving surface water are important in

undeveloped and soon-to-be-developed areas. This regulation can use existing data to determine the development impact that can be tolerated by the surface waters before that system will become degraded. Future development or redevelopment can be guided to control runoff so that local streams and water resources are not negatively affected by the development to the greatest extent practicable. The ordinance can incorporate requirements for managing the quality and quantity of runoff from new development sites, including residential, commercial and institutional sites. Adopting the Rules of the County Drain Commissioner's Office can be an element of the ordinance in order to be protective of local water resources. Modifications to existing engineering and design standards for stormwater management best practices are a necessary element of this activity. The stormwater ordinance enacted by a local township is included in Appendix J.

The watershed communities generally, and lake residents specifically, should consider enacting manufactured fertilizer ordinances to reduce or eliminate the amount of phosphorus-containing turf fertilizer that washes into Portage Creek and its lakes. Other communities in the Huron River watershed have demonstrated success in reducing excess nutrients in local waterways once the ordinance was implemented and a public information and education campaign begun. The manufactured fertilizer ordinance for the City of Ann Arbor provides a well-conceived example in Appendix K.

Establish an Environmental Protection Overlay Zoning District: Zoning maps may be amended to increase protection for water resources. Inclusion of natural features and natural areas zoning are two of the most common and useful ways. Allowing for compact development design in an area zoned for lower density development increases the ability to preserve a significant amount of natural, undeveloped land. By clustering buildings and paved surfaces around natural areas, a development can encompass the same amount of total area while avoiding the destruction of these resources. While individual lots can lose area in this type of zoning district, residents or tenants of the entire subdivision benefit from increased access to natural areas.

Two ordinances enacted by local townships for protecting natural areas are provided in Appendices M and N.

Adopt Site Design & Road Standards that Reduce Impervious Surface: Once natural resources have been protected to the greatest extent possible, impervious surfaces (roads, rooftops and parking lot dimensions) should be minimized, in order to maintain the natural balance between infiltration and runoff. Current studies suggest that when the amount of impervious area passes a threshold level of approximately 8%, downstream impacts become evident, as stream channels are destabilized and aquatic habitats are degraded. While minimizing the imperviousness may be a difficult objective, it is necessary to keep in mind that for every percent this threshold is surpassed in a given area, downstream effects are compounded significantly.

Utilizing a Low Impact Development (LID) plan for new developments can reduce directly connected impervious surfaces. LID plans combine a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. The result will

be a reduction in runoff peak discharge, a reduction in runoff volume and the removal of storm water pollutants. LID principles can apply to new residential, commercial and industrial developments.

Under the umbrella of LID are specific options such as reducing street widths, right of ways, minimum cul-de-sac radius, driveway widths and parking ratios, allowing for pervious materials to be used in spillover parking areas, and establishing a minimum percentage of parking lot area that is required to be landscaped (with native plants for maximum benefit). Communities are encouraged to minimize the total impervious cover in Zoning Ordinances to protect water resources in the build-out scenario. Also, a private road ordinance is a tool for managing the addition of roads; a sample ordinance used by a local township is included in Appendix L.

Tree Conservation – Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street rights-of-way, parking lot islands, and other landscaped areas to promote natural vegetation. The conservation of trees during development will preserve forest habitat, reduce costs of reforestation and keep intact the many natural services that trees provide, such as reduction of soil erosion.

Reduce Excessive Clearing and Grading – Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. Areas of a site that are conserved in their natural state retain their natural hydrology and do not erode during construction.

Farmland Preservation Zoning – A Sliding Scale is a favorable zoning tool for viability of agricultural and agricultural preservation that limits the number of lot splits allowed in agricultural areas for other than agricultural uses. Freedom Township (Washtenaw County) Zoning Ordinance is one example of a local township that includes Sliding Scale Zoning regulations for the Agricultural/Resource Zoning District (AR).

Increase Infiltration – A community can pursue multiple avenues for increasing infiltration of water, a number of which are presented here. In particular, Low Impact Development techniques favor infiltration and the reduction of water runoff. The Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers[vi] provides communities, agencies, builders, developers and the public with guidance on how to apply LID to new, existing and redevelopment sites. It outlines the technical details of best practices and provides a larger scope of managing water runoff through policy decision, including ordinances, master plans, and watershed plans.

> **Establish Design Criteria for Open Vegetated Channels**: While it is beneficial that your community does not require curbs, establishing criteria for vegetated channels can further reduce the introduction of pollutants into local waterways. Vegetated channels also have the benefits of encouraging groundwater recharge and reducing the volume of stormwater runoff.

Although there are several varieties of vegetated channels, the establishment of design criteria will ensure that developers incorporate an effective and efficient means to control water runoff.

Allow Bioretention Islands and other stormwater practices in landscaped areas: Bioretention encourages treatment of runoff at the source, before the runoff enters the storm system. These areas also can be used for snow storage during the winter. They provide groundwater recharge when runoff is allowed to infiltrate, and enhance the appearance of parking lots.

Change Parking Ratios: Enforce both a maximum and minimum in order to curb excess parking space construction, and review existing parking ratios for conformance to see if lower ratios are warranted and feasible. For example, consider parking ratios for professional office areas that are 2-3 per 1,000 sq ft of gross floor area, and 4-5 per 1,000 sq ft of gross floor area for shopping centers.

The estimated cost for this activity is $36,000 primarily for fees associated with township and village planning/ wetland consultants and attorneys, and township and village staffing to enact ordinances and revise codes. Each of these enacted measures will result in reducing pollution to local waterways, but quantifying them proves to be very difficult due to the many factors contributing to degradation of freshwater resources. Although, the City of Ann Arbor enacted a phosphorus fertilizer ordinance that went into effect in 2007 to reduce the amount of phosphorus entering the Huron River and local streams, and have reported a coincident 28-35% phosphorus reduction in the city's receiving waters.

Smart Land Use Planning and Saving Resources Protects the Portage Creek Watershed

Use Compact Development

Communities need to change land use patterns and infrastructure to reduce water pollution. Compact development is a land use strategy that helps to protect the Huron's water quality – developing in more compact patterns where infrastructure already exists and preserving natural areas – are those that must occur to both reduce greenhouse gas emissions and provide our communities with the resiliency to weather climate change. According to a new report by the U.S. EPA, 16% to 20% of the U.S.'s greenhouse gas emissions are related to how we develop land: transportation, construction, and lost vegetation when natural areas and farm fields are cleared for development. Conversely, the equivalent of 13% of U.S. emissions is absorbed by natural areas.

Protect Natural Areas

New subdivisions, shopping malls, parking lots, and roads increase greenhouse gas emissions through their energy demand (for heating and cooling). In contrast, forests, wetlands, prairies and fields absorb greenhouse gases as well as the sun's heat and provide a host of ecological services. Natural areas slowly absorb rainwater and melting snow, recharging groundwater supplies. Plants soak up and filter this water before it flows into the river, which cools the water and helps remove pollutants. This water is then released slowly into rivers and streams, keeping flow levels steady throughout each season, even during periods of little or no precipitation.

Natural areas also absorb excess water, preventing flooding. With predicted intense rainfalls, droughts, and impacts on wildlife, we will need these natural areas more than ever to clean and store water, prevent floods, and provide habitat to wildlife.

Reduce Dependence on Cars

Walkable, bikable communities with public transit are key to reducing automobile use, thus reducing greenhouse gas emissions and the impervious surfaces that accompany car culture. There is a lot of talk about new automotive technology, but studies by the Urban Land Institute show that any reductions in greenhouse gases gained from increased fuel economy and cleaner fuel will be overwhelmed if sprawling development continues to fuel growth in driving. The study projected a 48%increase in the total miles driven between 2005 and2030. Currently, most people have little choice but to drive everywhere. Providing people with alternatives to their cars and making it feasible to switch to those alternatives would have significant impacts. Shifting 60% of new growth to compact patterns would save 79 million tons of carbon dioxide annually by 2030. This savings is equivalent to increasing federal vehicle efficiency standards to 32 mpg.

Residents of the Portage Creek watershed can help their local freshwater resources through water conservation, efficiency and reuse.

Water Conservation

Water conservation is a fundamental strategy to preserving freshwater resources and reducing energy costs. If we can cut our water use across sectors, we can cut our water-related energy use at a roughly proportionate rate. Studies show that a 25% reduction in water usage is within our reach, and it would result in a 25% reduction in energy use – allowing us to retire hundreds of dirty power plants, give us cleaner, healthier air to breathe, and significantly advance efforts to reduce greenhouse gases. Plus it means keeping more water in streams and lakes where it belongs.

These reductions will require a fundamental change in the way we think about fresh water. As we continue to replace, upgrade, and build our water infrastructure (treatment plants, distribution and stormwater pipes, etc.) we need to do it with a new long-term vision for water management. A comprehensive and integrated approach is needed that focuses on three areas: conservation, efficiency, and reuse.

Water conservation includes changing habits to reduce water waste. On an individual scale, this means using less water for everyday activities like tooth brushing and lawn watering. On a community-wide scale, municipalities can change water use-related ordinances and water rate structures to add incentives to conserve water. Today, most municipalities charge one flat rate for water, and that rate is usually far lower than the actual cost of the water (cleaning it, transporting it through infrastructure, processing storm water, etc.). Increasing fees in general motivates residents to conserve more water. Staggered rates for water use can also inspire water conservation. For example, the City of Ann Arbor

recently implemented a new structure in which water rates increase as use increases. A similar approach would be to charge more for water used during dry seasons.

Water Efficiency

While conservation is about habits, efficiency is about hardware – the performance of our plumbing in and around our homes and businesses, and in our municipal systems. Efficiency strategies save resources, plus the investment in retrofits is often recovered quickly through water savings. There is tremendous existing potential in efficiency strategies. In our homes, this means using efficient toilets, faucets, showerheads, washing machines, dishwashers, and hot water heaters (tank less models save little or no water, but save a lot of energy). If even just 10% of existing fixtures were replaced with U.S. EPA Water Sense certified appliances – which are at least 20% more water-efficient than most other devices currently in the market –we could save 128 billion gallons of water each year. That's enough water to meet the needs of 3.5 million people.

U.S. EPA estimates that as much as 50% of the water we use outdoors is wasted. Outdoor water use is also a huge consideration at times of peak demand, which usually coincides with dry weather and low creek flows. Improving the efficiency of outdoor water use means better targeting of use(taking care not to water sidewalks and drives, and watering early in the morning to reduce evaporation), and better methods of use (drip irrigation, etc.). In our municipal systems, U.S. EPA estimates that, on average, 10-20% water and energy savings could be realized by tightening up the systems in practical ways, saving as much as 6 billion gallons per day (enough to supply the 10 largest American cities). Repairing leaks and properly maintaining pumps will pay for themselves in a few years or even months. In many cities, more than 20% of water is lost in leaks before it ever reaches homes or businesses. In the developing world, these estimates are often more than 50%.

Water Reuse

Water reuse may hold the greatest conservation potential. For reuse to work, we need to stop "throwing away" our water and instead look at ways to capture and reuse this precious resource. Examples include: rain water held on site (rain barrels and cisterns) for use on plants and lawns; water reused from activities such as dishwashing, showering, and laundry (known as "gray water"); and stormwater and "wastewater" treated to levels adequate for reuse. On a larger scale, when we capture water in retention or detention basins, the question should become, "Is there some good use that can be made of this water before it's released to the soils or the stream?" Stormwater is useful for many outdoor applications and some indoor uses as well.

These measures that residents and communities use now to protect natural features and quality of life are some of the same ones important to buffering the impacts of climate change solutions.

Regional Planning and Sewer/Water Service Areas

Some watershed communities may be interested in going beyond the recommendations from the codes and ordinance audit in their pursuit to preserve the quality of life for residents and the quality of the watershed. During the development of this plan, watershed partners recognized that future land use and development decisions made by local governments could have a significant impact on watershed health and community vitality. Working on a watershed or regional level with neighboring governments to coordinate services may be the most effective way to meet the goals for the Portage Creek watershed laid out in this plan.

Planning for how a community will incorporate growth is a central issue to the future viability of water resources. Portage Creek watershed communities have a few local examples to look to when considering how to address future growth, including sewer and water services to residents and businesses. For example, Waterloo Township in Jackson County and Ann Arbor Township in Washtenaw County have crafted policy concerning unsewered portions of those communities. The latter takes the position that no expansion of existing sewer and water areas will occur; therefore, any proposed developments have to comply with health standards for well and septic. The former is a more rural township that provides water or sewer service only to manufactured housing communities, and uses its Master Plan to prevent the premature provision of these services by calling for analysis for all available options including shared services with neighboring communities. Both townships recognize that premature provision of these services can lead to accelerated and poorly planned development that impacts the watershed.

15. Coordinate and Advance Water-Based Recreation in Portage Creek

An objective to improve the recreation experience on the Portage Creek system identified by the Watershed Advisory Group is to achieve coordinated management of Portage Creek for water-based recreation. At this time, lake-based recreation in the watershed is well-established. On the contrary, creek-based recreation is primarily for the intrepid due to the uncertainties with access, safety and water levels. The goal of this activity is to establish a committee with representation from the various interest groups that meets regularly to coordinate water-based recreation of Portage Creek and lakes, such as working with riparian landowners to improve access (e.g., low clearance on footbridges, dilapidated footbridges).

Costs for this activity are estimated at $8,000; no funding sources have been identified. Lead agents could be HRWC, MDNRE, local recreation groups and paddling enthusiasts.

16. Form an Intergovernmental Portage Creek Watershed Group

The goal of this activity is to oversee implementation of the Portage Creek Watershed Management Plan and chart progress, develop mechanisms to fund Plan activities, and revise the Plan.

The communities in the Portage Creek Watershed will implement recommended activities and report on progress through a new intergovernmental watershed group as no group exists that focuses on this area. This group will provide a structure for the following activities:

- reporting out on progress toward the WMP goals and objectives,
- coordinate regional activities and projects,
- discuss new developments that require attention or action,
- consolidating funding for watershed management activities,
- providing public input and involvement,
- educating community representatives, and
- discussing WMP updates.

To ensure successful implementation, nine key elements should be addressed, as summarized in Table VII-F.

Table VII-F. Nine Key Elements of Successful Watershed Plan Implementation[vii]

1. Appoint a single lead agency to act as an advocate and facilitator for the plan with the community and with political representatives.
2. Strong linkages to existing programs, including local and regional land use planning processes, water quality and flow monitoring programs, and similar programs, to optimize use of available information and minimize duplication of effort.
3. Clear designation of responsibilities, timetables, and anticipated costs for project actions.
4. Effective laws, regulations, and policies to provide a framework for the tasks identified in Element 3.
5. Ongoing tracking of the degree of implementation of management actions and of the success of those actions once implemented.
6. Ongoing monitoring and reporting of progress, both to assess the effectiveness of individual actions and to sustain public and political interest in and enthusiasm for the plan.
7. Ongoing public education and communication programs to consolidate and enhance the social consensus achieved in the planning process.
8. Periodic review and revision of the plan.
9. Adequate funding for these activities.

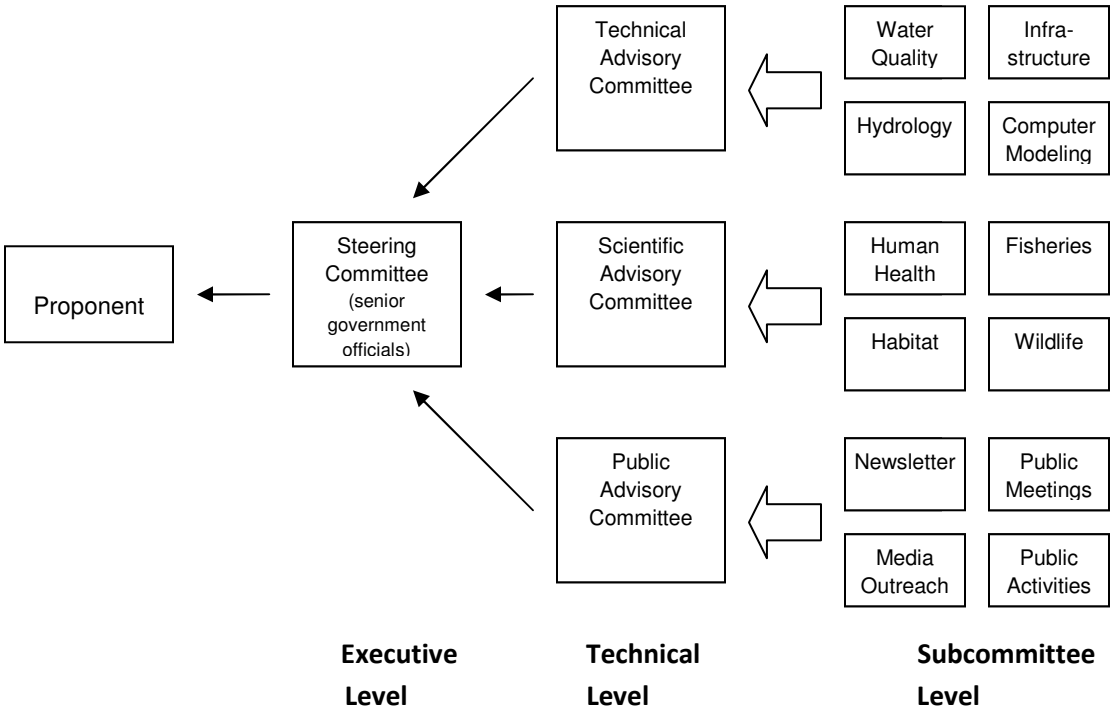
Advisory Committee Structure

To facilitate implementation of the Portage Creek Watershed Management Plan, a framework for a series of working groups within the intergovernmental watershed group will help to provide a useful feedback loop for determining how, and the extent to which, the goals and objectives of the Plan are being successfully implemented. These working groups would ideally be comprised of the following groups of stakeholders:

- Managers, planners, coordinators, and their staff members
- Boards and steering committees
- Volunteers (citizens and watershed stewards)
- Environmental interest groups
- Funders

These groups of stakeholders should ultimately allow for input and implementation assistance from a broad cross-section of all stakeholder and interest groups in the watershed. Figure VII-2 provides a theoretical example of a two-tier advisory committee structure that could be employed to oversee the implementation and evaluation of the Portage Creek Watershed Management Plan. A multi-tiered advisory structure is better suited for large watershed planning projects, as is the case in the Portage Creek watershed, as opposed to a single-tiered structure which is better suited for smaller, short-term projects.[viii]

Figure VII-2. A Typical Two-tier Advisory Committee Structure



A committee structure based on the organization shown in the figure above could be used to implement, evaluate, and revise the watershed plan over time. The "proponent" (lead agency) in this schematic could be Livingston County, which would ultimately provide support for, and oversight of, the activities of the various committees. The "Steering Committee," in this watershed could be composed of environmental program managers and staff who recommend final decisions to be coordinated with support from the HRWC and county government representatives, notably Ingham, Livingston and Washtenaw County. The "advisory committees" might be staffed by land use planners, commissions, boards, interested citizens, environmental group advocates, scientists, etc. who will pull together various aspects of the data and results during the implementation phases of the Plan.

The importance of public representation and broad stakeholder involvement throughout any advisory committee structure must be stressed, as these individuals are in a position to explain and influence community opinion and help to build support for needed changes. Following the approval of this Plan, the current members of the Portage Creek Watershed Advisory Group should consider an advisory committee structure that allows for involvement by a broad range of stakeholders as discussed above.

Community Involvement

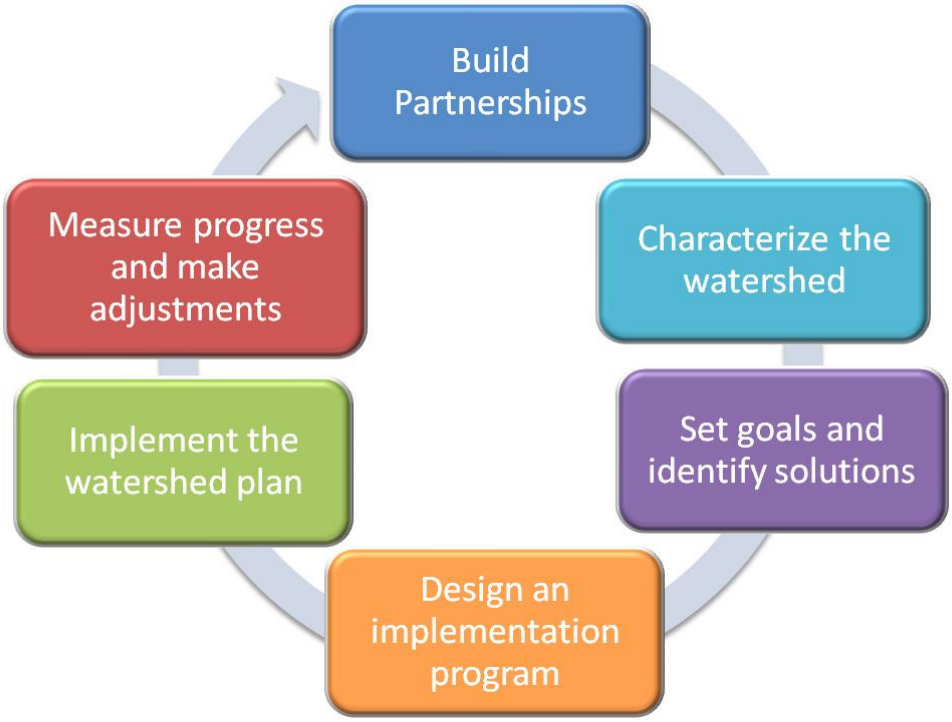
Implementation of this watershed plan depends on active participation and involvement of local communities and their citizens. Stakeholders critical to the success of this plan include local elected officials, local government department heads, public agency representatives, engineers, planners, businesses, residents, citizen groups and homeowner associations.

Watershed Plan Revisions

The watershed partners intend for this plan to be revised, on average, every five years. In addition, updates regarding watershed plan implementation and activities related to it will be updated on HRWC's website at www.hrwc.org.

Applying the concept of adaptive management to the revision process is essential for successful implementation of the plan. Evaluation of a specific management alternative (using the methods discussed in the next section) may suggest a change is needed to affect the desired result, or a shift in focus from one management alternative to another may be needed. The iterative nature of watershed planning, implementation, and revision is shown in Figure VII-3.

Figure VII-3. Steps of watershed management planning



One of the tasks of this group could be to plan for the development of a comprehensive study of the hydrology of the Portage Creek system to provide an understanding of the interaction of precipitation, infiltration, surface runoff, stream flow rates, water storage, and water use and diversions. A hydraulics study would yield information about the river's velocity, flow depth, flood elevations, channel erosion, storm drains, culverts, bridges and dams. Information resulting from these studies would provide greater detail on the sources and causes of problems related to hydrology-induced erosion and flooding. The studies are prerequisite to identify the most appropriate management alternatives and best locations for practices that can restore the hydrology of the river and its tributaries.

A GIS database would need to be established and maintained to assist with hydraulic, hydrologic, and water quality modeling. Washtenaw County has made a major commitment to developing multiple GIS layers that are useful in local government agency and citizen watershed management practices. With foundation grant funding, the HRWC and the Land Information Access Association (LIAA) worked with Washtenaw County to develop an easily accessible set of map-based data designed to improve the quality of local land use decisions.

The HRWC, in partnership with the Portage Creek Watershed Advisory Group, agrees to become custodian of the Portage Creek watershed datasets as funding and expertise become available, to maintain the data and to respond to requests for information regarding threats and implementation opportunities on parcels proposed for development and for conservancy candidates. Other duties may include finding and administering grants for waterway improvements and special projects, promote forums with the watershed partners on watershed issues, etc. This initiative is intended to ensure that

all the Portage Creek data is kept together with the intent to unify implementation efforts throughout the broader Huron River watershed.

The cost estimate for this activity is $10,000 per year but much depends on how actively the watershed partners implement the elements of the watershed management plan. Funding sources for this activity include the watershed partners, section 319 nonpoint source pollution program grants, seed money grants for operating expenses from Freshwater Future, to name a few.

17. Good Housekeeping

Review the Pollution Prevention/Good Housekeeping practices typically used for these operations in the Village of Stockbridge, the main area in the Portage Creek watershed where storm drains are located and population is clustered:

a. Street Repair and Maintenance
b. Street Sweeping
c. Storm Drain Maintenance

Street Repair and Maintenance
Routine road and bridge maintenance, winter-time operations, and vegetative maintenance are the major aspects of street repair and maintenance. Improvements to these operations are presented in the Urban Subwatershed Restoration Manual Number 9 (Center for Watershed Protection, 2008): http://www.cwp.org/PublicationStore/USRM.htm

Street Sweeping
Particulate matter or "street dirt" tends to accumulate along the curbs of streets and roadways in between rainfall events. Sources of pollutants include run-off, atmospheric deposition, vehicle emissions and wear and tear, breakup of street surface, littering, leaves and other organic material and sanding. This results in the accumulation of stormwater pollutants such as sediment, nutrients, metals, hydrocarbons, bacteria, pesticides, trash and other toxic chemicals. In many communities, these pollutants remain on public streets and roadways until they are washed into the storm drain system during a rainfall event. However, some communities use street sweeping to remove some of these pollutants and prevent them from being conveyed into the storm drain system.

The ability of street sweepers to remove common stormwater pollutants varies depending on sweeper technology, sweeper operation and frequency, street conditions and the chemical and physical characteristics of the pollutants that have accumulated on the pavement. Although newer street sweeping technology can remove more than 90% of street dirt under ideal conditions, street sweeping does not necessarily guarantee water quality improvements[ix]. Street sweepers are typically more effective at removing larger-sized particles than fine grained particles and nutrients, although newer technology such as small-micron surface cleaning technologies may be capable of picking up smaller particles[x]. Air or vacuum-assisted sweepers have greater efficiency than the mechanical brush sweepers.

Conducting street sweeping twice per month on the Village road network could result in pollutant reductions of 22%-31% TSS, 4%-8% P, and 4%-7% N. Capital expense to purchase a street sweeper is $150,000 plus operation expenses of $30-65/curb mile and $10-20/cubic yd for disposal.

Storm Drain Maintenance

Storm drain maintenance is often the last opportunity to remove pollutants before they enter the storm drain system. The effectiveness of this pollution prevention/good housekeeping practice depends on the basic design of the stormwater conveyance in a subwatershed. Most systems have a catch basin or sump pit located in the storm drain inlet to trap sediment and organic matter and prevent clogging. In some eras, however, conveyance systems were designed to be self-cleansing and thus have no storage. Each catch basin or sump pit tends to be unique in how quickly it fills up, and whether the trapped material is liquid, solid or organic. To this extent, each reflects the conditions and behaviors that occur within the few hundred feet of street it serves.

When performed properly, regular maintenance can improve water quality and prevent clogging and flooding. The amount of pollution removed by storm drain maintenance is influenced by the amount of pollution removed by street sweeping. The amount of dirt removed by street sweeping influences the quantity of dirt that can be trapped within storm drains, inlets or catch basins. Storm drain cleanout effectiveness is also impacted by both the frequency and method of cleanout. Additional benefits that resonate with residents are aesthetics and street safety.

Conducting storm drain cleanout semi-annually could result in pollutant reductions of 35% TSS, 6% N, and 2% P. Expenses are $100-300 per inspection of storm drains.

Cost for this activity is estimated at $205,000 with most of the expense attributed to the purchase of a street sweeper for $150,000, plus operation and maintenance for $25,000, and $30,000 for storm drain cleanout. Preliminary discussions are underway at the time of this writing concerning the development of a “Craig’s List” for public works departments to facilitate equipment sharing among southeastern Michigan communities. It could be beneficial to track the development of this service in order to reduce costs or to directly contact neighboring communities that own a street sweeper to negotiate a sharing agreement.

Additional best practices appropriate for the Village of Stockbridge and similar “suburban” areas of the watershed include the following[xi]:

- Watersmart landscaping, such as rain gardens and rain barrels
- Porous pavement
- Water quality swales
- Stormwater ponds and wetlands

The strategies discussed above are not intended to limit the power of the stakeholders in the Portage Creek watershed to espouse and support any project deemed of value to the health of Portage Creek. As a starting place, these initiatives touch the core of threats that can, if remedied, have significant and early impact on the health of the creek. Many other initiatives are difficult to quantify in terms of specific nutrient reduction but have great value to the long term and sustainable water quality; outreach is one such example. These future initiatives will be pursued within the comprehensive context of the Portage Creek Watershed Management Plan and result in ongoing updates to the databases developed for the purpose of tracking implementation of these recommended activities.

Table VII-G. Management Activities for Portage Creek Watershed

#	Implementation Activities	Entity Responsible for Meeting Management Objective	Schedule Short-term: 0-3 yrs; Long-term: 3-10 yrs	Measurable Indicators/ Performance Measures	Monitoring and Party Responsible for Monitoring	Public Involvement, Outreach or Education Component	Technical, Financial and Regulatory Assistance Needed	Cost Estimates
1	Restore Vegetated Stream Buffers *(Goal: 82 acres; 3 demonstrations)*	Ingham, Livingston, and Washtenaw County Conservation Districts, USDA Natural Resources Conservation Service, Huron River Watershed Council	Outreach: 2011 Implement: 2011-2013: 3 demonstration projects by 2012. 40 acres by 2012. 42 acres by 2013. Monitor: 2012-2014	Lineal ft of buffers installed. Number of farmers and number of acres enrolled. Pounds of nutrients and sediment reduced. Number of attendees at demonstrations.	Tracking of buffered acres: Conservation Districts. Pre- and post- water sampling for nutrients and sediment: HRWC. Survey of demonstration project participants: HRWC	Targeted Conservation District agricultural outreach effort/ enrollment initiative. Public will be invited to and involved in demonstration projects. Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds. Trained volunteers participate in stream monitoring.	Farm Bill incentive programs. Grant funding through s. 319 NPS program, GLBP for Soil Erosion and Sediment Control, GLRI. Supplemental budget requests to State legislature. MSU-Extension staff for instruction at demonstrations.	$175,000 Installation: $500/ac + staff = $75,000 Demonstration projects: $100,000
2	Restore Wetlands *(Goal: 500 acres)*	Ingham, Livingston, and Washtenaw County Conservation Districts, USDA Natural Resources Conservation Service, Huron River Watershed Council	Outreach: 2011 Implement: 100 acres by 2012. 130 acres by 2013. 150 acres by 2014. Monitor: 2012-2015	Number of acres restored. Pounds of nutrients and sediment reduced. Number of farmers and number of acres enrolled.	Tracking of restored wetlands acres: Conservation Districts. Pre- and post- water sampling for nutrients and sediment: HRWC.	Targeted Conservation District agricultural outreach effort/ enrollment initiative. Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds. Trained volunteers participate in stream monitoring.	Farm Bill incentive programs. Grant funding through s. 319 NPS program, GLBP for Soil Erosion and Sediment Control, GLRI. Supplemental budget requests to State legislature.	$1,000,000 Installation: $2,000/ac + staff

Table VII-G. Management Activities for Portage Creek Watershed *(continued)*

3	Develop Environmental Flow Recommendations *(Goal: set of recommendations)*	MDNRE, dam and lake level operators and their communities	Steps 1-3 of the 5-Step Process by the Nature Conservancy by 2013. Steps 4 and 5 by 2015.	% of responsible parties participating in meetings and flow recommendations workshop. Results of trial basis for implementing recommended flows.	MDNRE, operators, HRWC, other partners TBD	Presentation of flow recommendations to Portage Creek Watershed Group and general public	Involvement of water managers, scientists and other relevant professionals. Technical support from Nature Conservancy. Grant funding from private foundations, GLRI, university partnerships	$25,000 for facilitating 5-step process
4	Farm Best Practices and Farmer Outreach *(Goal: 5 projects)*	Ingham, Livingston, and Washtenaw County Conservation Districts, USDA Natural Resources Conservation Service	Outreach: 2011-2012 Implement: 2 projects by 2012. 2 projects by 2012. 1 project by 2013. Monitor: 2012-2015	Number of acres with conservation tillage. Number of farm operations with comprehensive nutrient management plans. Number of acres with 2-stage ditch design. Pounds of nutrients and sediment reduced.	Tracking of conservation practices installed: Conservation Districts. Pre- and post- water sampling for nutrients and sediment: HRWC.	Targeted Conservation District agricultural outreach effort, enrollment initiative. Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds. Trained volunteers participate in stream monitoring.	Farm Bill incentive programs. NRCS technical, engineering assistance for practice implementation. Expertise in 2-stage channel design, drain naturalization.	$139,625 Installation: $25,000/site + staff
5	Environmentally Sensitive Dirt and Gravel Roads Maintenance and Design *(Goals: 1 site; 2 trainings)*	Ingham, Jackson, Livingston and Washtenaw County Road Commissions	Resolve gully erosion at Tiplady Rd: 2010 2 trainings by 2012.	Natural drainage is restored. Stream impact is reduced. Erosion is reduced. Stream channel is restored. Number of road commission personnel trained in ESMPs. Number of upcoming Road Commisison projects with ESMPs incorporated.	Tiplady Rd. project tracking: Livingston County Road Commission Pre- and post- water sampling for nutrients and sediment: HRWC. Tracking of ESMPs in projects: Road Commissions. Pre-and post-surveys of participants in ESMPs trainings: Road Commissions, PSU Center for Dirt and Gravel Roads.	Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds. Trained volunteers participate in stream monitoring.	Pennsylvania State University Center for Dirt and Gravel Roads staff for instruction at trainings. Road Commission budgets. Grant funding through s. 319 NPS program, GLBP for Soil Erosion and Sediment Control, others.	$28,000 Restoration at Tiplady Rd: $18,000 Trainings: 2 @ $5,000 = $10,000

Table VII-G. Management Activities for Portage Creek Watershed *(continued)*

#	Implementation Activities	Entity Responsible for Meeting Management Objective	Schedule Short-term: 0-3 yrs; Long-term: 3-10 yrs	Measurable Indicators/ Performance Measures	Monitoring and Party Responsible for Monitoring	Public Involvement, Outreach or Education Component	Technical, Financial and Regulatory Assistance Needed	Cost Estimates
6	Stabilize Eroding Stream-Road Crossings and Other Eroding Sites *(Goal: 250 lineal ft)*	Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Townships, Ingham, Jackson, Livingston and Washtenaw County Road Commissions	Plann: 2011 Implement: 2012-2013 Monitor 2012-2013	Number of lineal ft stabilized. Pounds of sediment and nutrients reduced.	Project tracking: County Road Commissions, Townships, Village. Pre- and post- water sampling for nutrients and sediment: HRWC.	Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds. Trained volunteers participate in stream monitoring.	Road Commission, local government budgets. Grant funding through s. 319 NPS program, GLBP for Soil Erosion and Sediment Control, others.	$25,000 Installation: $40/lf + staff
7	Remove Fish Barriers *(Goal: 10 sites)*	Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Townships, Ingham, Jackson, Livingston and Washtenaw County Road Commissions	Plan: 2010-2011 Implement: 2012-2014 Monitor: 2012-2014	Number of flow-aligned stream-road crossings. Number of remnant dam structures removed. Completed alternatives analysis for HiLand Dam. Fish population study.	Project tracking: County Road Commissions, Townships, Village. Pre- and post-fish population study: MDNR, MSU, UM.	Public will be involved in meetings for HiLand Dam alternatives analysis to gather input and feedback. Meetings with individual landowners and dam owners. Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds.	Road Commission, local government budgets. Grant funding through s. 319 NPS program, other state and federal grant sources and private foundations that make a priority of river and freshwater fisheries restoration.	$1,600,000 Culverts: $150,000-200,000/site @ 8 sites = $1,400,000 Remnant dam removals and alternatives analysis: $200,000
8	Detect and Correct Failing and High Risk Septic Systems *(Goal: 4 counties)*	Ingham, Jackson, Livingston and Washtenaw County Public Health Departments	Planning: 2013 Implementation: 2014-2019 Monitoring: 2014-2019	Number of counties participating. Number of failing systems detected and corrected. Number of education packets mailed to residents with high risk septic systems. Pounds of nutrients and counts of *E. coli* reduced.	Program tracking: County Public Health Departments Pre- and post- water monitoring for nutrients and *E. coli* : County Public Health Departments, HRWC	Educational outreach to residents with high risk of failure septic systems via mailings. Follow-up with residents on corrective measures for failing septic systems. Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds.	Results transfer from Washtenaw County pilot program (2010-2013 if funded). County government budgets. Grant funding through s. 319 NPS program, Clean Michigan Initiative grants, and others.	$35,000 per county (once Washtenaw County pilot program is complete)

Table VII-G. Management Activities for Portage Creek Watershed *(continued)*

#	Implementation Activities	Entity Responsible for Meeting Management Objective	Schedule Short-term: 0-3 yrs; Long-term: 3-10 yrs	Measurable Indicators/ Performance Measures	Monitoring and Party Responsible for Monitoring	Public Involvement, Outreach or Education Component	Technical, Financial and Regulatory Assistance Needed	Cost Estimates
9	Establish a Coordinated Monitoring System of Portage Creek	MDNRE, HRWC, Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Township, Ingham, Jackson, Livingston and Washtenaw County	Plan/Secure Funding: 2010-2011 Implement: 2011-2015	aquatic macroinvertebrates, stream habitat, fish, freshwater mussels, stream flow, geomorphology, temperature, sediment, TSS, DO, TP, *E. coli*, chlorophyll, transparency, aquatic plants	Biomonitoring, physical monitoring and water quality monitoring for 3 stream sites and 11 lakes: multiple parties Produce periodic reports that synthesize data collected in the watershed to track progress: Huron River Watershed Council, Michigan Department of Natural Resources and Environment	Public will be involved in surveys and restoration efforts. Trained volunteers participate in stream and lake monitoring. Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds.	EPA-certified laboratory to process the water quality samples. Coordination with volunteer lake and stream monitoring programs. Approved QAPP. Permits obtained to install USGS gage, transducers.	$75,000 to initiate and operate for two years
10	Educate and inform public about good stewardship for stream and lake resources	Huron River Watershed Council	Plan: 2010 Implement: 2011-2015	Measuring/tracking homeowner behavior change as education process unfolds.	Behavior change measurements, participant involvement, household pollution reduced: Huron River Watershed Council	Public involvement in homeowner behavior change process	Grant funding through s. 319 NPS program, and others.	$136,000 for years 1-5
11	Develop a Tourism Campaign	Michigan Department of Natural Resources and Environment, Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Townships	Plan: 2011 Implement: 2012-2013	Measuring/tracking visits to State and County Parks and other venue as campaign unfolds.	Measurements in origin, numbers and timing of visits, tourism-based revenue at area businesses and outdoor recreation venues	Outreach will be conducted to residents to encourage "be a tourist in your own backyard"	Collaboration among state, county and local governments, and area businesses to leverage resources and ideas.	$60,000

Table VII-G. Management Activities for Portage Creek Watershed *(continued)*

#	Implementation Activities	Entity Responsible for Meeting Management Objective	Schedule Short-term: 0-3 yrs; Long-term: 3-10 yrs	Measurable Indicators/ Performance Measures	Monitoring and Party Responsible for Monitoring	Public Involvement, Outreach or Education Component	Technical, Financial and Regulatory Assistance Needed	Cost Estimates
12	Preserve High Priority Natural Areas *(Goal: 1,525 acres)*	Legacy Land Conservancy, Livingston Land Conservancy	Implement: 2010-2014	Number of finalized land protection agreements with landowners. Number of acres protected through easements.	Enrollment outreach and monitoring: Legacy Land Conservancy, Livingston Land Conservancy	Mailings to high-priority parcel owners. Meetings with individual landowners to identify interest in protecting their properties through conservation easements, purchase of development rights, or outright sale/donation of the property to an appropriate management organization	HRWC's Bioreserve Project map and database of high quality natural areas in the Portage Creek watershed.	$150,000 Easements: $3,250/50 ac + staff
13	Maintain and Improve Habitat for Reptiles and Amphibians	Michigan Department of Natural Resources and Environment	Plan/Secure Funding: 2010-2011 Implement: 2011-2012	Number of acres managed for invasive plant species. Number of turtle nests placed in proper habitat. Number of culverts installed in high traffic areas for reptile and amphibian passage. Number of adjacent property owners reached through education outreach.	Pre- and post- reptile and amphibian populations in 12-15 public land survey blocks: MDNR	Public will be involved in community meetings, education workshops, and field work as appropriate. Presentation of results to Portage Creek Watershed Group, public, and other Huron River creeksheds.	Grant funding through the GLRI, U.S. National Fish and Wildlife Foundation, and MDNR	$75,000

Table VII-G. Management Activities for Portage Creek Watershed *(continued)*

#	Implementation Activities	Entity Responsible for Meeting Management Objective	Schedule Short-term: 0-3 yrs; Long-term: 3-10 yrs	Measurable Indicators/ Performance Measures	Monitoring and Party Responsible for Monitoring	Public Involvement, Outreach or Education Component	Technical, Financial and Regulatory Assistance Needed	Cost Estimates
14	Adopt New Standards and Policies for Natural Features Protection	Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Townships	At least 3 buffer ordinances enacted by 2012. At least 3 stormwater ordinances enacted by 2012. Consistent policies for stream buffers, wetlands and stormwater enacted by all watershed communities by 2015.	Number of ordinances enacted. Number of development projects with Low Impact Development (LID) plans. Projected percent increase in impervious surfaces per community does not exceed 10% at build-out. Projected pounds of nutrients and sediment reduced from Smart Growth and LID technique application.	Projection of nutrients and sediment reduced as a result of code and ordinance changes: Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Townships. Projection of percent change in watershed imperviousness: Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Townships.	Public will be included in roundtables to gather input and feedback	Model ordinances available for wetlands, stream buffer and stormwater from Huron River Watershed Council. Access to community planners with experience in Smart Growth and LID techniques.	$36,000
15	Coordinate and Advance Water-Based Recreation in Portage Creek	Huron River Watershed Council	Form committee and devise strategy: 2010 Implement priority tasks: 2011-2012	Number of stream miles accessible for recreation. Number of footbridges improved.	Measure accessible stream miles: local paddling group	Adjacent landowners will be invited to meetings for input and feedback. Meetings with individual landowners as needed.	Grant sources to be identified.	$8,000
16	Form an Intergovernmental Portage Creek Watershed Group	Village of Stockbridge, Dexter, Lyndon, Putnam, Stockbridge, Unadilla and Waterloo Township, Ingham, Jackson, Livingston and Washtenaw County, Michigan Department of Natural Resources and Environment	At least 4 government entities participate regularly by 2010. 80% (10) of government entities participate regularly by 2012.	Number of meetings held. Percent of all stakeholders represented in group. Number of grant proposals submitted and received. Development of a GIS database for Portage Creek watershed projects and studies.	Meeting summaries: members of Portage Creek Watershed Group. Reporting of grant-writing activity: members of Portage Creek Watershed Group, Huron River Watershed Council Project tracking of GIS development: Huron River Watershed Council	Public will be invited to meetings of the Portage Creek Watershed Group and to participate in advisory committees as appropriate. Updates of group activity provided to public, and other Huron River creeksheds.	Grant funding through s. 319 NPS program, Freshwater Future, other state and federal grant sources and private foundations.	$10,000 for group participation and facilitation in year one

Table VII-G. Management Activities for Portage Creek Watershed *(continued)*

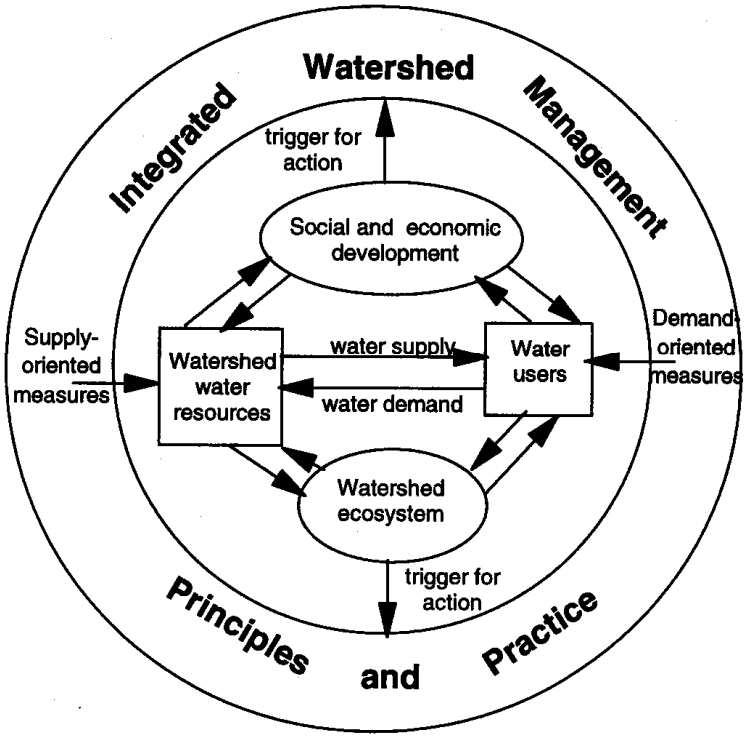
#	Implementation Activities	Entity Responsible for Meeting Management Objective	Schedule Short-term: 0-3 yrs; Long-term: 3-10 yrs	Measurable Indicators/ Performance Measures	Monitoring and Party Responsible for Monitoring	Public Involvement, Outreach or Education Component	Technical, Financial and Regulatory Assistance Needed	Cost Estimates
17	Good Housekeeping	Village of Stockbridge	Review Good Housekeeping practices in 2010. Incorporate practices for street sweeping, street repair and maintenance, and storm drain maintenance by 2012.	Number of street miles swept. Number of storm drains cleaned out. Pounds of nutrients and sediment reduced.	Project tracking: Village of Stockbridge. Pre- and post- water sampling for nutrients and sediment: Village of Stockbridge, Huron River Watershed Council	Residents will receive information on village practices, and associated costs and benefits. Presentation of updates to Portage Creek Watershed Group, public, and other Huron River creeksheds.	Funding for purchase or sharing of street sweeper. Lessons learned in implementing good housekeeping practices from other Huron River Watershed communities.	$205,000 street sweeper: $150,000, O & M $25,000 storm drain cleanout $30,000

B. Monitoring and Adaptive Management

Integrated Watershed Management and Adaptive Management

A watershed is a complex, integrated system, and its whole is greater than the sum of its parts. This complexity stems from the ever-changing interaction of social, economic, and biophysical forces. The interplay of these forces, as shown in Figure VII-4, is the basis for the concept of integrated watershed management.

Figure VII-4. Forces Affecting Integrated Watershed Management[xii]



Integrated watershed management is, by definition, dynamic in nature. Therefore, implementing the Portage Creek Watershed Management Plan in a way that follows the principles of integrated watershed management requires continuous evaluation of the effectiveness of the management alternatives in meeting the Plan's goals and objectives. The concept of "adaptive management" is central to successful implementation of the Plan. Adaptive management incorporates research into conservation action. Specifically, it is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn.

The goals and recommendations of this Plan are based on the understanding of the conditions of the natural watershed ecosystem at the time this Plan was developed. However, both the conditions of the watershed and the goals and actions will change over time as new information is collected, available

resources for implementation are assessed, and the values and needs of the watershed's residents evolve.

As stated by Veissman (1990) in Heathcote's Integrated Watershed Management: Principles and Practices:[xiii]

> *Watershed management institutions evolve from needs identified at some milestone in time. The problem is that times change, and so do needs. Unfortunately, institutions seem to march on with entrenched constituencies, and many in existence today are addressing yesterday's goals or addressing today's problems with yesterday's practices.*

Changes in social and economic forces can trigger changes in watershed management practices. Similarly, changes in a watershed's ecosystem can indicate a need for altered watershed management practices. Adaptive management recognizes the dynamic interplay of these forces, which implies a need to continually evaluate progress toward meeting the Plan's goals and objectives.

Evaluation Methods for Measuring Success

How can we measure whether the implementation activities listed in Table VII-G have been successful at reducing pollutants? That is to say, have changes in behavior occurred among target audiences, how many management practices have been implemented, or have documented improvements in water quality occurred? Several different ways are available to measure progress toward meeting the goals for the Portage Creek watershed. Objective markers or milestones will be used to track the progress and effectiveness of the best practices in reducing pollutants to the maximum extent possible (see Table VII-G). Evaluating the best practices that are implemented helps establish a baseline against which future progress at reducing pollutants can be measured. The U.S. EPA identifies the following general categories for measuring progress:

1. **Tracking implementation over time.** Where a best practice is continually implemented over the permit term, a measurable goal can be developed to track how often, or where, this best practice is implemented.

2. **Measuring progress in implementing the best practice.** Some best practices are developed over time, and a measurable goal can be used to track this progress until best practice implementation is completed.

3. **Tracking total numbers of best practices implemented.** Measurable goals also can be used to track best practice implementation numerically, e.g., the number of wet detention basins in place or the number of people changing their behavior due to the receipt of educational materials.

4. **Tracking program/best practice effectiveness.** Measurable goals can be developed to evaluate best practice effectiveness, for example, by evaluating a structural practice's effectiveness at reducing pollutant loadings, or evaluating a public education campaign's effectiveness at reaching and informing the target audience to determine whether it reduces pollutants to the Maximum Extent Practicable. A measurable goal can also be a practice design objective or a performance standard.

5. **Tracking environmental improvement.** Achievement of environmental improvement can be assessed and documented by ascertaining whether state water quality standards are being met for the receiving water body or by tracking trends or improvements in water quality (chemical, physical, and biological) and other indicators, such as the hydrologic or habitat condition of the water body or watershed.

Although achieving water quality standards is the goal of plan implementation, the Portage Creek Watershed Advisory Group needs to use other means to ascertain what effects individual and collective best practices have on water quality and associated indicators. In-stream monitoring, such as physical, chemical, and biological monitoring, is ideal because it allows direct measurement of environmental improvements resulting from management efforts. Targeted monitoring to evaluate practice-specific effectiveness is another option, whereas ambient monitoring can be used to determine overall program

effectiveness. Alternatives to monitoring include using programmatic, social, physical, and hydrological indicators. Finally, environmental indicators can be used to quantify the effectiveness of best practices.

Environmental indicators are relatively easy-to-measure surrogates that can be used to demonstrate the actual health of the environment based on the implementation of various programs or individual program elements. Some indicators are more useful than others in providing assessments of individual program areas or insight into overall program success. Useful indicators are often indirect or surrogate measurements where the presence of the indicator points to likelihood that the activity was successful. Indicators can be a cost-effective method of assessing the effectiveness of a program because direct measurements sometimes can be too costly or time-consuming to be practical. A well-known example is the use of fecal coliform bacteria as an indicator of the presence of human pathogens in drinking water. While *E. coli* is now the preferred indicator of bacterial contamination, fecal coliform has been successfully used for more than a century and is still in widespread use for the protection of public health from waterborne, disease-causing organisms.

Table VII-H presents environmental indicators that have been developed specifically for assessing water quality programs.[xiv] Indicators 1 through 16—physical, hydrological, and biological indicators—can be integrated into an overall assessment of the program and used as a basis for the long term evaluation of program success. Indicators 17 through 26 correspond more closely to the administrative and programmatic indicators and practice-specific indicators.

Table VII-H. Environmental Indicators for Assessing Water Quality Programs

Category	**#**	**Indicator Name**
Water Quality Indicators This group of indicators measures specific water quality or chemistry parameters.	1	Water quality pollutant constituent monitoring
	2	Toxicity testing
	3	Loadings
	4	Exceedence frequencies of water quality standards
	5	Sediment contamination
	6	Human health criteria
Physical and Hydrological Indicators This group of indicators measures changes to or impacts on the physical environment.	7	Stream widening/downcutting
	8	Physical habitat monitoring
	9	Impacted dry weather flows
	10	Increased flooding frequency
	11	Stream temperature monitoring

Biological Indicators This group of indicators uses biological communities to measure changes to or impacts on biological parameters.	12	Fish assemblage
	13	Macroinvertebrate assemblage
	14	Single species indicator
	15	Composite indicator
	16	Other biological indicators
Social Indicators This group of indicators uses responses to surveys, questionnaires, and the like to assess various parameters.	17	Public attitude surveys
	18	Industrial/commercial pollution prevention
	19	Public involvement and monitoring
	20	User perception
Programmatic Indicators This group of indicators quantifies various non-aquatic parameters for measuring program activities.	21	Number of illicit connections identified/corrected
	22	Number of best practices installed, inspected and maintained
	23	Permitting and compliance
	24	Growth and development
Site Indicators This group of indicators assesses specific conditions at the site level.	25	Best practice performance monitoring
	26	Industrial site compliance monitoring

Measurement and evaluation are important parts of planning because they can indicate whether or not efforts are successful, and they also provide a feedback loop for improving project implementation as new information is gathered. If the watershed partners are able to show results, then the plan likely will gain more support from the partnering communities and agencies, as well as local decision makers, and increase the likelihood of project sustainability and success. Monitoring and measuring progress in the watershed necessarily will be conducted at the local level by individual agencies and communities, as well as at the watershed level, in order to assess the ecological impacts of collective actions on the health of Portage Creek and the Huron River.

Monitoring and measuring progress in the watershed will be two-tiered. First, agencies and communities will monitor certain projects and programs on the agency and community levels to establish effectiveness. For example, a community-based shoreline stewardship education workshop will be assessed and evaluated by that community. Second, progress will need to be tracked on a subwatershed or watershed

level in order to assess the ecological affects of the collective actions by agencies and communities on the health of the Portage Creek system.

The watershed partners recognize the importance of a long-term water quality, quantity and biological monitoring programs to determine where to focus resources as they progress toward meeting collective goals. These physical parameters will reflect improvements on a regional scale. A watershed-scale monitoring program is recommended since this approach is the most cost-effective and consistent if sampling is done by one entity for an entire region.

Qualitative Evaluation Techniques

The Implementation Activities for the Portage Creek watershed present a range of programs and projects—ranging from storm drain maintenance to public education—to improve water quality, water quantity and habitat in the Portage Creek watershed. Finding creative ways to measure the effectiveness of each of these individual programs is a challenge. Many of the evaluation techniques utilized for individual projects are listed in the Activities table under columns labeled “Measurable Indicators/Performance Measures” and “Monitoring and Party Responsible for Monitoring”.

A set of qualitative evaluation techniques can be used to determine whether progress is being made toward achieving the Goals and Objectives for the Portage Creek watershed. Moreover, the techniques can be used for determining whether this Plan needs to be revised at a future time in order to meet the Goals and Objectives, or water quality standards. A summary (Table VII-I) of the methods provides an indication of how these programs and projects might be measured and monitored to evaluate success in the short-term and the long-term. Some of these evaluations may be implemented on a watershed basis, such as a public awareness survey to evaluate public education efforts. Most of these programs and projects will be measured at the local level. By evaluating effectiveness, communities and agencies will be better informed about public response and success of the programs and projects, how to improve them, and which ones to continue. Although many of these evaluation techniques are not direct measures of environmental impact, past experience shows successful implementation of these programs and projects, collectively and over time, will have a positive impact on in-stream conditions.

Table VII-I. Summary of Qualitative Evaluation Techniques for the Portage Creek Watershed

Evaluation Method	Program/Project	What is Measured	Pros and Cons	Implementation
Public Surveys	Public education or involvement program/project	Awareness; Knowledge; Behaviors; Attitudes; Concerns	Pro: Moderate cost. Con: Low response rate.	Pre- and post- surveys recommended. By mail, telephone or group setting. Repetition on regular basis can show trends. Appropriate for local or watershed basis.
Written Evaluations	Public meeting or group education or involvement project	Awareness; Knowledge	Pro: Good response rate. Low cost.	Post-event participants complete brief evaluations that ask what was learned, what was missing, what could be done better. Evaluations completed on-site.
Stream Surveys	Identify riparian and aquatic improvements.	Habitat; Flow; Erosion; Recreation potential; Impacts	Pro: Current and first-hand information. Con: Time-consuming. Some cost involved.	Identify parameters to evaluate. Use form, such as the USA, to record observations. Summarize findings to identify sites needing observation.
Visual Documentation	Structural and vegetative BMP installations, retrofits	Aesthetics. Pre- and post-conditions.	Pro: Easy to implement. Low cost. Con: Good, but limited, form of communication.	Provides visual evidence. Photographs can be used in public communication materials.
Phone call/ Complaint Records	Education efforts, advertising of contact number for complaints/ concerns	Number and types of concerns of public. Location of problem areas.	Con: Subjective information from limited number of people.	Answer phone, letter, emails and track nature of calls and concerns.

Participation Tracking	Public involvement and education projects	Number of people participating. Geographic distribution of participants. Amount of waste collected, e.g. hazardous waste collection	Pro: Low cost. Easy to track and understand.	Track participation by counting people, materials collected and having sign-in/evaluation sheets.
Focus Groups	Information and education programs	Awareness; Knowledge; Perceptions; Behaviors	Pro: Instant identification of motivators and barriers to behavior change. Con: Medium to high cost to do well.	Select random sample of population as participants. 6-8 people per group. Plan questions, facilitate. Record and transcribe discussion.

Adapted from: Rouge River Watershed, Lower One Subwatershed Advisory Group, 2001

Quantitative Evaluation Techniques

In addition to measuring the effectiveness of certain specific programs and projects within communities or agencies, it is beneficial to monitor the long-term progress and effectiveness of the cumulative watershed efforts in terms of water quality, water quantity and biological health. Watershed-based long-term monitoring will address many objectives established for the Portage Creek watershed. A monitoring program at the watershed level will require a regional perspective and county or state support. Wet and dry weather water quality, stream flow, biological and other monitoring will afford communities and agencies better decision making abilities as implementation of this Plan continues. Recommendations for the monitoring program, first presented in Management Activity #9, are presented below. Details for the monitoring program will be decided and approved on an ongoing basis by the Portage Creek Watershed Advisory Group.

Parameters and Establishing Targets for Portage Creek Watershed Monitoring

Beyond the data collected for this Plan, the watershed partners recognize the need to augment the type of parameters monitored, the number of locations in the watershed, and the frequency of wet weather monitoring. A holistic monitoring program has been recommended to help communities and agencies to

identify more accurately water quality and water quantity threats and their sources, as well as how these threats are impacting the biological communities that serve as indicators of improvements.

Monitoring Parameters

A long-term monitoring program is recommended so that progress can be measured over time. The program would include the following components:

- Stream flow monitoring to determine baseflows and track preservation and restoration activities upstream. Physical and hydrological indicators such as stream widening/downcutting, physical habitat, stream temperature, and a variety of geomorphology measures are collected at two (2) HRWC Adopt-a-Stream sites in the watershed. At least one additional site would be identified for inclusion in the program.

- Wet and dry weather water quality of Portage Creek to establish baseline for the watershed, and measure impacts of preservation and restoration activities upstream. Include as water quality indicators: water quality pollutant monitoring and loadings. Regular collection of these parameters along with sediment contamination and human health criteria need to be added to complete the program.

- Biological monitoring of benthic macroinvertebrates is conducted regularly at two (2) stream sites in the watershed. Monitoring of fish and mussels needs to be added to improve the scope of biological knowledge. These indicators are used as measures of the potential quality and health of the stream ecosystem. Include as biological indicators: fish assemblage; macroinvertebrate assemblage; single species indicators; composite indicators; and other biological indicators.

- Biological monitoring of fish, herpetiles and aquatic plants in 11 lakes, seven of which are in-line with Portage Creek and four of which are inland lakes. These indicators are used as measures of the potential quality and health of the lake ecosystem.

- Water quality monitoring of the eleven lakes to establish a comprehensive baseline, and measure impacts of preservation and restoration activities along the shore and in the watershed. Include as water quality and physical indicators: water quality pollutant monitoring and loadings, transparency and chlorophyll.

- Monitoring will maximize the use of trained volunteers to encourage citizen involvement and stewardship.

Based on the goals of the watershed, the monitoring program will include measurement of dissolved oxygen (DO), bacteria (*E. coli*), phosphorus (P), total suspended solids (TSS), stream flow, conductivity, fisheries, transparency, chlorophyll, aquatic macroinvertebrates, temperature, physical habitat, and channel structure. However, many of these measures are collected on a limited basis, and subject to insecure funding. Establishing a sustainable plan for monitoring is a goal for this watershed.

Establishing Targets

Measuring parameters to evaluate progress toward a goal requires the establishment of targets against which observed measurements are compared. The targets define either Water Quality Standards, as set forth by the State of Michigan, or scientifically-supported numbers that suggest measurements for achieving water quality, water quantity and biological parameters to support state designated uses such as partial or total body contact, and fisheries and wildlife.

As discussed in Section VI, no parts of the Portage Creek system are failing to meet state water quality standards based on available information. Yet, the Portage Creek Watershed Advisory Group can use these scientifically-based numbers as targets for success in evaluating whether restoration and preservation goals have been achieved. These targets are described below.

Dissolved Oxygen: The State of Michigan established state standards for Dissolved Oxygen (DO). The requirement is no less than 5.0 mg/l as a daily average for all warm water fisheries. The Administrative Rules (Michigan State Legislature, 1999) state:

> . . . for waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(4), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.

Bacteria: State standards are established for Bacteria (*E. coli*). For the designated use of total body contact (swimming), the state requires measurements of no more than 130 *E. coli* per 100 milliliters as a 30-day geometric mean during five or more sampling events representatively spread over a 30-day period. For partial body contact (wading, fishing, and canoeing), the state requires measurements of no more than 1,000 *E. coli* per 100 milliliters based on the geometric mean of 3 or more samples, taken during the same sampling event. These uses and standards will be appropriate for and applied to the creek and those tributaries with a base flow of at least 2 cubic feet per second.

Phosphorus: State water quality standards for phosphorus require that "phosphorus which is or may readily become available as a plant nutrient shall be controlled from point source discharges to achieve .03125 mg/l of total phosphorus as a maximum monthly average effluent concentration unless other limits, either higher or lower, are deemed necessary and appropriate.[xv]" The State also requires that "nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the waters of the state." Monitoring frequency and number of sites for phosphorus and nitrogen needs to be increased to capture seasonal variation and dry and wet weather conditions, and effectively estimate changes in loading of these nutrients.

Total Suspended Solids/Sediment: No numerical standard has been set by the state for Total Suspended Solids (TSS) for surface waters. However, the State requires that "the addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use." To protect the designated uses of fisheries and wildlife habitat, as well as the desired recreational and aesthetic uses of the surface waters in the watershed, there are recommended targets established on a scientific basis. From an aesthetics standpoint, it is recommended that TSS less than 25 mg/l is "good", TSS 25-80 mg/l is "fair" and TSS greater than 80 mg/l is "poor." The TSS target, therefore, will be to maintain TSS below 80 mg/l in dry weather conditions.

Another measurement that can be used to determine the impacts of sediment loading is to determine the extent of embeddedness of the substrate (how much of the stream bottom is covered with fine silts) and the bottom deposition (what percentage of the bottom is covered with soft muck, indicating deposition of fine silts). These are measurements taken by the Surface Water Assessment Section (SWAS) protocol habitat assessment conducted by the State of Michigan every five years, and by the Adopt-A-Stream program more frequently. Rating categories are from "poor" to "excellent." The target should be to maintain SWAS "excellent" and "good" designations at sites where they currently exist, and to improve "fair" sites to "good."

The State of Michigan, USGS and U.S. EPA are currently recommending using the alternate measure of Suspended Sediment Concentration (SSC) as a more accurate measure for open channel monitoring.

Stream Discharge: Stream flow, or discharge, for surface waters do not have a numerical standard set by the State. Using the health of the fish and macroinvertebrate communities as the ultimate indicators of stream and river health is most useful in assessing appropriate flow. Recommended flow targets for Portage Creek will be established once the necessary research has been conducted that will determine the natural, pre-development hydrology and current hydrology. Peak flow data is needed to compare more accurately observed flow to the target flow. Currently, no instrumentation is measuring continuous stream flow in Portage Creek. A foundation of the monitoring regime should be the installation of a USGS stream gage and the deployment of several level sensors. Data generated by

these stations can assist in establishing an appropriate flow targets and assessing any progress made toward such a goal, as well as contributing to loading calculations.

Conductivity: Conductivity measures the amount of dissolved ions in the water column and is considered an indicator for the relative amount of some types of suspended material in the stream. The scientifically-established standard for conductivity in a healthy Michigan stream is 800 µS, which should be the goal for the Huron River and its tributaries. Levels higher than the standard may indicate the presence of suspended materials from stormwater runoff, failing septics, illicit connections, ground water seeps or other sources.

Fisheries: Numerical or fish community standards have not been set by the state. However, the State of Michigan has developed a system to estimate the health of the predicted fish communities through the SWAS 51 sampling protocol. This method collects fish at various sites and is based on whether or not certain expected fish species are present, as well as other habitat parameters; fish communities are assessed as poor, fair, good, or excellent. The State conducts this protocol every five years in the Huron River Watershed. The target should be to maintain SWAS 51 scores of "excellent" and "good" at sites where they currently exist, and to improve "fair" and "poor" sites to "good." The SWAS 51 protocol also identifies whether or not there are sensitive species present in the Portage Creek system, which would indicate a healthy ecosystem. Certain species are especially useful for demonstrating improving conditions. These species tend to be sensitive to turbidity, prefer cleaner, cooler water, and their distribution in the Huron River watershed is currently limited. The target is to continue to find species currently found in self-sustaining population numbers, at a minimum. Improvements in habitat and water quality should also result in the expansion or recruitment of additional species.

Benthic Macroinvertebrates: Similar to the assessment of fish communities, the State employs the GLEAS 51 protocol for assessing macroinvertebrate communities on a five-year cycle for the Huron River Watershed. The HRWC Adopt-A-Stream program monitors macroinvertebrate health and physical habitat on 2 sites in the Portage Creek Watershed using an adaptation of the GLEAS 51 procedure. The sites are monitored for macroinvertebrates two or three times each year and periodically for physical habitat health. At least one additional site on Portage Creek will be added to the Adopt-A-Stream program. The monitoring target for macroinvertebrate communities will be to improve the existing database from "fair" to "good," while maintaining the "excellent" conditions at other site.

Temperature: The State lists temperature standards only for point source discharges and mixing zones – not ambient water temperatures in surface water. However, recommendations for water temperature can be generated by assessing fish species' tolerance to temperature change and these guidelines are found within the statute. Although some temperature data have been collected in the Portage Creek system by the HRWC Adopt-A-Stream program and as part of state monitoring, additional studies are needed to establish average monthly temperatures and whether increased temperatures are limiting biota habitat.

Wetlands: An annual review should be done of State wetland permit information and local records in order to track wetland fills, mitigations, restoration and protection to establish net loss or gain in wetlands in the watershed. The target for this parameter is to track the net acres of wetland in the watershed to determine action for further protection or restoration activities. In addition, the Bioreserve Project inventory should be completed to capture additional small, non-regulated wetlands. Once identified, these should also be tracked as above. Watershed partners should coordinate with a MDNRE-led effort to prioritize vernal pools to be considered for protection under the essentiality clause of the State regulations.

Details regarding responsible parties, monitoring standards, sampling sites, and frequency of monitoring for qualitative and quantitative evaluation techniques need to be periodically reviewed by the Portage Creek Watershed Advisory Group. HRWC produces a summary of results on the Adopt-a-Stream program annually.

Evaluation Monitoring for the Portage Creek Watershed

Based on an evaluation of the above information, the goals and objectives of this plan, and the causes and sources of water quality threats in critical areas, the monitoring plan detailed in Table VII-I has been established. This plan is contingent upon funding and participation of community partners and monitoring agencies.

The monitoring plan is based around three programs administered by three organizations, two existing and one to be developed. First, HRWC's Adopt-a-Stream Program collects data on benthic macroinvertebrates three times a year, including a special collection of winter stoneflies. Adopt also does a complete stream habitat assessment of each site every 4-5 years, which includes a number of geomorphic characteristics along with general habitat characteristics as with the MDNRE protocol. Adopt collectors also sample for water conductivity at each macroinvertebrate event. Summer temperatures are also documented every 5 years. The Adopt program uses volunteers to collect the vast majority of the data. Results from this program are included in section IV.

The second program is MDNRE's rotational watershed assessments. MDNRE returns to the watershed every five years to collect benthic macroinvertebrates, habitat assessment data and, in some cases, a suite of water chemistry parameters. Site selection varies each year and the next assessment for the Huron River watershed will be in 2012.

Finally, HRWC administers a water quality monitoring program on behalf of watershed partners in the middle Huron and Chain of Lakes regions of the Huron River watershed. In that program, HRWC uses volunteers and staff to collect water samples and deliver to a municipal Water Treatment Plant for

analysis. Analytes include total phosphorus, nitrates, nitrites, total suspended solids and *E. coli*. Volunteers and staff also collect stream discharge data from each site to allow for the calculation of pollutant loads. Currently, data is collected once or twice per month (depending on site) with additional storm event and high flow samples collected opportunistically during the April to September growing season. This program could expand to the Portage Creek watershed, possibly in partnership with county public health and environmental health departments, with sufficient funding and a municipal Water Treatment Plant on board to process the water samples.

A coordinated approach to monitoring the health of 11 major lakes in the Portage Creek watershed is sought through this monitoring plan. The lakes monitoring plan is based on the model followed by the State lake and stream volunteer monitoring program, the Michigan Clean Water Corps or MiCorps, of using trained volunteers to collect the data and water samples. During the watershed planning process, some residents received preliminary training and exposure to the lake sampling protocols of MiCorps during a day-long workshop. Additional outreach to lake residents and other residents, and requisite training will be necessary to establish and sustain a network of lake monitors on all 11 lakes.

Details for the monitoring plan and evaluative mechanisms are presented in table VII-J.

Table VII-J. Portage Creek Watershed Monitoring and Evaluation

Monitoring Site[1]	Parameter Target	Type of Analysis	Protocol	Frequency	Responsible Party
Portage Creek Adopt (Portage @ Unadilla, Portage @ Dexter-Tow nhall, 1 upstream site TBD)	S,N,DO,T,I, B, Bio[2]	Stream Habitat Assessment	HRWC Protocol	3-5 Yr Interval	HRWC, MDEQ[3]
		Total Suspended Solids	WTP protocol	1x/Mo Apr-Sept	HRWC to WTP[4]
		Total Phosphorus	WTP protocols	1x/Mo Apr-Sept	HRWC to WTP; MDEQ
		Temp, DO, pH, Conductivity	Horiba U10 Meter	1x/Mo Apr-Sept	HRWC
		E. coli	WTP protocol	1x/Mo Apr-Sept	HRWC to WTP
		Benthic Macroinvertebrates	HRWC Protocol	2-3x/Year	HRWC, MDEQ
Ellsworth Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU
Williamsville Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU
Patterson Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU
Bruin Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU

Table VII-J. Portage Creek Watershed Monitoring and Evaluation *(continued)*

Monitoring Site[1]	Parameter Target	Type of Analysis	Protocol	Frequency	Responsible Party
Halfmoon Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU
HiLand Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU
Joslin Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU
North Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU

Table VII-J. Portage Creek Watershed Monitoring and Evaluation *(continued)*

Monitoring Site[1]	Parameter Target	Type of Analysis	Protocol	Frequency	Responsible Party
Island Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU
Silver Lake (Site TBD)	N, DO, C, B, Trans[5]	Lake Chemistry	MDEQ protocols	1x/Mo Apr-Sept	MDEQ[3]
		Chlorophyll	MiCorps protocol	1x/Mo May-Sept	MiCorps volunteer to MSU
		Total Phosphorus	MiCorps protocol	3x/Yr Apr-Sept	MiCorps volunteer to MSU
		DO	MiCorps protocol	2x/Mo May-Sept	MiCorps volunteer to MSU
		E. coli	County Public Health protocol	1X/Wk June-Aug	County Public Health
		Secchi Disk	MiCorps protocol	2-4x/Mo May -Sept	MiCorps volunteer to MSU

1) Adopt = HRWC Adopt-A-Stream; HRWC = water quality monitoring
2) S= Sediment; N= Nutrients; DO= Dissolved Oxygen; T= Temperature; I= Ions; B= Bacteria; Bio= Biota
3) Specific sites will be included as part of the state's rotational water quality monitoring program
4) HRWC staff and volunteers to collect samples and deliver to municipal Treatment Plant for analysis under their direction
5) C = Chlorophyll; Trans = Transparency

D. Conclusions

The Portage Creek Watershed Management Plan has been created to provide a strong foundation and framework for protecting the freshwater resources of the Portage Creek system, and improving them where needed, for current and future generations of residents and visitors. The Plan is the jumping off point; it is not a means to itself. The next step of implementing the recommendations of this Plan will require the cooperation, patience, and persistence of many partners and stakeholders.

Many of the watershed partners have demonstrated an earnest desire to see this Plan through to action and real improvements in the watershed. Yet, other communities and entities in the watershed have not yet participated to any meaningful extent. They will need to be brought into the fray in order to make meaningful progress on reaching the goals and objectives laid out for the Portage Creek watershed.

The communities in this watershed will continue to face the challenges of balancing growth with natural resource protection. But the costs of maintaining the status quo and the benefits of long-term planning on a watershed scale will become increasingly apparent. Each community has a choice: to regard the Plan as merely an exercise to gain eligibility for state and federal funds, or to use the Plan as the tool for partnering with Portage Creek neighbors to protect the water and land that connects us all.

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