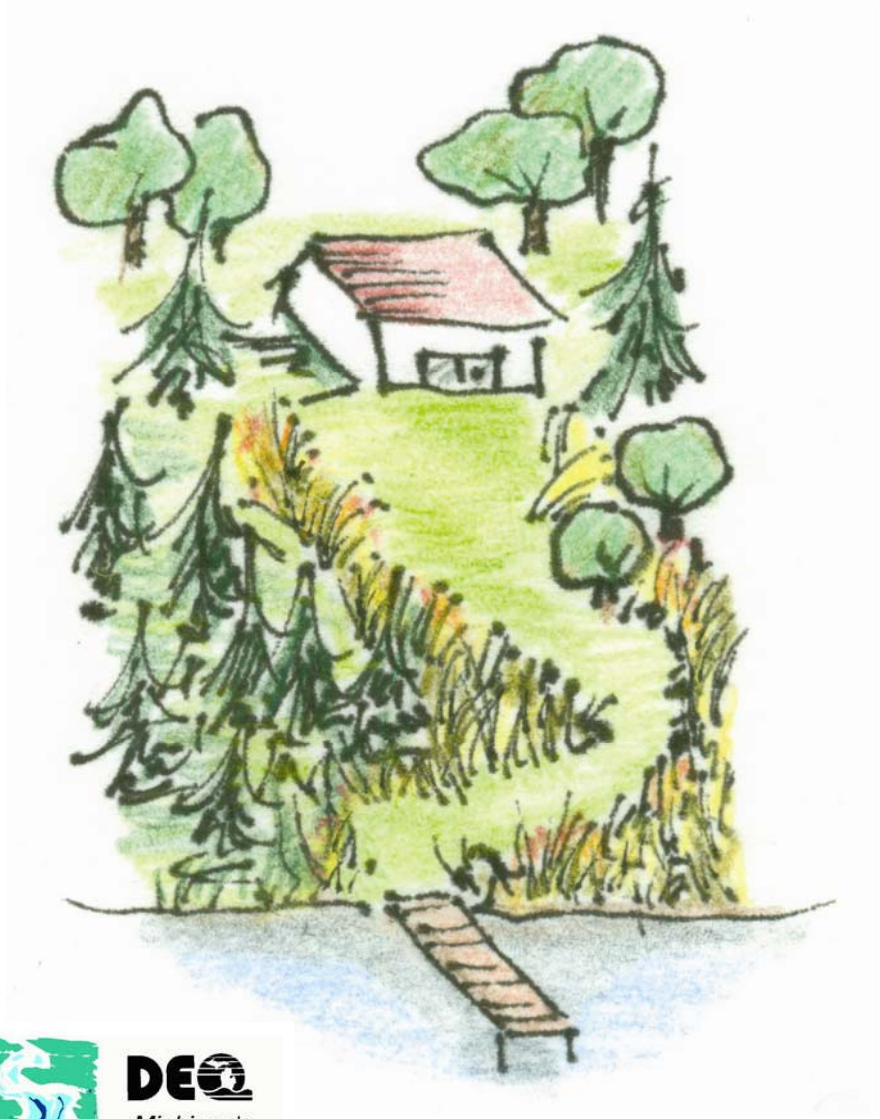
Riparian Corridor Protection in the Huron River Watershed



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Huron River Watershed Council

March 2008

Huron River Watershed Council

Protecting the river since 1965

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Table of Contents

Introduction and Purpose

This paper describes the status of the riparian corridor in the Huron River watershed and key findings of research conducted by HRWC on the strategies for effective maintenance and restoration of riparian corridor along the Huron River and its streams, ponds, lakes and wetlands. The Model Ordinance for Riparian Buffers (February 2007) developed by HRWC is based on the findings of this research.

Why are riparian corridors worth having?

If the Huron River and its tributaries could talk, one of the first things they might say to us is "Hey, can we get a little privacy here, please?" One of life's bare necessities is clothing and shelter to keep us safe, healthy, and protected from the elements. For a stream or river, the vegetated zones along its banks, known as riparian buffers, are the equivalent of the walls of our houses or the clothes on our backs.

A riparian buffer zone is a strip of undisturbed native vegetation, either original or reestablished, bordering a stream or river, or wetland. 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, the National Research Council, in its 2002 review of riparian areas across the nation, stated that *riparian areas perform a disproportionate number of biological and physical functions on a unit area basis*. That is, riparian areas are more productive than other ecosystems. A buffer is most effective when stormwater flows into and through it as a shallow sheet, rather than through concentrated channels or gullies.

Yet, much of the Huron's stream and river corridors have been stripped of natural vegetation, and natural shorelines and stream banks have been replaced with turfgrass, seawalls, concrete rubble, boulders, or other artificial barriers that sever the critical connection between land and water. The eventual result is bank erosion and a straight path for pollutants to flow directly into our waterways. In fact, removing buffer vegetation fundamentally changes the way a stream flows. A riparian buffer acts as a sponge, soaking up runoff from rainstorms and slowly releasing it to the stream. Removing or altering riparian buffers allows runoff to rush quickly and directly into streams during rainstorms, which can dramatically harm a stream's ecological and physical health.

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 the Huron River's physical, biological, and chemical integrity.

Status of riparian corridors

To date, riparian corridors in the Huron River watershed, and throughout the country, have been undervalued and poorly understood. As a result, to date, this important part of the river system has been abused in many stretches ranging from benign neglect to overt destruction. Few communities in the Huron River watershed, primarily those with Natural Rivers Zone designation, have policies or programs to protect riparian corridors. Even communities that boast a fairly comprehensive policy to protect natural features fail to include protections for riparian corridors specifically. The status of riparian corridor protection and restoration can be described as the missing piece of the puzzle to preserve natural features.

HRWC embarked on a two-year initiative to raise awareness and protection of riparian corridors in 2006 as a response to the continuing impairment of the resource. The Huron Riparian Buffer Initiative represents HRWC's initial effort to elevate the importance of riparian corridors on par with the other components of the Huron River system (i.e., river, tributary streams, wetlands, floodplains, floodways, lakes, ponds, and groundwater). While the Initiative plants the seeds for responsible stewardship of the riparian corridor through policy development, public education, and stakeholder discussions, efforts will need to be maintained long-term to nurture the growth of this program.

Tools for riparian corridor protection and restoration

Multiple tools are available to landowners and communities seeking to protect and restore riparian corridors. Each tool carries benefits and costs that need to be considered in the context of local conservation goals and land ownership patterns. In the Huron River watershed, as in most watersheds, no single tool will meet the disparate needs of the various types of landowners. In short, these tools can be described as regulatory or voluntary in nature.

Voluntary land preservation tools rely on incentives, education and landowner propensity to protect and restore the riparian corridor. The incentives take the form of direct payments to landowners not to develop riparian lands, payments to encourage use of environmentally compatible practices, payments or tax benefits for placing a conservation easement on the property, funding for restoration or demonstration projects, stewardship education and technical assistance, and outright purchase of the riparian lands.[1] For example, the incentive programs administered by the U.S. Department of Agriculture, such as the Conservation Reserve Enhancement Program and Environmental Quality Incentive Program, are key voluntary tools to entice agricultural land owners to protect and restore riparian corridors.

Regulatory tools for riparian areas protection may occur at the national, state and local levels of government. The National Research Council notes that the "degree of protection, the focus and the spatial coverage of these laws and programs are highly

[1] National Research Council. 2002. Riparian areas: functions and strategies for management. Washington, DC: National Academy Press.

variable" due to the patchwork of such tools that have developed since the 1990s when riparian areas began to receive legal recognition as places requiring special attention.[2] Some state governments have recognized the importance of protecting riparian corridors and were prompted to establish state-level regulatory programs (e.g., Massachusetts, Wisconsin, and New Jersey). In the absence of a state-level program in Michigan, the local unit of government is the level at which regulatory tools are implemented, and specifically, cities, villages and townships due to Michigan's emphasis on home rule.

Defining "riparian"

The National Research Council (2002) has developed the following definition to provide a consistent definition of the term:

Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines.

Holistic strategy needed

A holistic strategy for protecting and restoring riparian corridors in the Huron River watershed is needed to prevent irreparable harm to the Huron River. HRWC sought such an approach through the Riparian Buffer Initiative by examining the role of agencies and entities with jurisdiction over significant stretches of the stream network and by identifying opportunities to partner with them to improve management of riparian areas. Yet, to focus limited resources, HRWC chose to work in greater depth in two arenas: public information and education, and local policy measures. To these ends, HRWC conducted research through various means — researchers profiled the riparian corridor in the watershed for a snapshot of its condition; performed an extensive review of current scientific literature; conducted interviews with local government staff implementing riparian policies; and reviewed ordinances and guides throughout the country.

The following sections of this paper will describe the research findings in more detail:

- Section 1: Profile of the Huron River watershed riparian corridor
- Section 2: Review of scientific literature
- Section 3: Benchmarking existing riparian policy
- Section 4: Recommendations for enhancing riparian corridor management (including the HRWC Model Ordinance for Riparian Buffers)

[2] Ibid.

Section 1.

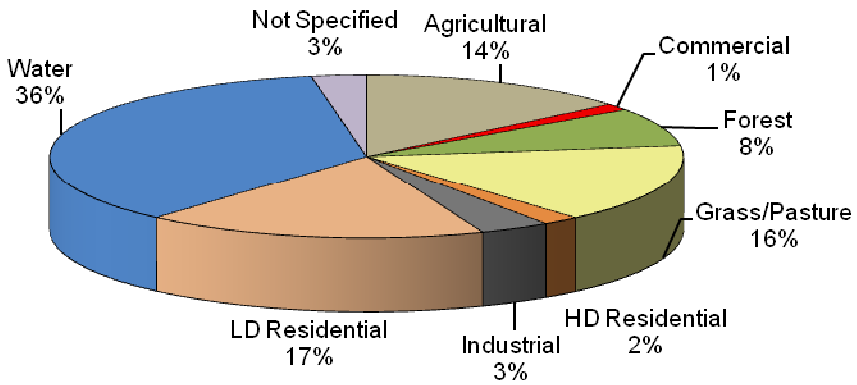
Profile of the Huron River riparian corridor

Characteristics of the riparian corridor

The main stem of the Huron River runs over 136 miles with an additional stream network of 367 miles flowing from 24 major tributaries. These waterways drain more than 900 square miles of land before emptying into Lake Erie. Conducting field work of this vast network of streams would be daunting. Due to the size of the watershed, assessments of buffer intactness were determined using spatial analysis tools such as GIS and aerial imagery. This level of analysis enables assessment of existence of buffers, approximate width, and connectivity. This level of analysis is not well suited to assessing the quality of vegetation in buffers and site-specific threats to them.

An analysis of the land cover type extending 300 feet from either side of the Huron River and its tributaries and waterbodies stream shows that 60 percent of the land remains undeveloped as forest, water or open pasture (Figure 1). The remaining 40 percent of land within that specified distance is developed either as agriculture, residential or commercial or industrial. Of that developed land, three-quarters are agricultural or low-density residential. Nearly five percent of the acreage in the corridor falls within the area designated as the Natural Rivers Zone when only riparian buffers are considered; that number drops to not quite three percent when lake buffers are considered along with riparian buffers. The Huron River is the only river in the southern lower peninsula of Michigan with a Natural Rivers Zone; the river and surrounding landscape meet the strict requirements for a "Country Scenic" river according to the program. While local conditions will vary based on slope, soil type, and hydrologic connectivity, the distance of 300 feet is supported in the scientific literature as a reasonable distance under which human activities can impact surface waters.

Figure 1. Land use/land cover types within 300 feet of the Huron River, its tributaries, and waterbodies per 2000 land use (MIRIS).



Buffer Initiative Community Partners

Four communities signed on to partner with HRWC to increase awareness and protection of riparian corridors through the Huron Riparian Buffer Initiative. The partner communities were the townships of Green Oak and Putnam in Livingston County, and the townships of Scio and Ypsilanti in Washtenaw County. The riparian corridors in these communities were studied in detail to craft appropriate policy and communicate corridor status to the public via public information and education materials, local Open Houses, and Internet-based outreach.

HRWC created a Riparian Buffer Tour Guide for each community as part of that study. The Tour Guide consisted of site photographs of working riparian buffers with descriptions and maps linked to the Internet via Microsoft Live Search Maps. The Tour Guides for each of the partner communities are presented on the following pages.

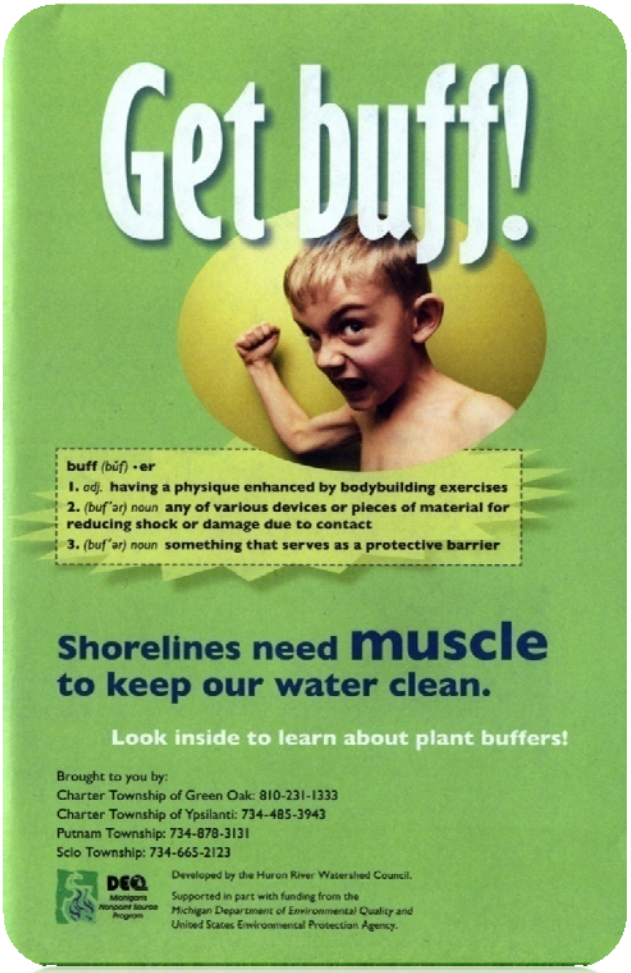


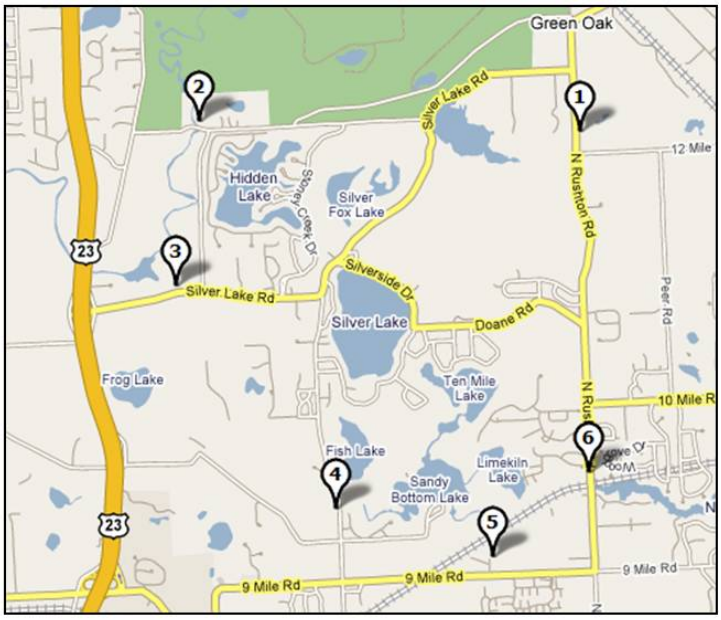
Figure 2. Cover of direct mail piece to educate residents in the partner communities about riparian buffers. Created by HRWC.

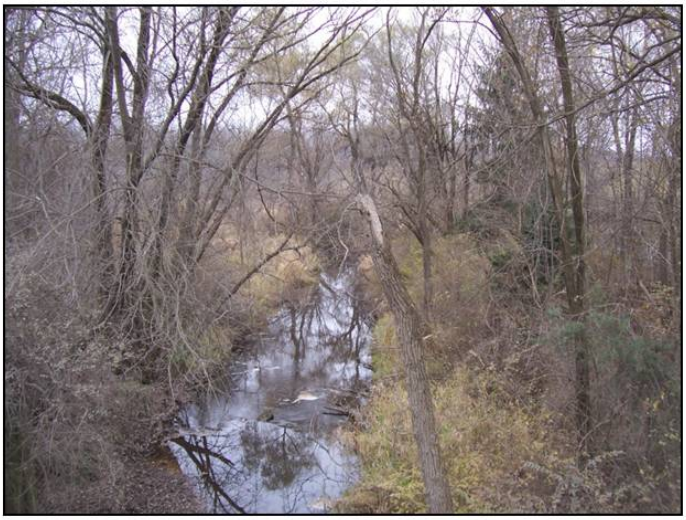
Tour of Riparian Buffers in Green Oak Township

You can see many excellent examples of riparian buffers right here in Green Oak Township!

Riparian buffers consist of plants, shrubs, and trees located near wetlands, lakes, and streams.

Riparian buffers
- **protect surface waters from harmful pollutants**
- **store flood waters during periods of high stream flows**
- **stabilize shorelines with deep-rooted native plants**
- **moderate stream and air temperatures**
- **provide critical wildlife habitat**





1. Davis Creek at Rushton Road

Deep tree and shrub roots help prevent streambank erosion along Davis Creek. Sediment is the top pollutant of streams and rivers in the United States. Vegetated riparian buffers can reduce erosion and filter sediment from runoff.

2. Huron River at McCabe Road

In addition to water quality benefits, this tree, shrub, and grass buffer on the banks of the Huron River provides excellent wildlife habitat for terrestrial and aquatic organisms. Fallen logs in the water are great shelter for small fish and insects, and birds can use low-growing shrubs for nesting sites.

3. Huron River at Silver Lake Road

In the summertime, tall trees form a canopy over the water and regulate stream temperature. Many aquatic organisms require cool, well- oxygenated water, and forested buffers can help protect organisms from thermal fluctuations.

4. Tributary to Huron River at Marshall Road

This forested buffer protects a tributary to the Huron River by filtering polluted runoff and storing floodwaters. An adjacent wetland provides additional filtering and storage capacity.

5. Tributary to Lime Kiln Lake at Rushton Road

Protecting small tributary streams is one of the most cost-effective ways to ensure the health and quality of our downstream waters.

6. Tributary of Davis Creek at Four Lakes Drive

This buffer, comprised of tall trees and grasses, slows down runoff to encourage rainwater to infiltrate into the groundwater.

Funding for the Huron Watershed Riparian Buffer Initiative comes from MDEQ and U.S. EPA through the section 319 program. This piece produced by the Huron River Watershed Council, 1100 N. Main Street, Ann Arbor, MI 48104. November, 2007. For more information, contact Elizabeth Riggs at (734) 769-5123 x15. Photos and text by A. Marino.

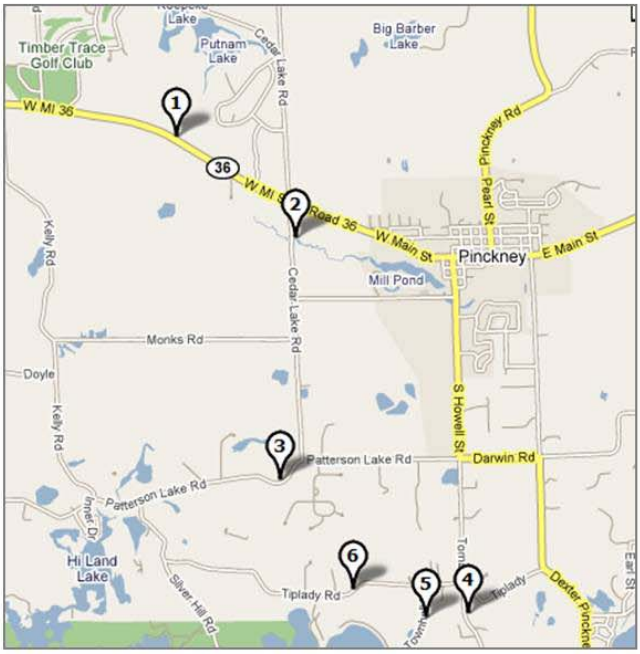
Tour of Riparian Buffers in Putnam Township

You can see examples of excellent riparian buffers right here in Putnam Township!

Riparian buffers consist of plants, shrubs, and trees located near wetlands, lakes, and streams.

Riparian buffers

- protect surface waters from harmful pollutants
- store flood waters during periods of high stream flows
- stabilize shorelines with deep-rooted native plants
- moderate stream and air temperatures
- provide critical wildlife habitat



1. Honey Creek at Highway 36 This riparian buffer with its established shrubs and grasses, along with hardwood trees and conifers, protects water quality by filtering storm runoff from roads and other impervious areas.

2. Honey Creek at Cedar Lake Road The riparian buffer contains trees, shrubs, and grasses. Wetlands adjacent to the stream store floodwaters, and provide habitat for songbirds, frogs, turtles, and other critters.

3. Portage (Hell) Creek at Patterson Lake Road
Trees and shrubs on both sides filter sediment and pollutants in runoff. Low-growing shrubs provide food and nesting sites for songbirds.

4. Portage (Hell) Creek at Toma Road
This buffer contains mostly trees and shrubs with deep roots that hold streambanks in place to control soil erosion and reduce sediment pollution.

5. Portage (Hell) Creek at Dexter Townhall Road
The trees provide a canopy over the stream during summer months, keeping the water cooler for fish and other aquatic organisms.

6. Portage (Hell) Creek at Tiplady Road
This buffer protects the stream from temperature fluctuations. Fallen logs provide additional in-stream habitat for fish and other organisms.

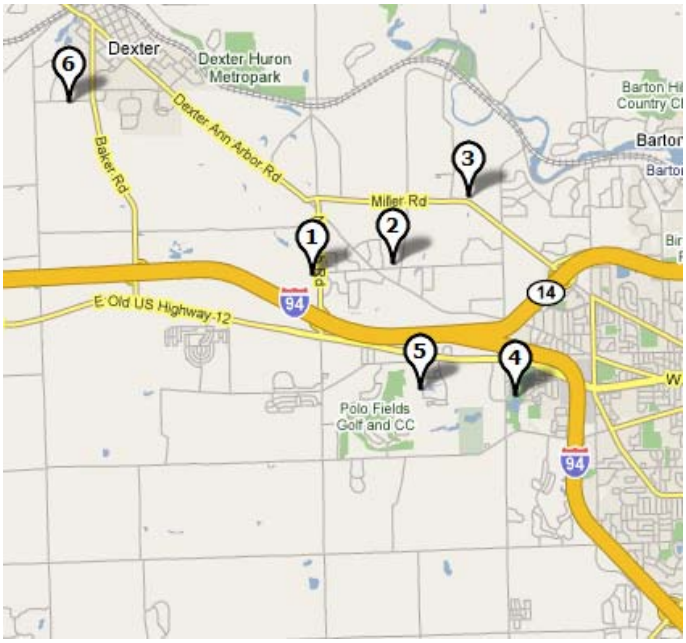
Funding for the Huron Watershed Riparian Buffer Initiative comes from MDEQ and U.S. EPA through the section 319 program. This piece produced by the Huron River Watershed Council, 1100 N. Main Street, Ann Arbor, MI 48104. November, 2007. For more information, contact Elizabeth Riggs at (734) 769-5123 x15. Photos and text by A. Marino.

Tour of Riparian Buffers in Scio Township

You can see some excellent examples of riparian buffers right here in Scio Township.

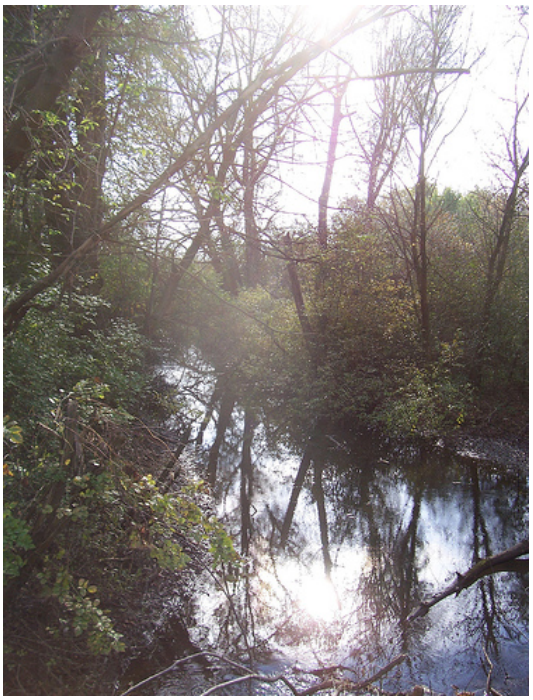
Riparian buffers consist of plants, shrubs, and trees. Located near wetlands, lakes, and streams, riparian buffers:

- provide natural, gradual transition from terrestrial to aquatic environments
- create critical wildlife habitat
- store flood waters during periods of high flows
- protect surface waters from harmful pollutants



1. Outside Scio Township Hall

The riparian buffer outside Scio Township Hall protects a tributary stream to Honey Creek. Protecting small, headwater streams with riparian buffers is a cost-effective way to protect water quality.



2. Pratt Road at Honey Creek

The well-developed buffer on both sides of Honey Creek at Pratt Road shades the water and makes it cooler and more oxygenated for aquatic organisms. The low shrubs provide food and nesting sites for songbirds.

3. Miller Road at Honey Creek

The buffer on the banks of Honey Creek at Miller Road contains mostly trees and shrubs, whose roots hold stream banks in place to control streambank erosion.

4. Second Sister Lake

Riparian buffers, like the one shown at Second Sister Lake, provide additional benefits for lake ecosystems. Besides filtering sediments and pollutants from stormwater, lakeshore buffers provide habitat and protection for small fish when trees fall into the water. Fallen logs are essential components of shallow water habitats in lakes.

5. Sunward-Touchstone Co-housing

Trees, shrubs, and other plants protect a wetland and stream near Sunward Touchstone Co-housing off of Jackson Road. These buffers filter any sediment and pollutants from run-off, store water during storm events, and provide habitat for songbirds, frogs, turtles, and other critters. The use of native vegetation to protect streams and wetlands demonstrates environmentally-friendly, aesthetically pleasing, and low-maintenance landscaping in this new housing development.

6. Shield Road at Mill Creek

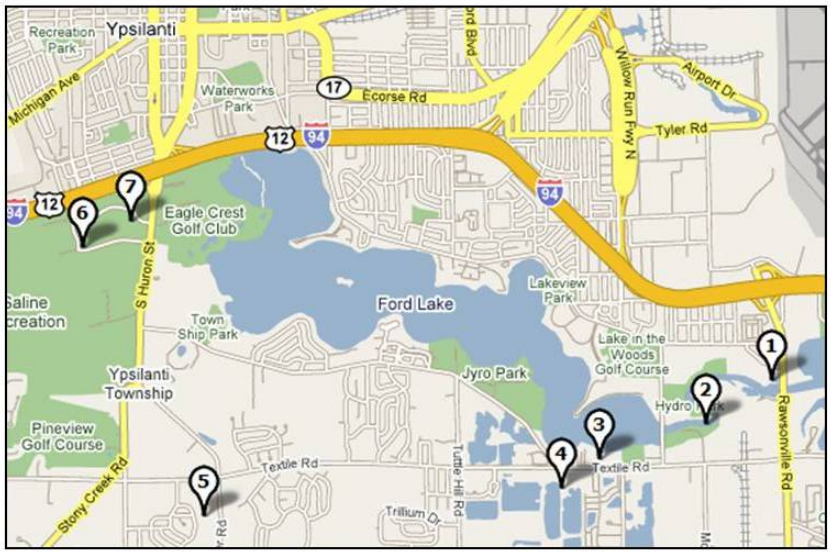
The photo of Mill Creek at Shield Road shows a healthy forested buffer on one side of the stream. On the other side of the stream, the protection of a buffer is lacking. Because there is little vegetation to slow stormwater, run-off travels quickly into the stream. Flooding is also a problem in this area. Simply allowing grass to grow tall and planting a few trees and shrubs along the stream bank could improve water quality in the stream and provide flood control.

Tour of Riparian Buffers in Ypsilanti Charter Township

You can see examples of excellent riparian buffers right here in Ypsilanti Charter Township!

Riparian buffers consist of plants, shrubs, and trees located near wetlands, lakes, and streams.

Riparian buffers
- protect surface waters from harmful pollutants
- store flood waters during periods of high stream flows
- stabilize shorelines with deep-rooted native plants
- moderate stream and air temperatures
- provide critical wildlife habitat



1. Huron River Corridor

The Huron River Corridor off Snow Road is a great example of a healthy forested riparian buffer. Mature hardwood trees provide shade and cover for small mammals and birds, while low growing shrubs supply nesting sites. Fallen logs create excellent habitat for fish, turtles, and other aquatic organisms.

2. North Hydro Park

The township's newest Hydro Park is located on the banks of the Huron River right off Bridge Road. Some reaches of the river are protected from pollutants, high water, and erosion by the plants growing along the banks. When you visit the park, try to compare the buffered and non-buffered areas of the river.

3. Ford Lake off Textile Road

Ypsilanti Charter Township has an Open Space Ordinance to discourage development within 50 feet of a lake or river and 25 feet of a wetland. In this example, trees and shrubs growing along the waterfront stabilize the shoreline with their deep roots and provide a transition from lawn to water.

4. Ponds of Lakewood Development

Located off Textile Road, this new development includes more than 2 acres of wetlands and riparian buffers. Native grasses such as Big Bluestem, Switch Grass, and Indian Grass, along with wildflowers including Aster, Black-eyed Susan, and Prairie Dock complement existing mature trees and woody shrubs. The project includes a one-half mile walking path.

In October, 2007, Ponds of Lakewood Development received an Honorable Mention for a "Bricks and Mortar" Project Award at the Michigan Association of Planning Conference.

5. Parkland Preserve Development

A riparian buffer along the west edge of the Parkland Preserve Development protects Paint Creek. Trees, shrubs, and grasses provide flood control, filter polluted run-off, and provide excellent wildlife habitat.

6. Paint Creek at Joe Hall Road

Paint Creek is a coldwater-designated stream in the Stony Creek watershed. The forested riparian buffer protects the stream from run-off and temperature fluctuations.

7. Wetland and Floodplain Mitigation at Washtenaw Business Park

A 50-foot grass buffer protects this newly established wetland mitigation project at Washtenaw Business Park. A mixture of native grasses helps slow and filter storm runoff that eventually drains to Paint Creek.

Funding for the Huron Watershed Riparian Buffer Initiative comes from MDEQ and U.S. EPA through the section 319 program.
This piece produced by the Huron River Watershed Council, 1100 N. Main Street, Ann Arbor, MI 48104. November, 2007.
For more information, contact Elizabeth Riggs at (734) 769-5123 x15. Photos and text by A. Marino.

Land management of the riparian corridor

Land ownership throughout the Huron River watershed is fragmented resulting in myriad property owners and parcels. Riparian land in the 300 foot buffer follows that fragmented pattern. Yet, a few entities have jurisdiction over significant acreage. The two entities with the most acreage are the Huron-Clinton Metropolitan Authority (HCMA) Metroparks that cover five percent of the land within 300 feet of the river network and the Michigan Department of Natural Resources that oversees more than seven percent of the land within the buffer. After the HCMA and MDNR, the next largest entity with riparian acreage is the group of agricultural producers, comprised largely of individual farmers. Collectively, farmers own more than 1,000 acres in the riparian corridor throughout the Huron River watershed.

The next tier of riparian land owners includes four entities that own more than 500 acres each. The University of Michigan, county governments, Chrysler Corporation and General Motors Corporation comprise this group. County drain commissioners have jurisdiction over a significant number of stream miles in the counties of the watershed, which means they are subject to requirements of the state drain code. For example, in Washtenaw County, eight percent of the acreage within the 300 feet buffer is designated county drains while in Livingston County three percent of the acreage is designated county drains.

Land owners with less than 500 acres each in the riparian corridor range from the State of Michigan to a private country club. Nine entities fall into this group and they are as follows: State of Michigan; River Place & Abbey Ltd., Partnership (scout reservation); City of Dearborn (public green space); Bates Service Co. (sand and gravel mine); American Aggregates (sand and gravel mine); Girl Scouts of Metro Detroit (scout camp); Ypsilanti Township (parks); Walnut Creek Country Club (golf course); and Walker Industries (sand and gravel mine).

Table 1 presents the basic profiles of the riparian land owners with more than 500 acres. Future efforts on stakeholder engagement and public information and education can refer to this table. Note that current parcel data should be referenced in order to record any changes of land ownership since this original table was created.

Table 1. Riparian land owner profiles in the Huron River watershed

LAND OWNER	CONTACT	MANAGEMENT APPROACH FOR RIPARIAN LANDS	PARTNERSHIP OPPORTUNITIES
Land owners with more than 1,000 acres in riparian corridor			
Huron-Clinton Metropolitan Authority	Sue Nyquist, Principal Planner, sue.nyquist@metroparks.com; Paul Muelle, Chief of Natural Resources, paul.muelle@metroparks.com	Maintains vegetative buffer zones along lakes, rivers, and streams; partners with Turfgrass Stewardship Program to develop guidelines for turf maintenance and BMPs that reduce negative impacts	Provide HCMA with model riparian buffer ordinance for guidance. Encourage protection of existing buffer. Identify stretches lacking buffer and seek restoration; also securing grant funds.
Michigan Dept of Natural Resources	Ron Olson, Chief, Parks and Recreation, olsonr@michigan.gov; Steve Sutton, Natural Rivers Program Manager, SuttonsL@michigan.gov	Agency implements the Natural Rivers Act for areas under the Act's jurisdiction; provides I&E to landowners on how to improve riparian habitat; engaged in biodiversity conservation planning statewide	HRWC's Bioreserve program identifies priority natural areas in the watershed and works with landowners to secure protection; watershed planning efforts can engage MDNR
Agricultural Producers	USDA NRCS; County Conservation Districts; MSU-Extension	Farm Bill voluntary cost-share incentive programs	Recommendation of USDA NRCS personnel: encourage landowner participation in continuous Conservation Reserve Program (CREP) for people with crop history; and Wildlife Habitat Improvement Program for rural landowners without crop history; advocate for the Huron for inclusion in the CREP
Land owners with more than 500 acres in riparian corridor			
Univ. of Michigan	Various preserve managers	Protective of riparian areas; educational areas for users	Identify opportunities to partner on riparian research
County Governments	County Drain Commissioners	Regulated by Michigan Drain Code to provide for flowing drains	Work with receptive drain commissioners in watershed counties to identify alternative practices that are less impacting to riparian corridors; advocate for drain code revisions
Chrysler Corporation	Facilities Supervisor; Environmental Manager	To be determined	Provide maintenance staff with tips on stewardship of riparian areas
General Motors Corporation	Facilities Supervisor; Environmental Manager	To be determined	Provide maintenance staff with tips on stewardship of riparian areas

Section 2.
Literature review

Summary of areas of research

The research conducted in preparation for HRWC's model ordinance for riparian buffers was extensive but not exhaustive. Measuring the impacts of riparian buffers on environmental indicators (water quality, wildlife, etc.) is a hot field with scores of new peer-reviewed articles being published annually. The tremendous interest in this area of research is evidenced further by the 2008 Summer Specialty Conference hosted by AWRA titled "Riparian Ecosystems and Buffers Conference: Working at the Water's Edge".

In order to cover the breadth of this complex topic, HRWC identified nine distinct research areas to review. Those areas of research are as follows:

- Species Composition
- Width
- Structure
- Management of Vegetation
- Sediment Removal and Erosion Control
- Water Quality Protection
- Moderation of Shade and Water Temperature
- Maintaining Habitat Structural Diversity and Ecological Integrity
- Landscape Quality

HRWC researchers reviewed guidebooks and literature reviews in addition to the peer-reviewed journals. In all, more than 30 publications were referenced to assess the state of research on the effectiveness of riparian buffers. The annotated bibliography is presented in Appendix A.

Key findings

The Model Ordinance for Riparian Buffers from HRWC is based on scientific underpinnings in order to make the policy useful in fulfilling its intent and defensible as communities seek to implement it.

The Model Ordinance calls for buffers along all orders of streams. Riparian buffers are important especially along the smaller headwater streams that make up the majority of stream miles in any basin (Osborne and Kovavic 1993, Binford and Buchenau 1993, Hubbard and Lowrance 1994, Lowrance et al. 1997). These streams have the most land-water interaction and have the most opportunities to accept and transport sediment. Protecting greenways along headwater streams may offer the greatest benefits for the stream network as a whole.

The recommendations set forth in HRWC's Model Ordinance strive to balance protection of the natural features and a community's demand for other uses to meet the needs of its citizens. The preponderance of peer-reviewed scientific literature concerning vegetated riparian buffers supports establishing and maintaining buffers at least 100 ft wide on each side of the waterway for the purposes of intercepting sediment and nutrient pollution, maintaining stream temperature, protecting streambanks from erosion, moderating stormwater flows and flooding, and providing wildlife habitat (Osborne and Kovacic 1993, Young et al 1980, Peterjohn and Correll 1984, Magette et al. 1987, Dillaha et al. 1988, Vought et al. 1994, Mander et al. 1997, Beschta et al. 1987, Mayer et al. 2006, and others). HRWC advocates in its Model Ordinance for Riparian Buffers, based on a review of the literature, establishing and maintaining vegetated buffer systems at least 100 ft wide on each side of the waterway in order to meet the goals of the ordinance. The goals are the following:

- Protect and improve water quality
- Attenuate flows
- Stabilize streambanks
- Remove sediment
- Moderate stream temperature
- Protect and improve the abundance and diversity of indigenous fish and wildlife

Furthermore, the width requirement needs to be modified if steep slopes are present within 500 feet of the stream. HRWC supports the width adjustments presented by the USDA, NRCS in its technical guide for riparian forest buffers in Michigan, which are presented in Section 7 of the Model Ordinance and here. The widths shown in the table below are in addition to the 100 ft width on each side of the waterway.

Table 2. Width for Zone 3 Vegetation in a Riparian Buffer

Percent Slope	Width (ft)
0-8	20
9-15	30
> 15	40

USDA, NRCS Technical Guide Section IV Statewide Riparian Forest Buffer 391

Where space is a premium

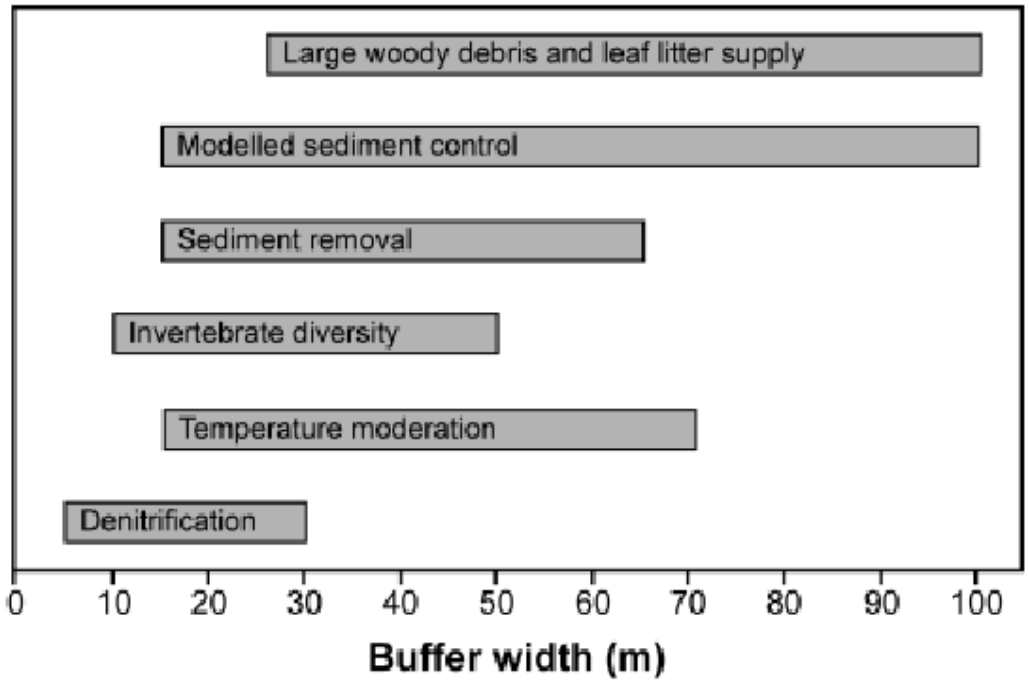
Attaining vegetated riparian buffer systems at least 100 ft wide may be unfeasible for built-out municipalities. HRWC recommends the following approach for municipalities limited to buffer widths of less than 100 ft.

Where the vegetated riparian buffer measures a minimum average width of 55 feet, the focus needs to be on encouraging sheet flow into the buffer and discouraging channelized flows that can short-circuit the buffer and deliver pollutants rapidly to receiving waters (Schueler (1995); Hernandez et al (2000)). A width of 50 feet plus 25 feet of turf (residential backyard) before reaching the first pavement or structure is preferable, while a width of 100 feet (75 feet plus 25 feet of turf) is optimum and should be attempted where possible. Benefits of the smaller buffer can be increased by requiring a streamside zone of 25 feet (approximately two mature trees deep). See sections 6, 8 and 9 of the HRWC Model Ordinance for Riparian Buffers for description of the buffer zones and allowed and prohibited uses within them.

More ambitious buffer sizing approaches can be found in the peer-reviewed and grey literature that may be more difficult for local municipalities to enforce yet yield more protective buffer widths. For example, Ward (2001) bases stream corridor protection on retaining a minimum floodplain width that is a function of the stream type and pre-development belt width. Ward uses an equation from Williams (1986) that calculates a minimum width that measures 6-7 bankfull widths plus a minimum floodplain width on each side of the stream equal to one bankfull width or 50 feet, whichever is larger. Todd (2000) presents five criteria for determining appropriate buffer width: 1) the value of the resource to be protected; 2) site, watershed and buffer characteristics; 3) the intensity of adjacent land use; 4) the specific buffer functions desired; and 5) the objectives of the landowner or land manager.

A range of riparian buffer widths have been reported in the literature as being required for the adequate performance of several specific buffer functions. Broadmeadow and Nisbet (2004) conducted a review of the effects of riparian forest management on freshwater systems and developed the following table based on the review of buffers. A caveat: Practitioners need to be mindful that vegetated riparian buffers cannot be relied upon as the sole stormwater management tool.

Figure 3. Range of riparian buffer widths reported in the literature review by Broadmeadow and Nisbet (2004) as being required for the adequate performance of several specific buffer functions (1 m = 3.28 ft)



Habitat for indigenous terrestrial and avian wildlife is another specific riparian buffer function that has been reported extensively in the scientific literature. Recommended minimum buffer widths on both sides of a stream range from 100 ft for herpetiles to 600 ft for avian migrants such as bald eagles and sandhill cranes (Table 3). Wildlife ecologists recommend minimum buffer widths beyond 600 ft to meet habitat needs of larger migratory mammals. Buffer widths towards the lower end of the 5-30 m (16-100 ft) range tend to protect the physical and chemical characteristics of the stream, while protection of ecological integrity requires widths at the upper end of the range.

Table 3. Recommended Widths for Various Wildlife Species on Both Sides of a Watercourse

Species	Minimum Buffer Width (ft)
Frog, salamander, turtle	100
Muskrat	165
Beaver, mink, salmonids	300
Pileated woodpecker, kingfisher	450
Bald eagle, cavity nesting ducks, heron rookery, sandhill crane, neotropical migrants	600

USDA, NRCS Technical Guide Section IV Statewide Riparian Forest Buffer 391

Minimum width of a riparian buffer is a key factor in predicting the level of pollutant removal effectiveness and wildlife habitat value. Desbonnet and others (1994) in Hernandez et al. (2000) attribute a minimum buffer width on each side of a stream to a level of pollutant removal effectiveness and wildlife habitat value ranging from 5 m(16 ft) to 200 m (660 ft). While various studies yield slightly different results, these categories appear fairly representative of the results found in the literature. [An exception can be found in Baker et al. (2001) where modeling results suggest that the width of hydrologically connected riparian zones may range widely and extend up to 500 m (1640 ft) or more in landscapes such as the Lower Peninsula of Michigan.]

According to this summary, the minimum widths supported in HRWC's Model Ordinance for Riparian Buffers may remove approximately 70% of sediments and pollutants in surface waters, and provide a wildlife travel corridor for some species and some avian habitat.

Width of the buffer alone cannot be a predictor for effectiveness of buffer performance. A buffer only will be effective at retaining sediment if drains terminate before the buffer and allow water to dissipate across it. Drains would need to be blocked and the landscape redesigned to create an intact buffer (Herring et al. 2006). The performance of a riparian buffer depends also on its continuity; fragmentation of the vegetation by roads, utility crossings, and other uses reduces the functions provided by a buffer (Blaha et al. 2002,

Hernandez et al. 2000). The Model Ordinance from HRWC addresses the need for continuity of the buffer as well as composition and management of vegetation in order to increase effectiveness of buffer functions.

Table 4. Summary of pollutant removal effectiveness and wildlife habitat value of vegetated buffers according to buffer width (Desbonnet et al. 1994)

Buffer Width	Pollutant Removal	Wildlife Habitat Value
5 m (16.5 ft)	~50% or greater sediment and pollutant removal	Poor habitat value; used for temporary activities of wildlife
10 m (33 ft)	~60% or greater sediment and pollutant removal	Minimally protects stream habitat; poor habitat value; used for temporary activities of wildlife
15 m (50 ft)	Greater than 60% sediment and pollutant removal	Minimal general wildlife and avian habitat value
20 m (66 ft)	~70% or greater sediment and pollutant removal	Minimal wildlife habitat value; some value as avian habitat
30 m (100 ft)	~70% or greater sediment and pollutant removal	May have use as a wildlife travel corridor as well as general avian habitat
50 m (165 ft)	~75% or greater sediment and pollutant removal	Minimal general wildlife habitat value
75 m (248 ft)	~80% or greater sediment and pollutant removal	Fair-to-good general wildlife and avian habitat value
100 m (330 ft)	~80% or greater sediment and pollutant removal	Good general wildlife value; may protect significant wildlife habitat
200 m (660 ft)	~90% or greater sediment and pollutant removal	Excellent wildlife value; likely to support a diverse community

Section 3.

Benchmarking existing riparian policy

HRWC researchers coupled review of the scientific literature with a review of existing guidance for creating effective local riparian buffer ordinances. We posed the question: What is the most effective policy strategy for maintaining and restoring the riparian zone along the Huron River and its streams, ponds, lakes and wetlands? To answer that question, HRWC conducted a review of other riparian policies and conducted interviews with local government personnel responsible for enforcing riparian policies.

Local government interviews

Prior to developing a model riparian buffer ordinance, HRWC researchers spoke directly with local government personnel responsible for enforcing their local riparian policies. The interviews were conducted to identify successes in local buffer policies and their implementation as well as to identify shortcomings that hamper the effectiveness of the policies. One-on-one phone interviews with local government staff were conducted during August and September, 2006. The following summary is based on interviews with personnel from six communities in the Huron River Watershed, two communities in other Michigan watersheds, and three communities outside of Michigan.

Interview Questions

The questions developed by the researchers and posed to the interviewees are provided here:

1. What are you trying to protect with this ordinance language?
2. Does the ordinance language define permitted and prohibited uses in the protected area?
3. Is agricultural land included in the ordinance language? (Any other exemptions?)
4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer?
5. Does the ordinance language address restoration in the protected area?
6. Does the ordinance language address maintenance in the protected area?
7. How would you characterize the success of long-term maintenance of the protected area?
8. Do you promote the use of conservation easements?
9. What steps have you taken to gain public understanding and acceptance of the policy?

10. Has your ordinance language ever been challenged in court? If so, what was the issue?
11. Have you had requests for permits that have been denied?
12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
13. How much does your community spend to enforce the ordinance?
14. What do you feel are the shortfalls in your policy?

Summary of Responses

A review of their responses yields interesting and useful information for the purpose of developing a model riparian buffer ordinance for the Huron River Watershed. Riparian buffer language can be found in zoning ordinances, planned residential development ordinances, natural features setback ordinances, and overlay districts. Of the communities interviewed, the width of riparian buffer zones range from 25 ft to 100 ft. A few communities employ several zones of varying distances with specific uses; e.g., one policy requires a minimum of 75 ft on each edge of a water body and includes two zones – zone one extends a minimum of 25 ft from the edge of a water body and zone two extends an additional 50 ft from the outer edge of zone one.

Most of the communities responded that their buffer policies are intended to protect the water quality of water bodies and wetlands, which includes streams with perennial flow, lakes, ponds, and steep slopes. One community also intends to protect the aesthetic value of the natural features.

Many buffer policies do not define permitted and prohibited uses in the buffer. Those policies that define prohibited and permitted uses often prescribe specific distances from the protected feature. Some communities allow very few activities within 25 ft of the protected feature, i.e. passive uses.

- Prohibited uses include construction, dredging, filling, removal of soils, minerals, and vegetation, the use of pesticides or herbicides, junkyards, pathways or boardwalks within 25 ft, hazardous substances, and raised septic systems
- Permitted uses include roads and driveways, water-dependent uses, passive open spaces uses (wildlife sanctuaries, streambank stabilization), recreational trails, agricultural uses, and sewer, water, and utility lines

Nearly all of the Michigan communities interviewed do not include agricultural land. The three communities outside of Michigan include agricultural land in their policies.

- In the Richmond County, VA ordinance, buffer size can be decreased on agricultural land if best management practices that address erosion control, nutrient management, or pest control are applied
- In the Warwick Township, PA ordinance, agricultural uses existing at the time of adoption of the ordinance are allowed in zone one (25 ft) and new agricultural uses are permitted by conditional use in zone two (50 ft)

- In the Upper Makefield Township, PA ordinance, customary agricultural practices in accordance with a soil conservation plan are permitted as long as they are not conducted within 25 ft of the edge of any stream channel

Buffer policies that include requirements for the kind of vegetation allowed in the buffer generally call for native vegetation. However, most of the policies reviewed here provide neither guidance nor requirements for vegetation type.

Three policies address restoration requirements with two of them giving specific standards. For example, one ordinance states that three layers of vegetation are required when replanting in the riparian corridor: herbaceous plants that serve as ground cover; understory shrubs; and trees that form an overhead canopy. The other policy references the state mitigation manual.

A minority of the buffer policies address maintenance requirements. One policy provides guidelines for invasive plant species removal and states that indigenous vegetation may be removed to provide for sight lines and vistas, access paths, and general woodlot management. Many interviewees noted that encroachments most often occur on residential lots because homeowners with waterfront property generally want to remove more vegetation than permitted.

Although conservation easements were not found to be specifically required in the buffer language, most communities encourage their use for the setbacks. One of the communities plans to promote conservation easements of the land in the buffer zone.

Community newsletters and websites, newspaper articles, and public meetings are the most common avenues used to inform the public about buffer policies.

Only one community has had its buffer policy challenged in court when a property owner disturbed the setback on his property and challenged the township's demand that the buffer be restored.

Many communities are lacking the necessary number of personnel to enforce adequately their buffer policy. Those communities that feel they are able to enforce adequately their policies indicate that they have a sufficient number of staff as well as monetary resources to do so; they cite as helpful receiving reports from people who observe their neighbors violating the policy, and setting the land development process fees to cover administrative costs. Still, some communities find they have adequate resources for the site plan approval process but not for the necessary follow-up to be sure the property continues to meet the conditions of the policy.

Nearly half of the communities interviewed perceived shortcomings in their riparian buffer policies. Areas noted for improvement included defining permitted and prohibited uses, specifying vegetation, restoration and maintenance standards, increasing the size of the buffer, addressing agricultural lands, conducting more education for residents, extending protections to wetland mitigation areas.

The communities that participated in the interviews from the Huron River watershed are Ann Arbor Charter Township, City of Ann Arbor, Highland Township, Van Buren Charter Township, Webster Township, and West Bloomfield Township. The other Michigan communities that participated in the interviews are Emmet County and Cheboygan County. Three communities in the Chesapeake Bay watershed, Pennsylvania's Upper Makefield Township and Warwick Township and Virginia's Richmond County, also participated in the interviews.

Transcripts of the interviews are available in Appendix B.

Riparian policy review

HRWC researchers assembled a library of reference policy documents from various levels of government in Michigan and around the country concerned with protecting riparian areas (see list below). Many of the policies reviewed are considered models by local or national groups. The elements of those policies appropriate for conditions in the Huron River watershed sometimes were included in the HRWC Model Ordinance. Interestingly, some of the sample policies had shortcomings similar to what government personnel mentioned during the one-on-one interviews.

Model Buffer Ordinances

Central Lake Superior Watershed Partnership
Chesapeake Bay Foundation, for Pennsylvania
Model ordinance from Protecting Streams and River Corridors, S. Wenger and L. Fowler
U.S. EPA (based mainly on Baltimore County, Maryland)

Buffer Ordinances

Baltimore County, Maryland
Lenexa, Kansas

Conservation Easement Ordinance

Natural Lands Trust

Floodplain Preservation Management

Portland Metro, Oregon

Natural Features Open Space/Setback Ordinances

Ann Arbor City, Michigan
Ann Arbor Township, Michigan
Warwick Township, Michigan
West Bloomfield Township, Michigan

Planned Residential Development Ordinance

Van Buren Township, Michigan

Preservation Area/Surface Water Protection Overlay District

Upper Makefield Township, Pennsylvania
Richmond County, Virginia
Webster Township, Michigan

Wetlands and Watercourses Ordinance

Croton-on-Hudson, New York

Summary of HRWC Model Ordinance for Riparian Buffers

HRWC's model ordinance is intended to assist municipalities in the Huron river watershed desiring to care for the quality of the environment and life within their jurisdictions. This ordinance can be adopted without modification. However, municipalities may wish to make changes pursuant to local conditions. The ordinance from February 2007 reflects HRWC's preferred version to date with additional comments, suggestions and options inserted throughout the document in italics. The ordinance was produced with funding from the U.S. EPA and the Michigan Department of Environmental Quality. Reproduction, circulation and other use of the ordinance is permitted and encouraged.

Section 1 lists the pertinent regulations that give AUTHORITY to the ordinance.

Section 2 presents the INTENT of the ordinance in ten subsections as follows in paraphrased form:

a. Improve surface water quality and subsurface water quality
b. Assist in implementing erosion and sediment control practices
c. Improve and maintain water supply for the full range of uses
d. Preserve and protect infiltration areas, provide wildlife habitat, moderate water temperature, attenuate flood flow, and provide scenic value and opportunities for passive recreation
e. Focus development to be consistent with the intent and objectives of the ordinance
f. Conserve natural features important to land and water resources
g. Integrate with other natural features protections
h. Recognize that natural features contribute to the health, safety and welfare and quality of life for residents
i. Conserve natural, scenic and recreation areas along riparian areas
j. Protect riparian rights of riparian property owners

Section 3 lists the DEFINITIONS used in the ordinance.

Section 4 defines the APPLICABILITY of the ordinance.

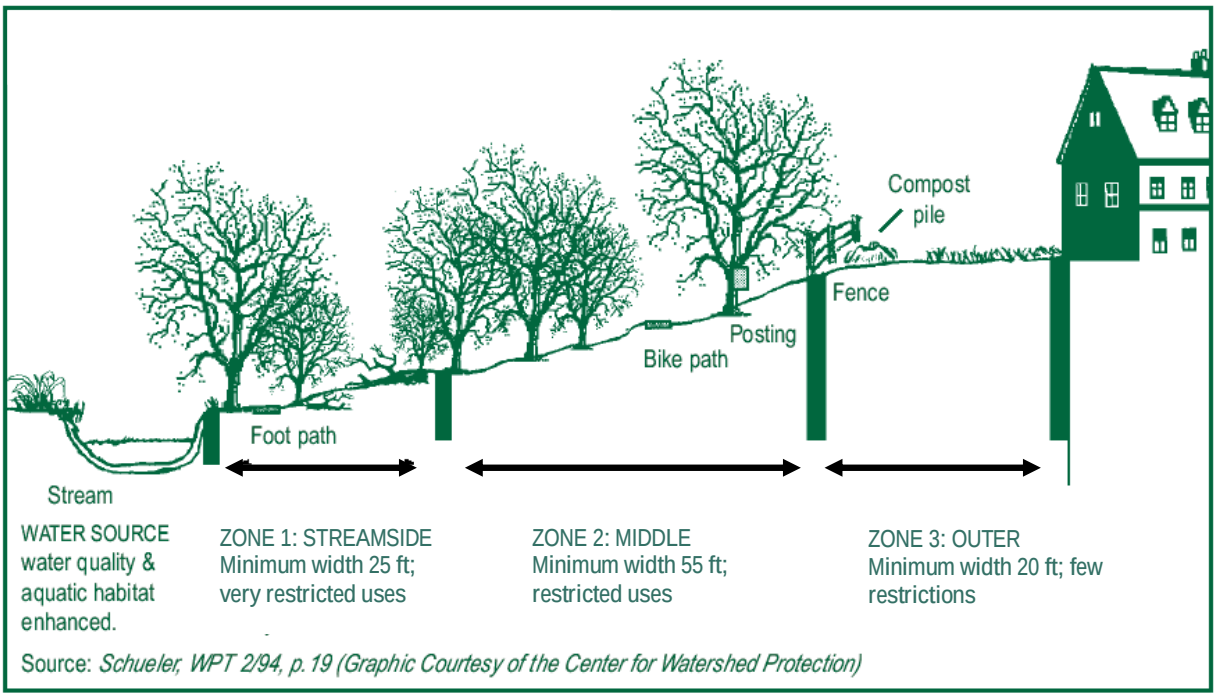
Section 5 presents the EXEMPTIONS of existing land uses under certain conditions, maintenance, repair or operation of certain utilities, single-family residential construction approved or platted ahead of ordinance adoption, and other uses permitted under certain state and federal legislation.

Section 6 describes the RIPARIAN BUFFER ZONES, the three distinct areas of the buffer that have minimum width and vegetation target requirements. The zones are presented in a simplified format in Table 5 and in profile in Figure 4.

Table 5. Three-Zone Riparian Buffer System

Characteristics	Streamside Zone	Middle Zone	Outer Zone
Function	Protect the physical and ecological integrity of the stream ecosystem	Provide distance between upland development and the streamside zone	Prevent encroachment, filter backyard runoff, encourage sheet flow of runoff
Width	Min. 25 ft, plus wetlands and critical habitats	Min. 55 ft depending on stream order, slope, and 100 year floodplain	20 ft min. setback to structures
Vegetative Target	Undisturbed native mature forest, reforest if grass	Managed forest, some clearing allowable	Forest encouraged or native woody and herbaceous plants, native grasses and forbs are acceptable
Allowable Uses	Very restricted (e.g., flood control, utility right of ways, footpath, etc.)	Restricted (e.g., some recreational uses, some stormwater BMPs, bike paths, tree removal by permit)	Less restricted (e.g., residential uses including lawn, garden, compost, yard wastes, most stormwater BMPs)

Figure 4. Three-Zone Riparian Buffer System for Intent and Purpose of this Riparian Buffer Ordinance including Pollutant Reduction, Temperature Moderation, and Wildlife Habitat



Section 7 details the WIDTH REQUIREMENTS OF THE RIPARIAN BUFFER including adjustments for steep slopes, areas designated as Natural Rivers under the Natural Rivers Act, and adjustments for floodplains and wetlands.

Section 8 describes the USES PROHIBITED SPECIFICALLY IN THE RIPARIAN BUFFER including clear cutting of trees and/or other vegetation, drainage, dumping, removal of soils and minerals, livestock, roads and driveways, vehicle traffic, parking lots, expansion of existing structures, permanent structures, and potential water pollution hazards such as storage of hazardous or noxious materials, CAFOs, and junkyards.

Section 9 describes the USES PERMITTED WITHIN THE RIPARIAN BUFFER based on the three-zone buffer system. First, the riparian buffer, including wetlands and floodplains, shall be managed to enhance and maximize their unique value. The limited uses allowed with a permit in the Streamside Zone are presented in Section 9.2. Specifications for stream crossings and water-dependent structures are provided for in Section 9.3 and require a special use permit. Section 9.4 describes the uses allowed with a permit in the Middle Zone. Section 9.5 presents the uses allowed with a permit in the Outer Zone.

Section 10 states that NONCONFORMING STRUCTURES AND USES IN THE RIPARIAN BUFFER existing at the effective date of the regulation and within a riparian buffer that are not permitted under this regulation may be continued but shall not be changed or enlarged in a manner that increases the degree of nonconformity.

Section 11 presents the RIPARIAN BUFFER PLAN AND MAINTENANCE REQUIREMENTS for all development activities as outlined in Section 4. All pertinent development activities are required to prepare and submit a plan, in addition to the site plan, that field-delineates and surveys the riparian buffers, maps steep slopes, provides a narrative of the species and extent of vegetation in the buffer, provides a statement that expresses no disturbance of the riparian vegetation will occur, and provides a note stating that the riparian buffer is subject to protective covenants, if applicable. This section also details the requirements for the final grading plan, permanent boundary markers and educational signage along the buffer, vegetation removal, buffer maintenance through protective covenant or conservation easement, lease and sales agreements, buffer inspection responsibilities, and land access. Finally, Section 11.11 provides for the reestablishment of riparian buffers when agriculture or silviculture is proposed to be converted to other uses. The USDA NRCS Technical Guide Section IV Statewide Riparian Forest Buffer 391 is provided (Appendix C) for specifications on plant types, spacing and density.

Section 12 details WAIVERS AND VARIANCES that may be granted to property owners to ensure their rights are protected. Buffer averaging and regulatory flexibility (clustering) are discussed. This section also presents criteria for determining whether a variance should be granted.

Section 13 gives INSPECTION authority to the community as it deems necessary to carry out the duties of the ordinance, specifically to investigate and inspect the sites for any land-disturbing activities within the riparian area.

The HRWC Model Ordinance for Riparian Buffers refers the sections concerning Performance Guarantees; Violations, Enforcement and Penalties; Administrative Appeal and Judicial Review; Severability; and Relationship to Other Laws to the relevant existing sections in the community's ordinance.

Section 4.

Recommendations for enhancing riparian corridor management

In its 2002 report, the National Research Council (NRC) committee on functions and strategies for riparian areas management reached several overarching conclusions and recommendations intended to heighten awareness of riparian areas "commensurate with their ecological and societal values." While the reader is encouraged to refer to the report for more information, the conclusions and recommendations of the NRC are outlined below.

- **Restoration of riparian functions along America's waterbodies should be a national goal.**
  Because riparian areas perform a disproportionate number of biological and physical functions on a unit area basis, their restoration can have a major influence on achieving the goals of the Clean Water Act, the Endangered Species Act, and flood damage control programs.

- **Protection should be the goal for riparian areas in the best ecological condition, while restoration is needed for degraded riparian areas.**

- **Patience and persistence in riparian management is needed.**
  Substantial time (years to decades) will be required for improving and restoring the functions of many degraded riparian areas. Commensurate with restoration must be efforts to improve society's understanding of what riparian functions have been lost and what can be recovered.

- **Although many riparian areas can be restored and managed to provide many of their natural functions, they are not immune to the effects of poor management in adjacent uplands.**
  Upslope practices contributing to riparian degradation must be addressed if riparian areas are to be improved. Riparian area management must be a component of good watershed management.

The need for state leadership

Today, protection and restoration of riparian buffer areas in Michigan falls to the individual property owner and local unit of government to commit to regulatory and/or voluntary tools as was discussed in the Introduction. [A possible exception is the MDNR's Natural Rivers Program that oversees the administration of the Natural Rivers Act.] What results from this approach is a patchwork of protections that are highly variable in their degree of protection, focus and spatial coverage. Moreover, existing state laws governing drains and other agricultural operations permit activities that can degrade riparian areas.

HRWC researchers, in developing the Model Ordinance, became acutely aware of the limitations of local policy to affect significant groups of riparian property owners. Developing a model ordinance for adoption by watershed communities is only part of the answer. Not all land managers follow local regulations. Farmers and drain commissioners, for example, engage in land use activities that are grandfathered by existing state laws, specifically the Drain Code and the Right to Farm Act. Strategies for riparian areas maintenance and restoration are needed for those land managers coupled with a scientifically defensible and practical ordinance.

State governments can play an important role in seeing that the NRC's recommendations are implemented and in providing a more coherent strategy to protecting this most maligned and vulnerable ecosystem in the state. See the Massachusetts River Protection Act of 1996 (Chapter 258 of the Acts of 1996) for an example of a statewide, state-driven riparian buffer program. The Act promotes green corridors along the state's rivers and streams to protect and enhance their ecological, economic, aesthetic and recreational values through the establishment of a uniform statewide 150-foot setback for most forms of development. [*Note: Russ Cohen, Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement, provides a detailed history of this legislative initiative in two unpublished papers "The Promises and Pitfalls of Legislative Initiatives for Private Land River Protection: A Report from Massachusetts" and "The Rivers Protection Act: A Giant Step Forward for Protection of the Commonwealth's Riverine Lands and Waters".*]

Leadership is needed in Michigan at the executive and legislative levels to enact statewide policy that recognizes the irreplaceable value of the riparian ecosystem and protects them accordingly. Existing state laws that degrade riparian ecosystems, as in the Drain Code and Right to Farm programs, need to be amended at the state level in favor of protecting and restoring the natural feature. In lieu of leadership at the state level, Michigan will continue to rely on the inadequate patchwork of local regulatory tools and various voluntary tools for land owners to address the unyielding threats to riparian ecosystems. To protect and restore this crucial component of Michigan's natural heritage, a coordinated, adequately funded statewide campaign is needed to educate riparian land owners of the value of riparian areas, to stem further degradation of these areas, and to initiate their restoration where possible.

Appendix A

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Articles referencing SPECIES COMPOSITION

◈ McNamara, M. L., M. Montgomery, T. Spivey, and B. Campbell. 2000. Shade for seven riparian vegetation groups, Upper Klamath Basin, Oregon. Pp. 41-46 In: Proceedings of the international conference on riparian ecology and management in multi-land use watersheds. R. L. Beschta and P. J. Wigington (eds.). Middleburg, VA: American Water Resources Association.

- The shade provides to streams from different types of riparian areas was evaluated in support of the formulation of TMDLs for stream temperature
- The types of community groups composing the riparian canopy along streams was found to be a major factor in defining the amounts of riparian shade that are possible along a stream reach
- Total average shade in tree-dominated communities ranged from 42% to 82% while total average shade in sedge/grass and willow/shrub communities ranged from 20% to 31%

◈ Wynn, T. M., S. Mostaghimi, J.A. Burger, A. A. Harpold, M. B. Henderson, and L. Henry. 2004. Variation in root density along stream banks. Journal of Environmental Quality 33:2030-2039.

In this study, root distributions and densities in streambanks with woody and herbaceous riparian buffers were compared. The overall goal of this ongoing research is to evaluate the effects of woody and herbaceous riparian vegetation on stream bank erosion by measuring the erodibility and critical shear strength of vegetated stream banks and relating those parameters to root density.

Twenty-five field sites on second- through fourth-order streams in the Blacksburg, Virginia area were sampled. Root length density (the total length of all roots within a unit soil volume) and root volume ratio (the total volume of roots per unit soil volume) were measured at each site. The riparian buffers varied between short turfgrass and mature forests.

Study results showed that streambanks with herbaceous vegetation were dominated by very fine roots in the upper 30cm of the stream bank. In contrast, forested sites had significantly greater fine and small root length density at depths greater than 30 cm. Forested streambanks also had a significantly greater volume and length of larger roots below depths of 15cm. This indicates that in forested sites, the density and volume of fine and small roots is higher where the greatest hydraulic stresses are applied. Additionally, the woody roots were better distributed over the bank face. Based on previous results, these findings suggest that riparian forests may provide better protection against streambank erosion than herbaceous buffers due to a greater distribution and quantity of larger diameter roots.

◈ Broadmeadow, S. and T.R. Nisbet. 2004. The effects of riparian forest management on the freshwater environment: a literature review of best management practice. Hydrology and Earth System Sciences 8(3):286-305.

- Buffer widths in the range of 5-30m have been found to provide at least 50% and often 75% or greater effectiveness at preserving the various functions associated with undisturbed forest streams (Castelle and Johnson 2000).
- Buffers should be of similar width on either bank where a stream flows north-south, but where it flows east-west, two-thirds of the buffer area should lie on the south of the stream. This allows maximum sunlight to reach the stream and introduces more variety within the landscape (Maitland et al. 1990)
- Buffer widths towards the lower end of the 5-30m range tend to protect the physical and chemical characteristics of the stream, while protection of ecological integrity requires widths at the upper end of the range.

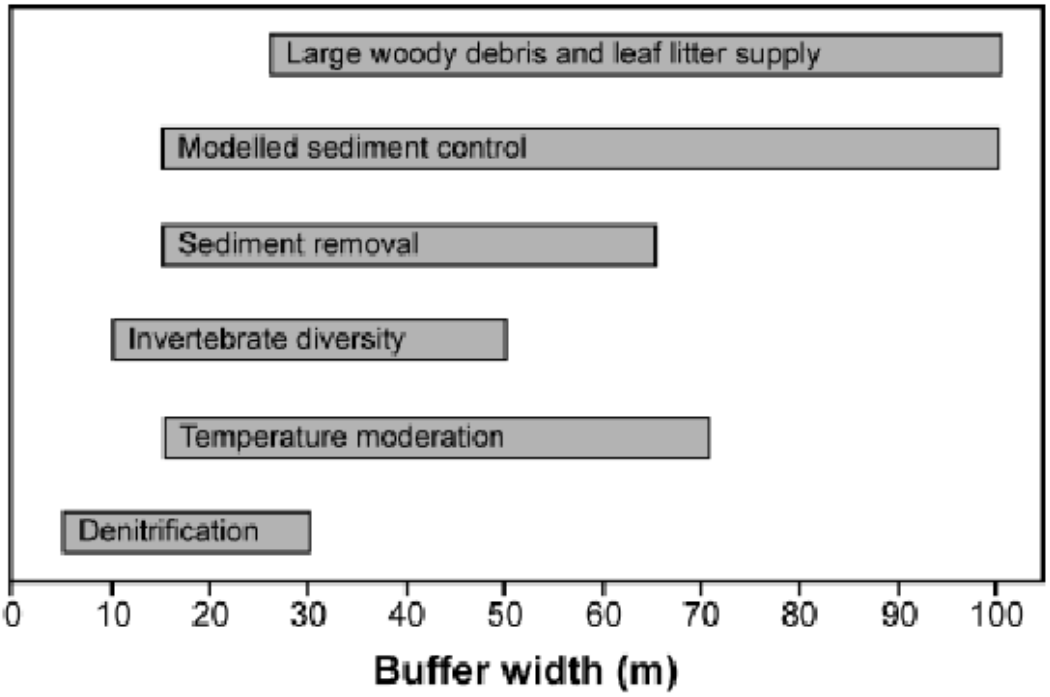

Fig. 2. *The range of riparian woodland buffer widths reported in the literature as being required for the adequate performance of several specific buffer functions.*

- Trees were densely planted close to streams so that they grew up to cast heavy shade over the water and bank sides. Herbaceous riparian vegetation often disappeared, exposing the riverbanks to erosion and reducing the biodiversity and productivity of the stream.
- Riparian buffers that are at least 30 m wide have generally been found to provide the same level of shading and maintain a similar temperature regime to that of an old-growth forest (Beschta et al., 1987).

- The influence of the riparian buffer on the stream will depend upon its width, structure, species composition and the management of the vegetation. Tree roots and marginal herbaceous vegetation stabilize stream banks and regulate the flow of sediment and nutrients. This helps to protect water quality and prevent siltation, as well as maintaining a deep channel suitable for fish. Tree and shrub canopies also moderate the riparian microclimate and the primary productivity of the stream, and through the contribution of leaf litter and coarse woody debris enhance the quality of wildlife habitat. Riparian trees form an important food source for adult fish both directly through the input of terrestrial invertebrates that fall from the canopy and indirectly via leaf-litter, which forms the basis of the food chain. The presence of coarse woody debris within the stream creates diversity in channel form and water depth and increases the retentiveness and productivity of the stream.
- An open tree canopy that provides sufficient light to maintain a vigorous understory and ground cover is often regarded as the most effective land cover for retaining sediment and minimizing bank erosion (Phillips, 1989; Swift and Norton, 1993).
- Structure of the buffer vegetation has less of an effect on water chemistry. Recommended vegetation structure for maintaining uptake is a matrix of different aged woodland communities. An intricate mosaic of open group, occasional large old trees, scrub thicket and closed canopy woodland is often the favored structure for riparian buffers.
- Obviously, a buffer will only be effective at retaining sediment if any drains terminate before the buffer and allow water to dissipate across it. Where possible, drains should be blocked off and the system redesigned to create an intact buffer.
- Regarding flooding caused by large woody debris, Linsted and Gurnell (1998) suggest that little management is generally needed in headwater streams less than 1.0 m wide, since the benefits of woody debris greatly outweigh any threats in such small streams.
- The optimum level of shade is difficult to quantify but limited work suggests that a good balance is achieved where around 50% of the stream surface is open to sunlight and the remainder covered by dappled shade.

◈ Todd, A. H. 2000. Making decisions about riparian buffer width. Pp. 445-450 In: Proceedings of the international conference on riparian ecology and management in multi-land use watersheds. R. L. Beschta and P. J. Wigington (eds.). Middleburg, VA: American Water Resources Association.

Five criteria are discussed for determining appropriate buffer width: 1) the value of the resource to be protected, 2) site, watershed, and buffer characteristics, 3) the intensity of adjacent land use, 4) the specific buffer functions desired, and 5) the objectives of the landowner or manager.

◈ Ward, A. 2001. Flood plain size to protect stream health. FAB Engineering. Columbus, OH: The Ohio State University.

Changes to river systems due to land use impacts are very site-specific and require detailed analysis by experts. Stream corridor protection should be based on:

1) Incorporating landscape measures that reduce runoff such as pervious pavements, green spaces, and bio-retention areas.
2) Detention/retention management strategies that result in similar post and pre-development bedload and sediment transport amounts.
3) River geomorphology concepts and specifically the ability of the stream to self-adjust to a state of dynamic equilibrium as a function of landscape changes during the life of the stream.

If there is a need to establish a simple stream corridor protection requirement it should be based on retaining a minimum floodplain width that is a function of the stream type and pre-development belt width and:

1) Provides a minimum belt width, determined using equation 4 or 5* (approximately 6-7 bankfull widths), plus a minimum floodplain width on each side of the stream equal to one bankfull width or 50 feet whichever is larger.

**The beltwidth, (B, ft), is related to the bankfull width as follows (Williams, 1986):*

$$B = 4.3\ W^{1.12} \quad (4)$$

However, equation (4) only provides a general relationship between bankfull width and belt width. This relationship is also a function of the stream type. A more robust approach might be to determine the belt width as a function of the drainage area, where:

$$B = 87\ DA^{0.43} \quad (5)$$

2) Land uses within this stream corridor be restricted to uses which sustain or enhance the ecological function of the system and allow the stream to self-adjust to a state of dynamic equilibrium.
3) Strategies which result in the same post and pre-development bedload transport rates.

◈ Ward, A., D. Mecklenburg, J. Mathews, and D. Farver. 2002. Sizing stream setbacks to help maintain stream stability. Chicago, IL: ASAE Annual International Meeting/ CIGR XVth World Congress.

Abstract. The objectives of the study were: (1) to evaluate the ability of an empirically based equation to predict the streamway width required to allow a stream to self-adjust its meander pattern; (2) to evaluate the influence of urbanization, floodplain width, and incision on bed load transport, the size of particle moved at incipient motion at flows approximating the effective discharge, and flood stage for the 100 year recurrence interval event; and to determine if knowledge obtained from Objectives 1 and 2 could be used to develop stream setback guidelines that would help avoid channel instability problems typically associated with urbanization. The results showed that 1) floodplain width reduction, 2) entrenchment and 3) changes in flow regime each had a high potential to increase bed load transport and collectively changes in all these factors could result in a five to fifteen fold increase. The recommended approach is to establish setbacks that are a function of the meander belt width as calculated by an empirical equation that is based on the drainage area. Also, land uses within the setback zone should be restricted to uses that sustain or enhance the ecological function of the system and accommodate the stream in a state of dynamic equilibrium. Based on a previous study by the authors it is also

recommended that storm water management strategies be used expressly to control bed load sediment transport rates.

The objectives of the study reported in this paper were to evaluate:

1. The ability of an empirically based equation to predict the streamway width required to allow a stream to self-adjust its meander pattern.
2. To evaluate the influence of urbanization, streamway width, and incision on bed load transport, the size of particle moved at incipient motion at flows approximating the effective discharge, and flood stage for the 100-year recurrence interval event.
3. If knowledge obtained from Objectives 1 and 2 could be used to develop stream setback guidelines that would help maintain stream stability.

An equation for the relationship between bankfull channel width and drainage area (DA, square miles) for rivers in the eastern USA (Dunne, 1978) gives:

(6) $W = 14.6\ DA^{0.38}$

Substituting equation 6 into equation 5 gives a streamway width as a function of drainage area:

(7) $Sw = 120\ DA^{0.43}$

Equations 6 and 7 only apply to the eastern USA

The usefulness of equation 7 was evaluated on six headwater stream reaches in Ohio.

When the influences of urbanization, incision and floodplain reduction were combined (BDF=12, FPR = 2, BHR=1.5) the relative bed load transport on the four watersheds was about 11 to 15 times greater than the baseline condition (BDF=0, FPR = 10, BHR=1.0). The combined impact of urbanization and floodplain reduction resulted in the flood stage increasing by as much as almost 400%.

Ideally, an empirical approach should be based on more site specific data.
Based on the results presented here, the authors' observations, and work reported in the literature it appears that:

1. Streamway widths that are at least 8 times the bankfull width will in many cases have a wide enough streamway to allow for meander migration over time. Streams with these magnitudes streamways might have the potential to self-adjust to low levels of urbanization and floodplain modification.
2. Small amounts of stream incision, floodplain modification in narrow valleys, and/or low levels of additional development on urbanized watershed, each have a high potential to cause instability.
3. Setbacks should be sized based on geomorphic concepts and in particular bed material mobilizations is appropriate for sand and gravel-bed streams. The empirical approach presented here is appropriate in valleys that are broad enough for the meander pattern to be a function of the bankfull width or drainage area.

◈ Herring, J. P., R. C. Schultz, and T. M. Isenhart. 2006. Watershed scale inventory of existing riparian buffers in northeast Missouri using GIS. Journal of the American Water Resources Association 145-155.

- Three study watersheds are located in northeast Missouri
- Results indicated that riparian buffers were abundant throughout the watersheds but were typically narrow along first-order and second-order streams; in many cases they may not have been wide enough to provide adequate stream protection based on the USDA NRCS minimum buffer width recommendations for new riparian buffers
- As few as 31% of first-order streams had buffers extending to 200 ft from the stream on at least one side
- Table below presents minimum widths required to meet USDA-NRCS Conservation Standards for the riparian forest buffer and filter strip conservation practices for removing excess sediment, nutrients and pesticides from surface runoff:

Stream Order	**Adjacent Land Slope (%)**	**Minimum Widths (ft)**		
		Riparian Forest Buffer	**Filter Strip**	**Total Combined Width**
1,2	0-5	50	50	100
1,2	5-10	50	100	150
3rd +	0-5	100	50	150
3rd +	5-10	100	100	200

Source: Riparian Forest Buffer AC 391 and Filter Strip AC 393 of USDA-NRCS, 2004

- As stream order increases, the amount of forested land in the riparian area increased sharply while the percentage of cropland dropped significantly (conversely, cropland was the primary land cover in the riparian buffer in 1st order streams)
- In first-order streams less than half of the stream length was buffered to a width of 200 ft
- This inventory has strong implications for surficial processes associated with overland flow, it does not consider the potential reductions in buffer effectiveness associated with tile drainage and channel incision

◈ Wissmar, R. C. and R. L. Beschta. 1998. Restoration and management of riparian ecosystems: a catchment perspective. Freshwater Biology 40:571-585.

The objective of this paper is to examine approaches and perspectives for restoration of riparian ecosystems. Restoration strategies should incorporate concepts of landscape ecology and principles of ecosystem restoration and conservation.

Landscape perspectives of riparian ecosystems must incorporate biophysical connectivity as well as human activity. For example, restoration in headwater portions of catchments where the catchment is not substantially altered by human activities and natural connectivity remains intact, may be very different than restoration downstream where the effects of human activities become more pronounced.

The choice of a restoration strategy requires the concise definition of the riparian process to be restored and the ecosystem characteristics required for restoration. The following biological and social conditions should be considered in any restoration strategy: 1) how nature is valued by society (e.g. success is most likely when resource use and restoration are based on long-term objectives), 2) social commitment to ecological restoration (e.g. success is most likely when commitment is high), 3) quality of judgments for accomplishing restoration (e.g. success is most likely when decisions are based on good data and expertise), and 4) ecological circumstances under which restoration is attempted (e.g. success is most likely when the initial damage is minor).

Strategies to modify riparian ecosystems include the following: 1) conservation when an ecosystem has not been substantially changed by human activity, 2) passive or natural restoration to eliminate human induced degradation (e.g. increased widths of buffer strips, elimination of grazing, stoppage of industrial wastes), 3) active restoration if a riparian system does not recover from passive restoration (e.g. removal of non-native species, reintroduction of native species, re-establishing flow regimes below dams) , and 4) rehabilitation, enhancement, or mitigation to offset the effects of anthropogenic effects if it is unlikely that a system will return to pre-disturbance conditions.

The following questions can be used to develop restoration objectives: 1) What physical and biological factors presently limit riparian populations and communities?, 2) What geomorphic and hydrological regimes have been historically modified and presently limit the connectivity of riparian and aquatic ecosystems?, 3) What native riparian species have been extirpated or displaced?, 4) What exotic plant species have invaded the riparian system?, 5) What geomorphic and hydrological regimes provide the most favorable future physical habitat and biological conditions?, 6) What are the target species or desired future riparian communities?, and 7) What are the expected recovery times and successional patterns for the riparian communities?
The restoration strategy should include the use of baseline data and a monitoring component. A thorough understanding of past natural disturbances and human-induced changes on riparian ecosystems, obtained by a historical reconstruction of the catchment, is very important.

Articles referencing SEDIMENT REMOVAL AND EROSION CONTROL

◈ Toledo, Z. O. and J. B. Kauffman. 2001. Root biomass in relation to channel morphology of headwater streams. Journal of the American Water Resources Association 37(6):1653-1663.

This objective of this study was to examine the relationships between riparian vegetation, root biomass, and channel morphology in incised and unincised stream channels. The authors hypothesized that there are four potential responses of root biomass to a decrease in water availability associated with channel incision: (1) lower total root biomass with a similar distribution within soil horizons, (2) lower total root biomass and an increased rate of loss with depth, (3) no change in total root biomass or distribution, or (4) an increased level of total root biomass.

Species composition and herbaceous root biomass were sampled for three streams in northeastern Oregon.

The results indicated that incision resulted in a compositional shift to species adapted to drier environments. Obligate-wetland and facultative-wetland species were found in unincised stream sections while facultative-upland species were found in incised stream sections. Additionally, total root biomass was approximately two times greater in the unincised stream sections than in incised stream sections. Unincised stream sections retained greater proportions of their root biomass at depth than incised sections.

These results are likely due to the loss of the water table (decreased availability of water) close to the soil surface in incised streams. These results support hypothesis (2), indicating that there is a great potential for erosion at these sites because of the overall decrease in root biomass. Linkages between stream channels and riparian zones must be reconnected and maintained.

◈ Baker, M. E., M. J. Wiley, and P. W. Seelbach. 2001. GIS-based hydrologic modeling of riparian areas: implications for stream water quality. Journal of the American Water Resources Association 37(6):1615-1628.

This paper links predictions of riparian hydrology gathered from several terrain-based GIS models to patterns of nutrient export in order to demonstrate the potential for augmenting the predictive power of land use/land cover (LU/LC) maps. Such maps identify the location and aerial extent of wetlands but do no capture the hydrologic processes responsible for their existence or characterize their function. The assumption of a LU/LC wetland summary in a nutrient export model is that all wetlands have the same magnitude and direction of influence on nutrient export, regardless of their hydroperiod or hydrologic source. However, it is the hydroperiod in riparian areas and hydrologic routing from surrounding landscapes that ultimately determine the degree to which riparian buffers are effective at intercepting watershed-derived pollutants.

The objectives were to compare the relative utility of simple GIS-based models of riparian hydrology with LU/LC map classes and to illustrate the importance of incorporating explicit hydrologic information into landscape-scale nutrient export models. The primary goal was to determine the ability of GIS-derived hydrologic classes to predict hydrologic function both with and without the vegetative structure or wetland information available from LU/LC maps. The analysis focused on riparian interaction with agriculturally derived pollutants such as $NO_2 + NO_3$ and SRP.

The study was based on data from the Lower Peninsula of Michigan which provided a broad range of hydrologic conditions.

The GIS ground water models demonstrated that ground water delivery clearly varied across broad regions in the state as well as within specific local landscapes. Additionally, all models using predicted hydrologic classes showed stronger relationships with patterns of nutrient export than models based solely on mapped LC/LU information.

Contrary to studies focused on standard vegetative buffer widths of 10 to 150 m as a measure of ecological integrity and buffer protection, the models used in this study suggest that the width of hydrologically connected riparian zones may range widely and extend up to 500 m or more in certain landscapes, depending on the hydrologic conditions that facilitate nutrient removal.

◈ Gold, A. J., P. M. Groffman, K. Addy, D. Q. Kellogg, M. Stolt, and A. E. Rosenblatt. 2001. Landscape attributes as controls on ground water nitrate removal capacity of riparian zones. Journal of the American Water Resources Association 37(6):1457-1464.

This paper examines the relationship between variability in ground water nitrate removal and riparian zone site attributes. The goal is to use the information to target high-value riparian locations for restoration or protection and to improve the modeling of watershed nitrogen flux. Twelve years of field data on nitrate-N removal rates were collected from mature, forested riparian zones in Rhode Island.

Ground water nitrate removal is dependent on water table dynamics and soil wetness (hydric soils). The results of this study demonstrate that hydric riparian zone soils can foster substantial removal of nitrate in the shallow ground water. High ground water nitrate-N removal was observed in hydric soils and minimal ground water nitrate-N removal was found in nonhydric soils.

However, these results do not demonstrate how nitrate is removed where ground water flows at deeper depths and upwells vertically to the stream or where surface seeps bypass riparian soils. Artificially drained cropland and urbanized riparian zones can also result in bypassing of riparian soils for nitrate removal. These relationships between ground water flowpaths and nitrate removal require further investigation.

◈ Lowrance, R., L. S. Altier, J. D. Newbold, R. R. Schnabel, P. M. Groffman, J. M. Denver, D. L. Correll, J. W. Gilliam, J. L. Robinson, R. B. Brinsfield, K. W. Staver, W. Lucas, and A. H. Todd. 1997. Water quality functions of riparian forest buffers in Chesapeake Bay watersheds. Environmental Management 21(5):687-712.

This study examined the role of riparian forest buffer systems (RFBS) throughout the Chesapeake Bay region in controlling nonpoint sources of nutrients. The study examined nutrient budgets for riparian forests, nitrate transport in shallow groundwater, vegetation uptake and denitrification, and removal of sediments and nutrients in surface runoff.

Among the factors that were found to affect non-point source pollution control was stream order/size. The authors state that regardless of the size of the stream or the hydrologic setting, water moving across the surface or through the root zone of a RFBS should show reduction in either nitrate (groundwater) or sediment and sediment-borne chemical loads reaching the stream (surface runoff).

On lower-order streams there is greatest potential for interactions between water and riparian areas. For first-order streams, the potential impact of the RFBS on chemical load or flow-weighted concentration is directly related to the proportion of the excess precipitation from the contributing area that moves through or near the root zone or surface of the RFBS.
For all streams above first order, the contributing area is only one source of pollutants, with upstream reaches providing the other source. For second-order and above, the pollution control by RFBS is based on both the proportion of water from the contributing area that moves through

the riparian system and the relative sizes of the two potential pollutant loads—upstream sources or adjacent land uses.

Clearly, the larger the stream, the less impact a RFBS along a particular stream reach can have on reduction in overall load within that reach. On a watershed basis, the higher the proportion of total streamflow originating from relatively short flow paths to small streams, the larger the potential impact of RFBS. In comparing the potential effectiveness of RFBS among watersheds, drainage density (length of channel per unit area of watershed) should provide a useful starting point. Higher drainage density implies greater potential importance for RFBS in NPS pollution control.

◈ Mayer, P. M., S. K. Reynolds, M. D. McCutchen, and T. J. Canfield. 2006. Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: a review of current science and regulations. EPA/600/R-05/118. Cincinnati, OH: U.S. Environmental Protection Agency.

Riparian zones, the vegetated region adjacent to streams and wetlands, are thought to be effective at intercepting and controlling nitrogen loads entering water bodies. Buffer width may be related to nitrogen removal efficiency by influencing nitrogen retention through plant sequestration or removal through microbial denitrification. We surveyed peer-reviewed scientific literature containing data on the relationship between riparian buffer width and nitrogen concentration in streams and groundwater of riparian zones to identify trends in the relationship between buffer width and nitrogen removal capacity. We also examined Federal and State regulations regarding riparian buffer widths to determine if such legislation reflects the current scientific understanding of buffer effectiveness.

While some narrow buffers (< 15 m) removed significant proportions of nitrogen, others contributed to nitrogen loads in riparian zones. Larger buffers (> 50 m) appeared more certain to remove significant portions of nitrogen. Subsurface removal of nitrogen was efficient but did not appear to be related to buffer width. Surface removal of nitrogen was partly related to buffer width, but was generally inefficient, removing only a small fraction of the total nitrogen flowing through soil surface layers and, in some cases, actually contributing to nitrogen loads. Type of vegetative cover was not related to nitrogen removal effectiveness in the subsurface but was in surface flow. The general lack of vegetation or width effects on nitrogen removal, especially in the subsurface, suggests that soil type, watershed hydrology and subsurface biogeochemistry may be more important factors due to their influence on denitrification.

State and Federal guidelines for buffer width also varied widely but generally were consistent with the peer-reviewed literature on effective buffer width, recommending or mandating buffers 15-30 m wide.

Articles referencing MODERATION OF SHADE AND WATER TEMPERATURE

◈ McNamara, M. L., M. Montgomery, T. Spivey, and B. Campbell. 2000. Shade for seven riparian vegetation groups, Upper Klamath Basin, Oregon. Pp. 41-46 In: Proceedings of the international conference on riparian ecology and management in multi-land use watersheds. R. L. Beschta and P. J. Wigington (eds.). Middleburg, VA: American Water Resources Association.

The purpose of this study was to evaluate the shade provided to streams from different types of riparian areas in the upper Klamath Basin, Oregon in support of the formulation of TMDLs for stream temperature. Shade measurements were made at the stream surface and seven community groups representing riparian vegetation types common to the area were identified.

The types of community groups composing the riparian canopy along streams was found to be a major factor in defining the amounts of riparian shade that are possible along a stream reach. Total average shade in tree-dominated communities ranged from 42% to 82% while total average shade in sedge/grass and willow/shrub communities ranged from 20% to 31%. This study suggests that determining shade generated by different vegetation components along streams could be a useful tool for evaluating the effects of management activities on riparian conditions.

◈ Blaha, D. W., C. May, R. Horner, and M. Dolan. 2002. The effectiveness of stormwater management and riparian buffers in mitigating the effects of urbanization on streams. Alexandria, VA: Water Environment Federation.

This paper evaluates the effectiveness of structural and non-structural BMPs used in the US, stormwater management facilities and forested riparian buffers. Studies are located in Piedmont (MD) and Puget Sounds Lowland (WA) ecoregions. Both case studies draw on unusually large and detailed data sets and quantify ecological integrity using a benthic index of biotic integrity (B-IBI).

Data indicate that maintaining natural riparian corridors along streams has a positive influence on ecological integrity. Natural riparian corridors appear particularly effective at low to moderate levels of urbanization. At higher levels of urbanization, the riparian corridors may be less effective, but this may be attributable to the piping of stormwater through the buffer and the fragmentation of the corridor by roads and utility crossings.

With few exceptions, streams with high riparian buffers have either excellent or good ecological integrity until approx. 20% TIA. Nevertheless, streams with wide, continuous forested riparian buffers generally maintained fair stream conditions even at very high levels of TIA (up to approx. 45% TIA).

◈ Fitzpatrick, F. A., B. C. Scudder, B. N. Lenz, and D. J. Sullivan. 2001. Effects of multi-scale environmental characteristics on agricultural stream biota in eastern Wisconsin. Journal of the American Water Resources Association 37(6):1489-1507.

The goal of this study was to examine the relations among fish, invertebrate, and algal assemblages represented by several metrics and environmental characteristics at multiple scales. Twenty-five agricultural streams in eastern Wisconsin were examined to investigate the importance of watershed-, segment-, and reach-scale environmental characteristics on fish, benthic invertebrate and algal assemblages, and aquatic habitat.

The watershed refers to the area less than 1 square kilometer to many thousands of square kilometers that contributes water, sediment, and dissolved materials to a common outlet along a stream channel. The segment scale refers to the length of stream approximately 1 to 15 km bounded by tributary junctions or major waterfalls and can influence aquatic habitat and biota. The reach scale is a length of stream generally less than 1000 m which may locally affect aquatic habitat and biota.

Fish, invertebrate, and algal data was collected using the U.S. Geological Survey's National Water Quality Assessment Program. Land-cover data was estimated at watershed, segment, and reach scales. Land cover percentages were calculated within a 50 m buffer on each side of the stream along the entire stream network.

In general, fish metrics had more and higher correlations with environmental characteristics at a variety of spatial scales compared to invertebrate and algal metrics. The following environmental characteristics were most to least important for fish assemblages: watershed area, buffer land cover, watershed land cover, and segment riparian vegetation width. Watershed agriculture had some impact of fish Index of Biotic Integrity (IBI) scores, with scores dropping to fair or poor when watershed agriculture increased above 30 percent. However, scores also dropped below good when buffer agriculture increased above approximately 10 percent or segment riparian vegetation width dropped below approximately 200 m. These results indicate that land cover in the buffer along the entire stream network is more important than watershed land cover or segment or reach riparian vegetation width for maintaining high IBI scores, a measure of stream quality.

Unlike fish metrics, the invertebrate metrics did not correlate with watershed area or buffer agriculture. The strongest correlation for algal IBI occurred with reach riparian vegetation width.

◈ Lee, K. E., R.M. Goldstein, and P. E. Hanson. 2001. Relation between fish communities and riparian zone conditions at two spatial scales. Journal of the American Water Resources Association 37(6):1465-1473.

The purposes of this study were to address three questions regarding local and upstream riparian zones. First, does the local riparian zone affect fish community characteristics in the reach; second, does the upstream riparian zone affect fish community characteristics in the reach; and third, are the effects of the upstream riparian zone cumulative with or independent of the local riparian conditions.

Fish and habitat data from eighteen streams in the highly agricultural Minnesota River Basin was used. The local riparian classification was based on the proportion of wooded vegetation within an area defined by a 200 m wide buffer. Streams that had wooded vegetation cover in 24 percent or less of the local riparian area were classified as open-local while wooded-local classification was based on 36 percent or more wooded vegetation cover. The upstream riparian zone width was set at 50 and 200 m although most of the wooded vegetation was within 25 m of the center of the stream. Streams that had less than 3.1 percent wooded riparian vegetation in the 200 m width were classified as open-upstream while wooded-upstream classification was based on 5.9 percent or more of wooded vegetation cover.

Mean species richness and Index of Biotic Integrity (IBI) scores were greatest at wooded-local sites. Although not statistically significant, mean species richness and IBI scores were greater at those sites with open-local riparian zones that had wooded-upstream riparian zones. Differences in physical habitat characteristics such as total instream cover (woody debris) and greater diversity in geomorphic units (percentage of pools and riffles) may explain why species richness and IBI scores were greatest at wooded-local sites.

The results of this study suggest that maintenance of wooded riparian cover along streams could be effective in maintaining or improving fish community composition in streams draining heavily agricultural areas.

◈ Stewart, J. S., L. Wang, J. Lyons, J. A. Horwatich, and R. Bannerman. 2001. Influences of watershed, riparian-corridor, and reach-scale characteristics on aquatic biota in agricultural watersheds. Journal of the American Water Resources Association 37(6):1475-1487.

This study focuses on describing the influences of watershed and riparian corridor land cover, and reach-scale habitat characteristics on biological communities. The objectives were: (1) to examine relations between land-use/cover characteristics at different scales versus stream habitat and biological communities; (2) to compare land use/cover within different areas of the riparian corridor and watershed on stream quality to determine if differences exist between location of land cover and their affect on stream quality; and (3) to identify the importance of continuity and width of an undisturbed riparian corridor to stream quality.

The study was conducted in agriculturally dominated river basins in eastern Wisconsin. Fish and macroinvertebrates were sampled and land-cover characteristics were derived from satellite maps for Wisconsin as well as ground-truthing surveys. Satellite maps were used to determine percent of forested, urban, grassland, wetland, and agricultural lands within buffers of 10 to 30 m wide as well as gaps within these buffers that indicate fragmentation of natural vegetation.

The results indicated that streams dominated by riparian corridor, without gaps and with less fragmentation of natural vegetation, had less organic and sediment pollution, healthier fish and macroinvertebrate communities, and a greater density of fish. Additionally, near stream agriculture, riparian corridor fragmentation, and near stream urban land use played a stronger role in influencing fish and macroinvertebrate communities than such land cover further away from the streams.

The results of this study suggest that stream health, as measured by fish and macroinvertebrate communities, is related to environmental factors at a variety of scales.

◈ Sweeney, B. W., T. L. Bott, J. K. Jackson, L. A. Kaplan, J. D. Newbold, L. J. Standley, W. C. Hession, and R. J. Horwitz. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services. Proceedings of the National Academy of Sciences 101(39):14132-14137.

- Study looks at forested and deforested reaches of 16 temperate streams in rural Piedmont watersheds in southeast Pennsylvania; streams ranged from first- to fifth-order with watershed areas of 0.1-123 km^2
- Objective is to test the hypothesis that the narrowing of small streams caused by riparian deforestation leads to a decline in the functional quality of the stream ecosystem and the ability of the ecosystem to process water pollutants
- Study shows that important ecosystem services and both structural and functional ecosystem parameters (e.g., levels of nitrogen and phosphorus processing, DOM

processing, pesticide degradation, net stream metabolism, and abundance of macroinverts and fish) in forested reaches equaled or exceeded those in deforested reaches per unit of length of stream

- Most forested stream channels studied were wider and had lower average water velocity and high bed roughness than adjacent deforested channels
- The increased channel width in forested reaches plays a critical role in the nutrient dynamics of first- through fourth-order streams
- Jones et al. (1999) found that fish abundance and community structure was insensitive to deforestation less than 1 km in extent

Articles referencing IMPROVEMENT OF LANDSCAPE QUALITY

◈ Nassauer, J. I., S. E. Kosek, and R. C. Corry. 2001. Meeting public expectations with ecological innovation in riparian landscapes. Journal of the American Water Resources Association 37(6):1439-1443.

The purpose of this paper is to describe some influential cultural values for riparian landscapes and demonstrate how attention to such values supports public acceptance of ecologically innovative design in rural and urban watersheds. Although it is important to determine ecological benefits when designing and planning for landscape change and management, it is also important to determine what people expect the landscape to look like and what they value in its appearance. Appearances affect public willingness to accept plans that improve ecological quality.
People see value in a stream because of its aesthetic appeal. They value the clarity of the water and the presence of trees, and hills or bluffs along river valleys. On the other hand, the ecological benefits of riparian landscapes may not be perceived as valuable. For example, a survey of the British public determined that they prefer channels unimpeded by woody debris and mown grass along river banks compared with tall grass.
To enhance the biological integrity of rivers, increased public knowledge needs to be augmented by culturally sustainable innovative design and planning. Cultural sustainability refers to ecologically beneficial practices that elicit sustained human attention over time. If people recognize an ecologically beneficial riparian landscape as something they value and enjoy, they are more likely to keep it that way.
In riparian landscapes, open water and trees are popularly recognized for their aesthetic value. Change can be made acceptable by coupling these values with ecologically beneficial features that are not as widely valued, like ephermerally inundated floodplains and wetlands. For example, in a wetland park in St. Paul, Minnesota, areas that were restored to wet meadow zone biodiversity (not widely appreciated by the public) were planted in visibly banded patterns and the edges of pathways were mown (signs of human care are appreciated).

◈ Schauman, S. 2000. Human behavior in urban riparian corridors. Pp. 335-346 In: Proceedings of the international conference on riparian ecology and management in multi-land use watersheds. R. L. Beschta and P. J. Wigington (eds.). Middleburg, VA: American Water Resources Association.

The paper focuses on the nature of individual behavior in riparian corridors. The questions explored were: 1) Do individual residents degrade or protect riparian corridors in their backyards? 2) Is individual behavior in riparian corridors broadly predictable? 3) Does an individual's behavior agree with his/her stated attitudes toward the corridors?
Stream experts in the greater Seattle area were surveyed to determine from their perspective, what types of individual behavior takes place in the riparian corridor. Most responses indicated that degrading activities such as clearing vegetation and dumping are more common than positive activities. Positive actions seem to be more attributable to site conditions (a homeowner's backyard is vertically separated from the stream) than individual behavior.

The researchers surveyed single-family detached residences both along suburban creeks and not along a creek. The researchers hypothesized that biological factors, cultural factors, and personal experiences would influence how people modify or maintain their landscapes. Most respondents considered low maintenance most important for landscaping considerations while less than 10% indicated that ecological considerations were important. Additionally, photo surveys of backyards along creeks indicate that riparian buffers remain more intact when protected by a subdivision covenant and a vertical topographical separation of more than 4 m between the stream and the backyard.

◈ Triangle J Council of Governments. 1999. An introduction to riparian buffers. TJCOG Technical Memo: Riparian Buffer Series, No.1. Durham, NC: Triangle J Council of Governments.

- Two features of buffers make them excellent resources for parks:
  - Edge
  - Linkage
- Buffers have high percentage of edge to overall land area, so they create a substantial corridor of green and are well-suited for use as a linear park. They can link larger preserves for wildlife purposes; can link parks and recreational facilities to create regional networks of open space that are accessible from neighborhoods and workplaces.

Riparian buffer GUIDEBOOKS and LITERATURE REVIEWS

◈ Hairston-Strang, A. 2005. Riparian forest buffer design and maintenance. DNR Publication No. 02-5312005-31. Annapolis, MD: Maryland Department of Natural Resources, Forest Service. 52 pp.

Buffer attributes that contribute to improved water quality include:

-Forests average higher nutrient reduction than grass
-A 100' buffer protects water quality functions; a 300' buffer protects wildlife
-Shallow soils (10' or less) and flatter slopes (12%) can remove nutrients better
-Trees immediately adjacent to the waterway optimize shading, streambank stability, and contribute large woody debris
-Mixed species of vegetation with multiple canopy layers are more resilient to insects, disease, storms, ice, and fire

◈ Hernandez, D., W. Reynolds, and L. Hajjar. 2000. Vegetated riparian buffers and buffer ordinances. Columbia, SC: South Carolina Department of Health and Environmental Control.

The following are the recommendations for vegetated buffer and buffer ordinances in South Carolina:

I. Minimum average width 50 feet. The inner (streamside) zone of 25 feet (approximately two mature trees deep) needs to be left pristine and forested. A width of 50 feet plus 25 feet of turf (residential backyard) before reaching the first pavement or structure is preferable, while a width of 100 feet (75 feet plus 25 feet of turf) is optimum and should be attempted where possible.

A. Attempt to make two-thirds of the vegetated buffer at least 75 feet wide. Consider incentives to developers (e.g. density bonuses elsewhere or property tax exemptions) for providing buffers of 75 or 100 feet.

B. Do not allow the buffer to become too fragmented. Continuity is as important as buffer width. Do not allow more than 10% of the buffer to be less than 33 feet (10 meters) wide.

II. Establish specific water quality and habitat goals for the outer, middle, and streamside zones of the buffer. Adopt a vegetative target for the buffer based on the native, predevelopment plant community. Allow property owners to prune some vegetation in a portion of the buffer on their property so that they may establish a view of the water from their home.

III. Make the buffer ordinance flexible. The use of buffer averaging, density compensation, conservation easements, and/or variances can ensure the rights of the property owner are protected.

IV. Actively manage buffers with annual buffer walks to ensure no improper encroachment by residents. Inform developers, builders, and residents on the location of and reason for the buffers.

Make the boundaries of buffers visible before, during, and after construction with posted signs that describe allowable uses.

V. Print buffer boundaries on all development and construction plans, plats, and official maps.

VI. Limit the number and conditions for stream buffer crossings (e.g. roads, bridges, and underground utilities). All footpaths running through the buffer to the water (perpendicular to the buffer) should be covered by non-elevated wooden boardwalks to prevent the channelization of stormwater runoff caused by dirt footpaths.

VII. Do not rely on vegetated buffers as the sole stormwater management tool.

The following table was excerpted from this article:
A summary of pollutant removal effectiveness and wildlife habitat value of vegetated buffers according to buffer width (1 meter = 3.28 feet) (Source: Desbonnet et al. 1994).

Buffer Width	Pollutant Removal	Wildlife Habitat Value
5 m (16.5 ft)	~50% or greater sediment and pollutant removal	Poor habitat value; used for temporary activities of wildlife
10 m (33 ft)	~60% or greater sediment and pollutant removal	Minimally protects stream habitat; poor habitat value; used for temporary activities of wildlife
15 m (50 ft)	Greater than 60% sediment and pollutant removal	Minimal general wildlife and avian habitat value
20 m (66 ft)	~70% or greater sediment and pollutant removal	Minimal wildlife habitat value; some value as avian habitat
30 m (100 ft)	~70% or greater sediment and pollutant removal	May have use as a wildlife travel corridor as well as general avian habitat
50 m (165 ft)	~75% or greater sediment and pollutant removal	Minimal general wildlife habitat value
75 m (248 ft)	~80% or greater sediment and pollutant removal	Fair-to-good general wildlife and avian habitat value
100 m (330 ft)	~80% or greater sediment and pollutant removal	Good general wildlife value; may protect significant wildlife habitat
200 m (660 ft)	~90% or greater sediment and pollutant removal	Excellent wildlife value; likely to support a diverse community

◈ Palone, R.S. and A.H. Todd (editors). 1997. Chesapeake Bay riparian handbook: a guide for establishing and maintaining riparian forest buffers. NA-TP-02-97. Radnor, PA: USDA Forest Service.

Science-Based Criteria for Determining Buffer Width:

1) Existing or potential value of the resource to be protected
2) Site, watershed, and buffer characteristics
   -Stream Order: Low order streams comprise 75 percent or more of total stream and river miles. These streams provide the greatest potential for interactions between water and riparian areas.
3) Intensity of adjacent land use
4) Specific water quality and/or habitat functions desired

Landowner-Based Criteria:

1) Economic considerations
2) Adjacent land uses
3) Competing uses
4) Existing developments

Three-Zone Urban Buffer System

Characteristics	Streamside Zone	Middle Zone	Outer Zone
Function	Protect the physical integrity of the stream ecosystem	Provide distance between upland development and the streamside zone	Prevent encroachment and filter backyard runoff
Width	Min. 25', plus wetlands and critical habitats	50' to 100' depending on stream order, slope, and 100 year floodplain	25' min. setback to structures
Vegetative Target	Undisturbed mature forest, reforest if grass	Managed forest, some clearing allowable	Forest encouraged, but usually turfgrass
Allowable Uses	Very restricted (e.g., flood control, utility right of ways, footpath, etc.)	Restricted (e.g., some recreational uses, some stormwater BMPs, bike paths, tree removal by permit)	Unrestricted (e.g., residential uses including lawn, garden, compost, yard wastes, most stormwater BMPs)

Buffer Crossings:

The following criteria should be followed:

- Crossing Width - Minimum width to allow for maintenance access.
- Crossing Angle - Direct right angles are preferred over oblique crossing angles, since they require less clearing in the buffer.
- Crossing Elevation - All direct outfall channels should discharge at the invert elevation of the stream. Underground utility and pipe crossings should be located at least three feet below the stream invert, so that future channel erosion does not expose them, creating

unintentional fish barriers. All roadway crossings and culverts should be capable of passing the ultimate 100-year flood event. Bridges should be used in lieu of culverts when stream crossings require a 72-inch or greater pipe. Small stream crossings should be avoided, as they tend to create fish barriers. Slab, arch, or box culverts are better alternatives to round, metal culverts for small stream crossings. Where possible, the culvert should be "bottomless" to ensure passage of water during dry weather periods.

Management of Buffers during Plan Review and Construction:

- Require preliminary buffer delineation on conceptual and final plans
- Confirm that buffer delineations and subsequent changes are calculated and mapped properly
- Field verify stream delineations as drawn
- Check buffer size calculations for suitability against the proposed use as a stormwater treatment facility
- Determine that other BMPs within and outside of the proposed project can perform to specified parameters, and that they have been properly integrated into the buffer system
- Carefully review all buffer crossings to minimize impact

Buffer Education, Encroachment, and Enforcement:

- Clearly designating buffer boundaries with durable, brightly colored signage that describes protection guidelines.
- Inviting construction personnel and adjacent property owners to presentations, field demonstrations, and stream walks.
- Providing concise information about the benefits and uses of the buffer, as well as follow-up meetings with homeowner associations.
- Providing a program whereby property owners are fully informed about buffer limits and uses at the point of sale for property or property transfers.
- Establishing a resident's buffer stewardship program for monitoring, reforestation, and backyard buffer enhancement that includes annual inspections.

◈ Triangle J Council of Governments. 1999. An introduction to riparian buffers. TJCOG Technical Memo: Riparian Buffer Series, No.1. Durham, NC: Triangle J Council of Governments.

- Provides brief overview of benefits under the four main goals of buffers: water quality protection and enhancement; ecosystem protection and restoration; recreational and educational use; and flood damage prevention
- Defines riparian areas as "a complex assemblage of plants and other organisms in an environment adjacent to water" and riparian buffers as "a policy tool and a management practice for protecting these areas and the functions they provide"
- Pollutant removal: references rates of removal from Schueler 1995; actual pollutant removal rate for a given buffer depends on site characteristics such as length and steepness of slope, soil type, kind and amount of vegetative cover, elevation of the water table, adjacent upland land uses, and management measures being used in and around the buffer.

- Per Schueler 1995, buffers only provide effective pollutant removal for runoff from the land adjacent to them. Schueler estimates that if stormwater is flowing off a paved area > 75 ft long or a grassy area > 150 ft long before it enters the buffer, then the stormwater will tend to concentrate into a channel. Channelized flow can short-circuit the buffer and deliver pollutants rapidly to receiving waters. So how water flows through a buffer as well as how much flows through affect the level of pollutant removal.
- Gilliam et al. (1997) indicate that the highest removal rates tend to occur when water passes through a buffer slowly as sheet flow, or uniform overland flow
- Ecosystem protection and restoration benefits are:
    - Protect wetlands
    - Provide food and permanent habitat for fish and other in-stream organisms, as well as for streamside plants and animals; and
    - Serve as wildlife corridors among larger natural areas
- Keller, Robbins and Hatfield (1993) detected 6 forest-interior breeding birds more frequently in riparian forests of greater widths. Corridors at least 330 ft wide provide at least some habitat for these species.
- In NC, DNR draft guidance recommends buffers of at least 200-1,000 ft on each side of the stream in order o protect interior bird species. Noss (1993) states that wildlife managers estimate that edge effects being to diminish at about 660 ft from the edge habitat.

◈ Wenger, S. 1999. A review of the scientific literature on riparian buffer width, extent and vegetation. Athens, GA: Office of Public Service and Outreach, Institute of Ecology, University of Georgia. 59 pp.

Over 140 articles and books were reviewed to establish a legally-defensible basis for determining riparian buffer width, extent and vegetation. These topics are addressed for the following buffer functions:

Sediment

- Width-The ability of riparian buffers to trap suspended solids is positively correlated with width and negatively correlated with slope. Six studies (Young et al 1980; Peterjohn and Correll 1984; Magette et al 1987, 1989; Dillaha et al 1988, 1989) have examined the effectiveness of buffers of two widths in trapping total suspended solids (TSS). In every case, buffer effectiveness increased with buffer width, although the relationship varied. It appears that a 30 m (100 ft) buffer is sufficiently wide to trap sediments under most circumstances.
- Extent- Riparian buffers are especially important along the smaller headwater streams which make up the majority of stream miles in any basin (Osborne and Kovavic 1993, Binford and Buchenau 1993, Hubbard and Lowrance 1994, Lowrance et al 1997). These streams have the most land-water interaction and have the most opportunities to accept and transport sediment. “Protecting greenways along low-order streams may offer the greatest benefits for the stream network as a whole” (Binford and Buchenau 1993).
- Vegetation- A combination of grass and forested buffers has been advocated by many researchers (e.g. Welsch 1991, Lowrance et al 1997).

Phosphorus

- Width-In the short term researchers have found riparian buffers retain the majority of total phosphorus that enters, and retention increases with buffer width. Studies in Sweden by Vought et al (1994) determined that after 8 m (26.2 ft), grassed buffers retained 66% of phosphate in surface runoff while after 16 m (52.5 ft) 95% was retained. Mander et al (1997) in Estonia found total phosphorus trapping efficiencies of 67% and 81% for riparian buffer widths of 20 m (65.6 ft) and 28 m (91.9 ft), respectively.
  Riparian zones wide enough to provide sediment control (15-30 m, increasing with slope) should provide short-term control of sediment bound phosphorus. Wider setbacks should be considered for application of animal waste, fertilization, and other activities that yield large amounts of nutrients.
- Limitations-The long-term effectiveness of riparian buffers in retaining available phosphate is questionable. The sediment-bound phosphorus trapped by buffers may slowly be leached into the stream, especially once the buffer is saturated (Omernik et al 1981, Osborne and Kovacic 1993, Mander 1997).

Temperature and Light Control

- In a review of several articles on the subject, Osborne and Kovacic (1993) concluded that buffer widths of 10-30 m (33-98 ft) can effectively maintain stream temperatures. Shading has the greatest impact on smaller streams. Collier et al (1995b) note that "generally, protecting or planting small headwater streams achieves the greatest temperature reduction per unit length of riparian shade." This again indicates the need to establish buffers on even the smallest streams when possible.

◈ Wenger, S. and L. Fowler. 2000. Protecting stream and river corridors: creating effective local riparian buffer ordinances. Athens, GA: Public Policy Research Series, Carl Vinson Institute of Government, University of Georgia. 68 pp.

An effective riparian buffer ordinance will have the following characteristics:

1. A good buffer ordinance will not only adhere to state requirements, but will incorporate those requirements into a single set of local regulations, making it easy to administer.

2. It will provide for flexibility and variance procedures. In many cases, it is possible to slightly reduce the width of a portion of the buffer to accommodate the needs of a landowner while not significantly affecting buffer performance. This can be incorporated into an ordinance through rules for "minor exceptions" or "buffer averaging." In extreme cases, a variance that significantly reduces the buffer width will need to be issued to provide regulatory relief to property owners. The buffer ordinance should include variance criteria and procedures that are stringent but fair.

3. It will provide an exception for existing land uses. In other words, properties are only affected by the buffer ordinance when they change use—for example, when agricultural land is developed for residences.

4. It will provide exceptions for certain activities. Agriculture is traditionally outside the regulatory domain of local governments and may be exempted (although certain restrictions on pesticide and fertilizer application are appropriate). Forestry is acceptable within limits, although cutting within 50 feet of the stream should not be allowed. Structures such as boat ramps, which by their nature need to be on or near a stream, are also excepted.

5. It will include guidelines for buffer crossings, which should be minimized, and buffer restoration, which is sometimes necessary.

Buffers are effective at trapping limited amounts of phosphorous. There are limits however to how much phosphorous a buffer can hold, and over the long term the soil can become saturated with the nutrient. For this reason, buffers should not be considered the primary method for controlling phosphorus runoff.

Variable-width buffers are more scientifically defensible than fixed-width buffers and are more likely to provide adequate but not excessive protection. Additionally, areas with different characteristics require different degrees of protection. Variable-width buffers can incorporate protection for other sensitive natural features such as floodplains, steep slopes, and wetlands. They do however have some potential drawbacks; they require slightly more staff time to administer, are less easily understood by the public, and may strike some landowners as unfair.

Courts have clearly demonstrated that laws designed to protect water quality or even the environment in general are justified in the interest of public health, safety, and welfare (Witten 1997, Zoeckler 1997). In the case of *Lucas v. South Carolina Coastal Council* (1992), the U.S. Supreme Court noted that uses of property may be denied if they constitute a public nuisance, in accordance with long-established common law (Patterson 1993). Since nonpoint source pollution of water may constitute a public nuisance and riparian buffers are effective at preventing such pollution, the buffers may be protected from takings claims on these grounds as well.

Economic Costs and Benefits of a Riparian Buffer Ordinance

COSTS	BENEFITS
Local Government	
Staff time	Increased property values
Staff training	Bank stabilization and erosion control
Technical assistance to developers and landowners	Low-maintenance stormwater management
Public education efforts	Reduction in flood damage
	Groundwater recharge
	Preservation of wildlife habitat
	Increased recreational opportunities and revenues
	Preservation of drinking water quality
Developers and Property Owners	
Technical surveys and reports	Increased property values

Buffer delineation	Low-maintenance stormwater management
Loss of developable land	Bank stabilization and erosion control
Buffer restoration	Increased diversity of wildlife
Buffer protection during construction	Increased recreational opportunities
	Direct economic uses of buffer (e.g., logging)

Fox et al. (1995) calculated the economic benefit of improved water quality from agricultural soil conservation practices, based on water treatment costs and the value of sport fishing. The researchers determined that narrow buffer strips on agricultural land in a 8,155 acre watershed will produce a water quality benefit of more than $36,000. The cost of sacrificing agricultural income from the land used for these narrow buffer strips was $481. Of course, such buffer strips are not the same as wide riparian buffers, but even if the land lost from production were 20 times as great as the authors suggested, the cost would still be under $10,000—less than a third of the benefits.

Appendix B

Transcripts from Interviews with Local Government Personnel

17 August 2006
Elizabeth J. Corwin, P.E., AICP
Planning and Development Director
Highland Township, Oakland County, Michigan

Ordinance on File? No. The "subaqueous setback" is listed in the setback sections of the zoning language. It's the same 65' in residential, industrial, and commercial zones. It limits the placement of a structure.

1. What are you trying to protect with this ordinance language?
The language is very broad. "Subaqueous" is defined as any wet area and applies to wetlands, streams, and lakes. We have done the best job in protecting wetlands. Lakes have been the hardest to deal with because the ZBA grants many variances for these sites.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
No, this is the weakness in the language. For example, vegetation can be cleared right up to a wetland or pavement can be laid down right up to a wetland. Again, the language only limits the placement of a structure. The language was probably written in the 1970s or 1980s and needs to be updated.

3. Is agricultural land included in the ordinance language? (Any other exemptions?) No.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer? No.

5. Does the ordinance language address restoration in the protected area? No.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area?
In terms of wetland protection, it has been successful with homeowners. People tend not to encroach on the protected area. It has worked especially well with large lots because homeowners aren't worried about having a manicured lawn in the protected area because it is so far away from their home.

8. Do you promote the use of conservation easements?
Yes, we work with the Land Conservancy to promote open space in residential developments and it is included in an ordinance.

9. What steps have you taken to gain public understanding and acceptance of the policy?
People understand the subaqueous setback policy. Most of the education about policy language occurs at the counter in the Township Hall when plans are reviewed.

10. Has your ordinance language ever been challenged in court? No.

11. Have you had requests for permits that have been denied?

The ZBA has not turned down permits for variances relating to the subaqueous setback. Most people revise their plan to fulfill the setback.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
We do a pretty good job of enforcing. Homeowners are very good at reporting if their neighbors are building something too close to a wetland. We also use aerial photos from the county and the DEQ has been good about enforcement.

13. How much does your community spend to enforce the ordinance?
We have two staff that work on these issues, one is full-time and the other is three-quarters-time. They probably spend about ten percent of their time on these issues.

14. What do you feel are the shortfalls in your policy?
The language does not limit activities in the setback area and does not address vegetation, restoration, and maintenance issues.

18 August 2006
Daniel Swallow
Deputy Director of Planning and Economic Development
Charter Township of Van Buren, Wayne County, Michigan

Ordinance on File? Excerpt from the Planned Residential Development Ordinance is on file. This is their cluster housing ordinance and requires a 75' setback from water bodies and wetlands. This setback is not required for *all* developments, hence the township's interest in HRWC's Buffer Initiative.

1. What are you trying to protect with this ordinance language?
The setback protects water bodies, wetlands, drains, and stormwater management basins. During public meetings for the township's Master Plan update procedure, there was great public interest in protection of natural features. Residents felt that this was an important part of maintaining the rural character of their area.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
No, the language only prohibits building within the setback. However, due to the irregularity of wetland boundaries, some developers have been given a release to modify the setback if overall, it does not have an impact on the wetland. This has been one of the biggest challenges with the setback language.

3. Is agricultural land included in the ordinance language? (Any other exemptions?)
No, the only land included in the ordinance is land intended for a PRD. Land in other zoning districts is not included.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer? No.

5. Does the ordinance language address restoration in the protected area? No.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area?
The PRD ordinance went into effect in 1999. Most PRD developments are still in the construction phase, therefore, it is difficult to characterize success of long-term maintenance at this time. However, enforcement actions have been taken when a builder encroaches on the setback.

8. Do you promote the use of conservation easements?
For cluster developments, conservation easements are required for any open space, including wetland and water body setbacks.

9. What steps have you taken to gain public understanding and acceptance of the policy?
Public hearings are required for all PRDs and include discussion of necessary setbacks. The township publication, "Premier Community Amenities Plan" identifies features of leading

communities; natural features ranked highly in this plan. A mapping project was also undertaken to identify properties with wetlands and streams.* The amenities plan and the natural features map have been presented to the Planning Commission, the Township Board, and the Township Environmental Commission. Again, the public was very involved in Master Plan update process.

10. Has your ordinance language ever been challenged in court? If so, what was the issue? No.

11. Have you had requests for permits that have been denied?
Permits have been denied for cluster developments, but these could have been denied for a number of reasons, not limited to setback violations.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
No, it would become particularly difficult to enforce an expanded township-wide policy. More personnel would be needed for site inspections and generating revenue for this activity would be difficult.

13. How much does your community spend to enforce the ordinance?
The Code Enforcement Officer manages site plan compliance. This includes landscape policies, a woodlands ordinance, and the water body setbacks, among others. The setbacks are just a small part of enforcement duties.

14. What do you feel are the shortfalls in your policy?
The biggest shortfall is that the ordinance is not applied township-wide. Additionally, it doesn't address landscaping (what types of vegetation are allowed) nor does it address physical uses (is the area for active recreation, what percent, etc.).

23 August 2006
Kris Olsson
Planning Commission Chairwoman
Ann Arbor Township, Washtenaw County, Michigan

Ordinance on File? The Natural Feature Setback ordinance is on file. It requires a 25' vegetated strip setback from wetlands and watercourses, a 100' building and construction setback from watercourses, and construction outside of areas with steep slopes.

1. What are you trying to protect with this ordinance language?
The ordinance protects natural features, defined as protected wetlands, watercourses, or steep slopes.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
Construction, deposit of materials, removal of soils, minerals, and vegetation, dredging, filling, land balancing, and seasonal operations are prohibited within the setback.

3. Is agricultural land included in the ordinance language? (Any other exemptions?) No.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer? No.

5. Does the ordinance language address restoration in the protected area? No.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area?
Once a permit has been granted, it is difficult to know what happens in the setback after that. Neighbors or the zoning administrator may report a violation but this is the only way we would know if the ordinance were violated.

8. Do you promote the use of conservation easements?
Yes, conservation easements are not required in the setback policy but developers are encouraged to place all setbacks in a conservation easement.

9. What steps have you taken to gain public understanding and acceptance of the policy?
The policy has been described in the Ann Arbor Township newsletter which all residents receive.

10. Has your ordinance language ever been challenged in court? No.

11. Have you had requests for permits that have been denied? No.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
Yes, the costs to enforce the policy are covered by development fees. The fees are specifically set to cover all administrative costs.

13. How much does your community spend to enforce the ordinance?
It is difficult to give a dollar amount. Very little staff time is spent specifically on this ordinance because it is part of the site approval process. The township wetland consultant spends time reviewing site plans to determine if a permit is needed.

14. What do you feel are the shortfalls in your policy?
The policy should be clearer about agricultural land within setbacks. Although the policy is not enforced on farmland, could or should it be? The policy is unclear about the type of vegetation required in the buffer. Should it be native, and if so, should landowners be required to restore vegetation to native varieties? The width of the buffer should also be increased.

25 August 2006
Christopher Jett
Director of Planning and Information
Richmond County, Virginia

Ordinance on File? Yes, Richmond County's "buffer ordinance" is actually an overlay district (Chesapeake Bay Preservation Area Overlay District) contained within the County's Zoning Ordinance. The overlay district language is based on the Chesapeake Bay Preservation Act model ordinance language provided by the Chesapeake Bay Local Assistance Department (now a division of Virginia's Department of Conservation and Recreation). See the following website for further information regarding buffer regulations: www.dcr.virginia.gov

1. What are you trying to protect with this ordinance language?
The overlay district protects water quality. A 100' buffer can go a long way to protect water quality from upland development. Wetlands, tidal shores, and water bodies with perennial flow are protected.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
Water-dependent uses (ports, intake and outfall structures of power plants, water treatments plants, sewage treatment plants, and storm sewers, marinas, beaches, and fisheries), redevelopment, and roads and driveways are permitted in the buffer.

3. Is agricultural land included in the ordinance language? (Any other exemptions?)
Buffer size can be decreased on agricultural land if best management practices that address erosion control, nutrient management, or pest control are applied. If all three plans are in place, the buffer can be reduced to 25'. Although responsibility for this exemption lies with the county, it is usually administered by the Soil and Water Conservation Office. Enforcement on agricultural land has not been very strict. There are also exemptions for public utilities, railroads, public roads, and facilities. Forestry activities are exempt because buffer guidelines are outlined in the Virginia Department of Forestry Manual. However, if these guidelines are not followed, the county can enforce the overlay district standards.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer?
The language calls for vegetation to be protected in its natural state.

5. Does the ordinance language address restoration in the protected area?
The state mitigation manual, which is referred to in the ordinance, addresses restoration standards such as density of plantings and the use of native vegetation.

6. Does the ordinance language address maintenance in the protected area?
There are vegetation removal guidelines, which include removal of invasives. Indigenous vegetation may be removed to provide for sight lines and vistas, access paths, and general woodlot management.

7. How would you characterize the success of long-term maintenance of the protected area?
Overall, the ordinance has been successful because without it, there would be even greater destruction of buffers. However, although the number of homeowners who completely clear their lots right down to the shoreline has decreased, people still clear most of the vegetation, leaving only the big trees. Homeowners with waterfront property generally want to remove more vegetation than permitted. The biggest problem with enforcement is that county staff do not have backing from their Board of Supervisors or Planning Commission for this ordinance. The mandate came from the state and there was never full buy-in by the Board or Planning Commission.

8. Do you promote the use of conservation easements?
Although the use of conservation easements for large lots is successful, the use of easements for buffers has not been as successful. The county tries to encourage homeowners associations, instead of individual property owners, to purchase conservation easements in order to preserve a more contiguous stretch of the buffer.

9. What steps have you taken to gain public understanding and acceptance of the policy?
The county level staff is very small and included a grant-funded inspector for only a few years. At that time, the inspector conducted educational workshops for real estate agents and watershed organizations.

10. Has your ordinance language ever been challenged in court? No.

11. Have you had requests for permits that have been denied?
Permits are denied fairly often. However, there are exceptions and variances spelled out in the ordinance that allow permits to be granted.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
No. However, funding for a full-time inspector position recently became available. We need additional staff to educate property owners up-front, when they are considering buying a property, about the importance of buffers and the associated regulations.

13. How much does your community spend to enforce the ordinance?
There are currently two staff members who do inspections for the buffer ordinance as well as wetlands and soil erosion inspections.

14. What do you feel are the shortfalls in your policy?
Overall, the policy is pretty good, but more staff are needed for enforcement. Additional education is also necessary because property owners don't understand how actions on their property affect water quality. The state is considering a new plan that would require stringent regulations only in the 50' closest to the water body and more relaxed regulations in the 50' farthest from the water body. These new regulations are based on scientific literature that indicate that the first 50' of the buffer is most important for protecting water quality. One of the most common concerns of waterfront homeowners is that a completely vegetated 100' buffer restricts their view of the water. A change to a 50' buffer may ease this concern.

25 August 2006
Anne Vaara
Environmental Consulting and Technology, Inc.
Previous experience: Code Enforcement, West Bloomfield Township, Oakland County, Michigan

Ordinance on File? Yes, the Natural Features Setback policy is excerpted from West Bloomfield's Zoning Ordinance.

1. What are you trying to protect with this ordinance language?
This ordinance protects natural features, specifically wetlands, streams, and lakes. It is important to be clear what the ordinance is intending to protect and why. It is also important to include a description of what the buffer will look like; an urban buffer may have grass mown to the edge of a water body while a rural buffer may be vegetated with trees and shrubs.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
Prohibited uses are only allowed within the setback with a permit and not before a public hearing. In Pittsfield Township's setback ordinance, no disturbances are allowed in the buffer at all.

3. Is agricultural land included in the ordinance language? (Any other exemptions?) No.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer?
Native vegetation is required in the buffer. However, installation of non-native vegetation is allowed with the permission of the Board and most often requires installation of native vegetation as well.

5. Does the ordinance language address restoration in the protected area? No.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area?
It is always a success if you can protect a natural area.

8. Do you promote the use of conservation easements?
Yes, the conservation easements cover wetlands and sometimes the buffer is included as well.

9. What steps have you taken to gain public understanding and acceptance of the policy?
Brochures about the importance of buffers were provided to the public as well as numerous newspaper articles. Public meetings about the ordinance were broadcast on cable television.

10. Has your ordinance language ever been challenged in court? If so, what was the issue?
Yes, a property owner disturbed the setback on their property and challenged the township's demand that the buffer be restored.

11. Have you had requests for permits that have been denied?

Yes, the requests that are denied are denied by the Wetland Board.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
Yes, the Code Department staff at the township is very well staffed.

13. How much does your community spend to enforce the ordinance? Unknown.

14. What do you feel are the shortfalls in your policy?
Having a setback policy is not a shortfall. The problem often arises with how a community is going to administer it because a number of staff are needed to do site plan review and enforcement.

28 August 2006
Bruce Pindzia, P.E.
Township Engineer/Zoning Administrator
Webster Township, Washtenaw County, Michigan

Ordinance on File? Yes, the current regulations are found within Webster Township's 1985 Zoning Ordinance (Natural Rivers Regulations, Section 4.06). The township is currently in the process of adopting a new zoning ordinance which includes a surface water protection overlay district (Section 16.20). It includes surface water overlay zones of 25' and 100' on each side of water bodies. The following is based on the proposed zoning ordinance.

1. What are you trying to protect with this ordinance language?
The ordinance language protects the environmental, ecological and aesthetic values of lakes, rivers, and streams.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
New buildings must be setback 100' feet from the water's edge. Commercial mining, extraction of soil materials, sand or gravel is prohibited within the overlay district. The use of pesticides, herbicides and fertilizers is prohibited in the overlay district. A natural vegetation strip must be maintained for 25' from the water's edge. Pathways or boardwalks are prohibited within this strip. A number of restrictions on land uses that pose water pollution hazards are included: hazardous substances (150'), petroleum storage facilities (150'), raised septic systems (250'), CAFOs (250'), and land application of biosolids (100').

3. Is agricultural land included in the ordinance language? (Any other exemptions?)
No. Nonconforming structures that existed at the time of adoption of the ordinance may be exempted as determined by the Planning Commission. Waivers for development may be granted in two forms: buffer averaging or density compensation.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer?
Noxious plants and shrubs or plants regarded as common nuisances should be removed. Planting of native species is encouraged.

5. Does the ordinance language address restoration in the protected area? No.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area? N/A

8. Do you promote the use of conservation easements? N/A

9. What steps have you taken to gain public understanding and acceptance of the policy?
There will be four workshops held from September to December 2006 for the public to review the new zoning ordinance.

10. Has your ordinance language ever been challenged in court? N/A

11. Have you had requests for permits that have been denied? N/A

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
There will be adequate resources to enforce the new surface water protection policy in areas that are currently under development. However, it will be much more difficult to enforce the policy in areas that have previously been developed. It is unlikely that a staff member will monitor previously developed sites unless a complaint is received.

13. How much does your community spend to enforce the ordinance? N/A

14. What do you feel are the shortfalls in your policy? N/A

**Bruce Pindzia expressed interest on the part of Webster Township to review the model buffer ordinance language developed by HRWC when it becomes available. If possible, he would like to incorporate some of the model language into the surface water protection section of their new zoning ordinance. Webster's new zoning ordinance will most likely be adopted in another 6-9 months (February 2007 at the earliest).

31 August 2006
Katrina Harding
Land Development and Special Projects Coordinator
Warwick Township, Pennsylvania

Ordinance on File? Yes, the township's natural resource protection standards are excerpted from their Zoning Ordinance. Section L addresses riparian corridor preservation.

1. What are you trying to protect with this ordinance language?
The water quality of all streams, tributaries, lakes, and ponds is protected through the establishment of the Riparian Corridor Conservation District (RCCD). The RCCD is a minimum of 75' on each edge of a water body and includes two zones; zone one extends a minimum of 25' from the edge of a water body and zone two extends an additional 50' from the outer edge of zone one.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
Passive open space uses that are permitted by right in zone one include wildlife sanctuaries, fishing areas, streambank stabilization, and corridor crossings by livestock. Uses permitted by conditional use in zone one include corridor crossings of recreational trails, roads, railroads, and sewer, water or utility lines. Passive uses permitted by right in zone two are the same as those in zone one with the addition of agricultural uses existing at the time of adoption of the ordinance and yards on private lots. New agricultural uses and camps, gold courses, and ballfields are permitted in zone two by conditional use. No construction, development, or encroachment is permitted unless described in the corridor management plan.

3. Is agricultural land included in the ordinance language? (Any other exemptions?)
Agricultural uses existing at the time of adoption of the ordinance are allowed in zone one and new agricultural uses are permitted by conditional use in zone two.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer?
Zone one must consist of native riparian tree and shrub species and zone two must consist of riparian trees and shrubs.

5. Does the ordinance language address restoration in the protected area?
Disturbed areas should be re-vegetated with riparian corridor plants.

6. Does the ordinance language address maintenance in the protected area?
Management techniques to be used in the RCCD as well as existing conditions and proposed activities must be included in a corridor management plan.

7. How would you characterize the success of long-term maintenance of the protected area?
The township has an open space requirement for all large residential projects. Developers often donate natural resource protection areas such as RCCDs to the township or the county in order to fulfill the open space requirement. Therefore, many riparian corridors have been protected.

8. Do you promote the use of conservation easements?
The township is currently promoting conservation easements for open space. As a result, many riparian corridors will be included in the long-run.

9. What steps have you taken to gain public understanding and acceptance of the policy?
The township newsletter informs residents about developments that are taking place and educates them about how they can help with protection efforts. Recently, a six million dollar bond to buy conservation easements was passed and had buy-in from all local officials and the public.

10. Has your ordinance language ever been challenged in court? If so, what was the issue?
No, there has only been one instance in which a private property owner encroached into the RCCD with the building of an addition to their home. They were granted a variance because their home encroached previous to the adoption of the ordinance.

11. Have you had requests for permits that have been denied? No.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
Yes, there are three to four staff members that enforce the policy.

13. How much does your community spend to enforce the ordinance?
Much of the enforcement cost is taken care of by the land development process fee of $5000.00.

14. What do you feel are the shortfalls in your policy?
Often, the open space requirement allows developers to kill two birds with one stone; they fulfill the requirement by giving up land that wasn't developable to begin with.

1 September 2006
Jerry Hancock
Land Development Coordinator
City of Ann Arbor, Washtenaw County, Michigan

Ordinance on File? The Natural Features Open Space section of the city's zoning ordinance is on file.

1. What are you trying to protect with this ordinance language?
An open space area of 25' is required around wetlands and watercourses.

2. Does the ordinance language define permitted and prohibited uses in the protected area? No.

3. Is agricultural land included in the ordinance language? (Any other exemptions?) No.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer? No.

5. Does the ordinance language address restoration in the protected area? No.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area?
The ordinance works about 75% of the time. Most encroachments occur on residential lots that have backyards or playground equipment in the buffer.

8. Do you promote the use of conservation easements?
The Planning Department promotes the use of conservation easements. Jerry Hancock would prefer other methods to preserve open space, such as deeding the land to the city, over easements. Often, the easement wording is not written upfront and developers later write the language when they are interested in developing a property. If conservation easements are to be used in conjunction with the model buffer ordinance, a model conservation easement ordinance should be written as well, in order to ensure that the wording is set in advance.

9. What steps have you taken to gain public understanding and acceptance of the policy?
The citizens of Ann Arbor are interested in natural features protection and often come to the city with proposals. The city really hasn't had to push the public about the ordinance.

10. Has your ordinance language ever been challenged in court? No.

11. Have you had requests for permits that have been denied?
A site plan that is denied is usually denied for multiple reasons, one of which may be because of an impact to the buffer.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?

There are adequate resources for the site plan approval process but not for follow-up.

13. How much does your community spend to enforce the ordinance?
In addition to time spent by the Planning Commission and City Council, 10% of one staff person's time is spent enforcing the ordinance.

14. What do you feel are the shortfalls in your policy?
The policy is outdated. It was originally adopted as a wetlands ordinance in 1992 and was then incorporated into the zoning ordinance in 1994. As part of the wetlands ordinance, the buffer varied on a sliding scale between 25' and 50' depending on the quality of the feature that was protected. This was a much better policy than the current fixed 25' because not all features are of equal quality. A maintenance program should be included in the ordinance. The buffer should be required around wetland mitigation areas so that mitigation doesn't abut a structure.

12 September 2006
Susan Procell
Code Enforcement Officer
Upper Makefield Township, Pennsylvania

Ordinance on File? Yes, the township's Riparian Buffer Overlay Zone, a subsection of the Natural Resource Restrictions section of their Zoning Ordinance, is on file. The buffer consists of two zones; zone one measures 25' from the edge of streams and zone two measures 25' from the edge of zone one or to the outer edge of the 100-year floodplain.

1. What are you trying to protect with this ordinance language?
The ordinance is intended to protect the water quality of streams and stream channels.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
Solid and hazardous waste facilities, junkyards, and commercial or industrial storage facilities are prohibited. Permitted uses in zone one include pruning and removal of trees, unpaved hiking, biking, and bridle trails, wildlife sanctuaries, and the removal of the top portion of trees to provide a solar access window to operate a solar energy system on the south side of structure. Permitted uses in zone two include the construction of residential accessory structures such as outdoor storage or swimming pools and recreational structures such as athletic fields and facilities that do not have a footprint greater than 200 square feet.

3. Is agricultural land included in the ordinance language? (Any other exemptions?)
Customary agricultural practices in accordance with a soil conservation plan are permitted as long as they are not conducted within 25' of the edge of any stream channel. This 25' buffer has not posed a problem for the agricultural community.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer?
Native vegetation must be used in replanting efforts.

5. Does the ordinance language address restoration in the protected area?
Three layers of vegetation are required when replanting in the riparian corridor: herbaceous plants that serve as ground cover, understory shrubs, and trees that form an overhead canopy.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area?
Enforcement of the ordinance is excellent. In this rural township, the citizens are very interested in protecting the natural resources and see this ordinance as an important means to do so.

8. Do you promote the use of conservation easements?
Conservation easements are promoted and often the riparian buffer will be protected through such an easement.

9. What steps have you taken to gain public understanding and acceptance of the policy?

Information about the policy is provided on the township website and in the township office. If issues arise, the ordinance is thoroughly explained to landowners. However, residents are generally receptive to the enforcement of the ordinance.

10. Has your ordinance language ever been challenged in court? No.

11. Have you had requests for permits that have been denied?
Permits have been denied and developers must change their site plan to conform with the buffer requirements.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
Yes, four code enforcers are responsible for this policy.

13. How much does your community spend to enforce the ordinance?
A portion of each of the four code enforcer's time is spent on this ordinance.

14. What do you feel are the shortfalls in your policy?
Overall, we feel that our policy is very adequate and is sufficiently protecting our streams.

13 September 2006
Brentt Michalek
Planning Director and Zoning Administrator
Emmet County, Michigan

Ordinance on File? The Minimum Waterfront Setback section of the county's zoning ordinance is on file. The setback is 60' in residential and farm districts and 25' in commercial and industrial districts from any lake, river, pond, or stream identified on a USGS map. There are no setbacks from wetlands.

1. What are you trying to protect with this ordinance language?
The setback intends to protect the waterfront and the water itself.

2. Does the ordinance language define permitted and prohibited uses in the protected area?
No, the ordinance only prohibits fill and permanent construction in the setback area.

3. Is agricultural land included in the ordinance language? (Any other exemptions?) No.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer? No.

5. Does the ordinance language address restoration in the protected area? No.

6. Does the ordinance language address maintenance in the protected area?
No, property owners can mow right up to the water's edge.

7. How would you characterize the success of long-term maintenance of the protected area?
The language only calls for a structural or zoning buffer, not a resource protection buffer. Long-term protection therefore falls short because the intent is only to prohibit construction, not to restore or maintain the natural vegetation that protects the waterway.

8. Do you promote the use of conservation easements?
Although the local conservancy will use conservation easements to protect a large tract of land or land within a subdivision, easements as not used for the buffer specifically.

9. What steps have you taken to gain public understanding and acceptance of the policy?
Developers are familiar with the setback. The county is currently in the process of updating the agricultural, natural, and cultural resource sections of their Master Plan. A buffer ordinance could result from this update. As part of the update, the county is educating citizens about the various issues, including the importance of buffers.

10. Has your ordinance language ever been challenged in court? If so, what was the issue?
No, in the past the ZBA allowed many encroachments. The ZBA has begun to tighten down in the past two years and as a result, a few individuals have come close to challenging the ordinance language in court. The biggest issue is that because most riparian frontage is already developed,

property owners are looking to expand a small cottage of 700 square feet to 3000 square feet. These are the types of encroachments the ZBA must make decisions about.

11. Have you had requests for permits that have been denied? Yes.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
In the past, there were too few staff members for enforcement. In the past year and a half, the planning, zoning, and enforcement staff has increased. Citizens have also been made more aware of the setback and as a result, there has been better compliance. The various commissions have also committed to enforcement.

13. How much does your community spend to enforce the ordinance?
There is one full time staff member that strictly works on enforcement. The Planning Director spends about 5% of his time on enforcement and the Assistant Director spends about 10% of his time on enforcement.

14. What do you feel are the shortfalls in your policy?
One issue is that if a water body is not identified on a USGS survey, then a setback is not required.

13 September 2006
Brian Duvalle
Planning and Zoning Administrator
Cheboygan County, Michigan

Ordinance on File? The Natural Vegetation Strip section of the county's zoning ordinance is on file. This 40'vegetated strip is a recommendation, not a requirement. The required waterfront construction setback is 40'.

1. What are you trying to protect with this ordinance language?
The language intends to protect water quality.

2. Does the ordinance language define permitted and prohibited uses in the protected area? No.

3. Is agricultural land included in the ordinance language? (Any other exemptions?) No.

4. Does the ordinance language have requirements for the kind of vegetation allowed in the buffer?
The planting of native species is encouraged in the vegetation strip and lawn is not considered an acceptable vegetation strip.

5. Does the ordinance language address restoration in the protected area?
Yes, in terms of planting with native species.

6. Does the ordinance language address maintenance in the protected area? No.

7. How would you characterize the success of long-term maintenance of the protected area?
Very little is known about the protected areas because maintenance is voluntary on the part of the property owner.

8. Do you promote the use of conservation easements? No.

9. What steps have you taken to gain public understanding and acceptance of the policy?
The county attempted to amend the 40' minimum construction setback to require that it be a natural vegetation strip. However, property owners protested this amendment and it will be very difficult to implement any kind of buffer ordinance for a long time.

10. Has your ordinance language ever been challenged in court? No.

11. Have you had requests for permits that have been denied?
If permits are denied, most applicants apply for a variance.

12. Do you have adequate resources to enforce the policy? If not, what additional resources are needed?
There are an adequate number of staff members that work on enforcement.

13. How much does your community spend to enforce the ordinance?
There are two staff members that work on enforcement, one of which works on enforcement full-time.

14. What do you feel are the shortfalls in your policy?
The setbacks should specify that natural vegetation is required in at least 10'-15' of the setback.

Appendix C

Model Ordinance for Riparian Buffers
by the Huron River Watershed Council

Huron River Watershed Council

Protecting the river since 1965

Model Ordinance

Riparian Buffer

This model ordinance, developed by the Huron River Watershed Council (HRWC) with funding from the U. S. Environmental Protection Agency and Michigan Department of Environmental Quality, is intended to assist municipalities in the Huron River Watershed desiring to care for the quality of the environment and life within their jurisdictions. Reproduction, circulation, and other use of this document is permitted and encouraged. This ordinance can be adopted without modification. However, municipalities may wish to make changes pursuant to local conditions. This ordinance reflects HRWC's preferred version to date with additional comments, suggestions and options inserted throughout the document in italics.

Huron River Watershed Council

Protecting the river since 1965

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HRWC also appreciates the contributions of the following professionals who provided guidance and contributions toward the development of this model ordinance:

J. David Allan, Aquatic Ecologist, University of Michigan

Harry Campbell, Scientist, Chesapeake Bay Foundation

Noah Hall, Law Professor, Wayne State University Law School

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Ellen Kohler, Environmental Attorney

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Barry Lonik, Land Conservation Consultant

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Steve Olds, District Conservationist, USDA Natural Resource Conservation District

Kris Olsson, Planning Commission Chair, Ann Arbor Township

Joseph Rathbun, Water Bureau, Michigan Department of Environmental Quality

Dennis Rice, Executive Director, Washtenaw County Conservation District

Laura Rubin, Executive Director, HRWC

Harry Sheehan, Environmental Manager, Washtenaw County Department of the Drain Commissioner

Stephen Shine, CREP Manager, Michigan Department of Agriculture

Section 1. Authority

The regulation is enacted pursuant to the authority of Public Act 451 of 1994 (Natural Resources and Environmental Protection Act, M.C.L. 324.101 et. seq.), Public Act 110 of 2006 (the Michigan Zoning Enabling Act), M.C.L. 125.3101 et. seq., and the Michigan Constitution Article 4, Section 52 and Article 7, Section 34 to protect the public health, safety, property, and welfare of the citizens of _____ [COMMUNITY] and to preserve and enhance the environmental, ecological, and aesthetic values of waterbodies in _____ [COMMUNITY], _____ [WATERSHED], and the Lake Erie Drainage of the Great Lakes Basin.

➲ *This section should also list any other pertinent regulation or plan that will be further supported by the Riparian Buffer Ordinance (such as the municipality's Comprehensive Plan or Open Space and Environmental Protection Plan).*

Section 2. Intent

The intent of this article is to:

2.1. Improve surface water quality and subsurface water quality by reducing the amount of nutrients, sediment, organic matter, pesticides, and other harmful substances that reach watercourses, wetlands, subsurface, and surface water bodies by using scientifically-proven processes including filtration, deposition, absorption, adsorption, plant uptake, and denitrification, and by improving infiltration, encouraging sheet flow, and stabilizing concentrated flows of stormwater runoff.

2.2. Assist in the implementation of pertinent state laws concerning erosion and sediment control practices, specifically the Natural Resources and Environmental Protection Act, Part 91, Soil Erosion and Sedimentation Control, 1994, Act 451, as amended 2000, Act 504, and any subsequent amendments thereto, as administered by the Michigan Department of Environmental Quality and the _____ [COUNTY] Conservation District.

2.3. Improve and maintain the safety, reliability, and adequacy of the water supply for domestic, agricultural, commercial, industrial, and recreational uses along with sustaining diverse populations of indigenous aquatic flora and fauna.

2.4. Preserve and protect areas that intercept surface water runoff, wastewater, subsurface flow, and/or deep groundwater flows from upland sources and function to remove or buffer the effects of associated nutrients, sediment, organic matter, pesticides, or other pollutants prior to entry into surface waters, as well as provide wildlife habitat, moderate water temperature in surface waters, attenuate flood flow, and provide scenic value and opportunities for passive recreation.

2.5. Regulate the use, siting, and engineering of all development to be consistent with the intent and objectives of this ordinance and accepted conservation practices, and to work within the carrying capacity of existing natural resources.

2.6. Conserve natural features important to land and water resources such as headwater areas, groundwater recharge zones, floodway, floodplain, springs, streams, wetlands, woodlands, prime wildlife habitats, and other features that provide recreational value or contain natural amenities whether on developed or undeveloped land.

2.7. Integrate with floodplain, steep slope, and other requirements that regulate environmentally sensitive areas to minimize hazards to life, property, and riparian features.

2.8. Recognize that natural features contribute to the health, safety, and welfare and quality of life of the residents of _____ [COMMUNITY].

2.9. Conserve natural, scenic, and recreation areas within and adjacent to riparian areas for the community's benefit.

2.10. Protect riparian rights of riparian property owners that include the right to the flow of the stream, the right to make a reasonable use of the waterbody provided reasonable uses of other riparians are not injured, the right to have access to the waterbody, the right to prevent erosion of the banks, the right to fish, and the right to purity of the water.

Section 3. Definitions

3.1 **"Conservation Plan"** is a site-specific plan developed for an agricultural operation which, at a minimum, outlines specific techniques to minimize accelerated erosion and related sedimentation associated with plowing and tilling activities on the agricultural operation.

3.2 **"County Designated Drain"** means the main stream or trunk and all tributaries or branches of any creek or river, any watercourse or ditch, either open or closed; any covered drain; any sanitary or any combined sanitary and storm sewer or storm sewer or conduit composed of tile, brick, concrete, or other material; any structures or mechanical devices, that will properly purify the flow of such drains; any pumping equipment necessary to assist or relieve the flow of such drains; and any levee, dike, barrier, or a combination of any or all of same constructed, or proposed to be constructed, for the purpose of drainage or for the purification of the flow of such drains, but shall not include any dam and flowage rights used in connection therewith which is used for the generation of power by a public utility subject to regulation by the public service commission.

3.3 **"Earth Disturbance"** means any land or vegetation change, including, but not limited to, clearing, grubbing, stripping, removal of vegetation, dredging, grading, excavating,

transporting and filling of land, that do not involve construction, paving or any other installation of impervious cover.

3.4 **"Earth Disturbance Activity"** means those actions or activities which comprise, facilitate or result in land disturbance.

3.5 **"Electric Distribution Line"** means underground lines below 30 kilovolts and lines supported by wood poles.

3.6 **"Electric Transmission Line"** means those conductors and their necessary supporting or containing structures located outside of buildings that are used for transmitting a supply of electric energy.

3.7 "**Farm**" means the land, plants, animals, buildings, structures, including ponds used for agricultural or aquacultural activities, machinery, equipment, and other appurtenances used in the commercial production of farm products.

3.8 "**Farm Operation**" means the operation and management of a farm or activity that occurs at any time as necessary on a farm in connection with the commercial production, harvesting, and storage of farm products, and includes, but is not limited to:

(i) Marketing produce at roadside stands or farm markets.

(ii) The operation of machinery and equipment necessary for a farm including, but not limited to, irrigation and drainage systems and pumps and on-farm grain dryers, and the movement of vehicles, machinery, equipment, and farm products and associated inputs necessary for farm operations on the roadway as authorized by the Michigan vehicle code, Act No. 300 of the Public Acts of 1949, being sections 257.1 to 257.923 of the Michigan Compiled Laws.

(iii) Field preparation and ground and aerial seeding and spraying.

(iv) The application of chemical fertilizers or organic materials, conditioners, liming materials, or pesticides.

(v) Use of alternative pest management techniques.

(vi) The fencing, feeding, watering, sheltering, transportation, treatment, use, handling and care of farm animals.

(vii) The management, storage, transport, utilization, and application of farm by-products, including manure or agricultural wastes.

(viii) The conversion from a farm operation activity to other farm operation activities.

(ix) The employment and use of labor to harvest or produce farm products.

3.9 **"Floodplain"** means any land area susceptible to flooding, which would have at least a one percent probability of flooding occurrence in any calendar year based on the basin being fully developed as shown on the current land use plan; i.e., the regulatory flood.

3.10 **"Impervious Cover"** means any manmade paved, hardened or structural surface regardless of material. Impervious cover includes but is not limited to rooftops, buildings, streets, roads, decks, swimming pools and any concrete or asphalt.

3.11 **"Land Development"** means any land change, including but not limited to clearing, grubbing, stripping, removal of vegetation, dredging, grading, excavating, transporting and filling of land, construction, paving and any other installation of impervious cover.

3.12 **"Land Development Activity"** means those actions or activities which comprise, facilitate or result in land development.

3.13 **"Natural Rivers"** refers to the surface waters designated by the Natural Rivers Act, Part 305 of Public Act 451 of 1994.

3.14 **"Nonconforming Uses/Structures"** means any uses or structures that were legally established prior to current ordinance provisions but which do not comply with current ordinance provisions.

3.15 **"Nonpoint Source Pollution"** means pollution generated by various land use activities rather than from an identifiable or discrete source and is conveyed to waterways through natural processes, such as rainfall, snowmelt, or groundwater seepage rather than direct discharges.

3.16 **"Parcel"** means any plot, lot or acreage shown as a unit on the latest county tax assessment records.

3.17 **"Permit"** means the final certificate issued by the _____ [COMMUNITY] required for undertaking any land development activity.

3.18 **"Person"** means any individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, city, county or other political subdivision of the State, any interstate body or any other legal entity.

3.19 **"Pipelines having a diameter of 6 inches or less"** means a pipe which is equal to or less than what is commonly referred to as a 6-inch pipe and which has an actual measured outside diameter of less than 6.75 inches.

3.20 **"Pollution"** means contamination of any waters of the State such as will create or is likely to create a nuisance or to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, municipal, commercial, industrial,

agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life, including but not limited to such contamination by alteration of the physical, chemical or biological properties of such waters, or change in temperature, taste, color or odor thereof, or the discharge of any liquid, gaseous, radioactive, solid or other substances into such waters.

3.21 **"Protection Area or Stream Protection Area"** means, with respect to a stream, the combined areas of all required buffers and setbacks applicable to such stream.

3.22 **"Riparian"** means areas that are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). They are adjacent to perennial, intermittent, and ephemeral streams, rivers, lakes, ponds, and riverine impoundments.

3.23 **"Riparian Buffer"** means a natural or enhanced vegetated area lying adjacent to perennial, intermittent, and ephemeral streams, rivers, lakes, ponds, and riverine impoundments, which is managed to maintain the integrity of stream channels and shorelines, to reduce the impact of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals, and to supply food, cover, and thermal protection to fish and other wildlife.

3.24 **"Steep Slope"** means a naturally occurring landform with a vertical change in elevation of 10 feet or more, a slope of 12% or more, and a length of 50 feet or more measured parallel to the contour lines.

3.25 **"Stream"** means a general term for a body of flowing water; natural water course containing water at least part of the year, and shall include rivers, creeks, lakes and ponds. In hydrology, it is generally applied to the water flowing in a channel that is natural in origin, even if subsequently modified by human activities, but does not apply to wholly artificial channels or canals.

3.26 **"Stream Bank"** means the sides of a stream channel, encompassing the area from that exposed during the lowest flow of the typical year (operationally defined as the seven-day minimum flow based on a ten-year data record) to the top of the bank, defined as that level where water spills out of the channel and into the floodplain (operationally defined as the 1.5-year recurrence flow based on a ten-year data record).

3.27 **"Stream Channel"** means an area that contains continuously or periodically flowing water that is confined by banks and a stream bed

3.28 **"Stream System"** means a stream channel together with one or both of the following:

1. 100-year floodplain
2. Hydrologically-related wetland

3.29 **"Watershed"** means the land area that drains into a particular stream, river or lake.

3.30 **"Wetlands"** means those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Section 4. Applicability

4.1 This regulation shall apply to all lands that are within the jurisdiction of _____ [COMMUNITY] and that border designated watercourses as defined in Section 3.13 and 3.25 of this regulation.

4.2 The provisions here shall apply to any land development activity or any earth disturbance activity resulting from or in connection with any activity or use requiring any of the following:

A. Building Permit

B. Zoning Board of Appeals approval

C. Planning Commission approval

D. Conditional Use Approval

E. Subdivision/Land Development approval

F. Grading Permit

G. Special Use Permit Approval

4.3 No approvals or permits shall be issued by _____ [COMMUNITY] without full compliance with the terms of this regulation where applicable.

Section 5. Exemptions

The following land uses are exempt from this ordinance:

5.1 Existing land uses, except as follows:

A. When the existing land use, or any building or structure involved in that use, is enlarged, increased, or extended to occupy a greater area of land; or

B. Land use existing as of the effective date of this ordinance, or any building or structure involved in that use, is moved (in whole or in part) to any other portion of the property; or

C. Where the existing land use is agriculture, pasture or another primarily unbuilt land use, and that land use ceases and is proposed to be converted to a built land use such as residential, commercial or industrial.

5.2 Maintenance, repair or operation of gas or oil pipelines, electric transmission and distribution power lines and construction of gas or oil pipelines having a diameter of 6 inches or less, and maintenance or repair of designated county drains, if the pipelines or drains are constructed, maintained or repaired in a manner to assure that any adverse effect on the riparian buffer will be otherwise minimized.

5.3 Construction of a single-family residence that is part of a plat for subdivision or approved site plan prior to _____ (DATE OF ORDINANCE ADOPTION), including the usual appurtenances, provided that:

A. Based on the size, shape or topography of the property, as of the effective date of this ordinance, it is not reasonably possible to construct a single-family dwelling without encroaching upon the riparian buffer area;

B. The dwelling conforms with all other zoning regulations;

C. Septic tanks or drain fields are not located within the riparian buffer area;

D. Dwelling avoids to maximum extent practicable disturbance of the riparian forest buffer area.

5.4 Other uses permitted under the Natural Resources and Environmental Protection Act or the federal Clean Water Act, Section 404 provided that they are consistent with all best management practices established by the Michigan Department of Environmental Quality and U.S. Environmental Protection Agency.

5.5 Notwithstanding the above, all exempted uses, structures or activities shall comply with the requirements of the Natural Resources and Environmental Protection Act, Part 91, Soil Erosion and Sedimentation Control, 1994, Act 451, as amended 2000, Act 504 and all applicable best management practices and shall not diminish water quality as defined by the Michigan Natural Resources and Environmental Protection Act and federal Clean Water Act.

Section 6. Riparian Buffer Zones

6.1 A riparian buffer shall consist of a vegetated strip of land extending along both sides of a stream and its adjacent wetlands, floodplains and slopes.

6.2 The Riparian Buffer Zone shall have three distinct areas requiring the following minimum widths and vegetative targets (Appendix A provides an illustration of the Three-Zone Riparian Buffer.):

A. Zone 1: Streamside Zone

1. Undisturbed vegetated area aims to protect the physical and ecological integrity of the stream ecosystem.

2. Begins at the edge of the stream bank of the active channel and extends a minimum distance of 25 feet, measured horizontally on a line perpendicular to the water course or water body

3. The vegetative target for the streamside zone is undisturbed native woody species with native plants forming canopy, understory, and duff layer; where such forest does not grow naturally, then native vegetative cover appropriate for the area (such as grasses, forbs or shrubs) is the vegetative target

B. Zone 2: Middle Zone

1. This managed area of native vegetation protects key components of the stream ecosystem and provides distance between upland development and the streamside zone.

2. Extends immediately from outer edge of Zone 1 for a minimum distance of 55 feet

3. The vegetative target for the middle zone is either undisturbed or managed native woody species or, in its absence, native vegetative cover of shrubs, grasses or forbs. Undisturbed forest, as in Zone 1, is encouraged strongly to protect further water quality and the stream ecosystem.

C. Zone 3: Outer Zone

1. This zone prevents encroachment into the riparian buffer, filters runoff from adjacent land, and encourages sheet flow of runoff into the buffer.

2. Extends a minimum of 20 feet immediately from outer edge of Zone 2

3. The vegetative target for the outer zone is native woody and herbaceous vegetation to increase the total width of the buffer; native grasses and forbs are acceptable

Section 7. Width Requirements of the Riparian Buffer

7.1 The width of the riparian buffer shall be established as the greatest of the following:

A. The total combined width of Zones 1, 2, and 3 shall be no less than 100 feet on each side of the stream with minimum required distances as given in Section 6, herein.

B. The riparian buffer width shall be modified if there are steep slopes which are within 500 feet of the stream. In those cases, the riparian buffer width shall be adjusted, as given in Table 1.

Table 1: Width for Zone 3 Vegetation in a Riparian Buffer

Percent Slope	Width (ft)
0-8	20
9-15	30
› 15	40

USDA, NRCS Technical Guide Section IV Statewide Riparian Forest Buffer 391

C. The riparian buffer width shall be expanded if the stream within or adjacent to the land development area is designated as Natural Rivers in Michigan Public Act 451 of 1994, Part 305, the Natural Rivers Act. In such cases the riparian buffer width shall meet the minimum required setback distances as defined in the Michigan Department of Natural Resources, Fisheries Division, Huron River Plan (revised 2002).

D. In the case of the presence of a floodplain, or wetland wholly or partially within the riparian buffer, an additional twenty-five (25) feet will be added to floodplain or wetland boundary.

➲ *Widths presented in the table below include the sum of buffer widths (Zones 1 and 2 combined) on both sides of water courses or water bodies for selected wildlife species should a community desire to increase the minimum required distances in order to provide habitat for specific wildlife species.*

Recommended Widths (Zones 1 and 2 combined)
for Various Wildlife Species on Both Sides of a Watercourse

Species	Minimum Buffer Width (ft)
Frog, salamander, turtle	100
Muskrat	165
Beaver, mink, salmonids	300
Pileated woodpecker, kingfisher	450
Bald eagle, cavity nesting ducks, heron rookery, sandhill crane, neotropical migrants	600

USDA, NRCS Technical Guide Section IV Statewide Riparian Forest Buffer 391

➲ *If a community's sole intended purpose for riparian buffers is to reduce pollution from sediment, nutrient and pesticide, then the total combined width of Zones 1, 2, and 3 shall be no less than 55 feet with minimum required distances following the proportions given in Section 6, herein.*

Section 8. Uses Prohibited Specifically in the Riparian Buffer

8.1 Any use or activity not authorized within Section 9, herein, shall be prohibited within the riparian buffer area (all zones) and the following activities and facilities are prohibited specifically:

A. Clear cutting of trees and/or other vegetation.

B. Drainage by ditching, underdrains, or other systems.

C. Deposit of materials.

D. Removal of soils and minerals.

E. Housing, grazing, or other maintenance of livestock, except as stated in Section 9.2, herein.

F. Roads or driveways, except where permitted as buffer crossings in compliance with Section 9.2, herein.

G. Motor or wheeled vehicle traffic in any area not designed to accommodate adequately the type and volume.

H. Parking lots.

I. Expansion of existing structures, except as permitted in Section 5, herein.

J. Any type of permanent structure, including fences, except structures needed for a use permitted in Section 9, herein.

K. The following land uses and/or activities are considered potential water pollution hazards, and must be set back from any stream or waterbody by the minimum distance indicated below and must be outside the floodplain:

1. Land application of biosolids (100 feet)
2. Storage of any hazardous or noxious materials including petroleum (150 feet)
3. Storage and use of fertilizers, pesticides, and/or other chemicals (150 feet)
4. Confined animal feedlot operations (250 feet)
5. Commercials or industrial storage facilities, junkyards (300 feet)
6. Subsurface sewage disposal areas (100 feet)
7. Raised septic systems (250 feet)

➲ *Some ordinances employ a simpler approach in which the zone classification is eliminated in favor of single standards for the entire buffer. In such cases, the prohibited and permitted uses presented in Zone 1: Streamside Zone are used for the entire buffer.*

Section 9. Uses Permitted within Riparian Buffer

9.1 The riparian buffer, including wetlands and floodplains, shall be managed to enhance and maximize the unique value of these resources.

9.2 Zone 1: Streamside Zone. Uses allowed with a permit from the Zoning Administrator:

A. Open space uses that are passive primarily in nature, such as wildlife sanctuaries, nature preserves, forest preserves, fishing areas, educational/public awareness signs. The area encompassed for any such use on a lot shall not include buildings and shall not result in disturbance of soil or vegetation that exceeds 20% of the area of the riparian buffer on that lot.

B. Reforestation and stream stabilization.

C. Removal of dead or diseased trees, and those causing safety concerns.

D. Water quality monitoring and stream gauging.

E. Designated historic building reconstruction.

F. Flood control structures and utility rights of way.

9.3 Zone 1: Streamside Zone. Uses requiring a special use permit from the planning commission of _____ [COMMUNITY].

A. Stream crossings, when no other feasible or prudent alternatives exist, such that the angle of any crossing shall be perpendicular to the stream or buffer to minimize clearing requirements; such that a single-span stream crossing shall be used wherever possible; and such that the right-of-way shall be the minimum width needed to allow for maintenance access and installation, are permitted by conditional use:

1. Driveways serving 1 or 2 single-family detached dwelling units.

2. The minimum number of road crossings should be used within each subdivision.

3. Agricultural crossings by farm vehicles and livestock.

4. Recreation trails of pervious material, railroads, and sewer, water or utility lines.

➲ Appendix B provides example language for maintenance and construction along the stream corridor that a community may consider for enhancing protection of the natural river environment.

B. Structures which, by their nature, cannot be located anywhere except within the riparian buffer area. These structures include docks, boat launches, public water supply intake structures, facilities for natural water quality treatment and purification, and public wastewater treatment plant sewer lines and outfalls. However, such structures should provide for the minimum practicable disturbance of the riparian buffer area by minimizing size and location, taking advantage of co-location, and satisfying the mitigation requirements of Section 9, herein.

9.4 Zone 2: Middle Zone. Uses allowed with a permit from the Zoning Administrator:

A. Uses listed in Section 9.2, herein.

B. Biking and hiking paths with pervious materials.

C. Stormwater management facilities, with the approval of _____ [COMMUNITY].

D. Recreational uses that do not involve impervious surfaces or encourage concentrated flow of stormwater into the buffer.

E. Limited forestry management techniques and timber harvesting with approval from _____ [COMMUNITY].

9.5 Zone 3: Outer Zone. Uses allowed with a permit from the Zoning Administrator:

A. Uses listed in Sections 9.2 and 9.3, herein.

B. There shall be no septic systems, permanent structures or impervious cover, with the exception of paths that measure 6 feet or less in width and overhead clearance of 8 feet or less.

C. Fences; provided that such fences must be constructed so as not to impede floodwaters.

Section 10. Nonconforming Structures and Uses in Riparian Buffer

All nonconforming uses and structures existing at the effective date of this regulation and within a riparian buffer that are not permitted under this regulation may be continued but shall not be changed or enlarged in a manner that increases the degree of nonconformity.

Section 11. Riparian Buffer Plan and Maintenance Requirements

11.1 A plan approved by _____ [COMMUNITY] is required for all development activities as outlined in Section 4 of this ordinance.

11.2 The plan shall contain the following information in addition to the existing site plan requirements of _____ [COMMUNITY]:

A. Field-delineated and surveyed riparian buffers by outside professional consultants

B. Steep slopes greater than twelve (12) percent for areas adjacent to and within two hundred (200) feet of streams, wetlands, or other waterbodies

C. A narrative of the species and distribution of existing vegetation within the buffer

D. A note to reference any riparian buffer stating: "There shall be no clearing, grading, construction or disturbance of vegetation except as permitted by the _____ [COMMUNITY]."

E. A note to reference any protective covenants governing all riparian buffer areas stating: "Any riparian buffer shown hereon is subject to protective covenants that may be found in the land records and that restrict disturbance and use of these areas."

➲ *Typically, communities require the applicant to retain the consultant of their choice to conduct the necessary field work. However, communities with their own wetlands or environmental consultants on staff may choose to make their consultant's field services available to applicants and add the cost to the permit fee.*

11.3 The buffer plan shall be submitted in conjunction with the required grading plan for any development, and the vegetated buffer should be delineated clearly on the final grading plan.

11.4 Permanent boundary markers, in the form of educational signage approved by _____ [COMMUNITY] shall be installed every 200 feet prior to final approval of the required clearing and grading plan. Signs shall be placed at the transitional edge of Zone 2 and Zone 3 (See Section 6.2).

11.5 Removal of vegetation shall be restricted to invasive vegetation including buckthorn, honeysuckle, and multiflora rose, or noxious vegetation including poison ivy, poison sumac, and poison oak, except as provided for in section 11.2, herein.

11.6 Selected removal or trimming of indigenous vegetation for woodlot management due to diseased woody species, access paths, or sight lines is allowed.

11.7 All riparian buffers shall be maintained through

EITHER

a declaration of protective covenant, which is required to be submitted for approval by the board of trustees of _____ [COMMUNITY]. The covenant shall be recorded in the land records and shall run with the land and continue in perpetuity.

OR

A conservation easement in favor of _____ [DESIGNATED LAND TRUST). The easement shall be recorded in the land records and shall run with the land and continue in perpetuity. Terms of such an easement shall be at least as restrictive as those included in this ordinance. The easement shall be submitted to the planning commission for their review prior to execution.

11.8 All lease and sales agreements must contain a notation regarding the presence and location of protective covenants for riparian buffers, and which shall contain information on the management and maintenance requirements for the riparian buffer for the new property owner.

11.9 An offer of dedication of a riparian buffer area by conservation easement to _____ [DESIGNATED LAND TRUST OR RESPONSIBLE ENTITY] shall not be interpreted to mean that this offer automatically conveys to the general public the right of access to this area.

11.10 _____ [DESIGNATED LAND TRUST OR RESPONSIBLE ENTITY] shall inspect the buffer annually and immediately following severe storms for evidence for sediment deposition, erosion, or concentrated flow channels and identify corrective actions to be taken to ensure the integrity and functions of the forest buffer.

11.11 Where land uses such as agriculture or silviculture within the area of the buffer are proposed to be converted to other uses, the full three-zone riparian buffer shall be reestablished in accordance with section 6 and section 7, herein. In reestablishing the buffer, management measures shall be undertaken to provide woody, shrub, and/or herbaceous vegetation that assures the buffer functions set forth in this ordinance. For specifications on plant type, spacing and density, refer to the USDA NRCS Technical Guide Section IV Statewide Riparian Forest Buffer 391 (Appendix C).

Section 12. Waivers and Variances

12.1 Waivers. _____ [COMMUNITY] may grant waivers for the following, if deemed appropriate by _____ [Specific legislative or administrative body/office in COMMUNITY]:

A. Buffer Averaging: The buffer width may be relaxed and the buffer permitted to become narrower at some points, as long as the average width and total area meets the requirements set forth in Section 7, herein. This averaging of the buffer may be used to allow for the presence of an existing structure or to recover a lost lot. However, the buffer width in any given location may be narrowed by no more than twenty five (25) percent.

B. Regulatory Flexibility: _____ [COMMUNITY] may allow clustering elsewhere on the site in compensation for the loss of developable land due to the requirements of this ordinance. This compensation may increase the total number of dwelling units on the site up to the amount permitted under the base zoning.

➲ *Refer to community's existing cluster requirement language to ensure consistency of this regulation with said language.*

12.2 Variances. Any applicant seeking a variance shall submit a written request for a variance to _____ [COMMUNITY].

A. Each applicant must provide documentation that describes:

1. Existing site conditions, including the status of the riparian buffer area; and

2. The needs and purpose for the proposed project; and

3. Justification for seeking the variance, including how the buffer encroachment will be minimized to the greatest extent possible; and

4. A proposed mitigation plan that offsets the effects of the proposed encroachment during site preparation, construction, and post-construction phases.

B. In determining whether a variance should be granted the following criteria shall be considered by _____ [COMMUNITY]:

1. Public and private need for the proposed activity
2. Availability of prudent and feasible alternatives
3. Extent of beneficial and detrimental effects
4. Probable cumulative impact
5. Impact on historic, cultural, scenic, ecological, or recreational values
6. Size of impact proposed relative to total size of the buffer
7. Amount of remaining buffer in the area
8. Proximity to the waterway or waterbody
9. Economic value of the proposed activity

C. Farm operations may encroach into the buffer area as follows:

1. No farm operations shall be conducted within Zone 1, i.e., within 25 feet of the edge of any stream channel.
2. Less intensive farm operations, such as hay harvesting, in accordance with a Soil Conservation Plan approved by the County Conservation District are permitted in Zones 2 and 3.
3. Farm operations upslope of the protected riparian buffer (all zones) shall be managed to prevent concentrated flows of surface water from breaching the buffer area and appropriate measures may be taken to prevent invasive or noxious vegetation (as described in Section 11, herein) from invading the buffer area.

Section 13. Inspection

13.1 _____ [COMMUNITY] shall have the authority to conduct investigations as it may reasonably deem necessary to carry out its duties as prescribed in this ordinance, and for this purpose to enter at reasonable time upon any property, public or private, for the purpose of investigating and inspecting the sites of any land-disturbing activities within the protection area.

13.2 The Zoning Enforcement Officer may make periodic inspections during the course of land development and shall make a final inspection following completion of the work.

The permittee shall assist the Zoning Enforcement Officer in making such inspections, if need be.

13.3 The Zoning Enforcement Officer may make periodic inspections following completion of the land development to determine riparian buffer intactness.

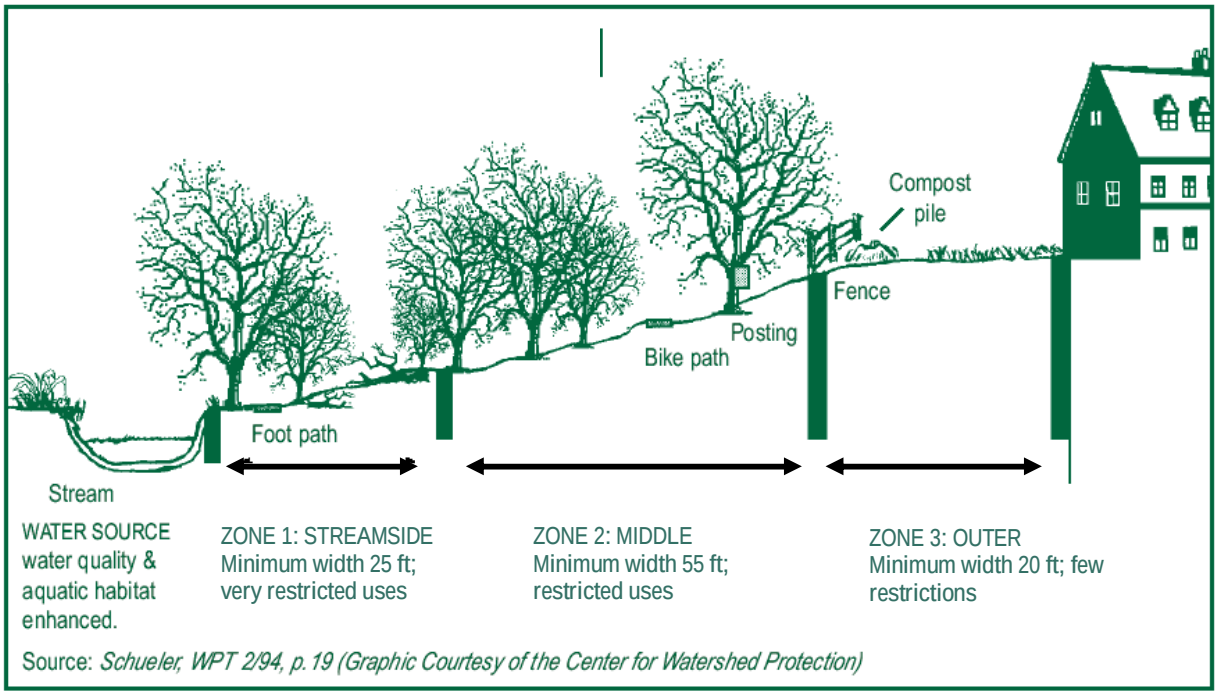
13.4 No person shall refuse entry or access to any authorized representative or agent who requests entry for purposes of inspection, and who presents appropriate credentials, nor shall any person obstruct, hamper or interfere with any such representative while in the process of carrying out official duties.

Sections Concerning Performance Guarantees; Violations, Enforcement, and Penalties; Administrative Appeal and Judicial Review; Severability; and Relationship to Other Laws

Refer to the relevant existing sections in the community's ordinance. Huron River Watershed Council or a local planner can provide sample language for these sections upon request.

APPENDIX A. ZONED BUFFER SYSTEM

Three-Zone Riparian Buffer System
for Intent and Purpose of this Riparian Buffer Ordinance
including Pollutant Reduction, Temperature Moderation, and Wildlife Habitat



Source: *Schueler, WPT 2/94, p. 19 (Graphic Courtesy of the Center for Watershed Protection)*

APPENDIX B. SAMPLE LANGUAGE FOR MAINTENANCE AND CONSTRUCTION OF UTILITIES AND PUBLIC ROADS ALONG THE STREAM CORRIDOR

(Based on Michigan Administrative Code R 281.306. Construction and maintenance of approved projects; applicable requirements and specifications.)

The _____ [COMMUNITY], in addition to the above requirements may require other reasonable measures to further protect the natural river environment, including the following as are deemed appropriate and necessary:

(a) Upon reaching the natural vegetation strip during clearing operations for overhead electric transmission line, communication line, and pipeline rights-of-way, tall-growing tree species may selectively be removed. Shrubs, low-growing tree species with a mature height of less than 20 feet, and other vegetation shall be left as natural as possible. Following construction, special measures may be required to discourage damaging off-road vehicle use, enhance wildlife habitat, or protect against soil erosion. The _____ [COMMUNITY] may require that the right-of-way be left in a rough, ungraded condition, and that slash and stumps be scattered over the right-of-way or made into brush piles, if landowner concurrence is obtained.

(b) If an underground utility right-of-way crosses the natural vegetation strip, only minimal brush and tree removal shall be performed during construction. Following construction, special measures may be required to restore the natural appearance of the area, stabilize river banks, discourage damaging off-road vehicle use, or enhance wildlife habitat. If revegetation is required, native plant materials commonly used in that area, as specified by the department, shall be replanted in the natural vegetation strip. The _____ [COMMUNITY] may require that the right-of-way be left in a rough, ungraded condition and that slash and stumps be scattered over the right-of-way or made into brush piles, if landowner concurrence is obtained.

(c) Management of trees, shrubs, and other vegetation for maintenance of all rights-of-way shall be done manually in the natural vegetation strip. However, herbicides may be applied by hand to stumps of selectively cut trees in the natural vegetation strip, where establishing and maintaining a low growing shrub community in this zone will further the objectives of the act. The _____ [COMMUNITY] may authorize application of selected pesticides to control insect or disease infestations.

(d) Materials used for bank stabilization following a river crossing shall maintain and enhance the natural and aesthetic qualities of the natural river area, control bank erosion, restore fish habitat, and discourage damaging off-road vehicle use. Specifications regarding stabilization efforts and revegetation shall be consistent with the goals of maintaining stream width as near as possible to the original width, and to provide early revegetation of the area involved.

(e) During construction for a new road or bridge, or reconstruction of an existing road or bridge, strict erosion control measures shall be taken to prevent sediment from reaching the river. Only minimal clearing of existing vegetation, grubbing, and grading shall be performed in the natural river area. The construction area shall be restored to as natural a condition as possible in the riparian buffer area immediately following construction.

(f) Where bank stabilization is needed to stabilize a bank along a road or at bridge crossings, materials shall be used that insure the maintenance and enhancement of the natural and aesthetic qualities of the riparian area.

APPENDIX C. USDA NRCS TECHNICAL GUIDE SECTION IV STATEWIDE RIPARIAN FOREST BUFFER 391

On following pages

Huron River Watershed Council

Protecting the river since 1965

1100 N. Main Street Suite 210
Ann Arbor, MI 48104
(734) 769-5123
www.hrwc.org

The Huron River Watershed Council is the first and oldest river protection group in Michigan. Founded in 1965 as a public, non-profit organization, the Council is a coalition of Huron Valley residents, businesses and local governments established under Michigan's Local River Management Act (253 P.A. 1964). Since its formation, the Council has grown to be a respected voice for protection of the Huron River and its tributary streams, lakes wetlands and groundwater.

The Huron River Watershed Council has a history and reputation of working creatively and cooperatively to tackle a wide variety of issues facing the basin. The Council has worked closely with local governments throughout the Huron River Basin to enact local wetland protection ordinances, stormwater management plans, and groundwater protection ordinances. The Council was instrumental in the passage of several of Michigan's wetland and water quality protection statutes, and in passage of State Natural River designation for the Huron. Today, more than forty communities, representing over 500,000 residents, support technical assistance, hands-on education and advocacy programs through voluntary HRWC membership.

Riparian Forest Buffer (Acre) 391

DEFINITION

An area of predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

PURPOSES

Improve and protect water quality by reducing the amount of sediment, pesticides, organic nutrients, and other pollutants in surface runoff, as well as in shallow groundwater flow.

Provide riparian wildlife habitat, maintain or restore water temperatures for fish and other aquatic organisms, and provide a source of large woody debris to form pools, help stabilize the channel bed, and create shelter for fish and other aquatic organisms.

CONDITIONS WHERE PRACTICE APPLIES

On areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands, and areas with groundwater recharge. Refer to Michigan Natural Resources Conservation Service (NRCS) Standard 393A, Filter Strip, for information pertaining to the establishment of riparian areas consisting of herbaceous cover only.

CRITERIA

General Criteria Applicable To All Purposes Named Above

The location, layout, and density of the riparian forest buffer will accomplish the intended purpose and function. All buffers, **as a minimum,** will consist of Management Zones 1 and 2. The addition of Zone 3 (Filter Strip) will be required to trap and filter sediment, nutrients, and pesticides leaving cropland or other sparsely vegetated or erosive areas.

Zone 1 - This area is adjacent to the water and will contain the trees and shrubs needed to provide aquatic shade, insect habitat, bank stability, and large woody debris. No harvesting of timber crops or grazing of livestock will be conducted in this zone in order to promote production of large woody debris and maintain bank stability (see Figures 1a, 1b, 1c, and 1d).

Zone 2 - This zone is landward of Zone 1 and will contain the trees and shrubs and other vegetation needed to filter runoff and provide uptake of nutrients and pollutants. Together, Zones 1 and 2 will provide a travel corridor and habitat for wildlife, in addition to producing shade and a source of large woody debris. Dominant vegetation will consist of existing or planted trees and shrubs suited to the site and the intended purpose. No grazing of livestock will be permitted in this zone to protect understory and forest floor vegetation. Harvesting and cutting of trees will be permitted in this zone as long as the intended purposes are not compromised. Harvesting specifications should be modified to retain a sufficient number of trees for shading of the stream, production of large woody debris, and to leave a stable, undisturbed forest floor (see Figures 1a, 1b, 1c, and 1d).

Zone 3 - This zone is landward of Zone 2 and consists of a strip of grass or herbaceous cover to spread and filter runoff which may be transporting sediment, nutrients, and pesticides off cropland or erosive or sparsely vegetated areas. Establishment of Zone 3 will be required when the control of sediment, nutrient, or pesticide pollution is necessary (see Figures 1a, 1b, 1c, and 1d and Table 2).

Site preparation and planting shall be done at a time and manner to ensure survival and growth of selected species. Only viable, high quality, and adapted planting stock will be used (see Michigan NRCS Standard 612, Tree/ Shrub Establishment). Site preparation will be sufficient for establishment and growth of selected species and be done in a manner that does not compromise the intended purpose.

Use vegetation adapted to the site that will accomplish the desired purpose. Preference shall be given to native species in order to: reduce the introduction of invasive plant species; provide management of existing invasive species; and minimize the economic, ecological, and human health impacts that invasive species may cause. If native plant materials are not adaptable or proven effective for the planned use, then non-native species may be used. Refer to the NRCS Field Office Technical

Guide (FOTG), Section I, Invasive Plant Species for plant materials identified as invasive species.

Any use of fertilizers, pesticides, and other chemicals shall be in accordance with labeling and not compromise the intended purpose(s).

The location, layout, and density of the forest buffer should complement natural features.

Any removal of timber or other crops shall be in a manner that maintains the intended purpose(s).

Any livestock access shall be provided in accordance with Michigan NRCS Standard 575, Animal Trails and Walkways.

Harmful pests present on the site will be controlled or eliminated as necessary to achieve and maintain the intended purpose(s).

Consideration will be given to allelopathy when selecting plantings.

Other applicable Michigan NRCS standards include, but are not limited to:

- Animal Trails and Walkways - 575
- Critical Area Planting - 342
- Fence - 382
- Filter Strip - 393A
- Forest Harvest Trails and Landings - 655
- Streambank and Shoreline Protection - 580
- Stream Channel Stabilization - 584
- Tree /Shrub Establishment - 612
- Use Exclusion - 472

Additional Criteria To Provide Optimum Fish And Wildlife Habitat

Specify in the management plan the type, amount, and distribution of vegetation required by wildlife and the management condition needed for survival and reproduction of sustained populations or communities. Avoid the use of non-native species of trees, shrubs, grasses, and forbs which may become hosts to undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests.

Address riparian forest buffer restoration on a watershed basis to reduce forest fragmentation and provide corridors for wildlife by maintaining continuous streamside vegetation.

The management plan will consider habitat and population objectives such as: habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors, and native plant communities.

Riparian widths and tree species will vary depending on the requirements of the fish and wildlife species and associated communities of concern (see Table 1).

Corridor configuration, species selection**,** and management should enhance habitats for threatened, endangered, and other species of concern where applicable.

Where wildlife management is an objective, the food and cover value of the planting can be enhanced by using an approved habitat evaluation procedure to aid in selecting plant species and providing for other habitat requirements necessary to achieve the objective.

The plant communities established and target successional stage will depend on wildlife needs and existing resources in the watershed.

Snag retention is a critical component of the riparian forest buffer ecosystem.

Additional Criteria To Protect Or Improve Water Quality

Concentrated flow erosion or mass soil movement shall be controlled in the up-gradient area immediately adjacent to Zone 2 prior to establishment of the riparian forest buffer.

The native plant community will be maintained to optimize erosion and water quality functions of the riparian zone.

Establish alternative water sources or control access by fencing to manage livestock access to the stream and all zones of the riparian forest buffer.

The severity of bank erosion and its influence on existing or potential riparian trees and shrubs will be assessed. Watershed-level treatment or bank stability activities may be needed before establishing a riparian forest buffer.

Where ephemeral, concentrated flow erosion, and sedimentation is a concern in the area up-gradient of Zone 2, the application of a vegetated strip (Zone 3) consisting of grasses and/or forbs shall be required (see Michigan NRCS Standard 393A, Filter Strip).

When concentrated flow erosion and sedimentation cannot be controlled vegetatively, consider structural or mechanical treatments.

CONSIDERATIONS

Location and Layout of New Riparian Forest Buffers in Areas Without Existing Woody Vegetation

For a riparian forest buffer to achieve intended purpose(s), it must be properly located and sized (width, length, area) in relation to the stream or water body. The buffer is located immediately adjacent to the watercourse or water body needing protection or enhancement. For streams, one or both sides may need treatment.

Establishment of Riparian Forest Buffers to Reduce Pollution by Sediment, Nutrients, Pesticides, or Other Pollutants and Restore Overall Water Quality

As a minimum, where soil erosion or nutrient or pesticide pollution is present or a concern, the riparian forest buffer will consist of Zones 1, 2, and 3. The total combined width of these 3 zones shall be no less than 55 feet. Zone 1 (identified as Zone 1 in Figure 1a) begins at the normal water line, or at the upper edge of the active channel, or shore or top of the bank and extends a minimum distance of 15 feet, measured horizontally on a line perpendicular to the water course or water body. Zone 2 (identified as Zone 2 in Figure 1a) extends immediately upslope from Zone 1 for a minimum distance of 20 feet. This zone will be managed to function as a zone of nutrient uptake and pesticide and pollutant entrapment. Zone 3 (identified as Zone 3 in Figure 1a) extends a minimum of 20 feet upslope, dependent on slope (see Table 2), from Zone 2. This zone will be established and managed in accordance to Michigan NRCS Standard 393A, Filter Strip.

Establishment of riparian forest buffers is not advised in areas of extremely high runoff or severe shoreline or streambank erosion unless Michigan NRCS Standard 580, Streambank and Shoreline Protection, measures can be successfully implemented. In such cases, these measures will be installed prior to the establishment of the riparian forest buffer.

Establishment of Riparian Forest Buffers to Provide Wildlife Habitat, Maintain or Restore Water Temperature, and Provide Large Woody Debris

Riparian forest buffers established primarily for the above purpose(s) will contain, as a minimum, Zones 1 and 2. The total combined width of these two zones shall be no less than 100 feet. Zone 1 (identified as Zone 1 in Figure 1b) begins at the ordinary high water mark or at the upper edge of the active channel or shore or top of the bank and extends a minimum distance of 15 feet, measured horizontally on a line perpendicular to the water course or water body. Zone 2 (identified as Zone 2 in Figure 1b) extends immediately upslope from Zone 1 for a minimum distance of 85 feet. If soil erosion, nutrient, pesticide, or other pollution is present, Zone 3 will be required. Zone 3 will extend a minimum of 20 feet, dependent on slope (see Table 2), immediately upslope of Zone 2. Note: If Zone 3 is present, Zone 2 may be reduced to a width of no less than 65 feet.

Buffer Width Requirements for Selected Wildlife Species

Widths below include the sum of buffer widths (Zones 1 and 2 combined) on both sides of water courses or water bodies and may extend beyond riparian boundaries. (In such cases, refer to Michigan NRCS Standard 612, Tree/Shrub Establishment, for establishment of upland forests.)

TABLE 1 - RECOMMENDED WIDTHS (ZONES 1 AND 2 COMBINED) FOR VARIOUS WILDLIFE SPECIES ON BOTH SIDES OF A WATERCOURSE

Species	Desired Width (Ft.)
Bald eagle, cavity nesting ducks, heron rookery, sandhill crane, neotropical migrants	600
Pileated woodpecker, kingfisher	450
Beaver, mink, salmonids	300
Deer	200
Muskrat	165
Frog, salamander, turtle	100

Joining of existing and new buffers increases the continuity of cover and will further moderate water temperatures. For habitat purposes, the buffer length can be extended along the entire stream reach on both sides within the ownership (or beyond, if possible) or

to existing riparian forests; i.e., the longest distance possible.

Location and Layout of Riparian Forest Buffers in Areas With Existing Woody Vegetation for All Purposes

Riparian forest buffers may be established within areas of existing woody vegetation. Species and stocking density should be assessed to determine if the intended purpose(s) will be served. If additional stocking is required, species selected will be adapted to the site and not compromise the function and purpose(s).

Establishment of Riparian Forest Buffers in Areas With Existing Woody Plants That Are Less Than 100 Feet Wide

Riparian forest buffers established under the above condition will have, as a minimum, Zones 1 and 2. The combined width of Zones 1 and 2 shall be no less than 35 feet for the purpose of sediment, nutrient and pesticide reduction. For wildlife habitat, temperature reduction and woody debris enhancement, a minimum width of 100 feet for Zones 1 and 2 will be needed. Zone 1 (identified as Zone 1 in Figure 1c) begins at the ordinary high water mark, or at the upper edge of the active channel, or shore or top of the bank and extends a minimum distance of 15 feet, measured horizontally on a line perpendicular to the watercourse or water body. Zone 2 (identified as Zone 2 in Figure 1c) extends immediately upslope from Zone 1 for a minimum distance of 20 feet. If soil erosion, nutrient, pesticide, or other pollution is present, Zone 3 will be required. Zone 3 will extend a minimum of 20 feet, dependent on slope (see Table 2) immediately upslope of Zone 2 (see Figure 1c).

Establishment of Riparian Forest Buffers in Areas With Existing Woody Plants That Exceed 100 Feet in Width

Riparian forest buffers established under the above condition will have, as a minimum, Zones 1 and 2. The combined width of Zones 1 and 2 shall be determined by the slope of the land immediately above the watercourse or waterbody but shall be no less than 100 feet (see Table 3). Zone 1 (identified as Zone 1 in Figure 1d) begins at the ordinary high water mark, or at the upper edge of the active channel, or shore or top of the bank and extends a minimum distance of 15 feet, measured horizontally on a line perpendicular to the watercourse or water body. Zone 2 (identified as Zone 2 in Figure 1d) extends immediately upslope from Zone 1 for a minimum distance of 85 feet. If soil erosion, nutrient, pesticide, or other pollution is present, Zone 3 will be required. Zone 3 will extend a minimum of 20 feet, dependent on slope (see Table 2), immediately upslope of Zone 2 (see Figure 1d).

Woody Plant Materials Selection and Size

Dominant vegetation in the riparian forest buffer will consist of existing or planted trees and/or shrubs suited to the site and the intended purpose(s). Select native species having multiple values such as those suited for timber, biomass, nuts, fruit, browse, nesting, aesthetics, and tolerance to locally used herbicides. Species that resprout are preferred when establishing new rows nearest to watercourses or waterbodies subject to flooding or ice damage. For production of detritus or large woody debris, use species that will meet the specific requirements of fish and other aquatic organisms for food, habitat, migration, and spawning (see Table 4, Plant List, for Riparian Forest Buffers). Plantings will consist of two or more species with individual plants suited to the site.

TABLE 2 - FILTER WIDTH FOR ZONE 3 VEGETATION IN A RIPARIAN FOREST BUFFER

Land Slope of Contributing Area Above Filter Strip (%)	Filter Width (Ft.)
0-8	20
9-15	30
>15	40

TABLE 3 - COMBINED WIDTHS FOR ZONES 1 AND 2 FOR RIPARIAN FOREST BUFFERS WITH EXISTING WOODY VEGETATION THAT EXCEEDS 100 FEET *

Slope of Land Above Water Body or Stream (%)	Minimum Width of Strip (Ft.)
0-10	100
10-20	115
20-30	135
30-40	155
40-50	175
50+	Activity may not be advisable due to erosion potential. Extreme care must be taken to prevent movement of soil

* Note: Contact Michigan Department of Natural Resources, Forest Management Division for regulations on federally designated Wild and Scenic Rivers and state designated Natural Rivers.

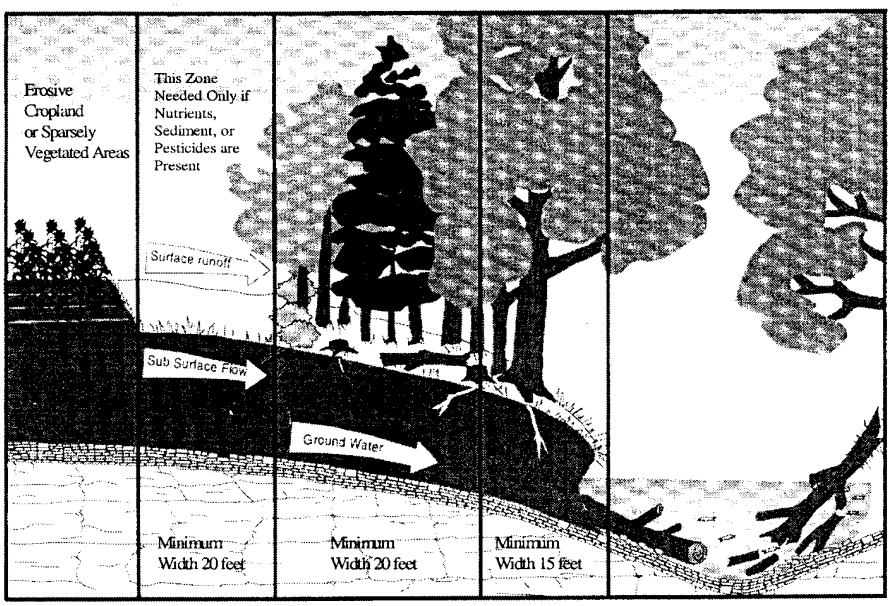


Figure 1a. Riparian Forest Buffer Widths for Purpose of:

Sediment, Nutrient, and Pesticide Reduction

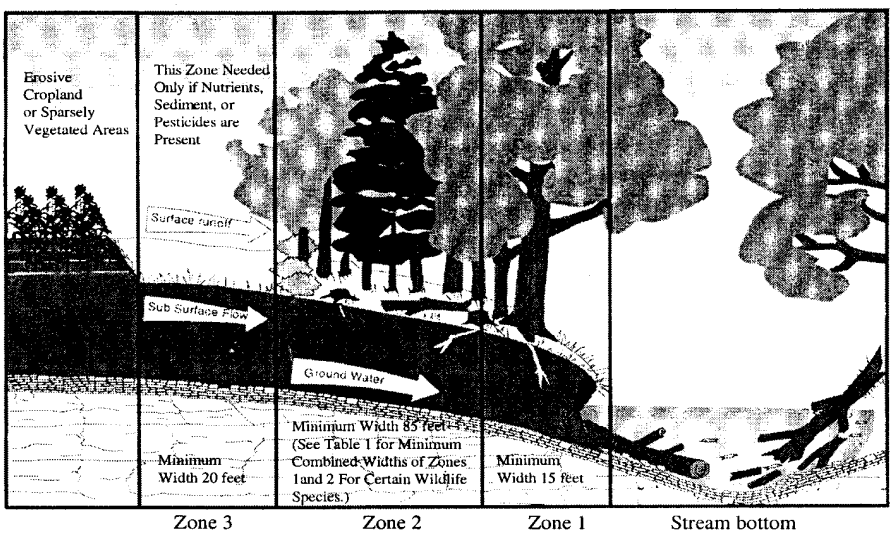


Figure 1b. Riparian Forest Buffer Widths for Purpose of:
Wildlife Habitat, Temperature Reduction, and Large Woody Debris

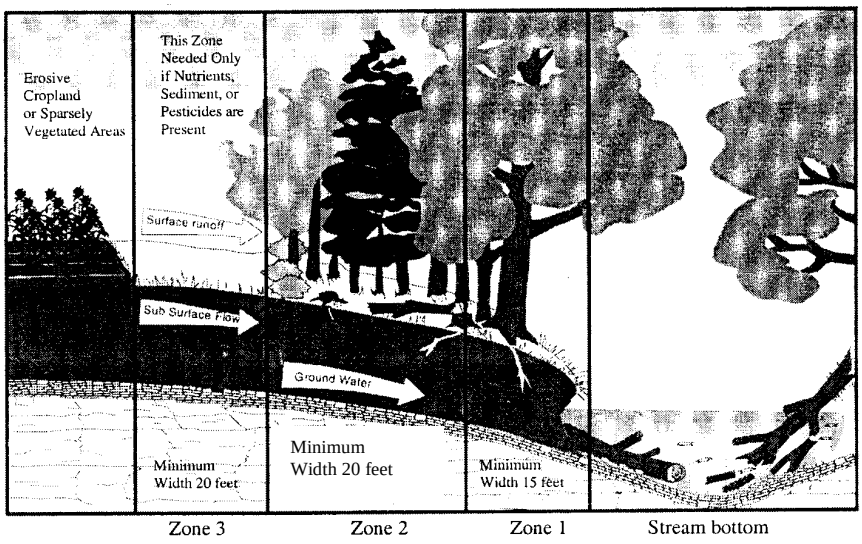


Figure 1c. Riparian Forest Buffer Widths for Areas with Existing Woody Plants that Are Less Than 100 ft Wide for the Purpose of Sediment, Nutrient and Pesticide Reduction.

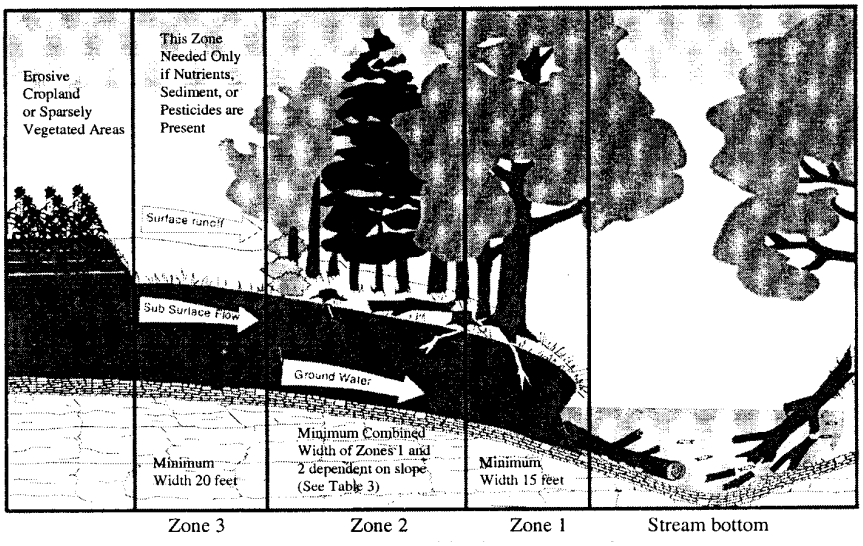


Figure 1d. Riparian Forest Buffer Widths for Areas with Existing Woody Plants that Exceed 100 feet in width for the purpose of sediment, nutrient and pesticide reduction.

TABLE 4 – PLANT LIST FOR RIPARIAN BUFFERS

Species	Flooding Tolerance	Large Debris	Soil Drainage	Shade Value	Wildlife Value	Height (Ft.)
Ash, Green	H	M	W, WD	H	M	60
Black	H	M	W, WD	H	M	60
White	L	M	WD	H	M	70
Balm-of-Gilead	M	M	W	M	M	70
Basswood	L	H	WD	H	H	75
Birch, Yellow	M	H	W, WD	M	M	70
Buttonbush	VH	L	W, WD	L	M	10
Cherry, Black	L	L	WD	L	H	70
Cottonwood	H	H	W, WD	M	H	90
Cranberry, Highbush	H	L	W, WD	L	H	15
Dogwood, Red-osier	H	L	W, WD	L	H	12
Silky	H	L	W, WD	L	H	12
Maple, Silver	H	H	W, WD	H	M	80
Sugar	L	H	WD	H	H	80
Red	H	H	W, WD	H	M	70
Oak, Bur	H	M	A	H	H	70
Red	L	M	W, WD	H	H	80
Swamp White	M	M	W, WD	H	H	70
White	L	H	WD, D	H	H	70
Pine, White	M	H	W, WD	L	M	90
Spruce, White	M	M	W, WD	M	M	75
Black	M	L	W, WD	L	M	60
Sycamore	H	H	W, WD	M	H	90
Tuliptree	L	M	WD	M	M	90
Walnut, Black	M	M	WD	M	H	80
White Cedar	M	L	W, WD	M	L	50
Willow, Black	VH	L	W	L	L	60

KEY			
A = All		M = Medium	
D = Dry		VH = Very High	
H = High		W = Wet	
L = Low		WD = Well Drained	

Flooding Tolerance - General capacity of the plant to withstand standing water. VH = able to survive deep, prolonged flooding for more than one year; H = able to survive deep flooding for one growing season, with mortality occurring if repeated the following year; and M = able to survive flooding or saturated soil for 30 consecutive days of flooding during the growing season without mortality.

Large Debris - Potential for the plant to produce trunk and limbs larger than ten inches in diameter before senescence. H = large debris possible within the life span of the plant; and L = large debris unlikely within the life span of the plant.

Soil Drainage - Adaptability of plant to grow in varying soil moisture conditions. W = wet or fully saturated soil; WD = well drained; D = dry soil conditions; and A = all soil conditions.

Shade Value - The density or fullness of shade provided by an individual plant's crown in full leaf-out condition. H = large crown providing full shade; M = partially open or medium sized crown that provides patchy or incomplete shade; and L = very open or small crown that provides minimal shade.

Wildlife Value - The potential for the plant to provide cover, useful cavity sites, and/or quality fruit production. H = excellent cover, large cavity potential, and/or high quality fleshy fruit or nut production; M = moderate cover, cavity, and fruit production; and L = low cover, cavity potential, and dry, non-nut/fruit production.

Height – Potential height at physical maturity.

Plant Spacing and Density

Initial plant-to-plant densities for trees and shrubs will depend on their potential height, crown characteristics, and growth form. Heights may be estimated based on: 1) performance of the individual species (or comparable species) in nearby areas on similar sites, or 2) predetermined and documented heights using Forestland/Windbreak/Conservation Tree/Shrub Suitability Groups (see Section II of the Michigan NRCS FOTG).

Types/ Heights	Plant-To-Plant Spacing In Feet No Less Than:
Shrubs less than 10 feet in height	8
Shrubs and trees from 10-25 feet in height	10
Trees greater than 25 feet in height	12

Care, Handling, Size, and Planting Requirements for Woody Planting Stock

Planting stock will be stored in a cool, moist environment (34-38 degrees F.) or heeled-in. Keep stock tops dry and free of mold, and roots moist and cool during all stages of handling and storage. Live cuttings and seedlings that will not be immediately planted shall be promptly heeled-in or placed in controlled storage (34-38 degrees F.) and protected until planting time. Plant stock size will be selected according to a shoot-to-root ratio of 2:1 (see Figure 2).

Proper plant and root placement of rooted stock will be accomplished mechanically or by hand (see Figure 3) using a planting bar or shovel.

Refer to Michigan NRCS Standard 612, Tree/Shrub Establishment; NRCS Conservation Design Sheet 612, Weed Control for Tree and Shrub Establishment; and Michigan State University-Extension Bulletin E-771, "Tree Planting in Michigan" for developing site-specific plans for establishing trees and/or shrubs.

PLANS AND SPECIFICATIONS

Specifications for this practice shall be prepared for each site. Specifications shall be recorded using approved specification sheets, job sheets, conservation design sheets, and/or narrative statements in the conservation plan. As a minimum, species, size, site preparation, spacing, location, and width of the buffer to be established will be addressed in the specifications.

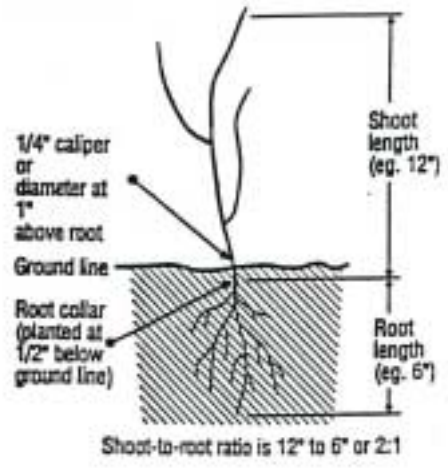


Figure 2. Plant or stock size requirements

OPERATION AND MAINTENANCE

The purpose of operation, maintenance, and management is to ensure that the practice functions as intended over time.

The riparian forest buffer will be inspected periodically and protected to maintain the intended purpose from adverse impacts such as: excessive vehicular, pedestrian, or animal traffic; timber removal; pest infestations and pesticide use on adjacent lands; livestock damage; and fire.

As applicable, control of concentrated flow erosion or mass soil movement shall be maintained in the up-gradient area immediately adjacent to Zone 2 to maintain buffer function.

Operation of heavy equipment, grazing of livestock, and harvesting of timber will not be permitted in Zone 1. Harvesting of wood products in accordance with proper forest management for the species (in accordance with accepted silvicultural methods and Society of American Foresters Standards) may take place in Zone 2. Consult Michigan NRCS Standard 655, Forest Harvest Trails and Landings for proper design of harvest trails and landings. Livestock will be excluded from Zone 2 to maintain species diversity and the desired stocking density. Zone 3 (Filter Strip) will be operated and maintained in accordance with Michigan NRCS Standard 393A, Filter Strip.

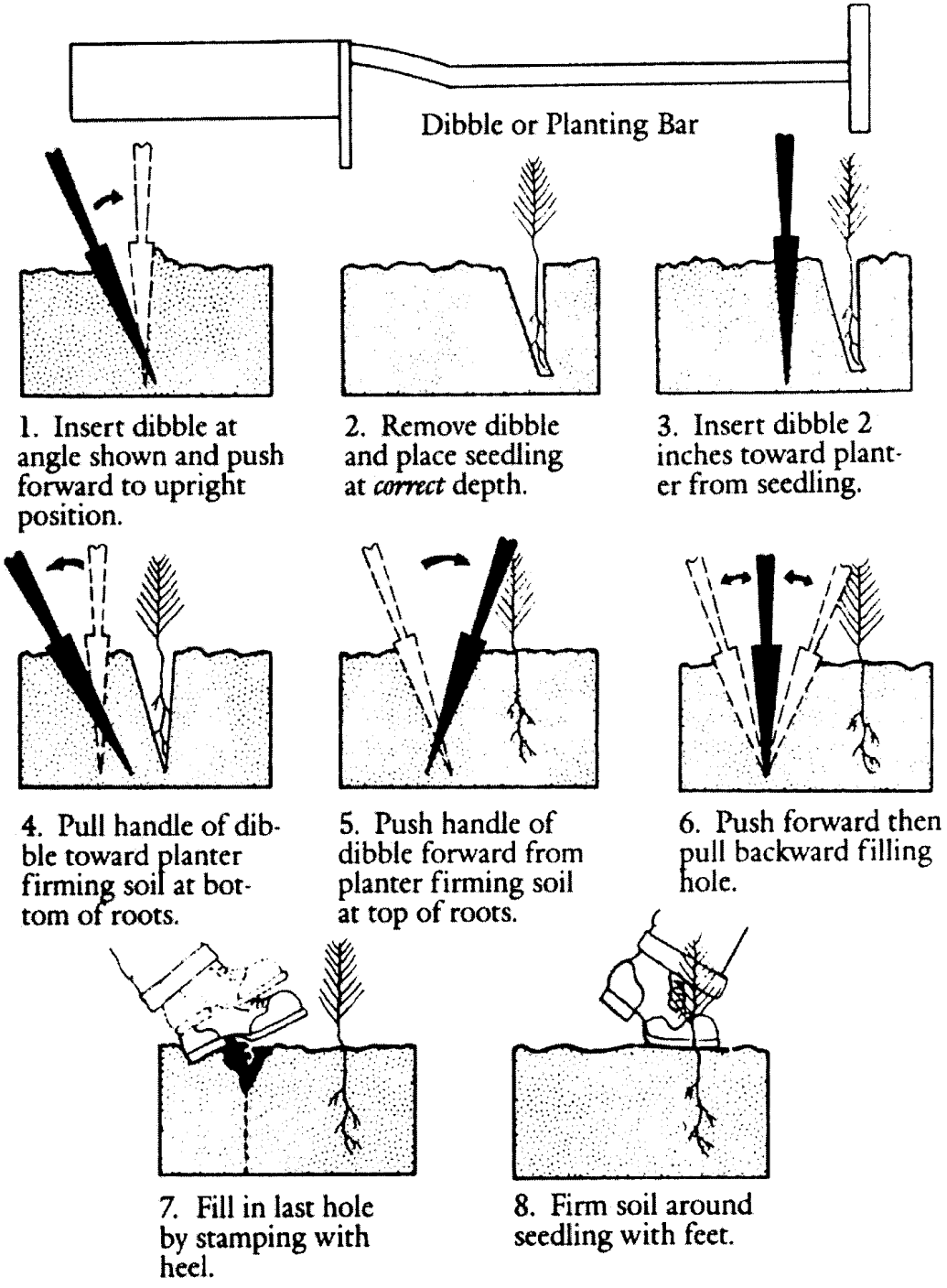


Figure 3. Proper plant and root placement of rooted stock using a planting bar.

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