Riparian Owner's Guidebook

For Watershed Management

What you can do to protect our lakes and streams

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The Robert B. Annis Water Resources Institute (AWRI) at Grand Valley State University is a multidisciplinary research and educational organization. The mission of the Institute is integrating research, education, and outreach to enhance and preserve freshwater resources. For questions, more information, or additional guidebooks please contact:

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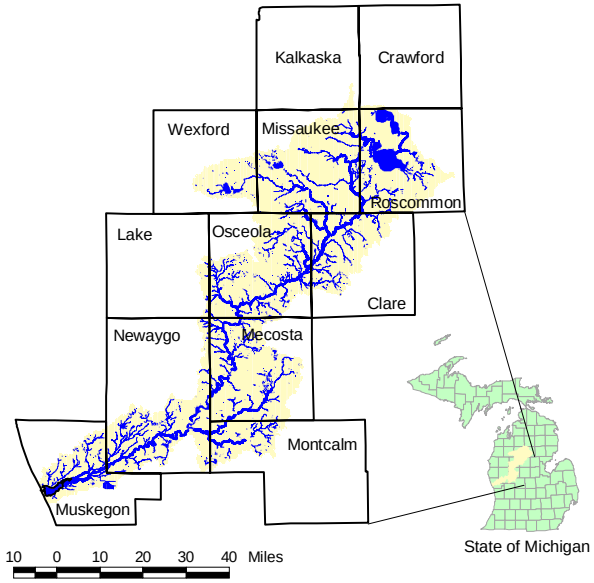

A **watershed** can be defined as the area of land that captures rainfall and other precipitation and funnels it to a particular river, lake, or stream. The Muskegon River Watershed drains approximately 2,723 square miles of land and is located in north-central Michigan. The river is approximately 219 miles long from its start at Houghton and Higgins Lakes down to its mouth at Muskegon Lake, and eventually, Lake Michigan.

The Muskegon River Watershed is one of the largest watersheds in the state of Michigan and spans the better part of nine counties. Cities and towns located within the boundaries of the Muskegon River Watershed include Cadillac, Lake City, McBain, Marion, Evart, Reed City, Big Rapids, Mecosta, Morley, Lakeview, Howard City, Newaygo, Fremont, and Muskegon.

Riparian landowners live on or adjacent to the banks of lakes, rivers, and streams. These waters offer boating, fishing, hunting, swimming, and other recreational opportunities. In addition, the natural aesthetic beauty of riparian areas provides us with a forum to view the wondrous workings of nature. Numerous species of plants and animals inhabit riparian areas and add to our enjoyment of the great outdoors.

User Note: Words printed in bold can be found under "Increasing Your Vocabulary" on page 22.

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It is important to understand the link between our everyday activities and the health of our waterways. Frequently, surface water and **groundwater** are impaired due to human actions. In particular, activities that affect riparian areas in turn affect the health of surface and groundwater. Unhealthy surface and groundwater can affect the economy of our community.

Some of the economic impacts caused by water pollution:

- *Decreased riparian property values*
- *Significant **erosion** of streambanks and shorelines*
- *Repeated dredging of ditches, streams, and resevoirs*
- *Increased flooding hazards from clogged drainage ways*
- *Increased potential for contamination of groundwater and other sources of drinking water*
- *Impacts to recreational and commercial fisheries*

This guidebook can help riparian landowners manage and maintain their property to ensure the continued existence of safe, clean, and natural waterways. It can also provide a better understanding of problems facing our water supplies and what preventative and corrective action we as landowners can put into effect. The guidebook is divided by issues that affect water quality, with possible problems and **best management practices (BMPs)** mentioned for each topic.

URBANIZATION AND WATER QUALITY

Lakes, rivers, and streams in urbanized or populated areas are severely affected by patterns of land use. Every aspect of the waterway is altered, including water quality, water levels, and aquatic habitat.

Urbanization is one of the major causes of **nonpoint source pollution (NPS)**. NPS pollutants do not have an identifiable entry point, such as a pipe, but rather come from many diffuse sources. NPS pollutants that affect our water resources include the following:

- *Invasive species*
- *Thermal pollution*
- ***Sediment**/eroded soil*
- *Nutrients/fertilizers*
- *Road salt*
- ***Hydrocarbons** (oil, gasoline)*
- *Heavy metals (cadmium, mercury)*
- *Herbicides/pesticides*

The following sources from residential areas contribute NPS pollutants to waterways:

1. *Urban runoff or stormwater*
2. *Lawn care and landscaping*
3. *Septic systems*
4. *Home construction/renovation*

New homes replace farmland. Photo courtesy of USDA-NRCS

Urban Runoff or Stormwater

Water that seeps into the ground recharges groundwater supplies. Groundwater provides many rivers and streams with a **base flow**. This base flow enables the rivers and streams to continue flowing during periods of drought. Water that cannot seep into the ground following a rain or snowmelt is called **runoff** or stormwater.

Problem

Development of land leads to an increase in hard, **impervious surfaces**, where rainwater cannot penetrate into the soil. Examples of impervious surfaces include parking lots, roads, driveways, sidewalks, and rooftops. These surfaces collect toxic pollutants, such as oil and gas, heavy metals (lead, mercury, and cadmium), fertilizers, and pesticides, which can be washed away during storms and discharged into nearby streams and lakes.

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These surfaces also prevent water from seeping into the ground. When stormwater is not able to seep into the ground, it must be collected and discharged through storm sewers, drainage ditches, or some other means of conveyance. Since most conveyances discharge directly into rivers and streams, serious effects on water quality can occur.

- *Stormwater picks up pollutants and sediment in its path and discharges them directly into surface water without prior treatment.*
- *Stormwater discharged through storm sewers reaches surface water quickly, often resulting in erosion problems and causing surface water levels to increase; high surface water levels can lead to severe and frequent flooding.*
- *An increase in stormwater runoff usually means a net loss to groundwater storage, and thus, base flow to rivers and streams decreases. As a result, these streams may dry up in the summer, killing aquatic wildlife.*
- *Excessive stormwater decreases the stability and diversity of the aquatic ecosystem.*

Increased volumes of stormwater runoff cause excessive streambank/shoreline erosion, which widens the waterway, and ultimately alters how water moves through the entire system. This is of great concern to all riparian landowners who stand to lose valuable property as their streambanks or shorelines wash away.

Many communities have begun to label storm sewers to discourage people from dumping any toxic materials. Photo courtesy of USDA-NRCS.

Pavement and other impervious surfaces, together with the use of ponds and other stormwater storage structures typical of storm sewer systems, can also lead to increased water temperatures. Problems associated with increased water temperatures are discussed more fully as part of "Thermal Pollution" found on page 20.

Best Management Practices and Prevention

• Create **buffer strips** of native vegetation along streambanks and shorelines to collect and filter stormwater. Buffer strips are areas of trees, shrubs, and other vegetation that border surface water. Native vegetation requires less maintenance, is more resistant to disease, and provides excellent habitat for wildlife. If interested in using native plants, please contact a local conservation district or visit the Springfield Township Native Vegetation Enhancement Project homepage or the Greenacres homepage for more information (see page 26). Areas with buffer strips should be void of any development.

Remember**…** The width of the buffer strip depends on the size of the water body, the type of buffer strip you plant, and the amount of runoff generated from your property. Buffers strips can range from 20 to 100 feet wide. Contact your local Department of Environmental Quality or USDA Natural Resources Conservation Service office for more information about the size and type of buffer strip you should plant (see pages 24 and 25).

Wetlands are natural systems that filter stormwater and release it slowly into lakes, streams, and rivers. Photo courtesy of GVSU-AWRI

• Protect **wetlands** and other environmentally sensitive areas. Wetlands provide habitat for wildlife and fish. They also help to collect stormwater, prevent erosion, and filter out water pollution.

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• Consider the use of conservation easements on lands adjacent to surface water. A conservation easement is a section of land where the right to develop has been donated or sold by a landowner to a government unit or nonprofit land trust. The landowner retains ownership. Although the landowner continues to pay property taxes, the owner may be eligible for income tax deductions, and estate and property tax reductions.

• **Rain gardens** can be used to convey stormwater back to groundwater storage, thus eliminating problems associated with increased stormwater velocity, volume, and temperature. These gardens are isolated pockets of natural or ornamental vegetation usually planted on fast draining material such as rocks, pebbles, or sand.

Lawn Care and Landscaping

Maintaining a healthy-looking lawn or garden can be an enjoyable and rewarding hobby. Surrounding your home with a beautiful landscape can enhance its value and provide an aesthetically pleasing environment. However, many products and practices involved in lawn maintenance and landscaping can have a negative impact on both surface water and groundwater quality. By incorporating a few minor changes and increasing your understanding of lawn care, gardening, and landscaping, these activities can be conducted without harming your community's water resources. In fact, your lawn can actually help prevent soil erosion, as well as filter out pollutants that may runoff from your roof or driveway.

Problem

How can yard care activities pollute water?

Fertilizers - Applying fertilizers or nutrients in excessive amounts, shortly before rainstorms, or too close to surface water, damages aquatic systems. When runoff containing fertilizers enters the waterway, the nutrients may cause algae blooms and growth of invasive weeds. The decay of these aquatic plants may deplete oxygen in the water, suffocating fish.

Pesticides - Insecticides, rodenticides, fungicides, and herbicides are collectively called pesticides. Applying pesticides in excessive amounts, or too close to surface water, is dangerous to human health and aquatic life. Pesticides (and fertilizers) can migrate into groundwater creating health risks in drinking water supplies. Pesticides in surface water can also be toxic to many aquatic insects, amphibians, fish, and plants.

Erosion - Exposed soil, especially on sloping ground, can quickly erode and be washed into surface water creating an excessive sediment load for the water body. Excess sediment in lakes, rivers, and streams destroys fish and insect habitat by covering it and by changing the temperature and oxygen levels in the water. Also, the eroding of riparian areas can undermine the foundations of nearby structures and homes.

Yard Wastes - Discarding leaves, grass, and branches in waterways can cause two problems: 1) as these wastes decompose, oxygen levels in the water are depleted, threatening the survival of fish and other aquatic life, and 2) nutrients are added to the water, often resulting in excessive growth of unwanted aquatic plants.

Best Management Practices and Prevention

- Plant buffer strips of native vegetation between waterways and lawn/garden areas. Vegetation, especially native species, has enormous potential for protecting waterways from a wide variety of pollutants. Buffer strips can do the following:

  - *Filter out sediment, fertilizers, pesticides, and other pollutants before they reach surface water*
  - *Prevent streambank erosion*
  - *Provide fish and wildlife habitat*
  - *Stabilize a stream*
  - *Reduce stream water temperature*
  - *Protect buildings and homes*

Test your soils for nutrient needs. Photo courtesy of USDA-NRCS

- Have your soil tested to determine proper amounts of fertilizer needed for lawn and garden activities. Tests are available from your local extension office (see MSU Extension Office, page 24).

- Fertilize and apply pesticides away from waterways.

- Read fertilizer and pesticide product labels carefully and follow directions to avoid over-application of these chemicals.

- Be sure that a rain event is not imminent so that fertilizers and pesticides will not be washed away.

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- Keep fertilizer away from sidewalks and driveways where it may be washed into surface water or storm sewers.

- Mulch grass clippings into the lawn to restore nutrients and diminish the need for chemical fertilizers.

- Dispose of yard wastes away from waterways, streambanks, or shorelines.

- Water lawns and gardens in the morning or evening when temperatures are cooler to maximize water absorption and retention.

- Use integrated pest management (IPM) to control pest populations without the excessive use of pesticides. An IPM program involves monitoring plants for signs of problems, determining acceptable levels of plant damage, and then applying only the control strategies necessary, such as physical and biological controls. Keep in mind that most insects in your lawn are not harmful. In fact, some insects are actually beneficial. Contact your local USDA Natural Resources Conservation Service office for more information about IPM programs (see page 25).

- Encourage animals to utilize your yard by landscaping for wildlife. Animals provide natural levels of pest control and add to the beauty of your land.

- Revegetate bare soil quickly to decrease erosion and soil losses. A quick cover can be supplied by planting annual rye grass.

- Substitute compost as a mulch and fertilizer for gardens and landscaping.

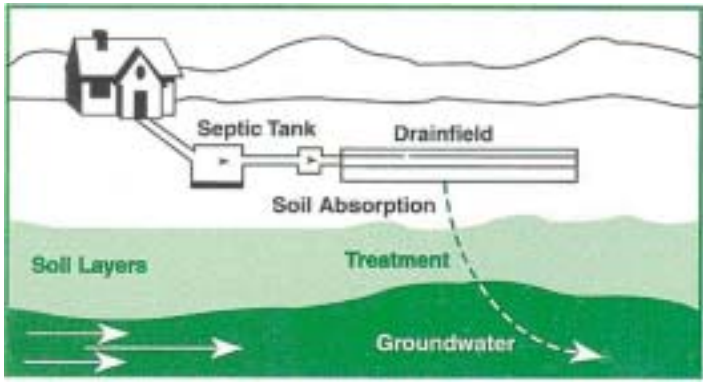
- Use commercial fertilizers with low amounts of nitrate and phosphate.

- Consider making your own pesticide by mixing 2 tablespoons of liquid soap with 1 quart of water and spraying on plants. Contact your local county extension office or the Department of Natural Resources for more tips on nontoxic gardening and lawn care (see page 24).

Remember**…** Your contribution of fertilizers, pesticides, erosion, and yard wastes may seem small. However, when combined with your neighbors' activities, the effect is greatly magnified and often results in damaged and unhealthy aquatic ecosystems.

Septic Systems

Septic systems are commonly used to dispose of household wastewater or **effluent**. Many older homes and rural communities depend upon septic systems, since public sewer systems may not be readily available. Onsite septic systems can be safe and efficient alternatives to public sewers if designed, installed, and maintained properly. In a septic system, household effluent is not transported to a community wastewater treatment plant. Instead, the system relies on natural bacteria in the septic tank to break down solid matter. The drainfield then transfers the liquid waste into the soil for treatment.



Problem

Septic system failure can lead to costly problems inside the home and to the pollution of both groundwater and surface water. Signs of a failing septic system include the following:

- *Sewage odors in your house or yard*
- *Slowly draining sinks and toilets*
- *Gurgling sounds in the plumbing or plumbing backups*
- *Soggy soil surrounding the septic tank or drainfield*
- *Lush green grass or excessive plant growth near the drainfield*
- *Excessive algae growth in nearby waters*

Malfunctioning septic systems can leak effluent with high concentrations of nutrients and bacteria to both surface water and groundwater. Nutrients reaching surface water can cause excessive growth of algae and other unwanted aquatic plants. Bacteria in surface water can create health risks for anybody directly contacting the water. Nutrients and bacteria in groundwater, as well as toxic and hazardous materials that get poured down household drains may impact drinking water in wells, creating a potential health risk.

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Best Management Practices and Prevention

How can you maintain an effective septic system?

- Know the capacity and location of your septic system.
- Inspect septic tank(s) regularly, at least every two years.
- Conserve water to avoid overloading the septic tank(s).
- Pump tank(s) out regularly, at least every three to five years.
- Divert other sources of water away from the drainfield through the use of roof drains, sump pumps, etc.
- Do not pave or build over a drainfield, and keep vehicles away from the septic tank and drainfield.
- Apply fertilizer away from the drainfield.
- Plant vegetative buffer strips along waterways to intercept septic system nutrients in groundwater and prevent them from entering waterways.

These materials should never be poured down household drains or flushed into toilets:

- *Motor oils/fuels*
- *Fats and greases*
- *Acids and cleaners*
- *Tampons*
- *Adhesive bandages*
- *Paper towels and facial tissues*
- *Filter tip cigarettes*
- *Disposable diapers*
- *Pesticides and fertilizers*
- *Paints, polishes, and solvents*
- *Hair*

Remember… Chemicals added to septic systems can kill naturally occurring bacteria that are responsible for breaking down the solid wastes. Without these microorganisms, septic systems will not function properly. Paper products, other than toilet paper, create an abundance of solid wastes, which can clog a septic system.

For more information about the proper installation and maintenance of septic systems, contact your local county health department (see page 25).

Home Construction/Renovation

Homeowners, especially those in riparian areas, should be aware of the potential pollution hazard that construction activities might cause. If large amounts of land are cleared and graded, the exposed soil becomes susceptible to erosion.

Care should be taken to ensure that sediment is not lost during rain events. Photo courtesy of USDA-NRCS

Problem

During rains, runoff carries eroded soil (or sediment) into the nearest drain or waterway. Sediment not only pollutes waterways, but it also clogs drains and channels and fills up detention ponds. This leads to increased flooding risks as well as inflated costs to maintain such structures.

Sediment buildup covers and destroys aquatic habitat.

Chemicals and hydrocarbons from materials commonly used during construction activities can also be picked up through surface water runoff and be washed into waterways.

Sediment is seen in the street because measures were not taken to protect the soil from erosion during development. Photo courtesy of USDA-NRCS

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Best Management Practices and Prevention

- Erosion control practices, which can help prevent **sedimentation** and runoff problems, can be easily installed prior to the onset of construction/renovation activities. Options for pollution control include the following practices:

  - *Minimize cleared and exposed areas during construction. Staging development of the construction site helps to decrease overall erosion losses.*
  - *Install silt fencing along the edges of the site. Silt fencing can be an effective control of eroded soils. However, silt fencing must be dug six inches into the ground and backfilled in order to be effective.*
  - *Leave strips of vegetation along the edges of the site. Vegetative buffer strips help slow runoff velocity and catch sediment.*
  - *Revegetate the area soon after construction. Even before construction activities cease, exposed soil should be seeded to prevent erosion problems. Annual rye grass is a quick, short-lived groundcover that works well in these situations.*

Streambank / Shoreline Care

Problem

Streambanks and shorelines with sparse vegetation are fragile and susceptible to erosion. Frequent human and animal traffic in these areas can increase erosion. Erosion leads to sediment pollution in lakes and streams, which can result in the following:

- *Degraded aquatic and riparian habitat*
- *Reduced water clarity, light penetration, and plant productivity*
- *An undesirable environment for fish feeding and spawning, and recreation*
- *Changes in the lake or stream bottom and increased flooding*

Fallen trees, stumps, or debris along streambanks and shorelines often provide excellent habitat for fish and wildlife. However, sometimes this debris diverts water into eroding banks or blocks the flow of water into wetlands. The riparian landowner's decision to leave or remove fallen debris can often be difficult. Riparian landowners often take streambank and shoreline stabilization and maintenance into their own hands to correct problems. Sometimes these actions do more harm than good to the water body.

Best Management Practices and Prevention

- Keep people, bicycles, cars, grazing animals, off-road vehicles, and heavy objects away from unprotected streambanks and shorelines.

- Maintain vegetative buffer strips along streambanks and shorelines to prevent surface water runoff from flowing into these waterways.

This streambank is stabilized with vegetation and riprap to protect the homes bordering this waterway. Photo courtesy of USDA-NRCS

- Consult a professional landscaper or architect for solutions to control erosion and stabilize streambanks and shorelines. **Riprap** (piles of stone, rock, or broken concrete) is one stabilization technique for property next to surface water. Caution in the use of riprap is recommended in that it can often lead to impacts on adjacent property.

- Avoid construction near streambanks and shorelines. Contact the Michigan Department of Environmental Quality (see page 24) before building steps, ramps, seawalls, or other structures near or over surface water. A permit may be required. The Michigan Department of Environmental Quality can also offer advice on the removal of fallen trees, stumps, etc. from surface water.

AGRICULTURE AND WATER QUALITY

Agriculture is an important land use in many watersheds. While agriculture provides significant areas of open space and wildlife habitat, it may also impact water quality. Sediment, fertilizers, pesticides, and animal wastes from agricultural practices can all be washed into surface water. In addition, some chemicals used in agricultural practices can leach into groundwater supplies.

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The following sources from agricultural areas contribute pollutants to waterways:

1. *Erosion and sedimentation*
2. *Manure storage/management*
3. *Nutrient/pest management*

Small farms with orchards, crops, and windbreaks. Photo courtesy of USDA-NRCS

Erosion and Sedimentation

Farmers should be aware of the potential pollution problem that agricultural practices might cause. Large amounts of land that are left exposed and unprotected, especially on sloping ground, become susceptible to erosion. Erosion is the result of water runoff, wind, and frequent animal traffic.

Problem

Erosion adds sediment to waterways, which can fill farm ponds, ditches, streams, and lakes. It covers insects and fish eggs, and damages fish gills. Sediment also makes the water more turbid, or cloudy, which makes recreational activities difficult and creates an unpleasant appearance. In addition, erosion leads to the loss of topsoil and crop damage.

Best Management Practices and Prevention

- Farmers should use conservation measures to help minimize the pollution of water resources. Protective groundcover on crops and grazing lands is one of the best methods of preventing erosion and sedimentation. Erosion control methods include the following:

- *Crop residue management*
- *Contour farming*
- *Grade control structures across drainage ways*
- *Grass or tree planting*
- *Strip cropping and crop rotations*
- *Leaving wetlands alone*
- *Windbreaks and vegetative barriers*
- *Buffer strips, or filter strips in a contoured field along waterways*
- *Cover crops, such as cereal rye, oats, winter wheat, or legumes*
- *Minimizing livestock access to streams and streambanks*
- *Providing off-stream watering for livestock*
- *Installing a water crossing for livestock and farm equipment*
- *Placing rock riprap along the streambank*
- *Installing water and sediment control basins*

Remember**…** Controlling erosion and sedimentation protects streambanks, improves wildlife habitat, increases water quality, and reduces the impacts of water, wind, and grazing. It also adds to the efficiency and production of grazing lands, and saves time, energy, and labor on croplands, therefore increasing profits.

For further information or questions, please contact your local USDA Natural Resources Conservation Service or Conservation District office (see page 25).

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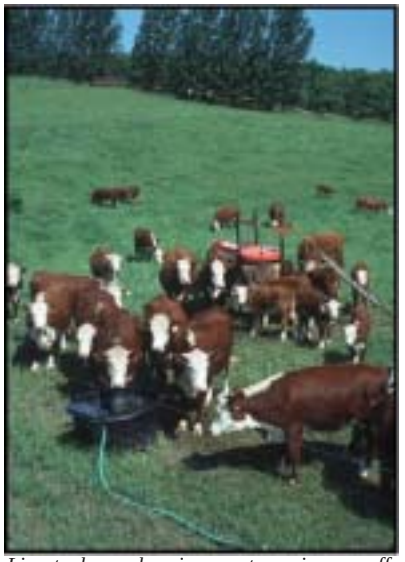
Crop residue increases water absorption and reduces the volume of surface water. Photo courtesy of USDA-NRCS

Grassed contour buffer strips cover an entire field. Photo courtesy of USDA-NRCS



Livestock can be given water using an off-stream portable watering system in the pasture. Photo courtesy of USDA-NRCS

Manure Storage/Management

Proper manure management can prevent runoff from feedlots, cut fertilizer costs, reduce nutrient losses, and allow for field application under the appropriate conditions.

Problem

Farmsteads (the buildings of a farm) have more potential to pollute drinking water supplies, streams, lakes, and other water sources than any other part of the farm. Improper management of manure can lead to manure runoff into nearby water bodies resulting in nutrient loss for the farmer and downstream water pollution.

Best Management Practices and Prevention

Manure from a livestock yard can run off into a nearby stream and degrade water quality. Photo courtesy of USDA-NRCS

- Install manure storage structures in order to safely contain manure so it can be applied to crops when soil conditions are right. Manure stacking facilities will keep rainwater from mixing with manure and creating runoff.

- Compost animal manure and carcasses. Compost can be applied to crops to reduce the amount of fertilizer needed by increasing soil organic matter and soil nutrients.

- Divert farmstead runoff away from animal feedlots and erosive areas.

- Store manure in a lagoon in order to break down waste material and reduce the concentration of nutrients.

- Provide buffer strips around manure storage structures and lagoons to filter any runoff and improve appearance.

- Test manure to determine nutrient content and prevent over-application to fields.

Remember… The best system for animal waste management depends on local environmental regulations, the number and type of animals, type of confinement, fertilizer needs, location of water sources, and the location of residences around the livestock operation. Contact your local USDA Natural Resources Conservation Service or Conservation District office for more information (see page 25).

Nutrient/Pest Management

The use of fertilizers and pesticides is a common practice in agriculture. Knowing the correct amount, form, and application method of these chemicals is important for reducing costs, producing optimum yield, and minimizing the impact on water quality. Sources of nutrients include animal manure, sludge, and commercial fertilizers. Sources of pesticides include insecticides, rodenticides, fungicides, and herbicides.

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Problem

Nutrients and pesticides that are not applied correctly can be toxic to humans, wildlife, livestock, and aquatic plants and animals. The potential health affects can be short term or long term. Excess phosphate in waterways also contributes to the enrichment of water causing excess algae growth and oxygen depletion, which can result in fish kills, reduced recreational opportunities, and reduced aesthetic values.

Algae overtakes this lake. Photo courtesy of USDA-NRCS

Water with excessive nutrients. Photo courtesy of USDA-NRCS

Nutrients and pesticides can be washed into lakes and streams during storms or they can leach into groundwater harming drinking water supplies.

Best Management Practices and Prevention

- Sample and test your soils, manure, compost, or other material regularly for nutrient content. Tests are available from your local county extension office (see MSU Extension Office, page 24).

- Read and follow fertilizer and pesticide product label instructions carefully, use spot applications when possible, and always calibrate your spray equipment.

• Maintain buffer strips to minimize **erosion** and runoff. Buffer strips filter out nutrients and sediment before they reach surface water. They also provide habitat for many beneficial plants, insects, frogs, birds, and other wildlife.

• Encourage diversity of plants and animals.

• Grow healthy, well-adapted crops that are less likely to be affected by pests.

Use a stopwatch to calibrate your sprayer prior to applying fertilizers and pesticides. Photo courtesy USDA-NRCS

• Monitor insect, disease, and weed populations to know when you need to apply pesticides.

• Use integrated pest management (IPM) for effective and economic control of pests, including insects, diseases, and weeds. Farmers using IPM techniques monitor for specific pests and apply only the necessary pesticides for adequate control.

• Apply fertilizers and pesticides during periods of minimal runoff potential.

• Use conservation crop rotations to break pest cycles.

• Use cover crops and mulches to smother weeds, and narrow plant spacing to outcompete weeds.

• Compost animal manure and carcasses. Carcasses and manure compost can be applied to crops to reduce the amount of commercial fertilizer needed by increasing soil organic matter and soil nutrients.

• Use commercial fertilizers with low amounts of nitrate and phosphate.

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THERMAL POLLUTION

Thermal pollution is both an urban and a rural concern. It occurs in areas where water bodies are exposed to sunlight, darkened by sediment, and/or fed by stormwater. These unwanted inputs can come from eroding farm fields, exposed ditches, riverside lawns, or city streets. It is a problem that can occur wherever riparian areas are cleared and developed.

There is an important relationship between water temperature and the amount of **dissolved oxygen** the water holds. The warmer the water, the less dissolved oxygen present. The amount of oxygen in water affects the life it can support. Many aquatic organisms, such as trout, require cold water with high levels of dissolved oxygen.

Problem

Thermal pollution results when there is a lack of shade coverage over a stream and water temperatures rise too high to support the aquatic life that would normally exist in that stream. Therefore, removing streambank vegetation reduces the amount of shade coverage, increases thermal pollution, and reduces the diversity of organisms that the stream can support.

Sediment in the water also can lead to thermal pollution because sediment darkens the water allowing more sunlight to be absorbed. At the same time, sediment blocks sunlight from reaching aquatic plant life, and therefore, slows or stops plant growth. Since plants add oxygen to the water, oxygen levels can become too low to support aquatic life. In addition, the buildup of sediment makes the stream shallower, and water temperature rises faster in shallower water.

Streams with no conservation buffers are at high risk for thermal pollution. Photo courtesy of USDA-NRCS

Best Management Practices and Prevention

Maintaining natural streambank vegetation is the best way to prevent thermal pollution. Streambank vegetation can have the following affects:

- *Provide shade to help keep water temperatures low enough to support cold-water fish populations such as trout*
- *Provide habitat for aquatic organisms such as crayfish, which tend to live in streambanks that are shaded*
- *Act as a buffer strip to prevent sediment from entering the stream system*

CONCLUSION

Riparian landowners enjoy many benefits from living on or adjacent to lakes, rivers, and streams. But with the many attractions comes responsibility. It is the responsibility of each riparian landowner and all people accessing waterways to: 1) increase their awareness of activities that impact surface water and groundwater, and 2) practice pollution prevention techniques to help keep our waterways and water supplies safe, clean, and healthy.

INCREASING YOUR VOCABULARY

Aquifer - an underground layer of porous rock or sand containing water in which wells can be developed for drinking water or other purposes.

Base Flow - the water in the stream that is not due to direct runoff from precipitation; it is usually supported by water entering from natural storage in groundwater, lakes, or wetlands.

Best Management Practices (BMPs) - any structural, vegetative, or managerial practice used to treat, prevent, or reduce water pollution.

Buffer Strip - an area of trees, shrubs, and other vegetation located in areas adjacent to and up gradient of water bodies. Buffer strips range from twenty to 100 feet wide depending on the type of buffer strip planted, the size of the water body, and the amount of runoff generated from a piece of property.

Dissolved Oxygen - the amount of gaseous oxygen (O_2) dissolved in water.

Effluent - outflowing liquid waste.

Erosion - the process in which soil particles are detached and transported away by wind, water, or frequent traffic.

Groundwater - water that is found beneath the earth's surface.

Hydrocarbon - any compound containing only hydrogen and carbon, such as oil and gasoline.

Impervious Surface - a surface through which little or no water will move, including paved parking lots and rooftops.

Nonpoint Source (NPS) Pollution - pollution that is not traceable to one particular source and is occurring at locations scattered throughout the drainage basin; typical sources include erosion, agricultural activities, and urban runoff.

Rain Garden - a garden, usually of native plants, used to direct stormwater back into groundwater supplies in order to reduce the amount of stormwater that enters local streams, rivers, and lakes.

Riparian - pertaining to the shoreline of a lake, river, or stream, and the bordering land area.

Riprap - a permanent cover of rocks, stones, or broken concrete used to stabilize streambanks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. Caution in the use of riprap is recommended in that it can often lead to adverse impacts on adjacent property.

Runoff - water that does not soak into the soil. Instead, it moves along the surface of the ground flowing toward surface water, drains, and other low points. Surface runoff often carries pollutants into these areas.

Sediment - solid fragments of organic and inorganic materials resulting from erosive processes.

Sedimentation - the phenomenon of sediment or gravel accumulation.

Watershed - a defined land area in which all surface water drains to a common point either by groundwater or surface water flow. Watersheds vary a great deal in size; some watersheds are large enough to include other small watersheds. For example, the Muskegon River Watershed is part of the Lake Michigan Watershed.

Wetland - an area that is saturated with water to the surface for a sufficient time to promote the growth of water dependent plants and/or the development of saturated soils; typically characterized by swamps, marshes, etc.

ANNIS WATER RESOURCES INSTITUTE

ENVIRONMENTAL CONTACTS

ENVIRONMENTAL CONCERNS/QUESTIONS

Michigan Department of Environmental Quality
Surface Water Quality Division
P.O. Box 30273 — Phone: (517) 373-1949
Lansing, MI 48909-7773 — Fax: (517) 373-9958

Michigan Department of Natural Resources
Information Services
P.O. Box 30711 — Phone: (517) 373-1214
Lansing, MI 48909 — Fax: (517) 373-9510

Robert B. Annis Water Resources Institute
Lake Michigan Center
740 W. Shoreline Drive — Phone: (231) 728-3601
Muskegon, MI 49441 — Fax: (616) 331-3864

Michigan State University Extension Office
Agriculture Hall, Room 108
Michigan State University — Phone: (517) 355-2308
East Lansing, MI 48824 — Fax: (517) 355-6473

SOIL EROSION AND SEDIMENTATION PREVENTION

Michigan Department of Environmental Quality
Land and Water Management Division
P.O. Box 30458 — Phone: (517) 373-1170
Lansing, MI 48909 — Fax: (517) 373-9965

WETLAND AND HABITAT IMPROVEMENT AND PROTECTION

Michigan Department of Environmental Quality
Land and Water Management Division
P.O. Box 30458 — Phone: (517) 373-1170
Lansing, MI 48909 — Fax: (517) 373-9965

Timberland Resources Conservation and Development Area Council, Inc.
6655 Alpine Avenue, NW, Suite 2 — Phone: (616) 784-1090
Comstock Park, MI 49321 — Fax: (616) 784-1268

AGRICULTURAL PRACTICES AND MANAGEMENT

Natural Resources Conservation Service
Grand Rapids Service Center
3260 Eagle Park Drive, NE, Suite 103 Phone: (616) 942-4111
Grand Rapids, MI 49525-4569 Fax: (616) 940-1403

Michigan Association of Conservation Districts
201 N. Mitchell Street, Suite 204 Phone: (231) 876-0328
Cadillac, MI 49601 Fax: (231) 876-0372

U.S.D.A. Agricultural Stabilization and Conservation Services
Kent County ASCS Office
3260 Eagle Park Drive, NE, Suite 101 Phone: (616) 942-4111
Grand Rapids, MI 49525

SEPTIC SYSTEM AND SEWAGE MANAGEMENT

Central Michigan District Health Department
2012 E. Preston Avenue Phone: (517) 772-8147
Mt. Pleasant, MI 48858 Fax: (517) 773-4319
Counties served within the Muskegon River Watershed: Clare, Osceola, Roscommon

District Health Department #10
401 Lake Street Phone: (231) 775-9942
Cadillac, MI 49601 Fax: (231) 775-5372
Counties served within the Muskegon River Watershed: Lake, Mecosta, Missaukee, Newaygo, Wexford

Mid-Michigan District Health Department
615 N. State Road, Suite 2 Phone: (517) 831-5237
Stanton, MI 48888 Fax: (517) 831-5522
Counties served within the Muskegon River Watershed: Montcalm

Muskegon County Health Department
209 East Apple Ave., Suite D104 Phone: (231) 724-6311
Muskegon, MI 49442 Fax: (231) 724-6674
Counties served within the Muskegon River Watershed: Muskegon

Muskegon County Wastewater Management System
8301 White Road Phone: (231) 724-3440
Muskegon MI 49442 Fax: (231) 724-3588

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YOU CAN ALSO VISIT THE FOLLOWING WEBSITES

Robert B. Annis Water Resources Institute
http://www.gvsu.edu/wri/index.htm

Greenacres
http://www.epa.gov/greenacres/

Michigan Association of Conservation Districts
http://www.macd.org/macdset.html

Michigan Department of Natural Resources
http://www.michigan.gov/dnr

Michigan Department of Environmental Quality
http://www.michigan.gov/deq

Michigan County Health Departments
http://michiganstartpages.com/michigan/health/departments.htm

Michigan Natural Resources Conservation Service
http://www.mi.nrcs.usda.gov/

Michigan State University Extension
http://www.msue.msu.edu/home/

Muskegon County Wastewater Management System
http://www.co.muskegon.mi.us/wwtf.htm

Springfield Township Native Vegetation Enhancement Project
http://www.epa.gov/glnpo/ecopage/springfieldtwp/

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Developing Sustainable Futures for the Muskegon River Watershed:
A Decentralized Approach

Partners: Michigan State University; Land Conservancy of West Michigan; The Nature Conservancy; and Langworthy, Strader, and LeBlanc, Inc.

Project goals are to find areas in the landscape that are important ecologically and particularly vulnerable to development, and to provide a strong information and education program necessary to protect natural resources and minimize development risks. Funding for this project is provided by the Wege Foundation, with additional support from the Fremont Area Community Foundation.

Grand Valley State
ANNIS WATER RESOURCES INSTITUTE
Lake Michigan Center

Do your part to protect our lakes and streams