SECTION 6: SELECTING MEASURES FOR IMPROVEMENT / BMPS TO APPLY

Improve Water Quality

The Steering Committee has identified the most significant causes of impairment to the Elkhart River Watershed as excessive concentrations of sediment, *E. coli*, and nutrient loads. The most significant identified sources of impairment to streams include row cropping practices, livestock directly accessing the waterway, municipal point sources, land development/construction, urban runoff/storm sewers. In general, the diverse and diffuse nature of nonpoint pollutant sources presents a challenge for improving water quality.

Determine BMPs to Achieve Load Reductions

The watershed restoration and management techniques described in this section, when applied to the Elkhart River Watershed, can help achieve the Watershed goals and objectives to decrease the concentrations of sediment, *E. coli*, and nutrient loads identified in this WMP. Selecting measures and BMPs for improvement are categorized as being either preventative or remedial in nature.

Preventative measures reduce the likelihood that new watershed problems such as water quality degradation will arise or that existing problems will worsen. Preventative techniques generally target new development in the Watershed and are geared toward protecting and preventing degradation of existing resources. Planning, regulatory, and administrative programs and alternative site designs are examples of preventative measures. Prevention also includes measures that protect the natural drainage system through land acquisition and conservation management.

Preventative BMPs include:

- Exclusion Fencing
- Rotational Grazing
- Nutrient Management Plan
- Manure Management Plan
- Alternative Watering System
- No-till/Reduced Till (Conservation Tillage)
- Grassed Waterways
- Buffers/Filter Strips
- Cover Crop
- Rain Barrel/Rain Gardens
- Green Roof
- Pervious Paving Options
- Soil Infiltration Trench
- Natural Stream Buffer

Remedial measures are used to solve known watershed problems or to improve current watershed conditions. Remedial measures include retrofitting drainage system infrastructure such as detention basins and stormsewer outfalls to improve water quality, adjust release rates, or reduce erosion. Water quality problems can be addressed by installing measures that improve infiltration and reduce runoff. Examples include disconnecting downspouts from storm sewers, installing biofilters, and re-landscaping with deep-rooted native vegetation. Other remedial techniques range from stabilizing eroded streambanks to restoring wetlands.

Remedial BMPs include:

- Grade-Stabilization Structures
- Wetland Restoration
- Naturalized Wet-bottom Detention Basin
- Filtration Basin
- Sand Filter
- Bioretention Practices

To choose an appropriate BMP, it is essential to determine in advance the objectives to be met by the BMP and to calculate the cost and related effectiveness of alternative BMPs. Once a BMP has been selected, expertise is needed to insure that the BMP is properly installed, monitored, and maintained over time. BMPs to consider for the Elkhart River Watershed and their potential effectiveness in meeting water quality objectives are found in Table 45.

Table 45. BMP effectiveness toward meeting BMP watershed objectives.

	BMP EFFECTIVENESS						
BEST MANAGEMENT PRACTICE	**Runoff Rate Control**	**Runoff Volume Control**	**Physical Habitat Preservation**	**Sediment Pollution Control**	**Nutrient Control**	**BOD Control**	**Other* Pollutant Control**
Impervious Area Reduction	2	2	2	2	2	2	2
Impervious Area Disconnection	2	2	1	2	2	2	2
Filter Strips	2	2	2	2	2	2	2
Swales	2	2	1	2	2	2	2
Infiltration Devices	2	3	1	3	3	3	3
Porous Pavement	2	2	1	3	3	3	3
Wet Detention	3	1	2	3	2	3	2
Wetland Detention	3	1	2	3	2	3	2
Dry Detention	2	1	1	2	1	1	1
Settling Basins	2	1	1	2	2	2	2
Water Quality Inlets	1	1	1	2	1	1	1
Sand Filters	1	1	1	3	2	2	2
Rock Outlet Protection	1	1	2	2	1	1	1
Storage Area Cover	1	1	1	2	2	1	2-3
Street Sweeping	1	1	1	1-2	1	1-2	1-2
Source Controls	1	1	1	1	2	2	2
Stream Protection/ Restoration	2	1	3	2	2	2	1

Effectiveness Key:

3 = Fully achieves objective

2 = Partially achieves objective

1 = Does not achieve objective

* Other pollutants include toxic compounds such as heavy metals and pesticides, fecal bacteria, petroleum based hydrocarbons and deicing materials such as salt. A "2" in this column indicates that the BMP controls some of these pollutants but not others.

Source: Dreher (1994)

Tables 46 through 49 depict percentage pollutant removal rates for different BMPs from data collected and reported by the Center for Watershed Protection (CWP) in June 1997. These removal efficiencies are based on one hundred twenty-three performance-monitoring studies that the CWP compiled into a database. Because performance can be extremely variable within a group of BMPs, estimates of BMP performance should be considered as a long-term average, not as a fixed or constant value.

Table 46. Comparison of Median Pollutant Removal Efficiencies among selected BMP groups: Conventional pollutants.

Median Stormwater Pollutant Removal Rate (%)							
Best Management Practice	**No. of Studies**	**Total Suspended Solids**	**Total Phosphorus**	**Soluble Phosphorus**	**Total Nitrogen**	**Nitrate**	**Organic Carbon**
Detention pond	2	7	10	2	5	3	(-1)
Dry Extended Detn. Pond	6	61	19	(-9)	31	9	25
Wet pond	30	77	47	51	30	24	45
Wet Extended Detn. Pond	6	60	58	58	35	42	27
PONDS [A]	36	67	48	52	31	24	41
Shallow marsh	14	84	38	37	24	78	21
ED* wetland	5	63	24	32	36	29	ND
Pond/wetland	11	72	54	39	13	15	4
WETLANDS	35	78	51	39	21	67	28
Surface sand filters	6	83	60	-37	32	(-9)	67
FILTERS [B]	11	87	51	-31	44	(-13)	66
CHANNELS	9	0	(-14)	(-15)	0	2	18
SWALES [C]	9	81	29	34	ND	38	67

[A] Excludes conventional and dry Extended Detention ponds.

[B] Excludes vertical sand filters and vegetated filter strips

[C] Includes biofilters, wet swales and dry swales

- A negative number indicates that there is an increase in the amount of pollutant present in the water

ND – no data

Table 47. Median Pollutant Removal reported for selected BMP groups: Fecal coliform, hydrocarbons and selected trace metals.						
	Median Stormwater Pollutant Removal Rate (%)					
Best Management Practice	**Bacteria [C]**	**Hydro-Carbons [D]**	**Cadmium**	**Copper**	**Lead**	**Zinc**
Detention and Dry Extended Detention Ponds	ND	ND	54	26	43	26
Ponds [A]	65	83	24	57	73	51
Wetlands	77	90	69	39	63	54
Filters [B]	55	81	--	34	71	80
Biofilters, wet swales, and dry swales	(-50)	62	42	51	67	71

[A] Excludes conventional and dry extended detention ponds.
[B] Excludes vertical sand filters and vegetated filter strips
[C] Bacteria values represent mean removal rates.
[D] Hydrocarbons measured as total petroleum hydrocarbons or oil/grease.
ND - no data

Table 48. Potential Pollutant Removal Capability of Urban Stream Buffers	
Pollutant	**Potential Removal Rate***
Sediment	75%
Total nitrogen	40%
Total phosphorus	50%
Trace metals	60-70%
Hydrocarbons	75%

Source: Schueler (1995).

*Potential removal rate based on combined 25-foot grass strip in outer zone and 75 foot forested buffer in middle and streamside zone.

Table 49. Potential Pollutant Removal Capability of Agricultural Stream Buffers	
Pollutant	**Potential Removal Rate***
Sediment	75%
Total nitrogen	40%
Total phosphorus	50%
Trace metals	60-70%
Hydrocarbons	75%

Source: Schueler (1995).

*Potential removal rate based on combined 25-foot grass strip in outer zone and 75 foot forested buffer in middle and streamside zone.

BMPs Chosen

Based on what is practical for this Watershed and what BMPs will provide the most cost effective pollutant reduction, the Steering Committee has chosen eleven agricultural BMPs and ten urban BMPs to help achieve the Watershed goals and objectives by decreasing the concentrations of sediment, *E. coli*, and nutrient loads.

Agricultural Best Management Practices:

1. Exclusion Fencing
2. Rotational Grazing
3. Nutrient Management Plan
4. Manure Management Plan
5. Alternative Watering System
6. No-till/Reduced Till (Conservation Tillage)
7. Grassed Waterways
8. Buffers/Filter Strips
9. Grade-Stabilization Structures
10. Cover Crop
11. Wetland Restoration

Urban Best Management Practices:

1. Rain Barrel/Rain Garden
2. Naturalized Wet-bottom Detention Basin
3. Filtration Basin
4. Green Roof
5. Pervious Paving Options
6. Soil Infiltration Trench
7. Sand Filter
8. Bioretention Practices
9. Natural Stream Buffer
10. Wetland Restoration

Implementing Agricultural Practices

Current landuse data indicate that 80.6% of the Elkhart River Watershed is used for agricultural purposes. The Natural Resource Conservation Service (NRCS) publishes guidelines for farmers to prevent soil erosion and to improve or protect water quality and water resources. The following information was taken from the NRCS Field Office Technical Guide (FOTG). Several of these practices described below are similar to BMPs for riparian sites (such as filter strips and buffers), but specific suggestions are given for agricultural sites. Table 46 illustrates pollutant removal efficiencies for the remainder of selected agricultural BMPs.

1. Exclusion Fencing

The impacts of livestock grazing riparian areas include manure and urine deposited directly into or near surface waters where leaching and runoff can transport nutrients and pathogens into the water. Unmanaged grazing may accelerate erosion and sedimentation into surface water, change stream flow, and destroy aquatic habitats. Improper grazing can reduce the capacity of riparian areas to filter contaminates, shade aquatic habitats, and stabilize stream banks.

A livestock exclusion system is a system of permanent fencing (board, barbed, etc) installed to exclude livestock from streams and critical areas, not intended for grazing, to reduce erosion, sedimentation, and to improve the quality of surface water.

2. Rotational Grazing

Intensive grazing management is the division of pastures into multiple cells that receive a short but intensive grazing period followed by a period of recovery of the vegetative cover. Pasture management practices that include the use of rotational grazing systems are beneficial for water and soil quality. Systems that include the riparian area as a separate pasture are beneficial because livestock access to these areas is controlled to limit the impact on the riparian plant communities.

3. Nutrient Management Plan

Nutrient management is the management of the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize the transport of applied nutrients into surface water or groundwater. Nutrient management seeks to supply adequate nutrients for optimum crop yield and quantity, while also helping to sustain the physical, biological, and chemical properties of the soil.

Nutrient management plans are developed with assistance from NRCS. A nutrient budget for nitrogen, phosphorus, and potassium is developed considering all potential sources of nutrients including, but not limited to, animal manure, commercial fertilizer, crop residue, and legume credits. Realistic yields are based on soil productivity information, potential yield, or historical yield data based on a 5-year average. Nutrient management plans specify the form, source, amount, timing, and method of application of nutrients on each field in order to achieve realistic production levels while minimizing transport of nutrients to surface and/or groundwater.

4. Manure Management Planning

Animal waste is a major source of pollution to waterbodies. To protect the health of aquatic ecosystems and meet water quality standards, manure must be safely managed. Good management of manure keeps livestock healthy, returns nutrients to the soil, improves pastures and gardens, and protects the environment, specifically water quality. Poor manure management may lead to sick livestock, unsanitary and unhealthy conditions for humans and other organisms, and increased insect and parasite populations. Proper management of animal waste can be done by implementing BMPs, through safe storage, by application as a fertilizer, and through composting.

4.1 Manure Management

Proper storage of manure is extremely important. There are many different types of manure storage facilities ranging from solid manure storage systems to lagoons or slurry systems. Different types of storage systems are site-specific depending on the site's nutrient concentrations, proximity to water sources, type of livestock, availability of land application equipment, and manure form and consistency. Prevailing wind direction, slope of ground, and soil type should also be considered when selecting a manure storage facility. By properly and safely storing animal waste, the input of toxic materials, such as fecal coliforms, to nearby streams and rivers will decrease.

4.2 Application and Spreading

Manure is full of vital nutrients (nitrogen, potassium, and phosphorous) required for soil fertility and plant growth. Simple reapplication of manure may also eliminate the need for expensive storage facilities. For safe application, manure should be applied away from natural drainage ways, a minimum of 100 ft away from a water source, and incorporated into the soil as soon as possible. Manure can be a beneficial resource when it is used as efficient fertilizer.

4.3 Composting

The addition of manure to other decaying organic matter to compost is another valuable and safe practice to manage animal waste. Composting reduces the volume of manure, kills parasites, reduces weed seeds, provides slow release fertilizer, reduces odor, and increases soil fertility. Compositing requires 2/3 oxygen, 50% moisture, 30:1 carbon to nitrogen ratio, and warm temperatures.

5. Alternative Watering System

Alternative watering systems (e.g. nose pumps or gravity flow systems) protect surface water by eliminating livestock's direct access to the stream. Providing an alternative watering source for livestock reduces soil erosion and sedimentation and improves surface water quality. Alternative watering systems help to provide additional bank stabilization and assist in the preservation of riparian buffers through a reduction in compaction.

6. No-till/Reduced Till (Conservation Tillage)

6.1 Residue Management, No-till/Strip Till

This practice manages the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round, while growing crops planted in narrow slots or tilled, residue free strips previously untilled by full-width inversion implements. The purpose of this conservation practice is to reduce sheet and rill erosion thereby promoting improved water quality. Additional benefits of this practice are to reduce wind erosion, to maintain or improve soil organic matter content and tilth, to conserve soil moisture, to manage snow, to increase plant available moisture or reduce plant damage from freezing or desiccation, and to provide food and escape cover for wildlife. This technique includes tillage and planting methods commonly referred to as no-till, zero till, slot plant, row till, direct seeding, or strip till.

Residue management is when loose residues are left on the field, and then uniformly distributed on the soil surface to minimize variability in planting depth, seed germination, and emergence of subsequently planted crops. When combines or similar machines are used for harvesting, they are equipped with spreaders capable of distributing residue over at least 80% of the working width. No-till or strip till may be practiced continuously throughout the crop sequence, or may be managed as part of a system which includes other tillage and planting methods such as mulch till (see below). Production of adequate amounts of crop residues is necessary for the proper functioning of this conservation practice and can be enhanced by selection of high residue producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacings.

Maintaining a continuous no-till system will maximize the improvement of soil organic matter content. Also, when no-till is practiced continuously, soil reconsolidation provides additional resistance to sheet and rill erosion. The effectiveness of stubble to trap snow or reduce plant damage from freezing or desiccation increases with stubble height. Variable height stubble patterns may be created to further increase snow storage.

6.2 Residue Management, Mulch till

Mulch tillage manages the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field surface is tilled prior to planting. The purpose of this conservation practice is to reduce sheet and rill erosion, which leads to improved water quality. Additional benefits are the same as no-till practices. It applies to stubble mulching on summer-fallowed land, to tillage for annually planted crops, and to tillage for planting perennial crops.

Mulch till may be practiced continuously throughout the crop sequence, or may be used as part of a residue management system that includes other tillage methods such as no-till. Like no-till, mulch till requires production of adequate amounts of crop residue to function properly.

7. Grassed Waterways

Grassed waterways are natural or constructed channels established for transport of concentrated flow at safe velocities using adequate vegetation. They are generally broad and shallow by design to move surface water across farmland without causing soil erosion. Grassed waterways are used as outlets to prevent rill and gully formation. The vegetative cover slows the water flow, minimizing channel surface erosion. When properly constructed, grassed waterways can safely transport large water flows downslope. These waterways can also be used as outlets for water released from contoured and terraced systems and from diverted channels. This BMP can reduce sedimentation of nearby waterbodies and pollutants in runoff. The vegetation improves the soil aeration and water quality (impacting the aquatic habitat) due to its nutrient removal (nitrogen, phosphorus, herbicides and pesticides) through plant uptake and sorption by soil. The waterways can also provide wildlife habitat.

8. Buffers/Filter Strips

8.1 Buffer

Maintaining buffers along stream and river channels and lakeshores can reduce some of the water quality and habitat degradation effects associated with increased imperviousness and runoff in the Watershed. Buffers provide hydrologic, recreational, and aesthetic benefits as well as water quality functions, and wildlife habitat. Sediment, phosphorus, and nitrogen are at least partly removed from water passing through a naturally vegetated buffer (see Table 48). The percentage of pollutants removed depends on the pollutant load, the type of vegetation, the amount of runoff, and the character of the buffer area. The most effective buffer width can vary along the length of a channel. Adjacent landuses, topography, runoff velocity, and soil and vegetation types are all factors used to determine the optimum buffer width. Buffer strips need to be a minimum of 30 feet wide to be eligible for most USDA programs.

Several state and federal programs exist to provide incentives for maintaining riparian buffers. The Wetlands Reserve Program (WRP) makes funding available for the purchase and restoration of wetlands and riparian buffer connections between wetlands.

8.2 Filter Strip

A filter strip is an area of permanent herbaceous vegetation situated between environmentally sensitive areas and cropland, grazing land, or otherwise disturbed land. Filter strips reduce sediment, particulate organic matter, sediment adsorbed contaminants, and dissolved contaminant loadings in runoff to improve water quality. Filter strips also restore or maintain sheet flow in support of a riparian forest buffer, and restore, create, and enhance herbaceous habitat for wildlife and beneficial insects. This practice applies only when used in conjunction with other conservation practices as part of a conservation management system.

The filter strip flow length is determined based on the field slope percent and length, filter strip slope percent, erosion rate, amount and particle size distribution of sediment delivered to the filter strip, density and height of filter strip vegetation, and runoff volume associated with erosion producing events.

Filter strips should be permanently designated plantings to treat runoff and should not be part of the adjacent cropland's rotation. Overland flow entering the filter strip should be primarily sheet flow. Concentrated flow shall be dispersed. Filter strips cannot be installed on unstable channel banks that are eroding due to undercutting of the toe bank. Permanent herbaceous vegetation should consist of a single species or a mixture of grasses, legumes and/or other forbs (a herbaceous plant other than a grass) adapted to the soil, climate, and farm chemicals used in adjacent cropland. Filter strips must be properly maintained so that they function properly.

Filter strips should be located to reduce runoff and increase infiltration and groundwater recharge throughout the Watershed. Filter strips should also be strategically placed to intercept contaminants, thereby enhancing the water quality in the Watershed. Filter strip sizes should be adjusted to accommodate planting, harvesting, and maintenance equipment. Filter strip widths greater than that needed to achieve a 30 minute flow-through time at ½-inch depth will not likely improve the effectiveness of the strip in addressing water quality concerns created by sediment, particulate organics, and sediment adsorbed contaminants.

8.3 Contour Buffer Strip

Contour buffer strips are narrow strips of permanent, herbaceous vegetative cover established across the slope and alternated down the slope with parallel, wider cropped strips. Crop strips are alternated with buffer strips down the hill slope. Normally a crop strip will occupy the area at the top of the hill. Contour buffer strips reduce sheet and rill erosion, reduce transport of sediment and other water-borne contaminants, and enhance wildlife habitat. This practice applies to cropland and is most suitable on uniform slopes ranging from 4 to 8 percent with slopes less than the Critical Slope Length (the length of slope above which contouring loses its effectiveness).

The buffer strips are generally of equal width, unless a varying width buffer strip is needed to keep either a cropped strip adjacent to it of uniform width or to maintain the strip boundary grades within NRCS criteria. Width of buffer strips at their narrowest point shall be no less than 15 feet for grasses or grass legume mixtures and no less than 30 feet when legumes are used alone.

9. Grade-Stabilization Structures

Grade-stabilization structures are permanent structures, which stabilize grades in natural or artificial channels by carrying runoff from one grade to another. These structures include vertical drop structures, chutes, pipe drop structures, and downdrains. They may be made of rock riprap, concrete, metal, wood, and/or heavy plastic.

Grade-stabilization structures are designed to prevent banks from slumping, reduce the velocity with which water runs off the land, and prevent erosion of a channel that results from excessive grade in the channel bed. Proper grade-stabilization, combined with adequately protected outlet structures, can reduce the likelihood that soil will be detached and transported to surface water.

10. Cover Crop

Cover crops can be legumes or grasses, including cereals, planted or volunteered vegetation established prior to or following a harvested crop primarily for seasonal soil protection and nutrient recovery. Cover crops protect soil from erosion and recover/recycle phosphorus in the root zone. They are grown for one year or less.

Cover crops are established during the non-crop period, usually after the crop is harvested, but can be interseeded into a crop before harvest by aerial application or cultivation. Cover crops reduce phosphorus transport by reducing soil erosion and runoff. Both wind and water erosion move soil particles that have phosphorus attached. Sediment that reaches water bodies may release phosphorus into the water. The cover crop vegetation recovers plant-available phosphorus in the soil and recycles it through the plant biomass for succeeding crops. The soil tilth also benefits from the increase of organic material added to the surface. Growing vegetation promotes infiltration, and roots enhance percolation of water supplied to the soil. This reduces surface runoff. Runoff water can wash soluble phosphorus from the surface soil and crop residue and carry it off the field.

11. Wetland Restoration

Because agriculture and urbanization have degraded many of the remaining wetlands in the Elkhart River Watershed, wetland enhancement projects are necessary to improve the diversity and function of these degraded wetlands. The term enhancement refers to improving the functions and values of an existing wetland. Converted wetland sites (or sites that were formerly wetlands but have now been converted to other uses) can also be restored to provide many of their former wetland benefits. Wetland restoration is the process of establishing a wetland on a site that is not currently a wetland, but once was prior to conversion.

Wetland functional values vary substantially from wetland to wetland; they receive special consideration because of the many roles they play. Because of the wetland protection laws currently in place, the greatest impact on wetlands from future development in the Elkhart River Watershed will likely be a shift in the types of wetlands. Often in mitigation projects, various types of marshes, wet prairies, and other wetlands are filled and replaced elsewhere, usually with existing open water wetlands. This replacement may lead to a shift in the values served by the wetland communities due to a lack of diversity of wetland types. The wetland restorations that are proposed in the Elkhart River Watershed should include a variety of different wetland types to increase the diversity of wetlands in the Watershed. The restoration of wetlands will provide new stormwater storage areas, will improve water quality by treating stormwater runoff, and will create new and better plant and wildlife habitat. In addition to these values, wetlands can be part of regional greenways or trail networks. They can be constructed with trails to allow the public to explore them more easily, and they can be used to educate the public through signs, organized tours, and other techniques. Wetland restorations are an exceptional way to meet multiple objectives within a single project.

Implementing Urban Practices

Listed below are the selected BMPs chosen by the ERA to assist in the reduction of sediment, *E. coli*, nutrients, and phosphorus in urban areas. Table 50 illustrates pollutant removal efficiencies for each of the selected urban BMPs.

1. Rain Barrel/Rain Garden

A rain barrel is a container that collects and stores rainwater from your rooftop (via your home's disconnected downspouts) for later use on your lawn, garden, or other outdoor uses. Rainwater stored in rain barrels can be useful for watering landscapes, gardens, lawns, and trees. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. In addition, rain barrels help to reduce peak volume and velocity of stormwater runoff to streams and storm sewer systems.

Rain gardens are small-scale bioretention systems that be can be used as landscape features and small-scale stormwater management systems for single-family homes, townhouse units, and some small commercial development. These units not only provide a landscape feature for the site and reduce the need for irrigation, but can also be used to provide stormwater depression storage and treatment near the point of generation. These systems can be integrated into the stormwater management system since the components can be optimized to maximize depression storage, pretreatment of the stormwater runoff, promote evapotranspiration, and facilitate groundwater recharge. The combination of these benefits can result in a decrease in the peak flow and total volume of runoff generated by a storm event. In addition, these features can be designed to provide a significant improvement in the quality of the stormwater runoff. These units can also be integrated into the design of parking lots and other large paved areas, in which case they are referred to as bioretention areas.

2. Naturalized Wet-bottom Detention Basin

Naturalized wet-bottom detention basins are used to temporarily store runoff and release it at a reduced rate. Native wetland and prairie vegetation improve water quality and habitat benefits. Naturalized wet-bottom detention basins can be designed as either shallow marsh systems with little or no open water or as open water ponds with a wetland fringe and prairie side slopes.

Naturalized wet-bottom detention basins are better than traditional detention basins because they encourage water infiltration, and thereby recharge groundwater tables and increase stream base flows. Naturalized detention basins also help to improve water quality by trapping sediment and other pollutants found in runoff, and are aesthetically pleasing.

3. Filtration Basin

Filtration basins provide pollutant removal and reduce volume of stormwater released from the basin. These basins utilize sand filters to filter stormwater runoff through a sand layer within an underdrain system that conveys the treated runoff to a detention facility or to the ultimate point of discharge. The sand-bed filtration system consists of an inlet structure, sedimentation chamber, sand bed, underdrain piping, and liner to protect against infiltration.

4. Green Roof

Green roofs are comprised of an impermeable membrane or similar structure, which supports a lightweight soil medium and living vegetation, e.g. grass or groundcover, placed on all or part of building roofs. Green roofs are a means of replacing the impermeable surfaces of building roofs to reduce stormwater runoff volume, control stormwater peak flows, to improve stormwater quality, and to reduce stormwater runoff temperature. They also have many non-stormwater related benefits, such as providing thermal and sound insulation and reducing the urban "heat island" effect. Experiences with green roofs in Europe show them to be cost-effective. A German study shows an absorption rate of 75% of rain falling on a green roof and runoff reduction of up to 25% of normal levels.

5. Pervious Paving Options

Pervious pavement has the approximate strength characteristics of traditional pavement but allows rainfall and runoff to percolate through it. The key to the design of these pavements is the elimination of most of the fine aggregate found in conventional paving materials. Pervious pavement options include porous asphalt and pervious concrete. Porous asphalt has coarse aggregate held together in the asphalt with sufficient interconnected voids to yield high permeability. Pervious concrete, in contrast, is a discontinuous mixture of Portland cement, coarse aggregate, admixtures, and water that also yields interconnected voids for the passage of air and water. Underlying the pervious pavement is a filter layer, a stone reservoir, and filter fabric. Stored runoff gradually drains out of the stone reservoir into the subsoil.

Modular pavement consists of individual blocks made of pervious material such as sand, gravel, or sod interspersed with strong structural material such as concrete. The blocks are typically placed on a sand or gravel base and designed to provide a load-bearing surface that is adequate to support personal vehicles, while allowing infiltration of surface water into the underlying soils. They usually are used in low-volume traffic areas such as overflow parking lots and lightly used access roads. An alternative to pervious and modular pavement for parking areas is a geotextile material installed as a framework to provide structural strength. Filled with sand and sodded, it provides a completely grassed parking area.

6. Soil Infiltration Trench

Soil infiltration trenches are excavated trenches backfilled with a coarse stone aggregate and biologically active organic matter. Infiltration trenches allow temporary storage of runoff in the void space between the aggregate and help surface runoff infiltrate into the surrounding soil.

Infiltration trenches remove fine sediment and the pollutants associated with them. Soluble pollutants can be effectively removed if detention time is maximized. The degree to which soluble pollutants are removed is dependent primarily on holding time, the degree of bacterial activity, and chemical bonding with the soil. It is important to remember that if stormwater runoff contains high amounts of soluble contaminants, groundwater contamination can occur. If soluble contaminants are known to be present, either pretreatment or source elimination of the contaminants must be pursued. The efficiency of the trench to remove pollutants can be increased by increasing the surface area of the trench bottom. Infiltration trenches can provide full control of peak discharges for small sites. They provide groundwater recharge and may augment base stream flow. They are effective at replacing infiltration lost due to the addition of impervious areas, and may be used strictly as a means to maintain the hydrologic balance after stormwater runoff has been treated by other means.

7. Sand Filter

Sand filters are devices that filter stormwater runoff through a sand layer into an underdrain system that conveys the treated runoff to a detention facility or to the ultimate point of discharge. The sand-bed filtration system consists of an inlet structure, sedimentation chamber, sand bed, underdrain piping, and liner to protect against infiltration.

In general, sand filters take up little space and can be used on highly developed sites and sites with steep slopes. They can be added to retrofit existing sites. This BMP is not recommended where high sediment loads are expected, unless pretreatment (e.g. for sedimentation) is provided, since fine sediments clog sand filters, or where the runoff is likely to contain high concentrations of toxic pollutants (e.g. heavy industrial sites).

8. Bioretention Practices

Bioretention practices (including bioinfiltration or biofiltration) are primarily used to filter runoff stored in shallow depressions by utilizing plant uptake and soil permeability. This practice utilizes combinations of flow regulation structures, a pretreatment grass channel or other filter strip, a sand bed, a pea gravel overflow treatment drain, a shallow ponding area, a surface organic mulch layer, a planting soil bed, plant material, a gravel underdrain system, and an overflow system to promote infiltration. Bioinfilitration systems such as swales are used to treat stormwater runoff from small sites such as driveways, parking lots, and roadways. They provide a place for stormwater to settle and infiltrate into the ground. Biofiltration swales are a relatively low cost means of treating stormwater runoff for small sites typifying much of the urban environment, such as parking, roadways, driveways, and similar impervious features. They provide areas for stormwater to slow down and pollutants to be filtered out. Careful attention to location and alignment of swales can lend a pleasing aesthetic quality to sites containing them. Bioretention is similar to a rain garden but applied to a larger, non-residential site.

In general, bioretention practices are highly applicable to residential uses in community open space or private lots. The bioretention system is very appropriate for treatment of parking lot runoff, roadways where sufficient space accommodates off-line implementation, and pervious areas such as golf courses. This BMP is not recommended for highly urbanized settings where impervious surfaces comprise 95% or more of the area due to high flow events and limited storage potential.

9. Natural Stream Buffer

Natural stream buffers provide multiple benefits, including erosion control, removal of nutrients and sediment from runoff, minimization of runoff volume, and wildlife habitat. Seeding with native grasses, legumes (nitrogen fixing plants) and forbs (broad leaved plants, including wildflowers) is an inexpensive method to quickly cover a site. Native grasses and forbs are adapted to regional conditions of climate and disease and are relatively low maintenance. Attention to species selection can provide an added benefit of aesthetic quality to sites containing them.

Once established, native annuals will reseed themselves, although they may require protection from exotic or invasive species. If left unmanaged, natural succession will usually result in the invasion of shrubs and trees. If managed by mowing and/or burning, the native annuals and perennials will persist. Some species of native grasses, legumes, and forbs are relatively easy to grow. These frequently dominate the mixtures used for roadside plantings. Other species may require more intensive management to ensure establishment but will provide a more complete and natural mixture. Seed mixtures can be prepared that will be appropriate for wet, dry, or mesic sites and for a variety of sun exposure regimes.

10. Wetland Restoration

Because agriculture and urbanization have degraded many of the remaining wetlands in the Elkhart River Watershed, wetland enhancement projects are necessary to improve the diversity and function of these degraded wetlands. The term enhancement refers to improving the functions and values of an existing wetland. Converted wetland sites (or sites that were formerly wetlands but have now been converted to other uses) can also be restored to provide many of their former wetland benefits. Wetland restoration is the process of establishing a wetland on a site that is not currently a wetland, but once was prior to conversion.

Wetland functional values vary substantially from wetland to wetland; they receive special consideration because of the many roles they play. Because of the wetland protection laws currently in place, the greatest impact on wetlands from future development in the Elkhart River Watershed will likely be a shift in the types of wetlands. Often in mitigation projects, various types of marshes, wet prairies, and other wetlands are filled and replaced elsewhere, usually with existing open water wetlands. This replacement may lead to a shift in the values served by the wetland communities due to a lack of diversity of wetland types. The wetland restorations that are proposed in the Elkhart River Watershed should include a variety of different wetland types to increase the diversity of wetlands in the Watershed. The restoration of wetlands will provide new stormwater storage areas, will improve water quality by treating stormwater runoff, and will create new and better plant and wildlife habitat. In addition to these values, wetlands can be part of regional greenways or trail networks. They can be constructed with trails to allow the public to explore them more easily, and they can be used to educate the public through signs, organized tours, and other techniques. Wetland restorations are an exceptional way to meet multiple objectives within a single project.

Table 50. Elkhart River Watershed BMP's Selected by the Steering Committee

Agricultural BMP	Goal(s)	TSS removal efficiency	*E. coli* removal efficiency	N removal efficiency	P removal efficiency	Efficiency source
Exclusion Fencing	2, 3, 4, 6	0.70	0.90	0.65	0.60	USEPA
Manure Management Plan	2, 3, 4, 6	0.60	0.85	0.80	0.90	USEPA
Nutrient Management Plan	2, 3, 4, 6	N/A	N/A	0.42	0.35	USEPA
No-till/Reduced Till (Conservation Tillage)	2, 3, 4, 6	0.75	N/A	0.55	0.45	STEPL
Rotational Grazing	2, 3, 4, 6	0.40	N/A	0.20	0.20	USEPA / STEPL
Buffers/Filter Strips	2, 3, 4, 5, 6	0.65	N/A	0.70	0.75	STEPL
Grassed Waterways	2, 3, 4, 5, 6	0.68	N/A	0.20	0.29	USEPA
Alternative Watering System	2, 3, 4, 6	0.80	N/A	0.75	0.78	USEPA / STEPL
Grade-Stabilization Structures	2, 6	0.80	N/A	0.55	0.85	USEPA
Wetland Restoration	2, 3, 4, 5, 6	0.80	0.78	0.45	0.55	USEPA
Cover Crop	2, 3, 4, 6	0.40	N/A	0.40	0.45	USEPA / STEPL

Urban BMP	Goal(s)	TSS removal efficiency	*E. coli* removal efficiency	N removal efficiency	P removal efficiency	Efficiency source
Rain Barrel/Rain Garden Combination	5, 6	0.80	N/A	0.20	0.20	STEPL
Pervious Paving Options	2, 3, 4, 6	0.95	N/A	0.85	0.85	USEPA / STEPL
Bioretention Practices	3, 4, 5, 6	0.40	N/A	0.63	0.80	STEPL
Green Roof	5, 6	0.73	N/A	0.40	0.45	STEPL
Natural Stream Buffer	2, 3, 4, 5, 6	0.73	N/A	0.40	0.45	STEPL
Soil Infiltration Trench	2, 3, 4, 6	1.00	N/A	0.42	0.42	USEPA
Filtration Basin	2, 3, 4, 6	0.75	N/A	0.60	0.65	STEPL
Sand Filter	2, 3, 4, 6	0.80	N/A	0.35	0.50	STEPL
Naturalized Wet-bottom Detention Basin	2, 3, 4, 5, 6	0.80	N/A	0.35	0.55	USEPA

*STEPL- Spreadsheet Tool for Estimating Pollutant Load, US Environmental Protection Agency http://it.tetratech-ffx.com/stepl/

Preventative Measures: Natural Resources Protection

Protecting Open Space and Natural Areas

Several techniques can be used for protecting natural areas and open space in both public and private ownership. The first step in the process is to identify and prioritize properties for protection. The highest priority natural areas should be permanently protected by the ownership or under the management of public agencies or private organizations dedicated to land conservation. Other open space can be protected using conservation design development techniques, and is more likely to be managed by homeowner associations.

Protected Ownership

There are several options for land transfer ranging from donation to fee simple land purchase. Donations can be solicited and encouraged through incentive programs. Unfortunately, while preferred by money-strapped conservation programs, land donations are often not adequate to protect high priority sites. A second option is outright purchase (or fee simple land purchase). Outright purchase is frequently the least complicated and most permanent protection technique, but is also the most costly. A conservation easement is a less expensive technique than outright purchase that does not require the transfer of land ownership but rather a transfer of use rights. Conservation easements might be attractive to property owners who do not want to sell their land at the present time, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Conservation Design Developments

The goal of conservation design development is to protect open space and natural resources for people and wildlife, while at the same time allowing development to continue. Conservation design developments designate half or more of the buildable land area as undivided permanent open space. They are density neutral, allowing the same density as in conventional developments, but that density is realized on smaller areas of land by clustering buildings and infrastructure. In addition to clustering, conservation design developments incorporate natural riparian buffers and setbacks for streams, wetlands, other waterbodies, and adjacent agricultural land (Dreher and Price 1997; Terrene Institute 1994; Schueler 1995; Arendt 1996).

The first and most important step in designing a conservation development is to identify the most essential lands to preserve in conservation areas. Natural features including streams, wetlands, lakes, steep slopes, mature woodlands, native prairie, and meadow (as well as significant historical and cultural features) are included in conservation areas. Clustering is a method for preserving these areas. Clustered developments allow for increased densities on less sensitive portions of a site, while preserving the remainder of the site in open space for conservation and recreational uses (such as trails, soccer or ball fields).

Clustering can be achieved in a planned unit development (PUD) or planned residential development (PRD). PUDs contain a mix of zoning classifications that may include commercial, residential, and light industrial uses, all of which are blended together. Well-designed PUDs usually locate residences and offices within walking distance of each other to reduce traffic. Planned residential developments (PRDs) apply similar concepts to residential developments.

Threatened and Endangered (T&E) Species

Threatened and endangered species are those plant and animal species whose survival is in peril. Both the federal government and the state of Indiana maintain lists of species that meet threatened or endangered criteria within their respective jurisdictions. Threatened species are those that are likely to become endangered in the foreseeable future. Federally endangered species are those that are in danger of extinction throughout all or a significant portion of their range. A state-endangered species is any species that is in danger of extinction as a breeding species in Indiana.

Considerations in protecting endangered species include:

- Making sure there is sufficient habitat available - food, water, and "living sites". For animals, this means areas for making nests and dens and evading predators. For plants, it refers to availability of preferred substrate and other desirable growing conditions.
- Providing corridors for those species that need to move between sites.
- Protecting species from impacts due to urbanization.

Several techniques can be used to protect T&E species. One technique is to acquire sites where T&E species occur. Purchase and protection of the site where the species is located (with adequate surrounding buffer) may be sufficient to protect that population. In some instances it is not feasible or possible to buy the needed land. Where the site and buffer area is not available for purchase, where an animal's range is too large of an area (or migrates between sites), or where changes in hydrology or pollution from outside the site affect the species, other techniques must be used to protect the T&E species.

Developing a resource conservation or management plan for the species and habitat of concern is the next step. Resource plans consider the need for buffer areas and habitat corridors, and consider watershed impacts from hydrology changes or pollutant loadings. The conservation plan will include recommendations for management specific to the species and its habitat, whether located on private or public lands. The conservation plan will guide both the property owner and the local unit of government that plans and permits adjacent landuses in how to manage habitat to sustain the species.

Greenways and Trails

Greenways can provide a large number of functions and benefits to nature and the public. For plants and animals, greenways provide habitat, a buffer from development, and a corridor for migration. Greenways located along streams include riparian buffers that protect water quality by filtering sediments and nutrients from surface runoff and stabilizing streambanks. By buffering the stream from adjacent developed landuse, riparian greenways offset some of the impacts associated with increased impervious surface in a watershed. Maintaining a good riparian buffer can mitigate the negative impacts of approximately 5% additional impervious surface in the Watershed (Schueler 1995).

Greenways also provide long, linear corridors with options for recreational trails. Trails along the river provide watershed residents with an opportunity to exercise and enjoy the outdoors. Trails allow users to see and access the river, thereby connecting people to their river and the overall watershed. Trails can also be used to connect natural areas, cultural and historic sites and communities, and serve as a safe transportation corridor between work, school, and shopping destinations.

Techniques for establishing greenways and trails involve the development of a plan that proposes general locations for greenways and trails. In the case of trails, the plan also identifies who the users will be and provides direction on trail standards. Plans can be developed at the community and/or county level, as well as regionally, statewide, and in a few cases, at the national level. Public and stakeholder input are crucial for developing successful greenway and trail plans.

Several techniques can be used for establishing greenways and trails. Greenways can remain in private ownership, they can be purchased, or easements can be acquired for public use. If the lands remain in private ownership, greenway standards can be developed, adopted, and implemented at the local level through landuse planning and regulation. Development rights for the greenway can be purchased from private landowners where regulations are unpopular or not feasible.

If the greenways will include trails for public use, the land for trails is usually purchased and held by a public agency such as a forest preserve district or local park system. In some cases, easements will be purchased rather than purchasing the land itself. Usually longer trail systems are built in segments, and completing connections between communities depends heavily on the level of public interest in those communities.

In new developing areas, the local planning authority can require trails. Either the developer or the community can build the trails. In some cases, the developer will voluntarily plan and build a trail connection through the development and use this as a marketing tool to future homebuyers. In other cases, the local planning authority may require the developer to donate an easement for the trail. To install trails through already developed areas, land can be purchased by a community agency with a combination of local, state, and federal funds. Impediments to land purchase can significantly slow up trail connections in already established areas.

Wetlands

Wetlands provide a multitude of benefits and functions. Wetlands improve water quality by removing suspended sediment and dissolved nutrients from runoff. They control the rate of runoff discharged from the Watershed and reduce flooding by storing rainfall during storm events. Wetlands also provide habitat for plants and animals including many of those that are threatened and endangered.

- ***No-Net-Loss/Wetland Mitigation***

Since the 1970s, wetlands have been regulated through a permit program administered by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act. In the 1990s, the Federal government adopted a policy of no-net-loss of wetlands to stem the tide of continued wetland losses. The no-net-loss policy has generated requirements for wetland mitigation so that permitted losses due to filling and other alterations can be replaced.

- ***Wetland/Stream Buffers***

Wetland buffers protect a wetland from water quality and hydrologic impacts resulting from adjacent landuses. In addition, if vegetated and managed properly, buffers can provide considerable wildlife habitat. Buffers should be comprised of native, unmowed vegetation that is periodically managed for non-native and invasive species.

Remedial Measures: Restore/Enhance Natural Resources

Septic Tank Maintenance and Repair

Septic, or on-site waste disposal systems, are the primary means of sanitary flow treatment in the unincorporated parts of the Elkhart River Watershed. Because of the prohibitive cost of providing centralized sewer systems to many areas, septic tank systems will remain the primary means of treatment into the future. Annual maintenance of septic systems is crucial for their operation, particularly the annual removal of accumulated sludge. The cost of replacing failed septic tanks is about $5,000-15,000 per unit.

Property owners are responsible for their septic systems. When septic systems fail, untreated sanitary flows are discharged into open watercourses that pollute the water and pose a potential public health risk. Septic systems discharging to the ground surface are a risk to public health directly through body contact or contamination of drinking water sources, provide conditions favorable to insect vectors such as flies and mosquitoes, and contribute significant amounts of nitrogen and phosphorus to the Watershed. Therefore, it is imperative for homeowners not to ignore septic failures. If plumbing fixtures back up or will not drain, the system is failing.

The proper feeding and maintenance of the septic system is crucial to its operation.

- Have the tank pumped every 3-5 years. An experienced septic maintenance operator will check the depth of the sludge in the tank and make pumping schedule recommendations. Depending on an individual's wastewater usage, pumping may be necessary more or less frequently. Sludge, if not pumped out will eventually spill out in to the absorption field, clogging it and causing failure.
- How long the absorption field lasts is basically a function of the volume and strength of water an individual puts into the system. Individuals should make a considerable effort to conserve water at every step. Hydraulic overloading is a main cause of early system failure. Install low flow shower heads, toilets and washing machines. Don't use a garbage disposal (or use it rarely). Composting your garbage is recommended instead.
- Do not use system additives (chemical or biological)
- Do not construct pools or other structures over any part of your system
- Do not flush anything that won't quickly decompose
- Do not plant trees or bushes in the area of your tank or absorption field
- Do not run clear water drains (i.e. foundation / basement drains) into your septic system
- Do not discharge water softener to the septic system. Sodium can corrode concrete and may interferer with the proper functioning of your septic tank. If the softener must

discharge to the septic system, set it to cycle less frequently. This will minimize the amount of sodium going to the septic.

- The use of antibacterial products (including soaps) will negatively affect the functioning of the septic tank
- Install a septic tank effluent filter on the septic tank's outlet. These keep suspended materials from getting out into the absorption field, thus increasing the life of the system. These filters are inexpensive and easy to maintain.

Usage is an important factor, especially for smaller lots common in lake areas. In general, homeowners should try to conserve water and avoid surge loading (i.e., many consecutive loads of laundry). Homeowners should never dispose of chemicals; food products, such as those produced by trash disposals; or materials that are not readily degradable, such as condoms and cigarette butts through a septic system. It is especially important that clearwater discharges from sumps or water softeners not be directed into the septic system. Routine use of most household chemicals should not harm the system.

To protect the seepage system, homeowners should avoid traffic and excessive cutting or filling over the system. Grass cover should be maintained for insulation and warm season evapotranspiration (the total moisture that leaves an area by evaporation from soil, snow, and water surfaces plus that transpired by plants). Stormwater flows overland or from sumps and gutters should not be discharged across the seepage areas.

Stream Restoration

Stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. For urban stream reaches, restoration to natural conditions may not be possible or feasible. For instance, physical constraints due to adjacent development may limit the ability to re-meander a stream. In addition, the natural stream conditions may not be able to accommodate the increased volume of flow from the developed Watershed.

Even in cases where restoring the stream to its natural condition is not possible, the stream can still be naturalized and improved by reestablishing riparian buffers, performing stream channel maintenance, stabilizing streambanks using bioengineering techniques, and, where appropriate, by removing manmade dams and installing pool/riffle complexes. Stream restoration projects may be one component of floodplain restoration projects, and can be supplemented with trails and interpretive signs, providing recreational and educational benefits to the community.

Pool/Riffle Complexes

Establishing pool/riffle complexes in the streambed is another method for restoring stream conditions. Pools and riffles naturally occur in streambeds in a sequence that follows the meander of the stream. However, pool/riffle sequences are usually lost when streams are channelized.

Riffle restoration is usually done with rock weirs placed in sequences at spacing intervals determined by the bankfull width of the stream. The cobble and boulder weirs are spaced so a distance of approximately six bankfull widths separates them. Pools develop between the riffles. The pool/riffle sequences benefit fish and macroinvertebrates by aerating the water during low flow conditions and by providing more diverse substrate and deeper water for habitat.

The placement of the stone for the riffles can also reduce streambank erosion immediately downstream as stream flow is funneled through the center of the stream channel and away from the banks. Pool/riffle complexes are often installed in conjunction with the other streambank stabilization techniques described above for even better stream restoration results (Illinois State Water Survey 1998).

Incentives and Cost-Share Opportunities

There are a number of incentive programs to implement BMP projects. Fund sources for wetland protection and restoration, as well as technical assistance, are available from programs at the local, regional, state, and federal levels of government including USEPA Section 319 grants.

US Army Corps of Engineers (USACE) Continuing Authorities Program

At the Federal level, the USACE Continuing Authorities Program (CAP) from Section 206 of the 1996 Water Resources Development Act targets wetland restoration. This section, also known as the “Aquatic Ecosystem Restoration” program gives the USACE the authority to carry out aquatic ecosystem restoration and protection if the projects will improve the quality of the environment, are in the public interest, and are cost effective. The objective of section 206 is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded and more natural condition. The local sponsors of aquatic ecosystem restoration projects are required to contribute 35% towards the total project cost.

U.S. Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS) Programs

The USDA - NRCS has four incentive programs that may have applicability in the Elkhart River Watershed: the Environmental Quality Incentives Program (EQIP), the Wetland Reserve Program (WRP), the Conservation Reserve Program (CRP), and the Wildlife Habitat Incentive Program (WHIP). The goal of WRP is to restore and protect degraded wetlands such as farmed wetlands. WRP has three options available: permanent easements, 30-year easements and restoration agreements. The NRCS will reimburse the landowners for easements on the property plus a portion of the restoration costs based on the type of easement agreed to by the landowner. EQIP is accommodating to grass-roots conservation. Typically EQIP monies will fund 75% of land improvements and installation of conservation practices such as grade stabilization structures, grassed waterways, and filter strips adjacent to water resources (including wetlands). EQIP and WRP are only applicable to agricultural lands.

The goal of the CRP program (and CREP - Conservation Reserve Enhancement Program) is to give incentives to landowners who take frequently flooded and environmentally sensitive land out of crop production and plant specific types of vegetation. Participants earn annual rental payments and sign-up incentives. This program offers up to 90% cost share. Rental payments are boosted by 20% for projects such as installation of riparian buffers and filter strips. Windbreaks, contour buffer strips, and shallow water areas are additional funded practices. The WHIP program is available for private landowners to make improvements for wildlife on their property. This program offers up to 75% cost share. This grant program is competitive and funding depends on the project's ranking compared to others in the state.