Rein in the Runoff

Alternative Stormwater Management Practices that Address the Environmental, Social, and Economic Aspects of Water Resources in the Spring Lake Watershed (MI)

FINAL PROJECT REPORT

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS

Adsorb: Take up or hold by adhesion.

Aggregate: Clustered mass of individual soil particles varied in shape and size.

Algal Blooms: Rapid excessive growth of algae, generally caused by high nutrient levels and favorable environmental conditions.

Alum: Aluminum sulfate.

Analytical Hierarchy Process: Systematic procedure for representing the elements of a problem that breaks down the problem into its smaller parts and then calls for only simple pairwise comparison judgments to develop priorities at each level.

Anoxia: Absence of oxygen in an aquatic system.

Antecedent Soil Moisture: Amount of moisture present in the soil at the beginning of a storm event.

Baseflow: The portion of channel flow that comes from groundwater and not from stormwater runoff.

Benefit Transfer: A practice used to estimate economic values by transferring information available from studies already completed in one location or context to another location. This can be done as a unit value transfer or a function transfer.

Benthic: Of, relating to, or occurring at the bottom of a body of water.

Best Management Practices (BMPs): Structural or nonstructural stormwater control measures that slow, retain or absorb nonpoint source pollutants associated with runoff. In the United States, the term “BMP” has come to mean any stormwater control measure, and not just the “best” ones.

Biomagnification: Process in which chemical levels in plants or animals increase from transfer through the food web.

Bioretention: Process of biological removal of contaminants or nutrients as fluid passes through media or a biological system.

Bioswale: Landscape element designed to remove silt and pollution from surface runoff water.

Biota: All the plant and animal life in a particular region.

BOD: Biological oxygen demand is the amount of water-dissolved oxygen consumed by microbes in waterbody.

Catch Basin: Reservoir for collecting surface drainage or runoff.

Check Dams: Low, fixed structure, constructed of timber, loose rock, masonry, or concrete, to control water flow in an erodible channel or irrigation canal.

Cistern: Underground tank for storing rainwater.

Coliform: Bacteria that are commonly-used bacterial indictors of the sanitary quality of water.

Created Wetland: A wetland established wetland where one did not previously exist.

Curve Number: A rainfall-runoff parameter commonly used in the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) hydrologic procedures. The larger the runoff curve number, the greater the percentage of rainfall that will appear as runoff. The runoff curve number is a function of soil type, land use, and land management practices.

Cyanobacteria: Blue-green algae.

Cyanotoxin: Poisonous substance produced by some blue-green algae.

Depression Storage: Volume of water contained in natural depressions in the land surface.

Detention Ponds: Low lying areas that are designed to temporarily hold a set amount of water while slowing draining into another location. Generally used for flood control when large amounts of rain could cause flash flooding.

Direct Costs: Expenses related to the labor and materials required for installation of stormwater best management practices (BMPs) or Low Impact Development (LID) strategies.

Drowned River Mouth: The end of a river where it enters into another waterbody that became submerged or flooded during the glacial retreat from the last Ice Age.

Dry Well: Underground chamber containing stones or gravel and used to collect stormwater runoff from the roof of the building as a means of avoiding soil erosion.

Enteric Virus: Class of infectious agents that can pass through bacteria-retaining filters.

Eutrophic: Having waters rich in mineral and organic nutrients that promote excessive plant growth, particularly algae, which reduces the dissolved oxygen content and often causes the elimination of other organisms and fish.

Event Mean Concentration (EMC): Average concentration of pollutants in the runoff from a storm event.

External Loading: Nutrients entering a waterbody from sources on the land and in the air.

Exurban Growth: Population growth that occurs outside the urban center, including its historic suburban periphery. It represents "sprawl beyond sprawl".

Filtration BMPs (Filtrative BMPs): Stormwater best management practices that utilize vegetation or soil media to remove sediment and nutrients from stormwater as it flows through the structure.

Function Transfer: The use of statistical models from one study conducted at one location to obtain an economic benefit estimate to transfer directly to another location, such as the Spring Lake Watershed.

Geomorphic Parameters: Series of physical properties relating to the processes that affect that form and shape of the surface of the earth.

Geographic Information System (GIS): Computer application used to store, view, and analyze geographical information, particularly maps and map data.

Geologic: Of or relating to the origin, history, and structure of the earth.

Groundwater: Water beneath the earth's surface, often between saturated soil and rock. Groundwater supplies wells and springs.

Grow Zone: Stormwater management practice utilizing native planting areas.

Herbaceous Wetlands: Wetlands consisting of plants with little or no woody plants that persist for a single growing season.

Hydrologic Modeling: The use of physical or mathematical techniques to simulate the hydrologic cycle and its effects on a watershed.

Hydrologic Soil Groups: Soil properties that characterize the stormwater runoff tendency of the soil.

Hydrology: The origin, circulation, distribution, and properties of water and waterways.

Illicit Connections: Illegal connections to a storm drain system from commercial establishments that result in contaminated wastewater entering into storm drains or directly into local waterways without receiving treatment from a wastewater treatment plant.

Illicit Discharges: Discharges to a municipal separate storm sewer system that are not composed entirely of stormwater, except for discharges allowed under a National Pollutant Discharge Elimination System Permit or waters used for firefighting operations.

Impervious Surfaces: Hard surfaces that prevent stormwater from soaking into the ground. Where there are more impervious surfaces in a watershed, stormwater runoff enters local waterbodies in greater volumes and at faster speeds. Examples of impervious surfaces include paved streets, sidewalks, parking lots, driveways, and building rooftops.

Infiltration: The movement of water into the soil.

Infiltration BMPs (Infiltrative BMPs): Stormwater best management practices that reduce runoff volume and improve water quality by promoting the movement of water into the soil.

Integrated Assessment: The use of existing social and physical scientific data analysis, synthesis, modeling, and stakeholder engagement activities to evaluate policy or management options on particularly difficult environmental problems.

Interception: The capture of rainwater by vegetation from which the water evaporates and is thus prevented from reaching the water table or contributing to stormwater runoff.

Internal Loading: Nutrients entering a waterbody from sources within the waterbody, such as release from sediments.

Invertebrates (Inverts.): Animals without a backbone. Aquatic invertebrates include insects, crustaceans, mollusks, and worms.

Littoral Buffers: A band of trees, shrubs, or grasses that border a lake. Such “buffer strips”, particularly when consisting of native vegetation, help capture or intercept stormwater runoff before it enters the waterbody.

Loam: Soil consisting of a coarse mixture of varying proportions of clay, silt, and sand.

Low Impact Development (LID): Stormwater design techniques that mimic presettlement hyrdrology and incorporate the basic principle of managing stormwater where it lands through infiltration, filtration, storage, evaporation, or detention.

Nonpoint Source Pollution: Another term for polluted stormwater runoff and other sources of water pollution whose sources do not come from a discrete conveyance (e.g., pipes). The term comes from the federal Clean Water Act of 1987.

Oil-Water Separator: Mechanical stormwater management system designed to separate oil and water from oil-contaminated drainage water.

Opportunity Cost: Value of the next best alternative foregone as the result of making a decision. Also called economic opportunity lost.

Orthophotograph: Aerial photograph geometrically corrected – "orthorectified" – such that the scale is uniform, so that the photo has the same lack of distortion as a map.

Pairwise: Two corresponding persons or items, similar in form or function and matched or associated.

Pathogen: Specific causative agent (as a bacterium or virus) of disease.

Percolate: When water passes through permeable surfaces to the soil and groundwater below.

Permeability: Quality or state of having pores or openings that permit stormwater and stormwater runoff to pass through to the soil or groundwater.

Porous Pavement: Paving system that allows water to infiltrate through the pavement to more accurately reflect pre-development hydrology.

Presettlement: Condition prior to widespread settlement by European Americans and industrial civilization.

Principal Component Analysis: Mathematical method that breaks down a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components.

Proximity Analysis: Analytical technique used to determine the relationship between a selected point and its neighbors.

Rain Barrel: A barrel used as an above-ground cistern to hold rainwater. Many are retrofitted to include a hose and spigot to re-use the rainwater for watering plants, gardens, and flowers.

Rain Garden: Planted depression that is designed to take all, or as much as possible, of the excess stormwater runoff from impervious surfaces.

Raster or Raster Grid Cells: Form of graphics in which closely spaced row of dots form an image on a computer screen.

Recharge: The replenishment of water in the ground.

Retrofits: Additions of new (stormwater) technology to older (traditional) systems.

Riparian Buffer: A band of trees, shrubs, or grasses that border a river or stream. Such "buffer strips", particularly when consisting of native vegetation, help capture or intercept stormwater runoff before it enters the waterbody.

Source-Controls: Stormwater best management practices that remove stormwater source materials or isolate them from contact with groundwater.

Stakeholder: Person, group, municipality, or organization that has a direct or indirect interest in a defined environmental or other natural resource.

Stewardship: Individual or community responsibility to manage property with regard to others.

Stormwater: Rain, snow or sleet that is a direct result of precipitation, which flows in both concentrated forms (pipes, gutters, ditches, streams, etc.) and diffuse forms (sheet flow) over or within all land forms. Stormwater soaks into the soil and becomes groundwater, is used by vegetation, evaporates, or flows into lakes or streams as surface or subsurface flow. Stormwater collects pollutants and debris as it travels to our local waterways.

Stormwater Runoff: Rain or melting snow that cannot soak into the ground, and instead flows from the land into nearby waterbodies. Stormwater runoff is not treated in any way.

Stormwater Utility: System of assigning user fees to landowners based on the amount of impervious surface per parcel. Stormwater utilities create monetary incentives for developers and property owners to use Low Impact Development stormwater best management practices.

Stormwater Vault: Stormwater detention basin.

Streamflow: Movement of water in streams, rivers, and other channels.

Swale: Shallow depression of land used to convey and absorb stormwater runoff.

Transpiration: Absorption of water by plants, usually through the roots, and the loss of the water to the atmosphere through evaporation from the leaves.

Tributary: Stream or small creek flowing into a river or larger body of water.

Underdrain: Small diameter perforated pipe that allows the bottom of a detention basin, channel, or swale to drain.

Unit Value Transfer: The use of one study conducted at one location to obtain an economic benefit estimate to transfer directly to another location such as the Spring Lake Watershed.

Vector or Vector Polygon: Data based on the representation of geographical objects by Cartesian coordinates commonly used to represent linear or shape features.

Waterborne Pathogens: Bacteria or virus that infects people or animals via contaminated water.

Watershed: The area of land that drains into a body of water. Watersheds come in all shapes and sizes, and cross county, state, and national boundaries. Smaller watersheds (e.g., Spring Lake watershed), may be part of a larger watersheds (e.g., Lower Grand River watershed), which may be part of an even larger watershed (e.g., Lake Michigan watershed). No matter where you are, you're in a watershed. A watershed is also called a drainage basin or a catchment.

Woody Wetlands: Areas where forest or shrubland vegetation accounts for 25% - 100% of the cover and the soil or substrate is periodically saturated with or covered with water.

Chapter 1: Introduction and Background

Rein in the Runoff is a collaborative, community-based Integrated Assessment project that examines the causes, consequences, and corrective alternatives available to the communities within and downstream of the Spring Lake Watershed (MI). The project goal is to minimize the negative impacts of polluted stormwater runoff to local water bodies. Led by researchers at Grand Valley State University's Annis Water Resources Institute (AWRI), an interdisciplinary team with expertise in aquatic ecology, environmental law and policy, environmental engineering and consulting, GIS and data analysis, economics, communications, and outreach and education, has been working with stakeholders to help address management and stewardship issues regarding stormwater discharges.

This 190-page report describes the environmental, social, and economic conditions in the Spring Lake Watershed that led to the development of the Rein in the Runoff Integrated Assessment (IA). It summarizes the technical and stakeholder components of the IA process, including the underlying data and modeling approaches relied upon by the project team to assess the causes and consequences of stormwater pollution within the watershed, and the extent of the stakeholder education and participation. A suite of common stormwater best management practices – or BMPs – are provided with spatial guidance for the most appropriate locations for implementation of structural BMPs throughout the Spring Lake Watershed, as well as an economic assessment of each structural and nonstructural stormwater BMP. The analysis also includes projections for future stormwater pollution in light of different rates of population growth and continued urbanization of the watershed. The Rein in the Runoff project report concludes with the Integrated Assessment results, project products, and potential next steps for watershed stakeholders. Appendices provide supplemental technical information regarding different aspects of the IA process and Rein in the Runoff products and results.

MANAGING STORMWATER RUNOFF

The management of stormwater and stormwater runoff is an important issue for municipalities, whose citizenry demand clean drinking water, the prevention of flooding, water drainage, and sanitation (Chocat et al. 2001). As new development throughout the United States continues to outpace population growth (Theobald 2005), there is a greater loss of rural and natural lands to increasing amounts of impervious cover (Dougherty et al. 2006). Impervious surfaces are roadways, rooftops, driveways, parking lots and other impermeable land covers within an urban landscape (Schueler 1994). As rainwater falls onto these hardened surfaces, it cannot soak into the ground, and instead runs off into local surface waterways.

Stormwater runoff creates a variety of problems for land use managers, homeowners, fish and wildlife, and ecological systems. As more water flows into streams and rivers, it can result in unstable and eroding channels, loss of instream habitat, and more severe and more frequent flooding problems (Schueler 1994). It also collects pollutants (such as street dust, eroded sediments, heavy metals, road salt, oil and grease, organic matter, nutrients, and pesticides) from impervious surfaces, farm fields, residential lawns, and commercial and industrial properties, and deposits them in receiving waterbodies (Obropta and Kardos 2007; Tsihrintzis and Hamid 1997; Domalgaski 1996; McFarland and Hauck 1999). This, in turn, can degrade water quality, lead to fish kills and loss of species diversity, stimulate algae blooms, and create public health risks (Schueler 1994; Trim and Marcus 1990; Steinman and Ogdahl 2008; Obropta and Kardos 2007). Generally, the more impervious surface cover within a watershed, the greater the problems associated with stormwater runoff tend to be (Alberti et al. 2007). Watersheds with impervious surface cover greater than 10% are considered to be impaired, but water quality impacts are measurable in watersheds with even lower levels of hardened surface areas (Schueler 1994).

Further, these effects are only expected to increase as global warming progresses (Madsen and Figdor 2007). Scientists are predicting that global climate change will cause warming temperatures and an increase in the frequency of extremes in the hydrologic cycle – i.e., severe storms, increased flooding, and more periods of drought (Patz et al. 2008).[1] Heavy runoff associated with these severe storm events can increase the risk of sewage overflows, contaminate local recreational waters, decrease the productivity of agricultural lands, and increase the risk of human illnesses (Patz et al. 2008; Madsen and Figdor 2007; McLellan et al. 2007). These problems can be further compounded by urbanized waterfront communities, which provide for decreased flow path lengths for stormwater runoff into local waterways (Beighley et al. 2008).

Although numerous studies have been conducted addressing the water quality impacts of stormwater and stormwater runoff, considerable obstacles continue to impede progress in developing and applying effective watershed-based approaches to managing stormwater. In many cases, local officials simply do not fully understand the impacts of, or the need to control, stormwater runoff. While they may be concerned about the quality of a natural resource, there may be no consensus about the goals for management of that resource. Alternatively, the value of the resource is not considered high enough to spend money fixing the associated problems, and other budgetary items take priority. Decision-makers simply may be unaware of the impacts of stormwater discharges to their local water resources. Although flood control is an obvious problem that needs attention, the reduction in groundwater baseflow resulting from impervious area that limits or prevents water from soaking into the ground, for example, might not be noticed. In addition, uncertainties in the performance and cost of stormwater control measures, limited funding and other resources, and ongoing maintenance and

[1] Grand Rapids (MI) is one of 55 cities nationwide to see a significant increase in the frequency of major storms with heavy precipitation in the last 50 years (Madsen and Figdor 2007).

opportunity costs can impede implementation of stormwater BMPs (Roy et al. 2008). Finally, future problems resulting from stormwater runoff have not been fully identified in urbanizing watersheds.

INTEGRATED ASSESSMENT

Because of the complex ecological, political, and social processes associated with stormwater management, the project team adopted an Integrated Assessment approach for the Spring Lake Watershed. Integrated assessment (IA) is the synthesis of existing natural and social scientific knowledge to solve a natural resource management problem or policy question (Parson 1995; Hillman et al. 2005). IA is an active and rapidly developing field, and a multitude of approaches exist to aid in solving environmental resource management questions and policy issues (Hisschemöller et al 2001). For the Rein in the Runoff IA, we selected the six-step approach outlined in Scavia and Bricker (2006):

1. Define the policy relevant question around which the IA is to be performed.

2. Document the status and trends of appropriate environmental, social, and economic conditions related to the issue.

3. Describe the environmental, social, and economic causes and consequences of those trends.

4. Provide forecasts of likely future conditions under a range of policy or management options.

5. Provide technical guidance for the most cost effective means of implementing each of those options.

6. Provide an assessment of the uncertainties associated with the information generated in Steps 1-5.

The initial policy question for this IA was developed by Michigan Sea Grant and public officials from Spring Lake Township and the Village of Spring Lake. The policy and management objectives that these communities had regarding water quality and the management of stormwater runoff included the identification of *the causes, consequences and correctives of stormwater discharges to the watersheds surrounding Spring Lake Township and the Village of Spring Lake, specifically Spring Lake, the Grand River and ultimately, Lake Michigan*. The primary objectives indentified for the Rein in the Runoff IA were to:

- Increase Spring Lake area residents' and decision-makers' general knowledge and understanding of the causes and consequences of stormwater runoff, and how they apply specifically to Spring Lake, the Grand River, and Lake Michigan;

- Increase stakeholder stewardship of the water resources surrounding Spring Lake Township and the Village of Spring Lake, and in particular, increase participation in stormwater control and management;

- Identify inconsistencies between state regulations and/or local ordinances that can improve local stormwater management and control;

- Provide a suite of alternative stormwater management Best Management Practices (BMPs) tailored to Spring Lake Township and the Village of Spring Lake.

However, once established, the project team – with input from these same community representatives – expanded the policy question to include the other communities within the Spring Lake Watershed, and the adjacent communities further downstream to the mouth of the Grand River at Lake Michigan to incorporate a broader group of stakeholders. The revised policy question for the Rein in the Runoff IA was:

> *What stormwater management alternatives are available to the communities in the Spring Lake Watershed that allow for future development and also mitigate the effects of stormwater discharges and improve the water quality in Spring Lake, the Grand River, and ultimately, Lake Michigan?*

To most effectively answer this policy question for local and regional stakeholders and accomplish the identified project goals, the project team adapted the Scavia and Bricker (2006) IA approach described above. This adapted approach included five underlying steps that guided the Rein in the Runoff Integrated Assessment (Figure 1-1). Each of these steps had several components, and each one was informed by a broad range of participants, including scientists (team members and project reviewers), decision-makers and stakeholders (project partners), and members of the general public (Rabalais et al 2002).

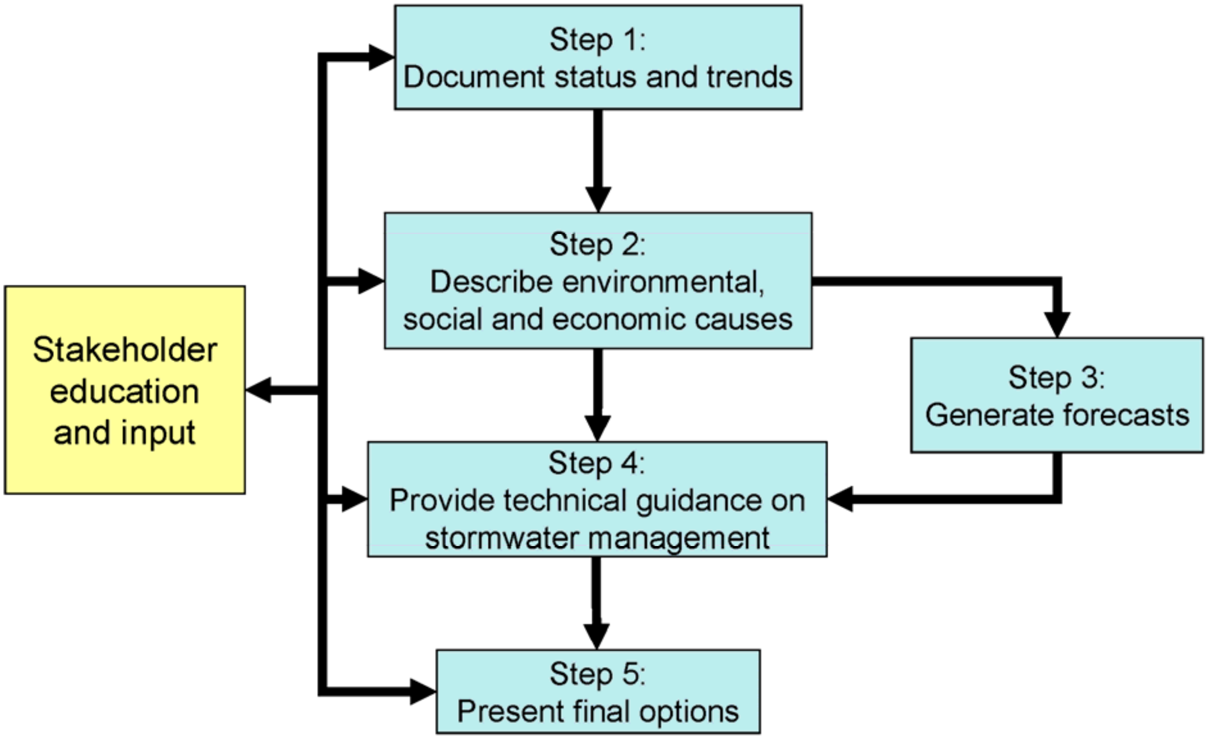

Figure 1-1. Rein in the Runoff Integrated Assessment approach for stormwater management alternatives in the Spring Lake Watershed.

Chapter 2: Conditions in the Spring Lake Watershed related to Stormwater Pollution

To identify the primary causes and consequences of stormwater discharges to Spring Lake and its adjoining waterbodies, the Rein in the Runoff project team looked at the environmental, social, and economic conditions within the watershed. This included the examination of existing datasets, data updates and analyses, and the use of hydrologic and population growth models to assess the current status and historic trends of those conditions related to the geography and natural features, development and population growth, changes in land use and land cover, and the effects of stormwater runoff on local and regional water quality and quantity within – and downstream – of the Spring Lake Watershed. For details regarding the underlying data and modeling approaches relied on by the project team, please see Appendix A.

GEOGRAPHY AND NATURAL FEATURES

Spring Lake is located on the west side of Michigan's lower peninsula (Figure 2-1). It is one of many drowned river mouths located along Lake Michigan's eastern shoreline. These geological features are remnants of the most recent Ice Age, when retreating glacial ice melted and flooded the mouths of these rivers where they entered Lake Michigan.

Spring Lake flows into the Grand River in northwestern Ottawa County, just 2.6 nautical miles to the east and upstream of Lake Michigan. The watershed encompasses 52.8 square miles in Ottawa and Muskegon counties, and includes 11 municipalities; there are two communities downstream of Spring Lake along the Grand River toward its outlet at Lake Michigan (Figure 2-2). Forty-one percent of the Spring Lake Watershed is forested, and other natural features include the lake and several tributary streams (~1,100 acres), approximately 340 acres of

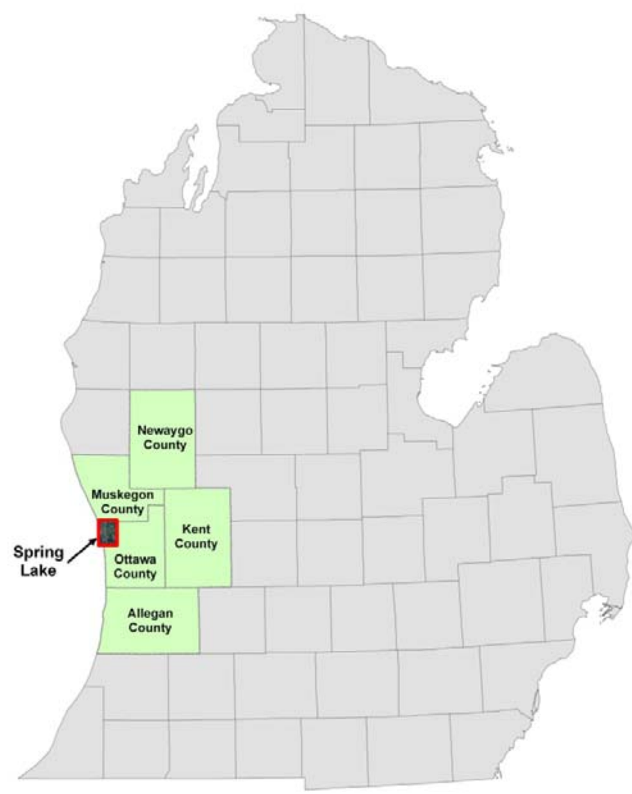

Figure 2-1. Geographic location of Spring Lake in Michigan's western lower peninsula.

wetlands, and more than 2,200 acres of urban and rural shrub and grasslands (Michigan Center for Geographic Information, Department of Information Technology 2008; Michigan Resources Information System (MIRIS), MDNR Land and Water Management Division 1978; 2006 update by AWRI).

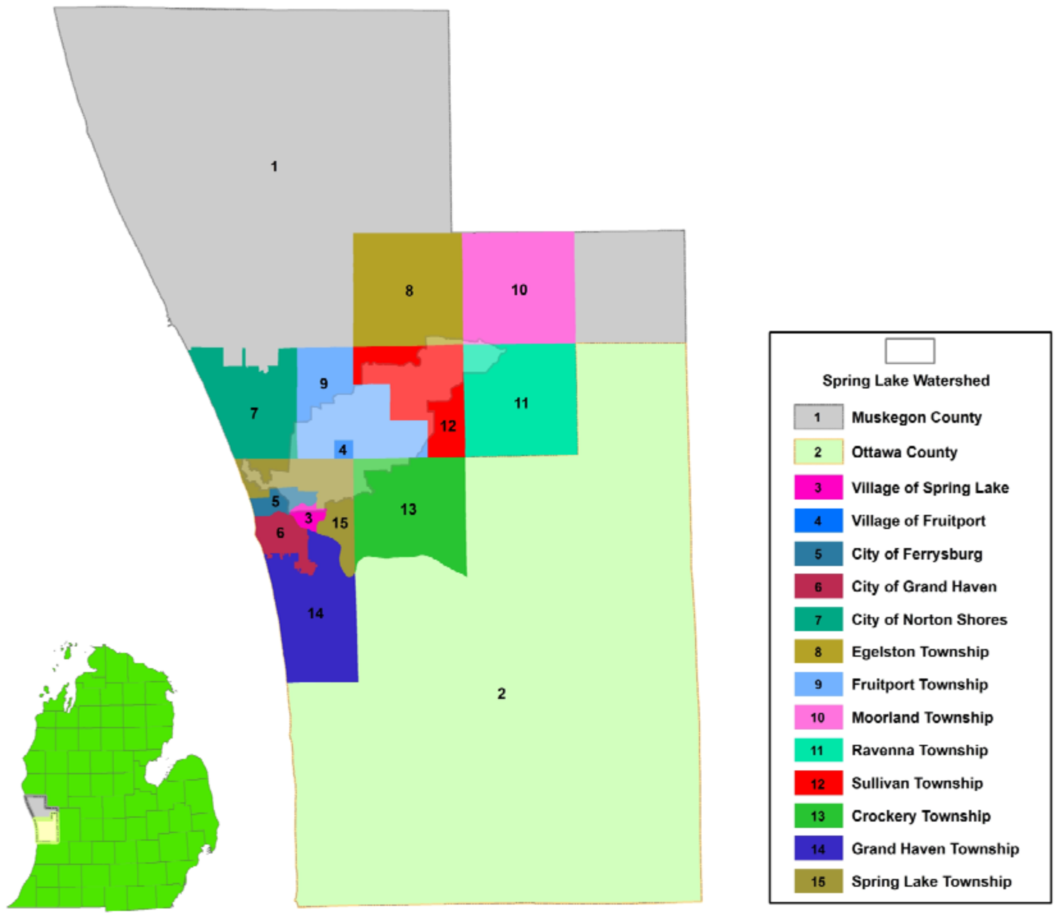

Figure 2-2. Municipal jurisdictions within the Spring Lake Watershed boundary and downstream to the mouth of the Grand River.

The soils throughout the watershed are predominantly sand or sandy-textured (Figure 2-3). More than 76% of the soils in the Spring Lake Watershed are classified under Hydrologic Soil Groups A or B, which have high to highly moderate rainfall infiltration rates and low stormwater runoff potential (Table 2-1). This results in a very pervious natural landscape which is well-suited to handle natural precipitation.

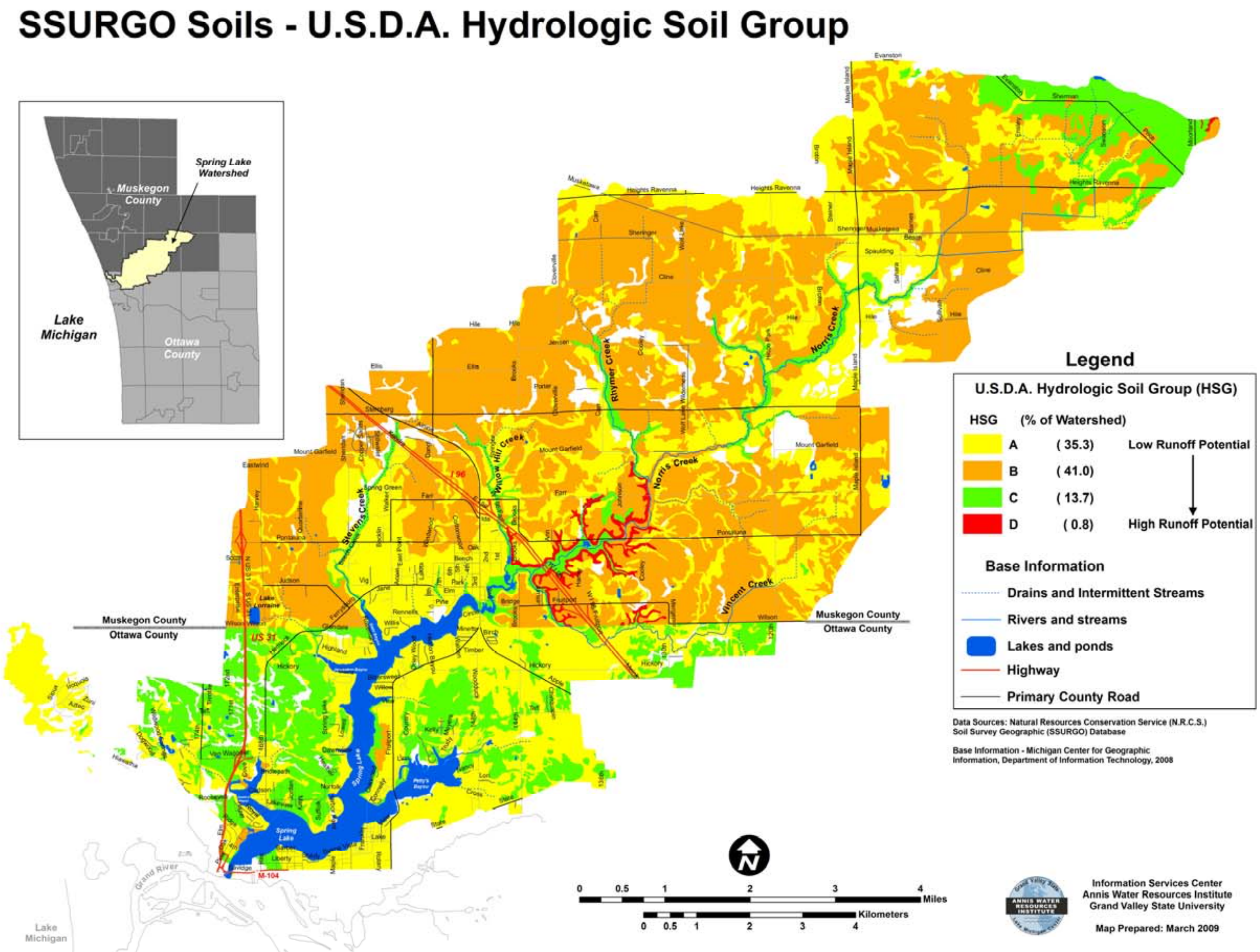

Figure 2-3. Classification of soils in the Spring Lake Watershed by Hydrologic Soil Groups.

Table 2-1. Natural Resources Conservation Service Hydrologic Soil Groups (USDA National Resources Conservation Service, TR-55, June 1986).

Hydrologic Soil Group	Runoff Potential	Description	Texture
A	Low	High infiltration rates, even when thoroughly wetted; consists chiefly of deep, well to excessively drained sand or gravel	Sand, loamy sand or sandy loam
B	Moderately Low	Moderate infiltration rates when thoroughly wetted; consists chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures	Silt loam or loam
C	Moderately High	Low infiltration rates when thoroughly Wetted; consists chiefly of a layer that impedes downward movement of water and with moderately fine to fine texture	Sandy clay loam
D	High	Very low infiltration rates when thoroughly wetted; consists chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material	Clay loam, silty clay loam, sandy clay, silty clay or clay

POPULATION GROWTH AND LAND USE CHANGE

Located in one of the only regions in Michigan to see continued population growth in the last decade, the Spring Lake Watershed has seen large historic increases in residential and commercial development, and corresponding decreases in forested and agricultural lands (Figure 2-4). Because Spring Lake is connected to Lake Michigan by the Grand River, boating is popular and property values are high. Most of the existing development has occurred along these waterways (Figure 2-5), and there is a great deal of continued pressure to develop the few remaining natural areas around the lake (Progressive AE, Project No. 54060102, April 2001). As natural lands are converted to residential and commercial development, water that was once absorbed by soil or transpired by vegetation is now conveyed from roadways, rooftops, and parking lots by storm drains, canals, and pipes to nearby surface waters as stormwater runoff. Spring Lake and the Grand River are already impacted by high levels of phosphorus, potentially-toxic cyanobacteria blooms, and waterborne pathogens; the nearshore areas of Lake Michigan are also showing significant signs of impairment from nonpoint source pollution.

2-4a.

2-4b.

2-4c.

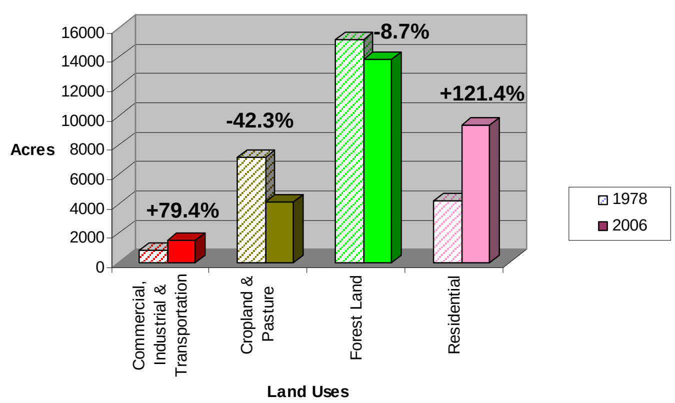

Figure 2-4: Significant land use change in the Spring Lake Watershed 1978-2006.[1]

1 Full-sized land use and land cover maps can be found in the Rein in the Runoff Project Atlas, Section 2.

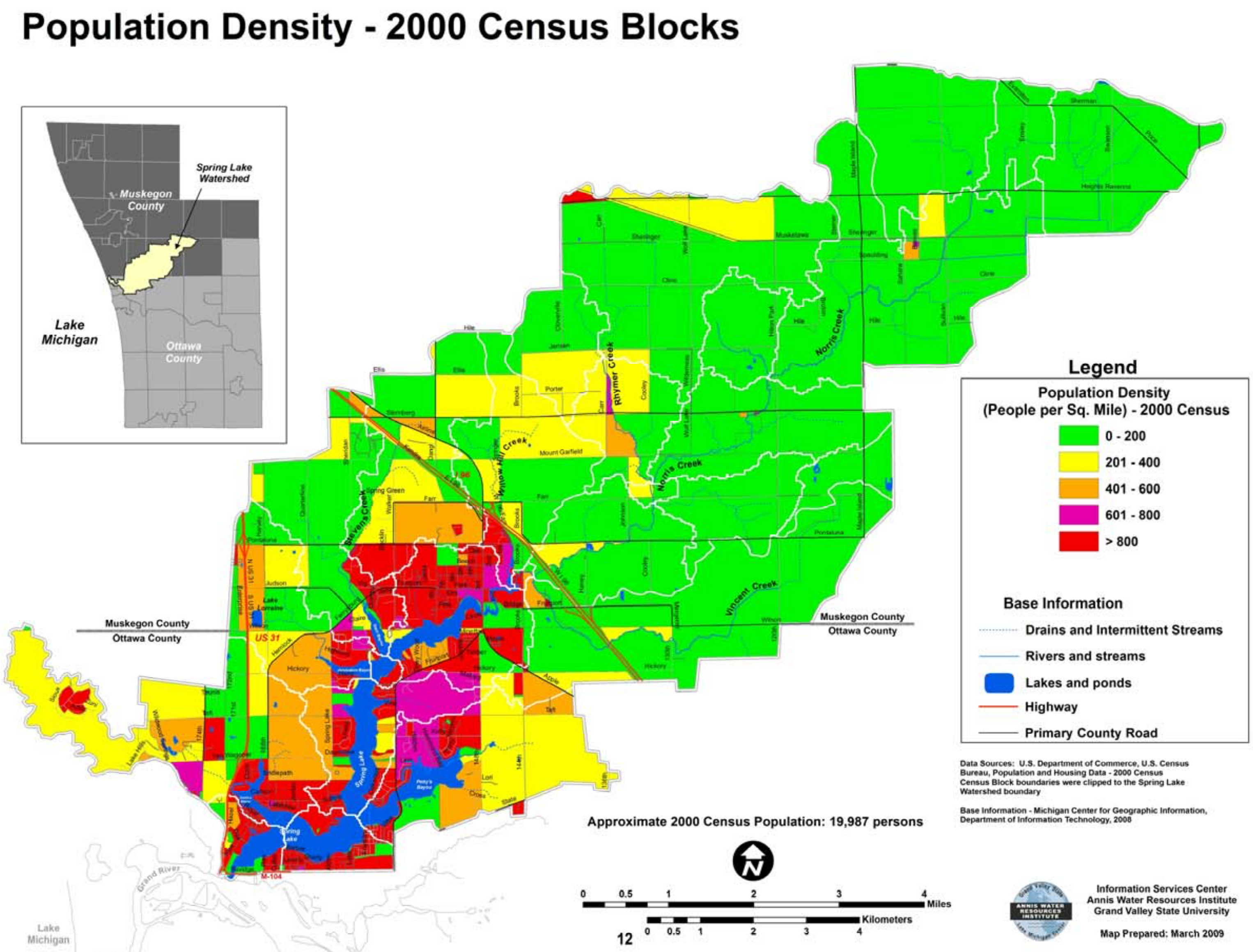

Figure 2-5. Population density (2000) of the Spring Lake Watershed.

This urban growth in the Spring Lake Watershed has resulted in a dramatic increase in total impervious area[1], particularly in the communities adjacent to Spring Lake (Figure 2-6). In the last decade, the watershed has gone from a mean percent impervious surface area of 10% to 15%. In 1992-97, more than 63% of the watershed consisted of land uses and land covers associated with impervious surface areas of less than 10%; in 2006, this percentage had decreased to less than 27% (see Figure 2-6). The areas immediately adjacent to Spring Lake have total impervious surface cover greater than 15% - and in most cases, greater than 20%. This has dramatically affected the way precipitation moves through this system. As noted above, in its natural, presettlement state, the predominantly sandy soils in the Spring Lake Watershed had high to moderately high rainfall infiltration rates and low runoff potential. The increase in imperviousness, particularly in the areas surrounding the lake, has removed these natural stormwater control benefits.

SCOPE OF STORMWATER PROBLEM

As a result of the dramatic increases in development and impervious surfaces in the watershed, Spring Lake has been impacted by stormwater pollution – most notably high levels of phosphorus (P). Spring Lake has had some of the highest P concentrations measured in West Michigan, with total phosphorus (TP) levels averaging 100 parts per billion (ppb) and reaching as high as 631 ppb during ice-free periods from 1999 – 2003 (Steinman et al. 2006; Figure 2-7). Approximately 55-65% of the TP entering the system during this period came from internal loading, which is the release of P from sediments on the lake-bottom (Steinman et al. 2004, 2006). Internal P loading can be a significant source of nutrients in shallow, eutrophic lakes such as Spring Lake, and can result in serious impairment to water quality (Welch and Cooke 1995, 1999; Steinman et al. 1999, 2004; Søndergaard et al. 2001; Nürnberg and LaZerte 2004).


Photo credit: Spring Lake Lake Board

[1] This analysis looked at total impervious area for the Rein in the Runoff-defined land use and land covers present in the Spring Lake Watershed sub-basins. The project team did not take into consideration connected impervious area, which includes only those impervious surfaces which flow directly into a storm sewer, drain, channel, or waterway, without flowing over any pervious surfaces. Because the team delineated percent impervious surface values based solely on land use and cover type, this analysis may overestimate potential impairments.

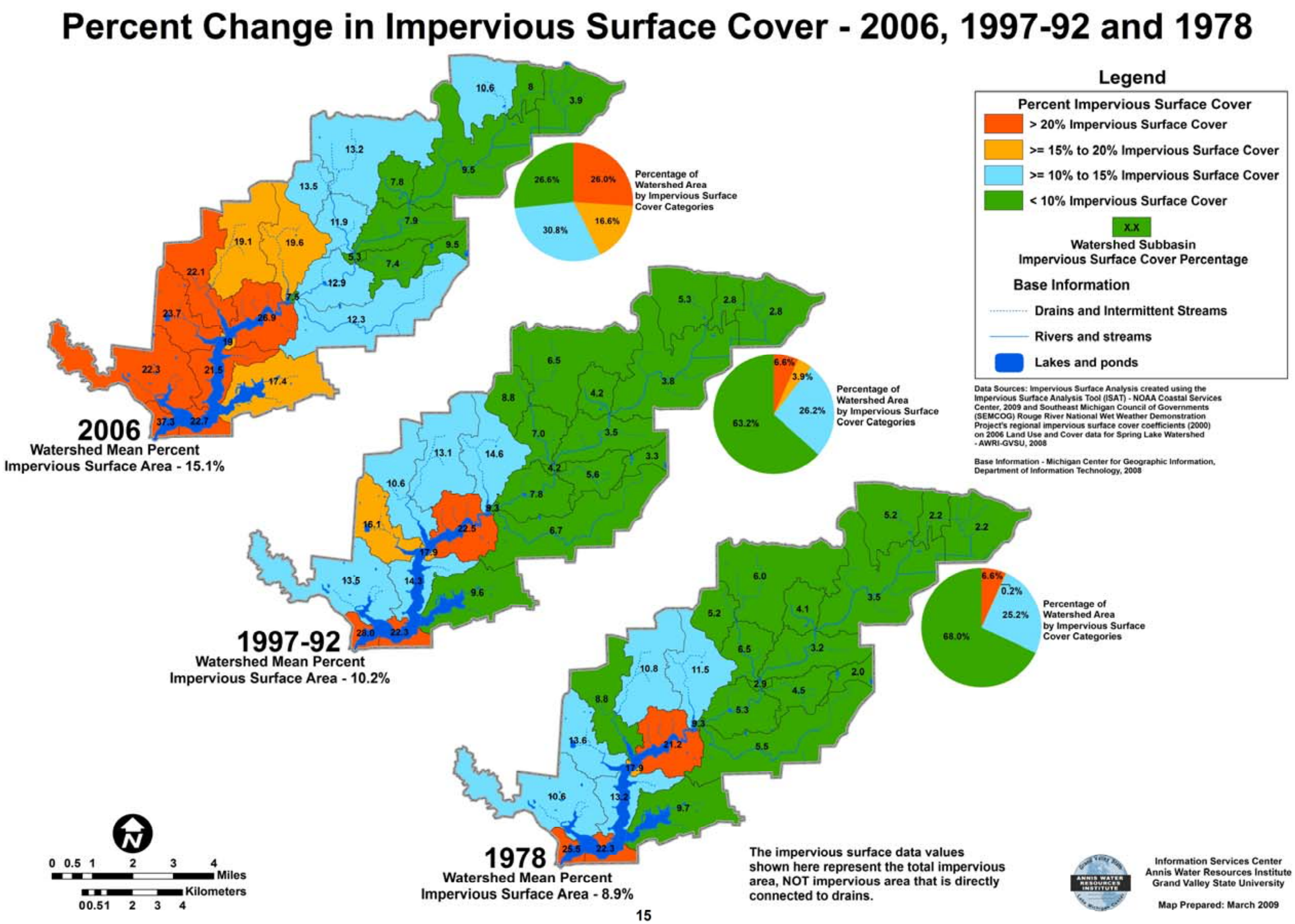

Figure 2-6. Percent change in impervious surface cover in the Spring Lake Watershed from 1978 – 2006.

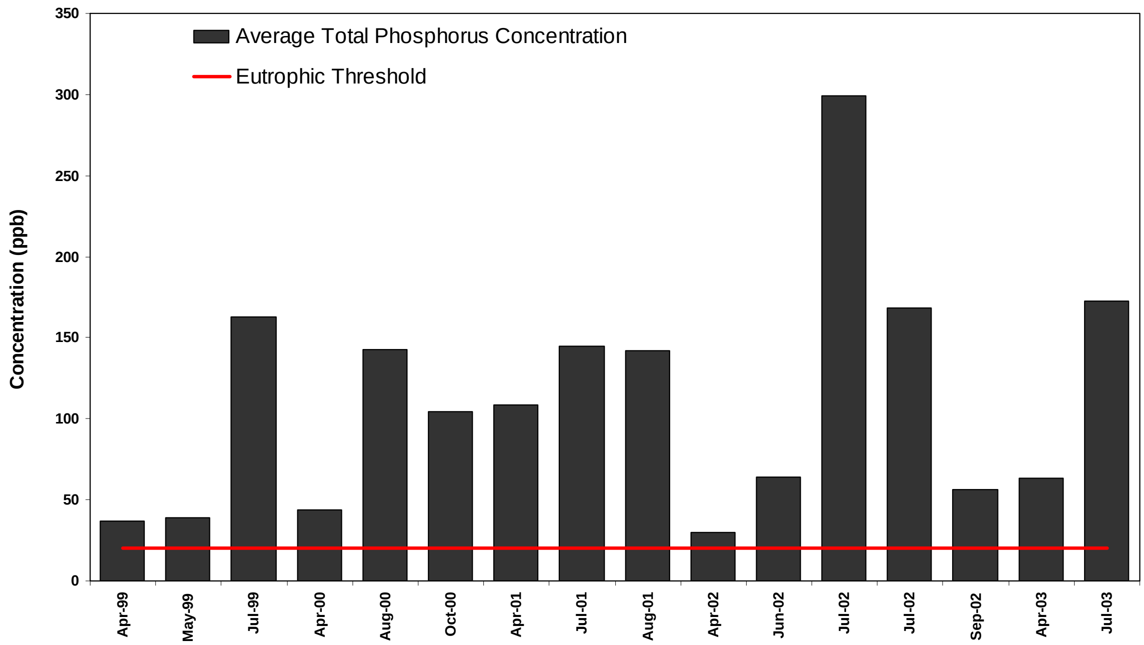

Figure 2-7. Total phosphorus levels (parts per billion) in Spring Lake (1999 – 2003) (data courtesy of Progressive AE).

Even when external P loading rates are relatively low, high internal loading rates can help trigger or sustain algal blooms, which was the case in Spring Lake. To help alleviate this problem, in the Fall of 2005 an alum treatment of ~80 g Al m^{-2} was applied to approximately 47% of the lake's surface area. Alum binds with P and restricts its release from the sediment (Steinman et al. 2004). This resulted in an overall decrease in P concentrations and reduced the rate of internal P loading (Steinman and Ogdahl 2008).

However, even after application of the alum treatment, mean TP concentrations in Spring Lake remain above eutrophic thresholds, suggesting ongoing external P loads to the system (Steinman and Ogdahl 2008). To support this conclusion, the Rein in the Runoff project team modeled the effects of past and current land use and cover in the Spring Lake Watershed on nutrient loads to Spring Lake (see Appendix A). The PLOAD model results showed increased pollutant loads for Total Phosphorus (TP) (Figure 2-8), Total Nitrogen (TN) (Figure 2-9), and Total Suspended Solids (TSS) (Figure 2-10) from 1978 to 2006.

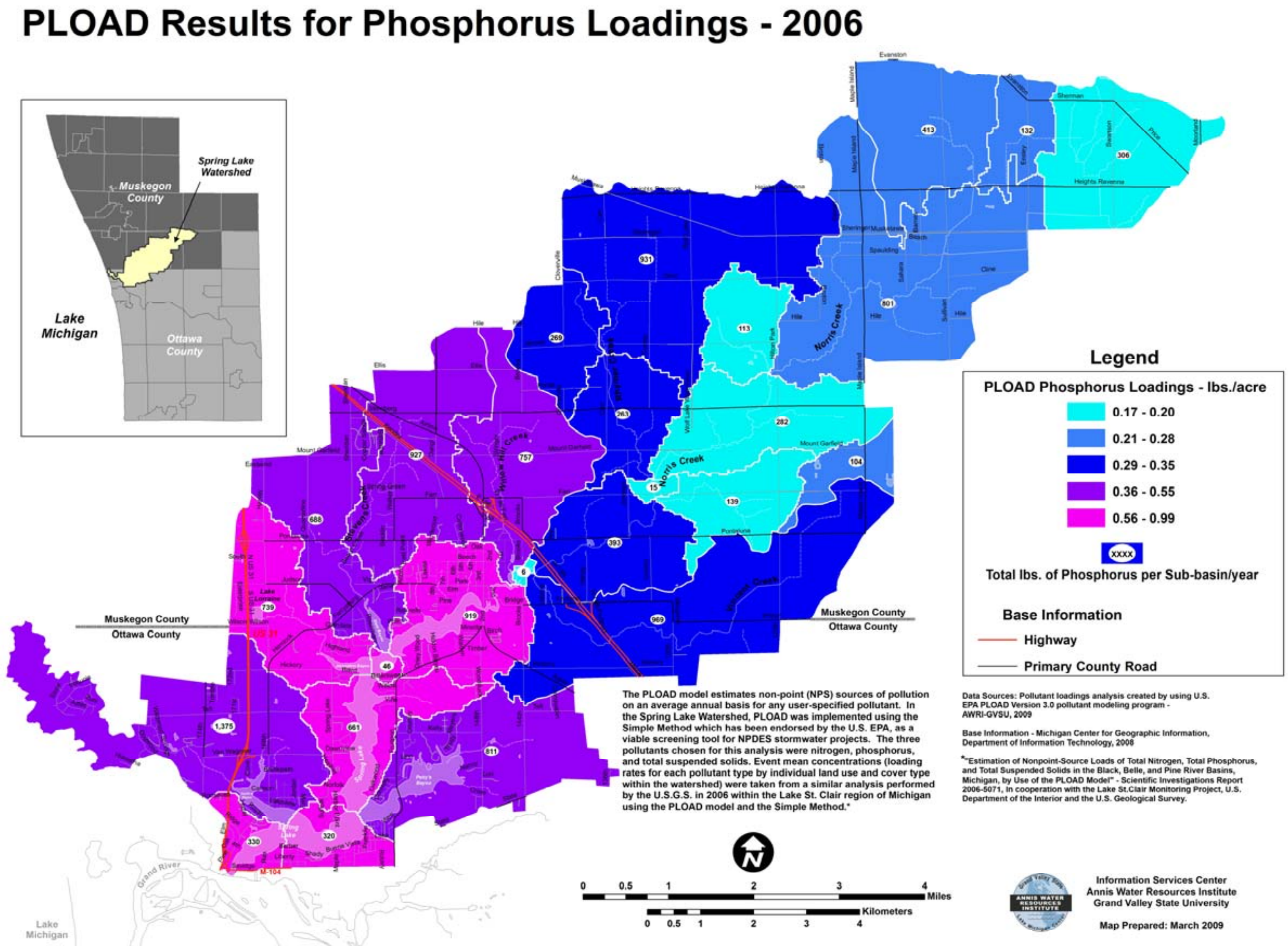

Figure 2-8. Rein in the Runoff modeling results for Total Phosphorus loadings from the Spring Lake Watershed based on 2006 land use and land cover.

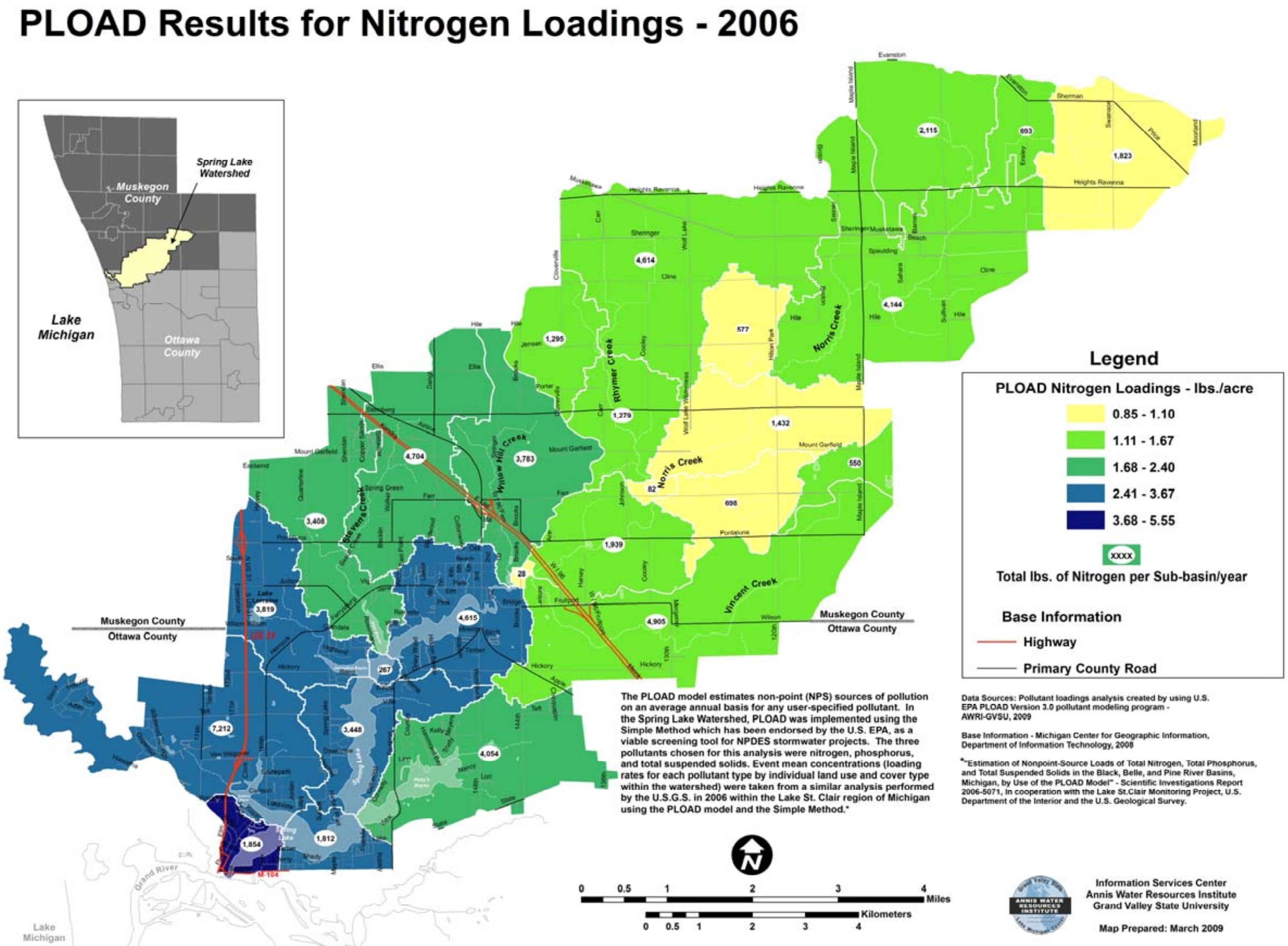

Figure 2-9. Rein in the Runoff modeling results for Total Nitrogen loadings from the Spring Lake Watershed based on 2006 land use and land cover.

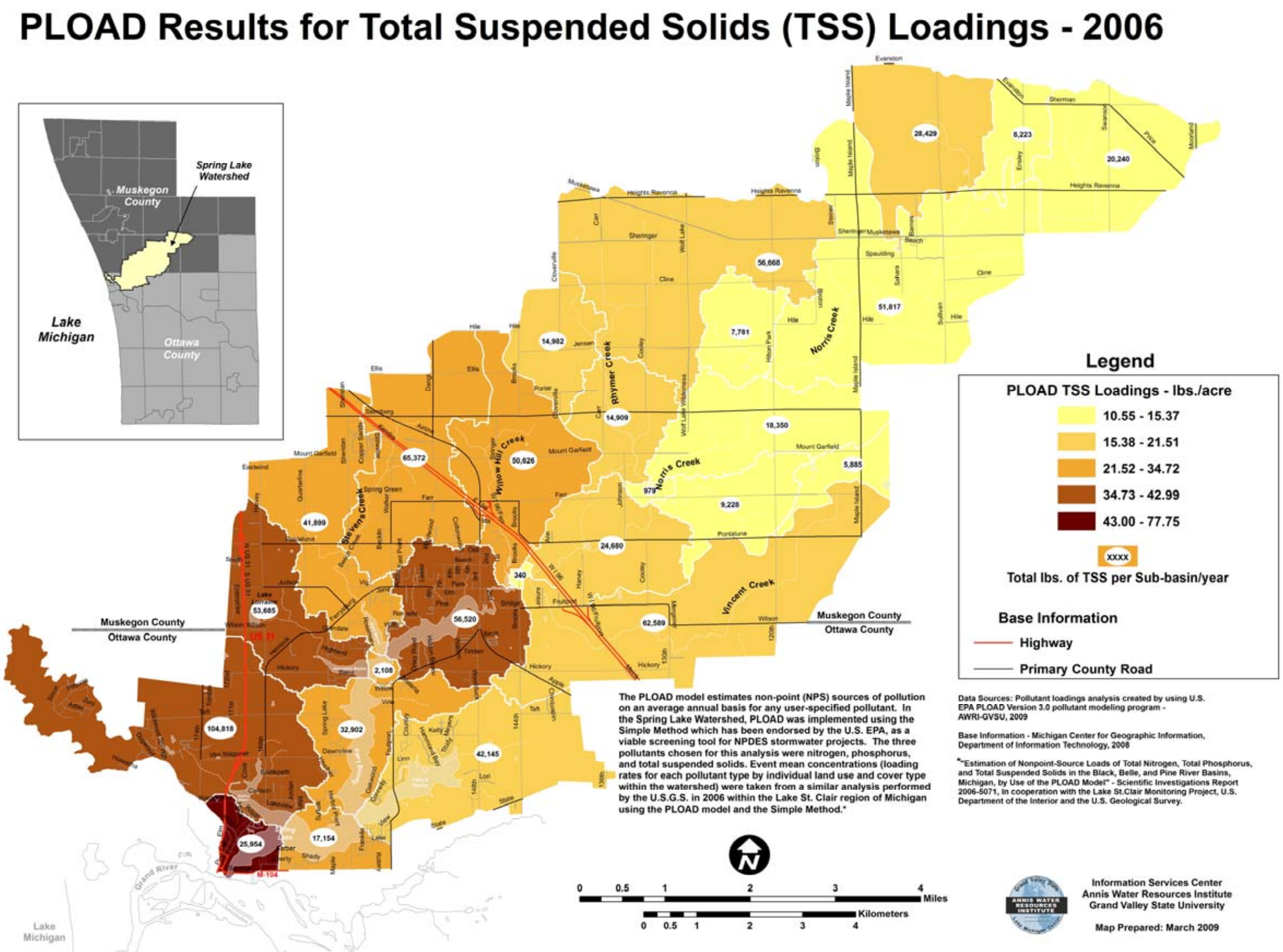

Figure 2-10. Rein in the Runoff modeling results for Total Suspended Solids loadings from the Spring Lake Watershed based on 2006 land use and land cover.

Historically, the three main external sources of TP to Spring Lake annually are tributary inflow (67%), septic tank systems (17%), and inorganic fertilizer applied to lands and agricultural lands (10%) (Lauber 1999). It is these, and other, nonpoint sources of stormwater pollution that still need to be addressed in the Spring Lake Watershed.

In addition to problems associated with water quality, stormwater runoff also affects the water quantity within the watershed. Increased storm flows associated with urban runoff have also eroded streambanks. In June 2008, severe streambank erosion resulting from persistent storm flows became evident when a 35-foot wide section of road collapsed into Norris Creek in Fruitport Township. The repair to the roadway and underlying culvert cost the Muskegon County Road Commission $144,700 in contractors, labor, and materials (Muskegon County Road Commission, personal communication, June 2009). Stormwater management practices need to be put into place throughout the Spring Lake Watershed to help minimize similar events in the future.

Chapter 3: Stakeholder Education and Participation

Stakeholders represented a key component of the Rein in the Runoff Integrated Assessment (IA) project. Stakeholder involvement is essential to knowing what is important to whom and why it is important, and also for encouraging broad-based approval of final recommendations and outcomes (National Park Service 2002). Input from all stakeholders should be constantly sought, and co-management of the natural resources should be encouraged (Ducros and Watson 2002). Governmental policymakers should be armed with information regarding the effects of management decisions and policies on individual properties and landowner interests (Dreyfus and Denbow 2003).

The project team identified a broad range of stakeholders to involve in the Rein in the Runoff IA that included local and county officials, watershed residents, schoolteachers, business owners, developers, nonprofit organizations, community groups, state agency representatives, and regional representatives. To help these stakeholders understand the causes and consequences of stormwater and its associated environmental, social, and economic problems for the Spring Lake Watershed, several methods of distributing information were adopted and implemented.

PROJECT WEBSITE

Researchers at the Annis Water Resources Institute (AWRI) assisted the project team in the design and maintenance of a detailed project website. Online information includes introductory information about the Rein in the Runoff IA project and the problems and challenges associated with stormwater runoff and management, both generally and in the Spring Lake Watershed in particular; stakeholder information, including meeting announcements, summaries, and presentations; stormwater education information, including information about what individuals and communities can do to minimize their own contributions of stormwater runoff to local waterways; project products; and project team contact information. Usage of the website has not been tracked by the project team, but there is a link that allows site visitors to send in electronic comments or questions. Although the stakeholders requested this comment feature, its use has been limited. The website has been updated throughout the duration of the project, and it will continue to be maintained after the IA's conclusion.

The Institutional Marketing Department at Grand Valley State University established a unique URL for the project website to increase ease of access. This URL is: http://www.gvsu.edu/wri/reinintherunoff.

PROJECT BRANDING

Developing the “Rein in the Runoff” project brand was an important component of this IA project. Not only is branding the cornerstone of successful services marketing (Berry 2000), but stakeholder participation in the development of the brand was expected to increase community “buy-in” for the project results. Guided by the communications expert on our project team and a volunteer graphic artist[1], stakeholders were asked to come up with an easy to remember name and simple logo for this IA project. The branding process was strengthened by the integration of traditional marketing communication tools with communication and service delivery strategies, and communication strategies aimed at different stakeholder groups (Gray 2006).

PRESENTATIONS, DISPLAYS, AND DEMONSTRATIONS

Stakeholder education and outreach was a large component of the Rein in the Runoff IA project, and several versions of an informational presentation were created to present to different stakeholder groups and organizations. The presentation was most often in the form of a formal PowerPoint presentation, but displays, flyers (Appendix B), newsletter articles, press releases, and demonstrations were also used. Each presentation generally consisted of four main sections: (1) a brief introduction of the IA project, including defining what is meant by “integrated assessment”; (2) a short overview of “what is stormwater” and “why it matters”, including basic principles of hydrology and stormwater discharges; (3) a description of current, local stormwater management practices, problems, and challenges; and (4) introductory information regarding stormwater management solutions.

The project team targeted different audiences for these different educational opportunities, including municipal officials and land use decision-makers, residents within and downstream of the Spring Lake Watershed, students, and other interested parties. The primary goals of these different education and outreach sessions included: increasing stakeholder knowledge about the causes, consequences, and correctives associated with polluted stormwater discharges from the Spring Lake Watershed; and encouraging implementation of behaviors, practices, and stormwater best management practices (BMPs) at the municipal and household level to help minimize local contributions of stormwater pollution to Spring Lake, the Grand River,


Photo credit: E.S. Isely.

[1] Shane VanOosterhout of Kendall College of Art and Design in Grand Rapids (MI) graciously volunteered to help with the Rein in the Runoff logo design. He created four basic designs and then finalized the Rein in the Runoff project design based on stakeholder input.

and Lake Michigan. The majority of these educational sessions were one-time events; the exceptions to this were presentations to the Stakeholder Steering Committee (see below) and to the Spring Lake Intermediate School Wetland Detectives Club. Team members gave the Wetland Detectives a formal presentation, an Enviroscape (Environmental Education Products, www.enviroscapes.com) stormwater demonstration, and a local BMP (or potential BMP) site tour.

For a complete list of project educational presentations to stakeholders and project partners, please see Appendix C.

STAKEHOLDER STEERING COMMITTEE

In late 2007, the Rein in the Runoff IA project team began to identify specific individuals, organizations, or municipal units to include in a Stakeholder Steering Committee. The initial member list of 47 included top officials for the 15 governmental units within and downstream of the Spring Lake Watershed; representatives from the MDEQ; developers, marina operators, anglers, and local businesses; nonprofit organizations and community groups; environmental consultants; schoolteachers; other potentially interested individuals; and individuals identified by members of the Stakeholder Steering Committee. The main roles of this group were to: receive information about the IA project; disseminate (formally or informally) project information to their neighbors, friends, constituents, etc.; and provide input on various technical and non-technical aspects of the IA.

Table 3-1. Rein in the Runoff Integrated Assessment Project Stakeholder Steering Committee Meetings.

Meeting Date	Participants	Discussion Topics
February 6, 2008	Meeting postponed because of severe weather conditions.	
March 19, 2008	12	Introduction to project/team/concepts; stormwater topics of concern; project name/identity ("Rein in the Runoff"); meeting format and preferred communications
June 4, 2008	15	Project overview; local conditions of concern; application of BMPs
September 30, 2008	8	Project overview; effects of land use and BMPs on stormwater runoff; selection of Rein in the Runoff project logo
January 27, 2009	8	Project overview; structural and non-structural BMPs; identification of specific sites for application of BMPs; identification of growth/building constraints

The inaugural meeting of the Stakeholder Steering Committee was held in March 2008[2], and the group met quarterly thereafter for approximately one year (Table 3-1). Meetings were conducted in the evenings to attempt to maximize stakeholder attendance; however, meeting attendance still declined over the course of the year. However, a member list of approximately 55 individuals was maintained throughout the project, and everyone on this list received copies of all correspondence, meeting notices, projects updates, and website updates via U.S. mail or email. All meetings of

[2] The inaugural Stakeholder Steering Committee meeting was originally scheduled for February 6, 2008. It was cancelled and rescheduled because of localized blizzard conditions.

the Stakeholder Steering Committee were held at the Spring Lake Library in the Village of Spring Lake; the presentations for each meeting can be found on the Stakeholders page of the project website.

Over the course of the year that the Stakeholder Steering Committee met, members provided input to the project team on a variety of administrative and technical matters. Administrative input included feedback on meeting time, location, and frequency; preferred methods of communication with the project team; format and timing (dates) for a public meeting (or open house); selection of the “Rein in the Runoff” project name; ongoing identification of potential members of the Stakeholder Steering Committee; identification of community groups, school groups, or special events for team members to do presentations, displays, or demonstrations regarding stormwater issues, the need for stormwater management and stewardship in the Spring Lake Watershed; and selection of the Rein in the Runoff project logo.

However, because of the complexities of the environmental, economic, and social aspects of stormwater management, stakeholder input on the technical aspects of the Rein in the Runoff IA project was more limited. Members of the Rein the in Runoff Stakeholder Steering Committee seemed to struggle with providing feedback on stormwater-related issues, and they were reluctant to provide input on the technical questions posed by the project team. These questions included stakeholder assistance in the identification of particular areas within the Spring Lake Watershed that potentially contribute stormwater pollution to the waterways (i.e., stormwater “hot spots”); where new building/development should be limited or restricted and where stormwater best management practices (BMPs) would be appropriate for implementation or installation; and identification of the most appropriate or most appealing BMPs to watershed residents.

Although a few individual members of the Stakeholder Steering Committee worked with the project team to help identify specific areas of concern within the watershed (e.g., road ends, areas lacking sewer systems, storm drain and pipe outlets, and an old landfill site), this input was also fairly limited. The primary reason for stakeholder reluctance appeared to be lack of sufficient knowledge on the many and varied facets of stormwater runoff and management. This was true even immediately after educational presentations that attempted to simplify these issues. The input that stakeholders were able to provide was not detailed enough in many cases to assist the project team in formulating BMPs specific to the Spring Lake Watershed.

The one area where stakeholders were willing and able to provide more-detailed feedback was on proposed ordinance changes. On February 16, 2009, the project team hosted a Joint Council Session with representatives from the Village of Spring Lake, Spring Lake Township, and the City of Ferrysburg. This well-attended session included approximately 20-25 council members, trustees, and top officials from these three communities, as well as few representatives from Ottawa County. The project team presented information about the Rein in the Runoff project, an overview of a proposed stormwater ordinance, and information about stormwater utility ordinances. Although not everyone was in agreement, there was a great deal of discussion about these proposed ordinances, the water quality in Spring Lake, and the need for ongoing stormwater management and education. This stakeholder meeting made it clear to the project team that not all local communities understand the need to manage and control stormwater discharges to Spring Lake, the Grand River, and Lake Michigan, and that ongoing local education regarding these issues is important and strongly needed.


Photo credit: P. Isely.

WATER QUALITY SURVEY

In the Spring of 2008, the project team developed the “Rein in the Runoff Water Quality Survey”, which was designed to do three things: (1) gather information about Spring Lake Watershed residents’ knowledge about, and their behaviors affecting, stormwater runoff; (2) provide another means of educating watershed residents about behaviors that affect the water quality of local waterbodies; and (3) gather information about watershed residents’ willingness to pay for improved water quality – i.e., reduced phosphorus levels in Spring Lake. There were two versions of the survey, which differed only in the amounts proffered in the willingness to pay questions (#21-23). Both versions of the Rein in the Runoff Water Quality Survey can be found in Appendix D.

This survey was kicked-off to the general public at the Rein in the Runoff Public Meeting and Open House on June 25, 2008, and subsequently distributed to a small group of conveniently sampled residents at stakeholder meetings, presentations, and community events. Version 2 of the Rein in the Runoff Water Quality Survey was also made available on the Stormwater Education page on the project website, with its own unique URL: http://www.gvsu.edu/wri/waterqualitysurvey. Notices regarding this URL were included on Rein in the Runoff project flyers, community newsletters, Spring Lake School District newsletters, and press releases from June 2008 – Spring 2009.

The project team received very few responses to the Water Quality Survey. From the hard copies handed out at community festivals and events and the survey posted online, only 40 surveys were completed and returned[3]. Because of the reliance on convenience sampling to distribute the survey, these responses are non-scientific and

[3] Forty one surveys were completed, but one was thrown out because the respondent was less than 18 years old.

likely biased toward individuals already having concerns about water quality in either Spring Lake, the Grand River, Lake Michigan, or another local waterbody. However, even with such a limited amount of responses, there were still some interesting results.

Sixty percent of survey respondents believe that the water quality of Spring Lake is fair or poor, with 35% of respondents believing that the water quality of the lake is good or excellent (Figure 3-1). This suggests that the majority of respondents understand the need for local water quality improvement. However, despite this, and the presumed bias of the response sample, only 40% of these respondents were willing to pay more than $50 per year if phosphorus levels could be reduced below the eutrophic threshold of 20 ppb (Figure 3-2). Respondents' answers to this question could have been influenced by the fact that they were already paying for phosphorus reductions in Spring Lake through local assessments related to the application of the alum treatment in 2005, or by the fact that parts of West Michigan were experiencing high rates of unemployment during the course of the Rein in the Runoff project period.

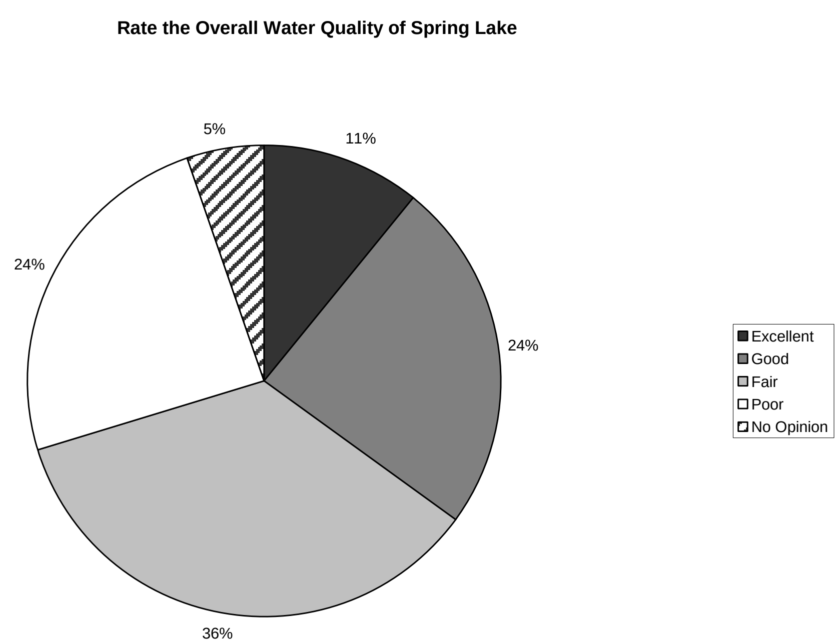

Figure 3-1. Water Quality Survey responses regarding the water quality of Spring Lake.

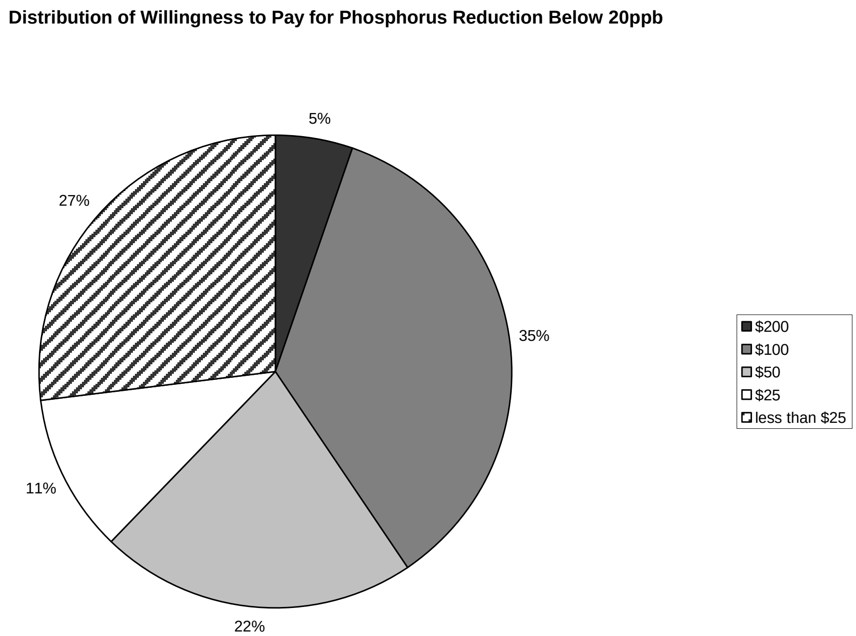

Figure 3-2. Water Quality Survey responses regarding stakeholder willingness to pay for phosphorus reduction below 20 ppb.

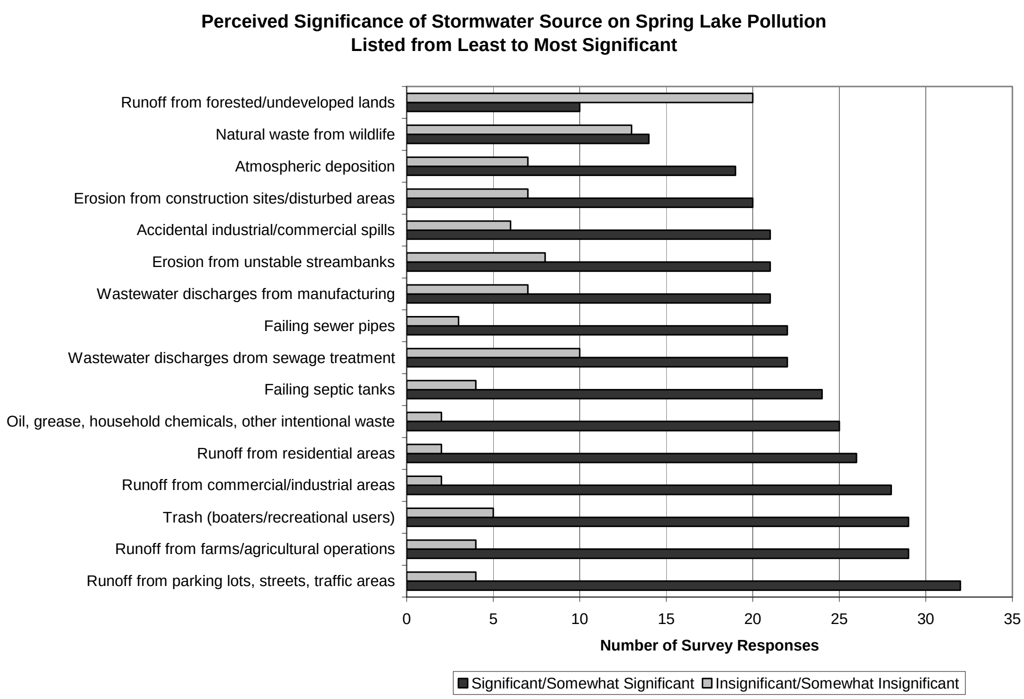

Figure 3-3. Water Quality Survey responses rating potential sources of pollution to Spring Lake.

Additionally, when asked to rate potential sources of water pollution to Spring Lake, the top five (5) ranked sources were runoff from parking lots, streets, and traffic areas; runoff from farming and agricultural operations; trash from boaters and recreational users of the lake; runoff from commercial or industrial areas; and runoff from residential areas (Figure 3-3). This suggests that there is at least some understanding among these stakeholders regarding the influence of development and land use on stormwater pollution in Spring Lake. However, given that 95% of these respondents live in the more urbanized areas of the watershed and 85% recreate on the water, there seems to be a disconnect between individual actions, urbanization, and their relationships to stormwater pollution in Spring Lake.

For example, 17% of respondents that change their own oil for their automobile simply throw the used oil into the garbage; 23% of respondents that own and walk their dogs rarely or never pick up after them; 72% of respondents that fertilize their own lawns have never had a soil test, and 9% continue to use a phosphorus-based fertilizer (Table 3-2.) These data suggest that while some stakeholders understand how their behaviors affect local water quality, ongoing educational efforts regarding local stormwater pollution and control are needed throughout the watershed. Table 3-2 provides guidance regarding potential opportunities for such educational efforts.

Table 3-2. Water Quality Survey Results Regarding Stakeholder Behaviors.

Survey Questions (Behaviors affecting Stormwater Pollution)	**Percent Responses**[1]
Respondents that have and mow their own lawn	98%
Leave grass clippings in the yard	40%
Throw grass clippings in the garbage	10%
Rake or blow grass clippings into storm drain or ditch	3%
Mulch, compost or otherwise recycle grass clippings	49%
Respondents that fertilize their lawn	80%
Have tested soil	28%
Use phosphorus free fertilizer[2]	91%
Respondents wash their personal vehicle at home	50%
Soapy water flows into grass, dirt or gravel	53%
Soapy water flows into the street or driveway	37%
Soapy water flows directly into a storm drain	11%
Respondents that change their own (motor) oil	30%
Dispose of used oil in garbage	17%
Dispose of used oil at recycling center	83%
Respondents have and walk a pet	53%
Always pick up after pet	65%
Often pick up after pet	13%
Rarely pick up after pet	19%
Never pick up after pet	4%
Respondents have a septic tank	18%
Pump it out every 3-5 years	86%
Pump it out more than every 5 years	14%

1 Percent responses for some survey questions do not add up to 100% because respondents could give multiple answers.

2 Ottawa and Muskegon counties have ordinances regulating the use of fertilizers containing phosphorus.

CITIZENS GUIDE TO STORMWATER

Hard copies of this Rein in the Runoff project report can be found at the municipal offices of Spring Lake Township, the Village of Spring Lake, the City of Ferrysburg, the Spring Lake Library, and at the Annis Water Resources Institute (AWRI) in Muskegon. Because of the length of this report and the complexity of the material presented, there is also a consolidated and condensed Citizens Guide to Stormwater that is more "user-friendly" than this full-length report.

The Rein in the Runoff Citizens Guide to Stormwater is an abbreviated version of this full Project Report, targeting the residents of the Spring Lake Watershed. This guide summarizes the IA processes and outcomes, and provides information directly relevant to how individuals can manage and control stormwater runoff associated with their own activities. The Citizens Guide is included as part of the final version of this Project Report (Appendix E).

Chapter 4: Stormwater Best Management Practices (BMPs)

Stormwater runoff is generally controlled through the implementation of various best management practices, or BMPs (Wu et al. 2006). BMPs are stormwater control measures that slow, retain, or absorb nonpoint source pollutants associated with runoff (Tsihrintzis and Hamid 1997; Chang et al. 2007). However, in the United States, the term “BMP” has come to mean any stormwater control measure, and not just the “best” ones (Roy et al. 2008). Better stormwater management practices include low impact development (LID), which incorporates the basic principle of managing stormwater where it lands by implementing design techniques that mimic presettlement hydrology (i.e., infiltration, filtration, storage, evaporation, and detention) (SEMCOG 2008). Particularly when LID strategies are widely applied at the watershed level, these practices can help achieve water quality improvement goals (Wu et al. 2006).

To help the Spring Lake Watershed stakeholders with the selection of appropriate BMPs to implement within their local communities and on individual properties, the Rein in the Runoff project team conducted a broad-scale analytical review of structural and non-structural BMPs that have been successfully implemented in other communities in Michigan and throughout the country. A summary of these BMP alternatives, and where they might be most successfully applied throughout the Spring Lake Watershed, is provided in this chapter. The technical details of the team’s methodology in selecting the BMPs described here are provided in Appendix F.

STRUCTURAL BMPS

Structural BMPs are constructed devices or structures such as detention ponds, created wetlands, or bioswales, that help manage stormwater by collecting and treating runoff (Jacob and Lopez 2009; Chang et al. 2007; Tsihrintzis and Hamid 1997). The Rein in the Runoff project team developed a table of common structural Low Impact Development (LID) BMPs that would be appropriate for implementation in the Spring Lake Watershed, based on the current land use and land cover, soils, general site conditions, and current and expected patterns of development. Table 4-1 provides summary descriptive information about 10 structural BMPs, including the best locations, benefits in addition to stormwater control, and local resources. This information is meant to assist the Spring Lake Watershed stakeholders in the selection of BMPs to help achieve water quality and stormwater management goals.

Table 4-1. Structural Best Management Practices (BMPs) Alternatives Appropriate for Implementation in the Spring Lake Watershed.

	Bioretention/Rain Gardens	Vegetated/Bio Swales	Grow Zones	Capture and Reuse (Rain Barrels/Cisterns)	Tree Planting	Green Roofs	Pervious Pavement	Infiltration Facilities	Constructed Wetlands	Stormwater Retrofits
Description	Shallow landscaped surface depressions designed to infiltrate or filter stormwater	Stormwater conveyance channel designed to filter or infiltrate stormwater	Native planting area	Storing and reusing stormwater	Increased tree cover	Rooftops partially or completely covered with vegetation	Pavements that allow for infiltration or stormwater	Facilities (above- or underground) that allow for infiltration of stormwater	Wetland constructed for the purpose of treating stormwater	Enhancements to an existing stormwater management system or site that provides improved stormwater treatment
Detail	• Shallow landscaped surface depressions • Recommend using deep-rooted native plants • Underdrain and mechanism to direct overflow runoff is necessary • Should be located at least 10 feet from any building	• Shallow stormwater channel that is densely planted with a variety of grasses, shrubs, or trees • Check dams can be used to improve performance and maximize infiltration, especially in steeper areas	• Upland or riparian native planting area	• Structures that capture stormwater for the purpose of reuse	• Tree canopy and forest cover has been shown to reduce stormwater runoff through interception and reduced surface runoff rates compared to un-wooded areas	• Rooftops that are partially or completely covered with vegetation and soil or a growing media planted over a waterproof membrane • Allows the roof to function more like a vegetated surface	• Pervious pavements, including concrete, asphalt, and pavers promote stormwater infiltration and groundwater recharge	• Dry wells, which generally consist of an open bottom chamber installed over a bed of coarse aggregate • Infiltration basins and trenches generally include a layer of coarse stone aggregate installed at or just below the surface • Subsurface infiltration beds consist of a stone storage bed installed below the ground surface	• Man-made wetland with over 50% of its surface area covered by wetland vegetation	• Structural practices such as updating detention basin to promote infiltration, filtration and habitat enhancement; installing catch basin inserts; proprietary stormwater quality enhancement structures; oil-water separators; and general updating of existing stormwater practices
Where Effective	• Residential and commercial areas • Parking lots (use curb cuts to direct stormwater runoff to depressed areas or consider "inverted" islands rather than landscaped islands)	• Vegetated swales typically treat runoff from highly impervious surfaces such as roadways and parking lots	• Parks • Riparian corridors • Other areas currently maintained as mowed lawn, but which are not actively used or accessed • Grow zones are excellent opportunities for reducing local maintenance costs by converting turf or impervious areas to deep-rooted native vegetation	• Rain barrels are well-suited for residential lots • Cisterns and other large storages tanks are more appropriate for commercial or industrial sites • Captured water can be re-used for a variety of applications, including irrigation and grey water uses in buildings	• Areas where cooling impervious surfaces is a priority • Adjacent to water bodies and BMPs	• Green roofs are not common for residential homes • Schools, libraries, and commercial or industrial buildings are perfect candidates for installation • Flat roofs are preferred, but green roofs can be installed on pitched roofs when designed accordingly	• Parking lots • Walking paths • Sidewalks • Playgrounds • Plazas • Tennis courts • Parking lanes	• Must be located in areas of permeable soils • Dry wells may work well for residential applications and retrofits for existing catch basins • Infiltration trenches would be appropriate along roadways without curb and gutter • Consider large infiltration beds for regional stormwater management	• Ideal for large, regional tributary areas where volume control is needed	• Basins that directly discharge to waterbodies and do not have any form of pretreatment
Mechanisms of Pollutant Reduction	• Infiltration • Vegetative transpiration	• Filtration • Infiltration • Vegetative transpiration	• Infiltration • Vegetative transpiration	• Capture and reuse of stormwater greatly improves water quality through reduction in the amount of volume and pollution entering the waterway	• Interception (keeping rain water from becoming stormwater runoff) • Infiltration	• Vegetative transpiration	• Stormwater drains through the permeable surface where it is temporarily held in the voids of a stone bed or other storage reservoir and then slowly infiltrates into the underlying substrate (soil)	• Stormwater is temporarily stored within the voids of the stone bed and then slowly infiltrates into the underlying soil	• Infiltration • Vegetative transpiration	• Depends on retrofit
Other Benefits	• Provides enhancements to landscapes • Could fulfill landscaping requirements for site plan approval	• For new construction, swales are more cost effective than storm sewers for conveyance	• Reduced maintenance costs compared to turf grass	• Reduced use of potable water • Energy savings • Money savings	• Stormwater volume reduction • Improved air and water quality • Wildlife habitat • Enhanced aesthetics • Reduction to the heat island effect if trees shade paved surfaces	• Stormwater volume control • Reduced heating and cooling costs • Increased roof lifespan • Heat island reduction • Habitat enhancement • Green roofs can also be used as an educational tool and site-seeing attraction	• Reduced storm sewer costs for new construction	• Increases groundwater recharge	• Hydrological restoration benefits • Creation or restoration of valuable wetland habitat for wildlife and environmental enhancement	• Remove or treat stormwater pollutants • Minimize channel erosion • Help restore stream hydrology • May be more cost effective than new BMPs
Local Resources	Rain Gardens of West Michigan (Grand Rapids) (616) 451-3051 http://www.raingardens.org		Ottawa Conservation District (Grand Haven) (616) 846-8770 http://ottawacd.org	Rain Gardens of West Michigan (Grand Rapids) (616) 451-3051 http://www.raingardens.org	Ottawa Conservation District (Grand Haven) (616) 846-8770 http://ottawacd.org	LiveRoof, L.L.C., Subsidiary of Hortech, Inc. (Spring Lake) (616) 842-1392 http://www.liveroof.com Center for Sustainability at Aquinas College (Grand Rapids) (616) 632-1994 http://www.centerforsustainability.org	Permaloc Corporation (Holland) (800) 356-9660 http://www.permaloc.com Green Built Michigan (Lansing) (517) 646-2560 http://greenbuiltmichigan.org			

In addition to the identification of these specific BMPs for stakeholders to consider, the project team conducted a macro-scale BMP selection analysis (Figure 4-1; for more details see Appendix F), and identified several opportunities for the implementation of structural BMPs in the Spring Lake Watershed. BMP opportunities were classified into five categories, which are described in more detail below: infiltration BMPs, filtration BMPs, regional storage area, regional treatment area, and site specific BMPs. The team then honed in on two priority areas for reducing phosphorus loadings to Spring Lake: restoring riparian buffers and providing BMPs in areas of high pollutant loading, based on the PLOAD modeling results described in Chapter 2. These locations were identified and delineated on an orthophotographic map of the Spring Lake Watershed (Figure 4-2). Infiltrative BMPs are generally preferred because they provide a reduction in stormwater runoff volume and often provide improvements to water quality that are more significant than comparable filtrative BMPs (SEMCOG 2008).

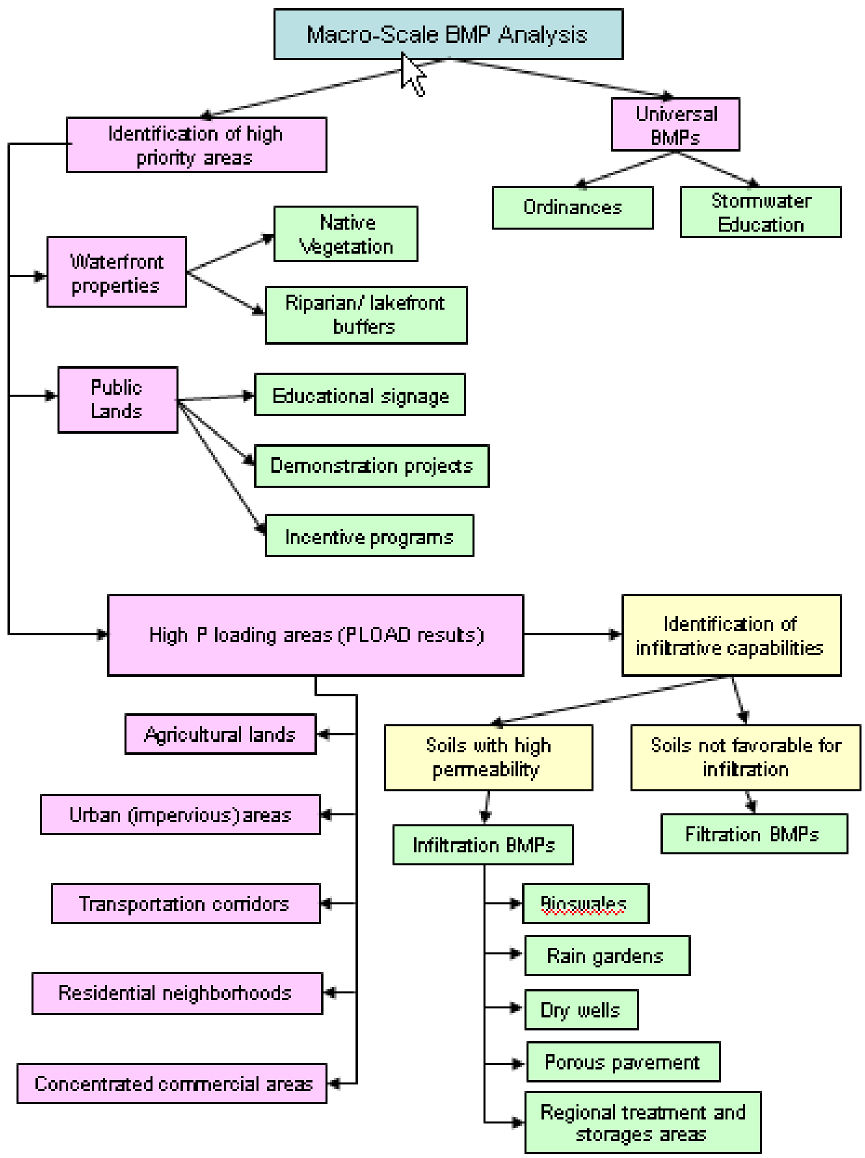

Figure 4-1. Rein in the Runoff macro-scale BMP selection analysis for the Spring Lake Watershed.

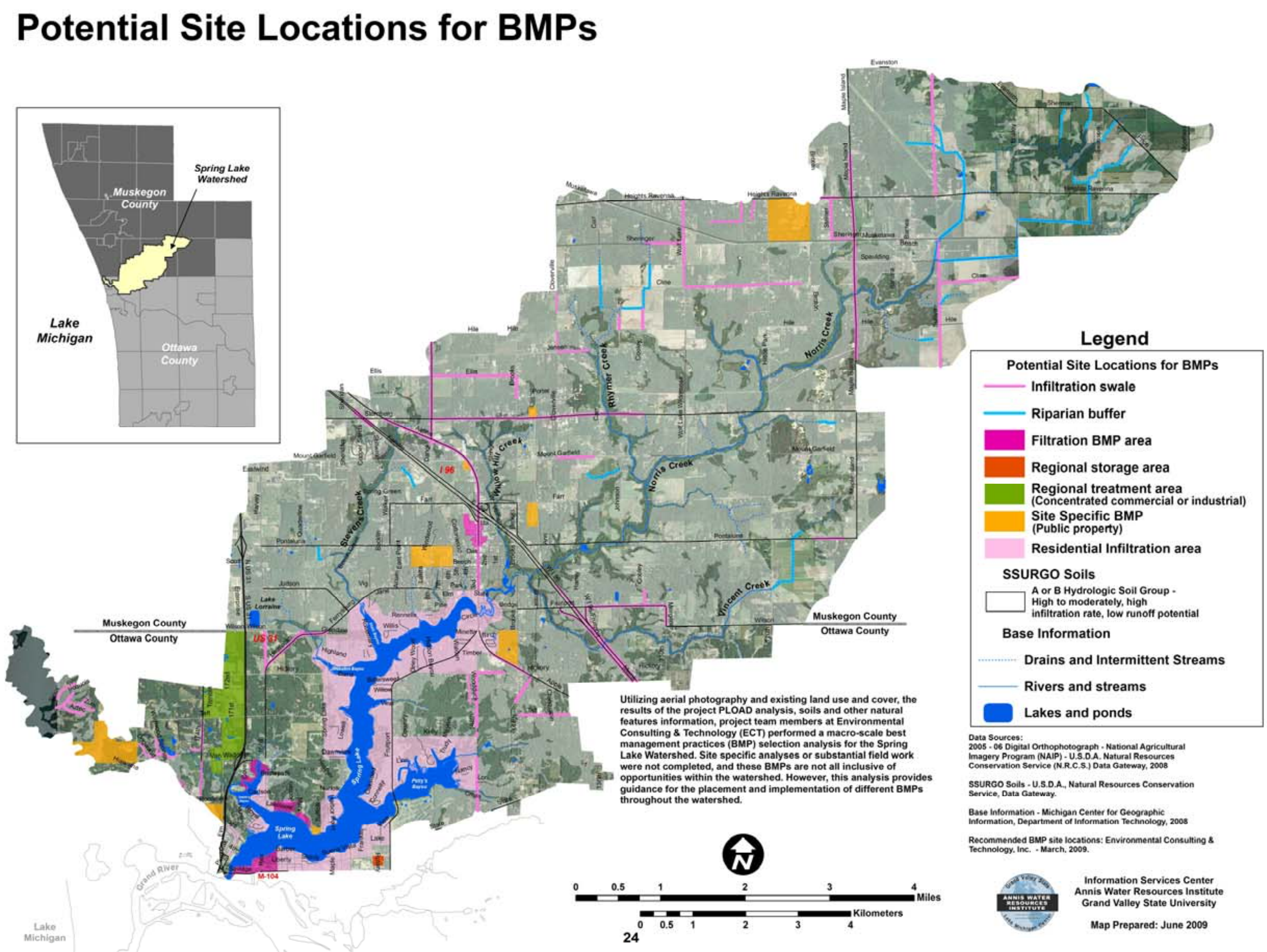

Figure 4-2. High priority areas for implementation of Low Impact Development (LID) BMPs in the Spring Lake Watershed.

Infiltration BMPs

Located in areas of high-permeability soil, infiltration BMPs reduce stormwater runoff volume and improve water quality by promoting infiltration of stormwater. Shallow vegetated swales or steeper swales with check dams are suitable for installation along roadways, while rain gardens are suitable for installation in residential neighborhoods, parks, schools, and other small sites.

Infiltration swales are ideally used along transportation corridors and in road rights-of-way. Where existing open channels or swales (rather than storm sewers) convey runoff, the existing swales are very easily modified to provide infiltration with installation of check dams. Where sufficient road rights-of-way exist, infiltrative swales can be installed along roads with existing curb and gutter. Curb cuts can be used to direct low flows into newly constructed infiltrative swales. High flows can be directed to the swales or allowed to overflow into the existing storm sewer. For smaller roads with existing curb and gutter, catch basins can be replaced with dry wells to promote infiltration for some of the runoff. For residential areas with well-draining soils, infiltration BMPs, including infiltration swales and rain gardens, can be installed in a development-wide fashion.

Rain gardens are one type of infiltration BMP that are ideally installed in residential neighborhoods, parks, and schools, because these BMPs can be designed to accept drainage from multiple properties. Costs will vary based on the plants and subsurface material used. In areas of well-draining soils, engineered underdrain systems are not required, thus reducing costs. However, sites with existing soil contamination, or sites with very high infiltration rates, may need additional treatment or other design provisions before implementation of these types of infiltration BMPs. This would increase costs and may make this option infeasible or inadvisable.

Filtration BMPs

Located in areas of low-permeability soil, filtration BMPs utilize vegetation or soil media to remove sediment and nutrients from stormwater. These BMPs can include planting media and sand layers and an underdrain to improve filtration, or may simply rely on the filtration capabilities of native plants. Vegetated swales and bioswales are suitable for installation along roadways and smaller bioretention basins, and they are suitable for installation in residential neighborhoods, parks, schools, or other small sites.

One critical priority area for implementation of filtrative BMPs in the Spring Lake Watershed includes the streets that terminate at, or very near to, the shoreline. During the limited site visits to the watershed, the project team noticed many dead-end streets which convey untreated stormwater runoff into Spring Lake or the Grand River. Specifically, properties in very close proximity or immediately adjacent to Spring Lake are critical to the nutrient levels within Spring Lake. Where soil conditions are not favorable for infiltration, filtrative BMPs should be applied. Some examples of filtrative BMPs include: bioretention/rain gardens, porous pavement with underdrains, vegetated/bio-swales, and detention/sediment basins.

Regional Storage Areas

In densely developed areas, it may not be feasible to install BMPs for each site. Because these areas often generate high pollutant loads and nutrients to local waterbodies, it might be worthwhile to provide one or more BMP(s) to store stormwater on a regional basis. Regional storage BMPs are generally constructed for the retention of water and stormwater runoff (e.g., retention basins).

Regional Treatment Areas

In urbanized areas, existing concentrated commercial and industrial areas contribute high amounts of nutrients to local waterbodies. Installation of BMPs on existing, developed sites often requires removal of pavement, extensive re-grading, removal or replacement of stormwater conveyance facilities, or other site changes, which can make such retrofits cost prohibitive. Similar to regional storage areas, provisions for more BMPs to treat stormwater on a regional basis would be appropriate. Depending on soil conditions, the regional treatment BMPs can be infiltration basins or sedimentation/filtration basins. Mechanical treatment structures can also provide treatment in areas where available land is limited.

Site-Specific BMPs

Publicly-owned properties present opportunities for BMP installation without complicated land ownership concerns. Of particular concern for improving water quality are sites with high pollutant loadings, including departments of public works or public safety storage facilities and material storage yards. Communities may want to focus on providing treatment for runoff from their own properties, which can also provide opportunities for educational demonstrations and signage.

Effects of Implementing Wide-Spread Structural BMPs

To help demonstrate to stakeholders that there are potential environmental benefits to the implementation of widespread, structural BMPs throughout the Spring Lake Watershed, the Rein in the Runoff project team converted the 2006 land use and cover associated with these BMPs to comparable classifications (see Appendix F), and, using PLOAD (see Appendix A), modeled the effects of this "land use and cover change" on nutrient loads to Spring Lake. These results (Table 4-2) showed that the introduction of these proposed widespread structural LID BMPs throughout the Spring Lake Watershed resulted in a reduction of the overall pollutant loads for Total Nitrogen (TN), Total Phosphorus (TP), and Total Suspended Solids (TSS), particularly from the areas proximate to Spring Lake (Figures 4-3, 4-4, and 4-5).

Table 4-2. PLOAD Results With and Without BMPs for TN, TP, and TSS in the Spring Lake Watershed for 2006 Land Use and Land Cover.

ArcSWAT Sub-Basin	Sub-Basin Acreage	Total Nitrogen (TN) (lbs/yr)		Total Phosphorus (TP) (lbs/yr)		Total Suspended Solids (TSS) (lbs/yr)	
		Without BMPs	With BMPs	Without BMPs	With BMPs	Without BMPs	With BMPs
1-1	642.4	577	574	113	112	7,782	7,758
1-2	78.4	82	82	15	15	979	979
1-3	824.0	698	698	139	139	9,228	9,228
1-4	537.5	693	693	132	132	8,223	8,223
1-5	1,499.1	2,115	2,081	413	405	28,429	28,084
1-6	2,957.9	4,614	4,594	931	926	56,668	56,328
1-7	1,653.3	1,823	1,810	306	304	20,240	20,169
1-8	1,446.4	1,432	1,432	282	282	18,350	18,348
2-1	1,416.9	4,615	3,068	919	596	56,520	33,697
2-2	74.8	267	164	46	22	2,108	941
2-3	1,104.3	3,448	2,342	661	409	32,902	19,951
2-4	494.1	1,812	1,191	320	181	17,154	9,562
2-5	334.2	1,854	1,327	330	227	25,954	17,446
2-6	1,252.1	3,819	3,278	739	619	53,684	46,952
2-7	2,579.9	7,212	4,461	1,375	874	104,818	54,704
1-9	3,399.8	4,144	4,072	801	786	51,817	51,111
2-8	1,958.9	4,054	3,221	811	618	42,145	32,601
2-9	1,961.5	4,704	4,361	927	927	65,372	59,392
2-10	1,615.2	3,408	3,061	688	609	41,899	37,921
1-10	397.0	550	550	104	104	5,885	5,885
2-11	32.2	28	28	6	6	340	340
1-11	779.6	1,295	1,283	269	226	14,982	14,878
1-12	856.8	1,279	1,269	263	261	14,909	14,815
2-12	1,610.4	3,783	3,590	757	721	50,626	47,341
2-13	3,081.8	4,905	4,803	969	950	62,589	61,010
1-13	1,230.6	1,939	1,929	393	391	24,680	24,507
Watershed Totals:	**33,818.8**	**65,150**	**55,963**	**12,706**	**10,819**	**818,284**	**682,171**

The application of these BMPs to the 2006 land use and land cover data layer, targeting the highest priority areas identified by the project team for the Spring Lake Watershed, decreased Total Nitrogen (TN) by 14%, Total Phosphorus (TP) by 15%, and Total Suspended Solids (TSS) by 17%. These results are watershed-wide; not all sub-basins saw reductions in these pollutant loads. The implementation of additional BMPs, or alternatively, a cooperative, regional approach to improving the water quality in Spring Lake, its tributary streams, the Grand River, and Lake Michigan would provide the best results.

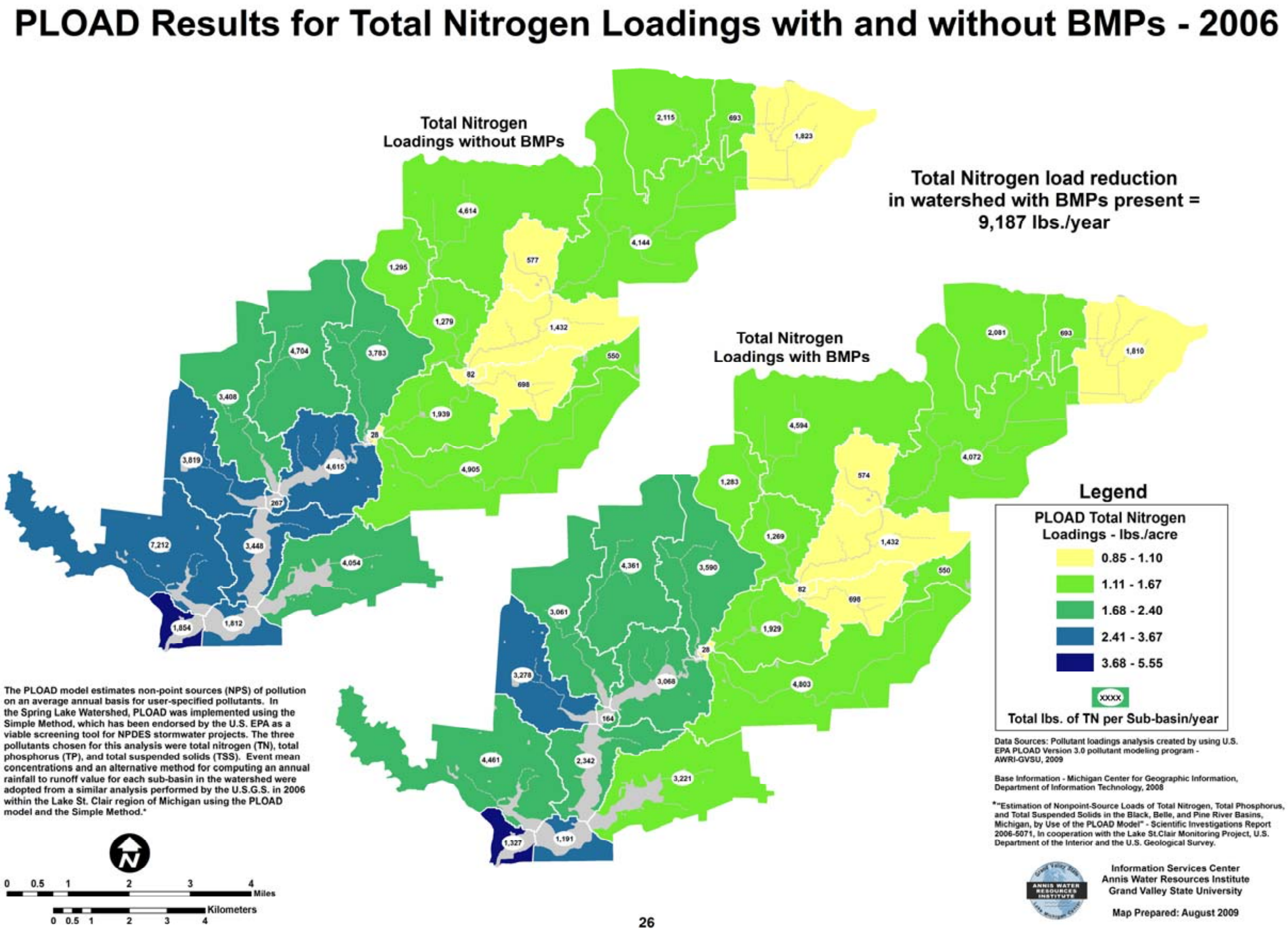

Figure 4-3. PLOAD Results with and without BMPs for Total Nitrogen mapped to the ArcSWAT sub-basins for the Spring Lake Watershed's 2006 land use and land cover.

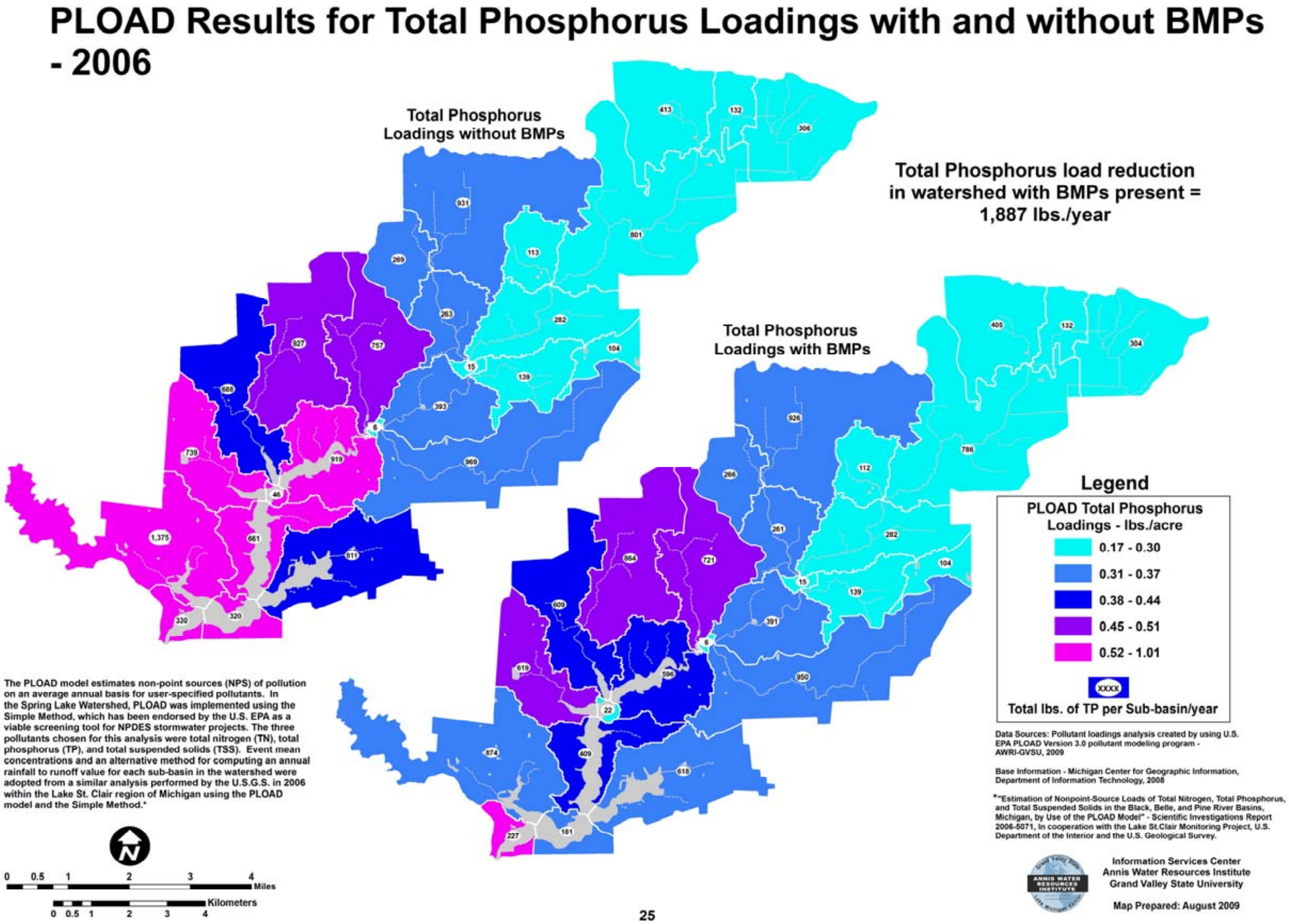

Figure 4-4. PLOAD results with and without BMPs for Total Phosphorus mapped to the ArcSWAT sub-basins for the Spring Lake Watershed's 2006 land use and land cover.

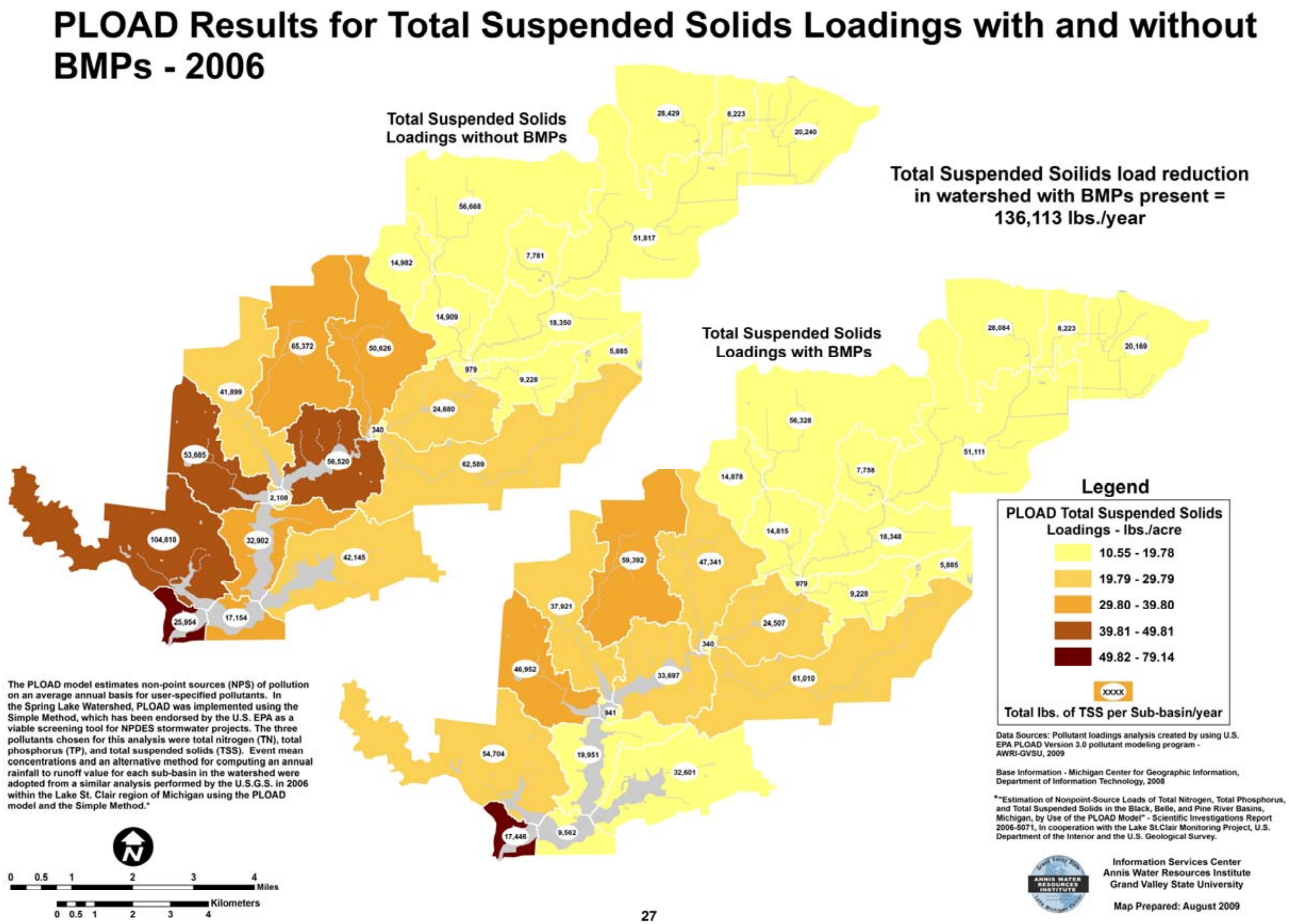

Figure 4-5. PLOAD Results with and without BMPs for Total Suspended Solids mapped to the ArcSWAT sub-basins for the Spring Lake Watershed's 2006 land use and land cover.

NONSTRUCTURAL BMPs

Nonstructural BMPs are regulatory, educational, or on-site “good housekeeping” practices that help manage stormwater runoff (Jacob and Lopez 2009; Chang et al. 2007; Tsihrintzis and Hamid 1997). Nonstructural BMPs can be appropriate independent of a geographic location within a watershed, soil type, or land use and land cover type. Table 4-3 provides summary descriptive information for four types of nonstructural BMPs, including examples of each and where these BMPs would be most effective. Where not already in place, these types of BMPs should be encouraged for implementation throughout the Spring Lake Watershed. Additional, more-detailed guidance regarding the implementation of these types of nonstructural BMPs concludes this chapter.

Ordinances

The Rein in the Runoff project team reviewed general, zoning, and special ordinances for the 15 municipalities in and downstream of the Spring Lake Watershed[1] to determine the extent that these local communities were trying to address stormwater control or management. Particular ordinances or ordinance provisions were extracted for more detailed review, including those pertaining to stormwater, LID, illicit discharges and connections, fertilizer, animal waste, flood prevention, wetlands, watercourses and natural resources, trees and woodlands, native vegetation, and stormwater utilities. These local ordinances were then compared with the general state and federal statutory requirements pertaining to stormwater management, including the Michigan Natural Resources and Environmental Protection Act (Michigan Compiled Laws, Section 324.101 et seq.), the Michigan Right to Farm Act (Michigan Compiled Laws, Section 286.471 et seq.), and the federal Clean Water Act.

In Michigan, local municipalities have general legislative authority to regulate stormwater runoff and nonpoint source pollution under the Michigan Natural Resources Environmental Protection Act (Public Act 451 of 1994, Michigan Compiled Laws 324.101 et seq.) and the Michigan Drain Code (Public Act 40 of 1956, Michigan Compiled Laws 280.1 et seq.). In the Spring Lake Watershed, the majority of the local jurisdictions have ordinances or ordinance provisions that somehow address stormwater management, or at least the control of polluted stormwater runoff (Table 4-4). Some municipalities have detailed, stand-alone ordinances that address stormwater management, fertilizer application, wetland protection, riparian or littoral buffers, or flood prevention. Others have only general requirements for the implementation of management practices that help protect against such stormwater-related problems as flooding, or the accidental discharge of prohibited materials or wastes into local

[1] Some of the local ordinances reviewed by the project team may have been incomplete or not fully up-to-date. A few of the online ordinance resources were missing code sections or the text differed slightly from the printed versions, which is not uncommon for state and local level regulations (Stevens and Edwards 2009). In one case, the official printed ordinance book had not been properly maintained over the years, and the project team had to review that municipality’s historical legal files at its attorney’s office.

drainage systems or waterbodies. Depending on the local municipalities' goals and overall ordinance structure, both of these approaches can be appropriate, although implementation and enforcement will be easier and more defensible with consistent and clear rules and standards.

Table 4-3. Nonstructural Best Management Practices (BMPs) Alternatives for Potential Implementation in the Spring Lake Watershed.

	Ordinances	Animal Waste Management	Nonpoint Source and Stormwater Education	Stormwater Utility Fee
Description	Local ordinances can be updated to control stormwater discharges directly, to increase or maintain green space or natural features, or to limit impervious surfaces.	Animal waste in urbanized watersheds can come from wildlife (e.g., raccoons, geese, and deer); domestic cats and dogs; and agricultural animals. Geese and dogs contribute a large portion of bacterial contamination to urban watersheds, especially from areas near lakes and detention ponds.	Nonpoint source education is a broad BMP that can help control pollution sources from homeowners, municipalities, riparian landowners, land and home associations, commercial lawn care businesses, and local businesses and institutions.	Property owners pay a stormwater utility fee based on the amount of stormwater runoff generated from their property, based on the total impervious surface area. Property owners must be given an opportunity to reduce the utility fee they pay, generally through the implementation of structural BMPs that reduce stormwater runoff volumes.
Examples	• Stormwater ordinances can be implemented or updated to require pretreatment and implementation of low impact development (LID) practices • Wetland, woodland, riparian buffers, or other natural features ordinances can be implemented or updated to provide protection for these local resources • Landscaping ordinances can be updated to encourage plantings with native vegetation or to regulate the use of phosphorus-based fertilizers • Zoning ordinances can be updated to allow for cluster developments, reduced setbacks, reduced parking and road widths, and other LID techniques	• Pet waste ordinances can be implemented or updated to require dog owners to pick up after their pets in all public and private property • Providing dog waste stations on public property • Requiring vegetative barriers around stormwater BMPs, lakefront areas and tributary streams • Ordinances prohibiting feeding of geese can be implemented • Making available educational signs or pamphlets	• The Rein in the Runoff project report, stakeholders guide, and watershed matrix will be available at the Spring Lake Library • The Rein in the Runoff project website will be maintained and will have links to other websites and resources • Municipalities can continue to host educational sessions, publish newsletter articles, and promote LID-BMPs through examples on public property	• Stormwater utility ordinances in Michigan must be based on user fees, and cannot be in the form of a local tax (Bolt v Lansing, 459 Mich. 152; 587 N.W. 2d 264 (1998)).
Where Effective	These non-structural BMPs are most effective in local communities with adequate enforcement mechanisms.		These BMPs are most effective in communities that make resources available for ongoing, long-term educational programs.	Communities with publicly-owned and maintained storm sewer infrastructure

Table 4-4. Current Spring Lake Watershed Local Ordinances that Address Stormwater Management.

Ordinance Provision	Ottawa County	Muskegon County[1]	Village of Spring Lake	Village of Fruitport	City of Ferrysburg	City of Grand Haven	City of Norton Shores	Egelston Township	Fruitport Township[2]	Moorland Township	Ravenna Township	Sullivan Township	Crockery Township	Grand Haven Township	Spring Lake Township
Stormwater	✓		✓	✓	✓	✓		✓		✓	✓	✓		✓	✓
Low Impact Development (BMPs)	✓							✓				✓		✓	✓
Illicit Discharge/Illicit Connections			✓	✓		✓	✓	✓							✓
Fertilizer	✓	✓	✓		✓										✓
Animal Waste			✓		✓	✓	✓							✓	✓
Flood Prevention	✓		✓	✓	✓	✓	✓	✓			✓		✓	✓	✓
Wetlands			✓			✓									✓
Watercourse/Natural Resource Setback			✓			✓	✓	✓		✓	✓		✓		✓
Tree/Woodland Protection															✓
Native Vegetation					✓										✓
Stormwater Utility															

1 The Muskegon County Drain Commissioner is currently developing written standards for stormwater retention and detention.

2 One of the goals in Fruitport Township's Master Plan (2002 – 2022) is to increase shoreline setbacks to retain natural features and to provide for vegetative filtration instead of manicured lawns that can contribute fertilizer runoff directly into local waterbodies.

In addition to this local ordinance review, the project team collected model ordinances, including the Michigan Low Impact Development model stormwater ordinance (SEMCOG 2008) and stormwater and stormwater utility ordinances from around the state, and from other communities in the United States and Canada. Utilizing a combination of these resources and stakeholder input, the team developed model ordinances, sample ordinance provisions, and stormwater performance standards targeting the local conditions in the Spring Lake Watershed. An initial draft stormwater ordinance was presented to representatives for Spring Lake Township, the City of Ferrysburg, the Village of Spring Lake, and Ottawa County for review and comment in the Spring of 2009. This model ordinance was modified based on the input and feedback from these representatives, and draft performance standards were proposed as a stand-alone document (Appendix G). Because of the different ordinance structures that existed throughout the watershed, any ordinance or ordinance provision considered for implementation should be reviewed by that municipality's attorney.

Despite the existence of ordinances geared toward stormwater management or environmental protection, many traditional zoning ordinance provisions – low density development; large lot, frontage, or front yard setbacks; curb and gutter requirements; street, sidewalk, and driveway width and composition specifications; and requirements for subdivision-wide detention basins – are still in place throughout the Spring Lake Watershed that not only inhibit the implementation of Low Impact Development (LID) and other stormwater BMPs, but also exacerbate other stormwater runoff problems. For example, subdivision-wide detention basins and traditional curb and gutter requirements are designed to convey and detain stormwater to prevent localized and downstream flooding with limited consideration for controlling the total volume of, and pollutants within, stormwater runoff. LID source-control techniques such as rain gardens or bioinfiltration swales are generally inconsistent with these types of design standards and present challenges to builders asked to incorporate LID design techniques (Roy et al. 2008). In addition, residential driveways and sidewalks constitute one third of an average parcel's impervious area, which is a significant source of stormwater runoff from a region. Allowances need to be made for alterative (i.e., LID) design components for these types of features, including installation of curb cuts or driveway runners (two strips of pavement instead of an entirely paved driveway surface), reduced road and sidewalk widths, BMPs that allow temporary ponding of water, and the use of permeable paving materials for driveways and sidewalks (Stone and Bullen 2006).

Additionally, many of the local zoning ordinances throughout the Spring Lake Watershed focus on low density residential development for much of the watershed land area. As an alternative, high density development – generally characterized by smaller lot sizes – should be considered. This type of development has been shown to reduce pollutant loads and runoff volume, although higher density development over an entire watershed area will result in greater total pollutant loads than lower density development over the same region (Stone and Bullen 2006; Jacob and Lopez 2009). In Madison (WI), it has been shown that a 25% reduction in standard residential lot size – particularly reduced frontage, front yard setbacks, and street widths – when combined with the use of porous pavement materials, minimizes the overall impervious surfaces which can reduce development-induced stormwater volumes by over 30% for the average residential parcel – and potentially more for larger, low density parcels (Stone and Bullen 2006).

Higher density development could fit into the existing regulatory stormwater framework under the rubric of "alternative site design" (Jacob and Lopez 2009). For example, the City of Grand Rapids (MI) is one of the first communities in the country to grant stormwater management waivers for higher density development (Lemoine 2007). If a high density development project can demonstrate a reduction of at least 80% in the "equivalent impervious area" for the same development at low density, then a waiver is granted for stormwater management features (detention). Currently the waiver is granted only for infill and not for greenfield development, and it does not take into consideration improvements to water quality (Jacob and Lopez 2009).

Animal Waste Management

Urban animal waste ordinances currently in effect in the Spring Lake Watershed come in many different forms. Some simply require that an animal custodian or caretaker immediately remove animal excrement deposited on any public or private property. Others identify specific domesticated animals (cats, dogs, or horses), and others specify removal only from public sidewalks or paths. Some ordinances make it illegal to appear on public or private land with an animal without the proper means of removing its waste. More complete ordinances require both immediate removal and having the appropriate means to do so; additionally, these ordinances make violation of the ordinance a civil infraction and specify the municipal officials who have enforcement authority.

None of the municipalities in the Spring Lake Watershed have an ordinance or management plan that addresses geese or waterfowl pollution. Geese and other migratory waterfowl are attracted to manicured and fertilized lawns, landscaped ponds and reservoirs, and food handouts from people (U.S. Department of Agriculture 2003). These waterfowl will congregate near lakes, ponds, detention basins, and other bodies of water, and they can contribute a large portion of bacterial and nutrient contamination to these waterbodies. In the Spring Lake Watershed, waterfowl contributions of phosphorus are low (16 kg/year) (Lauber 1999), but that does not diminish the importance of controlling local populations. One regulatory solution to this problem is the local enactment and enforcement of a municipal ordinance that prohibits the feeding of wild and domestic ducks and geese. Alternatively, ordinances encouraging the planting or maintenance of native shoreline vegetation, instead of manicured lawns or park-areas, would also inhibit the numbers of geese and waterfowl from congregating in such an area. In communities with waterfowl problems, this is a necessary first step to controlling and reducing environmental damage (U.S. Department of Agriculture 2003).

Sample animal excrement and waterfowl ordinances are included in Appendix H.

Nonpoint Source and Stormwater Education

The issues related to stormwater runoff, control, and management are complex, and despite even the more visible effects of stormwater pollution, many local officials and members of the general public do not fully understand the impacts of, or the need to manage, stormwater runoff. During the Rein in the Runoff project, even repeated educational sessions and participation in community events led to only a limited understanding regarding these issues for most stakeholders. Accordingly, local understanding and behavior change will require ongoing, long-term educational efforts to stakeholders of all ages throughout the Spring Lake Watershed.

Educational efforts can be targeted at three broad groups of stakeholders: municipal regulators and decision-makers; landowners and residents; and youth educators and students. At the municipal level, it should be recognized that water resources are often managed across local departments; e.g., municipal water, stormwater, surface water (Niemczynowicz 1999). Stormwater and nonpoint source pollution, in particular, are also managed across different jurisdictional levels: local, county, state, and federal (Roy et al. 2008). Each manager may understand only his or her role in these complex environmental and regulatory processes. Ongoing educational workshops and appropriate guidance documents regarding all issues related to stormwater management and control, including changes and advancements in Low Impact Development and stormwater BMPs, would help integrate overall management of water resources, generate increased support from managers to push legal mandates (Roy et al. 2008), and contribute to better stewardship and management at the local government level.

Watershed landowners and residents need to understand how their own, daily activities impact the water quality of their local water resources. While these stakeholders might support water quality goals, there still seems to be a reluctance to both acknowledge individual or household responsibility for water resource degradation, and to accept additional individual or household financial obligations to try and correct the problem (see, Table 3-2 and Figure 3-2 in Chapter 3). A study in Portland (OR) examining stakeholder attitudes toward various issues related to water resource management found similar results (Larson 2009). To address these shortcomings, locally-based stormwater education programs that address the environmental, social, and economic issues associated with stormwater management and control – including education sessions, demonstrations emphasizing interactions among the solutions, informational packets, and local partnerships – that connect residents to resources are crucial to the successful implementation and maintenance of LID practices (Larson 2009; Bedan and Clausen 2009; Roy et al. 2008).

Finally, it is important to target stormwater education efforts at education professionals (Roy et al. 2008), particularly those that teach schoolchildren. It is important to engage young people in the discussion regarding stormwater management and water resources stewardship so that they can bring that knowledge into their homes and into their personal and professional futures. Helping educators present these complex issues – particularly through active and experiential learning targeted at skill development and connections to local interests and concerns (Lane et al. 2005) – will help instill a culture of support and participation in environmental management.

In addition to the information provided in the Rein in the Runoff Final Project Report and the Rein in the Runoff Stormwater Education webpage (http://www.gvsu.edu/wri/reinintherunoff), sample stormwater education and outreach resources are listed in Appendix I.

Stormwater Utility Ordinance

Another means of encouraging the use of alternative LID BMPs is through the creation of a regional stormwater utility. Generally based on the amount of impervious surface per parcel, stormwater utility fees create a monetary incentive for developers and property owners to reduce the surface impervious area (Stone and Bullen 2006). This type of fee and rebate approach uses stormwater fees in combination with rebates on stormwater runoff abatement strategies, such as LID strategies, to encourage homeowners to better manage stormwater runoff on their properties (Fullerton and Wolverton 1999).

Stormwater utilities are generally acknowledged to be the most equitable means for funding stormwater management (Cowles 2009). It incorporates a “polluter pays” approach, which is generally accepted by the general public – even if it is not perfectly understood that it is applicable to individual residents and homeowners (Larson 2009). These utilities are already in place in many municipalities throughout the United States (Doll et al. 1998; Doll and Lindsey 1999); however, the fee is usually a flat rate – not tied to differing quantities of stormwater runoff – and too low to encourage implementation of LID-BMPs (Roy et al. 2008).

Stormwater utilities have been established in several Michigan municipalities, including Marquette, Lansing, and Ann Arbor. However, the Michigan Supreme Court struck down the Lansing statute in Bolt v. City of Lansing (459 Mich. 152; 587 N.W.2d 264 (1998)) and articulated a three-prong test that a stormwater utility must meet in order for the stormwater utility fee to not be considered an unauthorized tax: (1) the stormwater utility fee must serve a regulatory purpose other than to merely raise revenue; (2) the fee must be proportionate to the necessary costs of the service provided; and finally, (3) the stormwater utility fee must have a voluntariness component, where property owners can refuse or limit their use of the service. As a result of this decision, changes were made to existing stormwater utility statutes (see, Appendix J for a copy of Marquette’s (MI) amended statute). In addition, it has prompted the introduction of legislation to help guide municipalities in the establishment of a local stormwater utility (see, Michigan Senate Bill 256, accessible online:
http://www.legislature.mi.gov/(S(fgade055fi4jn5ahvlgmxruy))/mileg.aspx?page=getObject&objectName=2009-SB-0256.

Introductory information regarding stormwater utility ordinances, a summary of the ordinance currently in effect in Ann Arbor (MI), and information about the Bolt decision and Michigan S.B. 256 was presented to the Joint Council Session of representatives from Spring Lake Township, the City of Ferrysburg, the Village of Spring Lake, and Ottawa County in the Spring of 2009. Although there was general reluctance on the part of these local stakeholders to consider implementation of a stormwater utility at this time, the project team has provided guidance on how to calculate and set stormwater utility fees (Appendix J).

Chapter 5: Economic Analysis of Stormwater Management Alternatives

In order to help the Spring Lake Watershed stakeholders with the selection – and ultimately the implementation – of best management practices (BMPs), the Rein in the Runoff project team conducted an economic analysis of the different BMP alternatives listed for the Spring Lake Watershed. BMP costs generally included direct costs, such as those for construction and maintenance, and potential opportunity costs associated with alternative uses for the land where the BMP is applied (for example, a grow zone might be installed in place of cropland). Benefits of BMPs included lower stormwater flows into storm drains, decreases in external phosphorus loading to Spring Lake, decreases in sedimentation in waterways and storm drains, improved water quality, and in some cases a decreased need for city-provided domestic water and septic sewer services.

This economic analysis utilized the benefit transfer approach, which assigns economic costs and benefits at a targeted "policy site" (i.e., the Spring Lake Watershed), by using primary data and information collected by different researchers at other "study sites" (Groothuis 2005). Wherever possible, the project team estimated the construction and maintenance costs of BMPs using specific examples from the literature – instead of calculating cost estimates – so that policy-makers had data and information regarding actual usage of different BMPs. Alternatively, the team utilized online tools such as worksheets designed by the Minnesota Pollution Control Agency (2008) and the Water Environment Federation (2009) that can be used for estimating costs; however the team found that these tools were most appropriate for estimating costs for specifically-identified projects. All costs were converted to the cost of infiltrating runoff from one acre of impervious surface area so that the values for all BMPs were comparable. For those BMPs that could not completely infiltrate all of the runoff from a storm event, additional costs associated with traditional stormwater management features – such as curbs and gutters, stormwater vaults, and storm sewers – were included in the costs.

This chapter includes a technical description of the economic analyses completed by the Rein in the Runoff project team, as well as summary tables and information to assist Spring Lake Watershed stakeholders with decision-making.

DIRECT COSTS

Average direct costs were calculated by taking the total direct costs of BMP construction and implementation for bioretention/rain gardens, vegetated swales, pervious pavement, and constructed wetlands, and dividing these numbers by the total number of acres of impervious surfaces being treated. Those numbers were then converted to

2008 U.S. dollars using the Bureau of Labor Statistics consumer price index (http://www.bls.gov/cpi) and averaged together to give the average cost for these different BMPs. Finally, a study in Portland (OR) provided an estimation of $14.75 per square foot for green roofs (MacMullan et al. 2008). This number was converted to acres and used as the applicable direct cost (Table 5-1).

Table 5-1. Direct Initial Costs to Treat 1 Acre of Impervious Surface Area.

BMP	Burnsville, MN[1]	Durham, NH[2]	Fredericksburg, VA[3]	Rouge River Watershed, MI[4]	Portland, OR[5]	Case Study Average
Bioretention/ Rain Gardens	$24,000	$18,000	$14,473	$25,400		$21,500
Vegetated/Bio-Swales		$12,000		$18,150		$16,620
Green Roofs					$686,070	$686,070
Pervious Pavement		$371,100				$371,100
Constructed Wetlands		$22,500				$22,500
Stormwater Retrofits	Highly variable – depends on retrofit.					

1 (Minnesota Pollution Control Agency 2008).

2 (University of New Hampshire 2008).

3 (U.S. Environmental Protection Agency 2007).

4 (Alliance of Rouge Communities 2009).

5 (MacMullan et al. 2008).

For many of the alternative BMPs recommended for use in the Spring Lake Watershed, there were also additional maintenance costs. These included cleaning, planting, and periodic inspections. However, since the municipalities in the Spring Lake Watershed that actively participated in this project already had some type of street sweeping or roadside maintenance program in place, the project team assumed that this was in fact

Table 5-2. Additional Yearly Maintenance Costs per 1 Acre of Impervious Surface Area.

BMP	Burnsville, MN[1]	Durham, NH[2]	Rouge River Watershed, MI[3]	Portland, OR[4]	Case Study Average
Bioretention/Rain Gardens	$0 - $1,000	$0			$250
Vegetated/Bio-Swales		$0	$60		$32
Green Roofs				$600	$600
Pervious Pavement		$0			$0
Constructed Wetlands		$0	$60		$32
Stormwater Retrofits	Highly variable – depends on retrofit.				

1 (Minnesota Pollution Control Agency 2008).

2 (University of New Hampshire 2008).

3 (Alliance of Rouge Communities 2009).

4 (MacMullan et al. 2008).

true throughout the watershed. Since some watershed municipalities might budget less for such maintenance than others, this had the potential to bias these cost estimates downward. Estimates of the additional maintenance costs are provided in Table 5.2, but these were not used in the final capital cost comparisons. As a result, while these costs for street sweeping and roadside maintenance would not be greatly affected by implementation of BMPs, their omission in this analysis does create an underestimation of the true cost of these BMPs.

OPPORTUNITY COSTS AND BENEFITS

There are many costs and benefits beyond installation and maintenance of BMPs that must be taken into account. Opportunity costs are those costs related to a foregone alternative. For example, using a vegetated swale for stormwater management means that some other stormwater management technique (e.g., curb and gutter or storm sewers) did not have to be used. As the Spring Lake Watershed is primarily developed, some type of stormwater management system will need to be in place – whether it be a more traditional design or Low Impact Development (LID). From an economic standpoint, the only difference will be the cost of the different types of systems. The costs associated with traditional stormwater management systems were estimated using two case studies: Central Park Commercial Redesigns and Bellingham (WA) Parking Lots (U.S. Environmental Protection Agency 2007). These case studies were chosen because they were well-documented and had stormwater management needs similar to those in the West Michigan (i.e., in the Spring Lake Watershed). These case studies gave costs associated with traditional stormwater management systems, which the project team adjusted by dividing the value by the number of impervious acres being treated in each case. This gave an estimated range of values for stormwater management practices, from which the team took the average and converted to 2008 U.S. dollars (Table 5-3).

Another way to calculate the opportunity cost would be to compare not only the capital costs, but also the difference in the value of land area required by a particular BMP design. The project tam calculated the opportunity cost of land by using parking space data, because many of the BMP alternatives for the Spring Lake Watershed would be implemented near parking lots (or roadways), and most have a direct impact on the available parking area overall. An average sized parking space is 9x18 feet, but 270 square feet (9x30 feet) is needed to include the average space required to back out (Parkinglotplanet.com). If it costs $2,000 to install a standard parking space (University of New Hampshire 2008), the project team assumed that the market is in equilibrium and the value of the land is also $2,000 for the same 270 square feet. However, in some cases, BMPs would be incorporated into an already-existing land use, in which case the cost of the land would be zero. In particular, green roofs and pervious pavement needed no additional land, and other BMPs could be built into existing rights-of-way that currently have little value (e.g., vegetated swales and rain gardens). Accordingly, the opportunity cost for this lost land use and cover resulting from application of BMPs would be between $0 and $2,000 per 270 square feet, depending on the BMP implemented and its particular location.

Table 5-3. Opportunity Costs to Treat 1 Acre of Impervious Surface Area.

BMP	Durham, NH[1] (land area)	Durham, NH[1] (standard asphalt)	Fredericksburg, VA & Bellingham, WA[2] (standard stormwater)	Portland, OR[3] (cost of actual roof)	Future Re-Installation Costs	Case Study Average
Bioretention/ Rain Gardens	$0 - $24,000		$13,010 - $55,2000		$6,350	$17,100
Vegetated/Bio-Swales	$0 - $20,000		$13,010 - $55,200		$4,910	$20,500
Green Roofs			$0 - $27,600	$435,600	$0	$442,765
Pervious Pavement		$322,700	$6,505 - $27,600		$0	$340,400
Constructed Wetlands	$0 - $19,000		$13,010 – $55,200		$0	$25,900
Stormwater Retrofits	Highly variable – depends on retrofit.					

1 (University of New Hampshire 2008).

2 (U.S. Environmental Protection Agency 2007).

3 (MacMullan et al. 2008).

The opportunity costs calculated from these two different methods were averaged together to determine the cost for each Rein in the Runoff BMP. These values were added to the costs that were unique to specific BMPs. For BMPs such as green roofs and pervious pavement, the project team adjusted the possible replacement costs with the costs for standard sewer and alternative surfacing materials. The team assumed that BMP installation would require only half the sewer infrastructure for pervious pavement, and between zero and one-half of the sewer infrastructure for green roofs, which is consistent with studies summarized in MacMullan et al. (2008). The respective averages for the reduced sewer infrastructure were added to the estimated costs for these BMP substitutes. For pervious pavement, the substitute was the cost of a standard asphalt parking lot (University of New Hampshire 2008); for green roofs the substitute was a standard commercial roof estimated at $10 per square foot (MacMullan et al. 2008). For bioretention/rain gardens and vegetative swales, which have shorter life spans than standard sewer treatments (Conservation Research Institute 2005), the project team took the present value of replacement (r = .05) in 25 years and included that as a cost in the calculation (see Table 5-3).

Many direct benefits of BMPs were not used in these calculations because the numbers did not include enough detail to transfer to the Spring Lake Watershed. In each case, the project team chose to use the most conservative assumptions, so that net benefits would be generally biased downward. The team assumed that the sewer systems within the watershed were not at capacity, so there was no benefit from reducing the need to expand the current systems. The project team also assumed that these BMPs would not affect the overall maintenance costs associated with the current sewer systems. However, the use of BMPs will lower peak flows and remove suspended solids, which will lead to lower maintenance costs for the current sewer system. It was assumed that the BMPs will not affect energy costs, although, increased green space and green roofs have been shown to decrease energy use, particularly during the summer cooling season (Banting et al. 2005). This can be a substantial benefit for green roofs when compared to a traditional tar roof; however, when compared to other energy-saving roofing systems, this benefit shrinks considerably. Finally, pervious pavement has been shown to decrease the need for road salt in the winter in colder climates by 50% – 75% (University of New Hampshire 2008). By not including these benefits, the Rein in the Runoff project team derived a conservative estimate of the economic benefits of BMPs.

COST EFFECTIVENESS AND POLLUTION REDUCTION

Construction costs were added to the sum of the opportunity costs and benefits to generate the total cost of treating one acre of impervious surface area. However, some of the BMPs were better than others at reducing certain pollutants, and in some cases the BMP's effectiveness at reducing pollutant loads was highly variable (Table 5-4). To adjust for these factors, the project team divided the total cost by the average percent reduction in pollutants for each BMP. This effectively meant that if one BMP reduces pollutant loading by 100% and another BMP reduces it by only 50%, twice as many of the less effective BMPs would need to be implemented to achieve the same level of pollutant reduction.

Table 5-4. Average Percent Reductions in Pollutant Loads for Different BMPs.

BMP	**Percent Reductions in P Loads**			**Percent Reductions in TSS Loads**		**Percent Reductions in N Loads**	
	MPCA[1]	UNHSC[2]	**Average**	UNHSC	**Average**	UNHSC	**Average**
Bioretention/ Rain Gardens	50-100%	5-83%	**60%**	90-99%	**95%**	23-44%	**34%**
Vegetated Bio-Swales	0-100%	9-65%	**44%**	30-90%	**60%**	0-80%	**40%**
Pervious Pavement		38-71%	**54.5%**	82-99%	**91%**	N/A[3]	**N/A[3]**
Constructed Wetlands		40-55%	**48%**	80-99%	**90%**	75-81%	**78%**
Stormwater Retrofits	Depends on retrofit						

1 Minnesota Pollution Control Agency (2008).
2 University of New Hampshire (2008).
3 Data not available.

COST-BENEFIT ANALYSIS

One issue that came up repeatedly throughout the Rein in the Runoff Integrated Assessment (IA) project was the costs associated with BMP implementation and long-term maintenance. Stakeholders are reluctant to implement BMPs that are expensive at the outset or over the long run (or potentially both). However, there is some willingness among local officials in the Spring Lake Watershed to consider BMPs that have higher implementation costs if the long-term maintenance or replacement costs are lower than those associated with traditional stormwater management systems.

The project team transferred cost and benefit data from various published resources to calculate BMP costs and benefits for the Spring Lake Watershed stakeholders (Minnesota Pollution Control Agency 2008; University of New Hampshire 2008; U.S. Environmental Protection Agency 2007; Alliance of Rouge Communities 2009; MacMullan et al. 2008). However, the cost and benefit information for each BMP was generally limited to only a few case studies (generally, less than five). In addition, the use of these particular sources has generally resulted in upper bound estimates for the costs presented here for several reasons: (1) these reports do not focus on residential applications of these BMPs (where the main stakeholder cost would be time), but instead focus on contractor and municipal worker costs; (2) academic papers focus on novel uses of technologies that have not yet gained cost advantages associated with repetition of processes; and (3) the design and maintenance specifications for the BMPs in many of these studies were targeted solely at scientific study, as opposed to cost-saving applications, thereby increasing initial construction costs. As a result, the BMP costs calculated for the Rein in the Runoff project were biased upward. Finally, the actual cost of any given BMP varied greatly with existing vegetation and soil conditions at the site. Actual implementation costs for a particular BMP at a particular site could be well-above or well-below these benchmark costs (Table 5-5).

Table 5-5. Estimated BMP Costs per 1 Acre of Impervious Surface Area

BMP	Direct Initial Costs	Total Opportunity Costs	Annual Maintenance Costs
Bioretention/Rain Gardens	$21,500	$17,100	$250
Vegetated/Bio-Swale	$16,620	$20,500	$32
Green Roofs	$686,070	$442,765	$600
Pervious Pavement	$371,100	$340,400	$0
Constructed Wetlands	$22,500	$25,900	$32
Stormwater Retrofits	Highly variable. Depends on retrofit.		

The benefits associated with these same BMPs were calculated based on their ability to reduce average pollutant loads for Total Phosphorus (TP), Total Nitrogen (TN), and Total Suspended Solids (TSS) (Table 5-6) using the results reported in University of New Hampshire (2008). Total installation costs were added to opportunity and indirect costs to arrive at a total BMP cost number. A positive value for total cost was equivalent to a net cost, and a negative total cost value was actually a net benefit. For example, for vegetative swales the installation cost of alternative stormwater management BMPs was high enough that the vegetative swale BMP is actually cheaper than traditional stormwater management techniques, leading to a negative total cost.

Table 5-6. Cost Effectiveness Associated with Pollutant Load Reductions Per Treated Acre.

BMP	Total Installation Cost	Total Opportunity Cost[1]	25 Year Maintenance Costs[2]	Total Cost	Net Costs Associated with Pollutant Load Reductions[3]		
					TP	TN	TSS
Bioretention/ Rain Gardens	$21,500	($17,100)	$3,773	$8,173	$13,622	$24,038	$8,603
Vegetated/ Bio-Swales	$16,620	($20,500)	$483	($3,396)	($7,718)	($8,490)	($5,660)
Green Roofs	$686,070	($442,765)	$9,056	$252,361	$315,451	$315,451	$315,451
Pervious Pavement	$371,100	($340,400)	$0[4]	$30,700	$56,330	Not Calculated	$33,736
Constructed Wetlands	$22,500	($25,900)	$483	($2,917)	($6,077)	($3,740)	($3,241)

1 These represent added costs associated with traditional stormwater management practices and/or replacement costs.

2 Maintenance costs were the net present value of annual maintenance costs from Table 5-5 over 25 years, given a 5% discount rate.

3 These costs were adjusted based upon the BMPs' ability to reduce pollutant loads (Table 5-4).

4 Zero maintenance costs for pervious pavement are based on the assumption that current pervious pavement technologies were used and that high efficiency street sweeping is already in place.

In addition, these total costs (benefits) were also adjusted to take into account the effectiveness of each BMP at remediating particular pollutants. This was done by adjusting the total cost to the equivalent of eliminating all of the pollution from stormwater runoff from a 1 acre site. If a particular BMP is only 50% effective at reducing this pollution, then the installation for that BMP would need to be constructed to capture the stormwater flow from 2 acres. To illustrate this, notice that after the adjustment for TN, the total cost of rain gardens almost tripled, whereas the total cost of green roofs increased by only about 20%. This is because green roofs are generally much more efficient at reducing TN.

After all the adjustments were made, both vegetated/bio-swales and constructed wetlands were found to be cost effective BMPs to implement, even without the benefits of reduced pollutant loads to local waterbodies – an important consideration identified by the Spring Lake Watershed stakeholders. Bioretention/rain garden BMPs have lower costs and smaller footprints then swales or wetlands, making them better-suited economically to areas where land is available but not abundant. Although they cost on average $8,200 more to implement than the alternative practices used to calculate the opportunity costs contained in Table 5-3, there are some limited effects of pollution control to local waterways.

In general, green roofs and pervious pavement are extremely expensive to implement – with direct costs increasing by 10% to nearly 30% compared to traditional stormwater management practices. To make these BMPs worthwhile at the local level, the economic cost savings associated with the reduced pollution (i.e., water quality improvement) would have to make up the difference in cost. Alternatively, the cost of land would have to be prohibitive, thereby dramatically increasing the implementation costs of the other, less expensive BMPs, to make green roofs or pervious pavement competitive ways to reduce pollution. It should be noted here that there may be other reasons to install green roofs or pervious pavement (e.g., education, energy cost savings, etc. as discussed earlier) which offset their high implementation costs; our analysis was based strictly on stormwater-related pollutant reduction.

Three BMPs suggested for potential implementation in the Spring Lake Watershed have more variation in their net benefits, and also manage stormwater differently, than the suite of BMPs already discussed:

- Grow zones generally consist of native plants. These BMPs slow the flow of water toward the storm drain or waterbody, thereby reducing the overall pollutant loads. The degree to which a grow zone is effective at reducing these loads depends on the slope, soil type, and the type of plants. However, installation and maintenance costs for this BMP are relatively inexpensive at approximately $200 - $800 per acre, and $4 - $200 per acre, respectively (Alliance of Rouge Communities 2009).

- Rain barrels collect rainwater from downspouts. The water can then be slowly drained to facilitate infiltration (thereby decreasing peak flows and reducing pollutant loads to Spring Lake), or is used for irrigation. In West Michigan, the cost range for a

50-60 gallon rain barrel is $25 - $200. In addition to the stormwater control benefits, this BMP also reduces the household consumption (and monthly cost) of water for irrigating lawns and gardens.

- Tree plantings along roadways can also reduce the amount of water entering the stormwater system. An acre of tree canopy over impervious surface areas reduces stormwater discharge by 6,700 cubic feet during a 2.37 inch storm event (Denning and Sanborn 2008), which can reduce the need for additional stormwater infrastructure. However, the current sewer systems in the Spring Lake Watershed were assumed not to be at capacity and many of the residential areas are older neighborhoods with lots of mature trees, so these benefits of additional tree cover at this time would be minimal, particularly without some type of assurance that this BMP would be maintained for the life of the roadway or parking lot. Additional benefits associated with tree plantings include limited increases in property values, pollution reduction, cooler runoff temperatures, and energy saving benefits during the cooling season.

Chapter 6: Population Growth and Stormwater Pollution

Utilizing the combined results of different model outputs, stakeholder input, and field surveys of Spring Lake Watershed conditions, the Rein in the Runoff project team developed forecasts of future land use and land cover change related to population growth and projected development in the Spring Lake Watershed. These forecasts were then used to model the results of such development on the pollutant loads to Spring Lake as a result of stormwater runoff. Ecological forecasts such as these can help assist planning and decision-making, but they do come with some level of uncertainty (Clark et al. 2001). For such ecological forecasts to be useful, the underlying scientific information must be as accurate as possible, and its communication to the public must be effective. These technical and resource constraints may be large, but not insurmountable (Nilsson et al. 2003).

Accordingly, this chapter examines the forecasted effects of continued population growth and the accompanying land use changes in the Spring Lake Watershed. The project team applied PLOAD model runs (see Appendix A) to the results of the Population Allocation Model (PAM) analysis, the technical details of which are described in Appendix K. These combined results provide one potential future for the Spring Lake Watershed, assuming no change – or “business as usual”. Obviously, changes in policies or practices by the watershed stakeholders – including the widespread implementation of stormwater best management practices (BMPs) – would lead to different future outcomes.

POTENTIAL LAND USE CHANGES RESULTING FROM CONTINUED POPULATION GROWTH IN THE SPRING LAKE WATERSHED

Assuming that there is no change in current conditions, the model outputs from the PAM analysis conducted by the project team graphically show how the Spring Lake Watershed stakeholders could possibly develop and populate their watershed into the future. The population and allocation spatial data generated by PAM for 2010, 2020, 2030, and 2040 utilized the current population growth rate of 1.76% (PAM Scenario 1). These were then converted to land use and land cover GIS (geographic information system) data layers, and used to update the 2006 land use and land cover data for the watershed (Figure 6-1). This analysis focused on the increase in residential lands, but Figure 6-1 makes the concurrent loss of other land uses and land covers quite evident.

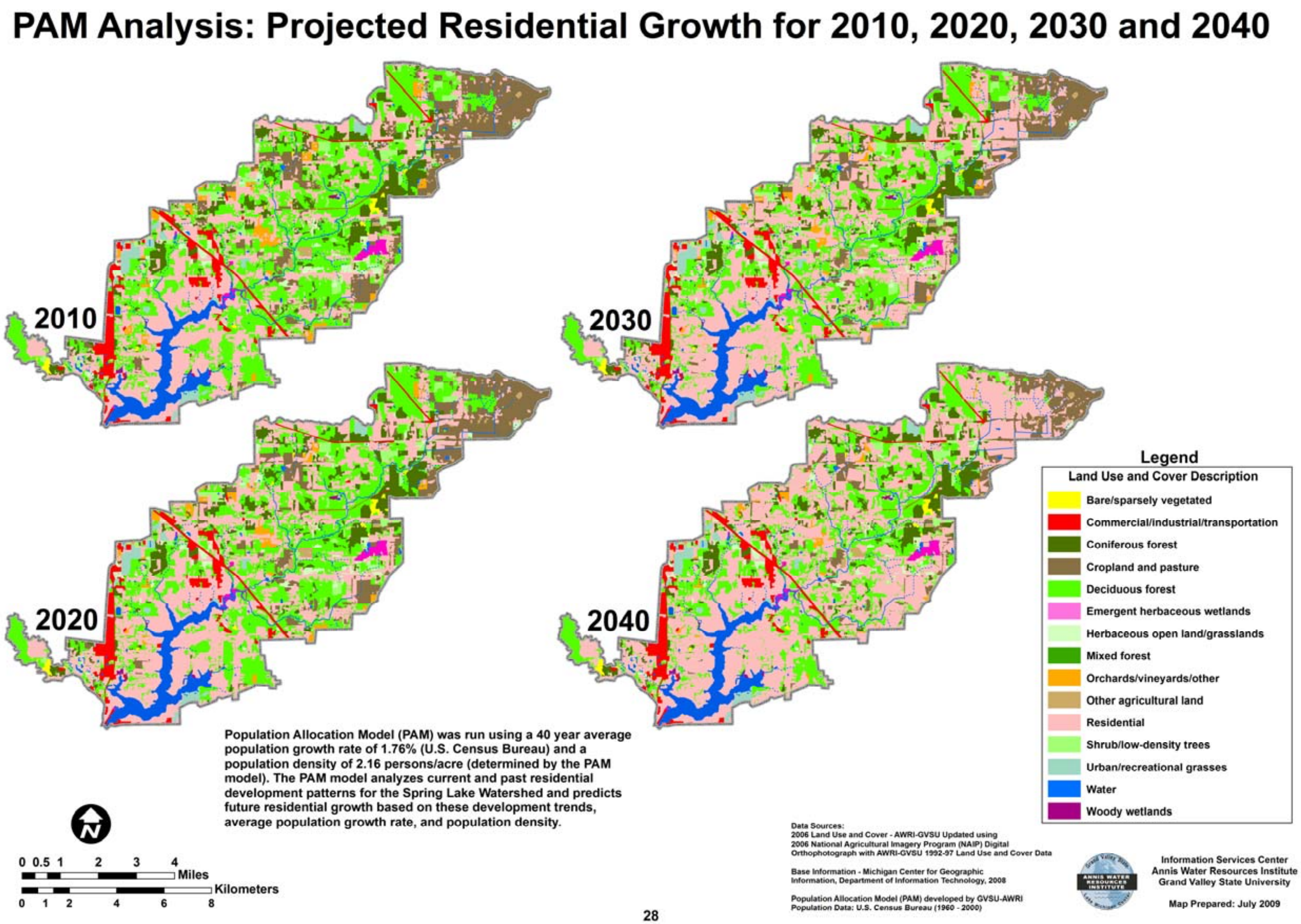

Figure 6-1. Projected land use and land cover changes in the Spring Lake Watershed in 2010, 2020, 2030, and 2040, based on the Population Allocation Model's (PAM) projected residential growth and population allocation.

EFFECTS OF FUTURE DEVELOPMENT ON POLLUTANT LOADS TO SPRING LAKE

The Rein in the Runoff project team then ran PLOAD on these projected future Spring Lake Watershed land use and land cover data for 2010, 2020, 2030, and 2040, to determine how this future residential growth might affect the pollutant loadings throughout the watershed. (For a detailed discussion of the PLOAD methodology utilized by the Rein in the Runoff project team, please see Appendix A.) The resulting linked model outputs showed projected increases in pollutant loads from 2010 – 2040 of 29% for Total Nitrogen (TN), 34% for Total Phosphorus (TP), and 25% for Total Suspended Solids (TSS) (Table 6-1). Although PAM projected residential growth throughout the entire Spring Lake Watershed, the highest pollutant loads were again seen in the sub-basins closest to Spring Lake for TN (Figure 6-2), TP (Figure 6-3), and TSS (Figure 6-4).

Table 6-1. PLOAD Results for Pollutant Loads from the Spring Lake Watershed based on the Population Allocation Model's (PAM) Forecasted Residential Growth and Patterns of Development in 2010, 2020, 2030, 2040.

Year	Residential Land Use and Land Cover		Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)	Total Suspended Solids (lbs/yr)
	Acres	% of Watershed			
2010	10,532.06	31.14	68,268	13,456	851,146
2020	12,248.19	36.22	73,239	14,639	904,040
2030	14,415.62	42.62	79,524	16,113	971,524
2040	17,218.64	50.89	87,966	18,090	1,062,751
Change from 2010 - 2040:	**6,586.58**	**19.75**	**19,698**	**4,634**	**211,605**

These patterns of development assumed that population growth would remain steady at the current rate of 1.76% (U.S. Census Bureau 2009), and were based on the current zoning ordinances and other regulations currently in effect throughout the Spring Lake Watershed. Certainly, if development continues unchecked, without proper stormwater BMPs to help control these pollutant loads to Spring Lake, the water quality in the lake and adjoining waterways will worsen. However, the implementation of stormwater BMPs – in particular Low Impact Development (LID) strategies – for new development will help limit the impact of increased pollutant loads associated with continued residential growth.

Recall that LID techniques attempt to mimic presettlement hydrology – or at least to maintain the hydrologic status quo. Although the project team did not re-run these linked model results with the suite of BMPs implemented in the high priority areas identified for the Spring Lake Watershed (see Figure 4-2 in Chapter 4), earlier model results showed that even without more development, the nutrient loads to Spring Lake will need to be controlled (see Table 4-2 in Chapter 4). The implementation of LID BMPs in new development projects would keep the stormwater runoff problem from worsening; however, these practices also need to be incorporated into already existing developed areas throughout the watershed.

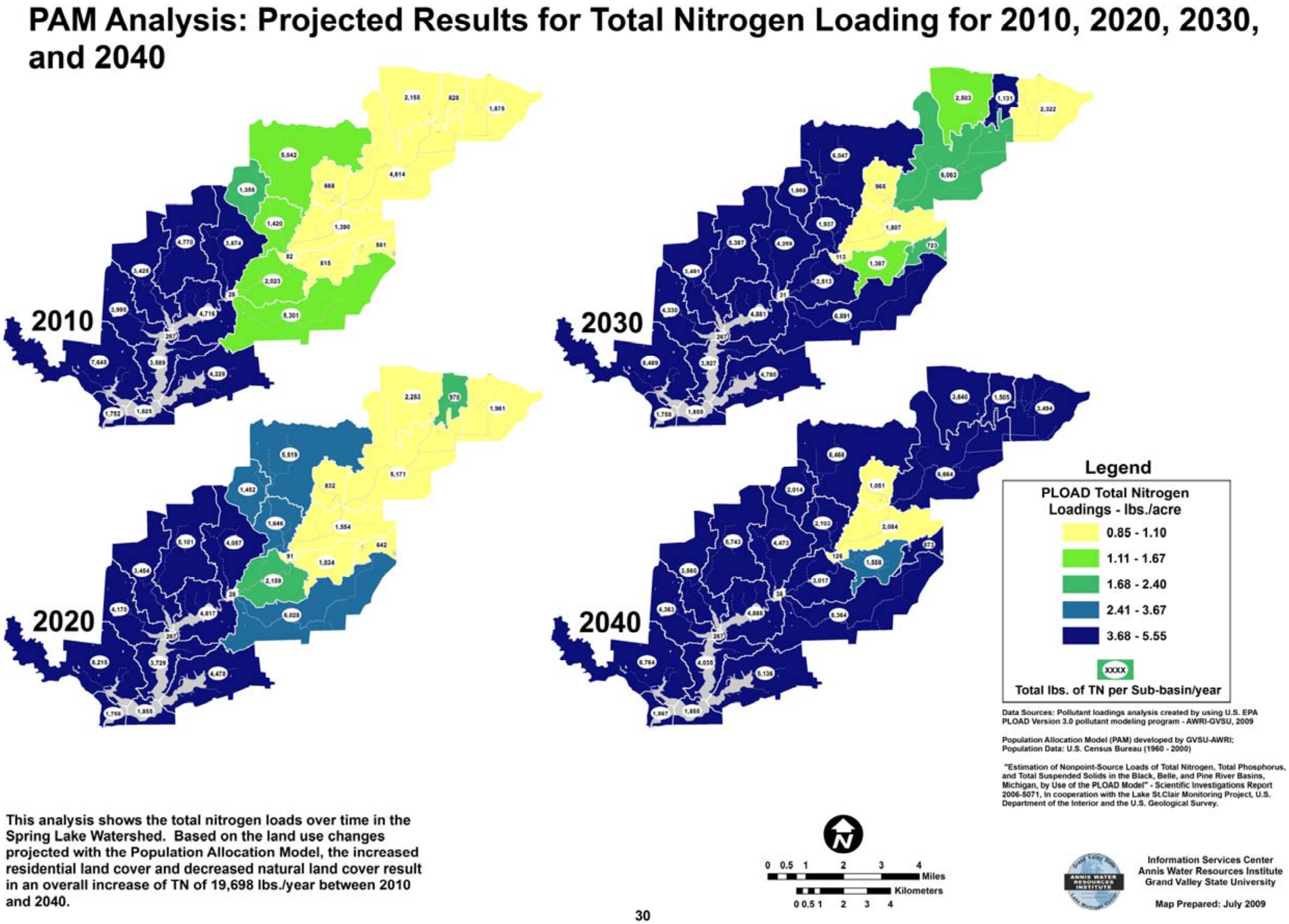

Figure 6-2. Linked model results from PAM and PLOAD for Total Nitrogen (TN) mapped to the ArcSWAT sub-basins for the Spring Lake Watershed based on projected residential growth and development in 2010, 2020, 2030, and 2040.

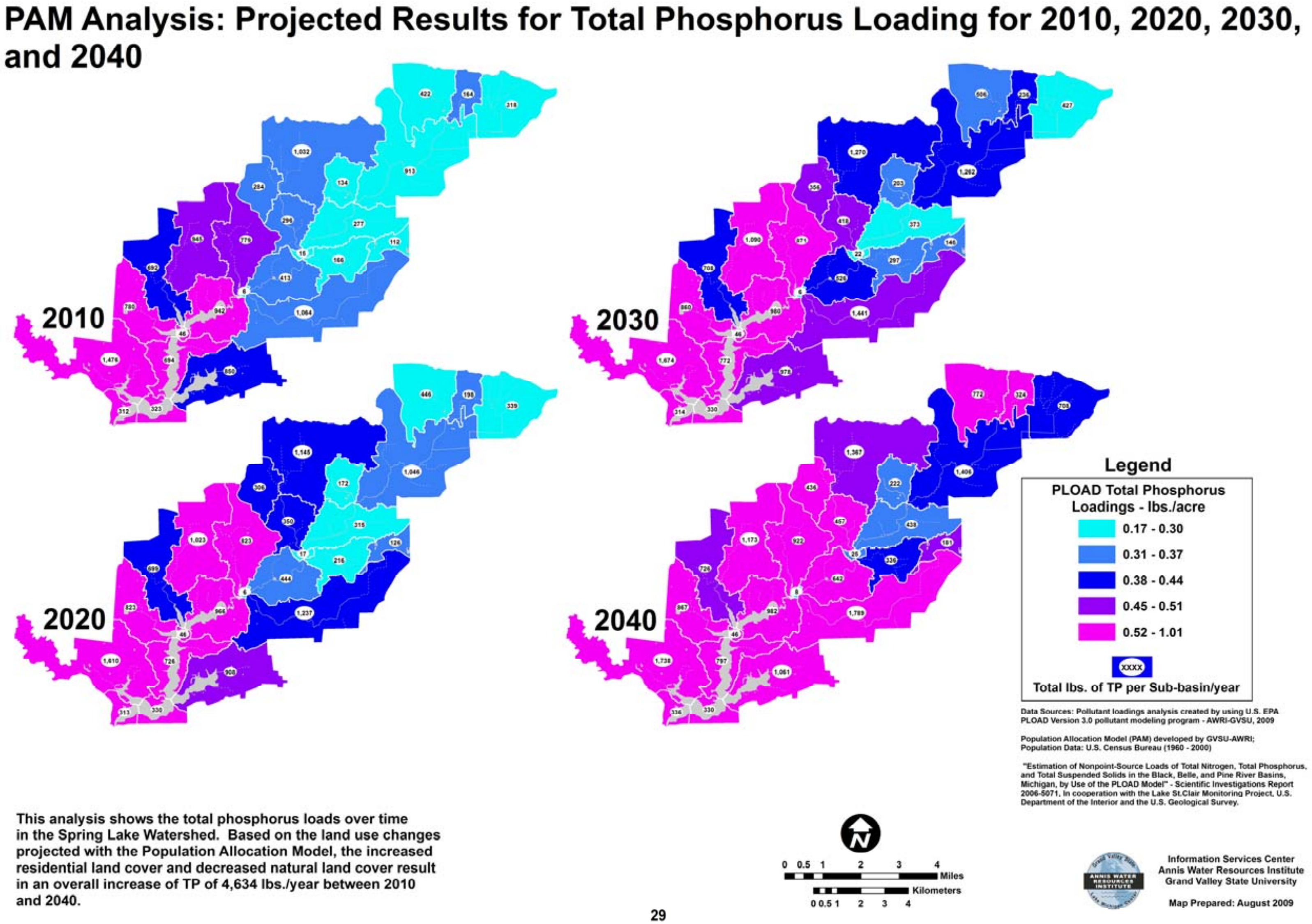

Figure 6-3. Linked model results from PAM and PLOAD for Total Phosphorus (TP) mapped to the ArcSWAT sub-basins for the Spring Lake Watershed based on projected residential growth and development in 2010, 2020, 2030, and 2040.

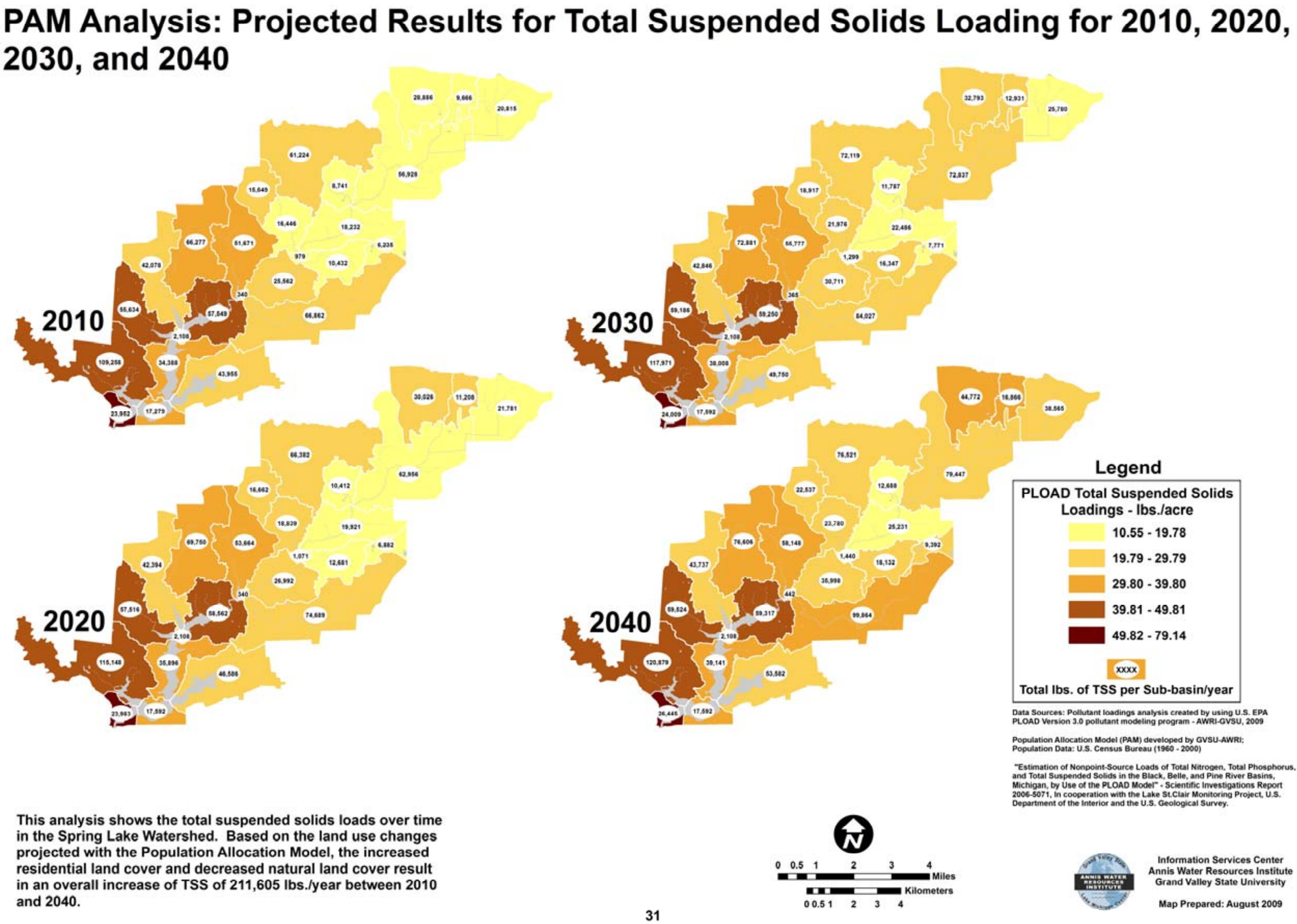

Figure 6-4. Linked model results from PAM and PLOAD for Total Suspended Solids (TSS) mapped to the ArcSWAT sub-basins for the Spring Lake Watershed based on projected residential growth and development in 2010, 2020, 2030, and 2040.

Chapter 7: Rein in the Runoff Products and Resultant Projects

The Rein in the Runoff project team developed a number of project products and tools for the stakeholders in the Spring Lake Watershed to use to help improve local stewardship of, and to better manage and control stormwater runoff to, their local waterways. These tools also provide resources, insight, and guidance to researchers and policy-makers interested in improving water quality through the control and management of stormwater runoff.

CONCEPTUAL MODEL

It is essential that resource agencies, institutions, and municipalities continue to move forward to resolve environmental challenges, despite incomplete understanding and imperfect information. One mechanism to assist this process is the development of non-quantitative conceptual ecological models. These models provide qualitative explanations of how natural systems have been altered by human-induced stressors, which in turn provides planners, resource managers, and elected officials with the information they need to focus on the best design and assessment strategy (Ogden et al. 2005). Utilizing the data and resources described above, the project team developed an ecological conceptual model to help stakeholders appreciate the complexities of the stormwater problem and think about which attributes of their water resources they most highly value.

The Rein in the Runoff Integrated Assessment (IA) conceptual ecological model for stormwater runoff (Figure 7-1) begins with the key ecosystem drivers affecting stormwater: land use change results in more impervious surfaces, management activities (or lack thereof) result in increased nonpoint source pollution, and climate change affects hydrology. Below the drivers are the stressors to the ecosystem. The influence of hydrology on stormwater impacts is pervasive, as this driver connects to all stressors (cf. Walsh et al. 2005). The stressors impact ecological structure and function, which can also be viewed as potential indicators of stress. Ultimately, local communities determine what value to place on environmental resources and ecosystem services. This model proposes three possible values (fish and aquatic fauna, water quality, and native vegetation), although depending on the ecosystem and the stakeholders, a very different set of societal values may emerge, which in turn may affect the structure of the conceptual model.

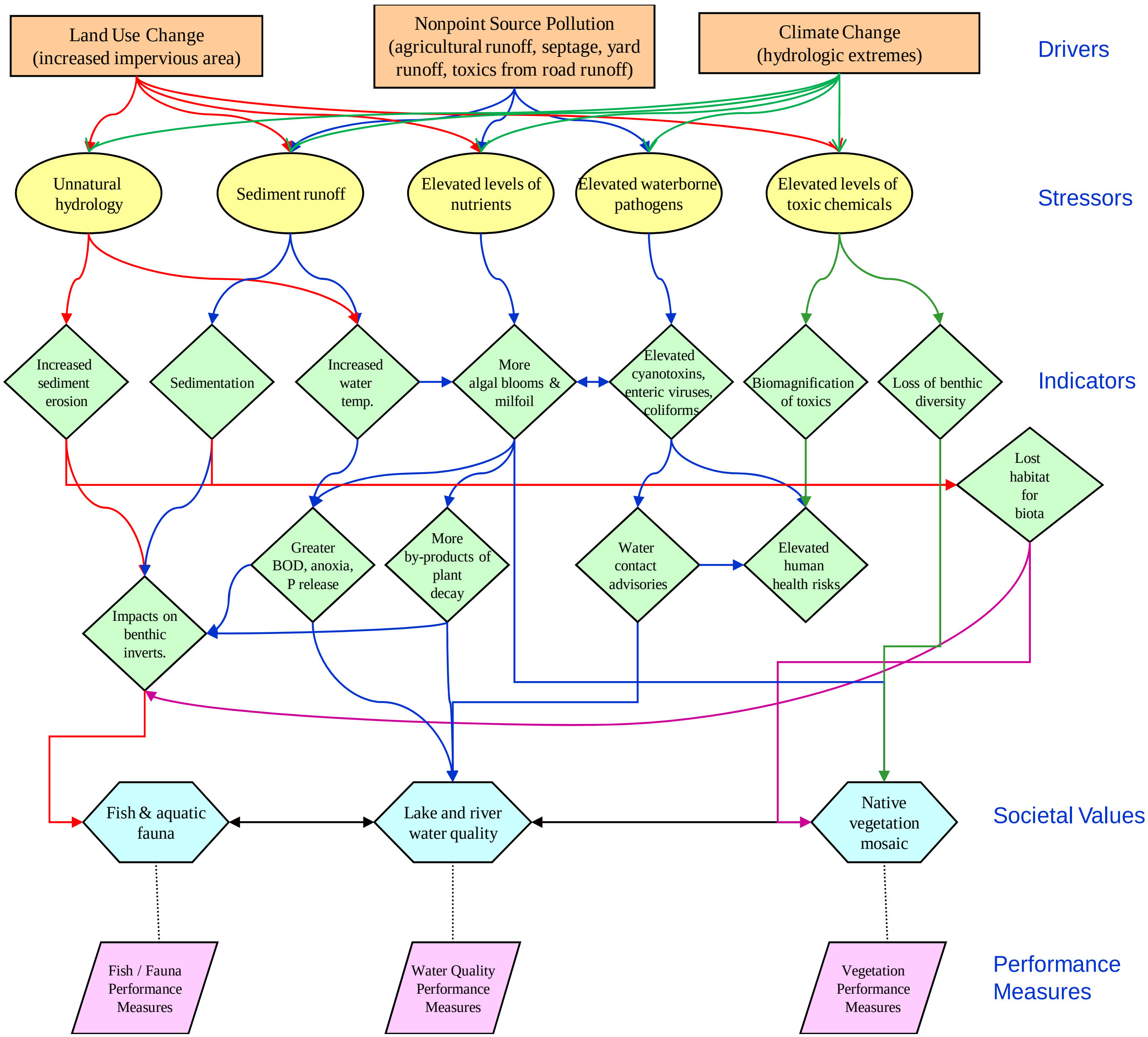

Figure 7-1. Rein in the Runoff Integrated Assessment stormwater runoff conceptual ecological model.

SPRING LAKE WATERSHED ATLAS

Because of the complex, environmental and social issues associated with stormwater runoff, management, and control, the Rein in the Runoff project team developed a variety of watershed maps to explain the IA project and scope, current watershed conditions, expected and potential future outcomes associated with current stormwater management practices, project results, and the results from additional projects within the Spring Lake Watershed that arose out of this IA (see below).

The Rein in the Runoff Spring Lake Watershed Atlas (CD-Rom version at Appendix L) is available for download on the Project Products section of the Rein in the Runoff project website: http://www.gvsu.edu/wri/reinintherunoff. Full-sized, hard-copies of the atlas are available with copies of this full project report and the Citizens Guide for on-site review at the municipal offices of Spring Lake Township, the Village of Spring Lake, and the City of Ferrysburg; as well at the Grand Valley State University's Annis Water Resources Institute (AWRI), 740 W. Shoreline Drive, Muskegon, MI 49441. Reference and Circulation copies are also at the Spring Lake Library, 123 East Exchange Street, Spring Lake, MI 49456.

Digital copies of the Rein in the Runoff Spring Lake Watershed Atlas are also available to order for $5. This price includes domestic, U.S. Postal Service, 1st class shipping, from AWRI. To order, please contact Elaine Sterrett Isely: (616) 331-3749 or iselyel@gvsu.edu.

SPRING LAKE SHORELINE ASSESSMENT

As a complement to the Rein in the Runoff IA stormwater project, the Grand Haven Area Community Foundation awarded funding to AWRI to identify the locations along the Spring Lake shoreline that still exist in a natural state – or which have been allowed to revert back to a natural state – and those that have been developed (hardened). The total length of the Spring Lake shoreline is 149,461 feet, and of that, nearly 2/3 (62.2%) has been developed and hardened (Table 7-1). As demonstrated throughout the Rein in the Runoff IA project, it is these hardened, impervious areas that contribute the most stormwater runoff into Spring Lake. It is these areas that can – and should be – targeted for installation of stormwater best management practices (BMP) and Low Impact Development (LID) retrofits (Figure 7-2).

The Spring Lake Shoreline Assessment provides more complete information for Spring Lake Watershed stakeholders about where polluted stormwater runoff enters Spring Lake. It offers additional guidance for local stakeholders to make better decisions about where the placement of stormwater BMPs would do the most good to improve water quality. More detailed results of the Spring Lake Shoreline Assessment, including the close up views of the three Area Maps, can be found in the Rein in the Runoff Spring Lake Watershed Atlas (Appendix L).

Table 7-1. Length and Percent of Shoreline Categories Identified for the Spring Lake Shoreline Assessment Conducted in August 2009.

Shoreline Category	Length (feet)	% Shoreline
Boat Launching Area – Concrete Pad	350.51	0.23
Boat Launching Area – Timber Slip	175.42	0.12
Cinder Block Seawall	150.88	0.10
Cinder Blocks – Metal Plates	248.43	0.17
Concrete Pad	74.45	0.05
Concrete Riprap	3,134.98	2.10
Concrete Slip	5,925.40	3.96
Concrete Seawall	100.64	0.07
Concrete Seawall – Metal Seawall Base	2,034.70	1.36
Concrete Seawall – Rock Riprap	132.95	0.09
Concrete and Metal Seawall	280.13	0.19
Decorative Brickwork	133.85	0.09
Metal Seawall	34,809.15	23.29
Metal Seawall – Concrete Riprap	243.34	0.16
Metal Seawall – Rock Riprap	2,722.81	1.82
Metal Seawall – Timber Header	185.41	0.12
Metal Stairs	73.40	0.05
Natural Shoreline	56,173.62	37.58
Open Water (Channel, River, Stream)	363.06	0.24
Rock Riprap	26,296.26	17.59
Rock Riprap – Concrete Footings	24.81	0.02
Stone Seawall	94.98	0.06
Timber Seawall	14,809.27	9.91
Timber Seawall – Rock Riprap	114.51	0.08
Timber Deck	43.22	0.03
Timber Pilings – Old Docks/Retaining Structures	238.45	0.16
Timber Seawall – Concrete Footings	169.67	0.11
Timber Seawall – Concrete Riprap	356.77	0.24
TOTAL	**149,461.07**	**1.00**

FUNCTIONAL WETLANDS ASSESSMENT

Researchers at AWRI also conducted a landscape level functional assessment of the wetlands in the Lower Grand River Watershed, of which the Spring Lake Watershed is a tributary. This project was funded by Region 5 of the U.S. Environmental Protection Agency to identify how the extent of wetland change within the greater watershed has impacted the functional services generally provided by those wetlands. Because of the Rein in the Runoff IA project, the Spring Lake Watershed was selected as a targeted sub-watershed for this wetland assessment. Preliminary locations were identified within the Spring Lake Watershed where there is high potential for floodwater storage, sediment retention, and nutrient transformation. Additional information about the Functional Wetlands Assessment in the Spring Lake Watershed can also be found in the Appendix to the Rein in the Runoff Spring Lake Watershed Atlas (see Appendix L of this report).

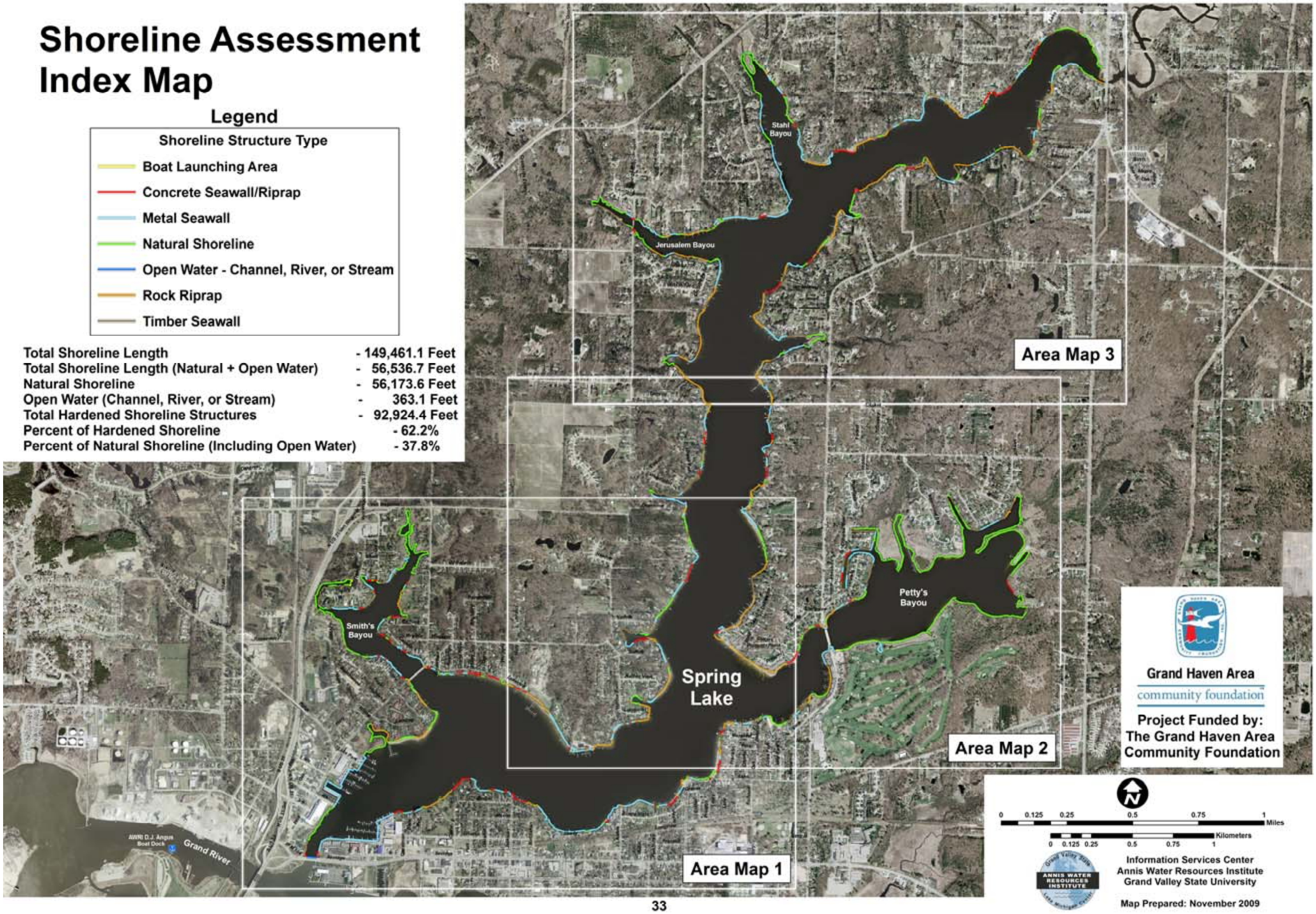

Figure 7-2. Spring Lake Shoreline Assessment of the hardened and natural shoreline features of Spring Lake (MI) in August 2009.

GRANT RESOUCES

At the request of the primary municipal partners that participated in the Rein in the Runoff IA project – the Village of Spring Lake, Spring Lake Township, and the City of Ferrysburg – the project team conducted research on potential funding sources to assist these communities with implementation of the Rein in the Runoff project outcomes. The primary research resources used were the Foundation Directory database (http://fconline.fdncenter.org/), the Michigan Great Lakes Plan Implementation Workshop's Near-Term Action Priorities subcommittee review of existing grant and loan programs supporting low impact development, the Grand Valley State University Office of Grants Development and Administration, and the FY2010 Great Lakes Restoration Initiative Interagency Funding Guide (Great Lakes Restoration Initiative 2010, http://greatlakesrestoration.us/action/?p=161, January 11).

Grant resources were identified by the project team as potential sources of funding for stormwater management, Low Impact Development, or other nonpoint source pollution control projects (Tables 7-2 and 7-3). The resources listed in Tables 7-2 and 7-3 are provided here as a guide to assist local stakeholders with finding potential sources of grant or loan funds. Funding sources or programs not listed in Tables 7-2 or 7-3 should not automatically be excluded as a potential funding source. Each funding source, program, or agency should be contacted directly to determine current funding priorities, application deadlines, and eligibility.

Table 7-2. Potential Sources of Federal Funding for Stormwater Management and Nonpoint Source Pollution Control Projects.

Funding Source	Description	For More Information
Federal Resources		
Great Lakes Restoration Initiative	Funding will be available for FY2010 and FY2011 through multiple federal agencies for Nearshore Health and Nonpoint Source Pollution.	http://greatlakesrestoration.us/action/?p=161
USDA Rural Water and Waste Disposal Program	USDA Rural Development field Community Programs office administers these funds to certain cities and rural areas to construct and/or modify water, sewer, stormwater, and solid waste disposal facilities. The funds can go towards acquiring land, water sources and water rights, as well as paying the legal and engineering fees associated with the development of these facilities. Only cities with a population of less than 10,000 are eligible for these funds.	http://www.rurdev.usda.gov/mi/cp/cpmain.htm Grand Rapids area office: Rickie Youngblood, Area Director Todd MacLean, RUS Specialist Paul Bristol, CF Specialist 3260 Eagle Park Drive, Suite 107 Grand Rapids, MI 49525 (616) 942-4111, ext. 6 (616) 949-6042 – fax todd.maclean@mi.usda.gov paul.bristol@mi.usda.gov

Table 7-3. Potential Sources of State and Private Funding for Stormwater Management and Nonpoint Source Pollution Control Projects.

Funding Source	Description	For More Information
State Resources		
Michigan Department of Natural Resources & Environment	Clean Water Revolving Fund: MDNRE makes low interest loans to local units of government for the construction of publicly owned wastewater collection/treatment facilities or the construction of nonpoint source water pollution control projects. Projects funded with Recovery Act money can receive some amount of forgiveness of loan principal.	http://www.michigan.gov/deq/0,1607,7-135-3307_3515_4143---,00.html
Michigan Department of Natural Resources & Environment	Clean Michigan Initiative (CMI) has several programs that could potentially help fund stormwater and nonpoint source pollution problems: • Clean Water Fund (CWF) • Nonpoint Source • Pollution Prevention • Contaminated Sediments • Waterfronts • Local Parks	http://www.michigan.gov/deq/0,1607,7-135-3307_31116---,00.html
Michigan Department of Natural Resources & Environment	MDNRE has additional grant and loan programs: • Local Water Quality Monitoring Grant • State Revolving Fund • Illicit Connections Grant • Targeted Watershed Grants Program	http://michigan.gov/deq/0,1607,7-135-3307_3515---,00.html
Private Funders		
Freshwater Future	Program and Technical Assistance Grants are small grants for grass-roots, volunteer-based organizations for projects to protect and restore wetlands; restoration activities; land use planning and zoning; or development, implementation and enforcement of local, state, provincial and federal habitat protection regulations.	http://www.freshwaterfuture.org
Great Lakes Protection Fund	GLPF supports collaborative actions to improve the health of the Great Lakes ecosystem.	http://www.glpf.org
Wild Ones Natural Landscape, Inc.	Lorrie Otto Seeds for Education Program provides $100-$500 for native plants and seeds to small schoolyard projects that involve student volunteers and teaching about native plants.	www.for-wild.org

TECHNICAL PRESENTATIONS AND PUBLICATIONS

Rein in the Runoff project team members also made several presentations and wrote articles for scientific and technical audiences regarding the Rein in the Runoff Integrated Assessment (IA) stormwater project in the Spring Lake Watershed (Appendix M). The Rein in the Runoff project team also anticipates submission of additional manuscripts to peer-reviewed scientific and policy journals at the conclusion of the IA.

Chapter 8: Rein in the Runoff Conclusions and Next Steps

The Rein in the Runoff Integrated Assessment (IA) consolidated and integrated a great deal of complex and widely dispersed information about the environmental, economic, and social aspects of stormwater pollution, control, and management for the Spring Lake Watershed in West Michigan. For more than two years, the project team provided information to different groups of stakeholders regarding the causes and consequences of stormwater runoff, as well as information regarding what individuals and municipalities can do to help control stormwater discharges to Spring Lake, the Grand River, and Lake Michigan. This project report summarizes the technical information compiled, analyzed, and tailored to the Spring Lake Watershed, and it provides local stakeholders with a suite of tools to help watershed communities, residents, and municipal leaders better manage stormwater runoff to Spring Lake and its adjoining waterbodies.

The primary messages for stakeholders to "take home" from this report are the following:

1. Continued population growth and development within the Spring Lake Watershed is resulting in more hardened – and less natural – surfaces, especially closer to the lake. These impervious areas have changed the natural hydrology of the watershed. Instead of rainwater and snowmelt soaking into the sandy soils, they now run off these impervious areas.

2. When rain cannot soak into the ground, it "runs off" these hard, impenetrable surfaces into local waterways – either indirectly through storm drains, or directly from road ends, parking lots, rooftops, and lawns. As the water flows over these surfaces, it collects pollutants and dumps them into Spring Lake, the Grand River, and eventually, Lake Michigan.

3. Different pollutants cause different water quality and water quantity problems:

    a. Pathogens in the water can lead to beach closings and illnesses;
    b. Dirt from erosion – or sediment – can cover fish habitat;
    c. Fertilizers can cause too much algae to grow – as thy die off, the oxygen in the water can be depleted by the organisms decomposing the algae, which can kill fish and other wildlife;
    d. Soaps (from washing your car) can hurt fish gills and scales;
    e. Chemicals can damage plants and animals;
    f. Water gets heated from running over impervious surfaces and can increase stream temperatures and kill fish; and,
    g. Excess water that cannot soak into the ground contributes to and aggravates flooding problems.

4. There are real costs to society to address these types of water quality and quantity problems. The costs are too numerous to mention all of them, but some examples include the following:

   a. Communities that use surface water for their drinking water supply must pay much more to clean up polluted water (North Carolina Department of Environment and Natural Resources 2010);
   b. Flooding causes damage to homes, roads, and other infrastructure; and,
   c. The alum treatment applied to Spring Lake in 2005 to help control algae blooms was paid for by residents living around the lake.

5. If the communities in the Spring Lake Watershed take no additional actions to control and manage stormwater runoff, excessive amounts of nutrients will continue to load into the local waterways during – and as a result of – rain events. The application of alum in 2005 decreased the loading (or release) of phosphorus from the sediments in Spring Lake, but has done nothing to stop new nutrient inputs from entering the lake from the land. If growth and development continue to occur, the nutrient loads to Spring Lake and its adjoining waterways will only increase.

6. The application of a combination of structural and nonstructural stormwater best management practices (BMPs) – particularly Low Impact Development (LID) strategies – to new and existing development throughout the Spring Lake Watershed will be necessary to prevent the continued degradation of water quality in Spring Lake and its adjoining waterways, including the Grand River and Lake Michigan.

7. The stormwater management priorities for the Spring Lake Watershed include the restoration of riparian and littoral buffers; implementation of LID BMPs in the areas that contribute the highest pollutant loads to Spring Lake, which according to the Rein in the Runoff model results are the urbanized sub-watersheds closest to the lake; and road ends immediately adjacent to the lake or other waterways.

8. BMP selection is ultimately up to each individual or municipal landowner. However, the Rein in the Runoff project team offers the following guidance:

   a. Vegetated/bio-swales are suitable for installation along roadways. These BMPs, along with constructed wetlands, are the most cost-effective.
   b. Rain gardens are suitable for installation in residential neighborhoods, parks, schools, and other small sites. These BMPs also have relatively low implementation costs, and their smaller footprint makes them well-suited for areas where land is available but not abundant.
   c. Grow zones, including riparian and littoral buffers, are relatively inexpensive BMPs, with installation costs ranging from $200 - $800 per acre, and annual maintenance costs ranging from $4 – 200 per acre.

d. Green roofs and pervious pavement are more expensive BMPs to implement, and the pollution control benefits, educational opportunities, energy cost savings, etc., should be evaluated on a site-by-site basis.
e. Rain barrels cost $25 - $200 in West Michigan. In addition to the stormwater control benefits they provide, this BMP can also reduce the household consumption (and monthly cost) of water for irrigating lawns and gardens.
f. Tree plantings in new developments can reduce the need for additional stormwater infrastructure. Additional benefits associated with tree plantings include limited increases in property values, pollution reduction, cooler runoff temperatures, and energy saving benefits during the cooling season.
g. In densely developed areas, it might be worthwhile to provide BMPs that store stormwater on a regional basis, such as retention basins.
h. Publicly-owned properties present educational opportunities for BMP installation without complicated land ownership concerns.
i. Nonstructural BMPs, such as ordinances (stormwater, fertilizer, high density development and other changes to traditional zoning rules), animal waste management programs, stormwater utilities, and stakeholder education, should be encouraged for implementation throughout the Spring Lake Watershed.

One of the primary challenges in the completion of the Rein in the Runoff Integrated Assessment project was the limited amount of feedback from stakeholders on the more technical aspects of local stormwater management goals and potential solutions. The issues associated with stormwater and stormwater runoff are complex, and sometimes difficult for members of the general public to grasp. Although a small group of stakeholders was involved in several aspects of the IA, overall stakeholder input was limited. This suggests a greater need for ongoing stakeholder education regarding stormwater runoff – in particular, how stakeholder choices and actions affect stormwater pollution and runoff, as well as the water quality of Spring Lake, its tributary streams, the Grand River, and Lake Michigan.

Going forward, the decision-makers and other stakeholders in the Spring Lake Watershed should use this report, the Rein in the Runoff project website, and the other stormwater management tools provided by the Rein in the Runoff project team. The information contained in the project report chapters and appendices, including the shoreline assessment, project atlas, grant resources, and citizens guide can be used for BMP implementation planning and stormwater educational purposes. For many BMP implementation projects, additional site-specific analyses may be necessary to better quantify the effects of different combinations of BMPs and Low Impact Development strategies. Local landowners and neighboring communities should be encouraged to continue to work together to reduce stormwater runoff and pollution to West Michigan's local waterways. The stormwater management alternatives identified in this report provide guidance to these local communities to meet these goals at a local and regional level.

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Appendix A: Datasets and Hydrologic Models

1. Existing Datasets

2. Land Use and Land Cover Update

3. Modeling the Effects of Stormwater Runoff on Current Conditions

4. Long-Term Hydrologic Impact Assessment and Nonpoint Source Pollutant Model (L-THIA NPS or L-THIA)

5. Pollutant Loading Application (PLOAD)

6. Figure A-1. Spring Lake Watershed sub-watershed basin divisions for PLOAD Simple Method Analysis

7. Table A-1. Rainfall to Runoff Ratios for the Sub-Watershed Basins in the Spring Lake Watershed

8. Table A-2. Event Mean Concentration (EMC)Tabular Input Data for PLOAD Model Runs

9. Figure A-2. Output window for BASINS 4.0 project for the Spring Lake Watershed 2006 land use and land cover PLOAD model run

10. Figure A-3. PLOAD results for total pollutant loads for the Spring Lake Watershed for 1978, 1992/97, and 2006

11. Impervious Surface Analysis Tool (ISAT)

The Rein in the Runoff Integrated Assessment (IA) began with an examination of the existing data available for the Spring Lake Watershed. The scope and timeline for the project did not afford the project team with opportunities to collect a great deal of new technical field data about the watershed. However, the project team did avail itself of existing local and statewide datasets, hydrologic modeling, and any new local field data that were collected by project partners throughout the course of the Rein in the Runoff project. These data and models informed the IA and provided the basis for the identification of the primary causes and consequences of the stormwater problems affecting the water quality in Spring Lake, the Grand River, and ultimately, Lake Michigan. This appendix provides a technical description of the datasets and the hydrologic modeling approaches and initial results utilized by the project team.

EXISTING DATASETS

The project team reviewed existing datasets and other information describing the environmental conditions in the Spring Lake Watershed. Team members assembled datasets held by project partner Annis Water Resources Institute (AWRI) related to land use and land cover for the Spring Lake/Grand Haven area. These data layers included the 1978 and 1992/97 land use and land cover inventory (Michigan Resources Information System, Michigan Department of Natural Resources (MDNR), Land and Water Management Division 1978; 1992/97 update by AWRI); ArcGIS and ArcView Extensions; digital orthophotographs (U.S. Department of Agriculture (USDA), National Agriculture Imagery Program 2005, www.fsa.usda.gov); presettlement vegetation (General Land Office 1816-1856); National Oceanic and Atmospheric Administration (NOAA) chart information (http://nauticalchargs.noaa.gov/); hydrologic soil group surveys (USDA Natural Resources Conservation Service (NRCS), TR-55, June 1986); National Wetlands Inventory, regional landscape ecosystems, baseflow, and 1982 quaternary geology; base watershed information (U.S. Geological Survey (USGS)); Digital Elevation Model (USGS 2007); county-level parcel data; and sub-basin information summaries (Michigan Department of Environmental Quality (MDEQ)).

The AWRI land use and cover dataset was developed from historical aerial photography taken at a 1:24,000 scale for the entire state of Michigan. The initial data were compiled using 1978 aerial photography by MIRIS in 1988. The geographic information system (GIS) land use and cover vector polygon layer was generated for each congressional township in the state from manually interpreted, color infrared aerial photography and classified using a revised version of the national land use and land cover classification system by the USGS. This Michigan Land Cover/Use Classification System was adopted as the statewide standard and used to classify the original 1978 dataset. This system has a multi-level, hierarchical structure which classifies Michigan's land use and cover into approximately 500 categories; it was updated in 2002 to categorize more modern land use and cover types. The minimum mapping unit for this classification system is between one and two and a half acres, and areas that are less than 100 feet wide are not mapped unless they are parts of larger (and subsequently, wider than 100 feet) mapping units. AWRI researchers had previously updated the initial 1978 GIS dataset for the area encompassing the Spring Lake Watershed using the Michigan Land Cover/Use Classification System and aerial photography from 1992 and 1997, for Ottawa County and Muskegon County, respectively.

Additional datasets regarding the water quality in Spring Lake and the adjacent waterways were provided by the various project partners for the Rein in the Runoff project, including AWRI (Lauber 1999; Steinman et al. 2004, 2006), Progressive AE (2002-2008), and Lakeshore Environmental, Inc. (2008). Specific reports that were also used to inform the Rein in the Runoff Integrated Assessment (IA), included the 2006 Annual Drinking Water Quality Report for the Northwest Ottawa Water System; National Pollution Discharge Elimination Systems (NPDES) site data from the MDEQ, and the Clean Water Legacy Plan of the greater Tri-Cities Area in Northwest Ottawa County (Lakeshore Environmental, Inc., Project No. 07-907-07, 2008).

LAND USE AND LAND COVER UPDATE

The existing AWRI land use and land cover data for the Spring Lake Watershed were current through 1992 for Ottawa County, and through 1997 for Muskegon County. However, for the Rein in the Runoff IA to be most useful for the watershed stakeholders a more consistent, and more recent, dataset was needed. To update the land use and land cover data, AWRI researchers obtained the latest 2006 National Agricultural Imagery Program (NAIP) digital orthophotograph (1-2 meter pixel resolution). These data were used in conjunction with the pre-existing 1992/97 land use and land cover vector polygon dataset within the ESRI™ ArcView GIS 3.3 program to clip out the Spring Lake Watershed boundary from the 2006 data and create the updated GIS layer through photographic interpretation using the Michigan Land Cover/Classification system.

The AWRI research team verified the land use and land cover data through field QA/QC (quality assurance/quality control) reconnaissance. Researchers field verified approximately 10% of the vector polygons throughout the Rein in the Runoff project area. Using hardcopy printouts of the project area’s 2006 NAIP orthophotograph overlain with the photo-interpreted land use and land cover polygon boundaries and their respective land use and land cover classification labels, as well as a street transportation layer by which to navigate, team members traveled throughout the watershed verifying the interpreted areal extent and land use and land cover classifications. Additionally, land use and land cover polygons that were difficult to interpret from the 2006 digital orthophotograph were also incorporated in this QA/QC process. As a result, it is estimated that 95% of the landscape surface of the Spring Lake Watershed is accurately represented in the 2006 land use and land cover update. This 2006 land use and cover data update for the Spring Lake Watershed was a critical component in subsequent pollutant modeling, in the identification of percent impervious surface cover, and the siting of potential BMPs within the watershed.

MODELING THE EFFECTS OF STORMWATER RUNOFF ON CURRENT CONDITIONS

To help assess the impacts of land use change and stormwater runoff on the overall water quality in Spring Lake, the project team utilized several computer-based models designed to predict some of the physical parameters associated with water quality. In particular, the project team modeled the effects of land use and land cover and the associated percent impervious surface cover on predicted nonpoint source pollution, and specific nutrient loadings (total phosphorus, total nitrogen, and total suspended solids) for the Spring Lake Watershed. Model selection for the Rein in the Runoff IA was based on current and previous usage and specific recommendations of the various models by project team partners.

Long-Term Hydrologic Impact Assessment and Nonpoint Source Pollutant Model (L-THIA NPS or L-THIA)

L-THIA NPS was developed by Purdue University Research Foundation for the U.S. Environmental Protection Agency (USEPA) as a tool to assess the impact of development on long-term runoff and nonpoint source pollution (Engel 2001). It utilizes long-term daily precipitation, land use and cover, hydrologic soil groups (see Table 2-1 in Chapter 2), and the USDA NRCS curve number technique for determining surface run-off hydrology (Bhaduri et al. 2000; Wang et al. 2005). The L-THIA model calculates runoff depth across the landscape and total runoff volumes, and computes various nonpoint source pollutant loadings and metals for current conditions (Bhaduri et al. 2001). The model works as an extension in ESRI™ ArcView GIS.

The Rein in the Runoff project team obtained 109 years of long-term precipitation data from the NOAA Daily Precipitation dataset (http://www.ncdc.noaa.gov) for the Muskegon County Airport (Station ID 205712) from January 1, 1899 to December 31, 2007. Hydrologic soils data for the Spring Lake Watershed were obtained from the USDA NRCS Soil Survey Geographic (SSURGO) database. SSURGO soils data are the most detailed level of soil mapping done by the NRCS. These data represent digital vector duplicates of the original soil survey maps; mapping scales generally ranging from 1:12,000 to 1:63,360, and SSURGO soils are linked to the National Soil Information System (NASIS) attribute database. USDA NRCS does not report measures of uncertainty for SSURGO soil database.

Land use and land cover data were consolidated into eight categories: Agricultural, Commercial, Forest, Grass/Pasture, High Density Residential, Low Density Residential, Industrial, and Water. The model was run for all three time periods of land use and land cover data: 1978, 1992/97 and 2006. However, because L-THIA utilizes only eight land use classifications and does not account for the impacts of snowmelt and frozen ground to stormwater runoff contributions during cold months, the project team decided that the L-THIA model outputs (total runoff depth, total runoff volume, total nitrogen (TN) loading, total phosphorus (TP) loading, and total suspended solids (TSS) loading) would primarily used for comparison and verification of the model results for PLOAD.

Pollutant Loading Application (PLOAD)

PLOAD is a simplified GIS-based model that estimates user-specified nonpoint sources of pollution to a watershed on an annual average basis. It was developed by CH2M Hill for the USEPA as an application extension to run under the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) 4.0 program (U.S. Environmental Protection Agency 2001). PLOAD can run on two different application methods: (1) The USEPA's Simple Method is an empirical approach for estimating nonpoint source pollutant loads from urban development sites in watersheds smaller than one square mile (Goodwin 2007; U.S. Environmental Protection Agency 2001). (2) The Export Coefficient Method uses a similar modeling approach to the Simple Method, but it is applicable to agricultural and undeveloped land uses, or in watersheds greater than one square mile in area (Telephone interview with Peter Vincent, MDEQ, Nonpoint Source Program, Summer 2008).

Because the Spring Lake Watershed encompasses 52.8 square miles, the project team initially determined that the use of the Simple Method to estimate the pollutant loads for TN, TP, and TSS to this watershed was potentially inappropriate. However, applying the Export Coefficient Method presented some significant challenges. The Export Coefficient Method calculates pollutant loads by taking the sum of the pollutant loading rate and the area for each land use type; it does not take into account precipitation or impervious surface area (U.S. Environmental Protection Agency 2001). The loading rate is derived from export coefficient tables, which were not available for Michigan or other regions similar to the Spring Lake Watershed. In addition, team members were unable to find any instance where the Export Coefficient Method had been applied. Even for watershed basins larger than the Spring Lake Watershed, researchers continue to apply the PLOAD Simple Method (Syed and Jodoin 2006; Goodwin 2007; Email correspondence from K. Goodwin, MDEQ, Water Bureau, April 9, 2008).

Accordingly, the Rein in the Runoff project team adopted the methodology used by Syed and Jodoin (2006), which applied the PLOAD Simple Method to sub-watershed basins of the Lake St. Clair drainage area. That study was part of a USGS project to estimate nonpoint source loadings in the Lake St. Clair region. Because both project areas are located in Michigan's lower peninsula and have similar geographies (~ same degree of Latitude), climates (within the southern zone of the Lower Peninsula), landscapes and soil creation histories (glacial modification of regolith), and land use and land cover types, the project team felt that reliance on this approach was appropriate.

To fit within the prescribed bounds on the PLOAD Simple Method, the USGS researchers sub-divided three Lake St. Clair sub-watersheds into smaller sub-watershed basins: the Black River Watershed (710 mi^2) was divided into 34 sub-watershed basins, ranging in area from 11.3 mi^2 to 31.2 mi^2 with an average of 20.9 mi^2; the Belle River Watershed (227 mi^2) was divided into 12 sub-watershed basins, ranging in area from 7.6 mi^2 to 23.1 mi^2 with an average of 18.9 mi^2; and the Pine River Watershed (195 mi^2) was divided into 6 sub-watershed basins, ranging in area from

23.7 mi^2 to 53.4 mi^2 with an average of 32.5 mi^2. Although the overall sub-watersheds in that study were large, they were fairly homogenous, and the urbanized areas were within smaller, 2-3 mile sub-basin drainage areas. In addition, a test run on one of these small, urban sub-watershed basins did not produce significantly different results than when it was further divided into one square mile sub-drainage watershed basins (Email correspondence from A. Syed, USDA NRCS, May 15, 2008).

The Spring Lake Watershed is divided into two sub-watershed drainage basins (MDEQ, Hydrologic Studies Unit, Land and Water Management Division; AWRI 2006 update of localized drainage conditions identified in Lauber (1999)). The Rein in the Runoff project team delineated these two sub-watersheds into smaller drainage areas using ArcSWAT (Soil and Water Assessment Tool for ArcGIS). ArcSWAT utilizes the Digital Elevation Model (DEM), a working area grid Mask (the watershed boundary vector files), and the stream network dataset (Michigan Framework version 8b, Hydrology file vector GIS data) to delineate a specified size (hectares) or number of sub-watershed reaches that follow known stream channels. The results are then refined to identify sub-watershed outlets or points in the stream drainage network where streamflow exits the drainage area into another sub-watershed. Finally, geomorphic parameters are calculated for each sub-watershed and relative stream reach, and transferred to ESRI™ raster GRID format GIS files. The Spring Lake Watershed was divided into 26 sub-watershed basins, ranging in area from 0.05 mi^2 to 5.31 mi^2 with an average of 2.03 mi^2, (Figure A-1).

To obtain estimates for TN, TP, and TSS nutrient loads to Spring Lake, the project team first assigned a unique numeric identifier to each sub-basin. To do this, the team first created a BASINS project file for each of our land use and land cover GIS data layers (1978, 1992-97, and 2006). Each layer was run individually as a separate project through the BASINS PLOAD modeling interface. At the onset of each PLOAD modeling run, the individual land use and land cover GIS data files were added to the BASINS GIS mapping legend, and then the ArcSWAT-delineated Spring Lake Watershed boundary GIS data layer (26 sub-basins) was added to provide the model with the unique numeric identifier and spatial context necessary for the model to calculate pollutant loadings for each of the individual sub-basins within the Spring Lake Watershed.

Team members then input the long-term precipitation data for the watershed and calculated a rainfall to runoff ratio for the project area sub-basins (Table A-1). PLOAD does not use GIS hydrologic soil group data in the model, so curve numbers were derived from the existing soil group and land use and land cover data to determine a rainfall-runoff coefficient. Utilizing these curve numbers with the long-term precipitation data gave a more accurate rainfall-runoff data per sub-basin rather than using the same average yearly rainfall value for the entire watershed, with no regard to the reduction of runoff because of storage and initial abstraction (interception; infiltration; depression storage; and antecedent soil moisture) (Syed and Jodoin 2006).

ArcSWAT Sub-basin Boundaries

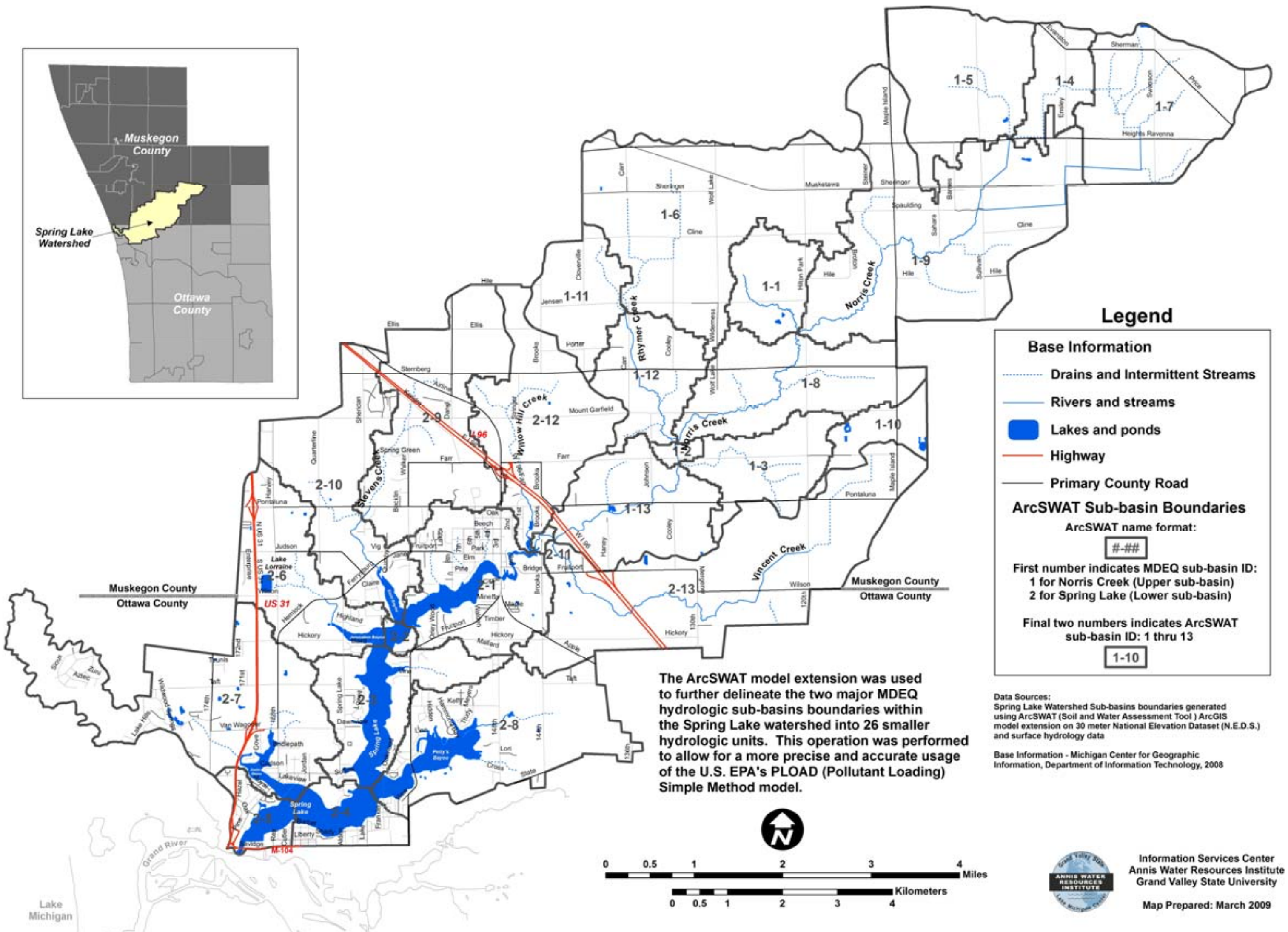


Figure A-1. Spring Lake Watershed sub-watershed basin divisions for PLOAD Simple Method Analysis.

Table A-1. Rainfall to Runoff Ratios for the Sub-Watershed Basins in the Spring Lake Watershed.

ArcSWAT Sub-Basin	Sub-Basin Identifier	Rainfall to Runoff Coefficient	ArcSWAT Sub-Basin	Sub-Basin Identifier	Rainfall to Runoff Coefficient
1-1	0	27.76	2-6	13	29.72
1-2	1	30.43	2-7	14	29.91
1-3	2	27.64	1-9	15	28.43
1-4	3	31.02	2-8	16	28.12
1-5	4	28.45	2-9	17	28.87
1-6	5	28.47	2-10	18	28.45
1-7	6	31.15	1-10	19	29.95
1-8	7	27.49	2-11	20	29.91
2-1	8	28.49	1-11	21	28.89
2-2	9	28.29	1-12	22	28.34
2-3	10	29.99	2-12	23	29.07
2-4	11	28.81	2-13	24	28.89
2-5	12	31.55	1-13	25	29.60

Next, the PLOAD model required the export of tabular data from user-created spreadsheets. The first tabular data file (Table A-2) constructed was an event mean concentration (EMC) table, utilizing a common land use and land cover identifying field (LUCODE) for each of the 15 discrete land use and cover categories in our 1978, 1992-97, and 2006 GIS data layers. While the USGS researchers in Syed and Jodoin (2006) utilized 1992 and 2001 land use and cover data (Michigan Center for Geographic Information 2002, MDNR 2001), which included subsets of data for the state of Michigan from the USGS National Land Cover Dataset (NLCD), the Rein in the Runoff team relied on the vector polygon data described above. The NLCD data, including the now-released 2006 land use and land cover data, span approximately 14 years and are comprised of 30 meter raster grid cells interpreted using unsupervised classification procedures on LandSat satellite images, which represent ~100 land use and land cover types. The Rein in the Runoff data provided the project team with approximately 23 - 28 years worth of consistently classified land use and land cover data with which to analyze landscape patterns across the watershed. The vector polygon data provided more accurate boundary distinctions between land use and land cover types, and represented actual landscape transitions in a smoother and more realistic manner than other land use and land cover datasets.

This LUCODE field provided PLOAD with the necessary EMC values for TN, TP, and TSS, as well as the percent impervious surface factor associated with each land use and cover type (Syed and Jodoin 2006). Sufficient data necessary to compute specific EMC values and percent impervious surface areas for specific sites within the Spring Lake Watershed were not available for the Rein in the Runoff IA project. The project team relied on the data tables presented in Syed and Jodoin (2006) after verification of potential accuracy utilizing limited data collected during or prior to the IA study period in the Spring Lake Watershed (Lakeshore Environmental, Inc. 2008; Lauber 1999). Similar to the Rein in the Runoff IA, project resources for Syed and Jodoin (2006) did not allow for the collection of new data to compute site-specific event mean concentrations (EMCs). After careful evaluation of published literature, the USGS researchers ultimately determined that the use of EMC values from national studies (Smullen et al. 1999; Brezonik and Stadelmann 2001; Line et al. 2002) and local Michigan projects

(Muskegon River Project, Generalized Watershed Loading Function Model (GWLF), http://148.61.56.211/mrems/chem/GWLF.htm, accessed August 10, 2005) was appropriate. Team members at AWRI supplemented this literature review with EMC data from the Southeast Michigan Council of Governments (SEMCOG) from some of their water quality monitoring projects (Rouge River Project 1998).

Table A-2. Event Mean Concentration (EMC) Tabular Input Data for PLOAD Model Runs.

LUCODE	Land Use and Cover Type	Percent Impervious Surface Area	TN (mg/l)	TP (mg/l)	TSS (mg/l)
11	Residential	25	2.25	0.50	25
12	Commercial/industrial/transportation	80	1.92	0.34	35
21	Cropland and pasture	2	2.50	0.40	27
22	Other agricultural land	2	2.31	0.39	25
23	Orchards/vineyards/other	25	1.92	0.37	17
24	Urban/recreational grasses	2	1.95	0.37	20
25	Shrub/low-density trees	2	0.94	0.15	22
31	Herbaceous open land/grassland	2	0.94	0.15	19
41	Deciduous forest	2	0.94	0.15	16
42	Coniferous forest	2	0.94	0.15	14
43	Mixed forest	2	0.94	0.15	15
50	Water	100	0.65	0.08	3
61	Woody wetlands	2	0.75	0.11	8
62	Emergent herbaceous wetlands	2	0.75	0.11	8
75	Bare/sparsely vegetated	50	0.65	0.08	30

Once these two GIS data layers were created, land use and land cover and sub-basin boundary data were added to each individual BASINS project file, and the two tabular files (Tables A-1 and A-2) were placed into the BASINS PLOAD program directory so that the PLOAD model could be run (Figure A-2). Team members ran PLOAD for each of the land use and cover data layers (1978, 1992/97, 2006), and new watershed data layers were created as encoded GIS watershed sub-basin data layers for each of the modeled pollutants (TN, TP, and TSS). Each of these pollutant loadings were represented by three discrete GIS data layers: EMC Value applied to each sub-watershed basin by pollutant, total pollutant load for each pollutant, and pollutant load per acre.

The PLOAD model runs for each of the land use and land cover time periods (1978, 1992/97, and 2006) provided the project team with total pollutant loads (lbs/year) for TN, TP, and TSS for the entire Spring Lake Watershed (Figure A-3). These results showed increased pollutant loads for all of the modeled pollutants, trending higher in each successive time period. From 1978 to 1992/97, TN increased by 7%, and TP and TSS both increased by 9%. From 1992/97 to 2006, TN increased by 39%, TP increased by 46%, and TSS increased by 36%. These data conformed to the expectations for this watershed, based on the increases in developed land use types (residential, commercial, industrial, and transportation corridors), at the expense of natural vegetation, forested, and even agricultural land use and cover types.

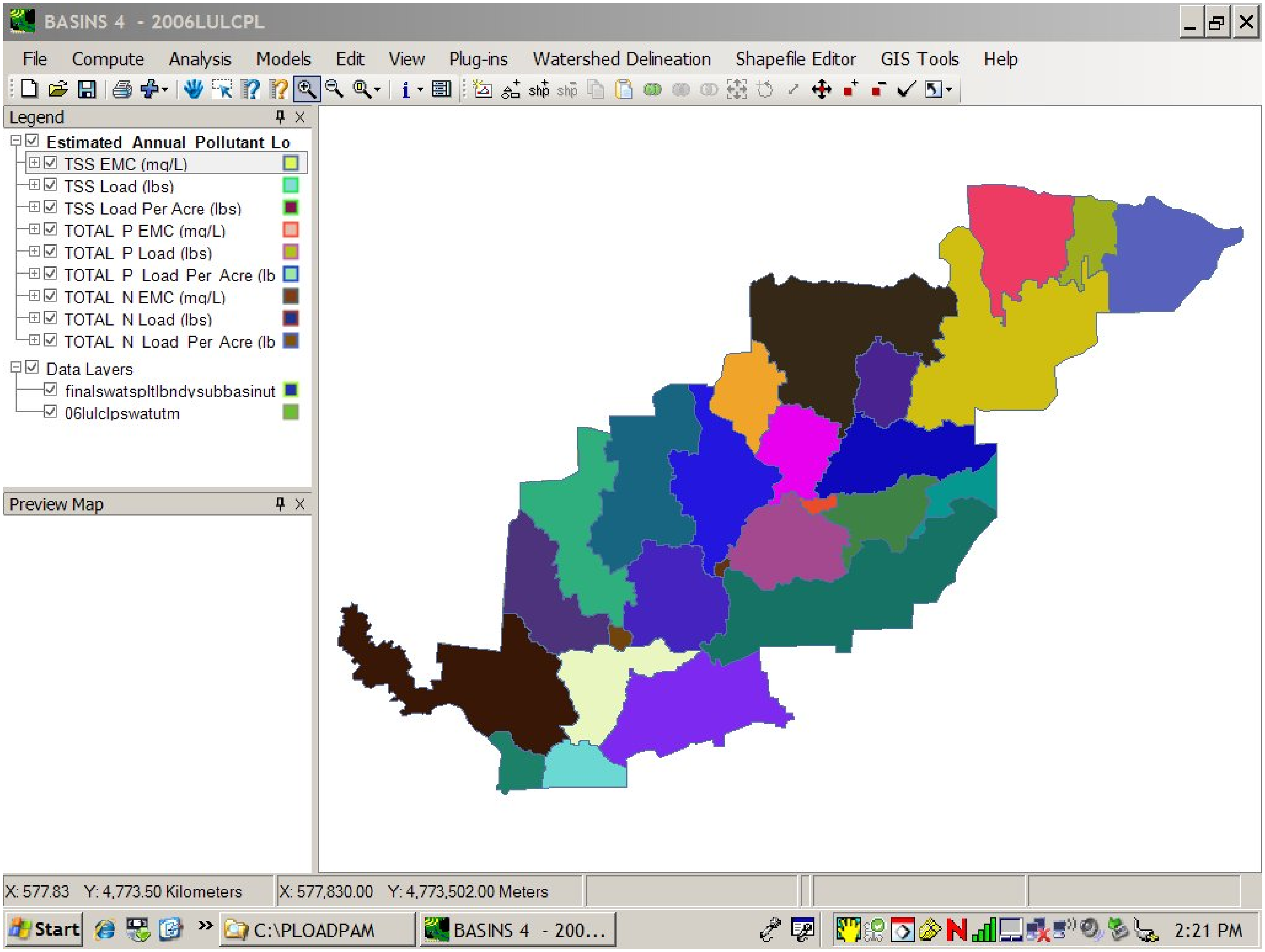
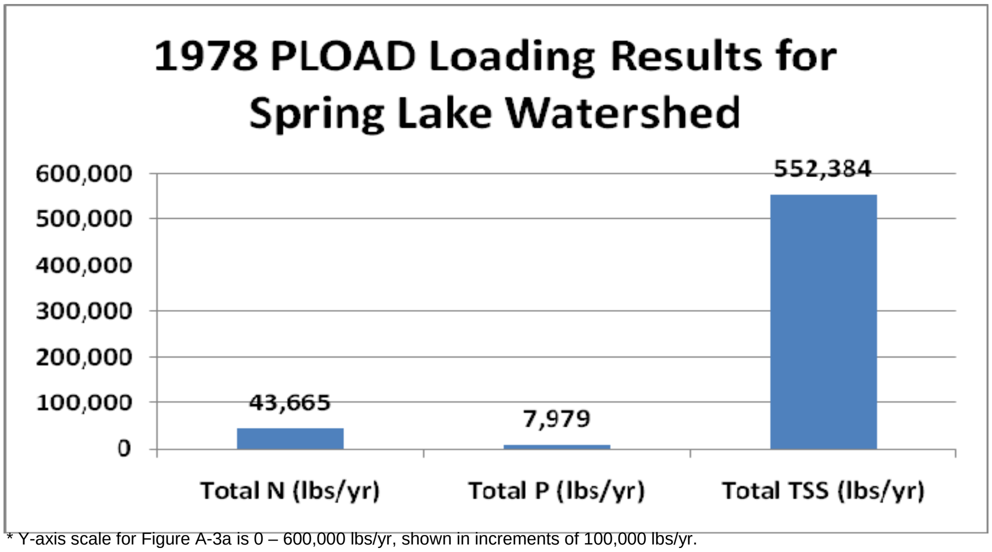


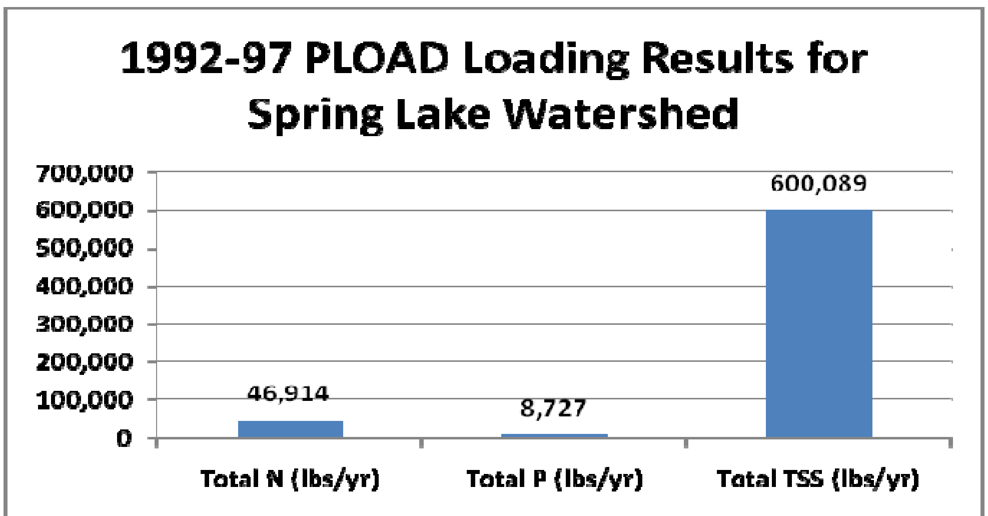
Figure A-2. Output window for BASINS 4.0 project for the Spring Lake Watershed 2006 land use and land cover PLOAD model run.

A-3a



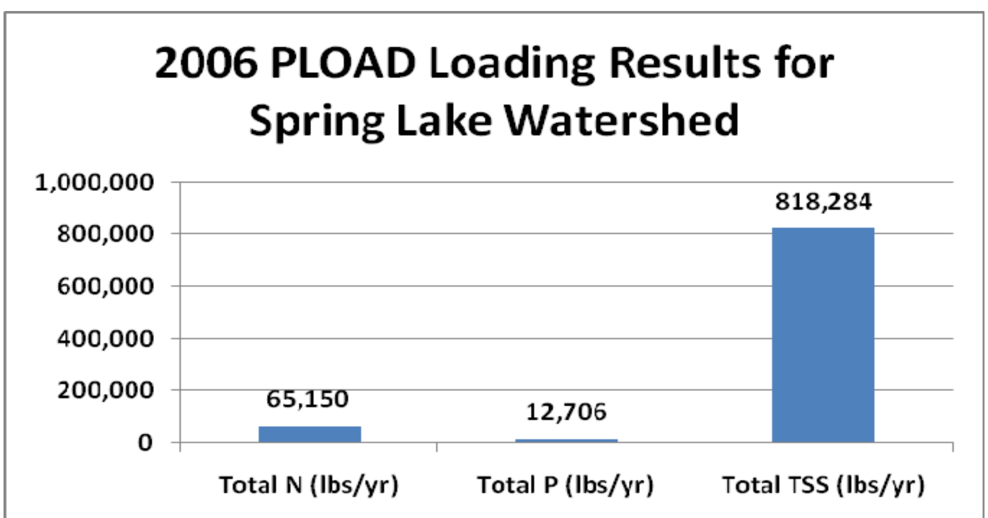
* Y-axis scale for Figure A-3a is 0 – 600,000 lbs/yr, shown in increments of 100,000 lbs/yr.

A-3b



* Y-axis scale for Figure A-3b is 0 – 700,000 lbs/yr, shown in increments of 100,000 lbs/yr.

A-3c



* Y-axis scale for Figure A-3c is 0 – 1,000,000 lbs/yr, shown in increments of 200,000 lbs/yr.

Figure A-3. PLOAD results for total pollutant loads for the Spring Lake Watershed for 1978, 1992/97, and 2006.

Impervious Surface Analysis Tool (ISAT)

ISAT was developed by the NOAA Coastal Services Center to determine the total percentage of impervious surface area within a specific landscape. ISAT is currently available as an extension in ArcView 3.3, Arc GIS 8.2, or Arc GIS 9.3 (ESRI, Inc.; NOAA Coastal Services Center, www.csc.noaa.gov/crs/cwq/isat.html), and it has previously been used as a stand-alone program. ISAT applies impervious surface coefficients to land use and land cover data to determine the total and the percentage of impervious surface area within specified vector polygons.

The Rein in the Runoff project team used ISAT with Arc GIS 9.4 to determine the percent of impervious surface cover for the Spring Lake Watershed over time, applying it to the land use and land cover data for each sub-watershed basin in 1978, 1992-97 and 2006. Impervious surface coefficients were obtained from the USGS study (Syed and Jodoin 2006), after comparison of these values to previous modeling projects conducted by AWRI in Zeeland Township (Ottawa County), Ensley Township (Newaygo County), and in other published studies conducted in the state of Michigan (Rouge River Project 1998). ISAT utilized these coefficients to calculate the total and percent impervious surface area within the Spring Lake Watershed. A separate QA/QC analysis was not conducted for the impervious surface area, because the determination of impervious surface percentages was directly based on the accuracy of the land use and cover types used in the project area which went through a QA/QC analysis.

Appendix B: Rein in the Runoff Integrated Assessment Project Flyers

1. Rein in the Runoff Project Flyer (Spring 2008)
2. Rein in the Runoff Project Flyer (Fall 2008)
3. Rein in the Runoff Project Flyer (Winter 2009)

"REIN IN THE RUNOFF"
Improving water quality in Spring Lake

What is Rein in the Runoff?

A collaborative project that is identifying the causes, consequences, and corrective actions required to minimize the adverse impacts of stormwater discharges to Spring Lake, the Grand River and Lake Michigan.

Who is involved?

- GVSU's Annis Water Resources Institute
- Michigan Sea Grant
- Municipalities and residents in the Spring Lake watershed
- Michigan Department of Environmental Quality
- Environmental Consultants
- A Stakeholder Steering Committee

How can you get involved?

Please join us at our upcoming meetings and events at the Spring Lake Library:

- Stakeholder Steering Committee Meeting: June 4, 2008, 7:00 – 8:30 p.m.
- "Rein in the Runoff" Open House: June 25, 2008, 5:00 – 7:00 p.m.
- "Rein in the Runoff" Public Presentation: June 25, 2008 7:00 – 7:30 p.m.

Why is stormwater a problem?

Rainwater runs off of hard surfaces, such as paved roads, parking lots, and rooftops, and flows into storm drains and then directly into the surrounding waterways. With this "runoff" comes pollutants, such as fertilizers, herbicides, oils and greases, trace metals, sediment, de-icing salt, excess nutrients, increased water temperatures, and pathogens. Collectively, these pollutants have adverse effects on water quality, including:

1. Restricted recreational access to your water bodies
2. Reduced groundwater recharge
3. Erosion of stream channels, with increased sedimentation
4. Overbank flooding

Photo credit: D. O'Keefe

For more information about this project, visit our website: www.gvsu.edu/wri/reinintherunoff

or contact Elaine Sterrett Isely (iselyel@gvsu.edu) or Alan Steinman (steinmaa@gvsu.edu) at the Annis Water Resources Institute (616-331-3749).

Sea Grant Michigan

Grand Valley State ANNIS WATER RESOURCES INSTITUTE Lake Michigan Center

"REIN IN THE RUNOFF"
Improving water quality in Spring Lake

Rein in the Runoff is a collaborative,

community-based project that is identifying the causes, consequences, and corrective actions required to minimize the adverse impacts of stormwater discharges to Spring Lake, the Grand River and Lake Michigan.

Algae bloom in Spring Lake at the Fruitport Boat Launch (July 2008).

Contact us

For more information about this project.

Elaine Sterrett Isely (iselyel@gvsu.edu)

Alan Steinman (steinmaa@gvsu.edu)

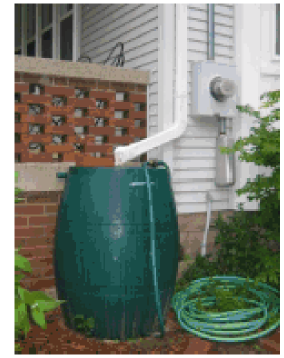
At GVSU's Annis Water Resources Institute: (616) 331-3749

Visit our Project Website:

www.gvsu.edu/wri/reinintherunoff

Visit our updated **Stormwater Education** page to learn more about what you can do to minimize your household contribution of pollutants to our waterways.

Take our online water quality survey and tell us what you know about stormwater and stormwater runoff: http://www.gvsu.edu/wri/waterqualitysurvey



Rain barrels capture rainwater that can be used to water lawns and gardens.

Join us

At our upcoming Stakeholder Steering Committee Meetings at the Spring Lake Library. Visit the **Stakeholder** page on our website or contact use for more information.

The Village of Spring Lake's rain garden provides rainwater and runoff infiltration, and it beautifies the lot (July 2008)

Rein in the Runoff

Improving water quality in Spring Lake

www.gvsu.edu/wri/reinintherunoff

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Algae bloom in Spring Lake at the Fruitport Boat Launch (July 2008).

Contact us

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Learn More

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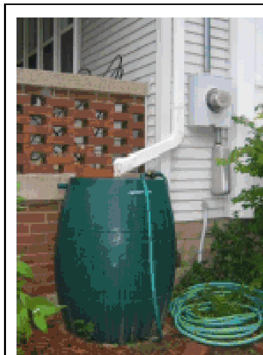
The Village of Spring Lake's rain garden provides rainwater and runoff infiltration, and it beautifies the lot (July 2008)



Rain barrels capture rainwater that can be used to water lawns and gardens.

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Rein in the Runoff Logo design compliments of Shane VanOosterhout, Kendall College of Art & Design, Grand Rapids, MI

Appendix C: Stakeholder Presentations for the Rein in the Runoff Integrated Assessment Project

1. Formal presentation[1] at the North Bank Meeting in Spring Lake on November 13, 2007

2. Informal presentation[2] at the Grand River Forum in Grand Rapids on November 14, 2007

3. Formal presentation at the 2nd Annual Ottawa County Water Quality Forum on November 19, 2007

4. Formal presentation to the Ottawa County Planning Commission in West Olive on November 26, 2007

5. Formal presentation to the Village Council in Fruitport on December 10, 2007

6. Formal presentation at the Egelston Township All Boards Meeting in Muskegon on December 11, 2007

7. Formal presentation to the Moorland Township Planning Commission in Ravenna on December 17, 2007

8. Formal presentation to the Village of Spring Lake Planning Commission in Spring Lake on December 18, 2007

9. Formal presentation to the Fruitport Township Planning Commission in Fruitport on December 18, 2007

10. Formal presentation to the Spring Lake Township Planning Commission in Spring Lake on December 19, 2007

11. Formal presentation to the City of Ferrysburg Planning Commission on January 3, 2008

12. Formal presentation to the City of Grand Haven Environmental Resources Committee in Grand Haven on January 3, 2008

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[1] A “formal presentation” is an invited or scheduled presentation that includes a prepared PowerPoint presentation or other display.
[2] An “informal presentation” is a Rein in the Runoff project update requested by a stakeholder during the course of a public forum.

13. Formal presentation to the City of Grand Haven Planning Commission in Grand Haven on January 8, 2008

14. Formal presentation to the Sullivan Township Planning Commission in Ravenna on January 8, 2008

15. Formal presentation to the City Council in Norton Shores on January 22, 2008

16. Formal presentation to the Crockery Township Planning Commission in Nunica on January 22, 2008

17. Formal presentation to the Grand Haven Township Planning Commission in Grand Haven on February 4, 2008

18. Formal presentation to the Ravenna Township Planning Commission in Ravenna on February 7, 2008

19. Formal presentation to the Muskegon County Community Development Commission in Muskegon on February 19, 2008

20. Formal presentation and display at the Rein in the Runoff Public Meeting and Open House at the Spring Lake Library on June 25, 2008

21. Formal presentation to the Northwest Ottawa County Sustainability Coalition in Grand Haven on August 11, 2008

22. Informal presentation at the Grand River Forum on the Grand River in Grandville on October 3, 2008

23. Formal presentation at a Joint Municipal Council Work Session (Village of Spring Lake, Spring Lake Township, and the City of Ferrysburg) in Spring Lake on February 16, 2009

24. Formal presentation and Enviroscape (Environmental Education Products, www.enviroscapes.com) to the Spring Lake Intermediate School Wetland Detectives Club in Spring Lake on March 31, 2009

25. Display at the Lakeshore Earth Day Event in Grand Haven on April 18, 2009

26. Display and information presentation at the Gathering on the Grand, Grand River Forum in Grand Rapids on April 22, 2009

27. Stormwater BMP Tour for the Spring Lake Intermediate School Wetland Detectives Club in Spring Lake on May 12, 2009

28. Informal presentation at the Northwest Ottawa County Sustainability Coalition meeting at the Community Center in Grand Haven on January 13, 2010.

29. Formal presentation at the final Stakeholder Steering Committee and public meeting at the Spring Lake Library in Spring Lake on March 3, 2010.

Appendix D: Rein in the Runoff Water Quality Surveys

1. Water Quality Survey (Version 1)
2. Water Quality Survey (Version 2)
3. Water Quality Survey Cover Page

REIN IN THE RUNOFF
Water Quality Survey

1. Based on your current knowledge and opinion, please rate the overall water quality of Spring Lake: ____ Excellent ____ Good ____ Fair ____ Poor ____ No Opinion

2. If you have a lawn and mow your grass, what do you do with the grass clippings?
   a. ____ Leave them in the yard
   b. ____ Collect them and throw them in the garbage
   c. ____ Rake or blow them into a storm drain or nearby ditch
   d. ____ Mulch or compost them
   e. ____ Other: ____
   f. ____ I don't have a grassed lawn

3. Do you put fertilizer on your lawn? ____ Yes ____ No
4. How often do you put fertilizer on your lawn?
   a. ____ More than once a month (Which months? ______________________)
   b. ____ Monthly (Which months? ______________________________)
   c. 2-3 times a year
   d. ____ Once a year or less

5. Does anyone ever test the soil on your lawn to determine how much fertilizer is needed? ____ Yes ____ No
6. Do you use a Phosphorus-free fertilizer? ____ Yes ____ No ____ Unsure

7. Where do you wash your personal vehicle(s)?
   a. ____ At home
   b. ____ At a commercial car wash
   c. ____ Both at home and at a commercial car wash
   d. ____ Other: ____

8. If you wash your car at home, where does the soapy water flow (check all that apply)?
   a. ____ Into the grass, dirt or gravel
   b. ____ Into the street or driveway
   c. ____ Directly into a drain

9. Do you change your own oil? ____ Yes ____ No
10. If yes, how do you dispose of the used oil?
   a. ____ In a designated lawn area
   b. ____ With other garbage (dumpster, trash bags, etc)
   c. ____ Pour if down a storm drain
   d. ____ Take it to a recycling center

11. Do you walk your pet? ____ Yes ____ No ____ Do not have pet
12. How often do you pick up you pet waste (either during your walk or in your yard?)
   a. ____ Always
   b. ____ Often
   c. ____ Sometimes
   d. ____ Rarely
   e. ____ Never
   f. ____ Do not have pet

13. Do construction sites in your community lose silt or mud from on-site during rain events? ____ Yes ____ No ____ Unsure
14. Does runoff from your neighborhood enter a storm drain? ____ Yes ____ No ____ Unsure
15. Does runoff from the storm drain enter into a nearby creek, lake or detention pond?
   ____ Yes ____ No ____ Unsure

16. Is your home connected to a ____ community sewer line or ____ septic tank?
17. If septic tank, how often do you have it pumped out?
    a. ____ Every 1-3 years b. ____ Every 3-5 years c. ____ More than every 5 years

18. How would you rate each of the following items as a potential source of water pollution to Spring Lake (1 = Significant, 2 = Somewhat Significant, 3 = Neutral, 4 = Somewhat Insignificant, 5 = Insignificant)
    a. ____ Wastewater discharges from manufacturing plants
    b. ____ Wastewater discharges from sewage treatment plants
    c. ____ Pollutants that are deposited from the atmosphere, like acid rain
    d. ____ Rainfall runoff from parking lots, streets, and other vehicular traffic areas
    e. ____ Rainfall runoff from farms and agricultural operations
    f. ____ Rainfall runoff from forested or undeveloped land areas
    g. ____ Rainfall runoff from developed residential land areas
    h. ____ Rainfall runoff from commercial and industrial land areas
    i. ____ Soil eroding form construction sites or disturbed land areas
    j. ____ Soil eroding from unstable streambanks
    k. ____ Oil, grease, household chemicals, and other wastes intentionally discarded
    l. ____ Accidental spills of industrial and/or commercial chemicals
    m. ____ Discharges from failing or inadequate septic tanks or septic systems
    n. ____ Discharges from failing or inadequate sanitary sewer pipes or systems
    o. ____ Trash that gets dumped by boaters and other recreational users
    p. ____ Natural waste matter from by wildlife

19. Of all the possible sources of water pollution listed in Question 18, please select (by letter) and rank those which you think are the five largest sources of pollution in Spring Lake.
    1. ______ 4. ______
    2. ______ 5. ______
    3. ______

20. Do you spend time on the water for recreation? ____ Yes ____ No

21. Spring Lake continues to have high levels of phosphorus, which can lead to algae blooms, dead fish, and bad odors. Historically, Spring Lake has seen phosphorus levels of 150 ppb (parts per billion), but that has dropped to levels of 30 ppb since the application of the alum treatment by GVSU. A healthy lake has levels of 20 ppb or less.

    Would you be willing to pay $100 per year if the phosphorus levels in Spring Lake could be reduced to less than 20 ppb? ____ Yes ____ No

22. If you answered yes to Question 21, would you be willing to pay $200 per year? ____ Yes ____ No
23. If you answered no to Questions 21, would you be willing to pay $50 per year? ____ Yes ____ No

24. What is your zip code? ________________________

25. What is your annual household income?
    a. ____ Less than $20,000 d. More than $60,000
    b. ____ $20,000 - $40,000 e. I'd rather not say
    c. ____ $40,001 - $60,000

26. Are you ____ Male or ____ Female?
27. Are you ____ less than 18 ____ 18-35 ____ 35-55 ____ over 55 years old?

REIN IN THE RUNOFF
Water Quality Survey

1. Based on your current knowledge and opinion, please rate the overall water quality of Spring Lake: ____ Excellent ____ Good ____ Fair ____ Poor ____ No Opinion

2. If you have a lawn and mow your grass, what do you do with the grass clippings?
   a. ____ Leave them in the yard
   b. ____ Collect them and throw them in the garbage
   c. ____ Rake or blow them into a storm drain or nearby ditch
   d. ____ Mulch or compost them
   e. ____ Other: ______________________________
   f. ____ I don't have a grassed lawn

3. Do you put fertilizer on your lawn? ____ Yes ____ No
4. How often do you put fertilizer on your lawn?
   g. ____ More than once a month (Which months? ______________________)
   h. ____ Monthly (Which months? ______________________)
   i. 2-3 times a year
   j. ____ Once a year or less

5. Does anyone ever test the soil on your lawn to determine how much fertilizer is needed? ____ Yes ____ No
6. Do you use a Phosphorus-free fertilizer? ____ Yes ____ No ____ Unsure

7. Where do you wash your personal vehicle(s)?
   k. ____ At home
   l. ____ At a commercial car wash
   m. ____ Both at home and at a commercial car wash
   n. ____ Other: ______________________________

8. If you wash your car at home, where does the soapy water flow (check all that apply)?
   o. ____ Into the grass, dirt or gravel
   p. ____ Into the street or driveway
   q. ____ Directly into a drain

9. Do you change your own oil? ____ Yes ____ No
10. If yes, how do you dispose of the used oil?
   r. ____ In a designated lawn area
   s. ____ With other garbage (dumpster, trash bags, etc)
   t. ____ Pour if down a storm drain
   u. ____ Take it to a recycling center

11. Do you walk your pet? ____ Yes ____ No ____ Do not have pet
12. How often do you pick up you pet waste (either during your walk or in your yard?)
   v. ____ Always
   w. ____ Often
   x. ____ Sometimes
   d. ____ Rarely
   e. ____ Never
   f. ____ Do not have pet

13. Do construction sites in your community lose silt or mud from on-site during rain events? ____ Yes ____ No ____ Unsure
14. Does runoff from your neighborhood enter a storm drain? ____ Yes ____ No ____ Unsure
15. Does runoff from the storm drain enter into a nearby creek, lake or detention pond? ____ Yes ____ No ____ Unsure

16. Is your home connected to a ____ community sewer line or ____ septic tank?
17. If septic tank, how often do you have it pumped out?
    y. ____ Every 1-3 yearsb. ____ Every 3-5 years c. ____ More than every 5 years

18. How would you rate each of the following items as a potential source of water pollution to Spring Lake (1 = Significant, 2 = Somewhat Significant, 3 = Neutral, 4 = Somewhat Insignificant, 5 = Insignificant)
    z. ____ Wastewater discharges from manufacturing plants
    aa. ____ Wastewater discharges from sewage treatment plants
    bb. ____ Pollutants that are deposited from the atmosphere, like acid rain
    cc. ____ Rainfall runoff from parking lots, streets, and other vehicular traffic areas
    dd. ____ Rainfall runoff from farms and agricultural operations
    ee. ____ Rainfall runoff from forested or undeveloped land areas
    ff. ____ Rainfall runoff from developed residential land areas
    gg. ____ Rainfall runoff from commercial and industrial land areas
    hh. ____ Soil eroding form construction sites or disturbed land areas
    ii. ____ Soil eroding from unstable streambanks
    jj. ____ Oil, grease, household chemicals, and other wastes intentionally discarded
    kk. ____ Accidental spills of industrial and/or commercial chemicals
    ll. ____ Discharges from failing or inadequate septic tanks or septic systems
    mm. ____ Discharges from failing or inadequate sanitary sewer pipes or systems
    nn. ____ Trash that gets dumped by boaters and other recreational users
    oo. ____ Natural waste matter from by wildlife

19. Of all the possible sources of water pollution listed in Question 18, please select (by letter) and rank those which you think are the <u>five largest sources of pollution in Spring Lake</u>.
    4. ______ 4. ______
    5. ______ 5. ______
    6. ______

20. Do you spend time on the water for recreation? ____ Yes ____ No

21. Spring Lake continues to have high levels of phosphorus, which can lead to algae blooms, dead fish, and bad odors. Historically, Spring Lake has seen phosphorus levels of 150 ppb (parts per billion), but that has dropped to levels of 30 ppb since the application of the alum treatment by GVSU. A healthy lake has levels of 20 ppb or less.

    Would you be willing to pay $50 per year if the phosphorus levels in Spring Lake could be reduced to less than 20 ppb? ____ Yes ____ No

22. If you answered yes to Question 21, would you be willing to pay $100 per year? ____ Yes ____ No
23. If you answered no to Questions 21, would you be willing to pay $25 per year? ____ Yes ____ No

24. What is your zip code? ________________________

25. What is your annual household income?
    pp. ____ Less than $20,000 d. More than $60,000
    qq. ____ $20,000 - $40,000 e. I'd rather not say
    rr. ____ $40,001 - $60,000

26. Are you ____ Male or ____ Female?
27. Are you ____ less than 18 ____ 18-35 ____ 35-55 ____ over 55 years old?

REIN IN THE RUNOFF
Water Quality Survey

You are being asked to voluntarily provide specific information on this water quality survey. The information you provide will by used to help the Annis Water Resources Institute (AWRI and the Rein in the Runoff Project Team understand the general level of knowledge held by survey respondents about the connections between stormwater runoff, human activities, and water quality. AWRI and the Project Team will use this information to target its stormwater educational efforts in the communities surrounding Spring Lake and Norris Creek. The information provided in this survey will also help AWRI and the Project Team determine the amount that residents might be willing to pay for improved water quality in Spring Lake, the Grand River and Lake Michigan.

AWRI and the Project Team estimate that this survey will take approximately 10-15 minutes to complete. All individual responses will remain confidential and anonymous; only summary statistics will be reported. If you have any questions about this water quality survey or the Rein in the Runoff Project, please contact Alan Steinman or Elaine Sterrett Isely at the AWRI: (616) 331-3749

Please also visit the Rein in the Runoff website: http://www.gvsu.edu/wri/reinintherunoff

Appendix E: Rein in the Runoff Integrated Assessment Citizens Guide to Stormwater in the Spring Lake Watershed

1. Citizens Guide to Stormwater
2. Growth and Development in the Spring Lake Watershed
3. Stormwater Problems in the Spring Lake Watershed
4. Potential Solutions

Rein in the Runoff

Citizens Guide to Stormwater

January 2010

Rein in the Runoff was a project led by researchers at Grand Valley State University's Annis Water Resources Institute to identify social, economic, and environmental causes and consequences of stormwater runoff in Spring Lake, the Grand River, and ultimately, Lake Michigan.

Grand Valley State ANNIS WATER RESOURCES INSTITUTE Lake Michigan Center

Sea Grant Michigan

This Integrated Assessment was funded by Michigan Sea Grant to examine the current conditions in the Spring Lake Watershed, and to apply current scientific standards to answer the policy question posed by local communities:

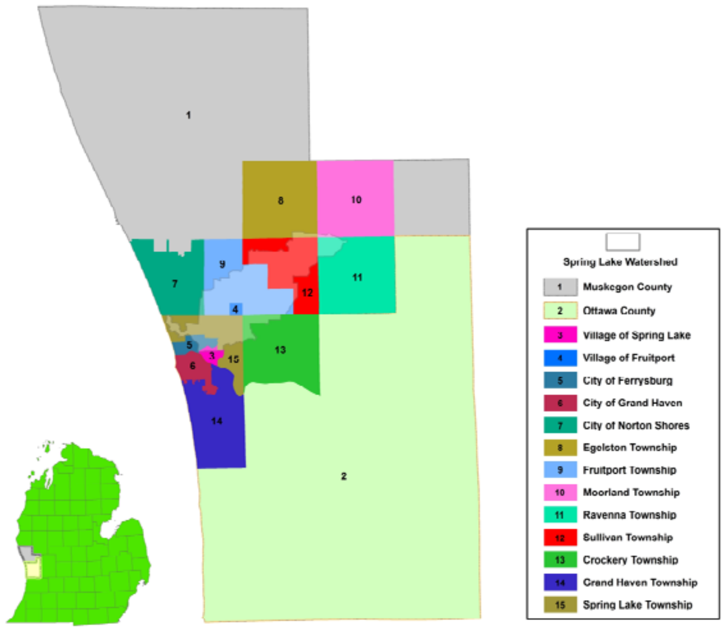
What stormwater management alternatives are available to the communities in the Spring Lake Watershed that allow for future development and also mitigate the effects of stormwater discharges and improve the water quality in Spring Lake, the Grand River, and ultimately, Lake Michigan?

The Rein in the Runoff project goals were to:

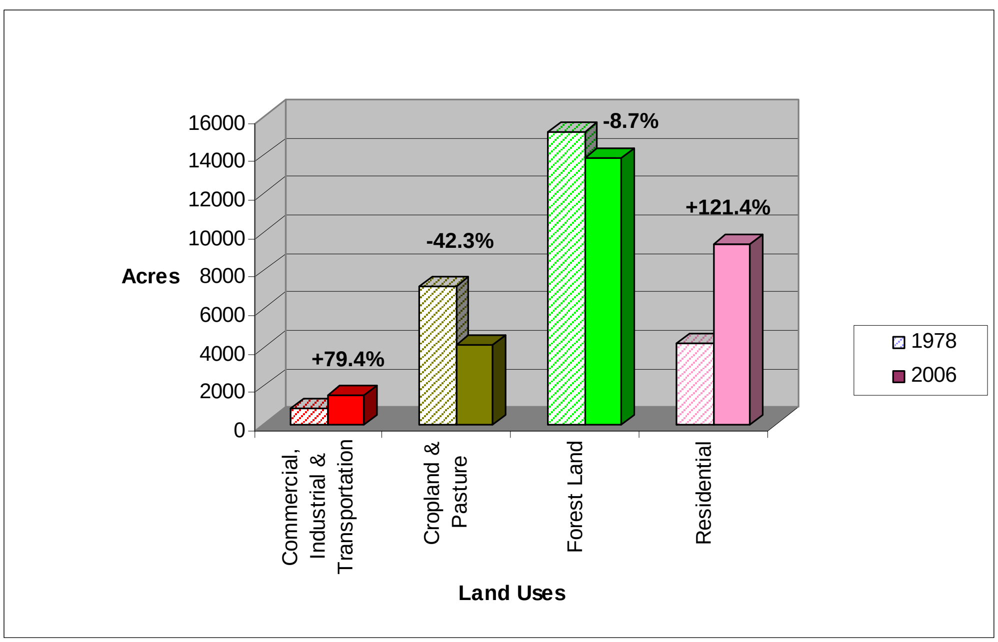
- Identify corrective actions and alternatives to current stormwater management to improve water quality in the community.
- Help local government leaders make informed decisions about stormwater management.
- Educate citizens and business owners and provide ideas for individual actions to improve local water quality.

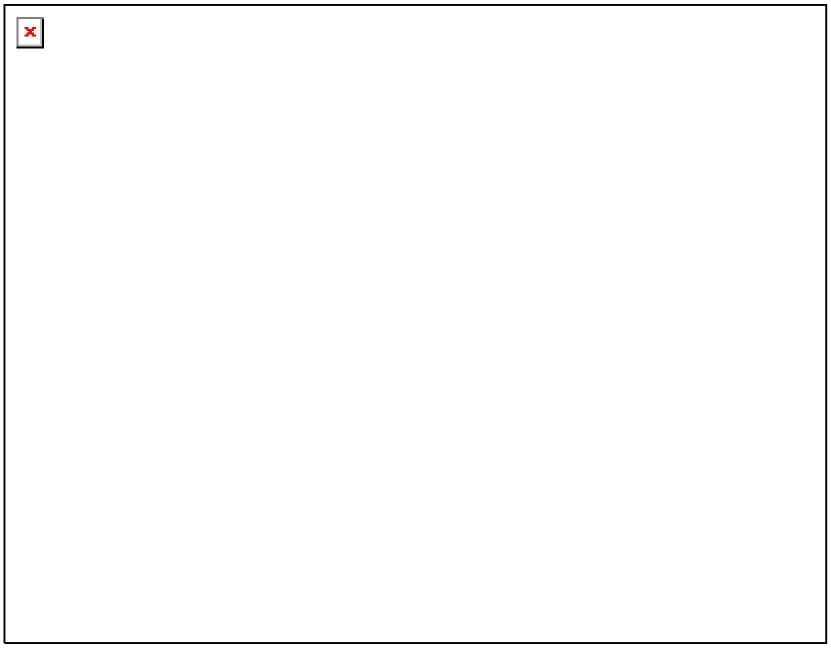
Growth and Development in the Spring Lake Watershed

The Rein in the Runoff project looked at stormwater runoff problems in and downstream of the Spring Lake Watershed. A watershed is an area of land that drains into a body of water – i.e. Spring Lake. There are 13 communities that make up the Spring Lake Watershed, and two downstream of where Spring Lake flows into the Grand River as it flows to Lake Michigan.



The Spring Lake Watershed is located in one of the only regions in Michigan to see continued population growth between 2000 – 2010. Residential and commercial development has increased, and the watershed has lost forested and agricultural lands.





A look at the land use and land cover change from 1978 to 2006 within the Spring Lake Watershed shows this dramatic increase in developed land, particularly closer to the lake.

This type of development increases the amount of land that is covered by hardened – and less natural - surfaces, especially closer to Spring Lake. These impervious areas prevent rainwater from soaking into the ground.

When rain cannot soak into the ground it “runs off” these hard, impenetrable surfaces into local waterways – either indirectly through storm drains, or directly from road ends, parking lots, rooftops, and lawns.

Stormwater Problems in the Spring Lake Watershed

As rainwater flows over the hardened – impervious – surfaces that come with urbanization and development, it collects pollutants and dumps them into Spring Lake, the Grand River, and eventually, Lake Michigan. Different pollutants cause different water quality and water quantity problems:

- Fertilizers can cause too much algae to grow – as they die off, the oxygen in the water can be depleted by the organisms decomposing the algae, which can kill fish and other wildlife
- Soaps (from washing your car) can hurt fish gills and scales
- Chemicals can damage plants and animals
- Dirt from erosion – or sediment – can smother fish habitat
- Excess water that cannot soak into the ground contributes to and aggravates flooding problems
- Pathogens in the water can lead to beach closings and illnesses
- Water gets heated from running over impervious surfaces and can increase stream temperatures and kill fish

There are real costs to society to address these types of water quality and quantity problems. Some examples of these costs include:

- Communities that use surface water for their drinking water supply must pay more to clean up polluted water
- Flooding causes damage to homes, roads, and other infrastructure
- Residents in Spring Lake paid for an alum application to control algae blooms

Potential Solutions

The application of a combination of structural practices and nonstructural tools – particularly Low Impact Development (LID) strategies – to new and existing development throughout the Spring Lake Watershed will be necessary to prevent the continued degradation of water quality in Spring Lake and its adjoining waterways, including the Grand River and Lake Michigan.

The stormwater management priorities for the Spring Lake Watershed include the restoration of waterfront buffers; implementation of LID practices in the areas that contribute the highest pollutant loads to Spring Lake, which according to the Rein in the Runoff model results are the urbanized sub-watersheds closest to the lake; and road ends immediately adjacent to the lake or other waterway.

“Best management practices” – or BMPs – are stormwater control measures that slow, retain or absorb nonpoint source pollutants associated with runoff. When placed in these priority areas throughout the watershed, these BMPs can help control stormwater pollution in our local waterways.

The selection of tools – or BMPs – is ultimately up to each individual or municipal landowner. However, the Rein in the Runoff project team offers the following guidance:

- Vegetated/bio-swales are suitable for installation along roadways. Swales and constructed wetlands, are the most cost-effective practices
- Grow zones, including riparian and littoral buffers, are relatively inexpensive, with installation costs ranging from $200 - $800 per acre, and annual maintenance costs ranging from $4 – 200 per acre

- Rain gardens are suitable for installation in residential neighborhoods, parks, schools, and other small site. They also have relatively low implementation costs, and their smaller footprint makes them well-suited for areas where land is available but not abundant
- Green roofs and pervious pavement are more expensive to implement, and the pollution control benefits, educational opportunities, energy cost savings, etc., should be evaluated on a site-by-site basis

- Rain barrels cost $25 - $200 in West Michigan. In addition to the stormwater control benefits they provide, rain barrels can also reduce the household consumption (and monthly cost) of water for irrigating lawns and gardens
- Tree plantings in new developments can reduce the need for additional stormwater infrastructure. Additional benefits associated with tree plantings include limited increases in property values, pollution reduction, cooler runoff temperatures, and energy saving benefits during the cooling season

- Publicly-owned properties present educational opportunities for the installation of stormwater controls without complicated land ownership concerns

- In densely developed areas, controls that store stormwater on a regional basis might be most effective (e.g., retention basins)

- Nonstructural tools, such as ordinances (stormwater, fertilizer, high density development and other changes to traditional zoning rules), animal waste management programs, stormwater utilities, and stakeholder education, should be encouraged for implementation throughout the Spring Lake Watershed.

For additional information about the Rein in the Runoff Integrated Assessment Project, visit our website: http://www.gvsu.edu/wri/reinintherunoff.

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Alan Steinman (steinmaa@gvsu.edu)
Annis Water Resources Institute
740 W. Shoreline Drive
Muskegon, MI 49441
(616) 331-3749

Appendix F: BMP Review and Analysis

1. Model Stormwater Management Projects
2. Macro-Scale BMP Analysis
3. Step 1: Identification of Priority Areas
4. Step 2: Evaluation of Existing Riparian Buffers
5. Step 3: Identification of Public Properties for BMPs
6. Step 4: Identification of Opportunities for Infiltration BMPs
7. Step 5: Identification of Opportunities for Filtration BMPs
8. Step 6: Identification of Universal BMPs
9. Modeling Pollutant Loads after Application of Structural BMPs
10. Table F-1. Spring Lake Watershed BMPs Conversions to Rein in the Runoff Project Land Use and Land Cover Classifications

The Rein in the Runoff project team evaluated a broad suite of stormwater best management practices (BMPs) that have been implemented in other parts of Michigan, and in communities similar to those in the Spring Lake Watershed around the United States and worldwide. Team members incorporated broad BMP types into a macro-scale BMP selection analysis for different locations throughout the Spring Lake Watershed. These locations were mapped onto the watershed to provide spatial data associated with the selected BMPs. These spatial data provided the basis for additional hydrologic modeling scenarios using PLOAD (see Appendix A) that examined changes in different pollutant loads after implementation of this suite of structural BMPs. For nonstructural BMPs, team members developed a menu of different alternatives that have been utilized in other, similarly-situated communities, with guidance for implementation by the communities within the Spring Lake Watershed.

MODEL STORMWATER MANAGEMENT PROJECTS

Team members visited several communities throughout the United States that have implemented successful stormwater management projects, including Grayling (MI), Portland (OR), Seattle (WA), Madison (WI), and Milwaukee (WI). Team members toured project sites and met with personnel to talk about “lessons learned” regarding specific BMP implementation and maintenance. Additional resources were obtained through participation in several technical conferences, such as the Center for Watershed Protection’s Stormwater Institute (2007), the International Low Impact Development Conference (2008), the Michigan Water Environment Association’s Innovative Stormwater Management Seminar (2008), and the Water Environment Federation’s Sustainability – Green Practices for the Water Environment Conference (2008).

MACRO-SCALE BMP ANALYSIS

The Rein in the Runoff project team conducted a macro-scale BMP selection analysis for the Spring Lake Watershed. This approach was based upon the methodology proposed by Schueler et al. (2007), although it was adapted to fit the project needs and the Spring Lake Watershed geographic region.

The timeline and resources allotted to this project did not allow for site-specific BMP analyses or substantial field evaluation. Because Rein in the Runoff was an Integrated Assessment, project team members had to principally rely on data and information that were previously collected by other researchers or community groups and readily accessible during the course of this project. The simplified BMP selection approach adopted by the project team identified only large-scale areas within the Spring Lake Watershed that would be suitable for the implementation of different types of BMPs: infiltration BMPs, filtration BMPs, regional storage areas, regional treatment areas, and site-specific BMPs on publicly-held lands. The project team did not develop site-specific target treatment volumes or costs, and the BMPs selected were not ranked in any way. The results of the following six-step analysis help identify opportunities for the implementation of different structural and nonstructural stormwater BMPs throughout the Spring Lake Watershed (see Figure 4-1 in Chapter 4).

Step 1: Identification of Priority Areas

The PLOAD model results, aerial photographs, and existing land uses and land covers were compared to identify priority implementation areas for stormwater BMPs. Proposed BMP types (i.e., infiltration BMPs, filtration BMPs, regional storage areas, regional treatment areas, and site-specific BMPs on publicly held lands) were focused in areas with higher phosphorus loadings (based on PLOAD results) and land use and land cover types generally associated with higher nutrient loadings. Specifically, impervious surfaces and agricultural lands will have the highest loadings.

Also of consideration was proximity to water bodies, including Spring Lake and its tributary streams. The closer the source of stormwater pollution is to these water bodies the less opportunity there is for natural processes to reduce nutrient levels, based on estimates for sediment reduction associated with increasing the flow path of runoff through vegetated swales or other filtering media. It was assumed that stormwater runoff from properties located at the upstream ends of each sub-watershed would have more opportunity for sediments to settle out, adsorb to particles, or be taken up by plants than runoff from properties located closer to a waterbody.

Step 2: Evaluation of Existing Riparian Buffers

Riparian buffers provide significant benefits to the watershed and to the water quality of surface waterbodies, such as Spring Lake. Forested, native meadow, or grass buffers improve the quality of stormwater runoff and provide a reduction in stormwater runoff volume compared to maintained turf grass. Because of widespread use and successful past performance, riparian buffers do not generally require detailed engineering or in-depth analysis of hydraulics and hydrology, so are easy BMPs to implement on a watershed-wide basis. Aerial photography was used to identify which streams or portions of streams currently have a forested riparian buffer. Areas without forested riparian buffers along tributaries were identified as BMP opportunities.

Another priority would be to install native vegetative buffers along the lakeshore. A native grass buffer would provide filtering of stormwater runoff from adjacent lawns and impervious surfaces prior to discharge to the lake. Compared with traditionally maintained lawns, native vegetation generates reduced stormwater runoff volumes, peak flow rates, and improved water quality. Mowed turf grass does not provide significant benefits to stormwater quality and can be a nutrient source when improperly fertilized or disposed of (Nielson and Smith 2005; Lehman et al. 2009).

Step 3: Identification of Public Properties for BMPs

One easy place to start with when installing BMPs is publicly-owned properties. In particular, public maintenance yards and areas where soils and minerals area stored above-ground are of higher priority based on the level of nutrients discharged within runoff from these types of sites. Depending on soil types, filtrative or infiltrative BMPs should be installed on these public sites. This type of installation does not rely on public participation and does not have easement requirements. Additionally, if public entities want to promote BMPs to private property owners, it is important to set a good example.

Step: 4: Identification of Opportunities for Infiltration BMPs

Hydrologic soil groups A and B (see Table 2-1 in Chapter 2), generally considered good for infiltration, were identified as an attribute of the maps used in BMP selection. Infiltration is the movement of water into the soil. Where subsoil and geologic conditions are appropriate, water that infiltrates from the surface can potentially percolate to recharge shallow water tables or groundwater. Infiltrative BMPs include infiltration swales and basins, rain gardens, porous pavement, dry wells, and others. A specific type of site or land use does not necessarily merit one type of BMP over another. Each site will vary when identifying the most effective or inexpensive solution. However, in very general terms, commonly suitable BMPs can be identified for land uses such as transportation corridors, residential neighborhoods, and urbanized areas.

Step 5: Identification of Opportunities for Filtration BMPs

Where existing soils do not have high rates of permeability, filtrative BMPs can be used. Filtrative BMPs generally include vegetation or subsurface layers of soil, sand, or aggregate which filter stormwater prior to discharge to a waterbody or outlet through a subsurface engineered underdrain system. While infiltrative BMPs will often provide a higher benefit to cost ratio than filtrative BMPs, filtrative BMPs are still appropriate in certain areas. Specifically, properties in very close proximity or immediately adjacent to a waterbody are critical to the nutrient levels within that waterbody. Where soil and other site conditions are not favorable for infiltration, such as for contaminated sites or sites with proposed future uses that are incompatible with infiltration, filtrative BMPs should be applied.

Step 6: Identification of Universal BMPs

Some BMPs are appropriate “retrofits” to existing development. These universal BMPs can be effective in any situation, independent of location within the watershed, soil type, or land use. Examples include structural BMPs such as the installation and maintenance of riparian buffers or the planting of native vegetation; and nonstructural BMPs such as the use and encouragement of rain barrels/cisterns, the disconnection of roof leads, or the enactment of fertilizer ordinances.

MODELING POLLUTANT LOADS AFTER APPLICATION OF STRUCTURAL BMPS

As noted in Chapter 4, following the macro-scale BMP analysis, the Rein in the Runoff project team applied the structural BMPs for the high priority-areas identified in Figure 4-2 to the 2006 land use and land cover data layer. These BMPs were burned into the GIS layer as land use and land cover changes: residential infiltration, regional treatment, and site-specific BMP areas in the Spring Lake Watershed were reclassified as urban/recreational grasses; regional storage areas were reclassified as emergent herbaceous wetlands; and filtration BMP areas were reclassified as woody wetlands (Table F-1). The project team then ran PLOAD (see Chapter 2) on the 2006 land use and land cover GIS layer to show the changes in nutrient loadings to Spring Lake after the application of these various BMPs throughout the watershed. The results of this analysis are discussed in Chapter 4.

Table F-1. Spring Lake Watershed BMPs Conversions to Rein in the Runoff Project Land Use and Land Cover Classifications.

Structural BMPs[1]	**Size**	**Land Use and Land Cover Classification**	**Size**
Infiltration Swales	60.8 miles	Grasslands	60.8 miles
Riparian Buffers	19.0 miles	Mixed Forest	19.0 miles
Filtration BMP Areas	140.9 acres	Woody Wetlands	140.9 acres
Regional Storage Areas	7.9 acres	Emergent Herbaceous Wetlands	7.9 acres
Regional Treatment Areas	321.0 acres	Urban/Recreational Grasses	2,620.4 acres
Site Specific BMPs	459.9 acres		
Residential Infiltration Areas	1,839.5 acres		

1 See, Figure 4-2, Chapter 4.

Appendix G: Model Stormwater Ordinance and Performance Standards

1. Rein in the Runoff Model Low Impact Development Stormwater Ordinance for the Communities in the Spring Lake Watershed

2. Rein in the Runoff Draft Stormwater Performance Standards

Rein in the Runoff Model Low Impact Development Stormwater Ordinance for the communities in the Spring Lake Watershed

This model ordinance is general guidance to assist local communities interested in implementing a stormwater ordinance. This ordinance is NOT legal advice. Details of both substance and process in an ordinance will vary from community to community based on local conditions and institutional structures. Proposed ordinances should not be finalized without advice and involvement of legal counsel.

AN ORDINANCE to provide for the regulation and control of stormwater runoff, which results in protecting <Insert Community Name> waterways and sensitive areas in the community. This ordinance is intended to protect sensitive areas and local waterways, but at the same time allowing the designer the flexibility in protecting these resources.

ARTICLE I. GENERAL PROVISIONS

Section 1.01 Statutory Authority and Title

This ordinance is adopted in accordance with the constitution and laws of Michigan that authorize local units of government to provide stormwater management services and systems that will contribute to the protection and preservation of the public health, safety, and welfare and to protect natural resources, including the Drain Code of 1956, as amended, being MCL 280.1 et seq.; the Land Division Act, as amended, being MCL 560.1 et seq.; the Revenue Bond Act, as amended, being 141.101 et seq.; and the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101 et seq.; Section 401(p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124, and other applicable state and federal laws.

This ordinance shall be known as the "<Insert Community Name> Stormwater Management Ordinance" and may be so cited.

Section 1.02 Findings

<Insert Community Name> finds that:

- Water bodies, roadways, structures, and other property within, and downstream of <Insert Community Name> are at times subjected to flooding;
- Flooding is a danger to the lives and property of the public and is also a danger to the natural resources of <Insert Community Name> and the region;
- Land development alters the hydrologic response of watersheds, resulting in increased stormwater runoff rates and volumes, increased flooding, increased stream channel erosion, increased sediment transport and deposition, and increased nonpoint source pollutant loading to the receiving water bodies and the Great Lakes;
- Stormwater runoff produced by land development contributes to increased quantities of water-borne pollutants;

- Increases of stormwater runoff, soil erosion, and nonpoint source pollution have occurred as a result of land development, and have impacted the water resources of the Spring Lake Watershed;

- Stormwater runoff, soil erosion, and nonpoint source pollution, because of land development within <Insert Community Name>, have resulted in deterioration of the water resources of <Insert Community Name> and downstream municipalities;

- Increased stormwater runoff rates and volumes, and the sediments and pollutants associated with stormwater runoff from future development projects within <Insert Community Name> will, absent proper regulation and control, adversely affect <Insert Community Name> water bodies and water resources, and those of downstream municipalities;

- Stormwater runoff, soil erosion, and nonpoint source pollution can be controlled and minimized by the regulation of stormwater runoff from development;

- Adopting the standards, criteria and procedures contained in, or cited by, this ordinance and implementing the same will address many of the deleterious effects of stormwater runoff;

- Adopting these standards is necessary for the preservation of the public health, safety and welfare;

- Illicit discharges contain pollutants that will significantly degrade <Insert Community Name>'s water bodies and water resources;

- Illicit discharges enter the municipal storm sewer system (MS4) through either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the storm drain system or spills connected by drain inlets);

- Establishing the measures for controlling illicit discharges and connections contained in this ordinance and implementing them will address many of the deleterious effects of illicit discharges.

Section 1.03 Purpose

It is the purpose of this ordinance to establish minimum stormwater management requirements and controls to accomplish, among others, the following objectives:

(1) To reduce artificially induced flood damage;

(2) To minimize increased stormwater runoff rates and volumes from identified land development;

(3) To prevent an increase in nonpoint source pollution;

(4) To minimize the deterioration of existing watercourses, culverts and bridges, and other structures;

(5) To encourage water recharge into the ground where geologically favorable conditions exist;

(6) To maintain the ecological integrity of stream channels for their biological functions, as well as for drainage and other purposes;

(7) To minimize the impact of development upon streambank and streambed stability;

(8) To reduce erosion from development or construction projects;

(9) To control non-stormwater discharges to stormwater conveyances and reduce pollutants in stormwater discharges;

(10) To preserve and protect water supply facilities and water resources by means of controlling increased flood discharges, stream erosion, and runoff pollution;

(11) To reduce stormwater runoff rates and volumes, soil erosion, and nonpoint source pollution, wherever practicable, from lands that were developed without stormwater management controls meeting the purposes and standards of this ordinance;

(12) To reduce the adverse impact of changing land use on water bodies and, to that end, this ordinance establishes minimum standards to protect water bodies from degradation resulting from changing land use where there are insufficient stormwater management controls;

(13) To ensure that storm drain drainage or stormwater BMPs are adequate to address stormwater management needs within a proposed development, and for protecting downstream landowners from flooding and degradation of water quality. The procedures, standards, and recommendations set forth in this Ordinance and the Low Impact Development Manual for Michigan are designed for these purposes;

(14) To regulate the contribution of pollutants to the municipal separate storm sewer system (MS4) by stormwater discharges by any user;

(15) To prohibit illicit discharges and connection to the municipal separate storm sewer system; and

(16) To establish legal authority to carry out all inspection, surveillance, monitoring and enforcement procedures necessary to ensure compliance with this ordinance.

Section 1.04 Applicability, Requirement of a Stormwater Permit

(1) This ordinance shall apply to every development requiring approval of a plat, a site development plan, building permit or any other permit for work which will alter stormwater drainage characteristics of the development site in <Insert Community Name>, including but not necessarily limited to:

(a) Land development proposals subject to site plan review requirements in the <Insert Community Name> Zoning Ordinance;

(b) Subdivision plat proposals;

(c) Site condominium developments pursuant to the Condominium Act, P.A. 59 of 1978 as amended; MCLA 559.101 et seq.;

(d) Any development on property divided by land division, on platted subdivision lots, or on site condominium lots;

(e) Any proposal to mine, excavate, or clear and grade, compact, or otherwise develop one acre or more of land for purposes other than routine single-family residential landscaping and gardening, or any proposal within 500 feet of the top of the bank of an inland lake or stream;

(f) Development projects of federal, state, and local agencies and other public entities subject to the <Insert Community Name> NPDES Permit for Municipal Separate Storm Sewer Systems;

(g) Maintenance of a stormwater basin constructed prior to the effective date of the regulations of which this subsection is a part.

(2) This ordinance shall apply to all discharges entering the storm drain system generated on any developed and undeveloped lands unless explicitly exempted in Section 1.05.

Section 1.05 Exemptions

Notwithstanding the requirements of Section 1.04, this ordinance shall not apply to:

(1) Activities protected by the Right to Farm Act 93 of 1981, although this exemption shall not apply to livestock production facilities as defined in this ordinance, greenhouses and other similar structures;

(2) Routine single-family residential landscaping and/or gardening which does not otherwise materially alter stormwater flow from the property in terms of rate and/or volume;

(3) The installation or removal of individual mobile homes within a mobile home park. This exemption shall not be construed to apply to the construction, expansion, or modification of a mobile home park.

(4) Plats that have received preliminary plat approval and other developments with final land use approval prior to the effective date of this ordinance, where such approvals remain in effect.

ARTICLE II. DEFINITIONS

Section 2.01 Definition of Terms

The following terms, phrases, words, and derivatives shall have the meaning defined below:

Authorized Enforcement Agency. Identify individual(s) and their agency affiliation responsible for enforcing this ordinance.

Applicant. Any person proposing or implementing the development of land.

Base Flood. A flood having a one (1) percent chance of being equaled or exceeded in any given year.

Base Flood Elevation. The high water elevation of the Base Flood, commonly referred to as the "100-year flood elevation".

Base Floodplain. The area inundated by the Base Flood.

BMP or "Best Management Practice". A practice, or combination of practices and design criteria that comply with the Michigan Department of Environmental Quality's Guidebook of BMPs for Michigan Watersheds, and Low Impact Development Manual for Michigan, or equivalent practices and design criteria that accomplish the purposes of this ordinance (including, but not limited to minimizing stormwater runoff and preventing the discharge of pollutants into stormwater) as determined by the <Insert Community Name> Engineer, Environmental Consultant and/or, where appropriate, the standards of the <Ottawa or Muskegon> County Drain Commissioner.

Building Opening. Any opening of a solid wall such as a window or door, through which floodwaters could penetrate.

Clean Water Act. The Federal Water Pollution Control Act, 22 USC 1251, et seq., as amended, and the applicable regulations promulgated under it.

Construction Site Stormwater Runoff. Stormwater runoff from a development site following an earth change.

Conveyance facility. A storm drain, pipe, swale, or channel.

Design Engineer. The registered and licensed, professional engineer responsible for the design of the stormwater management plan.

Detention. A system which is designed to capture stormwater and release it over a given period of time through an outlet structure at a controlled rate.

Developed or Development. The installation or construction of impervious surfaces on a development site that require, pursuant to state law or local ordinance, <Insert Community Name>'s approval of a site plan, site condominium, special land use, planned unit development, rezoning of land, land division approval, private road approval, or other approvals required for the development of land or the erection of buildings or structures. This shall include construction or improvement project on lands owned by <Insert Community Name> and local school districts.
Developer. Any person proposing or implementing the development of land.

Development Site. Any land that is being or has been developed, or that a developer proposes for development.

Discharger. Any person or entity who directly or indirectly discharges stormwater from any property. Discharger also means any employee, officer, director, partner, contractor, or other person who participates in, or is legally or factually responsible for, any act or omission which is or results in a violation of this ordinance.

Drain. Any drain as defined in the Drain Code of 1956, as amended, being MCL 280.1, et seq., other than an established county or intercounty drain.

Drainage. The collection, conveyance, or discharge of groundwater and/or surface water.

Drainageway. The area within which surface water or groundwater is carried form one part of a lot or parcel to another part of the lot or parcel or to adjacent land.

Drain Commissioner. <Muskegon or Ottawa> Drain Commissioner.

Earth Change. A human made change in the natural cover or topography of land, including cut and fill activities. Earth change includes, but is not limited to, any excavating, surface grading, filling, landscaping, or removal of vegetation roots. Earth change does not include the practice of plowing and tilling soil for the purpose of crop production.

EPA. The United States Environmental Protection Agency.

Erosion. The process by which the ground surface is worn away by action of wind, water, gravity or a combination of any or all.

Exempted Discharges. Discharges other than stormwater as specified in Section 5.02.

Federal Emergency Management Agency (FEMA). The agency of the federal government charged with emergency management.

Flood or Flooding. A general and temporary condition of partial or complete inundation of normally dry land areas resulting from the overflow of water bodies or the unusual or rapid accumulation of surface water runoff from any source.

Floodplain. Any land area subject to periodic flooding.

Flood-Proofing. Any structural and/or nonstructural additions, changes, or adjustments to structures or property that reduce or eliminate flood damage to land or improvements, including utilities and other structures.

Flood Protection Elevation (FPE). The Base Flood Elevation plus one (1) foot at any given location.

Floodway. The channel of any watercourse and the adjacent land areas that must be reserved to carry and discharge a base flood without cumulatively increasing the water surface elevation more than one-tenth (1/10) of a foot because of the loss of flood conveyance or storage.

Grading. Any stripping, excavating, filling, and stockpiling of soil or any combination thereof and the land in its excavated or filled condition.

Hazardous Materials. Any material, including any substance , waste or combination thereof, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property, or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Illicit Connection. Any method or means for conveying an illicit discharge into water bodies or the <Insert Community Name>'s stormwater system.

Illicit Discharge. Any discharge to water bodies that does not consist entirely of stormwater, discharges pursuant to the terms of a NPDES permit, or exempted discharges as defined in this ordinance.

Impervious Surface. A surface, such as a paved or gravel driveway, roof, parking area or road, that prevents the infiltration of water into the soil.

Infiltration. The percolation of water into the ground, expressed in inches per hour.

Livestock Production Facilities. An agricultural activity in which 100 or more livestock are fed, bred, and/or raised within a confined area, other than an open pasture either inside or outside an enclosed building.

Lowest Floor. The lowest floor or the lowest enclosed area (including a basement), but not including an unfinished or flood-resistant enclosure which is usable solely for parking of vehicles or building access.

Maintenance Agreement. A binding agreement that sets forth the terms, measures, and conditions for the maintenance of stormwater systems and facilities.

MDEQ. Michigan Department of Environmental Quality.

Municipal Separate Storm Sewer System (MS4). A publicly owned conveyance system designed or used for collecting or conveying stormwater.

NPDES. National Pollution Discharge Elimination System.

National Pollutant Discharge Elimination System (NPDES) Stormwater Discharge Permit. A permit issued by EPS (or by a state under authority delegated pursuant to 33 USC 1342(b)) that authorizes the discharge of pollutants to waters of the United States. The permit may be applicable on an individual, group, or general area-wide basis.

Non-Stormwater Discharge. Any discharge to the storm drain system that is not composed entirely of stormwater.

Offsite Facility. All or part of a drainage system that is located partially or completely off the development site which it serves.

Overland Flow-way. Surface area that conveys a concentrated flow of stormwater runoff.

Peak Rate of Discharge. The maximum rate of stormwater flow at a particular location following a storm event, as measured at a given point and time in cubic feet per second (CFS).

Person. An individual, firm, partnership, association, public or private corporation, public agency, instrumentality, or other legal entity.

Plan. Written narratives, specifications, drawings, sketches, written standards, operating procedures, or any combination of these which contain information pursuant to this ordinance.

Pollutant. A substance discharge which includes, but is not limited to the following: any dredged soil, solid waste, vehicle fluids, yard wastes, animal wastes, agricultural waste products, sediment, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological wastes, radioactive materials, heat, wrecked or discharged equipment, rock, sand, cellar dirt, and industrial, municipal, commercial and agricultural waste, or any other contaminant or other substance defined as a pollutant under the Clean Water Act.

Premises. Any building, lot, parcel of land, or portion of land whether improved or unimproved including adjacent sidewalks and parking strips.

Property Owner. Any person having legal or equitable title to property or any person having or exercising care, custody, or control over any property.

Retention. A system which is designed to capture stormwater and contain it until it infiltrates the soil, or evaporates, or drains.

Runoff. That part of precipitation, which flows over the land.

Sediment. Mineral or organic particulate matter that has been removed from its site of origin by the processes of soil erosion, is in suspension in water, or is being transported.

Soil Erosion. The stripping of soil and weathered rock from land creating sediment for transportation by water, wind or ice, thereby enabling formation of new sedimentary deposits.

State of Michigan Water Quality Standards. All applicable State rules, regulations, and laws pertaining to water quality, including the provisions of Section 3106 of Part 31 of 1994 PA 451, as amended.

Storm Drain. A conduit, pipe, swale, natural channel, or manmade structure which serves to transport stormwater runoff. Storm drains may be either enclosed or open.

Stormwater Best Management Practice (BMP). Any facility, structure, channel, area, process or measure which serves to control stormwater runoff in accordance with the purposes and standards of this ordinance.

Stormwater Permit. A permit issued by either the <Muskegon or Ottawa> County Drain Commissioner pursuant to state law or <Insert Community Name> pursuant to this ordinance.

Stormwater Pollution Prevention Plan. A document prepared by a registered engineer, registered landscape architect, or registered surveyor which describes the BMPs and activities to be implemented by a person or business to identify sources of pollution or contamination at a site and the actions to eliminate or reduce pollutant discharges to stormwater water, stormwater conveyance systems, and/or receiving waters to the maximum extent possible.

Stormwater Runoff. The runoff and drainage of precipitation resulting from rainfall or snowmelt or other natural event or process.

Stormwater Management Facility. The method, structure, area, system, or other equipment or measures which are designed to receive, control, store, or convey stormwater.

Stream. A river, stream or creek which may or may not be serving as a drain, or any other water body that has definite banks, a bed, and visible evidence of a continued flow or continued occurrence of water.

Swale. Defined contour of land with gradual slopes that transport and direct the flow of stormwater.

Wastewater. Any water or other liquid, other any uncontaminated stormwater, discharged form a facility.

Water Body. A river, lake, stream, creek, or other watercourse or wetlands.

Watercourse. Any natural or manmade waterway or other body of water having reasonably well defined banks. Rivers, streams, creeks and brooks, and channels, whether continually or intermittently flowing, as well as lakes and ponds are watercourses for purposes of stormwater management.

Watershed. An area in which there is a common outlet into which stormwater ultimately flows, otherwise known as a drainage area.

Wetlands. Land characterized by the presence of hydric soils and water at a frequency and duration sufficient to support, and that under normal circumstances does support wetland vegetation or aquatic life and is commonly referred to as a bog, swamp, or marsh, as defined by state law.

ARTICLE III. STORMWATER PERMITS

Section 3.01 Permit Required

(1) A developer shall not engage in any development without first receiving a stormwater permit from <Insert Community Name> pursuant to Section 3.02 of this ordinance.

(2) The granting of a stormwater permit shall authorize only such development for which the permit is required, subject to the terms of the permit, and it shall not be deemed to approve other development or other land use activities.

Section 3.02 Stormwater Permit Review Procedures

<Insert Community Name> shall grant a stormwater permit which may impose terms and conditions in accordance with Section 3.09, and which shall be granted only upon compliance with each of the following requirements:

(a) The developer has submitted a drainage plan complying with Section 3.03.

(b) The drainage plan contains a description of an adequate, temporary stormwater retention or system to prevent construction site stormwater runoff, satisfying the requirements of Section 3.05, and the developer has obtained a soil erosion permit, if necessary.

(c) The developer provides:

(i) A permanent on-site stormwater management system complying with the <Muskegon or Ottawa> County Drain Commissioner Standards & Specifications and the <Insert Community Name> Performance and Design Standards adopted by <Insert Community Name>.

(ii) Written construction plan approval from the <Muskegon or Ottawa> Drain Commissioner.

(d) The developer has paid or deposited the stormwater permit review fee pursuant to Section 3.04.

(e) The developer has paid or posed the applicable financial guarantee pursuant to Section 3.06.

(f) The developer provides all easements necessary to implement the approved drainage plan and to otherwise comply with this ordinance including, but not limited to Section 8.02. All easements shall be acceptable to <Insert Community Name> in form and substance and shall be recorded with the <Ottawa or Muskegon> County Register of Deeds.

(g) The drainage plan is designed in conformity with <Insert Community Name> or <Muskegon or Ottawa> County Drain Commissioner design and performance standards adopted by <Insert Community Name>.

(h) All stormwater runoff facilities shall be designed in accordance with the current BMP design standards.

(i) The developer provides the required maintenance agreement for routine, emergency, and long-term maintenance of all stormwater management facilities. This agreement shall be in compliance with the approved drainage plan and this ordinance, including, but not limited to Section 8.04. The maintenance agreement shall be acceptable to <Insert Community Name> in form and substance and shall be recorded with the <Muskegon or Ottawa> County Register of Deeds.

Section 3.03 Drainage Plan

During the site plan approval process, the developer shall provide a drainage plan to <Insert Community Name> for review and approval by <Insert Community Name> and <Muskegon or Ottawa> County Drain Commissioner. The drainage plan shall identify and contain all of the following:

(1) The location of the development site and water bodies that will receive stormwater runoff.

(2) The existing and proposed topography of the development site, including the alignment and boundary of the natural drainage courses, with contours having a maximum interval of one foot (using USGS datum). The information shall be superimposed on the pertinent <Muskegon or Ottawa> County soil map.

(3) The development tributary area to each point of discharge from the development.

(4) Calculations for the final peak discharge rates.

(5) Calculations for any facility or structure size and configuration.

(6) A drawing showing all proposed stormwater runoff facilities with existing and final grades.

(7) The sizes and locations of upstream and downstream culverts serving the major drainage routes flowing into and out of the development site. Any significant off-site and on-site drainage outlet restrictions other than culverts should be noted on the drainage map.

(8) An implementation plan for construction and inspection of all stormwater management facilities necessary to the overall drainage plan, including a schedule of estimated dates of completing construction of the stormwater runoff facilities shown on the plan and an identification of the proposed inspection procedures to ensure that the stormwater management facilities are constructed in accordance with the approved drainage plan.

(9) A plan to ensure the effective control of construction site stormwater runoff and sediment tracking onto roadways.

(10) Drawings, profiles, and specifications for the construction of the stormwater runoff facilities reasonably necessary to ensure that stormwater runoff will be drained, stored, or otherwise controlled in accordance with this ordinance.

(11) A maintenance agreement, in form and substance acceptable to <Insert Community Name>, for ensuring maintenance of any privately-owned stormwater management facilities. The maintenance agreement shall include the developer's written commitment to provide routine, emergency, and long-term maintenance of the facilities in perpetuity and, in the event that the facilities are not maintained in accordance with the approved drainage plan, the agreement shall authorize <Insert Community Name> to maintain an on-site stormwater management facility as reasonably necessary, at the developer's expense.

(12) The name of the engineering firm and the registered professional engineer that designed the drainage plan and that will inspect final construction of the stormwater runoff facilities.

(13) All design information must be compatible with the <Muskegon or Ottawa> County Geographic Information System.

(14) Any other information necessary for <Insert Community Name> and/or <Muskegon or Ottawa> County Drain Commissioner to verify that the drainage plan complies with the <Insert Community Name> and/or <Muskegon or Ottawa> County Drain Commissioner's design and performance standards for drains and stormwater management systems.

Section 3.04 Stormwater Permit Review Fees

(1) All expenses and costs incurred by <Insert Community Name> and/or <Muskegon or Ottawa> County Drain Commissioner directly associated with processing, reviewing, and approving or denying a stormwater permit application shall be paid (or reimbursed) to <Insert Community Name> and/or <Muskegon or Ottawa> County Drain Commissioner from the funds paid directly to the <Muskegon or Ottawa> County Drain Commissioner or from a separate escrow account established by the developer, as provided in subsection (2). <Insert Community Name> may draw funds from a developer's escrow account to reimburse <Insert Community Name> and/or <Muskegon or Ottawa> County Drain Commissioner for out-of-pocket expenses incurred by <Insert Community Name> and/or <Muskegon or Ottawa> County Drain Commissioner relating to the application. Such reimbursable expenses include, but are not limited to, expenses related to the following:

(a) Services of the <Insert Community Name> Attorney directly related to the application.

(b) Services of the <Insert Community Name> Engineer directly related to the application.

(c) Services of other independent contractors working for <Insert Community Name>, which are directly related to the application.

(d) Any additional public hearings, required mailings and legal notice requirements necessitated by the application.

(2) At the time a developer applies for a stormwater permit, the developer shall deposit with the <Insert Community Name> Clerk, as an escrow deposit, an initial amount as determined by resolution of the <Insert Community Name> Board/Council for such matters and shall provide additional amounts as requested by <Insert Community Name> in such increments as area specified in said resolution or shall pay the required fees established by <Muskegon or Ottawa> County Drain Commissioner for a stormwater review. Any excess funds remaining in the escrow account after the application has been fully processed, reviewed and the final <Insert Community Name> approval and acceptance of the development has occurred will be refunded to the developer with no interest to be paid on those funds. At no time prior to <Insert Community Name>'s final decision on an application shall the balance in the escrow account fall below the required initial amount. If the funds in the account are reduced to less than the required initial amount, the developer shall deposit into the account an additional amount to restore the balance to the required initial amount, before the

application review process will be continued. Additional amounts may be required to be placed in the escrow account by the developer, at the discretion of <Insert Community Name>.

Section 3.05 Construction Site Runoff Controls

Prior to making any earth change on a development site regulated by this ordinance, the developer shall first obtain a soil erosion permit from the <Muskegon or Ottawa> County Drain Commissioner issued in accordance with Part 91 of Act No. 451 of the Public Acts of 1994, as amended, if one is required. The developer shall install stormwater management facilities that conform to the <Insert Community Name>'s Stormwater Performance and Design Standards and shall phase the development activities so as to prevent construction site stormwater runoff and off-site sedimentation. During all construction activities on the development site, the <Insert Community Name> Engineer or other <Insert Community Name> representative may inspect the development site to ensure compliance with the approved construction site runoff controls.

Section 3.06 Financial Guarantee

(1) The <Insert Community Name> Engineer shall not approve a stormwater permit until the developer submits to <Insert Community Name>, in a form and amount satisfactory to <Insert Community Name>, a letter of credit or other financial guarantee for the timely and satisfactory construction of all stormwater runoff facilities and site grading in accordance with the approved drainage plan. Upon certification by a registered professional engineer that the stormwater management facilities have been completed in accordance with the approved drainage plan including, but not limited to, the provisions contained in Section 3.03(8), the <Insert Community Name> may release the letter of credit or other financial guarantee subject to final <Insert Community Name> acceptance and approval.

(2) Except as provided in subsection (3), the amount of the financial guarantee shall be equal to the construction costs estimate provided by the developer of all stormwater runoff facilities and site grading, unless the <Insert Community Name/Enforcement Authority> determines that a greater amount is appropriate, in which case the basis for such determination shall be provided to the developer in writing. In determining whether an amount greater is appropriate, <Insert Community Name/Enforcement Authority> shall consider the size and type of the development, the size and type of the on-site stormwater system, and the nature of the off-site stormwater management facilities the development will utilize.

(3) <Insert Community Name/Enforcement Authority> may waive the financial guarantee for a development if the <Muskegon or Ottawa> County Drain Commissioner or the <Muskegon or Ottawa> County Road Commission, as part of their review process, requires a letter of credit or other financial guarantee for the satisfactory construction of all stormwater management facilities.

(4) <Insert Community Name/Enforcement Authority> may reduce or waive the amount of the financial guarantee for a development that will not increase the percentage of impervious surface of the development site by more than ten percent (10%).

(5) This ordinance shall not be construed or interpreted as relieving a developer of its obligation to pay all costs associated with on-site private stormwater runoff facilities as well as those costs arising from the need to make other drainage improvements in order to reduce the development's impact on a drain consistent with <Insert Community Name>'s adopted Stormwater Performance and Design Standards.

Section 3.07 Certificate of Occupancy

No certificate of occupancy shall be issued until stormwater management facilities have been completed in accordance with the approved drainage plan; provided, however, <Insert Community Name> may issue a temporary certificate of occupancy if an acceptable letter of credit or other financial guarantee has been submitted to <Insert Community Name>, the <Muskegon or Ottawa> County Drain Commissioner, or the <Muskegon or Ottawa> County Road Commission for the timely and satisfactory construction of all stormwater management facilities and site grading in accordance with the approved drainage plan.

Section 3.08 No Change in Approved Facilities

Stormwater management facilities, after construction and approval shall be maintained in good condition, in accordance with the approved drainage plan, and shall not be subsequently altered, revised or replaced except in accordance with the approved drainage plan, or in accordance with approved amendments or revisions in the plan.

Section 3.09 Terms and Conditions of Permits

In granting a stormwater permit, <Insert Community Name> and/or the <Muskegon or Ottawa> County Drain Commissioner, may impose such terms and conditions as are reasonably necessary to effectuate the purposes of this ordinance. A developer shall comply with such terms and conditions.

A permit is considered to be granted by <Insert Community Name> when approval is granted to a development, unless authorization is required to be granted by the <Muskegon or Ottawa> County Drain Commissioner under state law and this approval has not been offered.

ARTICLE IV. STORMWATER SYSTEM, FLOODPLAIN AND OTHER STANDARDS, SOIL EROSION

Section 4.01 Management and Responsibility for Stormwater System

<Insert Community Name> is not responsible for providing drainage facilities on private property for the management of stormwater on that property. The property owner shall be responsible to provide for, and maintain, private stormwater runoff facilities serving the property and to prevent or correct the accumulation of debris that interferes with the drainage function of a water body.

Section 4.02 Stormwater System

All stormwater management facilities shall be constructed and maintained in accordance with applicable federal, state, and local laws, ordinances, rules and regulations, and they shall not conflict with any existing local stormwater management and watershed plans.

Section 4.03 Stormwater Discharge Rates and Volumes

<Insert Community Name> shall utilize the Performance and Design Standards adopted pursuant to Article VI of this ordinance for stormwater discharge and release rates. However, if the <Insert Community Name> Board/Council makes a specific finding that these standards are insufficient, <Insert Community Name> is authorized to establish minimum design standards for stormwater discharge release rates and to require dischargers to implement on-site retention, detention or other methods necessary to control the rate and volume of surface water runoff discharged into the stormwater drainage system, in the following circumstances:

(1) A parcel of land is being developed in a manner that increases the impervious surface area of the parcel; or

(2) The discharge exceeds the <Insert Community Name> approved pre-development discharge characteristics for the subject property, and <Insert Community Name> determines that the discharge is a violation of the drainage, flooding or soil erosion regulations of this ordinance.

Section 4.04 Floodplain Standards

(1) All new buildings and substantial (per state or federal laws or regulations) improvements to existing buildings shall be protected from flood damage up to the Flood Protection Elevation (FPE) and shall be in accordance with all applicable federal, state and local laws, ordinances, rules and regulations. Floodplain/floodway alteration shall be permitted only upon review and approval by <Insert Community Name> and <Muskegon or Ottawa> County Drain Commissioner, in accordance with an approved drainage plan. If authorized under state law, MDEQ review and approval is also required.

(2) A drainage plan providing for the filling or alteration of a floodplain/floodway shall include provisions to minimize erosion, stabilize the streambank and to protect water quality. A natural vegetation strip shall be maintained on each parcel or lot between the top of the streambank and a line, each point of which is twenty-five (25) feet horizontal from the top of the streambank toward the stream.

(3) Within any required buffer zone, no earth change shall take place except in accordance with the approved drainage plan and Soil Erosion and Sedimentation Control Permit as described in Section 4.05. Such a plan may also include provisions for the acceptable replacement of floodplain storage volume, where such storage volume is lost of diminished as a result of approved development.

Section 4.05 Soil Erosion and Sedimentation Control

(1) All persons who cause, in whole or in part, any earth change to occur shall provide soil erosion and sedimentation control so as to adequately prevent soils from being eroded and discharged or deposited onto adjacent properties or into a stormwater drainage system, a public street or right-of-way, wetland, wetland buffer, creek, stream, water body, or floodplain. All development shall be in accordance with Part 91 of Act No. 451 of the Public Acts of 1994, as amended, and all applicable federal, state and local laws, ordinances, rules and regulation.

(2) A Soil Erosion and Sedimentation Control (SESC) Permit is required for any earth change that is greater than one acre or less than 500 feet from any lake or stream. Permits are obtained from the SESC Agent in the <Muskegon or Ottawa> County Drain Commissioner office.

(3) During any earth change which exposes soil to an increased risk of erosion or sediment tracking, the property owner and other persons causing or participating in the earth change shall do the following:

(a) Comply with the stormwater management standards of this ordinance;

(b) Obtain and comply with the terms of a soil erosion and sedimentation control permit from the <Muskegon or Ottawa> County Drain Commissioner office;

(c) Prevent damage to any public utilities or services within the limits of grading and within any routes of travel or areas of work of construction equipment;

(d) Prevent damage to or impairment of any water body on or near the location of the earth change or affected by the earth change;

(e) Prevent damage to adjacent or nearby land;

(f) Apply for all required approvals or permits prior to the commencement of work;

(g) Proceed with the proposed work only in accordance with the approved plans and in compliance with this ordinance;

(h) Maintain all required soil erosion and sedimentation control measures, including but not limited to measures required for compliance with the terms of this ordinance;

(i) Promptly remove all soil, sediment, debris, or other materials applied, dumped, tracked, or otherwise deposited on any lands, public streets, sidewalks, or other public ways or facilities, including catch basins, storm sewers, ditches, drainage swales, or water bodies. Removal of all such soil, sediment, debris or other materials within 24 hours shall be considered prima facie compliance with this requirement, unless such materials present an immediate hazard to public health and safety;

(j) Refrain from grading land at locations near or adjoining lands, public streets, sidewalks, alleys, or other public or private property without providing adequate support or other measures so as to protect such other lands, streets, sidewalks, or other property from settling, cracking or sustaining other damage.

Section 4.06 Building Openings

(1) No building opening shall be constructed below the following elevations:

(a) The Flood Protection Elevation;

(b) The building opening established at the time of plat or development approval and on file in <Insert Community Name> and/or the <Muskegon or Ottawa> County Drain Commissioner.

(2) A waiver from elevations stated in Section 4.06(1) may be granted by the <Insert Community Name> Engineer following receipt of a certification from a registered professional engineer demonstrating that the proposed elevation does not pose a risk of flooding.

(3) If the <Muskegon or Ottawa> County Drain Commissioner has specified a minimum building opening at the time of plat or development approval or if construction occurs within the 100-year floodplain, upon completion of construction of the structure's foundation of slab on grade, a registered land surveyor shall certify any minimum building opening elevation specified by this ordinance. This certificate shall attest that the building opening elevation complies with the standards of this ordinance. The permittee for the building permit shall submit the certificate to <Insert Community Name> Building Inspector prior to the commencement of framing and/or structural steel placement. If the surveyor should find that the minimum building opening elevation is below the elevation specified in Section 4.06(1), that opening must be raised using a method that meets with the approval of <Insert Community Name>. After reconstruction, a registered land surveyor or engineer shall re-certify that the minimum building opening elevation complies with the standards of this ordinance prior to the commencement of framing and or structural steel placement.

(4) The <Insert Community Name> Building Inspector may waive the required land survey under Section 4.06(3) if the minimum building opening appears to be at or above the elevation of adjacent buildings that have already been certified, or if a grade map shows that the low opening elevation of the building is at least three feet higher than the minimum building opening established pursuant to Section 4.06(1).

Section 4.07 Sump Pump Discharge

(1) Whenever building footing drains are required or utilized, a direct connection between the footing drains through a sump pump-check valve system to a storm sewer is required. A gravity system is not permitted.

(2) In cases where Section 4.07(1) applies, a stormwater lateral shall be provided for each parcel at eth time of storm sewer construction.

(3) Laundry facilities or other similar features shall not be connected to a footing drain or pump system discharging to footing laterals and the storm sewer system.

Section 4.08 Public Health, Safety and Welfare

Protection of the public health, safety and welfare shall be a primary consideration in the design of all stormwater runoff facilities.

ARTICLE V. PROHIBITIONS AND EXEMPTIONS

Section 5.01 Prohibited Discharges

(1) No person shall discharge to a water body, directly or indirectly, any substance other than stormwater or an exempted discharge. Any person discharging stormwater shall effectively prevent pollutants from being discharged with the stormwater, except in accordance with BMPs.

(2) <Insert Community Name> is authorized to require dischargers to implement pollution prevention measures, utilizing BMPs, necessary to prevent or reduce the discharge of pollutants into the <Insert Community Name>'s stormwater drainage system.

Section 5.02 Exempted Discharges

The following non-stormwater discharges shall be permissible, provided that they do not result in a violation of the State of Michigan's water quality standards:

Water supply line flushing
Landscape irrigation
Diverted stream flows
Rising groundwater
Uncontaminated groundwater infiltration to storm drains
Uncontaminated pumped ground water

Discharges from potable water sources
Foundation drains
Air conditioning condensate
Individual residential car washing
Dechlorinated swimming pool water
Street wash water
Discharges or flows from emergency fire fighting activities
Discharges for which a specific federal or state permit has been issued

Section 5.03 Interference with Natural or Artificial Drains

(1) It shall be unlawful for any person to stop, fill, dam, confine, pave, alter the course of, or otherwise interfere with any natural or constructed drain or drainageway without first submitted a drainage plan to <Insert Community Name> and receiving approval of that plan. Any deviation from the approved plan is a violation of this ordinance. This section shall not prohibit, however, necessary emergency action so as to prevent or mitigate drainage that would be injurious to the environment or the public health, safety, or welfare. When any of the above activity involves an established County Drain, a Drain Use Permit is require from the <Muskegon or Ottawa> County Drain Commissioner.

(2) No filling, blocking, fencing or above-surface vegetation planting shall take place within a floodplain/floodway.

(3) For an overland flow-way:

(a) Silt fence shall not be permitted below the top of the bank of a water body.

(b) Chain link fences shall be permitted if <Insert Community Name> or the <Muskegon or Ottawa> County Drain Commissioner determine that the fence will not obstruct or divert the flow of water.

(c) If a fence is removed by <Insert Community Name> or the <Muskegon or Ottawa> County Drain Commissioner for drain access or drain maintenance, the fence shall be replaced by the owner of the fence at the owner's expense, as long as the owner complied with subsection (b) above.

(d) No shrubs or trees shall be planted below the top of the bank of a water body.

(4) Shrubs, trees or other above ground vegetation shall not be planted over the top of an underground storm sewer or over the top of the easement within which the storm sewer has been installed.

Section 5.04 Storage of Hazardous or Toxic Materials in Drainageway

Except as permitted by law, it shall be unlawful for any person to store or stockpile within a drainageway any hazardous or toxic materials unless adequate protection and/or containment has been provided so as to prevent any such materials from entering a drainageway.

Section 5.05 Discharge Prohibitions

(1) Prohibition of Illicit Discharges

No person shall discharge or cause to be discharged into the municipal storm drain system or watercourses any materials, including but not limited to pollutants or waters containing any pollutants that cause or contribute to a violation of applicable water quality standards, other than stormwater. The commencement, conduct, or continuance of any illegal discharge to the storm drain system is prohibited except as described as follows:

(a) The prohibition shall not apply to discharges specified in writing by the authorized enforcement agency as necessary to protect public health and safety.

(b) The prohibition shall not apply to any non-stormwater discharge permitted under an NPDES permit, waiver, or water discharge order issued to the discharger and administered under the authority of the Federal Environmental requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted for any discharge to the storm drain system.

(2) Prohibition of Illicit Connections

(a) The construction, use, maintenance or continued existence of illicit connections to the storm drain system is prohibited.

(b) This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.

(c) A person is considered to be in violation of this ordinance if the person connects a line conveying wastewater to the MS4, or allows such a connection to continue.

ARTICLE VI. PERFORMANCE AND DESIGN STANDARDS, BEST MANAGEMENT PRACTICES (BMPS)

Section 6.01 Resolution to Adopt and Implement Performance and Design Standards

The <Insert Community Name> Board/Council shall adopt by resolution Stormwater Performance and Design Standards to achieve the goals and purposes set for this ordinance.

Section 6.02 Responsibility to Implement Best Management Practices (BMPs)

The owner or operator of a commercial or industrial establishment, or any developer, shall provide, at the person's own expense, reasonable protection from accidental discharge of prohibited materials or other wastes into the municipal storm drain system or watercourses through the use of these structural and nonstructural BMPs. Further, any person responsible for the property of premise, which is or may be the source of an illicit discharge, may be required to implement, at that person's expense, additional structural and nonstructural BMPs to prevent the further discharge of pollutants to the stormwater drainage system or waterbody. Compliance with all terms and conditions of a valid NPDES permit authorizing the discharge of stormwater associated with industrial activity, to the extent practicable, shall be deemed compliance with the provisions of this section. These BMPs shall be part of the stormwater pollution prevention plan (SWPP) as necessary for compliance with requirements of the NPDES permit.

Section 6.03 Off-Site Stormwater Management

(1) Requirements

(a) In lieu of on-site stormwater BMPs, the use of off-site stormwater BMPs and storm drains may be proposed. Off-site stormwater BMPs shall be designed to comply with the requirements specified in the Stormwater Performance and Design Standards adopted by <Insert Community Name>, and all other standards provided by this Ordinance that are applicable to on-site facilities.

(b) Off-site stormwater management areas may be shared with other landowners, provided that the terms of the proposal are approved by the <Insert Community Name> Board/Council and <Insert Community Name> Attorney. Approval hereunder shall not be granted for off-site stormwater BMPs unless the applicant demonstrates to the <Insert Community Name>, following recommendation by the <Insert Community Name> staff, that the use of off-site stormwater management areas shall protect water quality and natural resources to an equal or greater extent than would be achieved by the use of on-site stormwater management areas.

(c) Adequate provision and agreements providing for maintenance and inspection of stormwater management facilities shall be made, and the documents, in recordable form, recorded instrument, including an access easement, approved by <Insert Community Name>.

(d) Accelerated soil erosion shall be managed off-site as well as on-site.

(2) Performance Guarantees, Inspections, Maintenance, and Enforcement

All provisions for performance guarantees shall apply to off-site stormwater conveyance and detention.

ARTICLE VII. INSPECTION, MONITORING, REPORTING, AND RECORD KEEPING

Section 7.01 Inspection and Sampling

To assure compliance with the standards described in this ordinance, <Insert Community Name> may inspect and/or obtain stormwater samples from stormwater management facilities of any discharger to determine compliance with the requirements of this ordinance. Upon request, the discharger shall allow the <Insert Community Name>'s or the <Muskegon or Ottawa> County Drain Commissioner's properly identified representative to enter upon the premises of the discharger at all hours necessary for the purposes of such inspection or sampling. <Insert Community Name> shall provide the discharger reasonable advance notice of such inspection and/or sampling. <Insert Community Name> or its properly identified representative may place on the discharger's property the equipment or devices used for such sampling or inspection.

Section 7.02 Stormwater Monitoring Facilities

A discharger of stormwater runoff shall provide and operate equipment or devices for the monitoring of stormwater runoff, so as to provide for inspection, sampling, and flow measurement of each discharge to a water body or a stormwater runoff facility, when directed in writing to do so by the <Insert Community Name>. <Insert Community Name> may require the discharger to provide and operate such equipment and devices if it is necessary to appropriate for the inspection, sampling and flow measurement of discharges in order to determine whether adverse effects from or as a result of such discharges may occur. All such equipment and devices for the inspection, sampling and flow measurement of discharges shall be installed and maintained in accordance with applicable laws, ordinances and regulations.

Section 7.03 Accidental Discharges

Any discharger who accidentally discharges into a water body any substance other than stormwater or an exempted discharge shall immediately inform <Insert Community Name> and/or the <Muskegon or Ottawa> County Drain Commissioner concerning the discharge. If such information is given orally, a written report concerning the discharge shall be filed with <Insert Community Name> or the <Muskegon or Ottawa> County Drain Commissioner within five (5) days. The written report shall specify:

(a) The composition of the discharge and the cause thereof.

(b) The exact date, time, and estimated volume of the discharge.

(c) All measures taken to clean up the accidental discharge, and all measures proposed to be taken to reduce and prevent any recurrence.

(d) The name and telephone number of the person making the report, and the name of a person who may be contacted for additional information on the matter.

Section 7.04 Record Keeping Requirement

Any person subject to this ordinance shall retain and preserve for no less than three (3) years any and all books, drawing, plans, prints, documents, memoranda, reports, correspondence and records, including records on magnetic or electronic media and any and all summaries of such records, relating to monitoring, sampling and chemical analysis of any discharge or stormwater runoff form any property.

ARTICLE VIII. STORMWATER MANAGEMENT EASEMENTS AND MAINTENANCE AGREEMENTS

Section 8.01 Applicability of Requirements

Requirements of this Article concerning stormwater management easements and maintenance agreements shall apply to persons required to submit a drainage plan to the <Insert Community Name> for review and approval.

Section 8.02 Stormwater Management Easements

(1) Necessity of Easements

Stormwater management easements shall be provided in a form required by the applicable approving body of the <Insert Community Name> and the <Insert Community Name> Attorney, and recorded as directed as part of the approval of the applicable <Insert Community Name> body to assure (1) access for inspections; (2) access to stormwater BMPs for maintenance purposes; and (3) preservation of primary and secondary drainageways which are needed to serve stormwater management needs of other properties.

(2) Easements for Off-site Stormwater BMPs

The proprietor shall obtain easements assuring access to all areas used for off-site stormwater management, including undeveloped or undisturbed lands

(3) Recording of Easements

Easements shall be recorded with the <Ottawa or Muskegon> County Register of Deeds according to county requirements.

(4) Recording Prior to Building Permit Issuance

The applicant must provide the <Insert Community Name> Clerk with evidence of the recording of the easement prior to final subdivision plat or condominium approval or other applicable final construction approval.

Section 8.03 Maintenance Bond

(1) A maintenance bond shall be provided to the <Insert Community Name>.

(2) The maintenance bond shall be provided for a period of two years commencing from the date of final approval of the stormwater permit.

Section 8.04 Maintenance Agreement

(1) Purpose of Maintenance Agreement

The purpose of the maintenance agreement is to provide the means and assurance that maintenance of stormwater BMPs shall be undertaken.

(2) Maintenance Agreement Required

(a) A maintenance agreement shall be submitted to the <Insert Community Name>, for review by the <Insert title> and his/her designee and <Insert Community Name> Attorney, for all development, and shall be subject to approval in accordance with the stormwater permit. A formal maintenance plan shall be included in the maintenance agreement.

(b) Maintenance agreements shall be approved by the <Insert Community Name> Board/Council prior to final subdivision plat or condominium approval, as applicable, and prior to construction approval in other cases.

(c) A maintenance agreement is not required to be submitted to the <Insert Community Name> for Chapter 18 of the Michigan Drain Code (P.A. 40 of

1956, as amended) that will be maintained by the <Ottawa or Muskegon> County Drain Commission.

(3) Maintenance Agreement Provisions

(a) The maintenance agreement shall include a plan for routine, emergency, and long-term maintenance of all stormwater BMPs, with a detailed annual estimated budget for the initial three years, and a clear statement that only future maintenance activities in accordance with the maintenance agreement plan shall be permitted without the necessity of securing new permits. Written notice of the intent to proceed with maintenance shall be provided by the party responsible for maintenance to the <Insert Community Name> at least fourteen (14) days in advance of commencing work.

(b) The maintenance agreement shall be binding on all subsequent owners of land served by the stormwater BMPs and shall be recorded in the office of the <Ottawa or Muskegon> County Register of Deeds prior to the effectiveness of the approval of the <Insert Community Name> Board/Council.

(c) If it has been found by the <Insert Community Name> Board/Council, following notice and an opportunity to be heard by the property owner, that there has been a material failure or refusal to undertake maintenance as required under this ordinance and/or as required in the approved maintenance agreement as required hereunder, the <Insert Community Name> shall then be authorized, but not required, to hire an entity with qualifications and experience in the subject matter to undertake the monitoring and maintenance as so required, in which event the property owner shall be obligated to advance or reimburse payment (as determined by the <Insert Community Name>) for all costs and expenses associated with such monitoring and maintenance, together with a reasonable administrative fee. The maintenance agreement required under this ordinance shall contain a provision spelling out this requirement and, if the applicant objects in any respect to such provision or the underlying rights and obligations, such objection shall be resolved prior to the commencement of construction of the proposed development on the property.

Section 8.05 Establishment of County Drains

Prior to final approval, all stormwater management facilities for planned subdivisions and site condominium developments shall be established as county drains, as authorized in Section 433, Chapter 18 of the Michigan Drain Code (P.A. 40 of 1956, as amended) for long-term maintenance.

ARTICLE IX. ENFORCEMENT

Section 9.01 Sanctions for Violations

(1) Any person violating any provision of this ordinance shall be responsible for a municipal civil infraction and subject to a fine of not less than $50.00 for a first offense, and not less than $250.00 for a subsequent offense, plus costs, damages, expenses, and other sanctions as authorized under Chapter 87 of the Revised Judicature Act of 1961 and other applicable laws, including, without limitation, equitable relief; provided, however, that the violations stated in Section 8.01(2) shall be a misdemeanor. Each day such violation occurs or continues shall be deemed a separate offense and shall make the violator liable for the imposition of a fine for each day. The rights and remedies provided for in this section are cumulative and in addition to any other remedies provided by law. An admission or determination of responsibility shall not exempt the offender from compliance with the requirements of this ordinance.

For purposes of this section, "subsequent offense" means a violation of the provisions of this ordinance committed by the same person within 12 months of a previous violation of the same provision of this ordinance for which said person admitted responsibility or was adjudicated to be responsible.
The <Insert Community Name> [zoning administrator, building inspector, enforcement officer, etc.] is authorized to issue municipal civil infraction citations to any person alleged to be violating any provision of this ordinance.

(2) Upon conviction, a person is guilty of a misdemeanor, punishable by a fine of not more than $500 or imprisonment in the county jail for not more than 93 days, or both such fine and imprisonment, plus costs as may be imposed in the discretion of the court, for any of the following:

(a) Neglecting or failing to comply with a stop work order issued under Section 9.02;

(b) Knowing, at the time of violation, that hazardous materials, pollutants, toxic materials, wastewater, or substance was discharged contrary to any provision of this ordinance, or contrary to any notice, order, permit, decision or determination promulgated, issued or made by the Authorized Enforcement Agency under this ordinance;

(c) Intentionally making a false statement, representation, or certification in an application for, or form pertaining to a permit, or in a notice, report, or record required by this ordinance, or in any other correspondence or communication, written or oral, with the Authorized Enforcement Agency regarding matters regulated by this ordinance;

(d) Intentionally falsifying, tampering with, or rendering inaccurate any sampling or monitoring device or record required to be maintained by this ordinance;

(e) Committing any other act that is punishable under state law.

(3) Any person who aids or abets a person in a violation of this ordinance shall be subject to the sanctions provided in this section.

Section 9.02 Stop Work Order

Where there is work in progress that causes or constitutes in whole or in part, a violation of any provision of this ordinance, the <Insert Community Name> is authorized to issue a Stop Work Order so as to prevent further or continuing violations or adverse effects. All persons to whom the stop work order is directed, or who are involved in any way with the work or matter described in the stop work order shall fully and promptly comply therewith. The <Insert Community Name> may also undertake or cause to be undertaken, any necessary or advisable protective measures so as to prevent violations of this ordinance or to avoid or reduce the effects of noncompliance herewith. The cost of any such protective measures shall be the responsibility of the owner of the property upon which the work is being done and the responsibility of any person carrying out or participating in the work, and such cost shall be a lien upon the property.

Section 9.03 Failure to Comply; Completion

In addition to any other remedies, should any owner fail to comply with the provisions of this ordinance, the <Insert Community Name> may, after the giving of reasonable notice and opportunity for compliance, have the necessary work done, and the owner shall be obligated to promptly reimburse the <Insert Community Name> for all costs of such work.

Section 9.04 Emergency Measures

When emergency measures are necessary to moderate a nuisance, to protect public safety, health and welfare, and/or to prevent loss of life, injury or damage to property, the <Insert Community Name> is authorized to carry out or arrange for all such emergency measures. Property owners shall be responsible for the cost of such measures made necessary as a result of a violation of this ordinance, and shall promptly reimburse the <Insert Community Name> for all of such costs.

Section 9.05 Cost Recovery for Damage to Storm Drain System

A discharger shall be liable for all costs incurred by the <Insert Community Name> as the result of causing a discharge that produces a deposit or obstruction, or causes damage to, or impairs a storm drain, or violates any of the provisions of this ordinance. Costs include, but are not limited to, those penalties levied by the EPA or MDEQ for violation of an NPDES permit, attorney fees, and other costs and expenses.

Section 9.06 Collection of Costs; Lien

Costs incurred by the <Insert Community Name> and the Drain Commissioner pursuant to Sections 9.02, 9.03, 9.04 and 9.05 shall be a lien on the premises which shall be enforceable in accordance with Act No. 94 of the Public Acts of 1933, as amended from time to time. Any such charges which are delinquent for six (6) months or more may be certified annually to the <Insert Community Name> Treasurer who shall enter the lien on the next tax roll against the premises and the costs shall be collected and the lien shall be enforced in the same manner as provided for in the collection of taxes assessed upon the roll and the enforcement of a lien for taxes. In addition to any other lawful enforcement methods, the <Insert Community Name> or the Drain Commissioner shall have all remedies authorized by Act No. 94 of the Public Acts of 1933, as amended.

Section 9.07 Suspension of MS4 Access

(1) Suspension because of Illicit Discharges in Emergency Situations

<Insert Community Name> may, without prior notice, suspend MS4 discharge access to a person when the suspension is necessary to stop an actual or threatened discharge which presents or may present imminent and substantial danger to the environment or to the health and welfare of persons or to the MS4. if the violator fails to comply with a suspension order issued in an emergency, <Insert Community Name> may take steps deemed necessary to prevent or minimize damage to the MS4 or the environment, or to minimize danger to the health or welfare of persons.

(2) Suspension because of the Detection of Illicit Discharge

Any person discharging to the MS4 in violation of this ordinance may have their MS4 access terminated if such termination would abate or reduce an illicit discharge. <Insert Community Name> will notify a violator of the proposed termination of its MS4 access. A person commits an offense if the person reinstates MS4 access to premises terminated pursuant to this Section, without the prior approval of <Insert Community Name>.

Section 9.08 Appeals

Any person to whom any provision of this ordinance has been applied may appeal the decision in writing to the <Insert Community Name> Board/Council, not later than thirty (30) days after that action or decision. The appeal shall identify the matter being appealed, and the basis for the appeal. The <Insert Community Name> Board/Council shall consider the appeal and make a decision to affirm, reject or modify the appealed action. In considering any appeal the <Insert Community Name> Board/Council may consider the recommendations of the <Insert Community Name> Engineer and the comments of other persons having knowledge of the matter. In considering any appeal, the <Insert Community Name> Board/Council may grant a variance from the terms of this ordinance so as to provide relief, in whole or in part, from the appealed action, but only upon finding that the following requirements are satisfied:

ARTICLE X. OTHER MATTERS

Section 10.01 Construction of Language

For purposes of this Ordinance, the following rules of construction apply:

(1) Words and phrases in this ordinance shall be construed according to their common and accepted meanings, except that words and phrases defined in Article II shall be construed according to the respective definitions given in that article.

(2) Particulars provided by way of illustration or enumeration shall not control general language.

(3) Ambiguities, if any, shall be construed liberally in favor of protecting natural land and water resources.

(4) Words used in the present tense shall include the future, and words used in the singular number shall include the plural, and the plural the singular, unless the context clearly indicates the contrary.

(5) Technical words and technical phrases which are not defined in this ordinance but which have acquired particular meanings in law or in technical usage shall be construed according to such meanings.

Section 10.02 Catch-Line Headings

The catch-line headings of the articles and sections of this ordinance are intended for convenience only, and shall not be construed as affecting the meaning or interpretation of the text of the articles or sections to which they may refer.

Section 10.03 Severability

The provisions of this ordinance are severable. If any section, clause, provision or portion of this ordinance is adjudged unconstitutional, invalid or unenforceable by a court of competent jurisdiction, the remainder of this ordinance shall remain in force and effect.

Section 10.04 Other Ordinances

This ordinance shall be in addition to the other ordinances of <Insert Community Name>. This ordinance shall not be deemed to repeal or replace other ordinances or parts of ordinances, except to the extent that repeal is specifically provided for in this Article.

Rein in the Runoff
Draft Stormwater Performance and Design Standards

Stormwater management facilities for new and redevelopment shall be designed in accordance with current Ottawa or Muskegon County Standards and the requirements adopted pursuant to the (Township/City) Stormwater Management Ordinance. In general, these standards are more stringent than the County standards to further protect the integrity of downstream surface waters, including Spring Lake.

1.0 Retention of Storm Water Runoff

All new developments within the (insert municipality name here) shall provide sufficient stormwater management facilities to fully retain stormwater runoff from events up to and including the 100-year, 24-hour storm onsite. Infiltration and/or capture and reuse technologies should be utilized to meet this standard.

2.0 Exceptions for Full Retention

Under a few circumstances, the (Township/City) (Board/Planning Commission) may waive the requirement for full retention of stormwater onsite. It will be the responsibility of the developer to adequately demonstrate why infiltration and/or capture and reuse technologies cannot be utilized to meet the retention requirement. Situations for which the (Township/City) (Board/Planning Commission) may consider waiving (or reducing) the retention requirement include:

- **Soil contamination**. Infiltration may not be feasible in areas of soil contamination if there is a risk of contaminating groundwater. The developer will need to demonstrate why soil remediation is not feasible. Capture and reuse technologies should be utilized to the extent possible for these sites.

- **Poorly draining soils**. The developer will need to provide documentation (based on on-site infiltration tests) identifying the permeability rates of the existing soils. Capture and reuse technologies should be utilized to the extent possible for these sites.

- **High groundwater table**. The developer will need to provide documentation (based on on-site tests) identifying the elevation of the groundwater table. Capture and reuse technologies should be utilized to the extent possible for these sites.

In approving a waiver to the full retention requirement, (Township/City) (Board/Planning Commission) will determine the appropriate alternate performance standards. In no instances will the alternate standard be less than what is required by Ottawa or Muskegon County.

3.0 Requirements for Redevelopment

Note to Reviewers – A few options are presented below. Individual components of each option may be combined if desired. Twenty percent (20%) is a fairly arbitrary number that should be adjusted based on the needs of the communities.

Option 1 Text:

A. It is the intention of the (City/Township) that redevelopment of all properties within the (City/Township) shall require the existing stormwater management facilities be upgraded to meet the current standards of the County and the requirements adopted pursuant to the (Township/City) Stormwater Management Ordinance. At the discretion of the (Township/City) (Board/Planning Commission), a redevelopment may not be required to fully upgrade the existing storm water management facilities of the site if all of the following apply:
   a. The impacted area of the site associated with the redevelopment is less than twenty percent (20%) of the total site area.
   b. The total impervious surface of the site is reduced or unchanged.

B. Where full compliance with the requirements of the current standards of the County and the requirements adopted pursuant to the (Township/City) Stormwater Management Ordinance is not required, the following reduced performance criteria will be required:
   a. Where the total impervious surface of the site is increased, retention shall be provided for the proposed impervious surfaces. Retention of a 100-year storm event shall be provided.
   b. Where feasible, stormwater quality BMPs shall be installed to provide treatment for runoff from the existing impervious surfaces.

Option 2 Text:

A. All redevelopment projects shall reduce the existing site impervious area by at least twenty percent (20%). Where site conditions prevent the reduction of impervious area then stormwater management practices shall be implemented to provide for retention of stormwater runoff from at least twenty percent (20%) of the site's existing impervious area. When a combination of impervious area and stormwater storage is used, the combined area shall equal or exceed twenty percent (20%) of the site.

B. Where conditions prevent impervious area reduction or on-site stormwater management, practical alternatives may be considered, including but not limited to:
   a. Fees;
   b. Off-site BMP implementation for a drainage area comparable in size and percent imperviousness to that of the project;
   c. Watershed or stream/lake restoration;
   d. Retrofitting; or
   e. Other practices approved by the (City/Township).

Appendix H: Animal Waste Management Ordinances

1. Animal Waste Ordinance
2. Waterfowl Ordinance

Animal Waste Ordinance

This sample ordinance is general guidance to assist local communities interested in implementing an animal waste control ordinance. This ordinance is NOT legal advice. Details of both substance and process in an ordinance will vary from community to community based on local conditions and institutional structures. Proposed ordinances should not be finalized without advice and involvement of legal counsel.

Animal Excrement Control

(a) Every person having any animal under his or her ownership, custody, supervision, or control shall promptly and thoroughly remove all excrement left by the animal upon any private or public property. Provided, however, a person may fail to remove such excrement from private property which that person owns or in which he or she has a lawful possessory interest, or on which he or she is an invitee with permission of the owner or lawful possessor to not remove animal excrement.

(b) It shall be unlawful for any person to appear with any animal or any private or public property unless that person has then in his or her possession an appropriate device for the immediate and thorough removal of any excrement left by that animal. Provided, however, a person may fail to have in his or her possession an appropriate device for the immediate and thorough removal of animal excrement from private property which that person owns or in which he or she has a lawful possessory interest, or on which he or she is an invitee with permission of the owner or lawful possessor to not have such a device.

(c) Penalty

  (1) A violation of this provision shall constitute a municipal civil infraction, which, upon an admission or finding of responsibility, shall result in a fine of not less than fifty dollars ($50).

  (2) A second violation of this provision within two (2) years shall constitute a municipal civil infraction which, upon an admission or finding of responsibility, shall result in a fine of not less than one hundred dollars ($100.00).

  (3) A third or subsequent violation of this provision within two (2) years of the first such violation shall constitute a municipal civil infraction which upon an admission or finding of responsibility shall result in a fine of not less than three hundred dollars ($300.00).

  (4) All police officers, public service department technicians, and the Building Inspector and Zoning Administrator are authorized to issue civil infraction citations pursuant to this section.

Waterfowl Ordinance

This sample ordinance is general guidance to assist local communities interested in implementing a waterfowl control ordinance. This ordinance is NOT legal advice. Details of both substance and process in an ordinance will vary from community to community based on local conditions and institutional structures. Proposed ordinances should not be finalized without advice and involvement of legal counsel.

Prohibition of Waterfowl Feeding Ordinance

(a) No person may feed waterfowl on public or private property within the (Township/City/Village), or place or permit to be placed on the ground, shoreline, waterbody, or any structure, food, food by-products, garbage, or animal food, which may reasonably be expected to intentionally result in waterfowl feeding, unless such items are screened or protected in a manner that prevents waterfowl from feeding on them.

(b) This prohibition shall not apply to:

(1) Veterinarians, municipal animal control officers, or state or federal game officials who while operating within the course and scope of their duties have waterfowl in custody or under their management;

(2) Persons authorized by the (Township/City/Village) to implement a Canada goose management program or any other waterfowl management programs approved by the (Township/City/Village) council;

(3) Any food place upon the property for purposes of trapping or otherwise taking geese or other waterfowl, where such trapping or taking is pursuant to a permit issued by the Michigan Department of Natural Resources.

(c) Penalty

(1) The first violation of this section shall result in a written warning from the (Township/City/Village);

(2) Subsequent violations shall be a municipal civil infraction, which, upon an admission or finding of responsibility, shall result in a fine of not less than fifty dollars ($50).

Appendix I: Stormwater Education and Outreach Resources

1. Grand Valley State University, Annis Water Resources Institute. Rein in the Runoff: Stormwater Education. URL: http://gvsu.edu/wri/director/index.cfm?id=4D8ED095-9CAD-958E-6D667C05AFE3E95B (accessed January 17, 2010).

2. Southeast Michigan Council of Governments (SEMCOG), Low Impact Development. Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers. URL: http://www.semcog.org/lowimpactdevelopmentreference.aspx (accessed January 18, 2010).

   Chapter 4: Integrating LID at the Community Level. URL: http://www.semcog.org/uploadedfiles/Programs_and_Projects/Water/Stormwater/LID/LID_Manual_chapter4.pdf (accessed January 18, 2010).

3. U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System (NPDES). National Menu of Stormwater Best Management Practices: Public Education and Outreach on Stormwater Impacts. URL: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=1 (accessed January 17, 2010).

4. Michigan Department of Transportation. Outreach Materials: Storm water education materials you can use. URL: http://www.michigan.gov/stormwatermgt/0,1607,7-205-30103---,00.html (accessed January 17, 2010).

5. Center for Watershed Protection. Resources: Residential Stewardship. URL: http://www.cwp.org/Resource_Library/Restoration_and_Watershed_Stewardship/residential.htm (accessed January 17, 2010).

6. University of Wisconsin, National Farm*A*Syst/Home*A*Syst Program. URL: http://www.uwex.edu/homeasyst/index.html (accessed January 17, 2010).

7. Mississippi Coastal Management and Planning Office. Stormwater Management Toolbox: Public Education BMPs. URL: http://www.dmr.state.ms.us/CMP/Storm/SECTION-2/Public-Education-BMPs.pdf (accessed January 17, 2010).

Appendix J: Stormwater Utility Ordinance Guidance

1. City of Marquette (MI) Stormwater Utility Ordinance
2. Guidance on Establishing Stormwater Utility Fees

City of Marquette (MI) Stormwater Utility Ordinance

This sample ordinance is general guidance to assist local communities interested in implementing a stormwater utility ordinance. This ordinance is NOT legal advice. Details of both substance and process in an ordinance will vary from community to community based on local conditions and institutional structures. Proposed ordinances should not be finalized without advice and involvement of legal counsel.

CHAPTER 57 - STORM WATER UTILITY

57.1 Definitions.

“Best Management Practices” or “BMP”. Combining of practices that form an effective, predictable means of preventing or reducing storm water pollution generated by dischargers into the system.

“Clean Water Act”. The Federal Water Pollution Control Act, 33 USC Sec. 1251 et. seq., as amended, and applicable regulations promulgated thereunder.

“Developed Parcel”. A parcel upon which man-made improvements have been made, such as buildings, roads, parking areas and lawns. Undeveloped areas include forested areas and property in its natural state, free of man-made improvements.

“Discharger”. Any individual, firm, partnership, association, public or private corporation or public agency or instrumentality or any other entity owning or in possession of a parcel of property which directly or indirectly impacts, influences or has an effect upon the system. For purposes of any judicial proceeding in connection with a violation of this Chapter, “Discharger” shall include any employee, officer, director, partner or other individual who was affiliated with such property owners or operator and was directly involved with, or responsible for, any act or omission which violated this Chapter.

“Equivalent Hydraulic Acre” or “EHA”. A measure of the amount of storm water runoff a parcel will produce from a precipitation event. A parcel’s EHA is based upon the amount of pervious and impervious areas within the parcel multiplied by the runoff factors applicable to each.

“Impervious Land Area”. The surface area within a parcel that is covered by any material which retards or prevents the entry of water into the soil. Impervious Land Area includes, but is not limited to, surface areas covered by buildings, porches, patios, parking lots, driveways, walkways and other structures. Generally, all non-vegetative land areas shall be considered impervious.

“On-Site Retention”. The withholding of all storm water from the system in an on-site area for a sufficient time to provide for it to dissipate by evaporation, infiltration into the soil, or other natural means in which no connection is made to the storm water system directly or indirectly.

“On-Site Detention”. Any facility employed to reduce to rate of storm water discharge from a property to the storm water system.

“Parcel”. A designated lot, tract or other area of land established by plat, subdivision, tax record description or as otherwise permitted or existing by law.

“Person”. An individual, firm, partnership, association, public or private corporation, or public agency or instrumentality or any other entity.

“Pervious Land Area”. All surface area within a parcel which is not Impervious Land Area.

“Pollutant”. Any substance defined as a pollutant under the Clean Water Act.

“Precipitation Event”. For purposes of this Ordinance, a precipitation event is any occurrence of atmospheric precipitation of water which can be characterized as a separate storm event. The terms rain, rainstorm, rainfall, snow, snowstorm, sleet, hailstorm, etc., shall be considered synonymous with the term precipitation event.

“Storm water”. The runoff and drainage of precipitation resulting from rainfall or snowmelt or similar precipitation event.

“Storm water System or Systems”. All rivers, streams, tributaries and lakes, including Lake Superior, within the City limits of the City of Marquette and all City owned storm sewers, culverts, retention and detention facilities, lift stations, curbs, gutters, and all other appurtenances now and thereafter existing, used or useful, in connection with the collection, control, transportation, treatment, or discharge of storm water. The storm water system does not include sewers or facilities connected with the sanitary sewage disposal system, or streets.

“User Charge”. A service fee imposed upon Dischargers into the system.

“Water Quality Factor”. A factor to adjust for the quality of storm water leaving the parcel.

57.2 Storm Water Service Charge.

Dischargers shall be charged for the administration, construction, operation, maintenance and replacement of the storm water system. The charge shall be based on the assigned or calculated equivalent hydraulic area as modified by any applicable water quality factor.

57.3 Flat Rate Charges.

The monthly charge per parcel for the following properties shall be:

Residential Developed, four living units or less on the following parcel size:

EFFECTIVE:	7/1/2005	7/1/2006	8/1/2006	7/1/2007
1/5 acres or less	$1.76	$1.87	$2.45	$ 2.58
Over 1/5 to 1 acre	$3.01	$3.19	$4.18	$ 4.39
Over 1 acre to 2 acres	$4.77	$5.06	$6.63	$ 6.97
Over 2 acres to 6 acres	$9.11	$9.68	$12.66	$13.30

Dischargers shall have the option to have their charges calculated pursuant to Section 57.4 of this ordinance if all or some of the parcel is serviced by a retention or detention facility designed by a licensed engineer in the State of Michigan and approved by the City Engineer.

57.4 Charges Based on Land Area.

1) Monthly Charges: The monthly charges for properties other than described in Section 57.3 shall be computed in the following manner:

EFFECTIVE:	7/1/2005	7/1/2006	8/1/ 2006	7/1/2007
Rate per EHA	$35.04	$37.23	$48.71	$51.15

multiplied by any applicable Water Quality Factor as determined by the City Engineer. The Water Quality Factor may be adjusted annually as additional supporting data becomes available. The minimum monthly charge shall be equal to the flat rate residential charge for a parcel of same acreage as defined in Section 57.3. except where charge is $0.00 due to use of approved retention area.

2) Calculation of EHAs: Individual EHAs are calculated by multiplying each parcel's pervious and impervious area by the following runoff factors:

(a) 0.15 for pervious area.

(b) 0.00 for impervious area discharging to an approved retention area. To receive credit under this section, the retention area shall be constructed and maintained pursuant to a permit approved by the City.

(c) 0.15 for impervious area discharging to an approved detention facility. To receive credit, the detention facility shall be approved pursuant to a permit issued by the City or a permanent dedication in a deed or plat.

(d) 0.00 for pervious area serviced by an approved retention area.

(e) 0.95 for impervious area.

Any detention basin permit issued pursuant to this section shall be supported by a certification of a professional engineer that runoff rates from the parcel for a 100 year, 24 hour duration storm event will not exceed a 10 year, 24 hour duration storm event for an equivalent undeveloped parcel. Any retention basin permit issued pursuant to this section shall be supported by a certification of a professional engineer that the basin volume is capable of holding the runoff from the parcel from a 100 year, 24 hour event.

57.5 Property Affected.

All dischargers shall be subject to the storm water service charge, regardless of whether privately or publicly owned property is involved, unless an exemption applies under 57.3 herein.

57.6 Billing.

The billing for storm water service shall be sent to the property owner or the owner's designee and may be: (1) combined with the billing for other utility services; (2) sent individually; or, (3) sent with property tax statements at the City's discretion. The basis for the billing shall be computed by the City Manager's designee.

57.7 Appeals.

Property owners may appeal to the City Commission the property classification or the computation of the service charge. Appeals of the decisions of the City Commission shall be by petition to a court of appropriate jurisdiction. Each storm water service bill sent out shall contain a telephone number that may be called for information regarding the appeal process. All due and delinquent storm water charges must be paid, or satisfactory arrangements for payment made with the City Commission, prior to the Commission's consideration of the appeal.

57.8 Payment.

All charges not paid on or before the established due date shall be considered delinquent and subject to the following:

(a) Interest charges.

(b) Rebilling charges.

(c) Property lien.

(d) Attorney fees, if a civil suit is filed to collect delinquent charges.

57.9 Collection.

Unpaid storm water service charges shall constitute a lien against the property affected from the date the charges were incurred. Charges which have remained unpaid for a period of three (3) months prior to April 1st of any year may, after notice to the owner, by resolution of the City Commission, be certified to the City Assessor who shall place the charge on the City Tax Roll. In the alternative, the City may file suit to collect unpaid charges.

57.10 Use of Funds.

All funds collected for storm water service shall be placed in an enterprise fund and used solely for the administration, construction, operation, maintenance and replacement of the storm water system. This storm water utility or enterprise fund shall be deemed to regulate and manage storm water quality and quantity in the City of Marquette.

57.11 Regulations.

The City Manager is authorized to promulgate regulations that require dischargers to implement pollution prevention measures, best management practices, and other methods to prevent or reduce the discharge of pollutants into, or by, storm waters. Regulations promulgated hereunder shall be effective ten (10) days after approval by the Marquette City Commission.

57.12 Severability.

If any portion of this Ordinance or the application thereof to any person or circumstances shall be found to be invalid, such invalidity shall not affect the remaining portions or applications of the ordinance which can be given effect without the invalid portion or application, provided such remaining portions are not determined to be inoperable, and to this end the ordinance is declared to be severable.

57.13 Penalty.

A person who violates any section of this chapter shall be responsible for a civil infraction. All sections in conflict herewith are repealed.

Guidance on Establishing Stormwater Utility Fees

Stormwater utility fees must be based on the costs associated with maintaining and improving the municipality's storm sewer system. Improvements could include installation of new BMPs or retrofits to existing BMPs. Costs associated with maintaining the system could include regular inspection and maintenance (including cleaning) of catch basins and other facilities and street sweeping.

To ensure equitability of the fee among users, stormwater fees should be assigned based on the amount of runoff generated from the site. The rational method is a commonly accepted method for determining peak stormwater flows for a given storm event. The calculation is based on total impervious acreage, which is the product of the watershed area (A) and a runoff coefficient (c). The portion of the total stormwater runoff generated by any given site will be directly proportional to the portion of impervious acreage for the site relative to the impervious acreage for the drainage area of the entire system.

The municipality will need to determine the total cost associated with treating stormwater within their community, and base utility fees on that amount. Adjustments to the fees (or quarterly usage fees) may be required as expenses are not likely to remain consistent with initial estimates. Additionally, the municipality should determine the total impervious acreage (A *c) served by the public system.

Utility fees for each site should be based on the following ratio:

$$\frac{(A \times c)_{site}}{(A \times c)_{total}}$$

Ideally, the municipality would determine the exact impervious acreage for each site using aerial photographs. The municipality could then identify a cost per impervious acre and assess each property a unique fee. Alternatively, a fee schedule may be generated that would assign a cost per acre for various ranges of percentage of imperviousness of a site. If identification of the exact imperviousness of each site is not feasible, the municipality could alternatively determine a "typical" imperviousness for various land uses, based on lot size. Generally, smaller properties have higher percentages of imperviousness than larger lots, and a fee per acre for a range of land use types and parcel sizes could be generated. A landowner will have the opportunity to appeal for a reduction in the fee if the actual imperviousness of the site is less than "typical." To be conservative, the "typical" value for imperviousness could be higher than what might be an average imperviousness.

Credits for LID-BMPs must be provided so that landowners can limit their use of the municipality's stormwater services. A good strategy for determining the value of these credits would be to identify what impact the BMP would have on the overall stormwater runoff within the community. This could be relative to the percent reduction in runoff from a "typical" site, or relative to the percent reduction in runoff for the entire system.

Appendix K: Population Allocation Model (PAM)

1. Potential Future Growth and Land Use Change
2. Figure K-1: Population Allocation Model (PAM) flow chart showing model components
3. Growth Potential Module
4. Table K-1: Population Allocation Model (PAM) Growth Potential Module Estimates for Spring Lake Watershed Population Over Time
5. Land Availability Module
6. Table K-2. PAM Population Density Calculations for the Spring Lake Watershed
7. Table K-3. PAM Land Availability Module Projected Growth and Development in the Spring Lake Watershed
8. Land Desirability Module
9. Table K-4. PAM Decision Support File for the Spring Lake Watershed
10. Figure K-2. PAM population growth and allocation map for the Spring Lake Watershed for 2010
11. Figure K-3. PAM population growth and allocation map for the Spring Lake Watershed for 2020
12. Figure K-4. PAM population growth and allocation map for the Spring Lake Watershed for 2030
13. Figure K-5. PAM population growth and allocation map for the Spring Lake Watershed for 2040

The Rein in the Runoff project team utilized the Population Allocation Model (PAM) (Koches et al. 2005) to help predict the patterns of future growth and development in the Spring Lake Watershed. PAM uses patterns of past development to predict the location of future urban and exurban growth. It was first created by researchers at the Annis Water Resources Institute (AWRI) to model expected landscape changes resulting from new residential development (Koches et al. 2005). This model is not intended to predict accurate placement of future home sites within a defined region, but it provides a way to test competing management scenarios and economic development strategies through the integration of environmental impact analysis. PAM is a planning aid for land use decision-makers; it is not a quantitative assessment tool.

POTENTIAL FUTURE GROWTH AND LAND USE CHANGE

The Population Allocation Model (PAM) was developed by AWRI as a distribution model intended to show the potential impacts associated with various land management scenarios, and to provide land use decision-makers with a relative comparison between competing solutions to common land use management choices. During its development, a Principal Component Analysis was used to help identify those factors which have the most influence on individuals making the selection of a future home site. However, these factors are limited to what can be measured spatially, using landscape features at an appropriate scale with the use of suitable spatial analysis tools, such as GIS (geographic information system). While a “great school district” or the relationship of family and friends may ultimately be the deciding factor in making the choice for the site for new home construction, these factors cannot be considered by PAM because they do not have a spatial component that is measurable on a map with GIS.

Weights assigned to each home site selection factor vary depending on the preferences of those involved. Pairwise comparison of all factors is employed to normalize the weighted scores for each factor, but results are still subjective. Therefore, AWRI employs a calibration technique to approximate the residential development that would occur for a past time period, and compares PAM results to the known land use changes for that same period. This provides a reasonable approximation of spatial patterns for a given, project-defined area.

After this calibration, factor weights are adjusted so that a similar spatial pattern is used to predict future growth and development. This is a subjective approach that limits the model outcomes by the type and number of factors used and the experience of the researchers making these weight adjustments. Given the similarity in landscape features for the undeveloped areas of West Michigan, it is difficult to distinguish between parcels using the limited types and number of factors currently employed by PAM, and model accuracy is considerably improved when using proximity analysis instead of point-by-point relationships. Whatever error lies inherent in the model would be consistently observed regardless of the management scenario being tested. PAM can approximate the general character of a known landscape without the highly precise identification of future individual building sites. This is considered sufficient for most

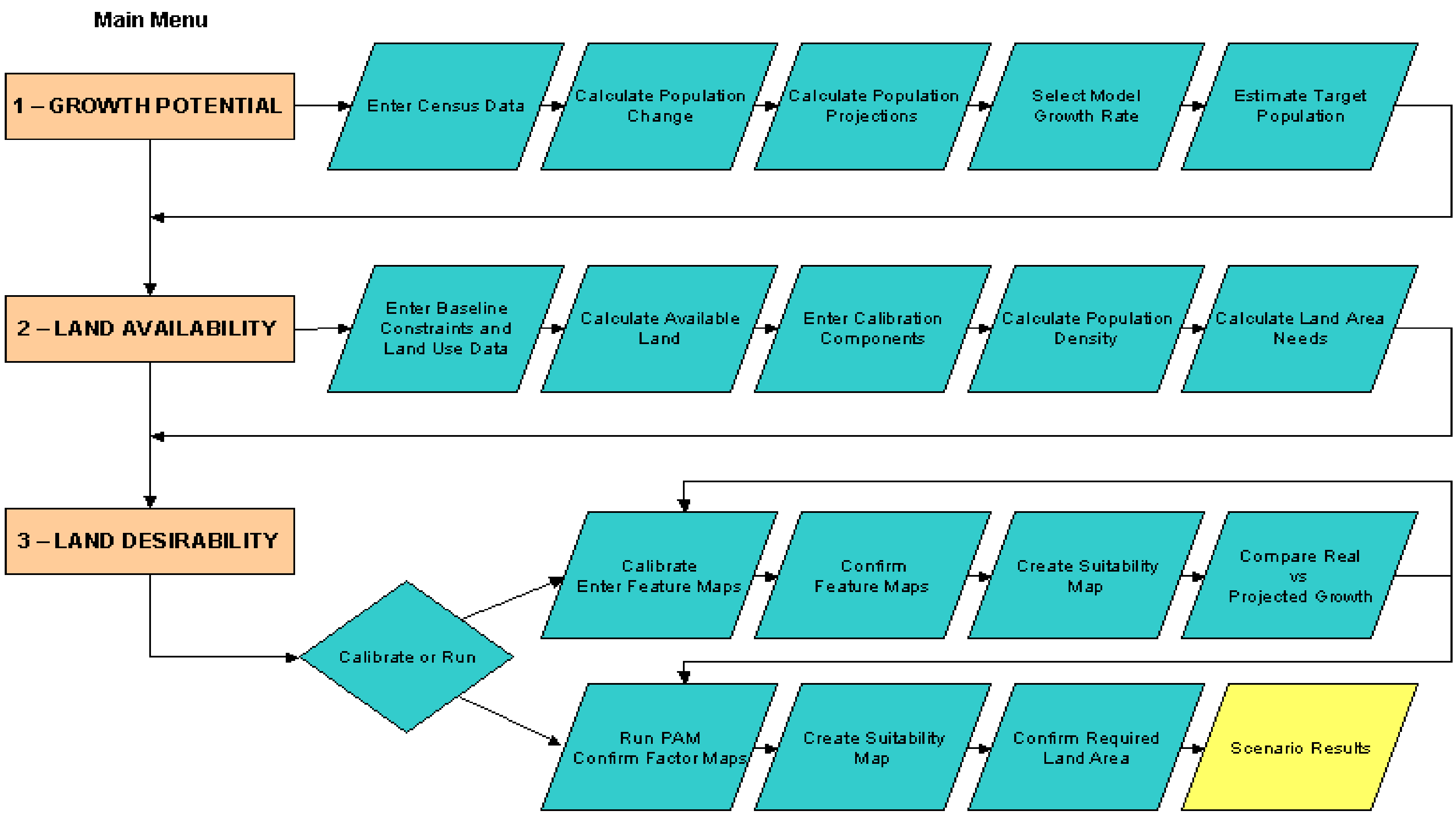

Figure K-1. Population Allocation Model (PAM) flow chart showing model components.

general land management assessments, including, for example, stormwater management assessments where impacts resulting from new residential development are dependent on soils, proximity to lakes and streams, topography, etc., and not on the exact location of a particular new home relative to its placement along a residential street.

PAM analysis has been tested in several communities in West Michigan for comparison of competing land use management scenarios. It has been paired with hydrologic models, impervious surface models, and nonpoint source pollution models to characterize the expected impacts of future residential growth and development on nearby lakes and streams. It was designed as a local land use management tool, and has never been submitted for academic peer review.

For the Rein in the Runoff project, PAM was used only to explore different scenarios of population growth and land use change, and not as a predictive model. The following sections will provide a description of the Rein in the Runoff project team's methodology and results for each of PAM's primary model components: Growth Potential Module, Land Availability Module, and Land Desirability Module (Figure K-1).

GROWTH POTENTIAL MODULE

The Growth Potential Module uses population data, most often from the U.S. Census Bureau, to calculate the population dynamics of the study area. The user enters population totals from previous years into PAM, and is then presented with summary statistics intended to describe the actual population change that has occurred within the community. This includes the amount of population growth that occurred during each 10-year census period and the total amount of change that occurred for the cumulative time period identified (whatever that may be). The location of the population is determined by the distribution of existing residential land use; PAM distributes the target population throughout the defined landscape using a variety of techniques based on known or estimated people-per-acre ratios or on a set rate of population growth. The Growth Potential Module allows the user to incorporate an exaggerated growth rate to demonstrate unsustainable growth, or even a rate less than estimated by the U.S. Census Bureau (e.g., loss of a major employer), as long as the net change over time is positive.[1] The end result is a population target for upcoming years (e.g., 2010, 2020, 2030, and 2040) using a growth rate calculated from past U.S. census data or an independently-derived estimate.

However, since PAM was originally designed for use in areas with distinct boundaries such as villages, cities, and townships, the Rein in the Runoff project was its first application at the watershed-scale. This posed a unique set of issues for calculating the population of a land area for which population data were not easily determined. The primary data used for PAM were from the U.S. Census Bureau's Decennial Census,

[1] PAM analysis cannot be performed for areas that have experienced losses in population.

which is collected and reported for different geographic units (e.g., state, county, township, city, village, or zip code), but not at the watershed level. Because of this, the Rein in the Runoff project team had to develop a method for estimating the population for the entire Spring Lake Watershed.

For each of the municipalities that make up the Spring Lake Watershed, the project team had to determine the population of each municipality that resides within the watershed boundary. To do this, team members took the percentage of land area within the watershed for each municipal unit and multiplied it by the U.S. Census population data for 1960, 1970, 1980, 1990, and 2000. This assumed that the population was evenly distributed throughout the municipal unit, but provided a reasonable estimate for the watershed's population.

However, three watershed municipalities – Fruitport Township, Ravenna Township, and Spring Lake Township – required additional calculations. Each of these municipalities contains another municipal unit (village) completely within its borders. To adjust for this, the area of each village was subtracted from the township area prior to the population calculation. In Fruitport Township, the Village of Fruitport is completely within the Spring Lake Watershed, so its population was added back into the watershed total. In Ravenna Township, the Village of Ravenna is completely outside of the watershed and was accordingly excluded. Spring Lake Township includes the Village of Spring Lake within its borders, but approximately 70% of the Village is outside of the Spring Lake Watershed. Once the township's population was calculated, the Village population within the watershed (29.4%) was also calculated and added back into the total for the entire watershed.

It should be noted that distribution and growth rates of a population are variables that are intended to be manipulated: PAM was created to examine different future scenarios based on a variety of population growth estimates and development trends. All that the model requires is the mean number of people living on each acre of current residential land use, and how many people are expected to live in any locality in the future. PAM uses this people-per-acre ratio to determine how much land will be necessary to accommodate the expected growth, and then determines where within the landscape these new home sites are located, given past development patterns.

Table K-1. Population Allocation Model (PAM) Growth Potential Module Estimates for Spring Lake Watershed Population Over Time.

Year	Estimated Population	Population Change	Percent Change
1960	11,134		
1970	13,894	+2,760	24.79%
1980	15,363	+1,469	10.57%
1990	16,700	+1,337	8.70%
2000	18,979	+,2,279	13.65%
1960-2000		+7,845	70.46%

The estimated 2000 population for the Spring Lake Watershed is 18,979 (Table K-1)[2], which represents an increase in watershed population of nearly 14% since 1990 – and more than 70% since 1960.

LAND AVAILABILITY MODULE

The Land Availability Module uses population and land use statistics from the past and present to calculate former and existing population densities so that users can determine if there is sufficient land to accommodate projected growth. To run the module, users must first identify any land use type or other area that is unavailable for new development. For example, land that is already developed, or land uses or areas identified for preservation (e.g., wetlands or riparian setbacks), are not available for new development. These "constraints" are entered into PAM as Boolean GIS map layers that instruct the model where growth is not allowed to occur. PAM compares these excluded areas to a map of existing land uses, and identifies where, what kind, and how much available land exists for new development.

The Rein in the Runoff project team initially considered the use of local community Master Plans to develop constraint maps for use with PAM. However, because of the variability among the Spring Lake Watershed municipalities in their land use classifications, exceptions, enforcement, relevance, and even the existence of such plans, the team felt that their use would not be a good indicator of land availability for the entire watershed. In general, the most important reason for including a Master Plan as a constraint overlay is to ensure that PAM does not identify industrial or commercial areas as locations for future home sites. Preliminary model runs for the Spring Lake Watershed indicated that such conflicts were rare and did not justify the added effort and expense to include the Master Plan overlays.

Accordingly, the project team developed a residential constraint map and a general constraint map identifying roads, waterways, wetlands, and parkland for use with this module. Applying these data, along with current (2006) land use and cover data, PAM calculated total acres available for new development; total acres currently classified as residential; current (2000) census population; an estimated study population at the time of the most recent land use and land cover survey; and an estimated population for the baseline land use and land cover survey. To determine how much land in the Spring Lake Watershed was actually available for development and growth, PAM then used a model-calculated or researcher-defined population density (people/acre), to be used to allocate future population projections (Table K-2).

[2] The estimated population for the Spring Lake Watershed listed in Table K-1 was calculated from U.S. Census Bureau tract-level data. This differs from the watershed population estimate listed in Figure 2-5 (Chapter 2), which was calculated utilizing U.S. Census Bureau block-level data.

Table K-2. PAM Population Density Calculations for the Spring Lake Watershed.

Population Density Factors	**Model Results**
Total watershed acres available for new development	19,219
Total watershed acres currently classified as residential (2006 land use and cover)	9,433
Watershed population (2000 U.S. Census)	18,979
Estimated watershed population based on 2006 land use and land cover	20,346
Estimated watershed population at baseline (1978) land use and land cover	15,069
PAM Estimate for Current Population Density for the Spring Lake Watershed	**2.16 persons/acre**

Finally, the Land Availability Module took the projected future population for the Spring Lake Watershed and determined the amount of land (acres) required to support it. The Rein in the Runoff project team utilized three different population growth scenarios to determine where and how much land was available for development in the Spring Lake Watershed for the years 2010, 2020, 2030, and 2040. Scenario 1 utilized actual population growth over time (1.76%) within the Spring Lake Watershed (U.S. Census Bureau 2009); Scenario 2 assumed that the population in the watershed remained stable (0.00%); and Scenario 3 assumed a slightly accelerated population growth rate (2.00%). In each of these scenarios, the population density was held constant at 2.16 people/acre (Table K-3).

Table K-3. PAM Land Availability Module Projected Growth and Development in the Spring Lake Watershed.

Year	**Expected Population Increase**			**Land Area Required to Accommodate New Development (acres)**		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
2010	3,343	0	3,796	1,547.69	0	1,757.41
2020	3,932	0	4,555	1,820.37	0	2,108.80
2030	4,625	0	5,466	2,141.20	0	2,530.56
2040	5,439	0	6,559	2,518.06	0	3,036.57
Total	**17,339**	**0**	**20,376**	**8,037.21**	**0**	**9,433.33**

LAND DESIRABILITY MODULE

The Land Desirability Module examines former land use trends in an attempt to understand what factors in the past landscape influenced decisions to build new homes, in order to forecast where people are likely to live in the future within the given landscape. The module employs six factors: (1) distance to water features, such as lakes and streams; (2) distance to roads; (3) the location of existing residential development; (4) distance to forest lands; (5) septic system suitability; and (6) slope. These factors can be weighted by stakeholder input, or with a decision support system such as analytical hierarchy process (Saaty 1990), which is available within IDRISI, the GIS software used as the spatial platform for PAM analysis (IDRISI Andes, Clark Labs at Clark University (idrisi@clark.edu). After calibration of PAM using these assigned weights, the module is then ready for scenario analysis of what the community will look like into the future. The default module settings will provide an approximation of the status quo, but users can also modify the constraint map in the Land Availability Module to incorporate new zoning restrictions, or apply a new weighting curve to the water proximity factor if, for example, stream corridor setback widths are increased. What is important is not that PAM captures the exact location of an existing home site, but rather the actual “pattern of development” that occurred.

The Rein in the Runoff project team first calibrated PAM using the default weights generated by the analytical hierarchy process within the model. The decision support file (Table K-4) was constructed to satisfy the IDRISI format necessary to process the subsequent macro. The first number in the array, and in this case “0”, indicated that no constraint map was used. The second number told IDRISI that there were 6 factor maps. What remained in the array were the file names for each factor listed above (water, roads, residential development, forests, septic system suitability, and slope) followed by its associated weight. These weights, which add up to 1.0, provide the user with information regarding the relative importance of each factor in the underlying analysis. For example, the road factor is given the greatest weight in the calibration model, and in fact is weighted 10 times higher than septic system suitability, the least weighted factor.

Table K-4. PAM Decision Support File for the Spring Lake Watershed.

0
6
Waterfactst
0.1936
Roadfactst
0.3519
Resfactst
0.2672
Forestfactst
0.1112
Septicfactst
0.0323
Slopefactst
0.0438

Calibrating the model based on past land use and cover gives an indication of PAM model accuracy, as well as information regarding community development patterns. The project team used 1978 land use and land cover data for the Spring Lake Watershed to generate PAM factor maps for hydrology, roads, historic forest lands, slope, septic system suitability, historic residential lands, and historic residential growth (increases in residential land cover from 1978 and 2000). PAM then integrated these underlying factor maps to predict the best places to build within the watershed based on the model-defined weighting system and the population density calculated in the Land Availability Module. These were compared to actual residential development in the Spring Lake Watershed from 1978 to 1998.

The Land Desirability Module calibration indicated that PAM correctly predicted future development for the Spring Lake Watershed for 16.7% of the pixels (1 pixel = 1 acre) that make up the spatial data for the watershed. Compared to previous model runs on other study areas in West Michigan, this was a very good result. PAM depends on only a limited number of factors to rank parcels for selection of potential future residential development. Because the model uses GIS technology as the basis for its predictions, it relies on factors which can be described in a spatial context, such as distance to roads, distance to current residential development, and the location of suitable soils for installation of septic systems. There are, of course, many other factors potential homeowners use in the selection of a new home site that are not easily spatially-defined: quality of schools, availability of building contractors, real estate price, character of existing housing/neighborhoods, and the influence of friends and family. The calibration confirmed that the pattern of development within the Spring Lake Watershed conformed to research expectations as to where future development would have occurred. So, despite the limitations of the model, PAM provided valuable information for stakeholders about how their decisions regarding future growth affect the "build-out" of their community.

After calibration, the second component of the Land Desirability Module was implemented. PAM predicted the distribution of future residential land use throughout the watershed. New factor maps were created for forested and residential areas using current land use and cover data (2006), and PAM generated the expected population growth and the amount of land required for this growth to occur into the future (2010, 2020, 2030, and 2040). The spatial allocations for this projected growth are also mapped by PAM for each future timeframe: 2010 (Figure K-2), 2020 (Figure K-3), 2030 (Figure K-4), and 2040 (Figure K-5). These maps show where the projected, growing population for each time period is expected to develop within the Spring Lake Watershed.

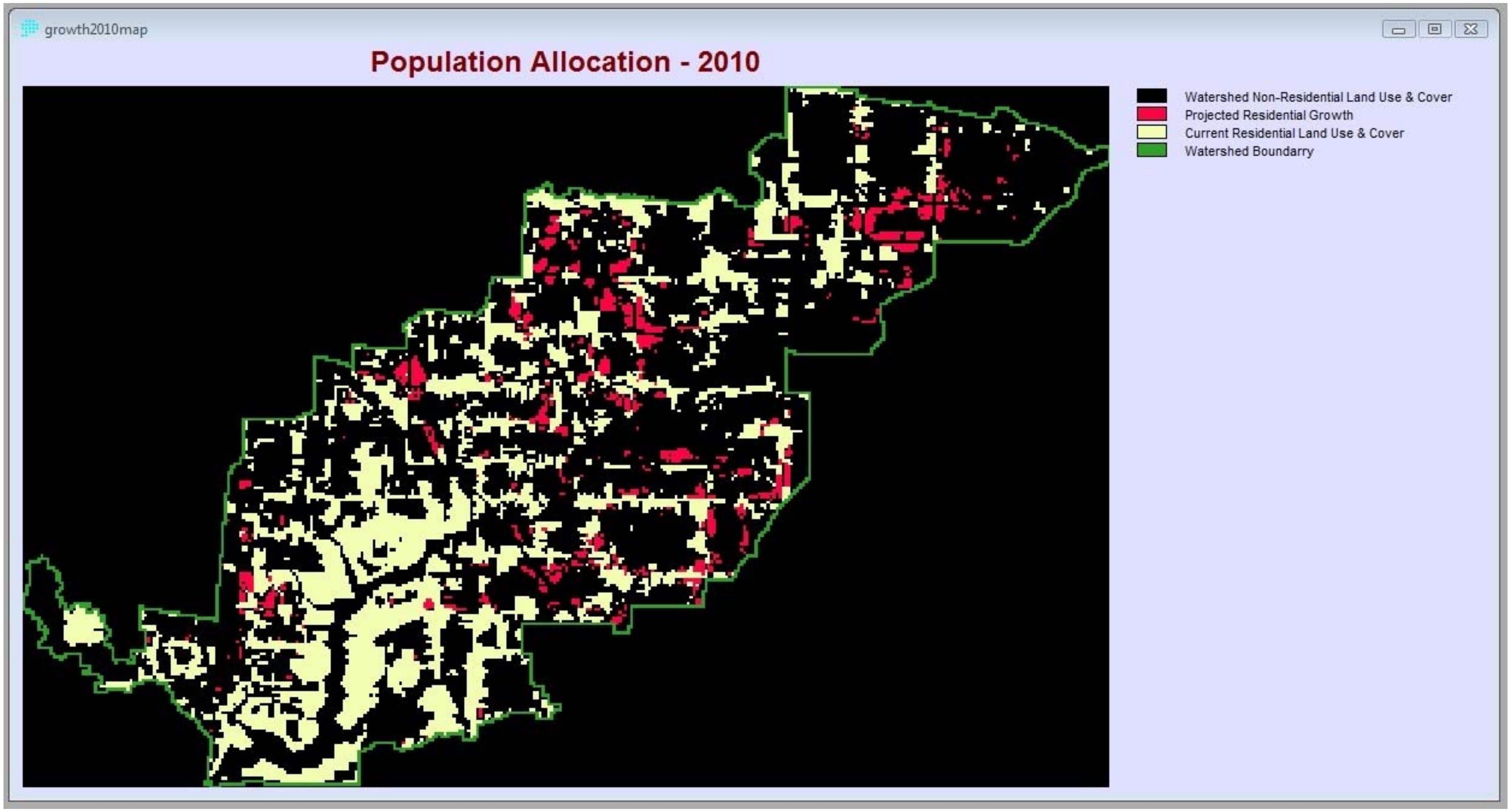

Figure K-2. PAM population growth and allocation map for the Spring Lake Watershed for 2010.

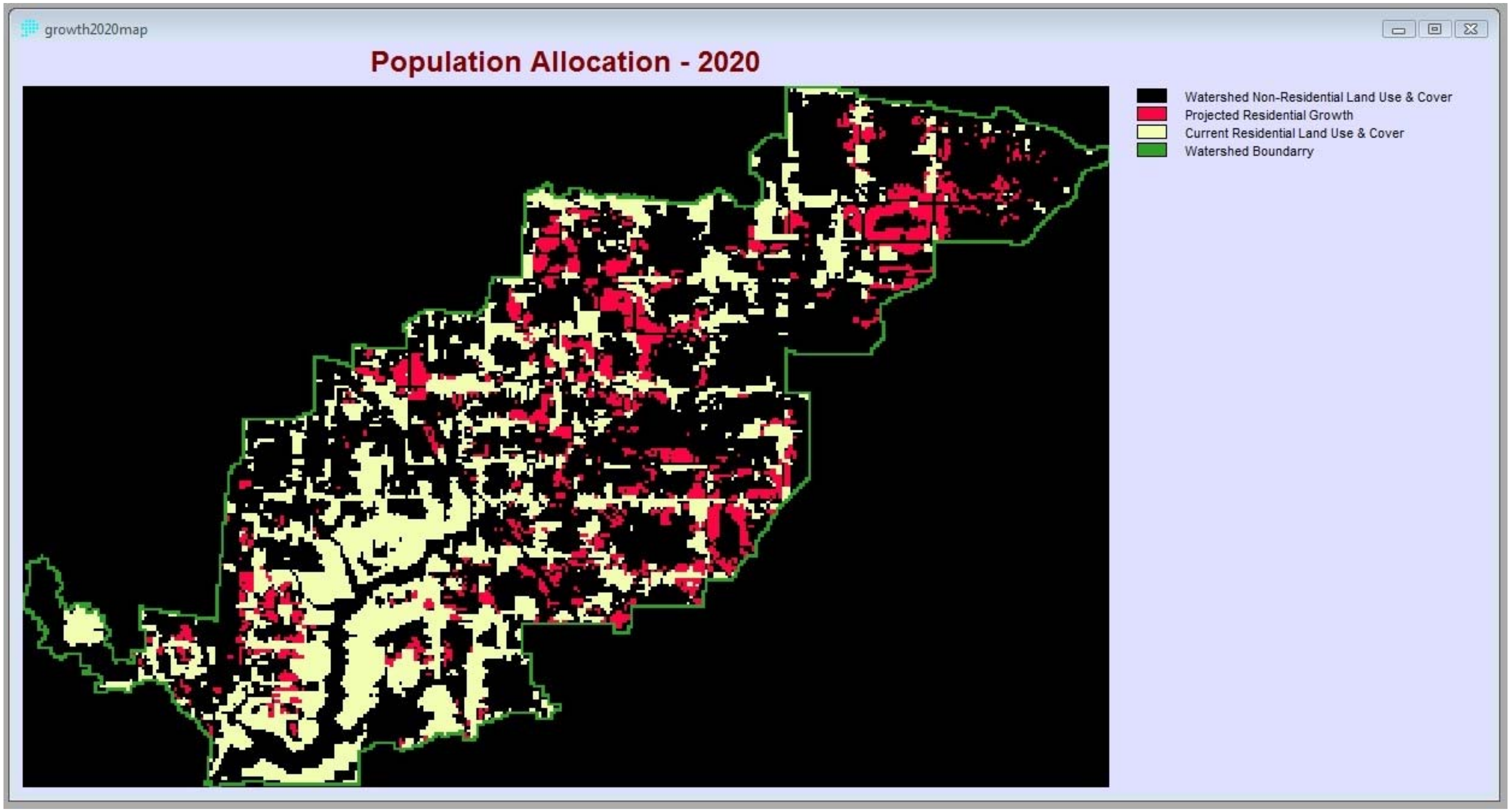

Figure K-3. PAM population growth and allocation map for the Spring Lake Watershed for 2020.

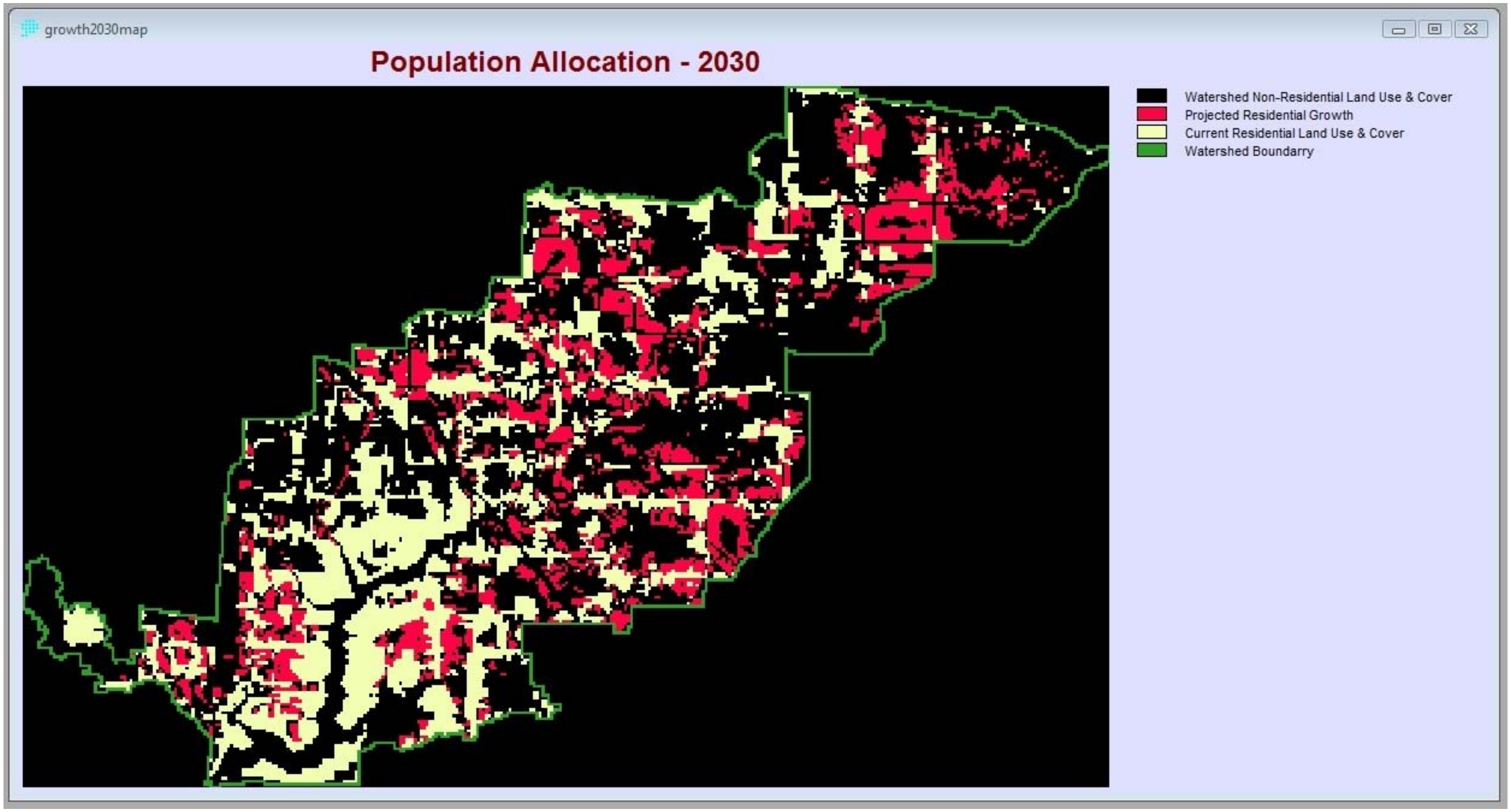

Figure K-4. PAM population growth and allocation map for the Spring Lake Watershed for 2030.

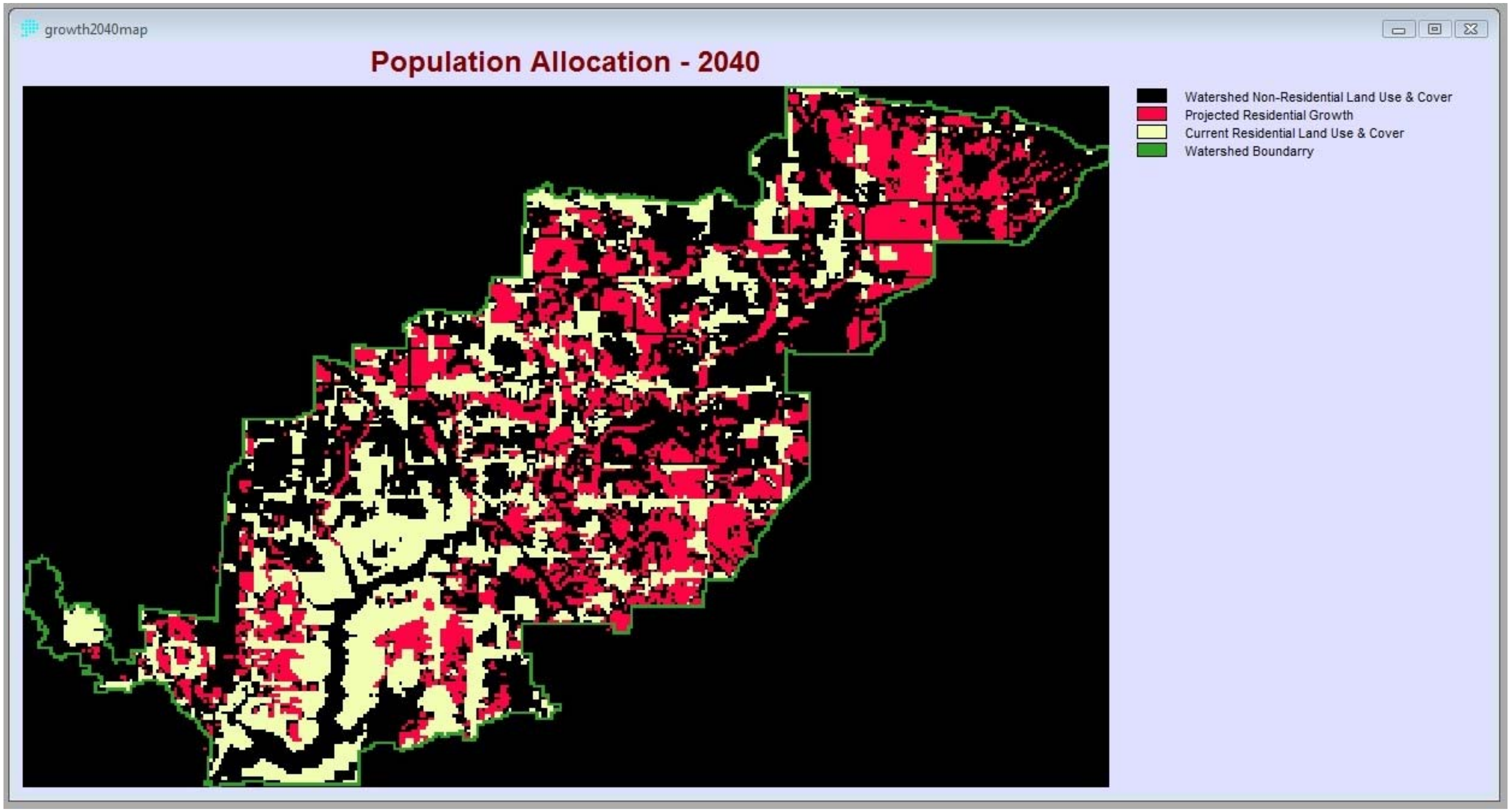

Figure K-5. PAM population growth and allocation map for the Spring Lake Watershed for 2040.

Appendix L: Rein in the Runoff Spring Lake Watershed Atlas

1. Digital copy (CD-Rom or DVD) of the Rein in the Runoff Spring Lake Watershed Atlas.

Appendix M: Rein in the Runoff Scientific and Policy Publications and Presentations

1. Isely, E.S. and A.D. Steinman 2008. Rein in the Runoff: Storm Water Management In Spring Lake. Grand Valley State University, R.B. Annis Water Resources Institute, Water Resources Review 21(1): 1.

2. Isely, E.S. and A.D. Steinman. Alternative Stormwater Management Practices in Spring Lake (MI). Rein in the Runoff: An Integrated Assessment. Poster session by E.S. Isely at the International Low Impact Development Conference, Seattle, WA (11/17 – 19/08).

3. Isely, E.S. and A.D. Steinman. Alternative Stormwater Management Practices in Spring Lake (MI). Rein in the Runoff: An Integrated Assessment. Poster session by E.S. Isely at the North American Benthological Society Annual Meeting, Grand Rapids, MI (5/18 – 21/09).

4. Isely, E.S. and A. Steinman 2009. Spring Lake Area Residents Are Learning How To “Rein in the Runoff”. Michigan Water Environment Association, MWEA Matters 5(2): 34-35.