CHAPTER 5
STORM WATER QUALITY ANALYSIS

INTRODUCTION

As outlined in Chapter 2, urbanization increases the amount of pollution in surface water runoff and thus a major goal of the storm water management plan is to reduce the input of storm water pollutants into the many lakes and waterways within the Town boundaries. The first step in developing a management strategy for storm water pollutants is to identify their sources on the landscape.

Studies have concluded that mapping of the urban land covers and using developed land surface pollutant relationships can identify pollutant sources. Monitoring has shown problem pollutants in urban surface water runoff to include sediment, nutrients, chlorides, bacteria, oil and grease, heavy metals, pesticides, and volatile organic compounds. Agricultural and rural land uses also contribute to surface water pollution by means of soil erosion, nutrients from manure and croplands, and other nonpoint source pollutants that enter waterways.

The study of agricultural land covers, however, is not as developed as urban land covers and current monitoring and modeling techniques do not provide as reliable a pollutant loading summary as is available in urbanized areas of the Town. Other non-modeling best management practices are encouraged for agricultural lands and are explored further later in this chapter. Water quality modeling was completed with the urbanized area of the Town for the purposes of this study and in conjunction with the Town’s MS4 General Permit requirements.

ANALYSIS METHODOLOGY

As stated in this permit, the Town is required to achieve a 20% reduction in the annual average mass of Total Suspended Solids (TSS) as compared to no storm water management controls, by March 10, 2008 within the urbanized area. The TSS reduction requirement increases to 40% by March 10, 2013.

The Town is identified as part of the Round Lake Beach, Illinois Urbanized Areas by the Environmental Protection Agency (EPA). An urbanized area is defined by the EPA as a land area comprising one or more places and the adjacent densely settled surrounding area that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile. Other communities in this urbanized area include the Town of Bristol, the Village of Paddock Lake, the Town of Randall, the Village of Silver Lake, and the Village of Twin Lakes. Figure 5-1 shows the Urbanized Areas within the Town of Salem.

The Source Loading and Management Model© (WinSLAMM) V9.3.1 was used to identify the sources of storm water pollutants being exported from the study area. There are some areas that were not included in the WinSLAMM model because they were considered to be optional or prohibited from inclusion based on guidelines released by the Wisconsin Department of Natural Resources (WDNR) in June of 2005 for the modeling required by the Town’s MS4 Permit submitted in 2008. Specifically, the following areas were removed from the Town-wide WinSLAMM analysis:

- State of Wisconsin owned lands
- Kenosha County owned lands
- Agricultural lands
- Industrial WPDES permitted lands
FIGURE 5-1
TOWN OF SALEM
URBANIZED AREAS AND PLANNED DEVELOPMENTS

Legend

♀ 2000 Urbanized Area
• Property draining directly to waters of the state
• Railroad areas

There are approximately 8,560 acres of Urbanized Area within the Town of Salem. However, once the above-mentioned properties were removed, only 3,566 acres of urbanized area remained in the Town-wide pollutant loading calculations (See Figure 5-2).

WINSLAMM Model

The WinSLAMM model breaks the analysis into three components. First, the model generates a runoff volume and pollutant loading from a particular land surface, such as a roof, street, or parking lot. The model then routes the water into the drainage control component. In this component, any treatment of the water in the drainage system is calculated. Examples of the treatment in a drainage system are the infiltration and filtering that takes place in a grass waterway. The third component of the modeling is the outlet controls. Examples of outlet controls include wet detention ponds, infiltration basins, and biofiltration devices.

Pollutant Loadings

The pollutant loading calculations in WinSLAMM are based on the land use types and source areas for each subbasin. As identified in Chapter 3, land use in the study area is a mixture of residential, commercial, industrial, institutional, roadway, and open space. Source areas in WinSLAMM consist of rooftop, paved/unpaved parking, driveway, sidewalks, roadways and landscaped areas.

Pollutant loadings were generated for each subbasin using the drainage basin data for a No Controls scenario and the Existing Controls scenario. The No Controls scenario assumes pollutant loading based solely on land type without considering any treatment devices. The Existing Controls scenario factors in the removal capabilities of all existing treatment devices within the system. The analysis also assumed that the pollutant contribution from any natural water features such as lakes, rivers and wetland areas were negligible.

Water Quality Treatment Devices

The following section discusses some common water quality treatment techniques and highlights which ones were used in the Town’s analysis pollutant loading analysis.

Wet Detention Pond Treatment

Wet detention ponds are impoundments that have a permanent pool of water and also have the capacity to temporarily store excess storm water runoff and release it in a slow and safe manner. They are also effective at removing sediment related pollutants. Pollutants removed by wet detention ponds include sediment, nutrients, heavy metals, oxygen demanding compounds (BOD), hydrocarbons, and bacteria.

According to the WDNR Technical Standard 1001, pollutant reduction for both TSS and Phosphorus is a function of the wet pond depth, the outlet structure, the active storage volume, and the permanent pool surface area. The minimum wet pool depth required in this standard is three feet, excluding the safety shelf and sediment storage depth. The principal water quality outlet should be designed to control the 2-year 24-hour discharge without use of the emergency spillway or other outlet structures. The active storage volume is required to be designed in conformance with the method outlined in Natural Resources Conservation Service (NRCS) Technical Release 55 (TR-55) and outlined in Appendix B of WDNR Technical Standard 1001. The permanent pool surface area is based on the particle size and the peak
FIGURE 5-2
TOWN OF SALEM
AREAS INCLUDED IN WINSLAMM ANALYSIS

Legend

- 303(d) Impaired Water
- Publicly Owned BMPs
- Major Watershed Boundary
- Water of the State - Waterways
- Water of the State - Open Waters
- Non-Town Owned Lands
- Town of Salem Municipal Boundary
- Urbanized Area

Removed Areas within Salem’s Urbanized Area

- State Owned Lands
- County Owned Lands
- Agricultural Lands
- WPDES Permitted Lands
- Directly Draining Lands
- Railroad Owned Lands
- Wetlands

DRAFT

September 2009
outflow during the 1-year, 24-hour design storm. In general, the minimum surface area of the permanent pool must address the total drainage area to the pond as a percentage of land use as shown in Table 5-1.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Percent of Drainage Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeways</td>
<td>2.8%</td>
</tr>
<tr>
<td>Industrial</td>
<td>2.4%</td>
</tr>
<tr>
<td>Commercial</td>
<td>2.1%</td>
</tr>
<tr>
<td>Institutional</td>
<td>1.8%</td>
</tr>
<tr>
<td>Residential (low, medium, high)</td>
<td>0.7%, 0.8%, 1.0%</td>
</tr>
<tr>
<td>Open Space</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

There are two wet ponds within the Town that are publicly owned and meet the above requirements, and thus, were included in the model to account for their water quality benefits. These ponds were constructed many years ago to help protect water quality in Camp Lake. They are located in subbasins TC-3 and TC-5, as shown in Figure 5-3.

It should be noted that dry detention basins are also a common storm water management practice. However, dry detention basins are solely designed to provide water quantity relief and provide very minimal water quality treatment. This is due to the fact that solids deposited in these basins during a rainfall event will be scoured and resuspended with each new storm. Therefore, the solids are not actually being captured and are instead allowed to eventually flow downstream. Dry detention basins can typically be converted to a wet detention basin to provide water quality treatment. However, the Town of Salem does not own any dry detention basins, and therefore this was not evaluated in the water quality element of this study.

**Street Sweeping**

Street sweeping involves the removal of dust, debris, and trash from parking lots and street surfaces. The effectiveness of street sweeping is a function of the type of equipment, effectiveness of the operator, presence or absence of parked cars along the curb, time of the year, traffic volumes, and frequency of sweeping.

The majority of the Town’s roadways have a rural cross section that includes gravel shoulders and drainage ditches, which limit the effectiveness of this practice. The Town does not perform street sweeping on these roadways; therefore, the WinSLAMM modeling in this report does not include this practice.

The number of curbed streets within the developing subdivisions of the Town continues to increase over time, and so the Town recently decided to purchase a used mechanical broom street sweeper to start addressing this issue. This practice will be added to the model in the future for compliance with the 40% TSS removal goal set in the Town’s MS4 General Permit by March 10, 2013.
Drainage System Pollutant Reductions

The type of drainage system can affect the amount of pollutants exported from a subbasin. In areas with grass drainage systems, pollutants are removed through the processes of infiltration and filtering by the vegetation. Curb and gutter drainage receives very little if any pollutant removal.

As mentioned previously, the majority of the Town’s roadway system has a rural cross section, and therefore has grass ditch drainage systems. The remaining streets (approximately 14 curbed streets within the developed subdivisions) were modeled with storm sewer drainage systems in good condition.

ANALYSIS RESULTS

A summary of the Town’s pollutant loading analysis is shown in Table 5-2. This table displays the annual Phosphorus and TSS pollutant loadings for the Town during the No Controls and Existing Controls scenarios.

| Table 5-2 | Town of Salem Pollutant Loading Analysis Summary of Annual Phosphorus and TSS Reductions |
|------------|---------------------------------|---------------------------------|
|            | No Controls (lbs/yr) | Existing Controls (lbs/yr) | Percent Reduction (%) |
| Phosphorus | 1,603               | 1,281               | 20%                  |
| Total Suspended Solids (TSS) | 593,485       | 457,476             | 23%                  |

The Town’s total No Controls phosphorus pollutant loading is 1,603 lbs/year, and the Existing Controls phosphorus pollutant loading is 1,281 lbs/year. This represents a reduction of 322 lbs/year, which equates to a total Phosphorus pollutant loading reduction of 20%. The Town’s total No Controls TSS pollutant loading is 593,485 lbs/year, and the Existing Controls TSS pollutant loading is 457,476 lbs/year. This represents a reduction of 136,009 lbs/year, which equates to a total TSS pollutant loading reduction of 23%.

Therefore, the Town exceeded the 2008 compliance goal of 20% TSS removal. The complete loading results for runoff volume, phosphorus and total suspended solids for both the No Controls and Existing Controls scenarios are summarized by subbasin in Appendix F.

As shown in the modeling results, the 40% TSS reduction requirement has not been met with the Town’s existing storm water management practices and, therefore, further analysis will be required over the next few years to determine how the Town will reach this permit requirement by March 10, 2013. Due to uncertainty with the current NR151 regulations and scheduled updates to the WinSLAMM model expected to be completed by January 2010, further analysis was not completed as part of this plan.
ADDITIONAL STORM WATER BEST MANAGEMENT PRACTICES FOR CONSIDERATION

Additional storm water management practices will need to be considered for future projects within the Town to meet the 40% TSS reduction goal. This section briefly describes some additional storm water Best Management Practices (BMPs) that could be considered by the Town.

Infiltration Basin

An infiltration basin is defined as a basin created either by excavation or an embankment, with a flat, densely vegetated floor dedicated to the infiltration of runoff through the ground surface. The purpose of these basins is to reduce storm water peak runoff flows and volumes, reduce pollutants through filtration, increase recharge of groundwater, and preserve base flow in streams.

Bioretention Devices

A bioretention device is an infiltration device consisting of excavated area that is back-filled with an engineered soil mix, covered with a mulch layer and planted with a diversity of woody and herbaceous vegetation. Storm water directed to the device percolates through the mulch and engineered soil, where it is treated by a variety of physical, chemical and biological processes before infiltrating into the native soil.

Porous Pavement

This practice includes porous asphalt, concrete, paving stones or bricks. All of these pervious materials allow precipitation to percolate through areas that would traditionally be impervious and the storm water infiltrates through to the soil below. The infiltration capacity of the native soil is a key design consideration for determining the depth of base rock for storm water storage and determining whether an under drain system is needed. These pervious surfaces allow groundwater recharge, while capturing the pollutants.

Rain Gardens

A rain garden is a planted depression that is designed to allow rainwater runoff to be absorbed from impervious urban areas like roofs, driveways, walkways, and compacted lawn areas. This reduces runoff by allowing storm water to soak into the ground rather than running to a storm drain. Compared to a conventional patch of lawn, a rain garden allows about 30% more water to soak into the ground. Benefits include a decrease in runoff peak rates and volume, an increase in groundwater recharge, and a decrease in urban storm water pollutants. This practice is commonly applied by individual private property owners and allows residents the ability to assist in the water quality and quantity issues within the Town while giving them a sense of ownership and responsibility.

Rain Barrels

A rain barrel is a water tank which is used to collect and store rain water runoff, typically from rooftops via rain gutters. Rain barrels are installed to capture rain water for later use. Stored water may be used for watering gardens, agriculture, flushing toilets, in washing machines, and washing cars. Like rain gardens, this practice is commonly applied by individual private property owners and allows residents the ability to assist in the water quality and quantity issues within the Town while giving them a sense of ownership and responsibility.
Restored Wetlands

Wetland restoration is the re-establishment of a previously drained wetland by excavation, diking or removing and breaking drain tile. Benefits of wetland restoration include the improvement of water quality and wildlife habitat for native birds, and hundreds of plant and amphibian species. A wetland will temporarily hold runoff, which reduces flooding downstream and filters out pollutants before the water infiltrates and recharges groundwater.

AGRICULTURAL PRACTICES

The management of the runoff from agricultural lands throughout the Town is also a concern with respect to protecting and improving water quality. The WDNR and the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) have developed rules, performance standards, and conservation practices to address agricultural lands and activities.

NR 151, Subchapter II, provides performance standards and prohibitions that are intended to protect water quality by minimizing the amount of soil erosion, nutrients from manure and croplands, and other nonpoint source pollutants that enter waterways. ATCP 50 is the DATCP’s companion rule to the WDNR’s runoff rules. The rule implements the state’s soil and water resource management program. ATCP 50 provides tools to help meet the NR 151 standards by establishing nutrient management plans, DATCP approval of County land and water resource management plan, and allocation of DATCP funds for county implementation of said plans.

Implementation and enforcement of the agricultural performance standards and prohibitions are intended to be carried out according to a strategy that will be developed by the WDNR, the local governments, DATCP, and other state agencies. Currently compliance with the performance standards and prohibitions is not mandatory for existing agricultural facilities, unless a cost sharing agreement is executed. County land conservation departments will play a key role in helping landowners meet these requirements.

The Town of Salem is encouraged to work with these agencies to promote better conservation practices and seek opportunities to work with landowners on projects. Some of the techniques are described below.

Manure and Nutrient Management

Using manure to fertilize crops is a cost-effective way to save money on commercial fertilizer, and can be an environmentally responsible means of manure management. However, while manure is a good fertilizer on land, it can have undesirable effects when it enters nearby streams and lakes. Pathogens in manure can make water unsafe to drink or use for recreation. The nitrogen and phosphorus that make manure so productive on farm fields can create an over-fertilized "soup" when they run off into the water, leading to undesirable algae blooms. These effects are not only unpleasant for recreation and aesthetics, but they also deteriorate the underwater habitat necessary for fish and other aquatic organisms to live.

For farmers, nutrient management is an integral part of business, and there are important steps that can be taken to reduce their nutrient loss to streams and lakes. The two main ways of reducing the nutrients that enter our waterways from agriculture are 1) decreasing the amount of nutrients applied to the landscape, and 2) preventing spills, runoff, and erosion from transporting those nutrients to our waterways.

Decreasing excess nutrients applied to the landscape is the first step necessary for maintaining good water quality. Careful nutrient management planning can help farmers determine how much nitrogen and phosphorus is in their manure and how much the crops on each field require to be productive. This
planning can help farmers apply only as much nitrogen and phosphorus as their crops will use, preventing excess runoff. In areas that already have phosphorus buildup in the soil or impacted waterways, farmers may need to manage specifically to reduce phosphorus levels. One way livestock operators can reduce unnecessary phosphorus in manure is by changing their feed supplements. Phosphorus is typically fed to cattle to ensure reproductive success. However, new research is showing that lower phosphorus levels in feed can be optimal for both maintaining herd health and for cost-effectiveness.

The second important step is to prevent the nutrients that are stored or applied to the land from getting into waterways. In many cases, manure should be stored over the winter while the ground is frozen. Because of this, manure storage facilities are a management option often chosen for operations that handle large quantities of manure. Sound construction and maintenance of these storage structures is essential to preventing leaks to groundwater and overflows that can damage nearby streams and lakes. Prevention of erosion and runoff is essential for keeping nutrients out of our lakes and streams. Maintaining good plant cover is one of the most effective ways to reduce the amount of soil and phosphorus that runs off into the water. Plant roots stabilize the soil and help reduce erosion. Buffer strips of grasses or trees along stream banks catch runoff and sediments flowing from upland fields and trap them before they enter waterways. Well-vegetated uplands and buffers are critical for water quality.

**Buffers**

By putting a buffer between the crop and the stream bank, you don’t invest in seed, fertilizer and chemicals on lower-yielding land while preventing erosion from robbing the topsoil and cutting gullies into the high-yielding parts of the field. The 2007 SEWRPC Regional Water Quality Management Plan Update found that a 75 foot buffer width was required for adequate pollutant removal efficiencies along streams adjacent to agricultural lands.

Since Conservation Reserve Program rental rates have been updated, more farmers are finding that putting in conservation buffers with CRP along streams or other water can be more profitable than cropping those field edges. This is especially true if the area is wet, shaded, droughty, steep or consistently low-yielding land. A recent study in Kenosha County compared CRP payments to corn and soybean profits. It showed that field edges with low yields – less than 40 bu./ac. for soybeans and less than 115 bu./ac. For corn – would be more profitable if enrolled as buffers in CRP.

In order to find out whether CRP is more profitable than cropping field edges, consider production costs (seed, chemicals, equipment and fuel), expected yield, crop prices, and CRP rates and incentives for your area. In Wisconsin, the average CRP rental rate is $65 per acre. However, as most farmers will tell you, conservation buffers through CRP are not only about profits. Buffers reduce erosion and protect water quality. They make field management easier by reducing gullies, brush and trees crowding the crops. Buffers allow easy access to the stream and stream bank, even during the growing season. And conservation practices like buffers improve property values and protect natural resources – essential to long-term success and future farm generations.

**No Till and Reduced Till Practices**

This is a technique where crops are planted directly into the soil without disturbing the soil with plowing or disking. Old stubble and plant parts from past crops are left on the surface of the ground to lessen erosion caused by rainfall and runoff.
Contour Strip Cropping

This is a technique where alternating strips of crops and hay are planted to slow down erosion. Strips follow contours lines perpendicular to runoff.

Rotational Grazing

Grazing land is divided into paddocks which are allowed limited grazing on a rotational basis. Rotational grazing prevents erosion and deterioration of pasture due to overgrazing.