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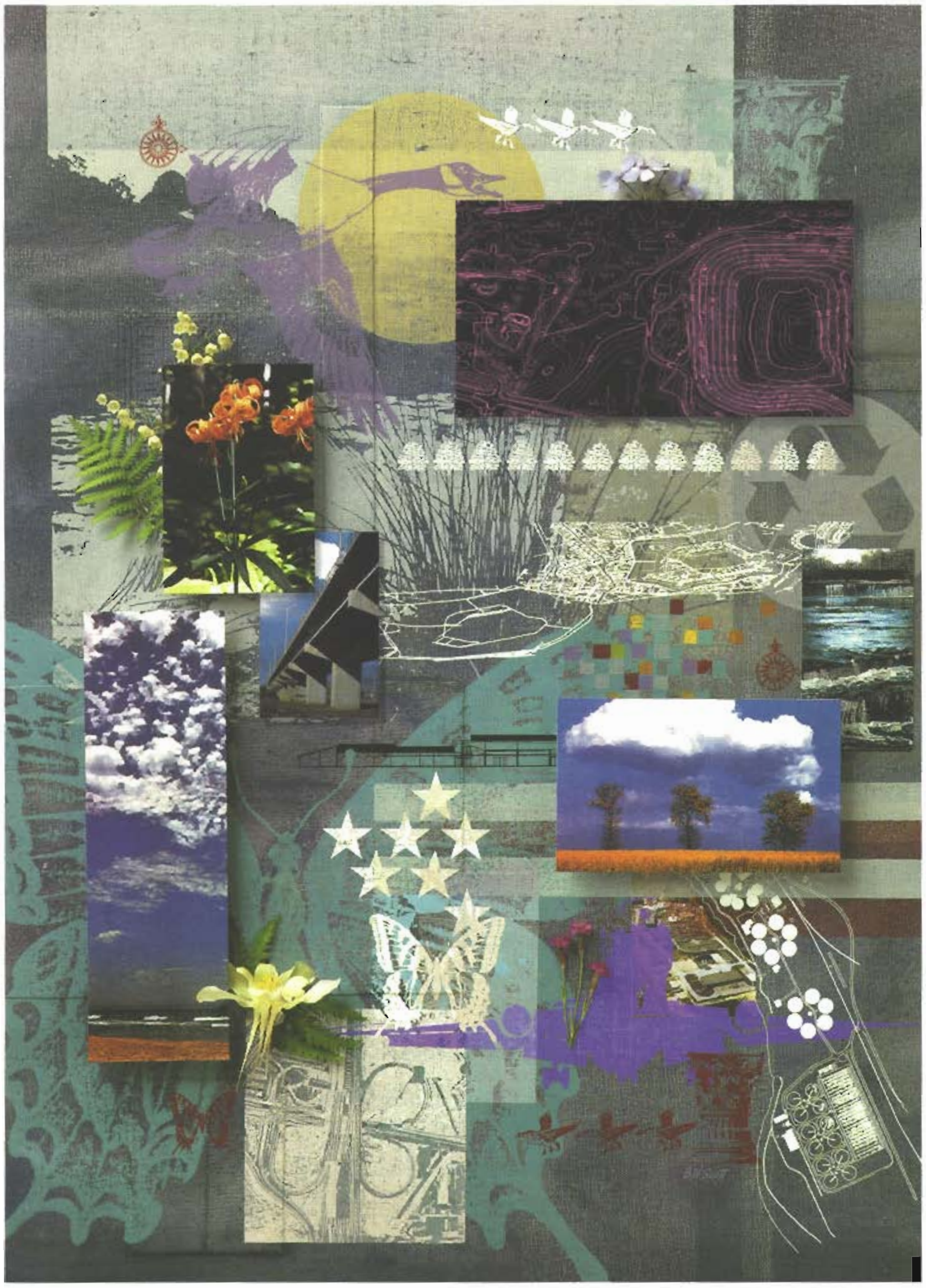

Quality through teamwork

FINAL STORMWATER MANAGEMENT PLAN

FOR THE

TOWN OF NORWAY
Wisconsin

December, 1997

PREPARED BY

Rust Environment & Infrastructure

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1 Project Summary

BACKGROUND

The Town of Norway contracted with Rust Environment and Infrastructure (Rust) to conduct this stormwater management study. This document reports on the findings and recommendations of this study. Recommendations are made in an effort to meet or exceed the water quality goals of the watersheds, identify solutions to the flooding problems, and set forth specific objectives. An implementation plan for the phased development and financing of the recommendations is also included.

This stormwater plan was conducted as part of the "Muskego-Wind Lakes Priority Watershed Project" under the Wisconsin Nonpoint Source Water Pollution Abatement Program. This program provides state funding for the prevention of nonpoint source pollution, and is administered by the Wisconsin Department of Natural Resources (WDNR) and the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP). The Muskego-Wind Lakes Priority Watershed was designated a "priority watershed" in 1991, but did not include the areas tributary to Waubeesee and Kee-Nong-Go-Mong Lakes.

To assist in carrying out the priority watershed plan, the Wind Lake Management District (WLMD) received grants from the WDNR to conduct stormwater management planning. In addition, the Town of Norway obtained two lake planning grants for Waubeesee and Kee-Nong-Go-Mong Lakes. The above grants, along with the Town's required cost share portion was used to fund the study. The Town of Norway, along with the WLMD and the Tri-Lakes Association contracted with Rust Environment & Infrastructure (Rust) to conduct this stormwater management study.

PURPOSE AND OBJECTIVES

The purpose of the Stormwater Management Plan for the Town of Norway is to implement the recommendations set forth in the *A Nonpoint Source Control Plan for the Muskego-Wind Lake Priority Watershed Project* and to expand these recommendations beyond the original. The Stormwater Management Plan for the Town of Norway addresses remediation of existing water quantity and quality problems from stormwater runoff, and prevention of future similar problems as a result of expected growth.

Early in the planning program, a variety of means were used to establish specific objectives that would be used to guide preparation of this Stormwater Management Plan. These means included review of the recommendations set forth in *A Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project*, discussions within the Town/WDNR/Rust project team, and interaction with the Town of Norway Ad Hoc Stormwater Advisory Committee. The advisory committee was established to assist Rust with stormwater planning effort. The committee is composed of members representing various interest groups of the Town and the three lakes.

The objectives for this project are as follows:

1. Provide recommendations to help attain water resource goals for the project area and related water bodies as defined in *A Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project*. For the watershed, in the Town of Norway, these goals are:

- ♦ Improve swimmable water by increasing water clarity.
- ♦ Improve recreational and aesthetic value by decreasing the growth of nuisance algae and nuisance aquatic plants.
- ♦ Enhance fish and wildlife habitat.

2. Contribute to the attainment of the pollution reduction goals set forth in *A Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project* for Wind Lake and as developed by the stormwater plan project team for Waubeesee and Kee-Nong-Go-Mong Lakes. Nonpoint source pollution reduction goals for urban and rural areas include:

   - ♦ Wind Lake - reduce mass loading of sediments by 57 percent, and phosphorus by 49 percent;
   - ♦ Kee-Nong-Go-Mong Lake - reduce mass loading of sediments and phosphorus by 40-60 percent;
   - ♦ Waubeesee Lake - Prevent future increases of mass loadings of sediments and phosphorus.

3. Reduce erosion from agricultural sources.

4. Reduce erosion from construction activities.

5. Address current flood control and drainage needs and prevent future flooding from stormwater within the Town by limiting peak flows from developing areas to pre-development peak flows using stormwater detention.

6. Provide a plan of action to control existing streambank erosion.

7. Reduce negative aesthetic impacts, such as turbidity, sediment deposits, algae, litter and debris.

8. Produce a practical and implementable plan for attaining the stormwater management goals.

9. Produce a Database Information System containing information for: existing and future land uses; soils; wetlands; hydrologic basins; and floodplains.

10. Present alternative approaches to generating revenue to support future stormwater management needs including: stormwater utilities; impact fees; fees in lieu-of; and state/federal grant programs.

SUMMARY OF PROJECT FINDINGS

- Urban sources of nonpoint source pollution were identified using the SLAMM (Source Loading and Management Model) model. Agricultural sources of nonpoint source pollution were identified with records from the Racine and Waukesha County Land Conservation Departments. The two major sources of nonpoint source pollution were estimated to come from agricultural and residential sources. Under existing land use conditions, agricultural and residential land uses accounted for 47 percent and 36 percent of the nonpoint source phosphorus loading, respectively. Under future land use conditions, agricultural and residential land uses accounted for 35 percent and 37 percent of the nonpoint source phosphorus loading, respectively. This shift is due to the transition of agricultural land to residential land. Under existing land use conditions, agricultural and residential land uses accounted for 24 percent and 30 percent of the total area. Under future land use conditions this shifted to 19 percent agricultural and 35 percent residential.

- Areas were identified which contributed a disproportionate share of nonpoint source pollution. Stormwater control in these areas is critical in order to achieve significant pollution reduction in the project area.

- Streambank erosion does not appear to be a significant contributor of nonpoint source pollution in this project area. Three areas of streambank degradation were identified in the project area exclusive of the Muskego Canal.

- The project area drainage system consisting of open channels, culverts, and storm sewers was modeled using XP-SWMM. Flooding problem areas were identified with results of the computer modeling and by interviewing residents of the area for anecdotal information on flooding. Flooding problem areas were defined as areas which threatened roads and property during the 10-year, 12 hour rain storm.

- Identified sixteen funding mechanisms to finance the Town's stormwater management program.

SUMMARY OF RECOMMENDATIONS FOR POLLUTION AND FLOODING CONTROL

♦ **Adopt a stormwater ordinance to require stormwater management from new land developments.** Due to the amount of future expansion planned, addressing the proper development of these areas with adequate stormwater quantity controls, and nonpoint source pollution controls, will reduce future flooding problems and nonpoint source pollution loads. An important benefit to requiring proper development in these areas, is that developers and new property owners, not the Town or its present residents, would bear the cost of this effort. To achieve these goals, an ordinance is proposed for adoption by the Town. The proposed ordinance requires land developers to control stormwater flow and nonpoint pollution.

The adoption of an ordinance will serve the Town throughout a period of growth. The benefits, with proper enforcement, would be: 1) appropriate level and quality of infrastructure for the Town, and 2) reduced future stormwater problems.

♦ **Vigorously enforce the existing construction erosion control ordinance.**

♦ **Develop and implement a citizen information/education program**. Many of the pollutants found in stormwater can be reduced through changes in daily homeowner activities. Proper disposal of household and automotive products, lawn care practices, and reducing use of automobiles are examples of actions that can reduce nonpoint source pollution through homeowner education. The program may take the form of: newsletters, demonstration projects, informational stations at local festivals, or other use of other media.

♦ **Continue sound Town operation and maintenance practices which affect water quality and drainage.**

♦ **Establish a Town program to inspect the drainage system for illicit non-stormwater discharges which are not permitted.**

- **Preserve wetland and floodlands in accordance with Wisconsin State Administrative Codes NR103 and NR 116.**

- **Acquire grants to fund soil testing for agricultural nutrient management.**

- **Enact exclusive agricultural zoning to encourage improved tillage methods.** Exclusive agricultural zoning makes it easier for farm operators to apply for the Wisconsin Farmland Preservation Program. It should be noted that this program is to end by approximately 1999.

- **Consider Enacting an Agricultural Shoreland Management Ordinance.** An agricultural shoreland ordinance would require practices to minimize nonpoint source pollution in the shoreland zone if funding is available.

- **Structural Measures - Nonpoint Source Pollution Control and Flood Control**:

  Structural nonpoint source pollution and flood control measures were identified in each of the three lake watersheds. Several locations throughout the project area were analyzed for the potential of constructing wet detention basins, stormwater bioswales, storm sewer inlet filters, agricultural buffer strips, and grass waterways to remove pollutants from the runoff. Solutions for flood prone areas and streambank degradation were also evaluated. The following projects were recommended as being the most feasible and cost effective structural measures. The projects are summarized in Table 1-1. This table does not include structural control measures which are recommended for future development.

  Costs for the non-structural recommendations (information/education program, street sweeping, etc) were not estimated or presented in this project.

CONCLUSIONS

Implementing the structural and non-structural recommendations will result in a reduction of the annual sediment and heavy metal loads from 1996 land use conditions. The predicted pollution reductions do not meet the reduction goals for the Wind Lake and Kee-Nong-Go-Mong watersheds. Lack of feasible pollutant reduction alternatives restricts the amount of pollution which can realistically be reduced. The plan, if implemented meets the pollution reduction goals for Waubeesee Lake. Waubeesee Lake currently has good water quality, but needs protection from future development.

It is important to note that if the recommendations are not carried out, the future pollutant loads and future flooding conditions will increase. The periodic road flooding that occurs in portions of the project area is expected to become more frequent and more damaging, if stormwater management measures are not enacted. New developments will contribute more runoff to downstream areas unless proper controls and installed.

The recommended stormwater management program is not expected to be completed in the next few years. Stormwater management requires the long term commitment to installing, maintaining, and repairing the physical infrastructure, and the continued monitoring of Town activities to reduce nonpoint pollution.

TABLE 1-1
STRUCTURAL STORMWATER CONTROL PRACTICES

Description	Location	Cost
Nonpoint Source Pollution Control Measures		
Wind Lake		
0.4 acre wet pond*	S. Loomis Rd.	$113,000
retrofit dry pond to 0.25 acre wet pond	Creekside Meadows	$37,000
200 ft Bio-swale	Wind Lake Plaza	$8,000
4 inlet filters	Wind Lake Plaza	$6,000
buffer strip 1**	Muskego Canal tributary west	$897
buffer strip 5**	Hwy 36 sod farm	$1,102
grass waterway**	Muskego Canal vegetable farm	$35
streambank restoration	Creekside Meadows	$6,600
streambank revegetation	Hwy 36 sod farm	$500
Subtotal		$173,134
Kee-Nong-Go-Mong Lake		
retorfit to 0.14 acre wet pond	Scenic View	$25,000
Drainage Improvement Measures		
replace stormsewer pipe	Harbor Point	$86,800
replace culvert	Muskego Dam Road	$3,300
ditch and stormsewer	Settler Road	$69,300
Subtotal		$159,400
Total		$357,534

* Does not include cost of land acquisition.
** Cost for annual land rental.

PROJECT BACKGROUND

The Town of Norway, located in the northwestern corner of Racine County, has had a long history of stormwater problems. The high groundwater table and the large amount of low lands have historically lead to flooding problems. More recently, water quality problems have surfaced in the Town. These stormwater problems led the Town to conduct this Stormwater Management Plan.

The Town of Norway stormwater management plan will provide a comprehensive analysis of the town's present and future stormwater management needs within the study area. The conclusions and recommendations may be helpful in addressing stormwater management problems in the remaining area of the town. The general goals of this study is to correct and prevent flooding from stormwater runoff, and to reduce the amount of pollutants found in stormwater runoff.

The project area is located within the Fox River watershed. This study addresses the northern portion of the Town, specifically the tributary area to the three lakes located within the Town. These lakes are Wind Lake, Waubeessee Lake and Kee-Nong-Go-Mong (Long) Lake. The area upstream of Wind Lake and Kee Nong Go Mong Lake is being concurrently addressed by the City of Muskego in their "Phase Two" stormwater management plan. The study area covers approximately 8.4 square miles (see Figure 2-1).

This stormwater plan was conducted as part of the "Muskego-Wind Lakes Priority Watershed Project" under the Wisconsin Nonpoint Source Water Pollution Abatement Program. This program provides state funding for the prevention of nonpoint source pollution, and is administered by the Wisconsin Department of Natural Resources (WDNR) and the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP). The Muskego-Wind Lakes Priority Watershed was designated a "priority watershed" in 1991, but did not include the areas tributary to Waubeesee and Kee-Nong-Go-Mong Lakes.

Under the Wisconsin Nonpoint Source Water Pollution Abatement Program, a plan (commonly called a "Priority Watershed Plan) for the Muskego-Wind Lakes watershed was developed which:

- Identified critical sources of nonpoint pollution.
- Set water resource objectives for the wetlands, streams, and lakes within the watershed.
- Established pollution reduction goals.
- Recommend a set of actions to reach the pollutant reduction goals.
- Set a budget and schedule to carry out the recommendations of the plan.

To assist in carrying out the priority watershed plan, the Wind Lake Management District (WLMD) received grants from the WDNR to conduct stormwater management planning, and to implement the recommendations of the stormwater management plans. In addition, t[redacted]nts for W[redacted] The above grants, along with the Town's required cost share portion will be used to fund the study. The Town of Norway, along with the WLMD and the Tri-Lakes Association contracted with Rust Environment & Infrastructure (Rust) to conduct this stormwater management study.

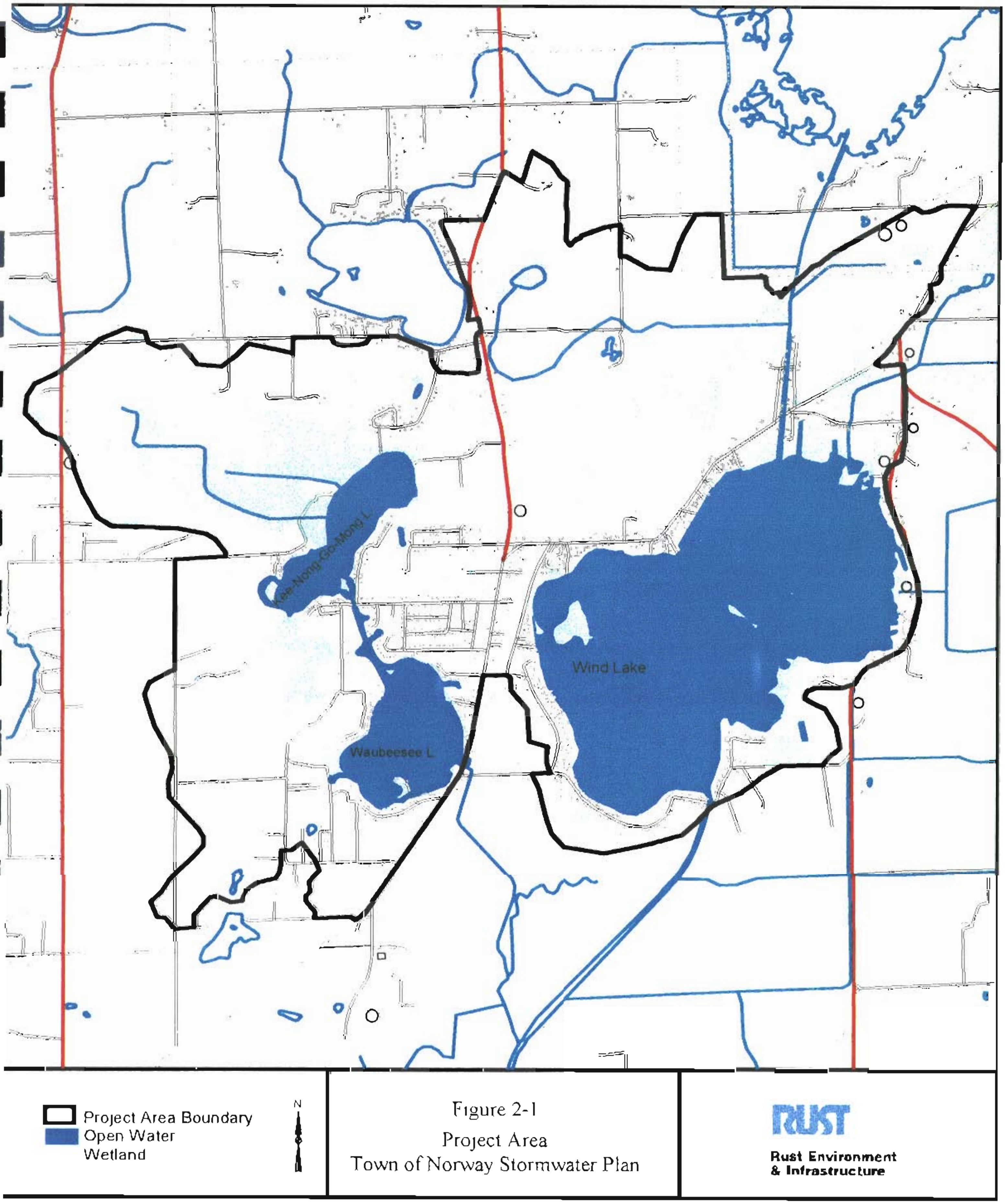

Figure 2-1
Project Area
Town of Norway Stormwater Plan

Rust Environment & Infrastructure

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2. Contribute to the attainment of the pollution reduction goals set forth in *A Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project* for Wind Lake and as developed by the stormwater plan project team for Waubeesee and Kee-Nong-Go-Mong Lakes. Nonpoint source pollution reduction goals for urban and rural areas include:

    - Wind Lake - reduce mass loading of sediments by 57 percent, and phosphorus by 49 percent;
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5. Address current flood control and drainage needs and prevent future flooding from stormwater within the Town by limiting peak flows from developing areas to pre-development peak flows using stormwater detention.

6. Provide a plan of action to control existing streambank erosion.

7. Reduce negative aesthetic impacts, such as turbidity, sediment deposits, algae, litter and debris.

8. Produce a practical and implementable plan for attaining the stormwater management goals.

9. Produce a Database Information System containing information for: existing and future land uses; soils; wetlands; hydrologic basins; and floodplains.

10. Present alternative approaches to generating revenue to support future stormwater management needs including: stormwater utilities; impact fees; fees in lieu-of; and state/federal grant programs.

SCOPE OF SERVICES

This Stormwater Management Plan for the Town of Norway was initiated in July 1996. The scope of services for this planning project included the following:

1. Develop Project Work Plan - The work plan set forth the project team, schedule and milestones, lines of communication, and deliverables.

2. Meet with citizen advisory committee to present project status, findings, recommendation, and to receive review comments, suggestions, and direction.

3. Define Project Setting - Collect data, inventory the stormwater conveyance system, delineate drainage patterns, create a data base system, inventory soils, survey the business community, assess land use, create a geographic information system, summarize water quality data, and assess operations/maintenance. Discussion of the methods for conducting these tasks are in Chapters 3, 4, and 5.

4. Establish Project Objectives - Solicit ideas from the Ad-Hoc Committee and assemble into a set of objectives.

5. Interview Town personnel to learn: a) the current level and location of stormwater flooding problems; b) the current operation and maintenance practices for stormwater facilities in the Town; and c) to solicit concerns regarding potential stormwater management recommendations.

6. Perform Analyses - Select computer models, calculate stormwater flows and volumes, evaluate hydraulic capacities, and compute nonpoint source pollutant loads.

7. Identify Critical Areas - Locate sources of nonpoint pollution and flood prone areas.

8. Formulate and Evaluate Alternatives - Consider wetland/environment corridor preservation, develop solutions for existing flooding problems and prevention plans for potential future flooding problems, select best management practices for pollutant reduction, site best management practices, and suggest operation/maintenance improvements.

9. Streambank Erosion Summary - Prepare a summary of existing streambank erosion problems and suggest alternative solutions to reduce the streambank erosion.

10. Prepare Implementation Plan - Address priorities, schedule, information/education activities, responsible agencies/entities, legal requirements, estimate budgets, and evaluate funding mechanisms.

11. Stormwater Ordinance - Develop a stormwater ordinance for the Town of Norway.

12. Produce report and deliver mapping and data base.

This is a planning investigation, not an engineering design, and as such, is intended to define systems and problems, explore a range of alternative solutions, and recommend the course of action. Implementation of facilities recommended in this report will require preparing detailed design and construction documents and possibly obtaining WDNR, other state, or federal permits.

This chapter describes the natural, constructed, and institutional features which influence surface water runoff in the project area. These features include: sub-basins of the project area, existing stormwater conveyance and storage facilities, soils, existing and future land use, precipitation, water resources, stormwater quality, and the governmental stormwater regulatory framework.

PROJECT AREA SUB-BASINS

Sub-basins are small watershed which form the building blocks for surface water runoff analysis. The project area was partitioned into 49 sub-basins ranging in size from 0.74 to 728 acres, with an average size of 109 acres. Within the basins, 177 subbasins were delineated, ranging in size from 1.6 to 102 acres, with an average size of 14 acres. Sub-basin boundaries are shown in Figure 3-1.

The project area sub-basins were grouped according to which lake they drained into. The project area drained as follows: 61 percent to Wind Lake; 29 percent to Kee-Nong-Go-Mong Lake; 8 percent to Waubesee Lake; and 2 percent to outside the project area.

Elevations within the project area vary from about 850 feet above mean sea level in the extreme western portions to approximately 770 feet above mean sea level around Wind Lake, for a total relief of 80 feet. The project area is relatively flat, with an average land slope less than 5 percent. Surface depressions are common in the project area. Six of the sub-basins drain to closed depressions which flow out of the sub-basin only during large rain storms. Sub-basins were delineated using two foot topographic maps, field reconnaissance, and surveyed elevations of culverts and ditches. The subbasin boundaries, along with most of the other natural resources and land use data discussed in this chapter, were entered into the Geographic Information System (GIS), to facilitate use of the data.

STORMWATER CONVEYANCE AND STORAGE SYSTEM

Knowledge of the conveyance and storage system is essential to watershed planning efforts because this system determines the route by which stormwater and its pollutants move from the land surface through the watershed to Wind, Waubesee, and Kee-Nong-Go-Mong Lakes. The system also effects flow velocity and discharge as well localized flooding due to drainage backup. Data and information on the conveyance system, particularly storm sewers and culverts, helps to diagnose the cause of local flooding problems.

The stormwater conveyance system consist of swales, roadside ditches, culverts, channels (both natural and constructed), and storm sewers. Stormwater storage locations within the project area include natural wetlands, wetland remnants, detention areas created by road construction, and constructed stormwater detention facilities. The network includes approximately 4.6 miles of open channels, 50.5 acres of wetland depressions, and 3.7 acres of natural dry depressions. The known stormwater detention areas are described in Table 3-1.

TABLE 3-1
DESCRIPTION OF STORMWATER DETENTION LOCATIONS

Location	Type	Size (acres)	Comments
Sub-basin N12 (north of Muskego Dam Rd.)	wetland	7.67	
Sub-basin M63 (south of Muskego Dam Rd.)	constructed pond	-	flood control
Sub-basin N8 (north of Loomis Rd.)	wetland	30	
Sub-basin N10 (north of Wind Lake Rd.)	dry depression storage	0.22	
Sub-basin N57 (north of Long Lake Rd.)	wetland	2.86	
Sub-basin N60 (west of Hwy. 36)	dry depression storage	0.9	created by road fill
Sub-basin N68 (west of Lakeview School)	wetland	2.8	
Sub-basin IN2 (east of Settler Rd.)	dry depression storage	0.15	
Sub-basin N75 (south of Tichigan Rd.)	dry depression storage	0.18	
Sub-basin N89 (north of Tichigan Rd.)	wetland	1.02	
Sub-basin N87 (east of Town Line Rd.)	wetland	2.86	
Sub-basin N89 (east of Town Line Rd.)	wetland	2.69	

WATER RESOURCES

One of the main goals of this stormwater project is to improve the water quality of the surface water bodies in the project area. The surface water resources in the project area consist of three lakes; Wind Lake, Waubeesee Lake, and Kee-Nong-Go-Mong Lake (Long Lake); and the system of canals and streams which connect these lakes to the Muskego and Wind Lake Canal system which flows to the Illinois-Fox River.

Water chemistry samples from the three lakes have been analyzed to determine their water quality. The United States Geological Survey (USGS) has been monitoring the water quality of the three lakes since 1985. This water quality data can be used to classify the lakes according to their degree of nutrient enrichment, or trophic status. The degree of nutrient enrichment affects a lakes quantity of plant material, fish community structure, and aesthetic appearance. The three trophic classifications are oligotrophic, mesotrophic, and eutrophic. Oligotrophic lakes are nutrient poor and typically have a small quantity of aquatic plants and algae. Mesotrophic lakes are moderately fertile lakes with abundant aquatic plants and algae but not to the degeree that they are a nuisance. Eutrophic lakes are nutrient rich lake often characterized by excessive growths of aquatic plants and algae. The desired water quality level for the three lakes was assumed to be a mesotrophic lake water quality status. It is a commonly held belief among lake scientists in the region that the majority of lakes in southeastern Wisconsin were mesotrophic prior to European settlement. A water quality summary of these water bodies follows.

Wind Lake

Wind Lake is a 936 acre lake which receives the drainage from Big Muskego Lake. Three reports have been written pertaining to Wind Lake water quality; Hydrology and Water Quality of Wind Lake in Southeastern Wisconsin (U.S.G.S., 1990), A Management Plan for Wind Lake, Racine County, Wisconsin (SEWRPC, 1991), A Nonpoinst Source Control Plan for the Muskego- Wind Lakes Priority Watershed Project (WDNR, 1993).

The water quality data collected by the USGS since 1985 indicates that Wind Lake is a eutrophic lake. The excessive phosphorus inputs to the lake are distributed as follows: 50 percent from internal cycling of bottom sediment nutrients; 34 percent from surface drainage from Big Muskego Lake; and 16 percent from direct drainage to the lake and atmospheric deposition. The Nonpoint Source Control Plan for the Muskego- Wind Lakes Priority Watershed Project identified the nonpoint source pollution reduction goals for the Wind Lake watershed to be a **57 percent reduction in sediment loadings and a 49 percent reduction in phosphorus loadings.**

Kee-Nong-Go-Mong Lake (Long Lake)

Kee-Nong-Go-Mong Lake is an 88 acre lake. The USGS has been collecting water quality data on this lake since 1988. The water quality data indicates that this lake is mildly eutrophic to mesotrophic. The average spring turnover phosphorus concentration over the monitoring period is 30 micrograms/liter. The mesotrophic range of phosphorus concentrations is 5 to 16 micrograms/liter.

The Wisconsin Lake Model Spreadsheet (WILMS) was used to determine what level of nonpoint source phosphorus reduction would be required to bring the lake to a mesotrophic status. The WILMS spreadsheet uses a number of predictive lake water quality models. The model was selected based upon how close the model predictions for phosphorus concentrations came to the real life spring turn over phosphorus concentrations. The Rechow natural lake model made the most accurate prediction.

Two tiers of nonpoint source phosphorus reduction goals were determined; 1) to bring the lake to the top range of the mesotrophic index, 2) to bring the lake to the middle of the mesotrophic index range. The first tier is held to be a more easily achieved goal and the second tier is held as the ultimate goal. Reduction goal 1 requires a 40 percent reduction in nonpoint source phosphorus loadings, and goal 2 requires a 60 percent reduction. It was assumed that the majority of phosphorus to the lake was transported by sediment, so by association, the reduction goals for both sediment and phosphorus were assumed to be equivalent. The water quality goal for Kee-Nong-Go-Mong Lake is to **reduce nonpoint source loadings of phosphorus and sediment 40 to 60 percent.**

Waubeesee Lake

Waubesee Lake is a 129 acre lake which receives drainage from Kee-Nong-Go-Mong Lake. The USGS has been collecting water quality data on this lake since 1988. The water quality data indicates that this lake is mesotrophic with good to very good water quality. Additional water quality improvements over the current status is not necessary. However, precautions should be taken to protect the current level of water quality. Prevention should be stressed and any new development or changes in the watershed should have controls to keep water quality impacts at or below the current level. The water quality goal for Waubeesee Lake is to **maintain or reduce the current level of nonpoint source loadings of phosphorus and sediment**

Canals and Streams

The major canals in the project area include the Muskego Canal (connecting Big Muskego Lake with Wind Lake), the Wind Lake Canal (connecting Wind Lake to the Fox River), and the Anderson Canal (connecting Kee-Nong-Go-Mong Lake with Waubeesee Lake). The canals and streams in the project area have been extensively modified for drainage purposes. These constructed canals and channelized streams have diminished aquatic habitat value.

SOILS

The soils in the project area is important partly because soil properties are a primary factor in determining the volume of runoff associated with a given rainfall. The U.S. Department of Agriculture Soil Conservation Service classifies soils based on their runoff potential in hydrologic groups of A, B, C, or D. Hydrologic soil Group A soils (generally sandy type soils), have a high infiltration capacity and low runoff potential whereas, at the other end of the spectrum, soil Group D soils (generally high clay content soil), have a low infiltration capacity and a high runoff potential. Hydrologic soil Group A/D are wetland soils which display A soil characteristics if they are well drained and D soil characteristics if they are saturated by a high water table. The A/D soils in the project area coincides primarily with wetland land cover, therefore, it is assumed that they experience a high water table and have D soil characteristics. The distribution of soils within the project area is shown in Table 3-2 and Figure 3-2. The soils in the project area are predominantly Group C, D, and A/D soils, which have low rainfall infiltration capacities, and, therefore produce large volumes of runoff.

TABLE 3-2
SOIL HYDROLOGIC GROUPS WITHIN THE
TOWN OF NORWAY PROJECT AREA

Hydrologic Group	Acres	%
A/D	1,169	22
B	402	7
C	3,394	63
D	422	8
Totals	**5,387**	**100**

In urban areas caution must be used when characterizing the soils from the USDA Soil Surveys. The high degree of land disturbing activities in urban areas changes the soil's physical properties which is not reflected in the Soil Survey. For the majority of the project area which is in non-urban land use, however, the USDA Soil Survey information is appropriate. For purposes of this planning level study, the USDA Soil Survey was used.

Short of actually conducting soil infiltration tests in the field, the soil survey is the best source of information regarding infiltration rates. For implementation of site specific recommendations from this report, field measurements are necessary to properly construct the best management practices.

Additional information on soils in the area tributary to Wind Lake is available in A Management Plan for Wind Lake, Racine County, Wisconsin. (Southeastern Wisconsin Regional Planning Commission. 1991). This plan maps areas which have soils inappropriate for septic systems, mound sewage disposal systems, or public sanitary sewer service. These maps indicate that under the state administrative rules in place in February, 1991; the entire direct drainage area to Wind Lake is unsuitable for septic systems; and a large portion of the direct drainage area is unsuitable for mound sewage disposal systems, or has severe limitations for public sanitary sewer service. This information is consistent with the observation that the majority of the soils in the project area have a low infiltration capacity.

LAND USE

Type and distribution of land use--both existing and future--are important elements in a water quality and flood control investigation. The type and amount of nonpoint source pollution and the volume and timing of runoff are directly influenced by land use. Although the underlying soil type, as already noted, is an important factor in determining runoff amounts, the land use can also significantly runoff amounts and the timing of runoff. Adverse effects usually occur when land is converted from rural to urban uses because such conversion results in a large increase in impervious surface and, therefore, an increase in the volume of runoff and decrease in runoff time. The net effect can be very large increases in peak flow, flood stages, areas of inundation, and nonpoint source pollutant generation and transport.

Existing Land Use: Existing land use was delineated based on 1995 SEWRPC aerial photographs. Field surveys were then conducted to update the land cover to 1996 conditions. Figure 3-3 is a map of the project area's 1996 land use. Agricultural lands comprise the largest land use group and residential land use is the next largest group.

Future Land Use: Future land use was based upon the citizen advisory committee's knowledge of future development plans. Figure 3-4 shows the predicted future land use of the project area. Several assumptions were used in completing the future land use map:

- the lands developed in 1996 would remain under that condition in the future; and
- the mapped wetlands within the project area (as mapped by DNR) would remain intact in the future.

Comparison of Existing and Future Conditions: Table 3-3 and Figure 3-4a compares the existing (1996) with the predicted future land use. The major predicted changes are the increase in residential lands and decrease in agricultural and open space lands over the next 10 to 20 years. This is important because the decrease in open space land use and the increase in the industrial, commercial, and residential land uses will result in significant increases in the volume of stormwater runoff and the urban types of nonpoint source pollutants unless management measures are implemented. On the other hand, the reduction in cropland within the project area will likely result in a decrease in the sediment pollutant amounts. This is because a stable, landscaped mixed urban area will generally cause less sediment pollution then croplands.

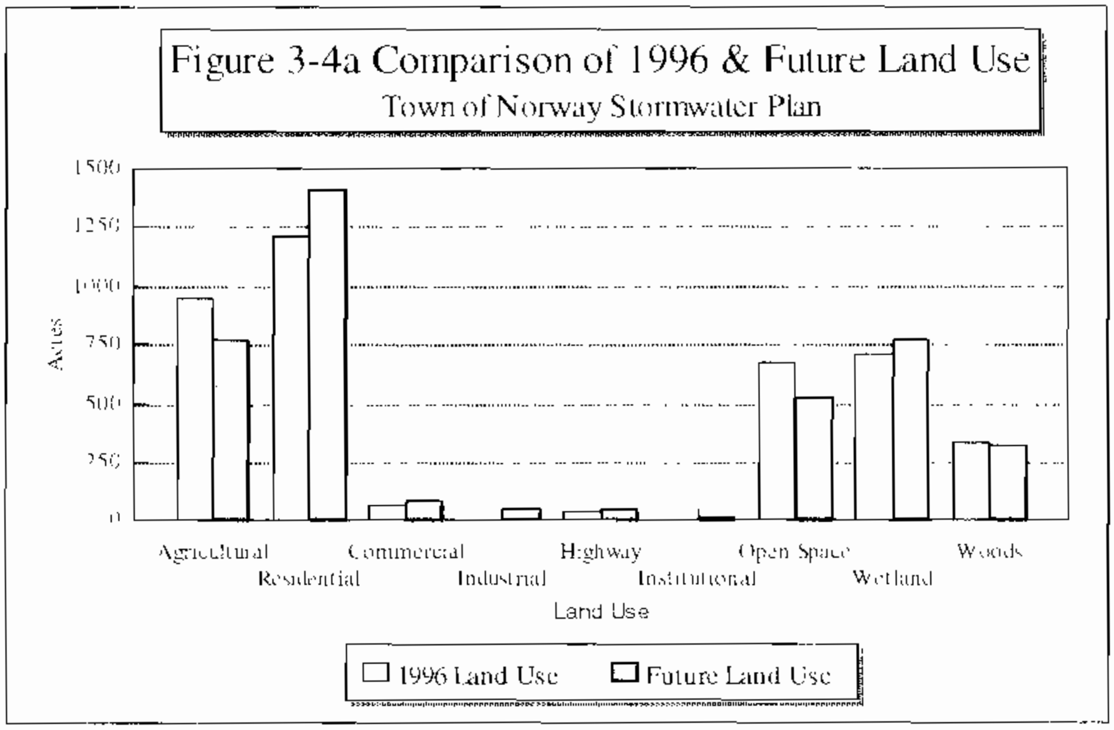

TABLE 3-3
LAND USE COMPARISON

Land Use Type	1996 Land Use		Future Land Use	
	acres	%	acres	%
Agricultural	946	24%	769	19%
Residential	1,209	30%	1407	35%
Commercial	67	2%	81	2%
Industrial	0	0%	47	1%
Highway	42	1%	45	1%
Institutional	3	0.1%	43	0.3 %
Open Space	672	17%	525	13%
Wetland	710	18%	769	19%
Woods	326	8%	320	8%
TOTAL	3,976	100%	3975	100%

WETLANDS

Wetlands are areas which are perennially or seasonally inundated or saturated, have hydric soils, and support wetland vegetation adapted to these conditions. Wetland vegetation communities are varied and include emergent marsh, sedge meadow, bogs, and wooded swamp. Water depth also varies and helps determine the vegetation community.

Wetlands perform functions important to stormwater management, and protection of wetlands is an important element of stormwater management. They provide areas for detention of stormwater flows and reducing peak flows. They also provide water quality treatment through the vegetative uptake of nutrients and the physical settling out of sediment in the stands of vegetation. However, untreated urban stormwater can damage a wetland vegetation (from salt, heavy metals, and the "flashy" nature or urban runoff). Wetlands may also be areas of groundwater recharge or discharge. Beyond stormwater management, wetlands are particularly rich ecological areas and can provide important wildlife and fish habitat..

The locations of wetlands in the study area are shown in Figure 3-5. Approximately 970 acres of wetlands exist within the project area, based on the WDNR Wetland Inventory Maps for the project area (April, 1992). The wetland areas for future conditions were increased by 59 acres to reflect the addition of the Wisconsin Department of Transportation wetland mitigation site north of Muskego Dam Road and west of the Muskego canal. This mitigation site will be incorporated into a wetland water quality treatment system, which the Wind Lake Management District and the WDNR is constructing to remove nutrients from the water going from Big Muskego Lake to Wind Lake. This wetland water quality treatment system will also incorporate an additional 131 acres of land north of the DOT site, most of which is outside of the project area.

FLOODPLAINS

Floodplains are defined as the area along a stream or lake which would be inundated during a 100 year recurrence interval flood. The floodplain is generally not suited for development since development would be periodically flooded development in the floodplain exacerbates the severity of the flood. There are a number of state regulations which prohibit construction in the floodplain. Floodplains in the study area are shown in Figure 3-5. The shoreline fringe around all three lakes is in the floodplain and does infringe upon areas with existing buildings. The extensive wetlands to the northwest and southwest of Kee-Nong-Go-Mong Lake are also in the floodplain. There are also large areas north of Wind Lake in the floodplain. The floodplain is delineated based upon maps produced by the Federal Emergency Management Agency (FEMA) in 1981.

PRECIPITATION

The watershed has a climate characterized by markedly different seasons with corresponding large variations in temperature and precipitation type, amount, and intensity. The average annual rainfall for the project area is 33.20 inches (NOAA, Union Grove station). For the north central portion of the United States an average of 55 separate precipitation events occurs annually (Urbonas B. and Stahre P., 1993). The primary source used to predict rainfall amounts for individual events, and the intensity of the precipitation events was the USDA, Soil Conservation Service Technical Paper No. 40: "The Rainfall Frequency Atlas of the United States" (compiled by the U.S. Department of Commerce). Also, the Southeastern Wisconsin Regional Planning

Commission's (SEWRPC) Technical Report, Volume 3, No. 5 ("Development of Equations for Rainfall intensity-Duration-Frequency Relationship"), was consulted.

Storms were analyzed for this study to determine which types of storms resulted in critical peak flows for flooding conditions. Precipitation events can be characterized in many ways; two parameters are: *recurrence interval* and *duration*. A storm's *recurrence interval* is a statistical prediction of how often a storm of a certain size is likely to occur. For example: a "10 year storm" on the average will occur once in 10 years. The *duration* of a storm is the length of time the precipitation is falling. Each combination of *recurrence* and *duration* results in a unique rainfall amount (in inches). Table 3-4 summarizes the storm events and precipitation amounts analyzed for this project.

TABLE 3-4
RECURRENCE-DURATION-RAINFALL-DEPTH (INCHES)

Duration	Recurrence interval			
	2-Year	10-Year	25-Year	100-Year
1-Hour	1.4	1.9	2.2	2.7
2-Hour	1.62	2.3	2.65	3.2
6-Hour	2.00	2.95	3.4	4.1
12-Hour	2.4	3.4	3.95	4.9
24-Hour	2.65	3.95	4.5	5.6

Source: U.S. Department of Commerce, Climatological Data, Annual Summary, Wisconsin, 1995,

The rainfall data for pollutant loading analysis came from Mitchell Field (Milwaukee) rainfall records for the year 1981. This is defined by the WDNR to be a "typical" year of rainfall and is assumed to best predict the potential average runoff and pollutant loadings. The Source Load and Management Model (SLAMM); the model used to predict nonpoint source pollution loads, uses the 1981 rainfall year to generate the pollutant loadings for the 1996 and future land use conditions.

STORMWATER REGULATORY FRAMEWORK

Over the past few years, several changes have occurred in the federal, state, and local levels of government resulting in significant impacts to stormwater quality and stormwater management. Below is a summary of the major programs at each governmental level which in some way affect stormwater regulatory issues. The regulations summarized below are constantly evolving, and the requirements may change over time. A much more detailed description of the natural resources regulatory framework is provided in An Environmentally Sensitive Lands Preservation Plan for the Town of Norway Sanitary District No. 1 (SEWRPC, 1996).

Federal Government

Stormwater Permit Program

In 1987, the federal government passed the amended Clean Water Act which included several regulations related to stormwater management and nonpoint source pollution control. The programs are administered by the U.S. Environmental Protection Agency (USEPA) which issued final regulations (40 CFR, part 122) in 1990 and are targeted to controlling nonpoint source pollution from municipal, industrial, and construction site runoff. The federal program directs municipalities greater than 100,000 in population to inventory, monitor, and develop plans to reduce the pollutants found in municipal runoff. The municipalities must obtain "pollution permits" to regulate the quality of their runoff. Selected industries must also obtain permits to regulate their runoff quality. Industries must monitor their runoff quality and develop Stormwater Pollution Prevention Plans (SWPPPs) in compliance with the program. Construction sites greater than five acres in size must develop construction erosion control plans to minimize the pollutants in runoff from these sites.

In 1997, new draft rules for a "phase 2" stormwater permit program are scheduled for release. Although these rules are not available for review at this time, changes that are being considered include:

- requiring urban areas of populations 50,000 or greater to be included in the program;
- requiring states to assess impacts from municipalities down to populations of 10,000; and
- defining minimum measures for permitted municipalities to implement (such as construction erosion control: stormwater management on new developments, illicit discharge control, and public information/education.

404 Permit Program

Section 404 of the Clean Water Act provides the authority to the federal government for administering activities which may impact navigable waters of the United States. This program is generally administered by the U.S. Army Corps of Engineers. Activities requiring a 404 permit include placing fill or dredging a navigable waterway or wetland. The permitting process is coordinated by the Regional Office of the WDNR.

State Government

Stormwater Permit Program (NR 216)

In Wisconsin, the State's WDNR has taken on the responsibility to carry out the federal stormwater management program (40 CFR, part 122). The WDNR developed an administrative code to implement the program (commonly referred to as "NR 216"). In addition to the larger cities (populations greater than 100,000), the state program allows for the inclusion of other communities to be regulated by NR 216. Other categories of cities to be regulated under the NR 216 programs are those cities in the "Great Lakes Areas of Concern", and communities within priority watershed areas with populations greater than 50,000. The Town of Norway has not been included in the NR 216 program. Certain types of industries may also be affected by these rules. Currently there are no industries within the project area, however, industries may locate here in the future which would be affected by these rules. Construction sites greater than five acres in size must develop construction erosion control plans to minimize the pollutants in runoff from these sites.

Wisconsin Nonpoint Source Pollution Abatement Program (NR 120)

Because this study is partially funded through the State's Nonpoint Source Pollution Abatement Program, the city must comply with the program's policies as defined in the administrative rules NR 120. The Town must comply with the WDNR's "core program" as described in the Priority Watershed Plan in order to accept continued funding through the priority watershed program. The core program includes requirements for: maintaining and enforcing a construction site erosion control ordinance; conducting a water quality focused information and education program; and evaluating and improving its urban "housekeeping practices" (housekeeping practices include items such as: pet waste ordinances, ditch cleaning, and proper disposal of snow and sediments removed during ditch cleaning.)

Currently, the program is under review to determine if modifications may improve the effectiveness of the urban and rural nonpoint pollution control. These changes will likely require public hearings, legislative action, and administrative rule changes.

State Wetland Permit Requirements (NR 103)

In 1991, the State of Wisconsin adopted administrative rules (NR 103) which described a review process to be used by WDNR for projects affecting delineated wetlands. The NR 103 process applies to projects funded through the Wisconsin Nonpoint Source Pollution Abatement Program, if impacts on wetlands are involved. The impacts may be direct (such as constructing a structural management practice within the boundaries of the wetland) or indirect (such as changes in the hydrology of a nearby wetland). The review criteria to be used by the WDNR include: (1) is the project wetland dependent? (2) are there practical alternatives? (3) what are the impacts on wetland water quality standards? (4) what are the cumulative impacts? and (5) what are potential secondary impacts? Projects that are not wetland dependent and have practical alternatives will be denied a permit for proceeding. Applications for this permit are handled through the Regional Office of the WDNR.

State Water Regulation Permit (Chapter 30)

The State of Wisconsin has the authority to regulate activities that affect navigable waterways. This includes lakes, streams, and rivers within Wisconsin. Almost all waterways with a defined channel and bank are considered "navigable" if the channel carries water for a portion of the year. Projects (regardless of the funding source) that place fill in or remove fill from a waterway, or in any way impact navigation, require a permit through the "Chapter 30" process. Projects such as stream bank stabilization, dredging, or "improvements" to an existing channel likely will require this permit.

The permit application process is generally coordinated with local zoning and/or shoreland requirements. Applications for this permit are handled through the Regional Office of the WDNR.

Shoreland/Wetland Zoning

NR 115 and NR 117 of the Wisconsin Administrative Code requires county adoption of shoreland-wetland zoning. The shoreland zone is the land within 1000 feet of the ordinary high water mark (OHWM) of a lake, pond, or flowage or 300 feet from the OHWM of a navigable stream or river. Zoned wetlands are either five acres or greater in size or are within the shoreland zone. Minimum lot sizes and building setbacks are established with the shoreland zone. There are restrictions on clear cutting of trees and brush within 35 feet from the OHWM and in shoreland areas beyond 35 feet trees and shrubs can be cut only in accordance with sound forestry and soil conservation practices. In shoreland-wetland zones draining, dredging, filling, or flooding are not permitted. WDNR requires the counties to adopt their own shoreland-wetland zoning and WDNR has the power of review over the county zoning ordinances.

Department of Agriculture, Trade, and Consumer Protection

The Department of Agriculture, Trade, and Consumer Protection (DATCP) operates the Farmland Preservation Program. This program offers tax credits for maintaining land in agriculture. A requirement of this program is the implementation of a soil and water conservation plan. DATCP also operates the Feed Grain Program which offers payments for implementing conservation plans on highly erodible land (6% slopes or greater). Most of the Town of Norway is flatter than this.

Department of Industry, Labor, and Human Relations

The Department of Industry, Labor, and Human Relations (DILHR) regulates erosion control at building sites of one and two family dwellings and commercial sites. The Uniform Dwelling Code (UDC, ILHR 21.125) regulates erosion control at building sites of one and two family dwellings. The UDC is a permit system where the applicant must prepare an erosion control plan. The UDC permit is in effect from the beginning of construction to the time of occupancy of the building. The UDC may be implemented at the local government level. Local governments implementing the UDC must have certified inspectors. Municipalities and communities of population greater than 2500 are required to adopt the UDC. Communities less than 2500 have the option to adopt the UDC.

Commercial construction sites are regulated by ILHR 50-64, which requires an erosion control plan. For commercial sites five acres or larger a stormwater management plan is required. Local governments may do the permitting and inspection but are not required to do so. Plans for commercial buildings greater than 50,000 cubic feet in volume must be reviewed by a certified engineer or architect. Currently erosion control for small commercial sites of less than five acres are not regulated by DILHR but the code is being revised to include these. Local ordinances regulating small commercial sites may supersede ILHR 50-64 if they are more restrictive and they were adopted before January 1, 1994.

Local Government

Town of Norway

Soil Disturbance Ordinance

On November 7, 1988 the Town revised its ordinance concerning soil disturbing activities (Chapter 10, Section 20). The purpose of the ordinance is to minimize soil erosion during disturbing activities. "Land Disturbance" means any man-made change of the land surface **including** removing vegetative cover, excavating, filling, and grading **but not including** agricultural land uses such as planting, growing, cultivating and harvesting crops: growing and tending gardens, or harvesting trees.

All sites on which land disturbance take place, whether or not subject to the permit process of this ordinance must meet these standards:

- The area of bare soil exposed at any one time shall be kept to a minimum by conducting activities in sequence;
- Disturbed ground left inactive for 15 or more days shall be stabilized by seed, mulch or other equivalent measures;
- Channelized runoff from adjacent areas passing through the site shall be diverted around disturbed areas, if determined practical by the Town's Consulting Engineer.
- All control measures required to comply with this ordinance shall be based upon accepted engineering practice as identified by the Town's Consulting Engineer. The Town's Consulting Engineer and the Plan Commission any impose additional standards upon a site to minimize air and water pollution and erosion and may use the DNR Construction Site Handbook as revised from time to time as a guideline.

Land disturbing activities require an approved control plan for the site and a permit from the Town. A separate permit and control plan is not required if the land owner or land user has another permit for activities necessarily involving land disturbing activities such as; subdivision development, fill permit, zoning permit, special use permit, or building permit. Typically the erosion control plan is part of the building plan which includes the property survey and staking (David Hendricks, Town of Norway Building Inspector, Personal Communication June 25, 1997). The most common type of erosion control implemented is the installation of silt fence or straw bales.

Enforcement of the ordinance may be accomplished with the following measures.

- A stop work order may be issued to the violator of the ordinance;
- A violator of the ordinance by be subject to a fine not less than $100 nor more than $1,000 plus the costs of prosecution for each violation and in default of payment, up to 30 days in the County Jail.
- Compliance with the provisions of the ordinance may also be enforced by injunction.

Construction site erosion control inspections are conducted by the Town Building Inspector while conducting other site inspections such as for electrical work. On average four or five inspections are conducted on each building site.

In 1996 93 building permits were issued along with the land disturbance permits. As of June 25, 1997, 47 building permits were issued in 1997 (David Hendricks, Town of Norway Building Inspector, Personal Communication June 25, 1997).

Yard Waste Burning Ordinance

In June, 1997, the Town passed an ordinance prohibiting the burning of yard waste (leaves, brush, garden residue) in drainage ditches and in areas within 25 feet of any lake. The burning of yard waste in ditches is a common practice which contributes nutrients to runoff flow.

Ditch Maintenance Ordinance

The Town's ditch maintenance ordinance requires that the property owner of the ditch or land adjacent to the ditch maintain the ditch. This would include mowing of the ditch. In addition, filling of the ditch is prohibited.

Racine County

Racine County Land Conservation Department

The Racine County Land Conservation Department (LCD) coordinates the various federal and state agricultural conservation programs. These programs include the Farmland Preservation Program (DATCP), the Feed Grain Program (DATCP), the Conservation Reserve Program (USDA), the Water Bank Program (USDA), and the Nonpoint Source Pollution Abatement Program (WDNR).

Racine County Planning Department

The County is responsible for implementing shoreland-wetland zoning and reviewing land divisions under state codes NR 115 and NR 117. Under the shoreland/wetland zoning powers the County has jurisdiction within the shoreland/wetland zone including regulating construction site erosion control. This zone is the land within 1000 feet of and lake or 300 feet of any stream.

In Racine County a land owner must first sign a shoreland contract prior to the issuance of a zoning permit. This contract includes items for construction site erosion control. All erosion control measures are to meet the design criteria, standards, and specifications identified in the "Wisconsin Construction Site Best Management Practice Handbook". Erosion control requirements are based on the size of disturbed area and are presented below.

Disturbed Area (acres)	Erosion Control Required
Less than 2	Filter Barriers and Mulch/Seeding/Sodding
2 - 5	Sediment Traps
Greater than 5	Temporary Sediment Basin

Inspections for erosion control measures are not regularly scheduled.

4 Hydrologic/Hydraulic Analysis: Methodology and Results

INTRODUCTION

Achieving the established flood control objectives requires an understanding of the hydrologic, hydraulic characteristics of the Town of Norway project area. The volume (e.g., acre-feet) and a rate (e.g., cubic feet per second) of stormwater runoff under existing and future land use conditions are the most important aspects of the project areas' hydrology.

METHODS AND RESULTS OF DRAINAGE SYSTEM CAPACITY ANALYSIS

Introduction

Computer modeling was conducted to determine locations within the project area's drainage system that would flood under certain rain storm conditions. Flooding occurs when the stormwater conveyance system (road ditches, culverts, storm sewers, and channels) does not have the capacity to carry away the stormwater runoff water quickly enough. When the system's capacity is not adequate, stormwater overtops roads and pools on property. Eleven major drainage systems in the Town, each with their own discharge point (usually one of the three lakes or an adjacent wetland) were evaluated for the system's ability to convey the runoff from four different size storms. In addition, the drainage system was evaluated for the effect high lake levels would have on the capacity of the system.

Procedure

The process used to evaluate the drainage system's capacity and indicate potential flooding concerns is explained below.

1. The Stormwater Management Model (SWMM), developed by the U.S. E.P.A., was used for the hydrologic/hydraulic (flooding) analysis for the project area. The program has the ability to combine and route water flows through a variety of channels, pipes, and ponds. The model works in two steps:

   1) *hydrologic* simulation: The hydrologic simulation generates the amount of water flowing from each sub-basin; and

   2) *hydraulic* simulation: The hydraulic simulation takes the amount of water generated and moves the water through the drainage system ((road ditches, culverts, storm sewers, channels, and storage areas) The hydraulic simulation calculates the depth of water in the channels and pipes, and how high the water will back up if the channels or pipes are not large enough to convey the water.

2. The project area was broken up into distinct drainage systems. There were eleven drainage systems modeled in this study (Figure 4-1). Each system consists of conduits (channels and pipes) and nodes (intersections of conduits and storage areas). Sub-basins which did not have a distinct drainage system (i.e. channel, and culverts) were modeled to produce runoff volumes but were not modeled for drainage capacity.

3. The basis for the computer modeling and the predicted flooding potential is based on analyzing various size rain storms (2-year, 10-year, 25-year, and 100-year storms). The rain storms are defined by their *duration* and *recurrence interval*. The concepts of *duration* and *recurrence interval* were discussed in Chapter 3 and Table 3-5 presents the rainfall amounts associated with combinations of these factors. It was found that the 12 hour duration storms generally produced the highest peak flow and the most surcharging of the drainage system. "Surcharging" is a condition where rate of runoff exceeds the capability of a drainage system to carry the water away. During this condition, stormwater may overtop roads.

4. The effect that varying degrees of high lake levels has on flooding potential was also analyzed. High lake levels can impede drainage of upstream reaches. Three lake levels were assumed for each of the four size rain storms modeled. These lake levels were the ordinary high water mark, 25-year level, and the 100-year level. The ordinary high water mark is defined as an every year high water mark sustained for some duration. The ordinary high water mark was used instead of the average lake level because it is a more well defined level. The lake levels for each of the three lakes is in Table 4-1.

TABLE 4-1
SUMMARY OF LAKE ELEVATIONS

Location	Ordinary High Water Mark (NGVD)	25-year level (NGVD)	100-year level (NGVD)
Wind Lake	768.7	772.3	773
Kee-Nong-Go-Mong	777.7	779	779.6
Waubeesee Lake	777.7	779	779.6

Source: Federal Insurance Management Agency, 1981.

5. The U.S. Soil Conservation Service (SCS) Curve Number method of calculating runoff in the XP-SWMM model was selected. Due to the large amount of agricultural land in the project area, it was determined that this would be the most appropriate method. In conjunction with this method, the SCS Type II distribution storm was selected as the most appropriate storm distribution to use for this project.

6. The effect that increased urban development in the project area was also analyzed. The subbasin curve numbers were calculated for both future and existing conditions. In many subbasins, the curve numbers did not change over time because either no development occurred in the subbasin, or because of the similarity in curve numbers between current agricultural lands in clayey soils and future residential land uses. The subbasins were modeled where the curve numbers did increase under future conditions.

7. The results of the analysis were used to determine capacity deficiencies in the drainage system. The 10-year rain storm was chosen as the key rain storm. Drainage systems are commonly designed based upon the 10-year storm. Flooding that occurs from larger storms is infrequent enough that it is not considered a major hindrance to community activities. As a criteria in the analysis, culverts which flooded to within one foot of the road surface were identified as areas of concern. In many instances, the water backed up to the ground elevation and overtopped the road. Roads which overtopped even during the 2-year storm are particularly prone to flooding.

Results

The results of the drainage system modeling under existing land use conditions are presented in Tables 4-2 to 4-5. The tables show the flow rates and water levels for each of the conduits in a drainage system. These systems and conduits are identified in Figure 4-1. Each table contains the results for a given storm size, the length, shape and design capacity for each conduit. The run-off volume results for the sub-basins which did not have distinct drainage systems are presented in Appendix C.

The results for future conditions are shown in Tables 4-6 to 4-9. Only systems N12 (west of the Muskego Canal) and N60 (by Highway 36 and Oakridge Drive) were modeled since they were the only areas with increases in Curve Numbers under future conditions. Changes in future land use had minor effects on the drainage capacity of the systems. The frequency of road overtopping in system N12 was not increased.

Increases in lake levels had an influence in capacity in some of the systems but not in all of them. The N12 system (west of the Muskego Canal), the N11 system (draining the Harbor Point sub-division), the N50 system (west of Kee-Nong-Go-Mong Lake), and the N10 system (north of West Loomis Road) were all affected by high lake water levels.

Flooding Problem Areas

Flooding problem areas were identified with results of the computer modeling and by interviewing residents of the area for anecdotal information on flooding. Flooding problem areas were focused on areas which threatened roads and property. There were a number of ditches through wetlands and open areas which flooded but were not considered important enough to report here.

During discussions with Town staff and Citizen Advisory Committee members, the following eight areas were identified as existing street flooding areas:

1. Whispering Hills (south side)
2. Pioneer Road
3. South Wind Lake Road (North side)
4. Settler Road between Homestead and Pioneer

5. Town Line and East River Bay Road
6. Waubessee Lake Drive and Fritz Street
7. Waubessee Estates
8. Fox Haven

Table 4-10 presents the identified drainage system capacity problems areas, the severity of the flooding, the causes of the problems, and supporting evidence from local observations. The information in the "comments" column is from discussions with Town staff, and citizen observations. These areas are also shown in Figure 4-1.

Table 4-2
Summary of Drainage System Capacity Analysis

Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	2-YEAR RECURRANCE INTERVAL STORM					
					Normal Lake Level		25-Year Lake Level		100-Year Lake Level	
					Flow (cfs)	Water Elev. (NGVD)	Flow (cfs)	Water Elev. (NGVD)	Flow (cfs)	Water Elev. (NGVD)
N2 SYSTEM										
SN1	Trapezoidal	0.20	80	95.4	5.9	809.8	5.9	809.8	5.9	809.8
CIN2B	Trapezoidal	1.00	600	243.5	7.7	807.7	7.4	807.7	7.4	807.7
N11 SYSTEM										
PN11	Circular	2.50	50	20.1	20.8	773.4	21.3	773.9	35.0	774.7
PN111	Circular	2.50	86	22.1	20.8	773.0	21.2	773.5	23.6	774.2
PN112	Circular	2.50	162	9.1	20.7	772.5	21.0	773.0	20.2	774.2
DN113	Natural	2.25	255	209.9	20.6	770.8	21.2	772.5	-1.6	773.0
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	22.9	782.9	22.9	782.9	22.9	782.9
P90	Circular	3.00	101	98.4	22.9	780.3	22.9	780.3	22.9	780.3
P90B	Circular	3.00	100	90.2	29.2	778.3	29.1	778.3	29.1	778.3
DN669	Natural	2.63	60	102.2	29.2	771.8	29.2	771.8	29.2	771.8
N68 SYSTEM										
DN68	Trapezoidal	3.00	770	124.7	0.4	783.2	1.9	783.2	1.3	783.2
N57 SYSTEM										
CN57	Circular	2.00	50	5.5	0.0	784.8	0.0	784.8	0.0	784.8
DN570	Trapezoidal	5.00	1300	471.3	0.0	789.0	0.0	789.0	0.0	789.0
DN58	Trapezoidal	4.00	750	803.2	18.9	787.7	18.5	787.7	18.3	787.7
N75A SYSTEM										
CN75A	Circular	1.00	90	2.0	3.7	806.5	3.7	806.5	3.7	806.5
DN89B	Trapezoidal	5.00	600	843.1	0.0	799.8	0.0	799.8	0.0	799.8
N76 SYSTEM										
DN76	Trapezoidal	1.00	780	60.0	34.4	789.9	34.8	790.0	33.8	790.0
DN74B	Trapezoidal	1.00	2000	41.0	27.6	784.9	24.6	784.8	21.4	784.8
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	3.7	776.8	4.3	776.8	4.3	776.8
CN12	Circular	2.50	74	16.5	3.9	774.6	4.4	774.7	4.5	774.7
D132	Natural	3.33	2840	21.5	4.5	774.6	5.1	774.7	5.1	774.7
CN13	Circular	1.25	32	2.0	4.5	781.8	4.5	781.7	4.5	781.7
DM632	Natural	2.81	420	118.6	4.5	779.4	4.5	779.4	4.5	779.4
P633	Circular	3.00	74	32.0	0.0	779.1	0.0	779.1	0.0	779.1
P634	Circular	3.00	250	55.3	4.5	778.4	4.5	778.4	4.5	778.4
P635						776.1		776.1		776.1
P636	Circular	1.00	30	0.2	0.4	776.0	0.4	776.0	0.4	776.0
D637	Trapezoidal	1.50	60	43.5	2.9	775.0	2.6	775.0	2.8	775.0
D15	Natural	4.03	2140	58.5	13.6	774.9	14.1	775.0	14.8	775.0
CN15	Circular	3.00	66	48.9	13.9	774.8	14.3	774.9	14.2	774.9
DN157	Natural	4.86	550	119.9	15.2	774.7	15.4	774.7	15.3	774.7
CN16	Circular	3.00	47	9.1	40.4	774.7	37.6	774.8	37.8	774.8
DN165	Natural	6.10	2500	76.7	29.3	774.1	29.4	774.2	29.4	774.2
DN7	Natural	5.57	600	168.9	172.7	773.0	180.1	773.3	180.5	773.3
DN81	Natural	6.04	1150	504.2	66.2	771.1	136.3	771.7	135.8	771.7
CN8	Circular	5.00	29	368.3	67.0	771.0	-104.8	771.6	-112.7	771.6
DN83	Natural	6.30	820	811.0	68.0	770.9	259.6	772.1	274.0	772.1
CN7	Circular	4.00	266	79.8	52.4	770.9	-72.0	772.4	-75.7	772.4
CN7	Circular	4.00	274	53.5	54.7	770.9	-79.8	772.4	-83.4	772.4
DN77	Trapezoidal	4.50	33	1567.5	108.2	768.8	-156.5	772.8	-168.0	773.2
N87 SYSTEM										
DN87	Trapezoidal	1.00	100	31.5	0.0	801.3	0.0	801.3	0.0	801.3
DN89A	Trapezoidal	1.00	1470	24.0	9.4	797.7	9.4	797.7	9.4	797.7
N50 SYSTEM										
DN50	Natural	4.21	4090	26.2	30.1	780.2	29.6	780.2	29.6	780.2
CN2	Circular	4.00	26	153.2	30.0	778.1	29.6	778.6	29.6	778.6
DN502	Natural	3.80	550	56.9	30.0	777.9	-47.2	778.5	-70.4	778.5
N10 SYSTEM										
CN10	Circular	1.25	207	3.8	4.0	772.4	2.6	773.5	2.3	773.9

Table 4-3
Summary of Drainage System Capacity Analysis
Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	10-YEAR RECURRANCE INTERVAL STORM: Normal Lake Level Flow (cfs)	Normal Lake Level Water Elev. (NGVD)	25-Year Lake Level Flow (cfs)	25-Year Lake Level Water Elev. (NGVD)	100-Year Lake Level Flow (cfs)	100-Year Lake Level Water Elev. (NGVD)
IN2 SYSTEM										
SN1	Trapezoidal	0.20	80	95.4	12.5	809.9	12.4	809.9	12.4	809.9
CIN2B	Trapezoidal	1.00	600	243.5	17.0	807.8	17.0	807.8	17.0	807.8
N11 SYSTEM										
PN11	Circular	2.50	50	20.1	27.5	774.8	26.2	774.8	38.6	774.8
PN111	Circular	2.50	86	22.1	27.4	774.1	25.9	774.2	20.6	774.2
PN112	Circular	2.50	162	9.1	27.3	773.2	25.6	773.4	20.5	774.2
DN113	Natural	2.25	255	209.9	27.2	771.0	26.2	772.5	-2.3	773.0
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	31.4	784.5	31.4	784.5	31.4	784.5
P90	Circular	3.00	101	98.4	31.4	780.7	31.4	780.7	31.4	780.7
P90B	Circular	3.00	100	90.2	42.2	778.7	42.2	778.7	42.2	778.7
DN669	Natural	2.63	60	102.2	42.2	772.0	42.2	772.0	42.2	772.0
N68 SYSTEM										
DN68	Trapezoidal	3.00	770	124.7	1.0	783.4	1.9	783.4	1.8	783.4
N57 SYSTEM										
CN57	Circular	2.00	50	5.5	0.0	785.8	0.0	785.8	0.0	785.8
DN570	Trapezoidal	5.00	1300	471.3	0.0	789.0	0.0	789.0	0.0	789.0
DN58	Trapezoidal	4.00	750	803.2	37.8	788.0	37.4	788.0	37.1	788.0
N75A SYSTEM										
CN75A	Circular	1.00	90	2.0	5.0	809.0	5.0	809.0	5.0	809.0
DN89B	Trapezoidal	5.00	600	843.1	1.5	800.3	1.5	800.3	1.9	800.3
N76 SYSTEM										
DN76	Trapezoidal	1.00	780	60.0	59.6	790.0	57.5	790.0	54.0	790.0
DN74B	Trapezoidal	1.00	2000	41.0	41.0	785.0	41.0	785.0	38.8	785.0
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	7.8	777.2	10.4	777.1	7.7	777.2
CN12	Circular	2.50	74	16.5	7.8	775.3	10.2	775.7	7.8	775.3
D132	Natural	3.33	2840	21.5	9.2	775.2	10.9	775.5	9.2	775.2
CN13	Circular	1.25	32	2.0	4.5	782.7	4.5	782.7	4.5	782.7
DM632	Natural	2.81	420	118.6	4.5	779.4	4.5	779.4	4.5	779.4
P633	Circular	3.00	74	32.0	0.0	779.1	0.0	779.1	0.0	779.1
P634	Circular	3.00	250	55.3	4.5	778.4	4.5	778.4	4.5	778.4
P635						777.4		777.4		777.4
P636	Circular	1.00	30	0.2	0.6	777.1	0.6	777.1	0.6	777.1
D637	Trapezoidal	1.50	60	43.5	3.2	775.1	3.4	775.1	3.2	775.1
D15	Natural	4.03	2140	58.5	28.4	775.3	28.4	775.3	28.6	775.3
CN15	Circular	3.00	66	48.9	22.1	775.1	22.1	775.1	22.1	775.1
DN157	Natural	4.86	550	119.9	18.9	774.7	20.0	774.7	19.3	774.7
CN16	Circular	3.00	47	9.1	46.0	774.9	43.8	774.9	43.4	774.9
DN165	Natural	6.10	2500	76.7	29.7	774.2	29.5	774.2	29.5	774.2
DN7	Natural	5.57	600	168.9	242.6	773.6	229.8	773.6	224.3	773.6
DN81	Natural	6.04	1150	504.2	79.9	771.6	194.2	771.8	191.7	771.8
CN8	Circular	5.00	29	368.3	81.1	771.5	-83.6	771.6	-113.4	771.6
DN83	Natural	6.30	820	811.0	110.1	771.3	231.8	772.1	313.1	772.1
CN7	Circular	4.00	266	79.8	61.5	771.3	-62.7	772.3	-75.7	772.5
CN7	Circular	4.00	274	53.5	60.8	771.3	-70.7	772.3	-83.4	772.5
DN77	Trapezoidal	4.50	33	1567.5	123.1	768.8	-137.3	772.4	-168.1	773.2
N87 SYSTEM										
DN87	Trapezoidal	1.00	100	31.5	0.0	802.4	0.0	802.4	0.0	802.4
DN89A	Trapezoidal	1.00	1470	24.0	23.9	798.0	23.9	798.0	23.9	798.0
N50 SYSTEM										
DN50	Natural	4.21	4090	26.2	30.1	780.2	29.6	780.2	29.6	780.2
CN2	Circular	4.00	26	153.2	30.0	778.1	29.6	778.6	29.6	778.6
DN502	Natural	3.80	550	56.9	30.0	777.9	-47.2	778.5	-70.4	778.5
N10 SYSTEM										
CN10	Circular	1.25	207	3.8	5.3	774.9	4.4	775.7	4.2	776.0

Table 4-4
Summary of Drainage System Capacity Analysis

Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	25-YEAR RECURRANCE INTERVAL STORM: Normal Lake Level Flow (cfs)	Normal Lake Level Water Elev. (NGVD)	25-Year Lake Level Flow (cfs)	25-Year Lake Level Water Elev. (NGVD)	100-Year Lake Level Flow (cfs)	100-Year Lake Level Water Elev. (NGVD)
IN2 SYSTEM										
SN1	Trapezoidal	0.20	80	95.4	16.5	809.9	16.5	809.9	16.5	809.9
CIN2B	Trapezoidal	1.00	600	243.5	17.0	807.8	17.0	807.8	17.0	807.8
N11 SYSTEM										
PN11	Circular	2.50	50	20.1	27.6	774.8	26.1	774.8	38.1	774.8
PN111	Circular	2.50	86	22.1	27.5	774.1	25.7	774.2	21.5	774.2
PN112	Circular	2.50	162	9.1	27.3	773.2	25.6	773.4	20.1	774.2
DN113	Natural	2.25	255	209.9	27.2	771.0	26.4	772.5	-1.6	773.0
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	34.6	785.1	34.6	785.1	34.6	785.1
P90	Circular	3.00	101	98.4	34.6	780.9	34.6	780.9	34.6	780.9
P90B	Circular	3.00	100	90.2	48.2	778.9	48.2	778.9	48.2	778.9
DN669	Natural	2.63	60	102.2	48.2	772.1	48.2	772.1	48.2	772.1
N68 SYSTEM										
DN68	Trapezoidal	3.00	770	124.7	1.4	783.5	2.9	783.5	2.8	783.5
N57 SYSTEM										
CN57	Circular	2.00	50	5.5	0.0	786.4	0.0	786.4	0.0	785.8
DN570	Trapezoidal	5.00	1300	471.3	0.0	789.0	0.0	789.0	0.0	789.0
DN58	Trapezoidal	4.00	750	803.2	49.1	788.1	48.6	788.1	37.1	788.0
N75A SYSTEM										
CN75A	Circular	1.00	90	2.0	5.4	810.0	5.4	810.0	5.4	810.0
DN89B	Trapezoidal	5.00	600	843.1	2.8	800.4	2.8	800.4	3.1	800.3
N76 SYSTEM										
DN76	Trapezoidal	1.00	780	60.0	60.0	790.0	60.0	790.0	60.0	790.0
DN74B	Trapezoidal	1.00	2000	41.0	41.0	785.0	41.1	785.0	38.8	785.0
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	13.4	777.3	13.4	777.3	13.4	777.3
CN12	Circular	2.50	74	16.5	13.2	776.0	13.2	776.0	13.2	776.0
D132	Natural	3.33	2840	21.5	13.0	775.7	13.1	775.7	13.1	775.7
CN13	Circular	1.25	32	2.0	4.5	783.1	4.5	783.1	4.5	783.1
DM632	Natural	2.81	420	118.6	4.5	779.4	4.5	779.4	4.5	779.4
P633	Circular	3.00	74	32.0	0.0	779.1	0.0	779.1	0.0	779.1
P634	Circular	3.00	250	55.3	4.5	778.4	4.5	778.4	4.5	778.4
P635						778.0		778.0		778.0
P636	Circular	1.00	30	0.2	0.6	777.7	0.6	777.7	0.6	777.7
D637	Trapezoidal	1.50	60	43.5	3.7	775.1	3.8	775.1	3.5	775.1
D15	Natural	4.03	2140	58.5	29.8	775.3	30.0	775.3	29.8	775.3
CN15	Circular	3.00	66	48.9	22.2	775.1	22.2	775.1	22.2	775.1
DN157	Natural	4.86	550	119.9	22.4	774.7	22.7	774.7	22.7	774.7
CN16	Circular	3.00	47	9.1	46.7	774.9	44.7	774.9	44.2	774.9
DN165	Natural	6.10	2500	76.7	29.7	774.2	29.5	774.3	29.5	774.3
DN7	Natural	5.57	600	168.9	248.3	773.6	230.3	773.6	224.3	773.6
DN81	Natural	6.04	1150	504.2	134.1	771.7	221.3	771.8	219.2	771.8
CN8	Circular	5.00	29	368.3	81.5	771.6	-85.7	771.6	-113.4	771.6
DN83	Natural	6.30	820	811.0	111.8	771.5	233.9	772.1	313.9	772.1
CN7	Circular	4.00	266	79.8	64.7		-62.7		-75.7	
CN7	Circular	4.00	274	53.5	63.8		-70.7		-83.4	
DN77	Trapezoidal	4.50	33	1567.5	128.5	768.7	-137.3	772.4	-168.1	773.2
N87 SYSTEM										
DN87	Trapezoidal	1.00	100	31.5	0.0	802.9	0.0	802.9	0.0	802.9
DN89A	Trapezoidal	1.00	1470	24.0	24.0	798.2	24.0	798.2	24.0	798.2
N50 SYSTEM										
DN50	Natural	4.21	4090	26.2	30.1	780.2	29.6	780.2	29.6	780.2
CN2	Circular	4.00	26	153.2	30.0	778.1	29.6	778.6	29.6	778.6
DN502	Natural	3.80	550	56.9	30.0	777.9	-47.2	778.5	-70.4	778.5
N10 SYSTEM										
CN10	Circular	1.25	207	3.8	6.0	776.2	5.0	776.7	4.6	776.7

Table 4-5
Summary of Drainage System Capacity Analysis

Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	100-YEAR RECURRANCE INTERVAL STORM: Normal Lake Level Flow (cfs)	Normal Lake Level Water Elev. (NGVD)	25-Year Lake Level Flow (cfs)	25-Year Lake Level Water Elev. (NGVD)	100-Year Lake Level Flow (cfs)	100-Year Lake Level Water Elev. (NGVD)
N2 SYSTEM										
SN1	Trapezoidal	0.20	80	95.4	23.8	809.9	23.8	809.9	23.8	809.9
CN2B	Trapezoidal	1.00	600	243.5	17.0	807.8	17.0	807.8	17.0	807.8
N11 SYSTEM										
PN11	Circular	2.50	50	20.1	27.5	774.8	26.1	774.8	38.7	774.8
PN111	Circular	2.50	86	22.1	27.5	774.1	25.7	774.2	22.5	774.2
PN112	Circular	2.50	162	9.1	27.3	773.2	25.6	773.4	21.0	774.2
DN113	Natural	2.25	255	209.9	27.2	771.0	26.6	772.5	-1.5	773.0
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	38.1	786.2	38.2	786.2	38.2	786.2
P90	Circular	3.00	101	98.4	38.2	781.1	38.2	781.1	38.2	781.1
P90B	Circular	3.00	100	90.2	57.4	779.3	57.4	779.3	57.4	779.3
DN669	Natural	2.63	60	102.2	57.4	772.3	57.4	772.3	57.4	772.3
N68 SYSTEM										
DN68	Trapezoidal	3.00	770	124.7	2.5	783.7	4.9	783.6	4.9	783.6
N57 SYSTEM										
CN57	Circular	2.00	50	5.5	0.0	787.3	0.0	787.3	0.0	787.3
DN570	Trapezoidal	5.00	1300	471.3	0.0	789.0	0.0	789.0	0.0	789.0
DN58	Trapezoidal	4.00	750	803.2	69.3	788.3	69.0	788.3	68.7	788.3
N75A SYSTEM										
CN75A	Circular	1.00	90	2.0	5.8	811.0	5.8	811.0	5.8	811.0
DN89B	Trapezoidal	5.00	600	843.1	3.8	800.5	3.8	800.5	4.1	800.4
N76 SYSTEM										
DN76	Trapezoidal	1.00	780	60.0	60.0	790.0	60.0	790.0	60.0	790.0
DN74B	Trapezoidal	1.00	2000	41.0	41.0	785.0	41.0	785.0	38.8	785.0
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	15.1	777.7	18.1	777.6	18.1	777.6
CN12	Circular	2.50	74	16.5	14.8	776.2	17.7	776.6	17.7	776.6
D132	Natural	3.33	2840	21.5	14.7	775.8	17.4	776.0	17.3	776.0
CN13	Circular	1.25	32	2.0	4.5	783.7	4.5	783.7	4.5	783.7
DM632	Natural	2.81	420	118.6	4.5	779.4	4.5	779.4	4.5	779.4
P633	Circular	3.00	74	32.0	0.8	779.2	0.8	779.2	0.8	779.2
P634	Circular	3.00	250	55.3	4.6	779.1	4.6	779.1	4.6	779.1
P635						779.1		779.1		779.1
P636	Circular	1.00	30	0.2	0.7	778.6	0.7	778.6	0.7	778.6
D637	Trapezoidal	1.50	60	43.5	3.9	775.1	1.2	775.1	1.2	775.1
D15	Natural	4.03	2140	58.5	32.2	775.3	31.4	775.3	31.2	775.3
CN15	Circular	3.00	66	48.9	22.2	775.1	22.9	775.1	22.9	775.1
DN157	Natural	4.86	550	119.9	22.9	774.7	23.7	774.7	23.7	774.7
CN16	Circular	3.00	47	9.1	46.5	775.0	44.8	775.0	44.2	775.0
DN165	Natural	6.10	2500	76.7	29.6	774.3	29.5	774.3	29.5	774.3
DN7	Natural	5.57	600	168.9	248.8	773.6	230.3	773.6	224.4	773.6
DN81	Natural	6.04	1150	504.2	202.6	771.8	265.1	771.9	263.6	771.9
CN8	Circular	5.00	29	368.3	82.5	771.6	-89.1	771.6	-113.4	771.6
DN83	Natural	6.30	820	811.0	112.0	771.6	235.7	772.1	314.6	772.1
CN7	Circular	4.00	266	79.8	66.9		-62.7		-75.8	
CN7	Circular	4.00	274	53.5	67.6		-70.7		-83.4	
DN77	Trapezoidal	4.50	33	1567.5	134.5	768.7	-137.3	772.3	-160.2	773.0
N87 SYSTEM										
DN87	Trapezoidal	1.00	100	31.5	7.7	803.7	7.7	803.7	7.7	803.7
DN89A	Trapezoidal	1.00	1470	24.0	24.4	798.7	24.4	798.7	24.4	798.7
N50 SYSTEM										
DN50	Natural	4.21	4090	26.2	30.0	780.2	29.6	780.2	29.4	780.2
CN2	Circular	4.00	26	153.2	30.0	778.1	29.6	778.6	29.4	777.5
DN502	Natural	3.80	550	56.9	30.0	777.9	-47.2	778.5	29.3	777.3
N10 SYSTEM										
CN10	Circular	1.25	207	3.8	6.2	776.7	5.0	776.7	4.6	776.7

Table 4-6
Summary of Drainage System Capacity Analysis

Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	2-YEAR RECURRANCE INTERVAL STORM: Normal Lake Level Flow (cfs)	Normal Lake Level Water Elev. (NGVD)	25-Year Lake Level Flow (cfs)	25-Year Lake Level Water Elev. (NGVD)	100-Year Lake Level Flow (cfs)	100-Year Lake Level Water Elev. (NGVD)
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	24.03594	783.0127	24.0	783.0	24.0	783.0
P90	Circular	3.00	101	98.4	24.03611	780.3463	24.0	780 3	24.0	780.3
P90B	Circular	3.00	100	90.2	30 02498	778.3436	30.0	778.3	30.0	778 3
DN669	Natural	2.63	60	102.2	30 02884	771.7813	30 0	771.8	30 0	771 8
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	3.636384	776.7745	3.6	776 8	3 6	776.8
CN12	Circular	2 50	74	16.5	3.820828	774.6416	3 8	774.6	3.8	774 6
D132	Natural	3.33	2840	21.5	4 458923	774.6047	4.5	774.6	4 5	774 6
CN13	Circular	1.25	32	2.0	4.523122	781 7415	4.5	781.7	4.5	781 7
DM632	Natural	2.81	420	118.6	4.509686	779 4086	4.5	779.4	4.5	779 4
P633	Circular	3.00	74	32.0	0	779.1312	0.0	779 1	0.0	779.1
P634	Circular	3.00	250	55 3	4 508935	778.3638	4.5	778.4	4 5	778 4
P635						776.09		776.0891		776 1
P636	Circular	1 00	30	0.2	0.417445	776.0151	0.4	776.0	0.4	776.0
D637	Trapezoidal	1 50	60	43.5	2.887645	774.9512	2.7	774 9	2.7	775.0
D15	Natural	4.03	2140	58.5	13.58605	774.9456	13.8	775.0	13.7	774 9
CN15	Circular	3.00	66	48 9	13.86548	774 8486	14.1	774.9	14.1	774 9
DN157	Natural	4.86	550	119.9	15.13743	774.72	15.4	774.7	15.4	774.7
CN16	Circular	3 00	47	9 1	40.49676	774.7441	38.6	774 7	39.2	774.7
DN165	Natural	6.10	2500	76.7	29.29301	774.1213	29.4	774 1	29.3	774.1
DN7	Natural	5.57	600	168 9	172.688	772.9484	173.8	773.1	171.0	773 1
DN81	Natural	6.04	1150	504.2	66 15895	771.0773	124.9	771.7	116 4	771 6
CN8	Circular	5.00	29	368 3	67 02038	771.0479	-3 1	771.6	-3.1	771.6
DN83	Natural	6.30	820	811.0	67.98774	770.9127	139.1	771.9	151.4	772.1
CN7	Circular	4 00	266	79 8		770.89	27.1	771.9	11.4	772.2
CN7	Circular	4.00	274	53 5		770.89	26.7		10.4	
DN77	Trapezoidal	4.50	33	1567 5	108.1663	768 7944	-2205 4	771.4	-2919 7	771 4

Table 4-7
Summary of Drainage System Capacity Analysis

Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	10-YEAR RECURRANCE INTERVAL STORM — Normal Lake Level: Flow (cfs)	Normal Lake Level: Water Elev. (NGVD)	25-Year Lake Level: Flow (cfs)	25-Year Lake Level: Water Elev. (NGVD)	100-Year Lake Level: Flow (cfs)	100-Year Lake Level: Water Elev. (NGVD)
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	32.0	784.6	32.0	784.6	32.0	784.6
P90	Circular	3.00	101	98.4	32.1	780.7	32.0	780.7	32.0	780.7
P90B	Circular	3.00	100	90.2	42.8	778.8	42.8	778.8	42.8	778.8
DN669	Natural	2.63	60	102.2	42.8	772.0	42.8	772.0	42.8	772.0
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	7.8	777.2	7.8	777.2	7.8	777.2
CN12	Circular	2.50	74	16.5	7.8	775.3	7.8	775.3	7.8	775.3
D132	Natural	3.33	2840	21.5	9.2	775.2	9.2	775.2	9.2	775.2
CN13	Circular	1.25	32	2.0	4.5	782.7	4.5	782.7	4.5	782.7
DM632	Natural	2.81	420	118.6	4.5	779.4	4.5	779.4	4.5	779.4
P633	Circular	3.00	74	32.0	0.0	779.1	0.0	779.1	0.0	779.1
P634	Circular	3.00	250	55.3	4.5	778.4	4.5	778.4	4.5	778.4
P635						777.4		777.4		777.4
P636	Circular	1.00	30	0.2	0.6	777.2	0.6	777.1	0.6	777.2
D637	Trapezoidal	1.50	60	43.5	3.6	775.1	3.1	775.1	3.3	775.1
D15	Natural	4.03	2140	58.5	28.4	775.3	28.4	775.3	28.4	775.3
CN15	Circular	3.00	66	48.9	22.1	775.1	22.1	775.1	22.1	775.1
DN157	Natural	4.86	550	119.9	19.0	774.7	19.1	774.7	19.1	774.7
CN16	Circular	3.00	47	9.1	46.0	774.9	45.5	774.9	45.8	774.9
DN165	Natural	6.10	2500	76.7	29.7	774.2	29.6	774.2	29.5	774.2
DN7	Natural	5.57	600	168.9	242.6	773.6	234.0	773.6	232.1	773.6
DN81	Natural	6.04	1150	504.2	79.9	771.6	179.1	771.7	169.5	771.7
CN8	Circular	5.00	29	368.3	81.2	771.5	-7.4	771.6	-7.4	771.6
DN83	Natural	6.30	820	811.0	110.1	771.3	152.5	772.1	198.5	772.1
CN7	Circular	4.00	266	79.8	61.5	771.3	47.2	772.2	26.0	772.3
CN7	Circular	4.00	274	53.5	60.8		46.5		25.1	
DN77	Trapezoidal	4.50	33	1567.5	123.3	768.8	-2205.3	771.4	-2919.7	771.4

Table 4-8
Summary of Drainage System Capacity Analysis

Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	25-YEAR RECURRANCE INTERVAL STORM: Normal Lake Level Flow (cfs)	Normal Lake Level Water Elev. (NGVD)	25-Year Lake Level Flow (cfs)	25-Year Lake Level Water Elev. (NGVD)	100-Year Lake Level Flow (cfs)	100-Year Lake Level Water Elev. (NGVD)
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	35.1	785.3	35.1	785.2	35.1	785.2
P90	Circular	3.00	101	98.4	35.1	780.9	35.1	780.9	35.1	780.9
P90B	Circular	3.00	100	90.2	48.7	778.9	48.7	779.0	48.7	779.0
DN669	Natural	2.63	60	102.2	48.7	772.1	48.7	772.1	48.7	772.1
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	13.4	777.3	13.4	777.3	13.4	777.3
CN12	Circular	2.50	74	16.5	13.2	776.0	13.2	776.0	13.2	776.0
D132	Natural	3.33	2840	21.5	13.0	775.7	13.1	775.7	13.0	775.7
CN13	Circular	1.25	32	2.0	4.5	783.1	4.5	783.1	4.5	783.1
DM632	Natural	2.81	420	118.6	4.5	779.4	4.5	779.4	4.5	779.4
P633	Circular	3.00	74	32.0	0.0	779.1	0.0	779.1	0.0	779.1
P634	Circular	3.00	250	55.3	4.5	778.4	4.5	778.4	4.5	778.4
P635						778.0		778.0		778.0
P636	Circular	1.00	30	0.2	0.6	777.7	0.6	777.7	0.6	777.7
D637	Trapezoidal	1.50	60	43.5	3.7	775.1	3.7	775.1	3.7	775.1
D15	Natural	4.03	2140	58.5	29.8	775.3	30.3	775.3	30.1	775.3
CN15	Circular	3.00	66	48.9	22.2	775.1	22.2	775.1	22.2	775.1
DN157	Natural	4.86	550	119.9	22.4	774.7	22.6	774.7	22.6	774.7
CN16	Circular	3.00	47	9.1	46.7	774.9	46.3	774.9	46.5	774.9
DN165	Natural	6.10	2500	76.7	29.7	774.2	29.6	774.2	29.5	774.2
DN7	Natural	5.57	600	168.9	248.3	773.6	234.3	773.6	234.1	773.6
DN81	Natural	6.04	1150	504.2	134.1	771.7	207.2	771.8	198.1	771.8
CN8	Circular	5.00	29	368.3	81.5	771.6	-11.4	771.6	-11.4	771.6
DN83	Natural	6.30	820	811.0	111.8	771.5	158.0	772.1	199.4	772.1
CN7	Circular	4.00	266	79.8	64.7	771.5	47.2	772.2	25.9	772.3
CN7	Circular	4.00	274	53.5	63.8		46.5		25.1	
DN77	Trapezoidal	4.50	33	1567.5	128.5	768.7	-2205.3	771.4	-2919.7	771.4

Table 4-9
Summary of Drainage System Capacity Analysis

Town of Norway

Conduit Number	Conduit Shape	Conduit Diameter/ Depth (ft/ft)	Conduit Length (feet)	Conduit Capacity (cfs)	100-YEAR RECURRANCE INTERVAL STORM: Normal Lake Level Flow (cfs)	100-YEAR RECURRANCE INTERVAL STORM: Normal Lake Level Water Elev. (NGVD)	100-YEAR RECURRANCE INTERVAL STORM: 25-Year Lake Level Flow (cfs)	100-YEAR RECURRANCE INTERVAL STORM: 25-Year Lake Level Water Elev. (NGVD)	100-YEAR RECURRANCE INTERVAL STORM: 100-Year Lake Level Flow (cfs)	100-YEAR RECURRANCE INTERVAL STORM: 100-Year Lake Level Water Elev. (NGVD)
N60 SYSTEM										
P90A	Circular	2.00	90	31.4	38.4	786.2	38.4	786.2	38.4	786 2
P90	Circular	3.00	101	98.4	38 4	781.1	38.4	781.1	38 4	781 1
P90B	Circular	3 00	100	90 2	57 7	779.3	57.7	779 3	57 7	779 3
DN669	Natural	2.63	60	102.2	57.7	772 3	57.7	772 3	57 7	772 3
N12 SYSTEM										
DN12	Natural	6.46	1160	212.5	15 1	777.7	18.1	777 6	18.1	777 6
CN12	Circular	2.50	74	16.5	14.8	776.2	17.7	776.6	17.7	776 6
D132	Natural	3 33	2840	21.5	14.7	775 8	17.4	776.0	17 4	776 0
CN13	Circular	1.25	32	2.0	4 5	783 7	4.5	783 7	4.5	783 7
DM632	Natural	2.81	420	118.6	4 5	779.4	4.5	779.4	4 5	779 4
P633	Circular	3.00	74	32.0	0 8	779.2	0.8	779.2	0 8	779.2
P634	Circular	3 00	250	55 3	4.6	779 1	4 6	779 1	4 6	779 1
P635						779 1		779.1		779 1
P636	Circular	1.00	30	0 2	0 7	778.6	0 7	778 6	0 7	778.6
D637	Trapezoidal	1.50	60	43.5	3.9	775.1	0.9	775 1	0 9	775 1
D15	Natural	4.03	2140	58.5	32 3	775 3	31.7	775 3	31 4	775 3
CN15	Circular	3.00	66	48 9	22 2	775.1	22.8	775 1	22 8	775.1
DN157	Natural	4 86	550	119 9	23.0	774 7	23 5	774 7	23 5	774 7
CN16	Circular	3.00	47	9.1	46.5	775.0	46 3	775 0	46.5	775.0
DN165	Natural	6.10	2500	76.7	29 6	774.3	29.6	774 3	29.5	774 3
DN7	Natural	5.57	600	168.9	248 9	773 6	234.6	773 6	234.7	773.6
DN81	Natural	6.04	1150	504 2	202 6	771.8	253.7	771.9	246 1	771.9
CN8	Circular	5.00	29	368 3	82.5	771.6	-17.1	771.6	-17 1	771 6
DN83	Natural	6 30	820	811.0	112 0	771 7	154.8	772 1	197.8	772 1
CN7	Circular	4.00	266	79 8	66.9	771.7	47.3	772 2	26.0	772 2
CN7	Circular	4.00	274	53.5	67.6		46.6		25 1	
DN77	Trapezoidal	4.50	33	1567 5	134.5	768 7	-2205 3	771 4	-2919.7	771.4

TABLE 4-10
SUMMARY OF DRAINAGE SYSTEM CAPACITY ANALYSIS FLOODING PROBLEMS

Location	Extent of Flooding	Reason for Problem	Comments
N11- West Loomis Road, Harbor Point	overtops road in 2-yr storm	insufficient pipe capacity	verification from residents
IN2 - Settler Road	overtops road in 2-yr storm	culvert has been opened, but water cannot drain away	verification from residents
M631 - north of Muskego Dam Road	overtops road in 2-yr storm	insufficient culvert, pipes downstream back pitched	verification from residents
N16 - west of Muskego Dam Road	within 1ft. of road in 2-yr storm-overtops in 100-yr	insufficient culvert capacity	
N155 - south of Muskego Dam Road	within 1 ft. of road in 10-yr but does not overtop	insufficient culvert capacity	
N50- Iverson Rd. west of Long Lake	within 1 ft. of road in with 25-yr + lake levels	high lake levels	
N10- north of West Loomis Road	within 1ft. of road in 10-yr storm, 100-yr lake level, overtops in 25-yr storm - 25-yr level	insufficient pipe capacity	residents have not witnessed any flooding

INTRODUCTION

The purpose of this analysis is to identify and quantify the amount of nonpoint source pollution runoff in the project area. Pollution sources identified in this analysis include:

- urban stormwater runoff
- agricultural upland erosion
- streambank erosion.

URBAN STORMWATER RUNOFF MODELING

For water quality simulation, the "Source Loading and Management Model" (SLAMM), developed by the Wisconsin Department of Natural Resources (WDNR) for use in the State's Nonpoint Source Pollution Abatement Program, was selected. The model was selected for several reasons, including:

- ♦ The model has been calibrated with extensive water quality monitoring conducted in southeastern Wisconsin. Thus, the model has been shown to accurately predict nonpoint source pollutant loads from urban areas in Wisconsin.

- ♦ The model was used in the development of the *Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project*. Thus, the results of the analysis conducted in the Town of Norway project area can be compared to the previous studies.

- ♦ The model is used extensively in nonpoint source pollution and stormwater management studies in Wisconsin, thus, the analysis is consistent with other studies.

Background Information

Information used as input to SLAMM included:

- ♦ Land use
- ♦ Hydrologic soil grouping
- ♦ Drainage system
- ♦ Existing stormwater control practices
- ♦ Annual rainfall

All of these parameters are discussed in Chapter 3 except for existing stormwater control practices.

Currently stormwater control practices such as street sweeping and catch basin cleaning are not conducted since most of the project area does not have a curb and gutter drainage system. Street sweepers require a gutter to effectively pick up sediment from the street.

Using the input data, SLAMM estimates for each sub-basin the annual loading (e.g., pounds or tons per year) of three types of pollutants to the Town of Norway project area drainage system and, ultimately, to Wind, Kee-Nong-Go-Mong and Waubeesee Lakes. The pollutants analyzed for this project are sediments, nutrients (phosphorous), and heavy metals (zinc). As a result of the analysis, each sub-basin had a pollutant load estimated (for each of the three pollutants) under 1997 (existing) and future land use conditions.

AGRICULTURAL UPLAND EROSION

The basis for the estimation of agricultural erosion was the Universal Soil Loss Equation (USLE). The USLE estimates annual soil erosion on a given field based upon rainfall intensity, soil type, flow length and slope, tillage practice, crop rotation, and cropping system. The USLE estimates the amount of sediment eroding from a field but it does not predict how much of that sediment actually reaches a water body. Much of the eroded sediment is deposited downslope on other fields, on densely vegetated areas, or in slow moving drainage ways.

For much of the agricultural lands in the watershed, soil loss rate calculations were available from the Land Conservation Department (LCD) farm plans for both Racine and Waukesha Counties. Farm plans for reduction of soil erosion are required by a number of state and federal programs which are administered by the LCD. These programs include the Nonpoint Source Pollution Abatement Program and the Farmland Preservation Program. For areas where farm plans were not available, loss rates from similar, adjacent fields were used.

To estimate the amount of soil erosion delivered to the water bodies in the project area, the results of a sediment yield computer model were used. The model, WINHUSLE, developed by the WDNR and the U.S. Soil Conservation Service, takes the results of the basic USLE equation and estimates the delivery of sediment to water bodies. WINHUSLE analysis was conducted in the *Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project*. Sediment delivery ratios calculated in this WINHUSLE analysis were used to develop delivery ratios in the Town of Norway project area which were not included in the Priority Watershed analysis.

STREAMBANK EROSION

Streambank erosion does not appear to be a significant contributor of nonpoint source pollution in this project area. Streambank erosion was identified by field investigation and in the streambank erosion inventory conducted in the Muskego-Wind Lakes Priority Watershed Project.

The streambank erosion inventory of the Muskego-Wind Lakes Priority Watershed Project identified only the Muskego Canal as a problem site in the Town of Norway project area. It is estimated that the Muskego Canal contributes 18 tons per year of sediment. An analysis of alternatives to mitigate the streambank erosion along the Muskego Canal is being conducted independently of this project.

Field investigations were conducted to locate areas of streambank erosion exclusive of the Muskego Canal (Figure 5-1). The major streams and drainage ways investigated include:

- stream segment 1, west tributary to the Muskego Canal which parallels Muskego Dam Road,

- stream segment 2, branch of the Goose Lake Branch Canal connecting to the northeast end of Wind Lake,
- tributary which connects to the west side of Kee-Nong-Go-Mong Lake,
- the Anderson Canal connecting Kee-Nong-Go-Mong Lake to Waubeesee Lake.

In general, the streams and ditches have little erosion with well vegetated banks and relatively flat grades. Three locations of erosion were identified.

- Site 1 in stream segment 1, east of Racine Avenue and south of Muskego Dam Road. Erosion in an area of fill material where no vegetation is established. Approximately 50 feet long, six foot high banks and a 10 foot recession.

- Site 2 in stream segment 1, downstream of the Creekside sub-division detention pond. Heavily shaded area with signs of minor bank erosion. Possibly increased flows due to development. Approximately 50 feet long, 14 inch high banks and a 12 inch recession.

- Site 3 in stream segment 1, approximately 200 yards upstream from Highway 36. Heavily shaded area. Little erosion but an area of no vegetation due to shade. Organic soils. Approximately 75 feet long, eight feet long with banks rising gently 2.5 feet.

These areas of stream bank erosion are a relatively minor source of nonpoint source pollution, and quantities of erosion were not estimated.

SUMMARY OF ANALYSES OF LOADINGS BY LAND USE

Tables 5-1 and 5-2, and Figures 5-2 and 5-3 compare the results of the nonpoint source pollution loading for 1997 and future land use conditions. Under 1997 conditions, agricultural land uses contribute the majority of the sediment and phosphorus (56 percent and 51 percent respectively). Under future conditions, these agricultural land use contributions drop below 50 percent (43 percent for sediment and 39 percent for phosphorus). Heavy metal (zinc) loadings are almost exclusively from urban land use areas.

Table 5-1
Existing Nonpoint Source Pollutant Loads
Town of Norway Stormwater Project

Land Use	Area		Sediment		Phosphorus		Zinc	
	(acres)	%	(tons/yr)	%	(lbs/yr)	%	(lbs/yr)	%
Agricultural	946.35	23.8%	91.74	51.6%	588.98	47.2%	----	---
Residential	1209.05	30.4%	39.68	22.3%	448.57	36.0%	360.26	66.2%
Commercial	66.72	1.7%	31.40	17.7%	122.57	9.8%	91.38	16.8%
Highway	41.86	1.1%	12.82	7.2%	51.87	4.2%	70.82	13.0%
Institutional	3.15	0.1%	0.60	0.3%	4.77	0.4%	3.13	0.6%
Open Space	672.47	16.9%	1.01	0.6%	20.17	1.6%	12.78	2.3%
Wetland	710.42	17.9%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Woods	326.29	8.2%	0.49	0.3%	9.79	0.8%	6.20	1.1%
Total	3976.32		177.74		1246.73		544.57	

Table 5-2
Future Nonpoint Source Pollutant Loads
Town of Norway Stormwater Project

Land Use	Area		Sediment		Phosphorus		Zinc	
	(acres)	%	(tons/yr)	%	(lbs/yr)	%	(lbs/yr)	%
Agricultural	769.36	19.4%	76.84	39.6%	493.14	35.2%	---	---
Residential	1407	35.4%	45.78	23.6%	517	36.9%	416.03	62.6%
Commercial	80.67	2.0%	37.65	19.4%	146.86	10.5%	109.59	16.5%
Industrial	47.65	1.2%	16.69	8.6%	145.96	10.4%	49.03	7.4%
Highway	44.72	1.1%	13.70	7.1%	55.47	4.0%	75.70	11.4%
Institutional	11.21	0.3%	1.90	1.0%	15.69	1.1%	10.28	1.5%
Open Space	524.93	13.2%	0.79	0.4%	15.75	1.1%	2.62	0.4%
Wetland	769.31	19.4%	0.00	0.0%	0.00	0.0%	0.00	0.0%
Woods	319.78	8.0%	0.48	0.2%	9.59	0.7%	1.60	0.2%
Total	**3974.64**		**193.83**		**1399.45**		**664.86**	
Percent change over existing loads			9%		12%		22%	

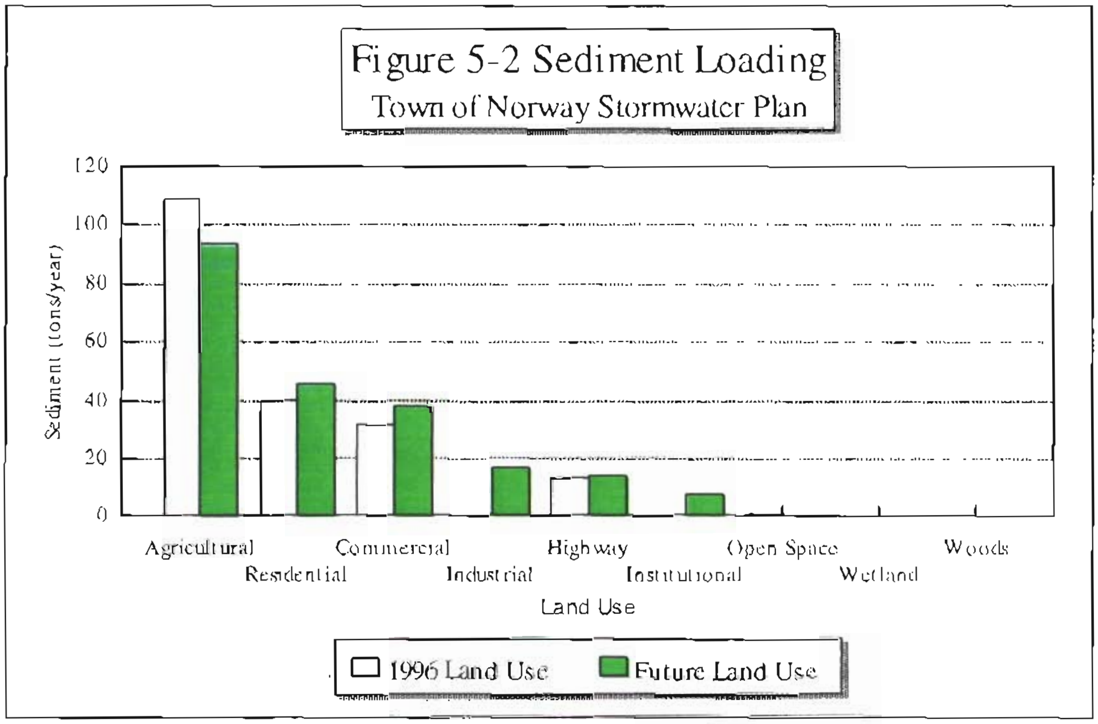
Figure 5-2 Sediment Loading
Town of Norway Stormwater Plan
Sediment (tons/year)
120
100
80
60
40
20
0
Agricultural
Residential
Commercial
Industrial
Highway
Institutional
Open Space
Wetland
Woods
Land Use
1996 Land Use
Future Land Use

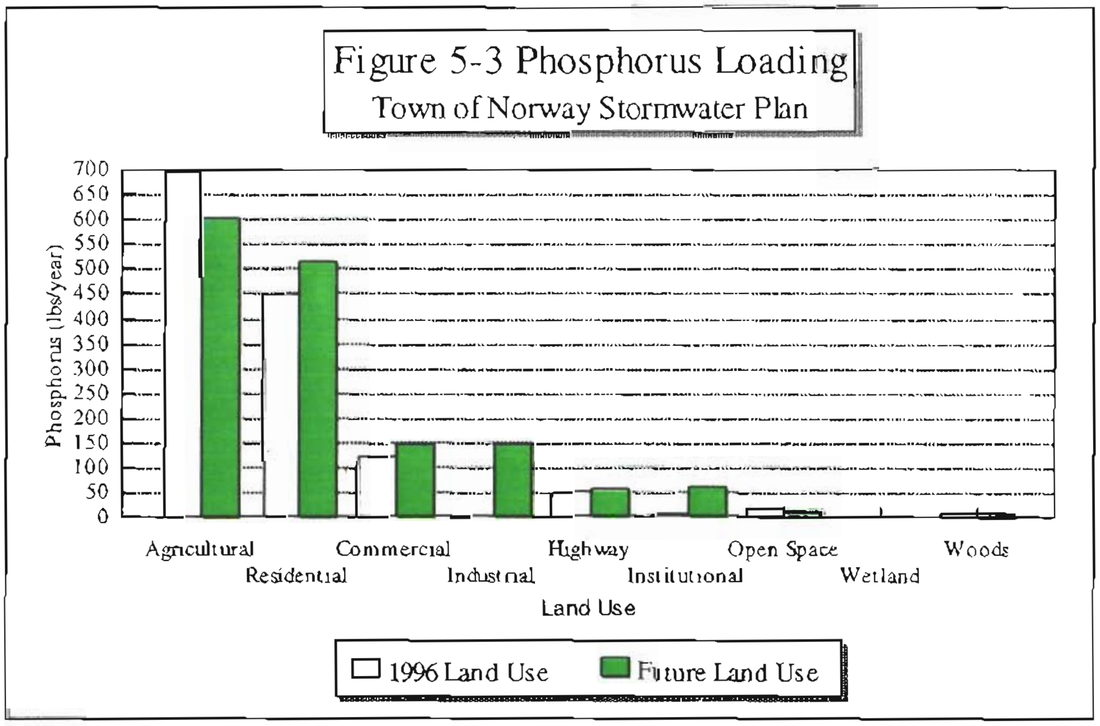
Figure 5-3 Phosphorus Loading
Town of Norway Stormwater Plan
Phosphorus (lbs/year)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Agricultural
Residential
Commercial
Industrial
Highway
Institutional
Open Space
Wetland
Woods
Land Use
1996 Land Use
Future Land Use

Chapter 5

IDENTIFYING CRITICAL NONPOINT SOURCE POLLUTION SUB-BASINS

Introduction

The most cost effective way of reducing nonpoint source pollution is by targeting the areas contributing the most pollution. As part of this analysis, the sub-basins which contribute the most pollution on a per acre basis were identified. Critical basins are those sub-basins which are critical to meeting the nonpoint source pollution reduction goals. Hypothetically, if the high pollutant loadings from the critical basins were reduced to a reasonable extent, then the water quality goals would be met.

The project area was divided into three sub-watersheds, each corresponding to the three lakes. Each lake sub-watershed has its own water quality goal, and by association, their own group of critical basins. As discussed in Chapter 3, the water quality goal for Wind Lake is to reduce nonpoint source loading of sediment by 57 percent and phosphorus by 49 percent. The water quality goal for Kee-Nong-Go-Mong Lake is to reduce nonpoint source loading of sediment and phosphorus by 40 to 60 percent. The water quality goal for Waubeesee Lake is to prevent future increases in nonpoint source loadings of sediment and phosphorus from present levels.

Identifying Critical Sources of Nonpoint Pollution

1. The nonpoint source loadings for 1997 conditions (both urban and agricultural) are calculated for each lake sub-watershed (Table 5-3). From these sub-totals, the **target nonpoint pollutant loadings** which accomplish the water quality goals are established. For instance, the sediment reduction goal for the Wind Lake sub-watershed is 57 percent. A reduction of the 1997 sediment load of 102 tons/year by 57 percent leads to a target sediment loading of 44 tons/year.

2. Critical sub-basins are identified under future land use conditions. Typically, pollutant loadings increase in the change from existing to future land uses. A per acre pollutant load (**unit area load**) is calculated for each sub-basin (Table 5-4). The sub-basins are ranked from the highest unit area load to the lowest on a lake sub-watershed basis.

3. A **target pollutant reduction** under future conditions is calculated. This is the amount that future loadings needs to be reduced to meet the target pollutant loading.

4. Going from the top of the ranked sub-basins to the bottom, the pollutant loadings are added to each successive sub-basin (**cumulative loadings**). The **critical basins** are the group of sub-basins whose reduction of cumulative loading results in meeting the target pollutant reduction. The cumulative loading for this group is greater than the target pollutant reduction, since in reality, a 100 percent reduction of the pollutants from a sub-basin cannot be achieved. It is assumed that sediment can be reduced by 80 percent from a given area with proper wet detention treatment. The **critical basins** are that group of sub-basins whose cumulative loading of sediment, which, if treated at an 80 percent, efficiency meet the target pollutant reduction. The critical basins are those sub-basins at or above the shaded line, as shown in Table 5-4 and Figure 5-4.

Table 5-3
Nonpoint Source Loadings under Existing Conditions
Town of Norway

Basin ID	Area: Total (acres)	Area: non-crop (acres)	Area: cropland (acres)	Sediment: non-crop (tons/yr)	Sediment: cropland (tons/yr)	Phosphorus: non-crop (lbs/yr)	Phosphorus: cropland (lbs/yr)	Zinc: non-crop (lbs/yr)
Wind Lake								
D00	0.74	0.74		0.22		0.90		1.21
M63	33.12	17.72	15.40	0.64	[illegible]	2.37	7.58	5.80
M70	367.34	167.44	199.90	11.40	[illegible]	53.06	83.40	40.73
M76	2.73	1.08	1.65	0.00	0.42	0.03	2.78	0.02
N10	22.84	22.84		0.43		5.01		3.96
N11	64.85	64.85		2.00		25.98		22.23
N12	180.70	61.87	118.83	0.88	22.49	9.57	80.19	7.76
N15	88.43	66.53	21.90	1.98	2.50	22.43	16.05	17.99
N16	62.29	9.58	52.71	0.31	3.74	3.58	23.98	2.86
N60	34.07	29.94	4.13	6.60	0.54	30.02	3.45	23.64
N62	79.69	78.50	1.19	3.40	0.08	25.60	0.53	24.52
N63	42.45	42.45		1.07		11.56		9.19
N64	15.11	15.11		2.01		8.58		10.95
N65	32.63	32.63		4.44		21.64		19.12
N66	9.12	9.12		2.79		11.36		15.33
N7	145.44	127.15	18.29	0.19	[illegible]	3.73	8.22	2.36
N70	21.26	21.26		1.15		11.35		8.32
N71	50.19	50.19		1.18		13.20		10.48
N79	76.61	76.61		[illegible]		14.33		11.44
N8	247.45	183.65	63.80	3.25	2.19	29.36	14.06	26.99
N80	99.00	80.24	18.76	0.74	[illegible]	8.31	8.43	6.47
N81	22.56	22.56		0.20		7.45		1.91
N81-A	8.59	8.59		0.22		2.19		1.99
N82	20.46	20.46		0.55		6.36		5.07
N83	24.36	24.36		0.48		5.56		4.38
N84	62.31	62.31		2.42		13.89		10.64
N85	45.00	45.00		1.77		8.93		6.73
N86	23.77	23.77		0.91		7.52		6.79
Sub-total	1878.13	1361.57	516.56	53.57	38.72	363.72	248.59	308.89
				Sed. Total	92.29	Phos. Total	612.31	
Pollution Reduction Goal					57%		49%	
Target Pollutant Loading					39.68		312.28	
Kee-Nong-Go-Mong								
N50	431.88	245.88	186.00	1.15	20.64	10.08	132.51	7.47
N51	182.23	153.93	28.30	0.60	4.06	7.48	26.07	5.74
N53	353.41	287.91	65.50	5.10	8.51	59.11	54.63	46.87
N54	78.85	68.60	10.25	0.98	1.33	11.58	8.55	9.35
N75	36.37	36.37		0.80		9.29		7.37
N77	32.00	24.90	7.10	0.23	1.46	2.86	9.37	2.20
N87	74.43	62.30	12.13	0.78	1.58	9.27	10.12	7.22
N89	314.77	295.51	19.26	2.31	2.55	28.41	16.07	21.92
Sub-total	1503.92	1175.38	328.54	11.96	40.08	138.10	257.32	108.15
				Sed. Total	52.04	Phos. Total	395.42	
Pollution Reduction Goal					40%		40%	
Target Pollutant Loading					31.22		237.25	
Wauheesee								
DN-2	9.86	8.06	1.80	0.26	0.26	2.93	1.67	2.34
N57	56.78	56.78		2.70		27.39		13.40
N58	29.46	29.46		1.09		12.22		9.86
N59	32.18	32.18		2.88		15.12		11.56
N68	31.34	31.34		6.79		30.10		28.39
N73	40.00	40.00		0.64		7.62		5.98
N74	190.77	190.77		4.14		47.53		37.86
N76	75.51	62.91	12.60	1.24	0.78	14.48	5.01	11.44
Sub-total	465.91	451.51	14.40	19.74	1.04	147.42	6.68	120.84
				Sed. Total	20.78	Phos. Total	154.10	
External Flow								
N78	83.48	29.58	53.90	0.41	6.36	4.94	40.83	3.86
N88	44.89	12.99	31.90	0.31	5.54	3.57	35.57	2.83
Sub-total	128.37	42.57	85.80	0.72	11.90	8.51	76.40	6.69
Total	3976.33	3031.03	945.30	85.99	91.74	657.74	588.99	544.57

Table 5-4
Nonpoint Source Loadings under Future Conditions
Town of Norway

Basin ID	Area	Sediment		Phosphorus		Zinc	Cumulative Sediment	Cumulative hosphorous
	(acres)	(tons/yr)	(tons/ac/yr)	(lbs/yr)	(lbs/ac/yr)	(lbs/yr)		
			Wind Lake					
N66	9.12	2.79	0.31	11.36	1.25	15.33	2.79	11.36
H02	0.74	0.22	0.30	0.90	1.22	1.21	3.01	12.26
N60	34.07	8.76	0.26	38.31	1.12	29.80	11.77	50.57
M76	2.75	0.42	0.15	2.73	1.00	0.62	12.19	53.30
N15	88.45	4.48	0.05	38.48	0.44	17.99	16.67	91.78
N65	32.63	4.44	0.14	21.64	0.66	19.12	21.11	113.42
N64	15.11	2.01	0.13	8.58	0.57	10.95	23.12	122.00
N8	247.45	28.83	0.12	211.71	0.86	98.87	51.95	333.70
M70	362.54	20.61	0.06	129.53	0.36	52.70	72.56	463.23
N12	180.70	5.73	0.03	58.08	0.32	18.60	78.29	521.31
N16	62.29	3.47	0.06	25.64	0.41	6.33	81.77	546.96
N70	21.26	1.15	0.05	11.15	0.52	8.32	82.91	558.10
N11	64.85	3.00	0.05	25.99	0.40	22.24	85.91	584.09
N62	79.69	3.65	0.05	26.65	0.33	25.36	89.56	610.74
N85	45.00	1.76	0.04	8.92	0.20	6.72	91.33	619.66
M63	33.12	1.28	0.04	12.74	0.38	8.76	92.60	632.40
N86	23.77	0.91	0.04	7.52	0.32	6.79	93.52	639.92
N84	62.31	2.38	0.04	13.75	0.22	10.54	95.90	653.67
N82	20.46	0.55	0.03	6.36	0.31	5.07	96.46	660.03
N81-A	8.59	0.22	0.03	2.49	0.29	1.94	96.67	662.52
N63	42.45	1.07	0.03	11.56	0.27	9.19	97.74	674.08
N7	145.44	3.61	0.02	23.35	0.16	1.86	101.35	697.42
N71	50.19	1.18	0.02	13.20	0.26	17.18	102.53	710.63
N80	99.00	2.05	0.02	16.74	0.17	6.47	104.58	727.37
N83	24.36	0.48	0.02	5.50	0.23	4.38	105.06	732.86
N10	32.84	0.43	0.02	5.01	0.22	3.96	105.49	737.88
N79	76.61	1.33	0.02	14.33	0.19	11.44	106.82	752.21
N81	22.56	0.20	0.01	2.45	0.11	.91	107.02	754.66
Sub-total	1878.13	107.02		754.66		416.40		
Target Loading		39.68		312.28				
Target Reduction		67.34		442.38				
			Kee-Nong-Go-Mong					
N50	431.88	21.79	0.05	142.59	0.33	7.47	21.79	142.59
N77	32.00	1.69	0.05	12.23	0.38	2.20	23.48	154.82
N53	353.41	14.03	0.04	118.27	0.33	50.58	37.51	273.09
N52	74.43	2.36	0.03	19.39	0.26	7.22	39.87	292.48
N54	78.85	2.31	0.03	20.14	0.26	9.35	42.18	312.62
N51	182.23	4.66	0.03	33.55	0.18	5.74	46.84	346.16
N75	36.37	0.80	0.02	9.29	0.26	7.37	47.65	355.46
N89	314.77	4.81	0.02	44.48	0.14	21.92	52.46	399.94
Sub-total	1503.92	52.46		399.94		111.85		
Target Loading		31.22		237.25				
Target Reduction		21.24		162.69				
			Waubeesee					
N59	32.18	6.08	0.19	33.42	1.04	24.13	6.08	33.42
N68	31.34	4.80	0.15	23.57	0.75	23.61	10.87	56.99
IN-2	9.86	0.52	0.05	4.42	0.45	2.34	11.39	61.41
N57	56.78	2.70	0.05	17.39	0.31	13.40	14.09	78.80
N58	29.46	1.09	0.04	12.23	0.42	9.87	15.18	91.03
N76	75.51	2.02	0.03	19.48	0.26	11.43	17.20	110.51
N74	190.77	4.33	0.02	49.54	0.26	39.52	21.53	160.05
N73	40.00	0.64	0.02	7.62	0.19	5.98	22.18	167.67
Sub-total	465.91	22.18		167.67		130.28		
Target Loading		20.78		154.10				
Target Reduction		1.40		13.57				
			External Flow					
N78	83.48	6.77	0.08	45.77	0.55	3.86		
N88	44.89	5.85	0.13	39.14	0.87	2.83		
Sub-total	128.37	12.62		84.91		6.69		
Total	3976.33	194.28	0.00	1407.18	0.00	665.23		

6 Development and Evaluation of Stormwater Management Alternatives

INTRODUCTION

This chapter presents the development and evaluation of management alternatives for urban stormwater quality, flooding problem areas, agricultural upland erosion, and streambank erosion. These alternatives are then incorporated in a plan which addresses the project's water quality and flooding objectives.

URBAN STORMWATER NONPOINT SOURCE POLLUTION MANAGEMENT

Nonstructural Control Methods

Nonstructural control methods include stormwater management methods which are not physical infrastructure. The two most typical nonstructural control methods in urban settings are street sweeping and catch basin cleaning. These two methods are not appropriate for the Town of Norway study area. The study area has a ditch and swale drainage system and these methods work only in areas served by a curb and gutter drainage system. Street sweepers require a curb to brush street debris up against and catch basins are part of curb and gutter storm sewer systems.

There are other activities which can improve stormwater management which will be discussed in the recommended plans for the three lakes. These include: enaction and enforcement of stormwater and construction site erosion control ordinances; Town operation and maintenance; hazardous materials handling; illicit discharge detection; prioritizing and tracking critical areas; education and information; monitoring; and annual reporting.

Structural Control Methods

Structural control measures analyzed for this project included wet detention ponds, constructed wetland treatment systems, bioswales, enhancement of existing wetlands, and storm sewer inlet filters. Pollution reduction performance and costs of these structural measures were estimated in order to determine the best alternatives.

Wet Detention Ponds

Wet detention ponds are sized based on the size and types of land uses of the watershed which it serves (Pitt, 1993). Design criteria include a permanent pool depth of 3-8 feet. Wet detention pond sizes and maximum outflow rates for the settling of the five micron sediment particle were calculated for the treated areas. For analysis purposes, it was assumed that a properly sized wet detention pond has a treatment efficiency of 80 percent for sediment and 60 percent for phosphorus. Appropriately designed wet detention ponds also are capable of reducing flooding by reducing peak storm flows.

Constructed Wetland Treatment Systems

Constructed wetland treatment systems can come in many forms (sub-surface flow, surface flow, multi-cell, single cell), but they all operate under the premise of distributing stormwater flow over a constructed wetland area. Pollutants are removed in the wetland by filtration in the plant mass, and uptake by the plants, associated bacteria, algae, and soil. Pollutant removal rates are not as well demonstrated as with wet detention ponds, but there is evidence that they may be more effective at removing dissolved phosphorus than wet detention ponds. For analysis purposes, it was assumed that a properly designed constructed wetland treatment system has a treatment efficiency of 80 percent for sediment and 60 percent for phosphorus. The size of a constructed wetland for a given tributary area is approximately the same as that for a wet detention pond. The constructed wetland should be designed to distribute flows over a large surface area and prevent short circuiting.

Bioswales

Bioswales are engineered swales designed to maximize removal of stormwater pollutants. Bioswale features which conventional swales lack include: low check dams spaced at regular intervals to slow down flow and create small temporary water pools, a granular substrate to enhance subsurface flow and water treatment; and specialized vegetation to optimize pollutant filtration and uptake. It is suggested that the check dams be constructed of gabion baskets lined with non-woven geotextile. Ideally a bioswale would operate in conjunction with a parallel drainage system, with the bioswale conveying only the low flow runoff, and the parallel system conveying the high flows. This arrangement would prevent the scour of accumulated pollutants from the bioswale during large storm events. Studies have shown that a properly designed conventional swale has a treatment efficiency of 70 percent for sediment and 30 percent for phosphorus (Schuler, 1992). For analysis purposes, it was assumed that bioswales have these same treatment efficiencies.

Enhancement of Existing Wetland Systems

In cases where stormwater drainage flows through existing, natural wetlands, these wetland can provide stormwater pollution treatment and flood storage. At times these functions may be enhanced by the following measures: 1) providing a presettling pond (forebay) to settle out large particles before the wetland; 2) disperse stormwater inflows over a larger area to prevent channelized flow; and, 3) lengthen the flow path of stormwater through the wetland. For analysis purposes, it was assumed that enhancing existing wetlands has a treatment efficiency of 80 percent for sediment and 60 percent for phosphorus.

Storm Sewer Inlet Filters

Storm sewer inlet filters are inserts which are placed withing existing storm sewer inlets. These inserts consist of a trough, which runs around the perimeter of the inlet. The trough contains a filter media, which absorbs petro-chemical bases pollutants and heavy metals in stormwater as it passes through. These filters are not designed to remove sediments or nutrients.

One type of storm sewer inlet filters is manufactured by Kristar Enterprises, Inc., in Santa Rosa, California. The fossil filter media is composed of amorphous aluminum silicate. The media should be replaced every year or two. The manufacturer claims that the filter removes 98 percent of petroleum based pollutants entering the filter and also removes heavy metals, but this has not been independently verified. The greatest benefit for these filter would be gained from placing them in parking lots, gas stations, service stations, etc. where automotive fluids and gasoline tends to spill.

Development of Stormwater Control Actions

Siting of structural control measures were determined using three criteria.

1) Locate measures where new development is likely to occur according to future land use projections. It is much easier and more cost effective to construct structural control measures as part of new construction rather than trying to retro-fit an existing development.

2) Locate measures in areas of "critical" land use. These land uses include commercial, industrial, highway, institutional, and high density residential. These lands produce greater pollutant loadings than low and medium density residential land uses. Control measures for existing "critical" land uses are eligible for WDNR Nonpoint Source Control grant dollars while non-critical land uses are not.

3) Locate measures in "critical" sub-basins as identified in Chapter 5 of this report.

Criteria for **types** of structural control measures considered for a given site is based upon the amount of space available for a structure and the drainage pattern of the site. For larger areas, wet detention ponds and wetland treatment systems were selected. For smaller areas, bioswales were considered. For areas with storm sewer inlets and the potential for petrochemical spills storm sewer inlet filters were considered. For areas which drain through existing wetland system, enhancement of wetlands were considered. For the purposes of this analysis, wet detention ponds and wetland treatment systems are considered interchangeable.

Stormwater control actions were separated into groups according to which lake watershed they reside, and whether they would be implemented as part of future development or would be inserted within existing development. A description of each action, its tributary area, the amount of sediment and phosphorus removed, and the cost of each action is tabulated in Tables 6-1 to 6-3.

FLOOD PRONE AREA ANALYSIS

Chapter 4 analysis identified drainage system capacity problems areas, the severity of the flooding, and the probable causes of the problems. Table 6-4 summarizes the management alternatives available to alleviate the problems in the flood prone areas. The flood prone areas were selected on the basis that they overtopped roads and threatened property in the 10-year storm event.

Table 6-1 Wind Lake Alternative Structural NPS Control Actions

Structure #	Location	Description	Tributary Area (ac)	Tributary Land Use	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Cost	Unit Cost Sediment ($/tons)
For Future Construction								
WI-1	N8	0.95 acre wet pond	47 7	Industrial	13.4	87.7		
WI-2	N8/N60	0.36 acre wet pond	20 9	Commercial	7.9	23.1		
WI-3	N12*	0.76 acre wet pond	94.4	Med. Residential	2.8	23.6		
WI-4	M70E	0.27 acre wet pond	33 2	Med. Residential	1	8 3		
WI-5	M70W	0.13 acre wet pond	16 3	Med. Residential	0 5	4.1		
WI-6	N16*	0 11 acre wet pond	13.6	Med. Residential	0.4	3 4		
WI-7	M70MFR	200 ft. Bio-swale	3.6	Multi-family Res.	0 2	1		
Total					26.2	151.2		
For Existing Conditions								
WI-8	N60	0.4 acre wet pond	34.1	Com/Res/Hwy/Opn	5.7	20.1	$113,000	$5,622
WI-9	M63	retrofit dry pond to 0.25 acre wet pond	33 1	Res/Agr.	1 5	8.8	$37,000	$4,205
WI-10	N66	1500 ft. Bio-swale	8.9	Hwy	1.9	3 4	$28,000	$8,235
WI-11	N65	200 ft Bio-swale	9.5	Com/Hwy	2.7	4 6	$8,000	$1,739
WI-12	N65	4 inlet filters		Com.	NA	NA	$6,000	NA
Total					11.8	36.9		
Pollutant Reduction Goal					67	442		

Table 6-2 Waubeesee Lake Alternative Structural NPS Control Actions

Structure #	Location	Description	Tributary Area (ac)	Tributary Land Use	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Cost	Unit Cost Sediment ($/tons)
For Future Construction								
WA-1	N59-com	0.14 acre wet pond	8.5	Commercial	3.2	9.4		
WA-2	N59-inst	0.14 acre wet pond	8.1	Institutional	1.3	7.5		
WA-3	N74	200 ft. of Bio-swale	2.8	Med. Residential	0.1	0.3		
Total					4 6	17.2		
For Existing Conditions								
WA-5	N68	Enhance Wetland	31 4	Res/Com/Hwy	5 4	18 1	$37,000	$2,044
Pollutant Reduction Goal					1.4	13.6		

Table 6-3 Kee-Nong-Go-Mong Lake Alternative Structural NPS Control Actions

Structure #	Location	Description	Tributary Area (ac)	Tributary Land Use	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Cost	Unit Cost Sediment ($/tons)
For Existing	Conditions							
K-2	N53	retrofit dry pond to 0 14 acre wet pond	17	Low Residential	0.5	4	$25,000	$6.250
Pollutant Reduction Goal					21.2	162.7		

Note: Constructed wetland treatment systems could be constructed in place of wet detention ponds.
* potential to alleviate flooding problems

The size (diameter in inches) of the "replacement pipes" suggested in the table assumes that the slopes of the new pipes are the same as the current pipes and the new pipes are made of reinforced concrete. The replacement size is based on the criteria of being able to handle the peak flows from the 10-year 12-hour rain storm, with normal lake levels. Storms larger, or more intense than this event, will result in surcharging of the replacement pipes, however, the frequency of such occurrences is generally considered acceptable by most communities.

Harbor Point

In addition to resizing the pipe system under Loomis Road to convey the 10-yr peak flows, a sub-surface detention alternative was investigated. Flood storage can be provided by box culverts placed under the existing ditches to detain peak runoff flows to a level where the current pipe system can convey the flows without overtopping Loomis Road. It is estimated that a storage volume of 2.7 acre-feet would be required to detain the flow. Cost estimates for both increasing the pipe sizes and detention storage is provided in Table 6-4. If the pipes are increased, the pipes must be extended all the way to the lake with an energy dissipator to prevent scour at the outlet in the lake.

Settler Road

In the case of the IN2 system along Settler Road, the runoff ponds in a low area until it evaporates or infiltrates. A storm sewer would have to be constructed along the west side of Settler Road north for 850 feet leading to a ditch which would flow 150 feet. The terminus of this ditch would be a closed depression at the southwest corner of Settler and Homestead Roads. The option of directing the drainage north along Settler Road and then east to Waubeesee Lake was investigated and then discarded for water quality concerns.

TABLE 6-4
FLOODING MANAGEMENT ALTERNATIVES

Pipe Location	Pipe I.D. #	Current Size (dia. in.)	Current Capacity (cfs)	10-yr, 12 hr Peak Flow (cfs)	Replacement		
					Size (dia. in.)	Length (ft)	Cost $
N11 system - Harbor Point							
	PN11	30	20.1	27.5	42	50	$8,500
	PN111	30	22.1	27.4	42	86	$14,600
	PN112	30	9.1	27.3	42	162	$25,700
	DN113			27.3	42	255	$38,000
Sub-total							$86,800
Harbor Point Flood detention		2.7 ac-ft	of storage in	box culverts			$150,000
N2- Settler Road							
new storm sewer along Settler				12 5	24	85520	$67,300
new ditch east of Settler						150	$2000
Sub-total							$69,300
M631 - north of Muskego Dam Rd	CN13	15	2	4.5	30	32	$3300

Creekside Meadows

Modeling results shows the culvert under Muskego Dam Road overtopping in the 2-year storm. The 15 inch culvert is undersized and a downstream pipe is backpitched. Computer modeling shows that by installing a 30 inch culvert, the road would not overtop in a 10-yr storm. It is likely that either an elliptical pipe or dual pipes would be necessary due to the lack of clearance between the culvert and road surface. Resetting the backpitched pipe downstream would not alleviate the flooding problem.

Muskego Dam Road

Modeling results shows the culvert level under Muskego Dam Road coming within a foot of the road in the 2-year storm. Future development in subbasins N12, N16, N16, and M63 should require stormwater detention to prevent exacerbation of the flood flows through this culvert

AGRICULTURAL UPLAND EROSION

Control Methods

Tillage Methods

Modifying tillage methods can reduce the amount of upland agricultural erosion. On fields with high erosion rates, cropping practices can reduce erosion rates by 50 - 75 percent. These methods include:

No till methods offers the most amount of erosion reduction.

Chisel plowing leaves crop residue and helps reduce erosion in comparison to the use of a traditional moldboard plow.

Fall plowing in certain circumstances is unnecessary and leads to more erosion. The fall plowing of soybeans leads to the winter breakdown of crop residue and greater erosion in the spring (Key, 1997).

Buffer Strips

Creating and/or maintaining a natural, permanently vegetated corridor along defined streams and canals provides several benefits to the stream, and downstream water resources. Some of these benefits include:

1) stabilizing the streambank itself to minimize erosion on the bank;

2) providing a vegetative filter strip to reduce overland flow velocities and promote adsorption, sedimentation, and filtration of pollutants from overland runoff;

3) improving stream corridor habitat for fish and wildlife; and

4) providing open space recreational lands (depending on land ownership, and/or easements).

The pollution reduction efficiency of buffer strips is dependent on a number of factors including, width, type of vegetation, slope, soil type, and potential management uses. Pollution reduction efficiencies have been measured in the field in a number of scientific studies. The results vary considerably and range from 60 - 90 percent for phosphorus reduction, and 33 - 95 percent for sediment reduction (Castelle, 1994).

Grass Waterways

Grass waterways differ from buffer strips in that rather than being along the edge of a defined stream or canal they are the actual drainage way for agricultural fields. Typically, the path of the grass waterway was once cropped but is taken out of production and planted in permanent grass cover to both prevent gully erosion and to filter sediment in runoff from the farm fields. Grass waterways can be narrower than buffer strips but wide enough to carry the runoff from the adjacent fields. Like buffer strips they provide a vegetative filter strip to reduce overland flow velocities and promote adsorption, sedimentation, and filtration of pollutants from overland runoff.

Nutrient Management

Nutrient management is a term for reducing the use of fertilizer to the optimum level necessary for a successful crop. Nutrient requirements vary, depending on the type of crop and soils. Soil samples are taken and analyzed for every one acre in a field to determine what the fertilizer application rate should be. The fertilizer rate is then varied depending on the nutrient needs.

Priority Watershed Gains

Improved agricultural practices on land tributary to Wind Lake are eligible for cost share agreements under the Muskego-Wind Lakes Priority Watershed Project. The amount of participation in the program has been good. An inventory for the Racine County portion of the watershed calculated a sediment load of 159 tons/year. With improved practices in place, the sediment load was reduced to 91.7 tons/year, close to the goal of 85.5 tons/year.

However, many of these gains were achieved in areas outside of this project area. This project area boundary differs from the project boundary of the Muskego-Wind Lakes Priority Watershed Project. Early on in this project, it was determined that the Goose Lake Canal east of Wind Lake does not drain west to Wind Lake but south to the Wind Lake Canal downstream of the lake. A number of the farms signed up in the Priority Watershed drained to the Goose Lake Canal. As a result, only a small part of the gains have a direct impact to the sediment loadings to Wind Lake. One Priority Watershed agreement was in the area tributary to the Muskego Canal and this amounted to a 7.2 ton reduction in sediment delivery to Wind Lake (Key, 1997).

Potential Gains

Tillage Methods

While, in general, there has been an increasing improvement in tillage practices, there is still room for improvement. Incremental reduction in the use of fall plowing of soybeans and using moldboard plows is still achievable. However, there is little room for improvement in cropping practices for crops such as vegetables and sod. From discussions with the Racine County Land Conservation Department, the following pollutant reductions may be possible (Table 6-5). The reductions assume that improved tillage practices would result in a 50 percent reduction of sediment and phosphorus loading on a given field. Fewer opportunities exist in the Wind Lake watershed for the following reasons; some of the fields are already under farm plans, some of the fields may change to urban development, and some of the fields are cultivated for vegetables or sod.

TABLE 6-5
POLLUTANT REDUCTIONS FROM IMPROVED TILLAGE

Lake Watershed	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)
Kee-Nong-Go-Mong Lake	11	71
Wind Lake	2.5	15

Buffer Strips

Potential areas for buffer strips were identified with the use of air photos. USGS quad maps and field checks. To qualify as a buffer strip it must be along a defined channel, which is defined as a waterway identified on a USGS quad map. Potential buffer strips locations were identified along the tributary which flows from north of Muskego Dam Road, south of the Creekside Meadows subdivision, and east to the Muskego Canal. In addition, potential locations were identified along the drainage ditch for the sod farm located in sub-basin N8 although this ditch is not shown on the USGS quad map. These buffer strip segments and their estimated pollutant reductions are described in Table 6-6.

Assumptions:

average annual unit area phosphorus load from agricultural lands = 0.58 lbs/acre/year; sediment load of 0.09 tons/acre/year;

lands contributing runoff to buffer zone does not exceed 400 feet of overland flow; thus contributing area = length of buffer x 400 ft. x number of sides buffer is on;

buffer zone lands contribute no sediment or phosphorus:

phosphorus loads from the contributing area is reduced by 60% and sediment loads by 70% (lowest values reported by Castelle, 1994);

TABLE 6-6
POLLUTANT REDUCTIONS FROM BUFFER STRIPS

Segment	Length (ft)	# of sides	existing buffer width (ft)	buffer area (ac.)	buffer trib. area (ac.)	sediment removed (tons/yr)	phos. removed (lbs/yr)	buffer rental cost ($/yr)
1	835	1	0	1.9	7.7	0.7	3.8	$240
2	250	1	30	0.4	2.3	0.2	1.0	$50
3	550	2	0	2.5	10.1	0.9	5.0	$316
4	1350	1	25	2.3	12.4	1.0	5.7	$291
5	2400	1	20	8.8	44.1	3.6	20.4	$1102
TOTAL	5385					6.4	35.9	$1999

Grass Waterways

Potential areas for grass waterways were identified with the use of air photos and were then confirmed to the Racine County Land Conservation Department staff. The only potential area is located in sub-basin M70 on the east side of the Muskego Canal. Same assumptions as for buffer strips except that the contributing area is the area which drains to the waterway. The grass waterway is estimated to be 750 feet long by 20 feet wide, treating an area of 30 acres, removing 1.9 tons/year of sediment and 10.5 lbs/year of phosphorus. The annual rental cost would be approximately $45/year.

STREAMBANK EROSION

The major drainage ways in the project area exclusive of the Muskego Canal were field checked for streambank erosion problems. Three problem areas were identified (Figure 5-1), all on the tributary west of the Muskego Canal in sub-basins N15 and N7.

Site 1 Erosion on both banks, 50 feet long, 10 foot recession, and 6 feet high in granular fill material. Recommend streambank restoration by cutting back banks to 3:1 slopes , placing topsoil and geotextile, and seed with grass seed mix. Estimated cost $6,600.

Site 2 South of Creekside Meadows detention pond. Erosion on both banks, 50 feet long, 14 inches high, 1 foot recession in shaded area. Recommend monitoring site for additional erosion as watershed develops and repair site as necessary.

Site 3 Bare soil area west of Highway 36. Bare soil on both banks, 75 feet long, 8 foot recession, 2.5 feet high. Recommend cutting trees and seed or sod. Estimated cost $500.

7 Stormwater Management Ordinance and Stormwater Management Guide

INTRODUCTION

This chapter presents a discussion of the proposed stormwater management ordinance and stormwater management guide. The proposed ordinance is presented in Appendix A and the proposed guide is presented in Appendix B.

PURPOSE AND INTENT

The Town of Norway has a rich diversity of water resources including lakes, rivers and streams, wetlands and groundwater. The stormwater management ordinance and guide are created to put stormwater management on par, in terms of public awareness, planning, financing and management measures, with other Town services. The American Society of Civil Engineers and the Water Environment Federation, broadly define stormwater management as "..the conceptualization, planning, design, construction, and maintenance of stormwater control facilities in urban/urbanizing drainage basins and includes all related political, social, economic considerations" (ASCE, 1992). Concern with quantity and quality is an essential aspect of modern stormwater management. Specifically, the purpose of the ordinance and guide is to:

- Regulate long-term, post-construction stormwater discharges from land development activities;

- Control the peak flow rates, and quality of stormwater discharges from land development activities;

- Manage stormwater to protect, maintain and enhance the natural environment; diversity of fish and wildlife; human life; property; and recreational use of the water resources within the Town.

BACKGROUND

Early in the project, a community advisory committee was created. A variety of citizens were invited to serve on this committee. The five citizens who served on committee are listed in Appendix D. At the first meeting, Kathy Aron, of the Wind Lake Management District was selected as chairperson. Mike Bruch of the Wisconsin Department of Natural Resources attended the meetings and provided input to the committee. Various personnel from Rust Environment & Infrastructure also provided input to the committee during this project.

Committee functions included: identifying issues, developing goals, suggesting courses of action, reviewing draft chapters of the stormwater management plan, and deciding on criteria to be included in the ordinance and guide. The committee recommended that the stormwater management plan, including the proposed ordinance and guide be forwarded to the Town's Planning Commission for review and for adoption by the Town Board.

STORMWATER MANAGEMENT ORDINANCE

The stormwater management ordinance provides stormwater requirements, criteria, and standards which will prevent and control water pollution, and diminish the threats to public health, safety, welfare and aquatic life caused by stormwater runoff from land development activities as defined in the ordinance. The ordinance applies to lands proposed for development and submitted for plat review. Lands that are currently developed would not be affected by the ordinance unless the addition of additional imperious areas within the land is planned. In general, the following activities will be controlled by the ordinance:

New Development
- Residential land development with a gross aggregate area of 1/3 acre or more;
- Land development, other than a residential land development;
- Land development that is likely to result in stormwater runoff which causes undue channel erosion, increases water pollution or which endangers downstream property or public safety.

Existing Land
- Residential Lands Lot Size of 0.999 acres or less, total impervious area including planned addition totals 35 percent or greater of the lot;
- Residential Lands Lot Size of 1.0 acres or more, total impervious area including planned addition totals 20 percent or greater of the lot;
- Other land (except agricultural) other than residential lands, any change in the total impervious area.

In general, stormwater runoff from a proposed development site must be controlled such that the post development peak flows during a 100-year storm do not exceed predevelopment peak flows during a 2-year storm. The methods and criteria for determining the pre- and post-development flows are defined in the ordinance. Nonpoint source pollutant loading analysis for the post-development conditions are also required using the Source Loading and Management Model (SLAMM). The complete ordinance is presented in Appendix A.

STORMWATER MANAGEMENT GUIDE

The stormwater management guide provides a standardized approach to calculate the stormwater requirements, criteria, and standards established by the ordinance. The guide allows the Town to receive a standard submittal for land development activities. This approach will allow the developers to be aware of all stormwater quantity and quality requirements and also allows the Town to quickly determine if the proposed development meets the requirements in the ordinance.

The guide requires that the developer submit a description of the existing conditions and post-development site conditions, calculations of peak flow rates for both pre- and post-development conditions, water quality calculations for both pre- and post-development conditions, design computations for all stormwater conveyance and stormwater treatment practices, a stormwater management treatment installation schedule and maintenance plan and cost estimates for the construction, operation and maintenance of each stormwater management practice. The proposed submittal information form is presented in Appendix B.

INTRODUCTION

The Town of Norway has a number of stormwater management problems that threaten the safety and environment of the Community. The Town has an opportunity to make use of grants from DNR's Priority Watershed Program to help pay for implementing some of the recommended controls. The proposed recommendations will enable the Town of Norway to come close to meeting the pollution reduction goals discussed Chapter 5.

SOURCE CONTROLS

Often called "Housekeeping Measures", source controls are procedures or activities that prevent or reduce the amount of stormwater coming into contact with potential pollutant sources. Source controls for the Town of Norway range from informing the public on proper use of fertilizers, to improved agricultural tillage, to spill containment barriers around fuel storage facilities, to routine cleaning of storm drainage systems. It is easier and less costly to prevent pollutants from coming in contact with stormwater than it is to try to remove the pollutants after the fact. Therefore, the Town should emphasize the implementation of source controls. Specific recommendations are described in the following paragraphs.

Adequate Enforcement Land Control Ordinance

Construction site erosion can be a significant source of nonpoint source pollution in a watershed undergoing urban development. Erosion rates from construction sites can be much higher than erosion from agricultural fields. Construction site erosion can be controlled with measures such as sedimentation basins, sediment traps, rock tracking pads, silt fence, straw bales, mulch, temporary seeding, and timely final landscaping of the site. These practices are described in the Wisconsin Construction Site Best Management Practice Handbook (WDNR, 1989).

As discussed in Chapter 3, the Town of Norway has a land disturbance ordinance requiring implementation of such practices. In addition, the Racine County Land Conservation Department is responsible for permitting and inspection of construction site erosion control measures in the shoreland zone which is defined as being withing 1000 feet of a lake or 300 feet of a navigable stream.

Effective construction site erosion control requires adequate enforcement of existing local erosion control ordinances. The keys to this are: requiring submittal of a detailed erosion control plan with the erosion control permit application which complies with the ordinance; frequent inspection of the site to check for compliance withe the erosion control plan; and, implementing quick and adequate responses to non-compliance such as shutting down the site, fines, or the withholding of a deposit.

Currently, the Town Inspector is processing a large number of erosion control permit applications and is conducting a large number of site inspections. It is recommended that if the enforcement of the land disturbance ordinance falls to an unacceptable level, then the Town should increase the construction erosion control efforts within the project area.

Stormwater Management Ordinances

Currently, the Town has no ordinance directly pertaining to stormwater quality control. The recommended stormwater management ordinance is described in greater detail in Chapter 7. In summary, the recommended ordinances has the following provisions:

- new development shall provide 80 percent reduction of sediment,
- new development shall release the post development 100-yr storm at a 2-yr pre-development rate,
- The pre-development curve number shall be specified by the ordinance,
- Land developments regulated include all commercial, industrial, and institutional land uses and residential land developments of 1/3 of an acre or greater.

Operation and Maintenance

The Town of Norway is responsible for maintaining Town facilities in an environmentally sound manner. The two major Town facilities, the Highway Department garage and the waste disposal site are both outside of the project area and were thus not evaluated. In addition, items such as yard waste and trash compactors, topsoil and mulch piles should be covered by roofs. Fuel should be stored above ground with concrete retaining walls and floors. Road paint should be water based.

The Town is considering building a composting facility. The drainage for this facility should be constructed in such a way to minimize pollution runoff.

The Town is also responsible for ensuring the maintenance of the roadside ditches and culverts. Ordinance 97-6 was passed requiring property owners to maintain ditches on or adjacent to their properties. A number of road culverts were found to be partially filled with sediment. Cleaning these on a regular basis would help reduce flooding problems in those areas.

Spills and Illicit Connections

Racine County has emergency procedures that include the Town of Norway for responding to the spill of potentially hazardous materials. The Town should review the established procedures to evaluate whether adequate measures would be taken that would prevent pollution of Town drainage systems and area water ways. The Town should establish an inspection program of the drainage system to locate and eliminate all non-stormwater discharges which are not properly permitted.

Of note is the storage of empty 55 gallon drums and old parts in the back parking lot of Wind Lake Plaza. In addition, stains are evident on the parking lot pavement near a storm inlet. It is recommended that the parts are stored appropriately and that fluids are disposed of appropriately.

Wetland and Floodland Preservation

It is recommended that wetlands and floodlands be preserved in accordance with Chapters NR 103 and NR 116 of the State Administrative Code. Wetlands and floodlands perform important functions in reducing the amount of flooding which could occur. In addition, wetlands perform important water quality functions and provide much needed wildlife habitat.

Agricultural Source Controls

It is recommended that the Town of Norway enact exclusive agricultural zoning and an agricultural shoreland management ordinance to reduce the amount of stormwater coming into contact with potential pollutant sources. The use of a nutrient management program is also suggested.

Enact Exclusive Agricultural Zoning to Encourage Improved Tillage Methods

Having exclusive agricultural zoning allows farm operators with agriculturally zoned fields to more easily apply for the Wisconsin Farmland Preservation Program. The Wisconsin Farmland Preservation Program gives participants tax credits to farmers which typically amount to about $1200/year. In return, the land must be farmed in compliance with county soil and water conservation standards. This program is destined to be closed in 1999. It is recommended that the Town enact exclusive agricultural zoning. It is hoped that this additional incentive will result in improved tillage methods.

Agricultural Nutrient Management

Nutrient management is a way of reducing the use of fertilizer to a the optimum level for crop success. It requires extensive soil sampling with a cost of $6/acre. It is recommended that the Town help fund the soil sampling cost. Grant programs such as the Environmental Quality Incentives Program (EQIP) and the Wisconsin Lake Protection Grant may be used to fund this. These programs are further described in Chapter 11.

Consider Enacting an Agricultural Shoreland Management Ordinance

It is recommended that the Town consider an agricultural shoreland management ordinance. Such ordinances are a relatively recent development. Brown County, Wisconsin has recently adopted one. Lands subject to this ordinance include: the Shoreland Corridor - lands within 20 feet of perennial and intermittent streams, lakes or ponds as identified on USGS quadrangle maps; and Agricultural Shoreland Management Areas (ASTHMA) - lands within 300 feet of the above water bodies. Ordinance provisions include:

- landowners will be eligible for up to 80 percent cost-sharing to install BMPs to control erosion;
- row cropping is not allowed in the Shoreland Corridor;
- livestock are not allowed in the Shoreland Corridor;

- cropland must meet the tolerable "T" erosion rate in the ASTHMA;
- lands must meet nutrient management standards in the ASTHMA.

Public Education

The objective of public education is to make individuals aware of the problems caused by stormwater runoff and the measures that individuals can take to minimize the harmful effects. Audiences must first be identified. There are at least three audiences in the Town of Norway, the business community, the general public, and school age children. A tailored message should be developed for each audience. Materials developed by the Town should be coordinated with University Extension Service. Articles could also be written for the local newspaper and other local publications.

The installation of informational signs at local boat ramps would help make urban residents aware of stormwater issues and the connection of drainage ways with area lakes. Signs could educate the public about water quality issues. Topics which could be included are nonpoint source pollution sources, citizen pollution prevention techniques, and recognition of the implementation of best management.

A public education program for the Town's recycling program will benefit the Town's stormwater program by providing instruction for the proper disposal of vehicle oil, antifreeze, fertilizers, pesticides, old paint and other house hold hazardous wastes that often find their way into area water ways.

The development of a comprehensive stormwater program targeting school aged children is an excellent way to reach the community. This approach has been very successful in getting participation in the recycling programs. In addition to classroom materials, audio visual materials could also be developed. A portable, interpretive water quality display could be part of the comprehensive program. The University of Wisconsin - Extension Service and the WDNR can provide assistance and information for this type of program.

RECOMMENDED STRUCTURAL NPS CONTROL MEASURES

The agricultural and urban structural control measures and streambank erosion controls were evaluated and developed into a set of recommendations. The pollutant reductions were then tallied and compared to the pollutant reduction goals developed in Chapter 5. In addition, costs estimates for each measure are presented.

Urban Structural Control Measures

Future Development

If a stormwater management ordinance is passed, new development will have to provide treatment of stormwater. The cost of this treatment would be born by the developer. Treatment options would include wet detention ponds, wetland treatment systems, and bioswales.

Existing Development

Potential locations for two wet detention ponds, one bioswale, and inlet filters are located in Figure 8-1. One wet detention pond is located adjacent to the Creekside Meadows sub-division south of Muskego Dam Road in sub-basin N15. This 0.25 acre wet pond is a retrofit of an existing 0.9 acre dry detention pond. Currently this dry detention pond is providing little water quality treatment. The 0.25 acre wet pool would be excavated within the existing dry pond. The second 0.4 acre wet detention pond would be located in sub-basin N60 on the east side of South Loomis Road.

The one bioswale would be located along the east side of West Wind Lake Road. This swale would carry the drainage from the back parking lot and roof of Wind Lake Plaza. Currently this discharge flows south along the road and is eroding the current drainage way due to the high flows. These flows will only increase as the condominium complex to the south of Wind Lake Plaza is completed. The bioswale in the median of Highway 36 in sub-basin N66 was not selected because of lack of space and safety concerns.

The four storm sewer inlet filters would be located in the back parking lot of Wind Lake Plaza. This is a particularly sensitive area for petro-chemical pollution due to the operation of an automotive repair shop and dry cleaner at this location. It is also recommended that such inlet filters be installed in any commercial parking lot.

Agricultural Structural Control Measures

Potential buffer strip and grass waterway locations were identified and located on Figure 8-1. Buffer strips and grass waterways are eligible for reimbursement under the Conservation Reserve Program. This reimbursement is a rental under a 10 year contract. The rents are determined by soil type. In addition, 50 percent of the ground cover seed costs are covered. Under this program, the buffer strips must be at least 66 feet wide from the stream bank. An alternate funding mechanism could be to combine monies from the Environmental Quality Incentives Program (EQIP) and the Wisconsin Lakes Protection Grant program for rental reimbursement. The advantages of this arrangement is that the buffer strip width could be less than 66 feet if the farmer thought that was too onerous.

Streambank Erosion

Three problem areas were identified (Figure 5-1), all on the tributary west of the Muskego Canal in sub-basins N15 and N7.

Site 1 Erosion on both banks, 50 feet long, 10 foot recession, and 6 feet high in granular fill material. Recommend streambank restoration by cutting back banks to 3:1 slopes , placing topsoil and geotextile, and seed with grass seed mix. Estimated cost $6,600.

Table 8-1 Summary of Structural NPS Control Practices

Description	Location	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Cost	Unit Cost Sediment ($/tons)
Urban Practices					
For Future Construction				born by developer	
0.95 acre wet pond	WI-1	13.4	87.7		
0.36 acre wet pond	WI-2	7.9	23.1		
0.76 acre wet pond	WI-3	2.8	23.6		
0.27 acre wet pond	WI-4	1	8.3		
0.13 acre wet pond	WI-5	0.5	4.1		
0.11 acre wet pond	WI-6	0.4	3.4		
200 ft. Bio-swale	WI-7	0.2	1		
For Existing Conditions					
0.4 acre wet pond	WI-8	5.7	20.1	$113,000	$5,622
acre wet pond	WI-9	1.5	8.8	$37,000	$4,205
200 ft. Bio-swale	WI-11	2.7	4.6	$8,000	$1,739
4 inlet filters	WI-12	NA	NA	$6,000	NA
Subtotal		**36.1**	**184.7**	**$164,000**	
Agricultural Practices					
Priority Wshd. tillage	N15	7.2	46.1		
Additional tillage gains		2.5	15		
buffer strip 1	N15	0.66	3.8	$240	rental
buffer strip 2	N15	0.18	1.0	$50	rental
buffer strip 3	N15	0.86	5.0	$316	rental
buffer strip 4	N16	0.99	5.7	$291	rental
buffer strip 5	N8	3.57	20.5	$1,102	rental
grass waterway	M70	1.89	10.4	$35	rental
Subtotal		**17.9**	**107.4**	**$2,033**	rental
Streambank Restoration					
Segment 1	N15	NA	NA	**$6,600**	
Segment 3	N7	NA	NA	**$500**	
		Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)	Capital Cost	Rental cost
Total		**54.0**	**292.1**	**$171,100**	**$2,033**
Project Goal		**67**	**442**		

9 Recommended Stormwater Management Plan for the Waubeesee Lake Watershed

INTRODUCTION

The Town of Norway has a number of stormwater management problems that threaten the safety and environment of the Community. The Town has an opportunity to make use of grants from DNR's Priority Watershed Program to help pay for implementing some of the recommended controls. The proposed recommendations will enable the Town of Norway to come close to meeting the pollution reduction goals discussed Chapter 5.

SOURCE CONTROLS

Often called "Housekeeping Measures", source controls are procedures or activities that prevent or reduce the amount of stormwater coming into contact with potential pollutant sources. Source controls for the Town of Norway range from informing the public on proper use of fertilizers, to improved agricultural tillage, to spill containment barriers around fuel storage facilities, to routine cleaning of storm drainage systems. It is easier and less costly to prevent pollutants from coming in contact with stormwater than it is to try to remove the pollutants after the fact. Therefore, the Town should emphasize the implementation of source controls. Specific recommendations are described in the following paragraphs.

Adequate Enforcement Land Erosion Control Ordinance

Construction site erosion can be a significant source of nonpoint source pollution in a watershed undergoing urban development. Erosion rates from construction sites can be much higher than erosion from agricultural fields. Construction site erosion can be controlled with measures such as sedimentation basins, sediment traps, rock tracking pads, silt fence, straw bales, mulch, temporary seeding, and timely final landscaping of the site. These practices are described in the Wisconsin Construction Site Best Management Practice Handbook (WDNR, 1989).

As discussed in Chapter 3, the Town of Norway has a land disturbance ordinance requiring implementation of such practices. In addition, the Racine County Land Conservation Department is responsible for permitting and inspection of construction site erosion control measures in the shoreland zone which is defined as being withing 1000 feet of a lake or 300 feet of a navigable stream.

Effective construction site erosion control requires adequate enforcement of existing local erosion control ordinances. The keys to this are: requiring submittal of a detailed erosion control plan with the erosion control permit application which complies with the ordinance; frequent inspection of the site to check for compliance withe the erosion control plan; and, implementing quick and adequate responses to non-compliance such as shutting down the site, fines, or the withholding of a deposit.

Currently, the Town Inspector is processing a large number of erosion control permit applications and is conducting a large number of site inspections. It is recommended that if the enforcement of the land disturbance ordinance falls to an unacceptable level, then the Town should increase the construction erosion control efforts within the project area.

Stormwater Management Ordinances

Currently, the Town has no ordinance directly pertaining to stormwater quality control. The recommended stormwater management ordinance is described in greater detail in Chapter 7. In summary, the recommended ordinances has the following provisions:

- new development shall provide 80 percent reduction of sediment,
- new development shall release the post development 100-yr storm at a 2-yr pre-development rate,
- The pre-development curve number shall be specified by the ordinance,
- Land developments regulated include all commercial, industrial, and institutional land uses and residential land developments of 1/3 of an acre or greater.

Operation and Maintenance

The Town of Norway is responsible for maintaining Town facilities in an environmentally sound manner. The two major Town facilities, the Highway Department garage and the waste disposal site are both outside of the project area and were thus not evaluated. In addition, items such as yard waste and trash compactors, topsoil and mulch piles should be covered by roofs. Fuel should be stored above ground with concrete retaining walls and floors. Road paint should be water based.

The Town is considering building a composting facility. The drainage for this facility should be constructed in such a way to minimize pollution runoff.

The Town is also responsible for ensuring the maintenance of the roadside ditches and culverts. Ordinance 97-6 was passed requiring property owners to maintain ditches on or adjustment to their properties. A number of road culverts were found to be partially filled with sediment. Cleaning these on a regular basis would help reduce flooding problems in those areas.

Spills and Illicit Connections

Racine County has emergency procedures that include the Town of Norway for responding to the spill of potentially hazardous materials. The Town should review the established procedures to evaluate whether adequate measures would be taken that would prevent pollution of Town drainage systems and area water ways. The Town should establish an inspection program of the drainage system to locate and eliminate all non-stormwater discharges which are not properly permitted.

Wetland and Floodland Preservation

It is recommended that wetlands and floodlands be preserved in accordance with Chapters NR 103 and NR 116 of the State Administrative Code. Wetlands and floodlands perform important functions in reducing the amount of flooding which could occur. In addition, wetlands perform important water quality functions and provide much needed wildlife habitat.

Agricultural Source Controls

It is recommended that the Town of Norway enact exclusive agricultural zoning and an agricultural shoreland management ordinance to reduce the amount of stormwater coming into contact with potential pollutant sources. The use of a nutrient management program is also suggested.

Enact Exclusive Agricultural Zoning to Encourage Improved Tillage Methods

Having exclusive agricultural zoning allows farm operators with agriculturally zoned fields to more easily apply for the Wisconsin Farmland Preservation Program. The Wisconsin Farmland Preservation Program gives participants tax credits to farmers which typically amount to about $1200/year. In return, the land must be farmed in compliance with county soil and water conservation standards. This program is destined to be closed in 1999. It is recommended that the Town enact exclusive agricultural zoning. It is hoped that this additional incentive will result in improved tillage methods.

Agricultural Nutrient Management

Nutrient management is a way of reducing the use of fertilizer to a the optimum level for crop success. It requires extensive soil sampling with a cost of $6/acre. It is recommended that the Town help fund the soil sampling cost. Grant programs such as the Environmental Quality Incentives Program (EQIP) and the Wisconsin Lake Protection Grant may be used to fund this. These programs are further described in Chapter 11.

Consider Enacting an Agricultural Shoreland Management Ordinance

It is recommended that the Town consider an agricultural shoreland management ordinance. Such ordinances are a relatively recent development. Brown County, Wisconsin has recently adopted one. Lands subject to this ordinance include: the Shoreland Corridor - lands within 20 feet of perennial and intermittent streams, lakes or ponds as identified on USGS quadrangle maps; and Agricultural Shoreland Management Areas (ASTHMA) - lands within 300 feet of the above water bodies. Ordinance provisions include:

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- row cropping is not allowed in the Shoreland Corridor;
- livestock are not allowed in the Shoreland Corridor;
- cropland must meet the tolerable "T" erosion rate in the ASTHMA;
- lands must meet nutrient management standards in the ASTHMA.

developed into residential lots. Drainage from such development should be done in an environmentally sensitive manner such as with bioswales.

Existing Development

Control measures on existing development are not necessary to meet the pollution reduction goals. Therefore, they are not recommended. However, if it is ever decided that additional reductions are necessary, there is potential for enhancing an existing wetland for stormwater treatment. The existing wetland exists in the wetland pond on the west side of West Loomis Road near the Phillips 66 station. Currently, water flows into the wetland through a culvert under Loomis Road from a smaller wetland to the east and then the water exits through a standpipe which is 10 feet south of the inlet. Having the inlet and outlet so close together eliminates any water quality treatment. This could be rectified by creating an outlet at the west side of the wetland draining to Waubeesee Lake. The cost estimate is based upon laying a 24 inch pipe from this wetland to the Lake.

TABLE 9-1
SUMMARY OF STRUCTURAL STORMWATER CONTROL PRACTICES

Description	Location	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)
For Future Construction			
0.14 acre wet pond	WA-1	3.2	9.4
0.14 acre wet pond	WA-2	1.3	7.5
200 ft. of bioswale	WA-3	0.1	0.3
Total		4.6	17.2
Pollution Reduction Goal		1.4	13.6

The recommended controls on future development would meet the water quality goals of this project. Since the water quality of Waubeesee Lake is currently very good, the goal is to maintain pollutant loadings at present levels. These recommendations would exceed these goals.

Chapter 10

DRAINAGE IMPROVEMENT RECOMMENDATIONS

There is one recommended drainage improvement. In the case of the IN2 system along Settler Road, there currently is not a place for the drainage to go. A storm sewer would have to be constructed along the west side of Settler Road north for 850 feet leading to a ditch which would flow 150 feet. The terminus of this ditch would be a closed depression at the southwest corner of Settler and Homestead Roads. The estimated cost for constructing this is **$69,300**. A second option would be to purchase the land or easement where the water currently pools on the east side of the road.

The Town has recently opened a culvert under Settler Road which has improved the movement of stormwater between the east and west sides of Settler Road. However, late fall rains have caused flooding in this area, according to local residents. Therefore, an outlet for this area should be considered.

INTRODUCTION

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Racine County has emergency procedures that include the Town of Norway for responding to the spill of potentially hazardous materials. The Town should review the established procedures to evaluate whether adequate measures would be taken that would prevent pollution of Town drainage systems and area water ways. The Town should establish an inspection program of the drainage system to locate and eliminate all non-stormwater discharges which are not properly permitted.

Wetland and Floodland Preservation

It is recommended that wetlands and floodlands be preserved in accordance with Chapters NR 103 and NR 116 of the State Administrative Code. Wetlands and floodlands perform important functions in reducing the amount of flooding which could occur. In addition, wetlands perform important water quality functions and provide much needed wildlife habitat.

Agricultural Source Controls

It is recommended that the Town of Norway enact exclusive agricultural zoning and an agricultural shoreland management ordinance to reduce the amount of stormwater coming into contact with potential pollutant sources. The use of a nutrient management program is also suggested.

Enact Exclusive Agricultural Zoning to Encourage Improved Tillage Methods

Having exclusive agricultural zoning allows farm operators with agriculturally zoned fields to more easily apply for the Wisconsin Farmland Preservation Program. The Wisconsin Farmland Preservation Program gives participants tax credits to farmers which typically amount to about $1200/year. In return the land must be farmed in compliance with county soil and water conservation standards. This program is destined to be closed in 1999. It is recommended that the Town enact exclusive agricultural zoning. It is hoped that this additional incentive will result in improved tillage methods.

Agricultural Nutrient Management

Nutrient management is a way of reducing the use of fertilizer to a the optimum level for crop success. It requires extensive soil sampling with a cost of $6/acre. It is recommended that the Town help fund the soil sampling cost. Grant programs such as the Environmental Quality Incentives Program (EQIP) and the Wisconsin Lake Protection Grant may be used to fund this. These programs are further described in Chapter 11.

Consider Enacting an Agricultural Shoreland Management Ordinance

It is recommended that the Town consider an agricultural shoreland management ordinance. Such ordinances are a relatively recent development. Brown County, Wisconsin has recently adopted one. Lands subject to this ordinance include: the Shoreland Corridor - lands within 20 feet of perennial and intermittent streams, lakes or ponds as identified on USGS quadrangle maps; and Agricultural Shoreland Management Areas (ASTHMA) - lands within 300 feet of the above water bodies. Ordinance provisions include:

- landowners will be eligible for up to 80 percent cost-sharing to install BMPs to control erosion:
- row cropping is not allowed in the Shoreland Corridor;
- livestock are not allowed in the Shoreland Corridor;
- cropland must meet the tolerable "T" erosion rate in the ASTHMA;
- lands must meet nutrient management standards in the ASTHMA.

Public Education

The objective of public education is to make individuals aware of the problems caused by stormwater runoff and the measures that individuals can take to minimize the harmful effects. Audiences must first be identified. There are at least three audiences in the Town of Norway, the business community, the general public, and school age children. A tailored message should be developed for each audience. Materials developed by the Town should be coordinated with University Extension Service. Articles could also be written for the local newspaper and other local publications.

The installation of informational signs at local boat ramps would help make urban residents aware of stormwater issues and the connection of drainage ways with area lakes. Signs could educate the public about water quality issues. Topics which could be included are nonpoint source pollution sources, citizen pollution prevention techniques, and recognition of the implementation of best management.

A public education program for the Town's recycling program will benefit the Town's stormwater program by providing instruction for the proper disposal of vehicle oil, antifreeze, fertilizers, pesticides, old paint and other house hold hazardous wastes that often find their way into area water ways.

The development of a comprehensive stormwater program targeting school aged children is an excellent way to reach the community. This approach has been very successful in getting participation in the recycling programs. In addition to classroom materials, audio visual materials could also be developed. A portable, interpretive water quality display could be part of the comprehensive program. The University of Wisconsin - Extension Service and the WDNR can provide assistance and information for this type of program.

RECOMMENDED STRUCTURAL NPS CONTROL MEASURES

The agricultural and urban structural control measures and streambank erosion controls were evaluated and developed into a set of recommendations. The pollutant reductions were then tallied and compared to the pollutant reduction goals developed in Chapter 5. A summary of pollution reductions for each measure are in Table 10-1.

Urban Structural Control Measures

Future Development

If a stormwater management ordinance is passed, new development will have to provide treatment of stormwater. The cost of this treatment would be born by the developer. [redacted] use, there [redacted] developed.

Existing Development

There are few locations to provide controls on existing development in the watershed. One opportunity exists to retrofit a dry detention basin along Scenic View Drive to provide some water quality benefit. If this pond were converted into a wet detention pond, it would require a 0.14 acre permanent pool. Currently, there are some issues with the neighboring houses concerning flooding basements, poor drainage of the pond, and improper grading. These issues would have to be resolved before this proceeds.

Agricultural Controls

There are potential opportunities to reduce the amount of erosion from agricultural field. Additional incentives for farmers to sign up in the Wisconsin Farmland Preservation program would be provided if the Town had zoned their land exclusively agricultural. It is recommended that the Town adopt exclusive agricultural zoning. This may result in more sign ups in the program and passably better tillage practices.

Summary of NPS Control Measures

The urban and agricultural nonpoint source control measures are summarized in Table 10-1. The total of the nonpoint source pollution reductions under this plan amount to 11.5 tons/year of sediment and 75 lbs of phosphorus/year. This falls short of the pollution reduction goals described in Chapter 5. The reductions are 55 percent and 46 percent of the goals for sediment and phosphorus respectively. There are a number of reasons why the goals were not achieved. There were few opportunities to put controls on urban land uses. There are few opportunities to greatly reduce agricultural pollution. Most of the streams and channels are already well buffered by vegetation.

TABLE 10-1
SUMMARY OF NPS CONTROL PRACTICES

Description	Location	Sediment Reduction (tons/yr)	Phosphorus Reduction (lbs/yr)
retrofit to 0.14 wet pond	K2	0.5	4
improved tillage	N50 & N77	11	71
Total		11.5	75
Pollution Reduction Goal		21	163

Table 11-1: Recommended Plan Implementation Schedule and Responsible Parties

Recommendation	1997	1998		1999		2000		RESPONSIBLE PARTY(S) Town of Norway	WDNR	Racine Co. LCD	Developer
Non-Structural											
Enforce Land Disturbance Ordinance	■	■	■	■	■	■	■	●		○	○
Enact Stormwater Management Ordinance	■	■						●			
Public Education Program	■	■	■	■	■	■	■	●			
Drainage System Inspection Program		■	■	■	■	■	■	●			
Enact Exclusive Agricultural Zoning	■	■						●		○	
Enact Ag. Shoreland Mgmt. Ordinance										○	
Funding for Agricultural Soil Testing		■	■	■	■	■	■	●		○	
Continue Operation and Maintenance	■	■	■	■	■	■	■	●			
Wind Lake Structural											
Agricultural Buffer Strips and Grass Swales		■	■	■				●	○	○	
Streambank Restoration		■	■	■				●	○		
Storm Sewer Inlet Filters		■	■	■				●	○		
Wind Lake Plaza Bioswale		■	■	■				●	○		
Creekside Meadow Pond Retrofit				■	■	■		●	○		
E. Loomis Rd. Wet Detention Pond				■	■	■		●	○		
Harbor Pl. Storm Sewer Reconstruction				■	■	■		●			
Muskego Dam Road Culvert		■	■	■				●			
Waubeesee Lake Structural											
Settler Road Drainage System				■	■	■		●			
Waubeesee Lake Structural											
Scenic View Pond Retrofit				■	■	■		●			

This will be started when a development plan is determined
Note: The Muskego-Wind Lake Priority Watershed Project ends in 2001

TABLE 11-2
ALTERNATIVE FUNDING METHODS STORMWATER MANAGEMENT ACTIVITIES

Funding Alternative	Functional Program Elements			
	Stormwater Management Administration and Design	Capital Improvement Program	Operation and Maintenance	Water Quality Monitoring
Stormwater Utility	☆	☆	☆	☆
General Fund	☆	☆	☆	☆
Special Taxing District	☆	☆	☆	
State WDNR Grants	☆	☆		☆
USDA EQIP Program	☆	☆		
USDA CRP Program	☆	☆	☆	
Homeowners Association		☆	☆	☆
Local Option Sales Tax		☆		
Bonds		☆		
Pay-as-you-go Sinking Fund		☆		☆
Subdivision Exactions		☆		
Fee-in-lieu-of		☆		
Developer Incentives		☆		
Betterment Charge		☆		
Fees/Permits	☆			
Penalties/Fines	☆	☆		

Alternatives

Stormwater Utility: Fairness and equity for all rate payers is an advantage of the stormwater user fee system. Historically, communities have paid for stormwater management from the general fund. The general fund is financed by and large by ad valorem taxes based on property value and the status of the property owner (exempt/nonexempt) which are not related to stormwater runoff or the water quality of runoff. Stormwater user fees, on the other hand, are based on a property's relative stormwater contribution. The stormwater customers who generate larger amounts of stormwater runoff pay proportionally more than other customers. There is a high correlation between impervious area, which was used to establish the rate structure for a stormwater user fee system, and the quantity and quality of stormwater runoff.

Under the user fee system, the majority of the costs of stormwater management is redistributed from the single family home owner to the commercial, industrial, and exempt customers. This more accurately reflects the second group's greater contributions to the problems of stormwater management. Table 11-3 shows how the costs of stormwater management are being reallocated in the Cities of Appleton and West Allis by converting to a stormwater utility program. In these two cases, with a stormwater user fee system, the burden on home owners, as a group, is reduced 30 to 40 percent.

TABLE 11-3
COMPARISON OF TAX BASE AND UTILITY FEE COSTS

Funding Method	Percentage of Cost - West Allis			Percentage of Cost - Appleton		
	Residential	Non-Residential	Exempt	Residential	Non-Residential	Exempt
Property Tax	64%	36%	0%	75%	25%	0%
Utility User Fee	42%	51%	5%	46%	41%	13%
% change	-32%	42%	--	-39%	64%	--

The stormwater utility provides funding for the five significant aspects of a comprehensive stormwater management program (administration, operation and maintenance, renewal/replacement, capital improvements, and monitoring). The income can also be used to pay the debt service for a stormwater capital improvement program, thereby leveraging the utility's annual revenue into a major program.

Using revenues from a user charge system to fund stormwater management programs is relatively new in Wisconsin. To date, six Wisconsin communities (Appleton, Lake Delton, Sheboygan, West Allis, Grafton, and

Glendale) have evaluated user fees as an alternative for financing stormwater management. The Town of Lake Delton and Glendale have operational stormwater utilities.

A stormwater utility in the Town of Norway could be structured to parallel the Sanitary District. While the sanitary district does not encompass the entire stormwater project area, it does contain the most densely settled land. The administration and billing mechanism for the stormwater utility could be coupled with the sanitary districts.

General Fund: In most communities, funds for stormwater management are provided from the General Fund. This source can be best considered a "bank" into which revenues are placed and from which most programs are funded. The major income source for the General Fund is ad valorem (property) taxes. This income is based primarily upon the assessed valuation of property within the Town. This revenue source can be used for funding for administration, renewal/replacement, construction, maintenance, and water quality monitoring.

Special Taxing/Assessment Districts: Income from a special taxing district or special assessment district is generally dedicated to that district. That is, the area that is designated as "special," for whatever reason, would pay an additional tax or have an increased assessment. The funds from the additional tax or assessment are returned to that area. For example, if stormwater management facilities are constructed to benefit a particular drainage basin within the Town then that area could be designated a special taxing district and an additional tax levy could be assigned to the property within the area.

WDNR Grants: Grants are available through the WDNR to help local communities implement nonpoint source pollution control programs. Three types of grants are available: the Local Assistance Grants, Nonpoint Source Grants, and Lake Protection Grants.

- Local Assistance Grants are intended to keep the administrative costs for the implementation of the priority watershed plans from becoming a burden for local communities. The state will pay up to 100 percent of the cost of additional staff, professional services, training, travel expense, and additional office space.

- Nonpoint Source Grants provide technical and financial help to implement nonpoint source pollution control practices. Nonpoint source grants require between 30 percent to 50 percent of the cost of the project to be paid by the local community. Part or all of the local share may be "in-kind" match.

- Lake Protection Grants provide up to a 75 percent state cost sharing assistance up to $200,000 to carry out lake protection, restoration, and improvement projects. Eligible projects include: land or conservation easement acquisition resulting in lake water quality or natural ecosystem improvement; wetland restoration resulting in lake water quality or natural ecosystem improvement; development of local regulations or ordinaces which prevent lake water quality or natural ecosystem degradation; or, lake improvement activities called for in a department approved plan.

USDA EQIP Program (U.S. Department of Agiculture Environmental Quality Incentives Program).: This program is administered by the Racine County Land Conservation Department. The program provides technical and financial assistance for conservation practices protecting soil and water quality. Covered practices include grassed waterways, streambank buffer strips, and critical area planting. Costs for buffer strips and grassed water ways are typically for rent and seed. Program provides a 75 percent cost share up to $10,000 per year and $50,000 for the contract life. Contracts are 5-10 years. The advanage of this program over the USDA CRP program is that the width of buffer strips can be flexible. This program has been teamed with the WDNR Lakes Protection Grant program to pay for BMPs in the Eagle Lake watershed in Racine County.

USDA CRP Program (U.S. Department of Agiculture Conservation Reserve Program): This program is administered by the Racine County Land Conservation Department. The program provides technical and financial assistance for conservation practices protecting soil and water quality. Covered practices include streambank buffer strips. Costs covered for buffer strips are land rental (based on soil type) and 50% of seed cost. Typical rental costs for the project area would be $57-$84 per year per acre. It may be advantagous for the Town to add up to a 20 percent additional payment to this rent to provide additional incentive for farmers to sign up for this program. Buffer strips are to be 66 to 100 feet wide. Contracts are for 10 years. There is a September 30th deadline. It is not a certainty that this program will be continued in 1998.

Local Option Sales Tax: The County could impose a local option sales tax if approved by the voting public. The revenue would be distributed to each of the local governments and could be used for infrastructure capital improvements.

Clearly, stormwater management Capital Improvement Projects (CIP) can be funded using this source. However, by law, the funds can only be used for capital improvements--the funds cannot be used for management services and operation and maintenance (O&M) activities. In addition, sales tax revenues can be unreliable, since they vary from year-to-year depending on the ups and downs of the economy. Therefore, it is not sufficient to form the foundation of the financial plan for the stormwater management program.

Homeowners Association: The homeowners association concept is often used with new development. It is similar to the special assessment district in that a relatively small area would receive an additional levy. This method is generally available only for residential parcels. In the case where no special district could be established, or where a private entity is responsible for the maintenance of a stormwater facility, a homeowners association fee may be a reasonable approach. Assessments are specific depending on the needs and desires of each association. Capital improvements, operation and maintenance, and water quality monitoring for the residential development can be funded by this method.

Bonds: General obligation, revenue, or special assessment bonds are normally used by governments to pay for large capital improvement programs. Repayment of a bond is normally through the General Fund (i.e., ad valorem tax income); however, special assessment district income, as well as utility revenues, can be used to pay the debt service. Bonds would allow large-scale capital improvement programs to be initiated when the facilities are needed rather than waiting until the funds are accumulated.

Pay-As-You-Go Sinking Fund: As an adjunct to revenue bond financing, this type of stormwater funding is most common. Essentially, a separate account is formed to receive revenues from numerous sources such as ad valorem taxes or stormwater utility income. The fund accumulates revenues until sufficient money is available for an identified project. Then the total project amount is removed from the fund and the fund "sinks" in size and the growth stage starts over. This method is generally associated with capital improvement programs where it is not advantageous to incur long-term debt.

Subdivision Exactions: As a condition of approval for a redevelopment, the Town can require the developer to construct stormwater management facilities and dedicate them to the Town upon completion. In addition, developers could be required to donate drainage easements or other types of partial rights to the Town for stormwater management purposes. Thus, the developer would be responsible for funding the capital program while the Town would be responsible for funding the operation and maintenance. It is possible, however, to find that stormwater facilities designed, constructed, and transferred to the Town may not have been properly designed or that its discharge may aggravate downstream flooding problems.

Fee-In-Lieu-Of: An alternative to requiring developers to construct stormwater management facilities is to require them to pay an initial front-end charge for the capital improvements needed to service their development. The charge would be representative of the development's contribution to the regional facility in the watershed. A fee-in-lieu-of is a technique to generate the funding needed for capital improvements in a watershed. The term is derived from the case in which a developer is required to construct infrastructure including stormwater systems. Since construction of small-scale systems is not always advisable, particularly because of the problems associated with the acceptance of the operation and maintenance costs, the better choice is a fee paid to the Town to construct a larger system. The fee is the developer's share of the regional facility.

There are two general areas where a fee-in-lieu-of is appropriate. First, a fee-in-lieu-of is appropriate where there is a large marginal cost of constructing additional facilities with the development. A developer may pay for a portion of the construction of a large regional detention facility in-lieu-of the construction of a detention facility for an individual development.

The second area where a fee-in-lieu-of is appropriate is where the introduction of a sizable development causes the need for a new type of stormwater management system. For example, the stormwater problem may be adequately controlled within a watershed with the use of drainage ditches and swales. However, with the introduction of a new development, a detention/retention facility may be required. In this case, the developer could elect to pay a fee-in-lieu-of for the construction of the facility.

The collection of fee-in-lieu-of monies promotes the implementation of regional systems rather than the small-scale individual systems. The larger stormwater facilities are easier to maintain and can handle large-scale problems. Developers may be required to wait until sufficient funding is available for the regional system and until the facility can be constructed unless they commit to building an interim system which can be either removed or incorporated into the regional system. In developed portions of the Town which may have significant existing needs, there would be fewer new developments to contribute to the construction of larger regional facilities. Nevertheless, the fee-in-lieu-of process can reasonably be associated with a stormwater utility in newer portions of communities.

Developer Incentives: Incentives could be offered to induce developers to use proper stormwater management planning techniques during the redevelopment of lands in the Town. Such incentives, for example, could include waiving maximum allowable residential densities if land is dedicated to the Town for stormwater management purposes. This method would still require the construction of the stormwater facility by the Town; however, the land costs for the stormwater management facility would be reduced. The two significant concerns regarding the implementation of this method are: (1) to review the compatibility of developers' plans with respect to the goals and objectives of the land use element of the Town's land use plan; and (2) to assess the magnitude of nonpoint source pollution problems due to higher intensity level of development.

Betterment Charges: When a stormwater management facility is constructed to deal with a problem near a community, the property within the community will tend to increase in value. For example, if a drainage system is installed along a street where no stormwater management system had previously existed, then the control of flooding increases the value of property next to the road. The capital cost for such improvements could therefore be apportioned to the property owner(s). This apportionment of charges provides that the benefactors of the stormwater management system improvements would fund the program. The increase in property values resulting from such improvements is hard to estimate and this value may be less than the construction cost, thus limiting recovery.

Fees/Licenses/Permits: Funding from this source is generally limited to the cost of permit review and the inspection of construction. Other revenue sources must be utilized to finance other aspects of the stormwater management program such as administration, operation and maintenance, and capital improvements.

Penalties and Fines: Similar to permit fees, penalties and fines are limited in scope. Such income can be placed in the General Fund; however, it may be more reasonable to use the fines to correct the violation or any subsequent ones. This type of income could be used to subsidize a comprehensive stormwater management program but would not support the entire program.

Summary of Alternatives

The challenge for many communities, like the Town of Norway, is to devise a way to adequately fund the stormwater projects. There are a number of funding mechanisms available to the Town to finance the recommended BMPs described in this report. A brief description of each funding mechanism has been presented in this report. The Town of Norway needs to identify how it plans to fund its stormwater program.

To begin the discussion, several funding scenarios are presented. Funding is broken down into two parts: land acquisition and construction.

Land Acquisition

It is important to set aside land needed for stormwater ponds so that the site is not developed and the Town loses the opportunity to construct a needed facility. Land can be set aside using a number of different procedures.

First, the Town could purchase the land in anticipation of pond construction. This reduces the flexibility to "blend" the location of the pond into or around a proposed development. Also, it may be difficult for Town to arrange for the purchase of the property, because of a reluctant or uncooperative land owner.

Second, the Town could require the developer to dedicate the land for the pond to the Town. However, the development that will be served by the facility may not include the location of the proposed pond. In some communities, developers have been successful in convincing the communities to waive the dedication requirement or pass it on to another developer. This is known as "sloughing" and often results in failure of the community to meet its stormwater management goals.

Third, the Town could establish an overlay district on the Town's Zoning Map showing the proposed location of the facility. The developer and the Town would then know to make provisions for the stormwater pond when the area is developed.

Construction

New stormwater facilities, such as stormwater ponds, can be paid for by any of a variety of combinations of public and private funds. A policy addressing the financing of large stormwater facilities should be established. The proposed stormwater ordinance, if passed, will require the cost of construction and maintenance of stormwater management features from new development to be borne by the developer and the eventual owner of the developed property.

Most often stormwater facilities are the responsibility of the local unit of government. Projects are paid for with General Revenue funds or General Obligation Bonds. However, funding for stormwater management has never competed well against other essential services such as police, fire, transportation, etc.

Meeting the goals established by this plan will require the Town to significantly increase expenditures for stormwater management. The Town should consider requiring certain developments to pay for stormwater facilities through fee-in-lieu-of construction, sub-division exactions, and/or special assessments. The Town should consider funding annual expenses, such as operation/maintenance, through dedicated user fees instead of general fund monies derived from property taxes.

The General Fund and a stormwater utility are the only two funding sources capable of addressing a stormwater management program on a community-wide basis. The major distinction between the two alternatives is the method of allocating the costs for stormwater management. The General Fund is made up of revenues generated from ad valorem taxes. Ad valorem taxes are based on property value, which do not correlate with the runoff contribution of the property nor to the benefits received from the stormwater management system. Competition from other municipal programs for General Fund revenues results in many communities in a less than adequate funding for the stormwater management program.

A stormwater utility would provide an "umbrella" organization which would allow the Town substantial latitude in designing a comprehensive funding program. The funding program could include user fees, special assessments, and connection fees/impact fees. Together, these various funding mechanisms enable the Town to fairly and equitably allocate the cost of providing stormwater management services and facilities to its customers. The stormwater utility offers clear advantages for funding a comprehensive stormwater management program. It is the most fair and equitable means of allocating the costs associated with all facets of stormwater management to all of the users of the facilities based on their contribution to stormwater runoff