CHAPTER 13

STORM WATER QUALITY MANAGEMENT EVALUATIONS AND RECOMMENDATIONS

This Chapter of the Sister Bay Comprehensive Utilities Plan evaluates storm water runoff quality within the planning area and recommends steps to reduce surface water pollutant loading while minimizing contamination of ground water. This chapter summarizes the findings from this evaluation.

13.1 GENERAL

Throughout this chapter several key terms and phrases are used to identify or describe important storm water management activities, facilities or natural features in addition to those found in Chapter 12. The following terms/phrases are defined for use in this section:

- **Developed** areas are generally those that were not subject to the post-construction performance standards (s. NR 151.12 or NR 151.24, Wis. Adm. Code).
- "**MS4**" means a conveyance or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, constructed channels or storm drains, which meets all the following criteria:
    - Owned or operated by a municipality.
    - Designed or used for collecting or conveying storm water.
    - Not a combined sewer conveying both sanitary and storm water.
    - Not part of a publicly owned wastewater treatment works that provides secondary or more
    - Stringent treatment.
- **P**- Phosphorus
- **TSS** – Total Suspended Solids

13.2 OBJECTIVES

Sister Bay has undertaken a Comprehensive Utilities Plan in part to improve water quality. The study is to "assess current non-point source pollution discharges into State waters, and establish pollution control elements that target the performance standards as defined in CH. NR 151 Wis. Adm. Code".

Sister Bay is voluntarily developing a plan to meet the permit requirements. The NR 151 performance standards do not apply directly to Sister Bay since the municipality is not required to secure a Municipal Separate Storm Sewer System (MS4) Wisconsin Pollution Discharge Elimination System (WPDES) permit. Although communities are encouraged to voluntarily apply for permits Sister Bay has not indicated that they intend to do so.

NR 151.13 Developed urban area performance standard is the most applicable section of the rule. It sets goals of 20 percent reduction of TSS by 2008 and a 40 percent reduction by 2013.

These goals are set for the level of development in effect at the time when the "new development" rules of NR 151.11 and 12 went into effect in 2004. The best available information for the level of development

is the 2005 digital ortho photos available from Door County. Development taking place after that time must meet the new rules for post-construction storm water; typically to reduce TSS by 80 percent compared to loading with no-controls. In effect, the scope of the water quality study is limited to the currently developed area, since future development is required to meet other goals and is explicitly excluded by NR 151 language. SEH's analysis with SLAMM however does include the loadings generated by future development, but assumes that the future development will meet the 80 percent reduction rule of the law.

Two of Sister Bay's stated primary concerns are to reduce and prevent beach closings and to prevent ground water contamination. However, the tasks requested in the scope of this study do not address how to prevent beach closings and protect ground water. This analysis and recommendations are focused on surface water pollutant loadings using SLAMM as directed by Sister Bay. SEH has made recommendations that provide some level of protection for ground water but a comprehensive analysis of ground water and Best Management Practice designs that treat water for infiltration are beyond the scope of this study.

13.2 STORM WATER QUALITY STUDY METHODOLOGY

The water quality analysis uses information developed as described in Chapter 12 to input to the Source Loading and Management Model (SLAMM). SLAMM version 9.1 evaluates the TSS and Phosphorus loading generated by the developed condition. SLAMM is strictly a surface water model for developed areas only which evaluates pollutant loadings. It is intended for developed areas only and is not intended for agricultural or natural undeveloped conditions. It is not a hydrologic model.

NR 151 compares annual pollutant loading of developed areas for the "no-controls" condition to the "with controls" condition. This is different from the H&H comparison of "undeveloped" compared to "developed" since water quality considers <u>only</u> the developed condition. The no- controls pollutant loading establishes the baseline of comparison. No-controls is defined as when no Best Management Practices (BMPs) are employed in the model to mitigate runoff pollutant loading. The drainage system is assumed to be curb and gutter in good condition regardless of actual conditions. The drainage system control for Sister Bay supplies some level of TSS/P reduction through the shallow roadside ditches that function as swales, a recognized BMP control in SLAMM.

13.4 SURFACE WATER QUALITY ANALYSIS

13.4.1 Water Quality Analysis

SLAMM was used to create a model that quantifies pollutant loadings from outfalls identified during the system inventory. Pollutant loadings included the amount of TSS and Phosphorus in the water for three stages. These three stages include (1) baseline (without pollution controls); (2) drainage controls; and (3) recommended BMPs to obtain the target amount of pollutant removal.

The analysis will present the pollutant load:

1. coming off the landscape with no controls, regardless of destination for the existing conditions;
2. coming off the landscape with no controls regardless of destination for the future condition;
3. reaching the surface waters with no controls for the existing condition;
4. reaching the surface waters with drainage control for the existing condition.

The difference between result #1 and #2 represents the added load due to full planned buildout. Twenty percent of that difference represents the added load allowed to reach the surface waters of the state. The twenty percent is the load result due to the construction site WPDES requirements.

The difference between result #1 and #3 represents the load measured by the state. The difference is the load diverted to NCDs.

The table below presents the results for the pollutant loading conditions, 1-4 noted above.

Annual Pollutant Loading (lbs)					
	1. Existing Baseline	2. Future Baseline	3. Existing 'No Controls' Excluding NCD loading	Difference due to NCDs (1 minus 3)	4. Existing with Drainage Control
TSS	418,860	788,000	296,352	122,508	262,052
Phosphorus	1,286	2,527	973	313	890

The existing condition reduction due to drainage control and capture by NCDs (1 minus 4) is already close to 40 percent. Although the unimproved NCDs cannot be counted, the improved NCDs can.

When measuring reduction for a permit, if the NCD is improved to treat the runoff, the influent load is added to the baseline amount and the effluent (water reaching a surface water) load, if any, is added to the "with treatment" result.

According to NR151 guidance correspondence:

> *"Areas and loadings that shall not be included: Any internally drained area with natural infiltration. (This does not include engineered or constructed infiltration areas.) However, an internally drained area that discharges to a karst feature is not likely to be receiving adequate treatment prior to any contact with the groundwater. The municipality is encouraged to look at the area for possible treatment options."*

Of the runoff reaching surface waters, the current treatment occurs in swales, otherwise referred to as drainage controls. In this case, swales refer to existing roadside grass ditches. Typical swales in Sister Bay appear to be shallow grass channels. The model swale geometry reflects this characteristic. The length of road in each non-NCD watershed was compared to the total acreage to create a typical "Swale Density" for each residential land use/soil type combination. This foot/acre swale density is used by the SLAMM software, along with assumed typical swale geometry to calculate the amount of TSS removed in each watershed.

The third treatment condition requires the design of additional BMPs to achieve final necessary treatment. These BMPs may include wet detention ponds, infiltration, additional swales, or street sweeping. BMPs will need to be implemented to achieve remaining treatment.

13.5 PLANNING LEVEL RECOMMENDATIONS

13.5.1 Storm Water Management Ordinance

Appendix D provides model ordinances that address both erosion control and post-construction storm water management. The post-construction ordinance has requirements parallel to DNR's NR 151 and is based on an ordinance that has met past DNR approval for compliance with MS4 permit ordinance enactment requirements. In addition to the NR 151 requirements this ordinance requires peak flow controls for the larger storms up to and including the 100-year event.

The ordinance still must be formatted to conform to Sister Bay's ordinance style. Generic references to "municipality" should be replaced by "Sister Bay" (if appropriate), and local authorities used for review, appeals, and recommendation such as a Board of Public Works should be inserted where appropriate in place of the language used in this model ordinance. The final version should be reviewed by the Village's legal counsel to assure that the Village recognizes the responsibilities and liabilities that may be encumbered by adoption of these ordinances.

Discussions are currently underway between DNR and Door County regarding how NR 151 Technical Standards for BMPs approved for use by DNR do not consider the unique karst and aquifer conditions for Door County. One example is on site infiltration which is a valued BMP that would help to minimize storm water runoff volume increases not mitigated by lined detention basins. The ordinance should be reviewed for revisions that will be coordinated with the outcome of these talks.

13.5.1.1 Why Ordinance is Needed

Currently, state storm water rules do not provide water quality protection for small sites and provide no protection from increased flooding from major storms. The state currently regulates both construction period and post-construction runoff from development that involves construction sites disturbing 1 acre or more with the Wisconsin Pollution Discharge Elimination System (WPDES) permit. Construction site erosion control of all one and two family dwellings is regulated by Commerce, but not post-construction runoff unless the 1 acre threshold is met. There are loopholes for land disturbing activity development for multifamily and nonresidential construction sites under one acre where no state requirements are in force, and for all construction under one acre for post-construction performance standards. Regardless of disturbed area size, only the discharge rates for the two year storm are addressed.

13.5.1.2 Recommendations

To close these loopholes the Village of Sister Bay will need to enact storm water and construction site erosion control ordinances. A Village ordinance should address the sites which are less than one acre and require controls to prevent flooding or runoff increases from major events. In lieu of individual lot specific practices, a regional site can be selected if all parties can agree, but the primary responsibility should remain with the developer, be it private or commercial.

13.6 BMP STRATEGIES - USE OF EXISTING FEATURES

13.6.1 Roadside Ditches as BMPs

Existing roadside swales are already providing some level of treatment. BMPs are most effective when they treat runoff at the source. Roadside ditches as swales treat road runoff and provide some

pretreatment prior to discharge to NCDs. New development should be required to treat runoff prior to discharge from the site. The treatment should occur as close to the area of origin as possible. Ideally, roadside swales should be reserved for treatment of the roadway runoff. When within a sub-watershed discharging to a NCD, the discharge from developments should be designed to bypass the swale system of existing roads and route the treated runoff at the undeveloped discharge rate to the NCDs.

13.6.2 Ground Water Protection Concerns Natural Closed Depressions as BMPs

Presently, runoff water carrying surface contact pollutants drains to NCDs. NCDs are natural traps for the surface water contaminants and divert runoff from surface water outlets. As noted in the previous chapter, it is recommended that the existing storage areas or natural closed depressions within the planning boundary be preserved. When the characteristics are favorable, it is beneficial for the aquifer to be replenished or recharged from these sources where the runoff has been captured and cleaned via vegetative uptake and soil adsorption. But aquifer contamination in these natural closed depressions is a very real concern.

If thin, chemically inert soils with high porosity overlie fractured bedrock or karst conditions, there is a direct route for contamination of the aquifer. In northern Door County, this is generally the case. Figure 13-1 illustrates the location of the Village's wellhead protection management zones. The wellhead protection zone represents the underground area supplying water to municipal wells within a given time span. It is the area of most vulnerable to contamination from surface water pollutants. Given the hydro geologic characteristics of the area, that is the ground water pathway through voids, all areas within the study area should provide protection whenever feasible.

The working assumption by professionals concerned with ground water contamination in northern Door County is that shallow fractured bedrock with karst features is prevalent throughout the study area. Although karst features sometimes provide evidence of their existence on the surface, it is not always the case. Short of scraping away the entire overburden to inspect the bedrock surface, it is not feasible to determine their existence. The NCDs themselves are a strong indicator of highly fractured bedrock and karst features.

Typical storm water BMPs are not intended to provide the needed ground water protection for Sister Bay's subsurface conditions. The storm water rules are primarily a surface water protection mechanism that includes some protections for ground water by exempting the infiltration requirements of NR 151.12 and prohibiting infiltration practices in areas with the conditions found in the Sister Bay planning area. The primary focus of the rules and BMPs is the reduction of Total Suspended Solids (TSS). Many of the pollutants of concern are related to TSS and a reduction in TSS provides a similar decrease in other pollutants. However, pollutants of concern to ground water are not always reduced by mechanisms that reduce TSS.

There are two basic alternatives to reduce aquifer contamination: treatment or diversion. One alternative is to line the bottom of the NCDs with impervious materials to minimize infiltration. Since the infiltration outlet no longer exists, it will be necessary to provide an alternative outlet. A storm system to convey excess runoff to Green Bay would be necessary, but to protect Green Bay from the new storm water pollutant load it would still be necessary to provide treatment prior to discharge. The other alternative is to treat water sufficiently to allow infiltration.

The natural closed depressions were shaped under undeveloped land use runoff conditions. The practical strategy for storm water conveyance is to follow the existing landscape and reconnect storm water with

the natural drainage system whenever possible. The NCDs are a final destination or receiver for much of the natural drainage system. The goal of the storm water management system is to mitigate human changes to the water cycle and restore as much of the natural system as possible. It is desirable and most efficient to utilize the NCDs to the extent possible. The alternative is to convey the majority of the runoff to Green Bay. This does not eliminate the step of reducing runoff water pollutants with BMPs. Due to shallow bedrock, construction costs for a storm system would be prohibitive when compared to the NCD outlet alternative.

Ideally, runoff would be treated prior to discharge to the NCD. Presently, there are developed and varying levels of undeveloped areas contributing to NCDs. As undeveloped areas are developed treatment will occur by regulatory requirement and by the proposed ordinance. The currently developed area runoff remains untreated except to the level of treatment provided by swales.

The problem that presents itself is how to capture and treat untreated runoff. Small events have been shown to carry the bulk of the annual pollutant load. (The caveat to this rule is that uncontrolled soil erosion from construction sites and bare agricultural fields is heavier during larger events). A standard water quality treatment strategy is to capture and treat the small storm runoff event. This is typically done by introducing a diversion structure within the conveyance system. Small discharges are diverted to the BMP for treatment, while larger discharge rates bypass the diversion and are conveyed to the outfall. The small (water quality) storm is selected as the design storm.

There are few if any concentrated flow conveyances in the landscape in which to install the design storm diversion. Since the landscape does not generally focus runoff into a distinct channel, the diversion strategy is not a practical means of isolating the small event for treatment. The NCDs represent the most logical and feasible location to treat the existing development runoff.

13.6.3 Recommended BMP

A unique BMP is needed to address the unique conditions of the Sister Bay area. Two mechanisms that will reduce pollutants of concern are wet retention and soil adsorption. Figure 13-2, “Improved Natural Closed Depression” is a schematic of the proposed BMP. The runoff events at or below the water quality storm are the primary source of storm water pollutants. SEH proposes an alternative strategy to “isolate” the small storm for treatment.

SEH proposes to utilize the NCDs as wet retention ponds as well as flood control practices. The bottom of the basin will be where the initial runoff accumulates. Ground water contamination is reduced from the current condition by lining the bottom of the natural closed depressions to the level equivalent to the volume of the water quality storm.

Wet retention ponds normally use a surface water outlet. The existing NCDs can be viewed as retention ponds that outlet through the soil/bedrock pores and voids. To capture the runoff long enough to afford treatment the bottom is lined. Then only the flooded area above the initial runoff volume is allowed to infiltrate. While passing through the soils, the second type of treatment known as soil adsorption will occur in soils with sufficient fines. This represents a secondary treatment system. Due to financial constraints only the liner soil is imported if native soils are unsuitable. The upper soils remain as undisturbed as possible. The secondary treatment option occurs only if the proper soil type is available, but is an extra step.

The water level in the NCD at the onset of the storm will dictate the behavior of the BMP. When the period between runoff events is prolonged, the NCD will be "dry". Any event less than the water quality storm, the event with the majority of the annual pollutant loading, will be captured within the lined area which in effect achieves100 percent capture.

When periodic runoff events are more frequent water is present. A similar condition occurs when the storm exceeds the design storm capacity elevation. The Improved NCD will function as a wet retention pond. Although the runoff event will flood the NCD to a level above the liner allowing runoff to infiltrate towards the ground water, infiltration represents a very small outlet, prolonging detention and leading to a cleaner discharge. Since the H&H analysis assumed no infiltration whatsoever (except as noted in Chapter 12 in a few isolated watersheds), the flood protection elevations of the proposed Storm Water Storage Zones are still conservative.

Surface discharge may not occur if the storm is small enough. Surface outlets are modified if necessary such that the elevation of the discharge invert is at the design storm storage elevation. Thus the first flush is either captured totally or treated, and the excess runoff from larger events carrying a minority of the annual pollutant load is allowed to escape to either the existing surface conveyance or through the soil to replenish the ground water.

13.6.4 When to Use an Improved Natural Closed Depression

This practice does not promote additional infiltration. Instead, infiltration is reduced and the practice allows some level of treatment before infiltration occurs. Careful selection of liner materials and type should be investigated. Locally available silts have shown better performance than clays. The liner should be constructed with the appropriate soils or in accordance with NRCS Field Office Technical Guide Standards including Clay, Geosynthetic, Polyethylene Geomembrane Liners.

When an opportunity presents to observe fractures and karst, they should be sealed. A geotextile should be installed below the liner, directly over the bedrock when possible, to prevent the migration of soil though voids.

Door County is currently in the process of working with DNR to provide more specific guidance on the use of BMPs to address the shallow bedrock and karst features conditions occurring there. SEH has forwarded information on this proposed BMP to both Door County and Wisconsin DNR and incorporated their comments into this discussion. DNR reports the use of a similar concept in other parts of the state.

Each NCD has unique characteristics that need to be established for the parameters of:

1. Storage volume
2. Outlet size, elevation
3. Soil profile
4. Bedrock depth
5. Seasonal high ground water
6. contributing area size and land use

These parameters are necessary to analyze and /or design both water quantity and quality functions of the NCD. A soil boring or excavation pit to determine: soil profile information for potential natural

attenuation and liner potential, bedrock depth, and seasonal high ground water elevation. The installation of a monitoring well with regular testing of ground water or interflow from monitoring well samples should establish if pollutants are migrating into the aquifer from runoff. The results of the testing will demonstrate which sites are contributing the most pollutants and provide a means of prioritizing implementation of ground water protection BMPs.

Each site needs to checked for the presence of wetlands prior to moving forward with design. The basin's topography should be established through a detailed site survey providing greater accuracy than the 2 foot contour mapping used for this study. This includes the presence of existing development, basement elevations, and potential surface outlets.

Current outlet conditions for these Natural Closed Depressions need to be investigated. There are three basic scenarios which may exist. The first is natural drainage through the bottom of the depression into the ground water aquifer. This is the anticipated method of drainage for the majority of NCDs within Sister Bay. This outlet conditions would be treated by the modified BMP as described above.

The second scenario may occur in NCDs near roads, where ditches and culverts may serve as outlets that are below the storage elevation of the 2 year storm. This outlet should be modified to force the lined NCD to act as a wet detention pond, releasing it at a reduced rate to promote sedimentation or deposition of TSS..

The third scenario involves NCDs which have a higher outlet, above the storage elevation of the 2 year storm. The lined bottom of the NCD treats the small storm first flush as described above, but leaves a route of escape for the larger, cleaner flows. This allows prevention of erosion of the NCD and liner by releasing excess water.

Like all BMPs, an Operation and Maintenance Plan should accompany the design. Use of the monitoring wells can provide evidence of changes in the function of the system and alert those responsible to the need for additional steps.

The final design of this BMP should incorporate the flood storage elements for the Storm Water Storage Zones as discussed in Chapter 12. The concerns expressed in Chapter 12 regarding the authority to implement both the flood control and water quality protection aspects apply to these recommendations as well. The responsible party must be identified, who may not be the developer. An easement or other legal instrument is necessary for the responsible party to gain access for investigation, construction, monitoring, and maintenance.

Surface water carrying pollutants is presently draining into NCDs and reaching the ground water through the subsurface drainage voids. The proposed BMP is not intended as the primary ground water protection feature to guarantee the prevention of ground water contamination from storm water runoff. Such protection is beyond the scope of this study. It does provide treatment counted by WI-DNR under NR 151.13 while improving the present level of groundwater contamination.

13.7 WATER QUALITY CAPITAL IMPROVEMENTS

The first step is to secure easements and property necessary to accomplish the work in order to minimize the potential for development encroachment on areas that require structural BMPs beyond the Improved NCD. It is believed that since the area of the NCD improvement lies within the Storm Water Storage Zones, this work can be done by easement vs. purchase if the authority to zone in this manner exists.

For the groundwater protection afforded by the Improved Natural Closed Depression aspects of the project, recommended improvements have been broken down by priority with respect to the Wellhead Protection Management Zones.

It is recommended the Village implement a Natural Closed Depressions improvement program as listed and prioritized in Table 13-1. The Natural Closed Depressions within Wellhead Protection Management Zone 1 are the highest priority. They include NCDs of Watersheds #3000, #3102, #3105 and #4401.

These priority improvements are estimated to cost approximately $5.2 million. The lower priority watershed NCD improvements are estimated to cost approximately $6.2 million .

The locations recommended for Improved NCDs are noted in the figures for each watershed in Chapter 12 of this report.

13.8 ONGOING OPERATIONS

The following are steps to take that follow the intent of the minimum control measures as found in NR 216.06 (2).

1. The erosion control and post-construction storm water management ordinances are discussed earlier and can be found in the appendix.

2. Review and update a building permit application package to include references to the Erosion Control Technical Standards used by DNR and found at:

   http://dnr.wi.gov/org/water/wm/nps/stormwater/techstds.htm.

Illicit Discharge Detection. See Appendix D for an example of the Illicit Discharge Detection program.

Municipal Storm Water Pollution Prevention Plans. Municipal sites and shops should take the following steps.

1. Store all hazardous materials under cover.
2. Municipalities operating Electrical Utilities should keep transformers containing oil coolant with PCBs under cover or inspect for leakage on a regular basis.
3. Wash vehicles inside with discharge to sanitary sewer system. Collect and dispose of clumps of soil attached to vehicles and equipment.
4. Install an oil/water separator where vehicles are stored outside.
5. Keep material stockpiles away from areas of concentrated flow and encircle with containment barricades.
6. Keep salt stockpiles stored under a roof.
7. Roof vehicle fueling stations and set grades to prevent water from draining across fueling area.

Replace inlets with catch basins with sumps greater than 18 inches with a monthly to semi-annual cleanout schedule.

TABLE 13-1

RECOMMENDED STORM WATER QUALITY IMPROVEMENTS

STORM WATER MANAGEMENT PLAN
SISTER BAY, WISCONSIN

Watershed No.	Wellhead Protection Management Zone		Area (acres)	Estimated NCD Improvement Cost	
	Zone 1	Zone 2			
Priority Watersheds					
3000	Yes	No	83	$	488,400
3102	Yes	No	119.5	$	703,200
3105	Yes	No	n/a	$	2,942,400
4401	Yes	No	58.8	$	346,000
4402	No	Yes	117	$	688,500
Priority Watershed Subtotal				**$**	**5,168,500**
Secondary Watersheds					
300	No	No	10	$	58,800
500	No	No	16	$	94,200
800	No	No	40	$	235,400
900	No	No	192	$	1,129,900
1002	No	No	203	$	1,194,600
1300	No	No	37.3	$	219,500
1600	No	No	70	$	411,900
1900	No	No	65	$	382,500
2002	No	No	52.3	$	307,800
2302	No	No	21	$	123,600
2500	No	No	11.3	$	66,500
3101	No	No	156	$	918,000
3200	No	No	29	$	170,700
3603	No	No	131.8	$	775,600
5200	No	No	11.4	$	67,100
6301	No	No	13.9	$	81,800
Secondary Watershed Subtotal				**$**	**6,237,900**
Overall Planning Area Total				**$**	**11,406,400**

Note

1. Estimates include engineering and contingency costs.

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Inspect ditches for signs of erosion and excessive sedimentation. Repair as needed.

Minimize use of salt for de-icing and sweep roadways to recapture and dispose of sanding.

Establish a leaf collection program for the fall.

Sweep roadways in the spring after local trees shed blossoms to prevent what has found to be significant sources of phosphorus.

Information and Education. Issue periodic bulletins of storm water information and education materials available from WI-DNR and the UW-Extension. Issue these with building permits and make available in a rack in the Village Hall.