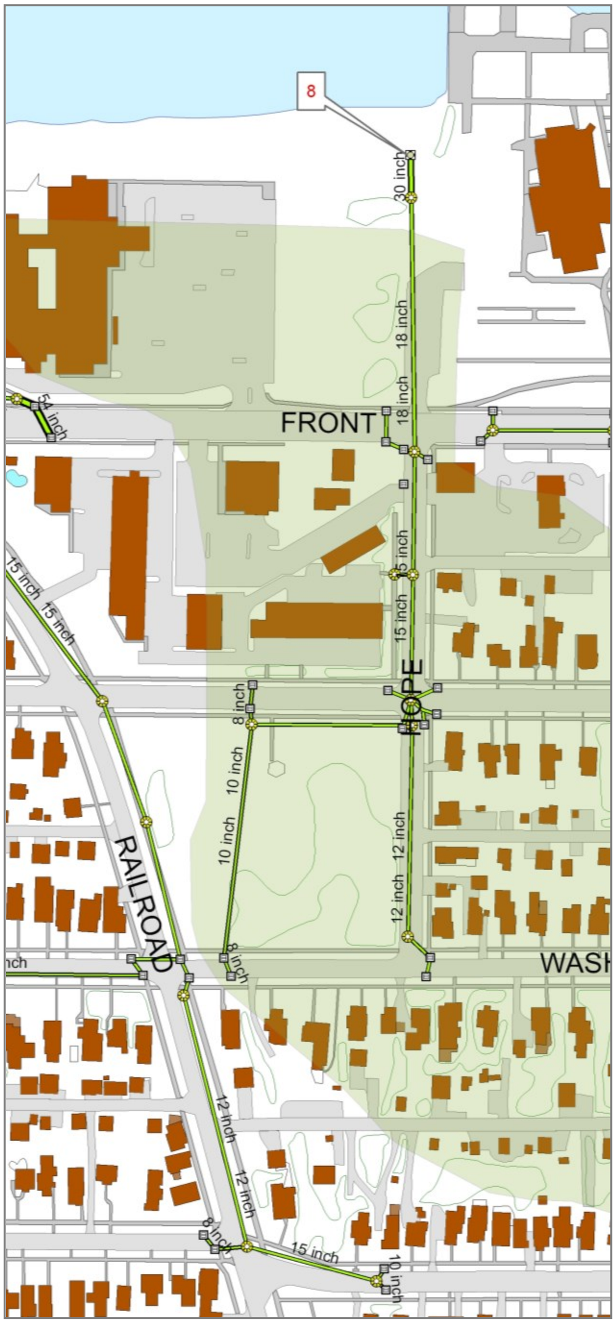
CITY OF TRAVERSE CITY

Engineering Department



2007

Stormwater

Management

Report

CREATED BY

City of Traverse City
Engineering Department
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Executive Summary

Stormwater runoff has been identified as one of the threats impacting water quality of the watershed of Grand Traverse Bay. The City of Traverse City was awarded funding from the MDEQ for the development of a Stormwater Management Report to investigate existing infrastructure conditions and assess options to improve the quality of stormwater runoff. The objectives of the Report were to:

- Identify points of stormwater entry into Grand Traverse Bay and its watershed within the city limits of Traverse City.
- Conduct site visits to assess current conditions of outfalls and infrastructure.
- Delineate and prepare Maps for drainage boundary areas.
- Conduct hydrologic and hydraulic investigations to determine the appropriateness of specific Best Management Practices (BMP's).
- Define system of BMP's to use for each point of entry to improve the quality of water that is discharged.
- Develop criteria to prioritize point of entry for future investments in storm water quality projects.
- Develop criteria for monitoring current/recent water quality projects to determine the effectiveness of the treatment system installed.
- Examine tools available to modify existing stormwater ordinance for the City of Traverse City to allow for BMP recommendations and prioritization.

These objectives are presented in four sections of the report and seven Appendices. These are explained as follows:

Section 1: Background Information references historical information such as previous reports, technical data, utility records, plans and mapping.

Section 2: Stormwater Infrastructure Inventory includes identifying the points of entry into Grand Traverse Bay and its watershed, determining the contributing drainage areas for each point of entry, and conducting a field review of accessible locations. Using the methodology in *Chapter 7* of the *MDEQ Soil Erosion and Sedimentation Control Training Manual (Revised 2005)* we determined the 2, 5, 10 and 25 year, 24 hour, potential runoff volume and discharge rates for the contributing areas for each point of entry.

Section 3: Stormwater Management identifies the minimum control measures of the Stormwater Management Plan to prepare the City to meet Phase II EPA Stormwater Regulations. This section includes criteria for prioritizing sites for future stormwater quality projects, defining BMP's to improve stormwater quality to the maximum extent possible, and includes an overview of treatment technologies.

STORMWATER MANAGEMENT PLAN

MINIMUM CONTROL MEASURES

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-Construction Runoff Control
- Pollution Prevention/Good Housekeeping

Section 4: Local Strategy for Water Quality examines local strategies to implement stormwater quality improvements to address stormwater pollutant threats impacting water quality.

Appendices A, B, C and D include the contributing drainage area map, hydraulic capacity of storm sewers and the field data sheet for the majority of the points of entry identified in Section 2. Some of the points of entry did not have data for storm sewers available and/or could not be field located.

Appendix E includes runoff calculations for the contributing drainage areas for the points of entry. The calculations include drainage area in acres, surface type by land use, and determination of the potential runoff volume and discharge rates.

Appendix F includes the current City ordinance and guidelines for stormwater runoff control. It also includes a copy of PA 507 of 2002 which enables local health officials to test, monitor and report beach area water quality.

Appendix G includes the current resources, references and links from the *Grand Traverse Region Stormwater Management Toolkit*.

Section 1: Background Information

To begin the process of identifying points of stormwater entry into Grand Traverse Bay and its watershed within the city limits of Traverse City it is necessary to review the historic information and technical data that is available. The following reports and documents were reviewed and key information about existing stormwater systems compiled.

Report on One Year Operation of Sewage Disposal System (1933)

This report focused on the success of the first year of operation of the City's sewage collection and treatment system including storm sewers.

Report on Sewerage and Drainage (1945) - This comprehensive report provided the basis of design and general plans for much of the City Storm and Sanitary Sewer system.

***Engineering Report Storm Sewer Study Centre-Carver Area for City of Traverse City (1965)* -** This report provided the basis of design for the storm sewer system in the Traverse Heights area of the City.

***Water Quality Models for Total Coliform Bacteria in Grand Traverse Bay (1967)* -** This study provided significant water quality data for the West Grand Traverse Bay and references the transfer of the City water supply intake to East Grand Traverse Bay in 1966 as a result of water quality concerns which affected public health.

***Report on Algal Nutrients in the Boardman River (1968)* -** This report provided significant water quality data for the Boardman River and discussed eutrophication of West Grand Traverse Bay.

***Sanitary Sewerage and Water Supply Systems (1970)* -** This report focused on the regional sanitary sewer and water supply and states; "The problems of combined sewers are evident in Traverse City" and; "A program to separate these flows should be taken as soon as possible, particularly in view of the fact that during periods of high run off substantial amounts of overflow are discharged directly into the Boardman River, including significant amounts of Raw Sewage."

> *" The problems of combined sewers are evident in Traverse City"*
> *—Sanitary Sewerage and Water Supply Systems (1970)*

***Boardman River Natural River Plan (1976) (revised 2002)* -** This plan and its updates are the guidelines for stewardship of the Boardman River. Our river care champion, The Grand Traverse County Soil Conservation District, maintains this plan as part of their Boardman River Project.

Infiltration/Inflow Analysis (1978)- This report focused on infiltration in the Sanitary sewer system but includes the reference "The Traverse City sewerage system was completely separated in 1973 when the last combined sewers were eliminated."

> *"The Traverse City sewerage system was completely separated in 1973 when the last combined sewers were eliminated."*
> *—Infiltration/Inflow Analysis (1978)*

***Greilickville Storm Water Plan (1979)* -** This report provided the basis of design and recommendations for stormwater management for the area between M-72 and Grand View Road in Elmwood Township and the City.

Stormwater Management, An Experiment and Demonstration in Traverse City (1980)- This study was a follow up to "Grand Traverse Bay Water Quality Investigations (1974)"which documented water quality concerns at municipal beaches. This report studied:

- Citizen Education- This best management practice (BMP) included the education of citizens as to how pollutants build up on streets, sidewalks, and lawns to reduce stormwater pollution at its source.
- Street and Catchment Maintenance- This BMP consisted of intensifying the regular street sweeping and catch basin cleaning in the study area. The report verified that these two BMP's are highly effective in reducing stormwater pollution to Grand Traverse Bay.
- Currently, we have partnered with the Watershed Center Grand Traverse Bay to continue the water quality awareness of our citizens and implementation of water quality projects.

Eastern Avenue Drainage Basin Study (1987)- This study examined solutions to drainage issues resulting from September 1986 storm event in the north east part of the City. The initial study was followed by several updates and plans for an area retention basin situated on Eastern Avenue in the vicinity of the water treatment plant.

***Tributary A of Kid's Creek Drainage Basin Study (1988)* -** This study examined solutions to flooding along Tributary A to Kid's Creek in the vicinity of Grand Traverse Commons and the hospital.

***Kid's Creek Stormwater Management Plan (1988)* -** This comprehensive plan addressed existing and future flooding and water quality concerns of Kid's Creek in the City and Garfield Township. The plan served as a catalyst for stormwater management ordinance and regulation in region.

***City of Traverse City Code of Ordinances Chapter 1068 Ground-Water Protection and Storm-Water Runoff Control (1991)*-** The purpose of this chapter is to aid in the prevention of surface and ground-water contamination, to regulate and control the construction and use of storm-water runoff facilities, to control discharges to the public storm drain system, to protect the public health, safety and general welfare and to prevent the pollution, impairment or destruction of a natural resource and the environment of the City and the State. The current version is included in **Appendix F** along with the Guidelines currently used by the City for regulating stormwater runoff.

***Mitchell Creek Watershed Protection Strategy (1995)*-** This study was an effort to balance preservation of the natural resource base while encouraging reasonable local economic development initiatives for the Mitchell Creek Watershed including the tributaries to Mitchell Creek.

***Various Wastewater Treatment Facility Reports*-** Subsequent years to the initial 1933 operational sewage treatment plant have produced many additional reports focused on the wastewater treatment plant and the extent of sewage treatment has evolved to the current facility, a nationally recognized sewage treatment facility completed in 2004, producing highly effective sewage treatment.

***The Grand Traverse Bay Watershed Protection Plan (2003) (Updated 2005)*-** The Grand Traverse Bay Watershed Protection Plan provides a description of the watershed (including such topics as bodies of water, population, land use, municipalities, and recreational activities), summarizes each of the nine sub-watersheds to Grand Traverse Bay, and outlines current water quality conditions in the bay. Within the initial two-year development phase of the protection plan, water quality threats were identified and efforts to address these issues were researched, developed, and prioritized. The plan was prepared by The Watershed Center Grand Traverse Bay, a private non-profit organization, founded in 1990 and devoted to the protection and enhancement of Michigan's Grand Traverse Bay and surrounding watershed through research, education and collaboration with partners (see **Appendix G**).

***The Boardman Lake Watershed Study (2003)*-** This study identified the physical, biological, and built infrastructure resources of the Boardman Lake watershed and evaluated them for potential impacts to the long term water quality of Boardman Lake and the lower reaches of the Boardman River. This study complemented previous and ongoing watershed management plans within the region.

Stormwater Source Identification (2001)- This study quantified mass loading of nutrients and fecal contaminants via urbanized tributaries and stormwater discharges to Grand Traverse Bay.

***Public Act 507 (2002)* -** This Public Act enables local health officials to test, monitor and report beach area water quality. The current version is included in **Appendix F**

***Grand Traverse Region Stormwater Management Toolkit (2006)* -** The Watershed Center Grand Traverse Bay put together a toolkit for local governments and other involved organizations for learning about options for stormwater management. The toolkit is a mix of online resources, books, electronic reports, and articles and information relating to stormwater management and best management practices.

***New Designs for Growth Development Guidebook (2006)* -** The *"Guidebook"* represents a continuation of efforts to demonstrate how development can occur while protecting natural resources. It is designed for appointed and elected officials and developers within the five county Grand Traverse Region.

Section 2: Stormwater Infrastructure Inventory

Taking inventory for the points of stormwater entry into Grand Traverse Bay and its watershed within the city limits of Traverse City is possible with the extent of the historic information and technical data that is available. The City Engineering Department recently completed Geographic Information Systems inventory and mapping of the City's existing storm sewer system. This included more than 1900 drainage structures and manholes, 54 miles of storm sewers open channels and culverts and more than 90 points of entry into area streams, rivers, lakes and the Grand Traverse Bay.

Discharge Locations and Drainage Area Boundaries

The City of Traverse City is home to 95 drainage area boundaries and associated points of entry into area bodies of water. Below is a table briefly describing the different boundary areas. Maps of these areas can be found in **Appendices A-D**.

Boundary Zone	Description
A-AZ	Primarily drainage areas in the northwest portion of the City such as the Munson Medical Campus and Slabtown neighborhood, and including the north portion of Pine St, the warehouse district, and the northeast corner of State St and Washington St
B-BZ	Primarily drainage areas on the central west side of the City such as the neighborhoods south of Fourteenth St, the entire length of Wadsworth St, Front St from Division St to Park St, Locust St north of Eleventh St, and Lake Ave
C-CZ	Primarily drainage areas on the east side of the City such as Airport Industrial Park, Orchard Heights Neighborhood, Central High School, the Civic Center, Traverse Heights Neighborhood, and Oak Park Neighborhood, and including Boardman Ave, State St from Union St to Boardman Ave, and Eighth St from Boardman Ave to Fair St
D-Z	Includes drainage areas throughout the City, including Union south of Thirteenth St, Cass St between Fourteenth St and Lake Ave, Boardman Neighborhood, Front St between Munson Ave and East Bay Blvd, Eighth St and the surrounding neighborhoods between Cochlin St and Cromwell St, and the neighborhoods immediately south of the NMC campus

Each drainage boundary also has an expected runoff volume and runoff depth calculated for the 2 year, 5 year, 10 year, and 25 year storm, as well as the area in acres of pavement, residential, forested ground cover, and the total area in acres and for each boundary. Each boundary area also has the percent of the boundary that is considered impervious calculated, along with the average runoff curve number, and average pipe and watershed slope. Using this information, the estimated unit peak discharge was calculated for the 2 year, 5 year, 10 year, and 25 year storm based on both the watershed and the average pipe slope for each boundary, along with the treatment flow range (1/3 of the unit peak discharge), following the methodology in Chapter 7 of the *MDEQ Soil Erosion and Sedimentation Control Training Manual (Revised 2005)* (see **Appendix G**). Tables for these values can be found in **Appendix E.**

STEPS IN CHAPTER 7 OF THE MDEQ SOIL EROSION AND SEDIMENTATION CONTROL TRAINING MANUAL

1. **Identify Soil Type**
   - All soils within the City Limits are assumed to be Hydrologic Soil Group B
2. **Evaluate Surface Conditions**
   - Use **Table 7-1 in Appendix E**: each boundary has the areas broken up into the number of acres considered pavement, residential, and forested, along with the calculated Average Runoff Curve Number
3. **Determine Runoff Depth and Runoff Volume**
   - Use **Table 7-2 in Appendix E** for the expected runoff depth for the 2 year, 5 year, 10 year, and 25 year storm
   - Use **Table 7-3 in Appendix E** for the expected runoff volume for the 2 year, 5 year, 10 year, and 25 year storm
4. **Determine Unit Peak Discharge**
   - Use **Table 7-4 in Appendix E** for the estimated unit peak discharge rate using the average pipe slope for the 2 year, 5 year, 10 year, and 25 year storm
   - Use **Table 7-5 in Appendix E** for the estimated unit peak discharge rate using the average watershed slope for the 2 year, 5 year, 10 year, and 25 year storm
5. **Determine the Treatment Flow Range**
   - Use **Table 7-6 in Appendix E** for the high end of the treatment flow range (1/3 of the higher unit peak discharge, using pipe slope versus watershed slope) for the 2 year, 5 year, 10 year, and 25 year storm
   - Use **Table 7-7 in Appendix E** for the low end of the treatment flow range (1/3 of the lower unit peak discharge, using pipe slope versus watershed slope) for the 2 year, 5 year, 10 year, and 25 year storm
6. **Design Stormwater Treatment System**
   - Design the stormwater treatment system based on the determined treatment flow range
   - Examine low impact development options as well as conventional BMP treatment options

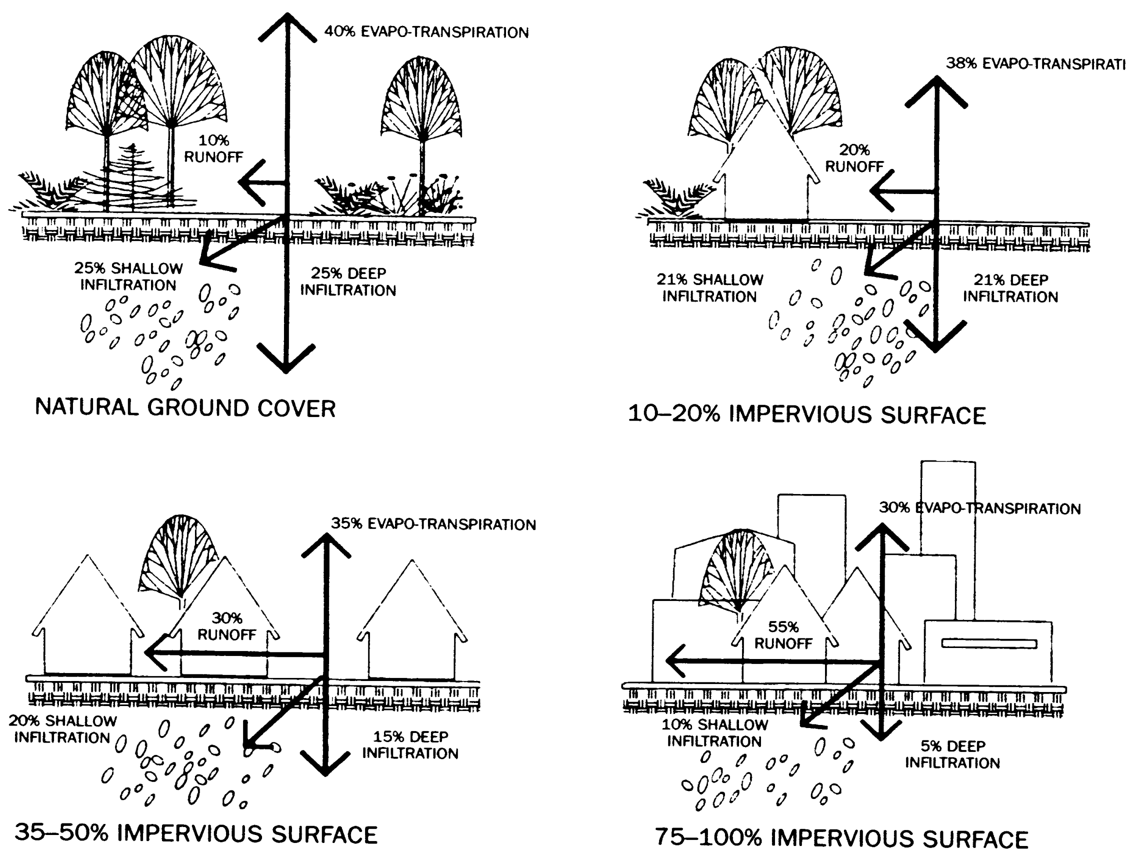
Field Review and Inventory of Discharge Locations

Included with each boundary map in **Appendices A-D** is a list of the catchbasins and manholes contained in each boundary, along with a storm outlet evaluation for the outlet associated with each boundary. The storm outlet evaluation sheet includes areas to enter information about the outlet itself such as the year it was constructed, if there are plans available, if there is an end treatment, and the pipe size and type. The evaluation sheet also includes areas to enter field observations such as if the outlet is submerged or if there is a portion exposed, if there are any deposits, the presence of slope protection and what type, any evidence of flooding or scour, and the high water mark. A copy of the storm outlet evaluation sheet can be found in **Appendix G**.

Section 3: Stormwater Management

Stormwater management is a key component to ensuring the longevity of storm water treatment systems and maintaining healthy natural water sources such as rivers, lakes, streams, and the Grand Traverse Bay. Stormwater management is a combination of stormwater treatment and stormwater system maintenance, as well as policies to help encourage the infiltration of stormwater before it reaches catchbasins, stormwater treatment systems, or surface waters.

Water Cycle Changes Associated with Urbanization



Source: Environmental Protection Agency, *Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters,* #840-B-92-002, 1993.

Stormwater Best Management Practice (BMP)

There are currently dozens of stormwater management BMP's to choose from to meet stormwater management goals. The list grows as technologies and testing of installed BMP's continues to develop. No single BMP can address all stormwater quality issues. Each type has unique effectiveness and limitations depending on the site specific characteristics, the intensity of stormwater events, and the ease of maintaining the system.

There are a number of low impact development (LID) options, options that mimic the natural environment, that have been proven to be effective stormwater management tools. These options include: green roofs, rain gardens, drainage swales, leaching basins, and permeable pavement. One benefit of most LID methods is that they allow stormwater to infiltrate back into the water table, which uses the soil and plants as natural filters, instead of entering a municipal stormwater system. The most prevalent limitation of most LID options is that the area required for LID methods to treat the desired volume of stormwater is often too great to be used as the only stormwater treatment option in highly developed areas. Some LID options are also weather dependent and may not be effective in the spring, when runoff can be at its peak, in areas that experience harsher winters due to the ground being frozen.

BMP's for municipal stormwater sewer systems also exist. These options include stormwater treatment units that can be installed in manholes to filter out debris and/or oils from stormwater before reaching an outlet to surface water. The benefit of these systems is that many municipalities already have an extensive stormwater sewer network, and these systems allow for treatment of existing systems with little to no change to the existing stormwater sewer network.

Often, it is most practical and sometimes most effective to use a combination of LID methods and stormwater sewer BMP's for stormwater management. These options include retention basins with stormwater sewer overflows, stormwater sewers connected to leaching basins, or raingardens surrounding raised catchbasins with outlets protected by filtration systems installed in manholes.

Stormwater System Maintenance

All stormwater systems require some degree of maintenance. For instance, catchbasins need to be regularly emptied of sediment to prevent clogging, filtration systems need to have filters cleaned and replaced, plants used in LID methods need to be maintained and collected debris and trash need to be removed, and storm sewers and culverts need to be evaluated to ensure that they are properly sized and free of clogs. If a system is not properly maintained, flooding can occur and debris and contaminates such as oil and sediment can end up in the area's lake, rivers, and streams. Contaminated and sediment heavy stormwater can lead to water quality issues and negatively impact aquatic animals and plant life. Towns like Traverse City, which depend on water sources for economic and recreational reasons, have to take into account the impact stormwater will have on the fishing industry, water sports, beach conditions, and the overall aesthetic quality of the area's lakes, rivers, and streams, as well as the environmental impact.

Site Prioritization

With the monumental task of achieving highly effective stormwater quality improvements throughout an entire municipality, it is important to prioritize projects based on criteria that will make the largest impact to the overall stormwater quality of the municipality. Prioritization helps ensure that money is being spent efficiently, that the greatest environmental benefit is being achieved, and often results in decreases in the amount of stormwater entering stormwater sewers, leading to less potential for the need to increase the size of existing sewer systems as an area becomes more developed.

Considerations for prioritization of sites to receive stormwater quality improvements should include attention to areas that are:

- Near public beaches and parks
- Adjacent to surface waters
- Known for water quality issues
- In Central Business Districts

Nonpoint Source Stormwater Pollution

Nonpoint source (NPS) pollution in stormwater comes from many diffuse sources. NPS pollution originates when rainfall or snowmelt moves over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into surface waters and even underground sources of drinking water.

NPS POLLUTANTS

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas
- Oil, grease, and toxic chemicals from urban runoff
- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks
- Bacteria and nutrients from livestock, pet wastes, wildlife, and faulty septic systems

EPA Phase II Stormwater Regulations

The purpose of the Environmental Protection Agency's (EPA) Phase II Stormwater Regulations is to significantly reduce pollutants in urban storm water compared to existing levels in a cost effective manner for small municipal separate stormwater systems through the implementation of six minimum measures identified by the EPA and to significantly reduce pollutant discharges and improve surface water quality at small construction sites through the implementation of BMP controls. Expected benefits listed by the EPA include: "reduced scouring and erosion of streambeds, improved aesthetic quality of waters, reduced eutrophication of aquatic systems, benefit to wildlife and endangered and threatened species, tourism benefits, biodiversity benefits and reduced costs for siting reservoirs. In addition, the costs of industrial storm water controls will decrease due to the exclusion of storm water discharges from facilities where there is "no exposure" of storm water to industrial activities and materials."

EPA PHASE II STORMWATER REGULATIONS

MINIMUM CONTROL MEASURES

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-Construction Runoff Control
- Pollution Prevention/Good Housekeeping

These regulations are of particular interest to Traverse City due to its classification as a "Potential Designate" for Phase II compliance. The EPA and Michigan Department of Environmental Quality (MDEQ) will decide if and when Traverse City will become a designate.

Factors that are weighed by the EPA and MDEQ for a municipality to become a designate are:

- High Growth or Growth Potential
- Significant Contribution of Pollutants
- Ineffective Control of Water Quality
- Discharge into Sensitive Waters

Considering that Traverse City is a small to moderately sized community that boarders Lake Michigan and is home to a number of rivers, streams, and the Boardman Lake, it seems that Traverse City is a good candidate for falling under the EPA Phase II Stormwater Regulations. Therefore, it is important that Traverse City, and similar municipalities, take the necessary steps to prepare for the EPA Phase II Stormwater Regulations to take effect. In the event that a municipality does not qualify as a designate, it is advisable to review the minimum control measures and update the municipality's current stormwater management policy to ensure that all of the recommended minimum control measures are still being addressed.

Section 4: Local Strategy for Water Quality

This Michigan state-level call for examining and repairing existing infrastructure, known as "fix-it-first" policies, translates readily to storm water management. Fix-it-first policies have long-term effects on storm water management by encouraging replacement of older infrastructure, which can be a significant source of water quality problems resulting from system overflows, failures, and leaks that dump pollution directly into rivers, lakes and groundwater. Repairing and replacing these failing systems before building new systems in undeveloped areas reduces the economic and environmental burden on Michigan's older urban and suburban areas. Fix-it-first policies also encourage infill construction, which saves open land on the urban fringe.

Communities implementing fix-it-first policies could examine their existing infrastructure and use the repair and maintenance of that structure as a BMP, or develop their watershed plan around achieving full use of existing infrastructure. Monitoring of existing demonstration projects along with control locations to determine effectiveness of BMP implementation, including maintenance and operational requirements and cost, is a cost effective way for communities to determine what BMP's are the most effective at treating the unique stormwater quality issues and conditions that are found in each community.

Working with the Community and Community Partners

It is important for municipalities to work with community partners to promote water quality education and outreach. Public education and outreach is a minimum control measure determined by the EPA Phase II Stormwater Regulations and is an important tool for improving stormwater quality within any community. Working with the community and community partners can help shed light on areas with existing water quality issues and flooding, as well as help to determine appropriate incentives for landowners and developers to implement LID and stormwater quality management strategies on private property. Education and public outreach is also important for notifying the public of environmentally sensitive areas that are in commercial, multi-family, and single-family areas, along with the stormwater management regulations that are to be enforced in those areas.

Community partners, such as the Watershed Center, which coordinates over 6000 of staff and volunteer hours towards water quality issues in our region, are key assets to the City of Traverse City. Not only are community partners important for water quality education and outreach, working with community partners and studying similar communities can aid in the refinement of a current stormwater ordinance and stormwater management guidelines. For example, suggested refinements of Traverse City's current stormwater ordinance include the promotion of water quality in addition to storage-flood management. Stormwater ordinances and stormwater management guidelines are important tools for communities to ensure that developments do not negatively impact surface waters or overburden existing systems. A copy of Traverse City's stormwater ordinance and guidelines can be found in **Appendix F**.

ITEMS INCLUDED IN THE TRAVERSE CITY GROUND-WATER PROTECTION AND STORM-WATER CONTROL ORDINANCE GUIDELINES

- Groundwater Protection
- Stormwater Runoff Control Facilities
- Stormwater Conveyance Facilities and Receiving Waters
- Site Construction Control
- Design Parameters for Facility Construction

Local Stormwater Quality Improvements

On a local level, ordinances, guidelines, and incentives can all help to encourage and, in some cases, demand that developers first examine LID strategies for stormwater management design. However, it is also imperative that local government projects, such as road and parking lot improvement projects, have examined LID strategies in the design phase. Within the City of Traverse City, the City of Indianapolis Stormwater Quality Unit Selection Guide (see **Appendix** G) is used to help determine what stormwater treatment units comply with the City's stormwater ordinance and guidelines for both public and private projects (see **Appendix F**). If the proposed stormwater treatment unit is not listed in the Indianapolis guide, a manufacturer's performance certification is required.

In order to maximize the impact that a stormwater quality improvement project will have, it is important for municipalities to prioritize stormwater quality improvement projects. Project prioritization is not only important for ensuring that the maximum positive environmental impact is being achieved, but it is also important for applying for grants and making sure that tax payers' are getting the most out of their investment in the City. As mentioned in Section 3, priority areas to receive stromwater quality improvements should include areas that are:

- Near public beaches and parks
- Adjacent to surface waters
- Known for water quality issues
- In Central Business Districts

With any stormwater management design, opportunities for centralized and decentralized storm water quality BMP should be examined. When possible, LID strategies and the *New Designs for Growth Development Guidebook* (the current evolution of the *Grand Traverse Bay Region Development Guidebook,* see **Appendix G**) should be implemented.

Current Procedures for Disposal of Known Contaminants

The DEQ, DNR, EPA, and Army Corps all have a number of rules and regulations in place for environmental protection, particularly when construction occurs near surface water. However, many municipalities choose to have ordinances in place to create rules and regulations that are stricter than those already in place or to designate who is responsible for environmental protection expenses. For example, The City of Traverse City has an environmental protection ordinance for hazardous spills expense recovery.

Along with the general maintenance and upkeep of stormwater quality utilities, municipalities should have a number of environmental stewardship programs in place. Environmental stewardship programs are programs aimed to increase the quality of the environment and prevent higher cost maintenance and environmental concerns down the road. These programs are sometimes a collaborative effort between the City and property owners, such as leaf pickup, or are the sole responsibility of the City, such as catchbasin cleanout. The City of Traverse City currently has a number of environmental stewardship programs in place. These programs include:

- **Fall Leaf Pickup**
  - To reduce the amount of leaves entering the storm system and to prevent the clogging of catchbasin inlets and storm sewers
- **Spring Cleanup**
  - To reduce the amount of organic matter entering the storm system, which clogs existing treatment systems and can lead to algae plumes
- **Annual Clean Up and Green Up Recycling Event**
  - Residents may bring a number of items to be recycled, repurposed, or reused to a designated location in the City for collection, free of charge
- **Street Sweeping**
  - To reduce the amount of road sediment and debris from entering the storm system during rain events
- **Catch Basin Cleanout**
  - To remove suspended solids including nutrients, pathogens and toxins which was demonstrated to be effective in reducing mass emissions of pollutants associated with solids via stormwater
  - The City invests $270,000 to $350,000 annually towards street sweeping and catch basin cleaning

- **Enforcement of Regulations**
    - For commercial, multi-family, and single family developments in environmentally sensitive areas requiring onsite storm water management- buffer zones
    - On construction sites where soil erosion and sedimentation control measures need to be in place and maintained
- **Waste Water Treatment Plant**
    - Waste water treatment facility to ensure that waste water is treated and solids removed to meet or exceed EPA standards before being discharged into surface waters
- **Capital Improvement Projects**
    - Most Capital Improvement Projects include stormwater quality improvements such as oil/grit separators, filtration systems, drainage swales, and leaching basins
    - Some of the recent Capital Improvement Projects include:
        - Hardy Parking Deck
        - Parking Lot C
        - Plastic Road
        - Driveway at Wayne Hill Water Booster Station
        - Rain Garden at Hull Park
        - DPS Garage Parking Lot
        - 2007 Stormwater Project
        - Sewer Trunkline Replacement and Sliplining

Appendix A

Stormwater Boundary Areas A to AZ

Appendix B

Stormwater Boundary Areas B to BZ

Appendix C

Stormwater Boundary Areas C to CZ

Appendix D

Stormwater Boundary Areas D to Z

Appendix E

Runoff Calculations

Rainfall Values from Figure 7-2, Zone 3 (Inches)			
2 Year	**5 Year**	**10 Year**	**25 Year**
2.09	2.70	3.21	3.89

Table 7-1: Average Runoff Curve Number (Acres)

Boundary	Hydrologic Soil Group B				
	Pavement 98	Residential 75	Forested 55	Total	Average Curve Number
A	1115.54	756.08	1332.44	3204.06	70.13
AA	296.16	66.58	80.28	443.02	82.51
AB	24.43	73.44	27.85	125.72	72.47
AC	38.85	1.84	66.86	107.56	65.72
AD	260.40	8.15	49.28	317.83	86.80
AE	474.96	503.42	265.13	1243.52	75.92
AF	65.88	110.62	34.53	211.04	76.05
AG	1603.92	814.82	4030.89	6449.63	64.16
AH	33.52	6.12	23.61	63.24	74.16
AI	1253.02	734.65	2695.57	4683.24	65.42
AJ	273.00	119.99	273.82	666.81	71.21
AK	919.91	281.08	528.10	1729.09	76.05
AL	31.80	0.00	9.26	41.06	83.32
AM	48.34	0.00	13.14	61.48	83.97
AN	930.41	279.66	376.77	1586.84	79.05
AO	1031.14	517.84	1154.35	2703.34	70.37
AP	53.67	4.65	90.58	148.90	65.99
AQ	782.22	255.05	425.16	1462.43	76.52
AR	117.71	40.57	56.67	214.95	77.53
AS	103.81	83.97	176.55	364.32	67.61
AT	227.12	164.86	306.81	698.79	69.23
AU	1504.25	1003.15	2046.62	4554.03	69.07
AV	101.06	25.74	39.70	166.51	79.43
AW	269.45	121.87	235.83	627.15	72.40
AX	315.14	107.40	146.86	569.40	77.81
AY	531.93	441.08	674.54	1647.55	69.89
AZ	67.73	30.20	67.27	165.21	71.30
B	540.05	262.64	295.08	1097.77	76.35
BA	123.77	65.93	75.01	264.72	75.51
BB	249.42	100.97	80.05	430.44	80.50

BE	111.61	93.39	157.75	362.74	69.07
Boundary	**Hydrologic Soil Group B**				
	Pavement 98	**Residential 75**	**Forested 55**	**Total**	**Average Curve Number**
BF	375.91	110.25	77.61	563.77	83.93
BG	95.57	86.44	135.88	317.90	69.13
BH	1871.89	1503.56	2730.54	6106.00	68.77
BI	621.24	381.24	620.59	1623.07	71.48
BJ	62.31	16.85	39.84	119.00	75.09
BK	1085.93	433.37	2282.04	3801.35	65.15
BM	4109.19	3661.99	4772.43	12543.60	70.66
BN	6.76	1.85	2.75	11.36	79.09
BO	5.87	0.96	0.68	7.51	88.26
BP	12.13	3.04	1.11	16.27	88.25
BQ	310.83	174.17	129.93	614.93	78.27
BR	90.63	6.81	11.29	108.73	89.06
BS	27.12	1.82	2.80	31.74	90.19
BT	71.88	2.46	11.61	85.94	87.94
BU	96.35	2.57	21.39	120.31	85.55
BV	118.34	140.17	2.23	260.73	83.65
BW	109.82	241.35	11.29	362.46	79.77
BX	85.20	156.14	30.22	271.56	77.57
BY	70.98	32.76	19.78	123.52	81.22
BZ	39.04	18.11	235.73	292.88	59.46
C	532.13	241.91	301.54	1075.58	76.08
CA	105.77	34.96	46.11	186.84	78.38
CB	521.77	258.70	278.93	1059.41	76.52
CE	1190.89	761.41	186.72	2139.03	83.23
CF	356.35	154.26	139.39	650.01	79.00
CG	110.06	37.92	35.36	183.34	80.71
CH	243.92	90.45	101.54	435.91	78.67
CI	1431.75	467.89	845.12	2744.76	75.79
CJ	725.34	316.45	666.99	1708.79	71.96
CK	1817.94	943.75	1828.91	4590.60	71.30
CL	6118.12	1686.48	3554.64	11359.23	75.96
CM	3625.98	1690.55	4160.97	9477.50	70.10
CN	202.96	78.43	338.22	619.61	66.87
CO	4043.57	2299.05	4147.03	10489.65	71.21
CP	3438.73	1512.81	11416.35	16367.89	62.28
CQ	19558.46	3071.04	37968.44	60597.94	65.10
CS	2818.81	1152.40	3834.68	7805.89	68.56
CT	4796.80	1889.01	4254.66	10940.47	72.22
CU	9876.47	3613.33	13754.27	27244.07	68.27
CV	57.60	33.72	426.16	517.48	58.90
CW	0.56	0.02	405.05	405.64	55.03

CX	199.33	124.81	803.42	1127.56	61.60
Boundary	**Hydrologic Soil Group B**				
	Pavement 98	**Residential 75**	**Forested 55**	**Total**	**Average Curve Number**
CY	1408.37	337.71	3343.50	5089.57	63.89
CZ	114.84	79.87	138.54	333.25	70.07
D	3142.04	1600.33	3032.01	7774.38	71.64
E	1032.36	734.96	2194.05	3961.37	65.78
F	38.77	1.84	7353.94	7394.56	55.13
G	851.13	457.61	915.17	2223.90	70.77
H	494.56	275.48	998.59	1768.63	65.81
I	19.76	138.16	312.63	470.54	60.89
J	359.99	92.17	473.09	925.25	68.52
K	253.51	155.82	386.32	795.65	68.07
L	109.37	7.96	6.77	124.10	92.25
M	27.04	6.59	3.72	37.35	86.57
N	125.70	16.42	8.38	150.49	90.99
P	47.44	2.08	3.15	52.67	92.55
Q	88.67	7.04	16.01	111.72	86.62
R	76.75	1.79	10.91	89.46	88.97
S	38.80	3.54	15.17	57.51	79.99
T	43.86	2.80	4.48	51.14	90.31
V	98.09	43.06	48.12	189.26	77.25
W	665.65	497.77	658.02	1821.43	71.73
X	64.28	22.51	13.84	100.63	83.32
Z	661.11	222.06	468.38	1351.56	74.17

Table 7-2: Expected Runoff Depth (Inches)				
Boundary	2 Year	5 Year	10 Year	25 Year
A	0.26	0.56	0.85	1.22
AA	0.72	1.16	1.56	2.06
AB	0.35	0.65	0.96	1.35
AC	0.17	0.38	0.62	0.94
AD	0.93	1.42	1.86	2.38
AE	0.43	0.77	1.11	1.54
AF	0.47	0.83	1.17	1.61
AG	0.15	0.35	0.58	0.89
AH	0.40	0.73	1.06	1.47
AI	0.17	0.38	0.62	0.94
AJ	0.32	0.61	0.91	1.28
AK	0.47	0.83	1.17	1.61
AL	0.76	1.22	1.63	2.13
AM	0.76	1.22	1.63	2.13
AN	0.57	0.98	1.36	1.82
AO	0.26	0.56	0.85	1.22
AP	0.17	0.38	0.62	0.94
AQ	0.47	0.83	1.17	1.61
AR	0.50	0.88	1.24	1.68
AS	0.22	0.45	0.71	1.05
AT	0.26	0.53	0.81	1.16
AU	0.26	0.53	0.81	1.16
AV	0.57	0.98	1.36	1.82
AW	0.35	0.65	0.96	1.35
AX	0.50	0.88	1.24	1.68
AY	0.26	0.53	0.81	1.16
AZ	0.32	0.61	0.91	1.28
B	0.47	0.83	1.17	1.61
BA	0.43	0.77	1.11	1.54
BB	0.62	1.03	1.42	1.89
BE	0.26	0.53	0.81	1.16
BF	0.76	1.22	1.63	2.13
BG	0.26	0.53	0.81	1.16
BH	0.24	0.50	0.76	1.11
BI	0.32	0.61	0.91	1.28
BJ	0.43	0.77	1.11	1.54
BK	0.17	0.38	0.62	0.94
BM	0.26	0.56	0.85	1.22

Boundary	2 Year	5 Year	10 Year	25 Year
BN	0.57	0.98	1.36	1.82
BO	1.04	1.56	2.01	2.57
BP	1.04	1.56	2.01	2.57
BQ	0.55	0.93	1.29	1.75
BR	1.11	1.64	2.10	2.65
BS	1.17	1.71	2.18	2.74
BT	0.99	1.49	1.94	2.47
BU	0.87	1.34	1.77	2.30
BV	0.76	1.22	1.63	2.13
BW	0.57	0.98	1.36	1.82
BX	0.50	0.88	1.24	1.68
BY	0.67	1.10	1.49	1.97
BZ	0.07	0.23	0.41	0.65
C	0.47	0.83	1.17	1.61
CA	0.55	0.93	1.29	1.75
CB	0.47	0.83	1.17	1.61
CE	0.76	1.22	1.63	2.13
CF	0.57	0.98	1.36	1.82
CG	0.62	1.03	1.42	1.89
CH	0.55	0.93	1.29	1.75
CI	0.43	0.77	1.11	1.54
CJ	0.32	0.61	0.91	1.28
CK	0.32	0.61	0.91	1.28
CL	0.43	0.77	1.11	1.54
CM	0.26	0.56	0.85	1.22
CN	0.19	0.42	0.67	0.99
CO	0.32	0.61	0.91	1.28
CP	0.12	0.29	0.50	0.78
CQ	0.17	0.38	0.62	0.94
CS	0.24	0.50	0.76	1.11
CT	0.35	0.65	0.96	1.35
CU	0.24	0.50	0.76	1.11
CV	0.06	0.21	0.38	0.61
CW	0.04	0.15	0.31	0.51
CX	0.10	0.27	0.46	0.73
CY	0.14	0.30	0.54	0.83
CZ	0.26	0.56	0.85	1.22
D	0.32	0.61	0.91	1.28
E	0.17	0.38	0.62	0.94
F	0.04	0.15	0.31	0.51
G	0.26	0.56	0.85	1.22

Boundary	2 Year	5 Year	10 Year	25 Year
H	0.17	0.38	0.62	0.94
I	0.08	0.23	0.42	0.68
J	0.24	0.50	0.76	1.11
K	0.24	0.50	0.76	1.11
L	1.34	1.89	2.39	2.95
M	0.93	1.42	1.86	2.38
N	1.17	1.71	2.18	2.74
P	1.34	1.89	2.39	2.95
Q	0.93	1.42	1.86	2.38
R	1.04	1.56	2.01	2.57
S	0.57	0.98	1.36	1.82
T	1.17	1.71	2.18	2.74
V	0.50	0.88	1.24	1.68
W	0.32	0.61	0.91	1.28
X	0.76	1.22	1.63	2.13
Z	0.40	0.73	1.06	1.47

Table 7-3: Expected Runoff Volume (Cubic Feet)				
Boundary	2 Year	5 Year	10 Year	25 Year
A	42791	92879	140314	201681
AA	14092	22610	30386	40112
AB	2173	4093	6027	8483
AC	992	2258	3660	5555
AD	12388	18875	24697	31622
AE	25269	45782	65819	91386
AF	4775	8361	11766	16188
AG	53638	127710	209810	322925
AH	1223	2260	3272	4542
AI	43400	98754	160085	242986
AJ	10707	20735	30797	43407
AK	39121	68502	96399	132631
AL	1365	2183	2912	3809
AM	2028	3242	4327	5658
AN	41825	71408	98878	132469
AO	35977	78089	117971	169565
AP	1368	3113	5046	7659
AQ	32886	57584	81035	111492
AR	5072	8856	12449	16887
AS	4225	8803	13810	20441
AT	9380	19420	29533	42358
AU	61273	126855	192915	276687
AV	4368	7458	10326	13835
AW	10848	20439	30092	42355
AX	13388	23376	32860	44574
AY	21906	45353	68970	98920
AZ	2649	5130	7620	10740
B	24739	43319	60959	83871
BA	5409	9799	14088	19561
BB	12092	19991	27522	36644
BE	4881	10105	15367	22039
BF	18604	29747	39695	51911
BG	4273	8847	13454	19296
BH	76069	161162	243677	356169
BI	25963	50277	74674	105253
BJ	2445	4430	6369	8843
BK	35373	80489	130477	198046
BM	166262	360880	545186	783624

Boundary	2 Year	5 Year	10 Year	25 Year
BN	299	511	707	948
BO	322	482	621	794
BP	698	1044	1346	1720
BQ	15799	26522	36732	49822
BR	4924	7268	9302	11744
BS	1496	2185	2784	3500
BT	3519	5286	6878	8758
BU	4452	6841	9031	11731
BV	8633	13804	18420	24088
BW	9468	16164	22383	29987
BX	6405	11183	15719	21323
BY	3715	6072	8214	10864
BZ	1284	4064	7257	11609
C	24326	42596	59943	82473
CA	4794	8048	11145	15117
CB	23822	41714	58701	80764
CE	71178	113811	151872	198609
CF	17143	29269	40528	54296
CG	5137	8493	11692	15568
CH	11143	18706	25907	35139
CI	55869	101222	145523	202050
CJ	27155	52585	78102	110084
CK	73623	142572	211754	298465
CL	230712	417996	600937	834363
CM	126615	274823	415180	596759
CN	6290	14127	22368	33166
CO	168448	326201	484488	682883
CP	111626	276681	472266	747993
CQ	564296	1284026	2081474	3159381
CS	97533	206638	312437	456670
CT	189720	357443	526267	740733
CU	341846	724250	1095066	1600592
CV	2017	6553	12061	19509
CW	1156	4018	8187	13691
CX	6512	17941	30833	48176
CY	39618	86755	157316	238576
CZ	4454	9667	14605	20992
D	124095	240311	356921	503077
E	36509	83075	134669	204409
F	21039	73123	148982	249148
G	29432	63882	96508	138716
H	16292	37072	60096	91218

Boundary	2 Year	5 Year	10 Year	25 Year
I	2188	6452	11894	18935
J	11569	24510	37059	54167
K	10013	21215	32076	46884
L	6533	9247	11647	14429
M	1459	2224	2909	3725
N	7030	10266	13082	16450
P	2764	3911	4927	6103
Q	4363	6648	8698	11138
R	3804	5694	7337	9377
S	1498	2558	3541	4745
T	2407	3515	4479	5632
V	4482	7826	11000	14922
W	29036	56228	83512	117710
X	3345	5349	7137	9334
Z	26129	48289	69920	97041

Table 7-4: Estimating Unit Peak Discharge (cfs/acre/inch of runoff depth)				
Boundary	Pipe Slope			
	2 Year	5 Year	10 Year	25 Year
A	0.63	0.63	0.63	0.63
AA	1.44	1.44	1.44	1.44
AB	1.46	1.46	1.46	1.46
AC	1.46	1.46	1.46	1.46
AD	1.46	1.46	1.46	1.46
AE	1.46	1.46	1.46	1.46
AF	1.35	1.35	1.35	1.35
AG	0.89	0.89	0.89	0.89
AH	1.46	1.46	1.46	1.46
AI	0.70	0.70	0.70	0.70
AJ	1.46	1.46	1.46	1.46
AK	0.74	0.74	0.74	0.74
AL	1.46	1.46	1.46	1.46
AM	1.46	1.46	1.46	1.46
AN	0.89	0.89	0.89	0.89
AO	0.95	0.95	0.95	0.95
AP	1.46	1.46	1.46	1.46
AQ	1.37	1.37	1.37	1.37
AR	1.46	1.46	1.46	1.46
AS	1.46	1.46	1.46	1.46
AT	1.32	1.32	1.32	1.32
AU	0.65	0.65	0.65	0.65
AV	1.46	1.46	1.46	1.46
AW	1.46	1.46	1.46	1.46
AX	1.46	1.46	1.46	1.46
AY	0.80	0.80	0.80	0.80
AZ	1.46	1.46	1.46	1.46
B	0.95	0.95	0.95	0.95
BA	1.46	1.46	1.46	1.46
BB	1.46	1.46	1.46	1.46
BE	1.46	1.46	1.46	1.46
BF	1.28	1.28	1.28	1.28
BG	1.46	1.46	1.46	1.46
BH	0.57	0.57	0.57	0.57
BI	0.93	0.93	0.93	0.93
BJ	0.93	0.93	0.93	0.93
BK	0.89	0.89	0.89	0.89
BM	0.67	0.67	0.67	0.67

Boundary	Pipe Slope			
	2 Year	5 Year	10 Year	25 Year
BN	1.46	1.46	1.46	1.46
BO	1.46	1.46	1.46	1.46
BP	1.46	1.46	1.46	1.46
BQ	1.38	1.38	1.38	1.38
BR	1.46	1.46	1.46	1.46
BS	1.46	1.46	1.46	1.46
BT	1.46	1.46	1.46	1.46
BU	1.45	1.45	1.45	1.45
BV	1.46	1.46	1.46	1.46
BW	1.46	1.46	1.46	1.46
BX	1.46	1.46	1.46	1.46
BY	1.46	1.46	1.46	1.46
BZ	1.46	1.46	1.46	1.46
C	1.31	1.31	1.31	1.31
CA	1.46	1.46	1.46	1.46
CB	1.38	1.38	1.38	1.38
CE	0.61	0.61	0.61	0.61
CF	1.17	1.17	1.17	1.17
CG	1.46	1.46	1.46	1.46
CH	1.40	1.40	1.40	1.40
CI	0.74	0.74	0.74	0.74
CJ	1.26	1.26	1.26	1.26
CK	0.76	0.76	0.76	0.76
CL	0.28	0.28	0.28	0.28
CM	0.81	0.81	0.81	0.81
CN	1.45	1.45	1.45	1.45
CO	0.62	0.62	0.62	0.62
CP	0.76	0.76	0.76	0.76
CQ	0.32	0.32	0.32	0.32
CS	0.34	0.34	0.34	0.34
CT	0.47	0.47	0.47	0.47
CU	0.43	0.43	0.43	0.43
CV	1.46	1.46	1.46	1.46
CW	1.46	1.46	1.46	1.46
CX	1.33	1.33	1.33	1.33
CY	1.46	1.46	1.46	1.46
CZ	1.46	1.46	1.46	1.46
D	0.58	0.58	0.58	0.58
E	0.76	0.76	0.76	0.76
F	0.60	0.60	0.60	0.60
G	0.96	0.96	0.96	0.96
H	0.92	0.92	0.92	0.92
I	1.46	1.46	1.46	1.46

Boundary	Pipe Slope			
	2 Year	5 Year	10 Year	25 Year
J	1.08	1.08	1.08	1.08
K	1.46	1.46	1.46	1.46
L	1.46	1.46	1.46	1.46
M	1.46	1.46	1.46	1.46
N	1.46	1.46	1.46	1.46
P	1.46	1.46	1.46	1.46
Q	1.46	1.46	1.46	1.46
R	1.46	1.46	1.46	1.46
S	1.46	1.46	1.46	1.46
T	1.46	1.46	1.46	1.46
V	1.46	1.46	1.46	1.46
W	0.95	0.95	0.95	0.95
X	1.46	1.46	1.46	1.46
Z	1.41	1.41	1.41	1.41

Table 7-5: Estimating Unit Peak Discharge (cfs/acre/inch of runoff depth)

Boundary	Watershed Slope			
	2 Year	5 Year	10 Year	25 Year
A	0.35	0.35	0.35	0.35
AA	1.06	1.06	1.06	1.06
AB	1.38	1.38	1.38	1.38
AC	1.46	1.46	1.46	1.46
AD	1.46	1.46	1.46	1.46
AE	1.10	1.10	1.10	1.10
AF	1.46	1.46	1.46	1.46
AG	0.53	0.53	0.53	0.53
AH	1.46	1.46	1.46	1.46
AI	0.71	0.71	0.71	0.71
AJ	1.24	1.24	1.24	1.24
AK	0.81	0.81	0.81	0.81
AL	1.46	1.46	1.46	1.46
AM	1.45	1.45	1.45	1.45
AN	0.74	0.74	0.74	0.74
AO	0.73	0.73	0.73	0.73
AP	1.46	1.46	1.46	1.46
AQ	1.28	1.28	1.28	1.28
AR	1.04	1.04	1.04	1.04
AS	1.24	1.24	1.24	1.24
AT	0.84	0.84	0.84	0.84
AU	0.28	0.28	0.28	0.28
AV	1.46	1.46	1.46	1.46
AW	1.46	1.46	1.46	1.46
AX	1.46	1.46	1.46	1.46
AY	0.54	0.54	0.54	0.54
AZ	1.46	1.46	1.46	1.46
B	0.61	0.61	0.61	0.61
BA	1.42	1.42	1.42	1.42
BB	1.06	1.06	1.06	1.06
BE	1.46	1.46	1.46	1.46
BF	1.24	1.24	1.24	1.24
BG	1.46	1.46	1.46	1.46
BH	0.28	0.28	0.28	0.28
BI	0.64	0.64	0.64	0.64
BJ	0.64	0.64	0.64	0.64
BK	0.79	0.79	0.79	0.79
BM	0.73	0.73	0.73	0.73

Boundary	Watershed Slope			
	2 Year	5 Year	10 Year	25 Year
BN	1.46	1.46	1.46	1.46
BO	1.46	1.46	1.46	1.46
BP	1.46	1.46	1.46	1.46
BQ	1.32	1.32	1.32	1.32
BR	1.44	1.44	1.44	1.44
BS	1.46	1.46	1.46	1.46
BT	1.46	1.46	1.46	1.46
BU	1.22	1.22	1.22	1.22
BV	1.28	1.28	1.28	1.28
BW	1.46	1.46	1.46	1.46
BX	1.42	1.42	1.42	1.42
BY	1.46	1.46	1.46	1.46
BZ	1.46	1.46	1.46	1.46
C	0.85	0.85	0.85	0.85
CA	1.46	1.46	1.46	1.46
CB	1.08	1.08	1.08	1.08
CE	0.74	0.74	0.74	0.74
CF	1.12	1.12	1.12	1.12
CG	1.32	1.32	1.32	1.32
CH	1.40	1.40	1.40	1.40
CI	1.00	1.00	1.00	1.00
CJ	0.65	0.65	0.65	0.65
CK	0.49	0.49	0.49	0.49
CL	0.33	0.33	0.33	0.33
CM	0.78	0.78	0.78	0.78
CN	0.94	0.94	0.94	0.94
CO	0.62	0.62	0.62	0.62
CP	0.71	0.71	0.71	0.71
CQ	0.15	0.15	0.15	0.15
CS	0.82	0.82	0.82	0.82
CT	0.40	0.40	0.40	0.40
CU	0.30	0.30	0.30	0.30
CV	1.46	1.46	1.46	1.46
CW	1.46	1.46	1.46	1.46
CX	1.46	1.46	1.46	1.46
CY	0.80	0.80	0.80	0.80
CZ	1.33	1.33	1.33	1.33
D	0.44	0.44	0.44	0.44
E	0.63	0.63	0.63	0.63
F	0.57	0.57	0.57	0.57
G	0.71	0.71	0.71	0.71
H	1.12	1.12	1.12	1.12
I	1.46	1.46	1.46	1.46

Boundary	Watershed Slope			
	2 Year	5 Year	10 Year	25 Year
J	0.62	0.62	0.62	0.62
K	1.18	1.18	1.18	1.18
L	1.46	1.46	1.46	1.46
M	1.46	1.46	1.46	1.46
N	1.40	1.40	1.40	1.40
P	1.46	1.46	1.46	1.46
Q	1.46	1.46	1.46	1.46
R	1.46	1.46	1.46	1.46
S	1.46	1.46	1.46	1.46
T	1.46	1.46	1.46	1.46
V	1.42	1.42	1.42	1.42
W	0.86	0.86	0.86	0.86
X	1.46	1.46	1.46	1.46
Z	0.89	0.89	0.89	0.89

Table 7-6: Treatment Flow Range (1/3 of Unit Peak Discharge)

Boundary	High			
	2 Year	5 Year	10 Year	25 Year
A	2.48	5.37	8.12	11.67
AA	1.87	2.99	4.02	5.31
AB	0.29	0.55	0.81	1.14
AC	0.13	0.30	0.49	0.74
AD	1.66	2.53	3.31	4.24
AE	3.39	6.14	8.82	12.25
AF	0.59	1.04	1.46	2.01
AG	4.40	10.48	17.22	26.51
AH	0.16	0.30	0.44	0.61
AI	2.78	6.33	10.26	15.58
AJ	1.43	2.78	4.12	5.81
AK	2.65	4.64	6.53	8.99
AL	0.18	0.29	0.39	0.51
AM	0.27	0.43	0.58	0.76
AN	3.43	5.86	8.11	10.86
AO	3.13	6.80	10.28	14.77
AP	0.18	0.42	0.68	1.03
AQ	4.14	7.25	10.21	14.05
AR	0.68	1.19	1.67	2.26
AS	0.57	1.18	1.85	2.74
AT	1.13	2.35	3.57	5.12
AU	3.67	7.60	11.55	16.57
AV	0.59	1.00	1.38	1.85
AW	1.45	2.74	4.03	5.68
AX	1.79	3.13	4.41	5.98
AY	1.60	3.32	5.04	7.23
AZ	0.36	0.69	1.02	1.44
B	2.15	3.77	5.30	7.30
BA	0.73	1.31	1.89	2.62
BB	1.62	2.68	3.69	4.91
BE	0.65	1.35	2.06	2.95
BF	2.19	3.50	4.67	6.10
BG	0.57	1.19	1.80	2.59
BH	3.98	8.44	12.75	18.64
BI	2.22	4.30	6.39	9.00
BJ	0.21	0.38	0.54	0.76

Boundary	High			
	2 Year	5 Year	10 Year	25 Year
BK	2.91	6.61	10.72	16.28
BM	10.18	22.10	33.39	47.99
BN	0.04	0.07	0.09	0.13
BO	0.04	0.06	0.08	0.11
BP	0.09	0.14	0.18	0.23
BQ	2.00	3.36	4.65	6.31
BR	0.66	0.97	1.25	1.57
BS	0.20	0.29	0.37	0.47
BT	0.47	0.71	0.92	1.17
BU	0.59	0.91	1.20	1.56
BV	1.16	1.85	2.47	3.23
BW	1.27	2.17	3.00	4.02
BX	0.86	1.50	2.11	2.86
BY	0.50	0.81	1.10	1.46
BZ	0.17	0.54	0.97	1.56
C	2.93	5.14	7.23	9.95
CA	0.64	1.08	1.49	2.02
CB	3.01	5.27	7.42	10.21
CE	3.96	6.33	8.45	11.05
CF	1.84	3.14	4.35	5.82
CG	0.69	1.14	1.57	2.09
CH	1.43	2.40	3.32	4.50
CI	3.80	6.88	9.89	13.73
CJ	3.14	6.09	9.05	12.75
CK	5.17	10.00	14.86	20.94
CL	5.93	10.75	15.45	21.45
CM	9.36	20.32	30.69	44.12
CN	0.84	1.89	2.99	4.43
CO	9.59	18.57	27.58	38.88
CP	7.79	19.31	32.96	52.20
CQ	16.77	38.15	61.84	93.87
CS	3.08	6.53	9.88	14.44
CT	8.21	15.47	22.77	32.06
CU	13.50	28.60	43.24	63.20
CV	0.27	0.88	1.62	2.62
CW	0.16	0.54	1.10	1.84
CX	0.80	2.19	3.77	5.89
CY	5.31	11.63	21.09	31.99
CZ	0.60	1.30	1.96	2.81
D	6.61	12.80	19.01	26.79

Boundary	High			
	2 Year	5 Year	10 Year	25 Year
E	2.53	5.77	9.35	14.19
F	1.15	4.00	8.16	13.64
G	2.58	5.61	8.47	12.17
H	1.38	3.13	5.07	7.70
I	0.29	0.87	1.59	2.54
J	1.15	2.43	3.67	5.37
K	1.34	2.84	4.30	6.29
L	0.88	1.24	1.56	1.93
M	0.20	0.30	0.39	0.50
N	0.94	1.38	1.75	2.21
P	0.37	0.52	0.66	0.82
Q	0.58	0.89	1.17	1.49
R	0.51	0.76	0.98	1.26
S	0.20	0.34	0.47	0.64
T	0.32	0.47	0.60	0.76
V	0.60	1.05	1.47	2.00
W	2.53	4.91	7.29	10.27
X	0.45	0.72	0.96	1.25
Z	3.38	6.25	9.04	12.55

Table 7-7: Treatment Flow Range (1/3 of Unit Peak Discharge)

Boundary	Low			
	2 Year	5 Year	10 Year	25 Year
A	1.37	2.97	4.48	6.44
AA	1.38	2.21	2.97	3.92
AB	0.27	0.52	0.76	1.07
AC	0.13	0.30	0.49	0.74
AD	1.66	2.53	3.31	4.24
AE	2.55	4.62	6.64	9.21
AF	0.64	1.12	1.58	2.17
AG	2.61	6.22	10.21	15.72
AH	0.16	0.30	0.44	0.61
AI	2.81	6.39	10.36	15.73
AJ	1.22	2.36	3.50	4.94
AK	2.90	5.08	7.15	9.83
AL	0.18	0.29	0.39	0.51
AM	0.27	0.43	0.58	0.75
AN	2.84	4.86	6.73	9.01
AO	2.41	5.23	7.90	11.35
AP	0.18	0.42	0.68	1.03
AQ	3.88	6.79	9.56	13.15
AR	0.49	0.85	1.19	1.62
AS	0.48	1.00	1.57	2.32
AT	0.72	1.49	2.27	3.26
AU	1.58	3.26	4.96	7.11
AV	0.59	1.00	1.38	1.85
AW	1.45	2.74	4.03	5.68
AX	1.79	3.13	4.41	5.98
AY	1.09	2.25	3.43	4.91
AZ	0.36	0.69	1.02	1.44
B	1.38	2.41	3.39	4.67
BA	0.71	1.28	1.84	2.55
BB	1.18	1.95	2.69	3.58
BE	0.65	1.35	2.06	2.95
BF	2.11	3.37	4.50	5.89
BG	0.57	1.19	1.80	2.59
BH	1.96	4.14	6.27	9.16
BI	1.53	2.96	4.40	6.20
BJ	0.14	0.26	0.38	0.52

Boundary	Low			
	2 Year	5 Year	10 Year	25 Year
BK	2.57	5.84	9.47	14.37
BM	11.19	24.29	36.70	52.75
BN	0.04	0.07	0.09	0.13
BO	0.04	0.06	0.08	0.11
BP	0.09	0.14	0.18	0.23
BQ	1.92	3.22	4.46	6.05
BR	0.65	0.96	1.23	1.56
BS	0.20	0.29	0.37	0.47
BT	0.47	0.71	0.92	1.17
BU	0.50	0.76	1.01	1.31
BV	1.01	1.62	2.17	2.83
BW	1.27	2.17	3.00	4.02
BX	0.84	1.46	2.05	2.79
BY	0.50	0.81	1.10	1.46
BZ	0.17	0.54	0.97	1.56
C	1.91	3.34	4.70	6.46
CA	0.64	1.08	1.49	2.03
CB	2.35	4.12	5.80	7.98
CE	4.85	7.76	10.35	13.54
CF	1.76	3.01	4.16	5.58
CG	0.62	1.03	1.42	1.89
CH	1.43	2.40	3.33	4.52
CI	5.11	9.26	13.31	18.48
CJ	1.63	3.15	4.68	6.59
CK	3.31	6.42	9.53	13.43
CL	6.99	12.67	18.21	25.28
CM	9.10	19.75	29.84	42.89
CN	0.54	1.22	1.93	2.86
CO	9.59	18.57	27.58	38.88
CP	7.24	17.95	30.64	48.52
CQ	7.77	17.69	28.67	43.52
CS	7.34	15.56	23.53	34.39
CT	6.99	13.16	19.38	27.27
CU	9.42	19.95	30.17	44.09
CV	0.27	0.88	1.62	2.62
CW	0.16	0.54	1.10	1.84
CX	0.87	2.41	4.13	6.46
CY	2.92	6.41	11.61	17.61
CZ	0.54	1.18	1.78	2.56
D	5.07	9.82	14.58	20.56

Boundary	Low			
	2 Year	5 Year	10 Year	25 Year
E	2.12	4.82	7.81	11.85
F	1.10	3.84	7.82	13.07
G	1.91	4.14	6.26	9.00
H	1.67	3.80	6.16	9.35
I	0.29	0.87	1.59	2.54
J	0.66	1.40	2.11	3.08
K	1.08	2.29	3.46	5.06
L	0.88	1.24	1.56	1.93
M	0.20	0.30	0.39	0.50
N	0.91	1.32	1.69	2.12
P	0.37	0.52	0.66	0.82
Q	0.58	0.89	1.17	1.49
R	0.51	0.76	0.98	1.26
S	0.20	0.34	0.47	0.64
T	0.32	0.47	0.60	0.76
V	0.58	1.02	1.43	1.95
W	2.30	4.45	6.60	9.31
X	0.45	0.72	0.96	1.25
Z	2.14	3.95	5.71	7.93

PROCEDURE FOR UPDATING STORM WATER SYSTEM TABLES (STORM WATER REPORT)

CURRENT ACCESS DATABASE (WHERE THE TABLES ARE GENERATED):

X:\TCPROJ\ENGINEER\Maps\STORM\reports\StormSystemReports.mdb

TO UPDATE THE TABLES:

1. Open ArcGIS using the Default SDE Storm Reach layer in your project, open the attribute table.

2. "Select by attributes" using "Type = Primary".

3. Right-click on the Storm Reach Layer and select: "Data", "Export data".

4. Export: Selected Features, this layer's source data and output shapefile or feature class: X:\TCPROJ\ENGINEER\Maps\STORM\reports\Reach.shp

5. This will overwrite the old data and import the new to your reports.

6. Open X:\TCPROJ\ENGINEER\Maps\STORM\reports\StormSystemReports

7. This database is now ready to use, in Reports, double-click on Storm Water Report and enter the System number you would like your report on.

Final PDF Output (including System tables & maps) is located:
K:\CITYENG\Projects\Storm water\2007StormwaterManagementReport

Appendix F

Environmental Regulations

TRAVERSE CITY GROUND-WATER PROTECTION AND STORM-WATER CONTROL ORDINANCE
GUIDELINES

PREAMBLE

The guidelines were developed to be used in conjunction with the Traverse City Ground-Water Protection and Storm-Water Runoff Control Ordinance. These guidelines will be updated as needed to reflect the new technology and best management practices available to deal with ground-water protection and storm-water runoff on sites within the City of Traverse City.

A. GROUND-WATER PROTECTION

1. General-purpose floor drains shall be allowed only if they are connected to: an on-site holding tank; to the public sanitary sewer system with approved oil separator system or; a system authorized through a State ground-water discharge permit.

2. Secondary containment for above-ground areas where hazardous substances and polluting materials are stored or used shall be provided. Secondary containment shall be sufficient to store the substance for the maximum anticipated period of time necessary for the recovery of any released substance.

3. Outside storage of hazardous substances and polluting materials shall be prohibited except in product-tight containers which are protected from weather, leakage, accidental damage and vandalism and are stored within a secondary containment system.

4. Out-of-service abandoned tanks shall be emptied and removed in accordance with the State of Michigan Underground Storage Tank Rules.

B. STORM-WATER RUNOFF CONTROL FACILITIES

1. Earth changes and related improvements shall be designed, constructed and maintained to minimize the extent and duration of earth disruption and to protect the natural environment.

2. On-site storm-water runoff control facilities which protect water quality and prevent unwanted flooding shall be required for all sites. Storm-water runoff control facilities may include but are not limited to detention basins, retention ponds, infiltration trenches, infiltration basins, drainage wells, grass swales, grass swales with check dams, filter strips and other facilities.

3. Storm-water control facilities shall be planned and designed to reproduce the pre-development hydrology of the site to the maximum possible extent.

4. Infiltration trenches, perforated pipe and infiltration basins shall be encouraged provided that (a) sediment is removed from storm-water runoff before runoff reaches the infiltration facility and (b) adequate provisions for facility maintenance have been made.

5. Infiltration basins shall be lined with a vegetative cover designed to slow the flow of runoff and to trap pollutants. Sediment traps, catch basins and/or sediment basins shall be provided for the purpose of collecting sediment before storm water reaches the infiltration basin or trench. Infiltration facilities shall be designed to distribute storm-water runoff volume evenly over the floor of the basin or trench and to prevent ponding or standing water.

6. Drainage wells, commonly known as dry wells, may be used as a storm-water control method if the use of storm-water retention or detention basins, either on- or off-site, is not feasible. All drainage wells must provide the following: (1) catch basins, sediment basins, silt traps or vegetative filter strips to remove sediment from storm water flowing to the drainage well, (2) an approved overflow system and (3) adequate provisions for maintenance.

7. Detention basins shall be designed as extended detention basins to detain runoff on the site for 24 hours or more to allow for maximum settling and removal of suspended solids and other pollutants. Vegetation shall be installed and maintained in the basin to help absorb pollutants.

8. When a downstream outlet (open channel or storm sewer) is unacceptable, minimum detention, retention and infiltration basins on the site shall have the storage capacity to hold the increase in runoff volume generated by the earth change. The required volume shall be calculated by comparing the undeveloped condition to the developed condition for a 25-year 24-hour frequency storm event. Provisions for overflow shall be made. In general, this paragraph shall apply to larger open areas where storm sewers do not exist.

9. If a quantity or capacity problem exists with an outlet as may be determined by the City Engineer, the peak rate of discharge from a site shall be as determined by the City Engineer. It should be assumed for design purposes, that such problems exist with almost all storm sewers within the City. However, in general, such runoff rate will normally not be less than the pre-developed rate, and required on-site storage shall not be greater than that required for a 10-year frequency storm event with 24 hour minimum detention. In general, a short hand design method of a 2½" rain over all impervious surfaces may be used. Drainage facilities for quantity purposes shall be designed to pass a 10-year frequency storm event.

10. As a minimum, all drainage control on all multi-family, commercial and industrial sites when developed shall be designed to allow infiltration or to retain in some acceptable manner all small storms or first-flush runoff which shall be the first one-

half (½") inch of runoff. The City Engineer, at the written request of the Michigan Department of Environmental Quality, may reduce the minimum infiltration retention requirements if it is determined that the introduction of surface storm-water infiltration into the groundwater would increase and/or exacerbate the existing known pollution at a site.

11. A two-stage design for detention and retention basins shall be used on sites where parking lots and other impervious surfaces exceed five (5) acres in size as well as for other sites identified by the City Engineer or the Michigan Department of Environmental Quality as requiring special protection for water quality purposes. In such cases, a meeting will be set up between the property owner/developer and City Engineer to discuss details of design and requirements.

12. The use of Swirl Concentrator technology or other "new technology" systems in which the removal of a minimum of 80% of pollutants, including grit, oil, hydrocarbons and floating contaminants for on-site storm-water runoff control facilities, is encouraged. Where these "new technology" systems are designed within projects for areas where off-site receiving and conveyance facilities have adequate capacity, the City Engineer may reduce or eliminate on-site retention/detention requirements.

C. STORM-WATER CONVEYANCE FACILITIES AND RECEIVING WATERS

1. Unless otherwise approved, storm-water runoff shall be conveyed through swales, vegetated buffer strips or other approved facilities so as to decrease runoff velocity, to remove pollutants, to allow suspended sediments to settle and to encourage infiltration.

2. When storm sewers are determined to be necessary by the City Engineer, the applicant shall design the drainage system to mitigate any harmful impact on water quality by using appropriate structural devices or other best management methods.

3. Drain spouts from roofs and sump pumps from basements shall be directed to on-site swales, detention basins or other measures designed to slow the flow of storm-water runoff to non-erosive velocities whenever possible.

D. SITE CONSTRUCTION CONTROL

1. All earth changes shall be designed, constructed and maintained in such a manner as to minimize the extent and duration of earth disruption.

2. Soil erosion control facilities shall be designed to remove sediment from storm water before the storm water leaves the site of the earth-change activity.

3. Vegetative stabilization or other soil erosion control measures shall be installed and maintained throughout the development process. Critical areas exposed during

construction shall be protected with temporary vegetation, mulching, filter fences or other methods of stabilization.

4. Storm-water runoff control and soil erosion control measures shall be installed before grading, filling or removal of vegetative cover is initiated.

5. Filter fences and other soil erosion control facilities installed at the perimeter of a development site shall be installed at least five (5') feet from the property boundary to allow for on-site maintenance.

6. Fill slope grades on the perimeter of the graded area adjacent to lakes, streams, wetlands and storm-water ponds, or adjoining properties shall not have a slope steeper than a 33 percent rise (3 feet horizontal to 1 foot vertical) unless approved by the City Engineer.

7. Retention and detention basins shall have an emergency overflow system. The overflow system shall be designed to accommodate flow from the 100-year storm event, or as otherwise required by the Michigan Department of Environmental Quality.

8. Side slopes of any storm-water retention or detention basin shall be no greater than 3:1 (horizontal to vertical) so as to prevent soil erosion and allow for basin maintenance.

9. Storm-water basins with depths greater than three feet shall have one or more of the following safety features: (a) Safety ledges at the basin perimeter which are at least eight feet wide for every three feet of vertical height; (b) aquatic vegetation surrounding the basin which discourages wading; or (c) fencing to prevent unauthorized access to the basin.

10. Soil erosion control measures shall be maintained throughout the duration of the earth change including the later stages of development. Maintenance activities include but are not limited to removal of accumulated sediment, structural repairs, reseeding or replacement of vegetative cover and lawn mowing.

11. Removal of natural vegetation and tree roots within twenty five (25) feet of the ordinary high water mark of any wetland, lake or stream shall be prohibited unless approved for recreational uses. A lake or stream buffer area greater than twenty five (25) feet may be required by the City Engineer if necessary for soil erosion control purposes.

12. Grading of land or other earth changes shall not be permitted in any flood plain unless approved by the Michigan Department of Environmental Quality as well as the City Engineer. Further, all approved grading of land or other earth changes within a flood plain or within the required buffer area of a lake or stream shall not

reduce the storage capacity of the flood plain and shall meet the requirements of the City Zoning Ordinance.

E. DESIGN PARAMETERS FOR FACILITY CONSTRUCTION

1. Design parameters for ground-water protection, storm-water management and soil erosion facilities shall follow best management practices as identified by the City Engineer, the Grand Traverse County Soil Conservation Service and/or the Michigan Department of Environmental Quality.

2. The Michigan Department of Environmental Quality "Urban Storm-water Best Management Practices Manual" will be used as a reference along with other manuals such as "Controlling Urban Runoff" by the Metropolitan Washington Council of Governments and the Small Business Guide to Secondary Containment by the Clinton River Watershed Council.

PUBLIC HEALTH CODE (EXCERPT : Act 368 of 1978)
Public Act 507 of 2002

333.12541 Testing and evaluating quality of water at bathing beaches; purpose; posting sign; injunction; definitions.

Sec. 12541.

(1) The local health officer or an authorized representative of the local health department having jurisdiction may test and otherwise evaluate the quality of water at bathing beaches to determine whether the water is safe for bathing purposes. However, the local health officer or authorized representative shall notify the city, village, or township in which the bathing beach is located prior to conducting the test or evaluation.

(2) If a local health officer or an authorized representative of a local health department conducts a test or evaluation of a bathing beach under subsection (1), within 36 hours of conducting the test or evaluation, he or she shall notify the department, the city, village, or township in which the bathing beach is located, and the owner of the bathing beach of the results of the test or evaluation.

(3) The owner of the bathing beach shall post at the main entrance to the bathing beach or other visible location a sign that states whether or not the bathing beach has been tested or evaluated under subsection (1) and, if the bathing beach has been tested, the location of where test results may be reviewed. Open stretches of beach or beaches at road ends that are not advertised or posted as public bathing beaches do not need to have signs posted.

(4) If a local health officer or authorized representative of the local health department conducts a test or evaluation under subsection (1) and, based upon the standards promulgated under section 12544, the health officer or the authorized representative determines that the water is unsafe for bathing, he or she may petition the circuit court of the county in which the bathing beach is located for an injunction ordering the person owning or operating the bathing beach to close the bathing beach for use by bathers or ordering other measures to keep persons from entering on the bathing beach. Upon receipt of a petition under this subsection, the court may grant an injunction if circumstances warrant it.

(5) As used in this section:

(a) "Bathing beach" means a beach or bathing area offered to the public for recreational bathing or swimming. It does not include a public swimming pool as defined in section 12521.

(b) "Department" means the department of environmental quality.

History: 1978, Act 368, Eff. Sept. 30, 1978 ;-- Am. 2002, Act 507, Eff. Mar. 31, 2003
Popular Name: Act 368

Appendix G

Resources, References and Links

Resource and Reference Links

City of Indianapolis Stormwater Quality Unit (SQU) Selection Guide:

www.indy.gov/eGov/City/DPW/Business/Specs/Pages/UpdatedStormWaterManual.aspx

New Designs for Growth Development Guidebook

www.newdesignsforgrowth.com

EPA Stormwater Phase II Final Rule

Fact Sheet 1.0: www3.epa.gov/npdes/pubs/fact1-0.pdf

Fact Sheet 2.0: www3.epa.gov/npdes/pubs/fact2-0.pdf

Certified Storm Water Operator and SESC Inspector Training Manual

http://michigan.gov/deq/0,4561,7-135-3311_4113-81197--,00.html

Grand Traverse Bay Watershed Protection Plan

www.gtbay.org/wp-content/uploads/2010/09/GTBayPlan2005.pdf

The Grand Traverse Bay Water Quality Database

http://data.gtbay.org/wqdb.asp

The City of Traverse City
Storm Outlet Evaluation

Page ____ of ______

Project No. ______________________________ **File:** ______________________________

Description: ______________________________ **Field Work by:** ________________ **Date:**_______

Drainage Systems: _________________________ **Checked by:** _________________ **Date:**_______

Available Information:

Plans: ☐ Yes ☐ No **Year Built:** ____________________

Plan Reference #: ________________ **Year Modified:** ____________________

Easement: ☐ Yes ☐ No **Pipe Size:** ____________________

Outlet Water Course: ____

____

Field Investigation:

Outlet Pipe Size: _________ **Pipe Type:** ☐ Concrete ☐ CMP ☐ Plastic
☐ Other: ________________

Outlet Submerged: ☐ Yes ☐ No ☐ Partial Depth: ___________
Sediment Depth: ___________

Deposits: ☐ Yes Type: ___________ ☐ No

End Treatment: ☐ Yes Type: ______________ ☐ No

Amount of Pipe Exposed: ____________

Slope Protection: ☐ Yes Type: ☐ Rip Rap ☐ Pave Spillway ☐ No
☐ Armor Stone ☐ Cobble
☐ Other: ______________

Scour: ☐ Yes Depth: ___________ ☐ No

High Water Mark/Watercourse: ______________________

Depth from Invert: ______________________ **High Watermark Pipe:** _________

Evidence of Flooding: ☐ Yes ☐ No

Photographs: ☐ Yes ☐ No Numbers: _____________

Comments:____

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k:cityeng/forms/Storm Outlet Evaluation April 2006