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CONCLUSIONS AND RECOMMENDATIONS

Conclusions

There are approximately 20 storm water discharge points in the City of West Branch and immediate surrounding area. The majority of the discharges are direct into the Rifle River or tributary creeks. A rough estimate of the peak discharge flow to the watershed during a 10-year/24-hour storm is 800 cubic feet per second (359,000 gallons per minute). A rough estimate of the yearly pollutant loading on the river caused by these discharges is: 170,000 lbs Total Suspended Solids, 700 lbs Total Phosphorus and 3900 lbs Total Nitrogen.

The primary objective of the Rifle River Watershed Storm Water Management Study is the protection of the Rifle River and its tributaries from the sediment and pollutants associated with storm water discharges. Throughout this report, several ways in which to achieve this objective have been detailed and discussed. In addition to the recommended Best Management Practices (BMPs) for each of the twenty delineated drainage zones, several general practices should be implemented to protect the waters of the Rifle River Watershed. Many of these general practices, when implemented, can provide significant reductions in the pollutant loads entering the river and creeks through storm water runoff.

Recommendations

- Implement structural BMPs – to retrofit existing drainage areas and discharge points
- Implement non-structural BMPs
- Evaluate existing ordinances for their compatibility with Low Impact Development concepts
- Draft and Implement a Storm Water Ordinance in the City of West Branch, West Branch Township, Ogemaw Township, or County wide
- Designate a storm water agent/permits officer to oversee the area's storm water system, perhaps through the development of an area wide Storm Water Authority.
- Implement a municipal storm water maintenance program (street sweeping, catch basin sump cleaning, etc.)

The City of West Branch and surrounding area recognize that they have a very valuable resource in the Rifle River and its watershed. Through the formation of the Ogemaw Storm Water Committee, the Committee's efforts thus far and their goals for the future, it is obvious that the protection of this resource is a priority. The Ogemaw Storm Water Committee has, through their work, made a commitment to future generations, so that they may also be able to enjoy the benefits and beauty of the Rifle River and all it has to offer. It is the efforts of groups like this, which serve as a model for other entities within the Rifle River Watershed.

CHAPTER 1

INTRODUCTION

INTRODUCTION

The Ogemaw Storm Water Committee recognizes the value that its natural resources such as the Rifle River and surrounding creeks and streams offer area residents and businesses. Concern has been raised about the quality of storm water runoff and its impact to these resources. The Ogemaw Storm Water Committee and Huron Pines Resource Conservation & Development Area Council have been working to establish a storm water management project for protection of the Rifle River Watershed. Together in this partnership, the Storm Water Committee and Huron Pines RC&D have developed plans for the first two phases of the storm water management project. Phase I of the project is intended to consist of a community outreach program and a feasibility study. Phase II is expected to include the implementation of Best Management Practices (BMP’s) to reduce the impact of polluted runoff to surface water. The focus of this report is the Phase I feasibility study, which involves the development of a storm water management study/report that will be used for planning future projects, applying for Phase II funding and as an overall guide and reference for storm water management to minimize pollution from land usage within the City of West Branch and surrounding Area.

The primary objective of the Rifle River Watershed Storm Water Management Study is the protection of the Rifle River. The Rifle River Watershed covers more than 240,000 acres in central Michigan and includes the 65 mile long Rifle River which empties into Saginaw Bay. Although much of the watershed remains forested with pockets of rural and urban development scattered throughout, research has documented that development often has a negative impact on the high-quality waters of the Rifle River. Closely associated with development, one of the most serious threats to water quality is storm water runoff. In the City of West Branch and immediate surrounding area, storm water runoff generally discharges directly to the Rifle River, carrying with it sediment and other pollutants. In an attempt to reduce the polluted runoff and thus provide protection of the Rifle River, the Ogemaw Storm Water Committee along with Huron Pines RC&D have joined forces with Capital Consultants/DesignWorks A|E (CC/DWAE) to conduct a storm water management study which addresses the following, specific objectives:

- Identification of the extent of runoff in the City of West Branch and surrounding urban area.
- Develop a map of drainage zones and discharge locations into the Rifle River and surrounding creeks and streams.
- Provide information on estimated pollutant loadings throughout the study area.

- Recommend Best Management Practices (BMP's) that may be practical for use in the West Branch Area.
- Produce cost estimates for recommended BMP's.
- Produce a final report to be used by the Storm water Committee to assist them in moving forward into Phase II of their storm water management project.

CHAPTER 2

STORM WATER INVENTORY

STORM WATER INVENTORY AND CALCULATIONS

Existing Data

The first step in the study's storm water inventory was to gather existing information from the City of West Branch, Ogemaw County, Ogemaw & West Branch Townships and the Michigan Department of Transportation. Maps of the existing City of West Branch storm sewer system were provided, along with some additional information from the City's DPW Superintendent regarding outlet locations and drainage ditches that were not shown on the maps. Limited information was obtained from West Branch Township and MDOT. No information was available from the Ogemaw County Drain Commissioner. Due to the limited information that was available to be obtained for areas outside of the City, the focus of the storm water management study is mainly on the City of West Branch, with only little concentration on the greater West Branch area.

Field Inventory

In an attempt to verify the storm sewer maps and other data provided by the City of West Branch and others, a field inventory was conducted on August 19, 2005. The field visit was scheduled to coincide with a rain event in the West Branch area in an attempt to allow for a chance to observe the storm water discharge points while they were functioning. Because most of the storm water pipes throughout the City were flowing with water, the majority of the discharge points were easily located. These storm water discharge point locations were noted and photos were taken. Photos of several of the discharge points are included in Appendix A. Also during the field visit, items such as discharge size, area surroundings and other notes were documented. A summary of field inventory notes is included in Table 2.1. During the field inventory, some of the storm water discharges were not able to be located. Possible reasons for this may be that these discharge locations were submerged by the high water, were not in the locations shown on the maps that were referenced, or perhaps the surrounding terrain and foliage disguised the actual discharge pipe from view.

Table 2.1
Summary of Field Inventory Notes

Zone	Discharge Size	Location	Notes
0	18” diameter	5th Street (south)	
1	18” diameter	5th Street (north)	
2	12” diameter	4th Street (south)	
3	12” diameter	4th Street (north)	
4	8-12” diameter	3rd Street	Discharge beneath bridge
5	24” diameter	Intersection of 2nd & Lindsey St.	
6	36” diameter	Discharge behind Sheriff Dept.	Could not locate outlet
7	18” diameter	Trinity Luthern Church Parking Lot	
8	18” diameter	First Street	
9	Unable to locate	On north/south right of way Between Burger King & 1st Street	Unable to locate
10	18” diameter	Burgess Street at covered bridge	Park property available ?
11	12” diameter	Valley Street (south)– adjacent to Irons Park	Unable to locate outlets. Most likely submerged
12	18” diameter	Valley Street (north) – adjacent to Irons Park	Unable to locate outlets. Most likely submerged
13	12” diameter	State Street (west)	
14	12” diameter	State Street (east)	
15	Unable to locate	Fremont Street	Unable to locate any functioning outlets.
16	12” diameter	Houghton Ave, west of Ann’s Hair Affair	
17	54” diameter	Discharge into ditch at intersection of 4th Street and Griffin Road	
18	Not observed		
19	I-75 Business loop		

Drainage Zone Delineation

The area within the City of West Branch and surrounding study area has been delineated into twenty (20) individual watersheds. A watershed is defined as the total land area that contributes runoff, or is within such an area, to a common outlet, such as a lake or a stream; it is also known as the drainage area. Each watershed included in this study drains, or discharges, to the Rifle River by one of several methods:

- Direct discharge to the West Branch of the Rifle River
- Direct discharge to Martin Creek
- Direct discharge to Nelson Creek
- Direct discharge to ditch that leads to Eddy Creek

The area of delineation for each watershed is limited to that portion within City boundaries. The approximate area of each of the twenty drainage zones was determined through the use of aerial photographs and the City of West Branch Base Map. The City of West Brach and surrounding areas' watersheds and associated outfalls are shown in Figure 2.1 (see map pocket).

Design Storm Event

Various governmental agencies have published design rainfall amount atlases for storm durations from 30 minutes to 24 hours and recurrence intervals from 1 to 100 years. Normal practice in Michigan has been to use 24 hours as the design rainfall duration. The rainfall amounts have been taken almost exclusively from Hershfield (1961), commonly known as the U.S. Weather Bureau's technical paper TP-40.

Rainfall amounts in excess of the 100-year values from TP-40 have been occurring in Michigan regularly for a number of years. Part of the reason may be that TP-40 only utilized data through 1958. Sorrell and Hamilton (1991) analyzed 24-hour rainfall data from Michigan gages in order to update the TP-40 information. These updated figures are attached as figures B.2, B.3 and B.4 in Appendix B. Design rainfalls obtained from updated figures may be used for drainage areas up to 10 square miles. For larger watersheds, rainfall should be adjusted to account for area distribution. These adjustment factors are found in Table 21.1 of the SCS National Engineering Handbook reference.

As a minimum, the design rainfall amount should account for the "first flush" storm, which is ½" for unpaved areas and 1" for paved areas. This design rainfall amount is used to size basins or other BMP's to regulate water quality by dropping out pollutants attached to sediments. First flush refers to the large percentage of storm pollutant loading that is produced by a relatively small percentage of the runoff volume during the initial stages of the runoff.

Typically, a 10-year/24-hour storm is used for storm water calculations. However, in some cases, a municipality may require a 25-year/24-hour storm. Reasonable and prudent engineering judgment should be used when choosing the design storm event. For at times, a 50-year/24-hour storm or even a 100-year/24-hour storm would be appropriate for storm water design. The client/developer or municipality along with the engineer must determine the amount of conservatism used in storm water design. For this study, a 10-year/24-hour storm will be used to analyze the design flows to produce an "average" case scenario. Then "average" scenario design elements will be used for developing preliminary opinions of probable project costs.

Estimated Storm Water Flows

The method used to estimate the storm water flows (peak runoff) for this study is the method presented in the MDEQ "Guidebook of Best Management Practices for Michigan Watersheds" reprinted in 1998. This method was first developed by Sorrell and Hamilton in their document entitled "Computing Flood Discharges For Small Ungaged Watersheds" (1991). Their document presents a method for computing flood discharges using unit hydrograph techniques and is similar to the method developed by the U.S. Soil Conservation Service (SCS) and described in the National Engineering Handbook, Hydrology: Section 4 (1972).

In order to determine the estimated storm water flows for each of the twenty identified drainage zones, the following steps were required to complete the calculations for each zone:

- Approximate area of each drainage zone (in square miles).
- Analyze each drainage zone to determine the Land Use Type and the Hydrological Soil Group, then assign a Runoff Curve Number for each drainage zone using this information.
- Choose a design storm frequency.
- Calculate the Time of Concentration & Surface Run Off.
- Calculate the Peak Unit Hydrograph.
- Calculate the estimated Storm Water Discharge.

The approximate area of each of the twenty drainage zones was determined through the use of aerial photographs and the City of West Branch Base Map. These approximate areas and other storm water calculation information are shown in Table 2.2.

The twenty drainage zones were analyzed to determine a Land Use and a Hydrological Soil Group. A Hydrological Soil Group B was used for all calculations in this study because the group provides for moderate water infiltration and transmission. This assumption appears appropriate because of the varying soil types in the West Branch Area. A Runoff Curve Number (RCN) was assigned to each drainage zone which was determined from Figure B.1, included in Appendix B.

Table 2.2
Storm Water Discharge Calculations
Based on 1 - Hour Data

											Est. Storm Water Discharge in CFS			
Zone #	Drainage Area (sq. miles)	Land Use Type	Hydrological Soil Group	% of Drainage Area	% of Soil Group	Runoff Curve Number	Time of Concentration (hours)	Surface Run Off (First Flush)	Surface Run Off (10 yr storm)	Surface Run Off (100 yr storm)	Event:	First Flush	10 Yr	100 Yr
											24 Hr - Rainfall (in.)	1.000	3.4	4.8
0	0.05022	Industrial	B	100	100	88	0.46000	0.25296	2.17770	3.47929	West Branch - Rifle River	6.5	55.6	88.8
1	0.06098	Residential 1/4 acre lots	B	100	100	75	0.39000	0.03030	1.23150	2.28810	West Branch - Rifle River	1.1	43.6	81.0
2	0.01022	Business	B	100	100	92	0.16000	0.40245	2.54114	3.89411	West Branch - Rifle River	4.9	31.1	47.6
3	0.04017	Residential 1/8 acre lots or less	B	100	100	85	0.26000	0.17360	1.92956	3.18369	West Branch - Rifle River	5.6	62.5	103.2
4	0.01184	Commercial	B	100	100	92	0.13000	0.40245	2.54114	3.89411	Martin Creek	6.7	42.5	65.2
5	0.04950	Residential 1/4 acre lots	B	100	100	75	0.31000	0.03030	1.23150	2.28810	West Branch - Rifle River	1.0	42.6	79.2
6	0.03587	Residential 1/4 acre lots	B	100	100	75	0.31000	0.03030	1.23150	2.28810	West Branch - Rifle River	0.8	30.9	57.4
7	0.00789	Commercial	B	100	100	92	0.12000	0.40245	2.54114	3.89411	West Branch - Rifle River	4.8	30.3	46.4
8	0.01740	Commercial	B	100	100	92	0.16000	0.40245	2.54114	3.89411	West Branch - Rifle River	8.4	52.8	81.0
9	0.03946	Residential 1/8 acre lots or less	B	100	100	85	0.31000	0.17360	1.92956	3.18369	West Branch - Rifle River	4.8	53.3	87.9
10	0.03587	Residential 1/4 acre lots	B	100	100	75	0.39000	0.03030	1.23150	2.28810	West Branch - Rifle River	0.6	25.7	47.7
11	0.00933	Residential 1/4 acre lots/Open Space	B	100	100	70	0.17000	0.00461	0.94692	1.88929	West Branch - Rifle River	0.0	10.0	20.1
12	0.04663	Residential 1/4 acre lots/Open Space	B	100	100	70	0.28000	0.00461	0.94692	1.88929	West Branch - Rifle River	0.2	33.5	66.9
13	0.01345	Residential 1/4 acre/Comm/Open	B	100	100	76	0.16000	0.03849	1.29324	2.37169	Nelson Creek	0.6	20.8	38.1
14	0.01040	Residential 1/4 acre lots/Open Space	B	100	100	70	0.17000	0.00461	0.94692	1.88929	Nelson Creek	0.1	11.2	22.4
15	0.03946	Residential 1/3 acre lots/Open Space	B	100	100	67	0.30000	0.00005	0.79450	1.66512	Nelson Creek	0.0	22.5	47.2
16	0.02009	Commercial	B	100	100	92	0.20000	0.40245	2.54114	3.89411	Nelson Creek	8.1	50.9	78.0
17	0.25109	Residential 1/4 acre lots/Open Space	B	100	100	68	0.75000	0.00073	0.84383	1.73859	Ditch - to Eddy Creek?	0.1	72.5	149.3
18	0.17935	Commercial/Open Space	B	100	100	76	0.45000	0.03849	1.29324	2.37169	Ditch - to Eddy Creek?	3.6	120.0	220.0
19		Not in Study									West Branch - Rifle River (I-75)	0.0	0.0	0.0
Totals												57.8	812.3	1427.3

For the purpose of this study, the First Flush, 10-year/24-hour and 100-year/24-hour design storm intensities were analyzed. See the rainfall intensity charts, Figures B.2, B.3, and B.4 in Appendix B. These three (3) storms provided the estimated storm water discharge information that was required. As noted above, a 10-year/24-hour storm will be used to analyze the design flows to produce an "average" case scenario.

Once the time of concentration (Tc), surface runoff (SRO) and Peak Unit Hydrograph (Qp) were determined for each zone, the estimated storm water design discharge was computed using the following equation:

Design Discharge = Qp x Area (sq. miles) x SRO

Estimated Pollutant Loadings

Storm water pollutants are one of the most significant, yet unrecognized groups of water contaminants. When a rain even occurs, storm water runs across streets, parking lots, yards, etc., carrying with it debris, sediment and pollutants. Eventually, the water will travel to a stream or river via land, ditch or storm sewer. Catch basins and storm drains are typically located alongside streets and parking lots and unlike sanitary sewers that divert water to a treatment plant, storm drains lead directly to surrounding lakes, rivers and streams without any type of treatment. All of the debris, sediment and pollutants associated with storm water runoff end up in our lakes, rivers and streams.

Most of the storm water contaminants are made up of common items used by residents and businesses, such as car oils and greases, fertilizers, soils and sediments and pet wastes (bacteria). Additional pollutants found in storm water include, but are not limited to, metals, toxic and synthetic chemicals, temperature effects and salt.

In order to estimate pollutant loadings, it is important to understand the mobility and transport of such pollutants. The impact of rain falling on land surfaces, especially parking lots, streets and other impervious surfaces, dislodges pollutants, making them readily available for transport by flowing runoff. This flowing runoff often dislodges more pollutants as it is carried toward the storm drains and eventually the rivers, lakes and streams. Therefore, those drainage zones and discharge locations with higher concentrations of impervious surface and storm drains located within the street or curb line, allowing limited opportunity for infiltration or sediment/pollutant filtering through grass and other natural areas, are those with the highest pollutant loadings.

The temperature impacts associated with storm water can be detrimental to streams, rivers and other water bodies. The Rifle River, in particular, is highly susceptible to temperature impacts, as it is designated as a cold water trout stream. Changes in water temperature can have a serious impact on aquatic ecosystems, as aquatic organisms (plants, fish, etc.) have specific water temperature preferences and tolerance limits. Water that infiltrates the ground and flows beneath the surface is usually much cooler than surface runoff. Not only do impervious surfaces such as pavement, rooftops and storm sewer piping prevent infiltration, they often warm storm water as it runs off. Unshaded rooftops, parking lots, and other impervious areas can be 10–12° F warmer than fields and forests and consequently can heat the storm water passing over them before it reaches a stream or river. Research has found that the average stream temperature increases directly with the percentage of impervious cover in the watershed. (From the National Resources Defense Council). Specific temperature impacts on the Rifle River and its tributaries in the West Branch and surrounding area were not included as part of this study.

Although not specifically studied or tested as part of this Storm Water Management Study, an important storm water pollutant to consider is that of illicit discharges. Federal regulations define an illicit discharge as…"any discharge to a municipal separate storm sewer system (MS4) that is not composed entirely of storm water"… with some exceptions. The most common sources of illicit discharges are: sanitary wastewater, effluent from septic tanks, car wash wastewaters, improper oil disposal, laundry wastewaters, spills from roadway accidents and improper disposal of auto and household toxics. Illicit discharges enter the system through either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the MS4 from cracked sanitary systems, spills collected by drain outlets, or paint or used oil dumped directly into a drain). The result is untreated discharges that contribute high levels of pollutants including heavy metals, toxics, oil and grease, solvents, nutrients, viruses and bacteria to receiving water bodies. Pollutant levels from these illicit discharges have been shown in EPA studies to be high enough to significantly degrade receiving water quality and threaten aquatic and wildlife health.

To provide a "textbook" estimate of the storm water pollutant loads in this study, a common and simple model, the Simple Method (Schueler, 1987) is used. This method estimates storm water pollutant loads as the product of mean pollutant concentrations and runoff depths over a one year time period. For the purpose of this study, we will estimate pollutant loads for Total Suspended Solids, Total Phosphorus and Total Nitrogen.

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 \times R \times C \times A$$

Where: L = Annual load (lbs)

R = Annual runoff (inches)

C = Pollutant concentration (mg/l)

A = Area (acres)

0.226 = Unit conversion factor

The Simple Method calculates annual runoff (R) as a product of annual runoff volume, and a runoff coefficient (Rv). Runoff volume is calculated as:

$$R = P \times Pj \times Rv$$

Where: R = Annual runoff (inches

P = Annual rainfall (inches)

Pj = Fraction of annual rainfall events that produce runoff (usually 0.9)

Rv = Runoff coeffiecient

The annual rainfall (P) for the West Branch area, approximately 31 inches per year, is taken from The Weather Channel on-line data. The runoff coefficient (Rv) is determined from Figure C-1 included in Appendix C, based on watershed imperviousness, and varies for each drainage zone.

Pollutant concentration (C) is based on the Pollutant Concentrations by Land Use Tables included in Appendix C. Area (A) is determined in acres as the drainage area for each zone. Calculations for the estimated annual pollutant loadings for each drainage zone are shown in Table 2.3

Table 2.3
Estimated Annual Pollutant Loading Calculations based on Schueler's Simple Method.

							Pollutant Concentrations			Annual Pollutant Loads			
Zone #	Drainage Area (sft)	Drainage Area (Acres)	Land Use Type	Annual Rainfall (inches)	Runoff Coeff.	Annual Runoff (inches)	TSS (mg/l)	Total Phosphorus (mg/l)	Total Nitrogen (mg/l)	Total Suspended Solids (lbs)	Total Phosphorus (lbs)	Total Nitrogen (lbs)	Total Annual Pollutant Load per Acre (lbs/acre)
0	1,400,000	32.1	Industrial	31	0.70000	19.5	120	0.4	2.5	17023	57	355	542.5
1	1,700,000	39.0	Residential 1/4 acre lots	31	0.50000	14.0	100	0.4	2.2	12304	49	271	323.5
2	285,000	6.5	Business	31	0.80000	22.3	150	0.5	3.0	4951	17	99	774.3
3	1,120,000	25.7	Residential 1/8 acre lots or less	31	0.60000	16.7	100	0.4	2.2	9727	39	214	388.2
4	330,000	7.6	Commercial	31	0.80000	22.3	150	0.5	3.0	5732	19	115	774.3
5	1,380,000	31.7	Residential 1/4 acre lots	31	0.50000	14.0	100	0.4	2.2	9988	40	220	323.5
6	1,000,000	23.0	Residential 1/4 acre lots	31	0.50000	14.0	100	0.4	2.2	7238	29	159	323.5
7	220,000	5.1	Commercial	31	0.80000	22.3	150	0.5	3.0	3821	13	76	774.3
8	485,000	11.1	Commercial	31	0.80000	22.3	150	0.5	3.0	8425	28	168	774.3
9	1,100,000	25.3	Residential 1/8 acre lots or less	31	0.60000	16.7	100	0.4	2.2	9554	38	210	388.2
10	1,000,000	23.0	Residential 1/4 acre lots	31	0.50000	14.0	100	0.4	2.2	7238	29	159	323.5
11	260,000	6.0	Residential 1/4 acre lots/Open Space	31	0.35000	9.8	75	0.4	2.2	988	5	29	171.3
12	1,300,000	29.8	Residential 1/4 acre lots/Open Space	31	0.35000	9.8	75	0.4	2.2	4940	26	145	171.3
13	375,000	8.6	Residential 1/4 acre/Comm/Open	31	0.40000	11.2	80	0.4	2.2	1737	9	48	208.3
14	290,000	6.7	Residential 1/4 acre lots/Open Space	31	0.35000	9.8	75	0.4	2.2	1102	6	32	171.3
15	1,100,000	25.3	Residential 1/3 acre lots/Open Space	31	0.35000	9.8	75	0.4	2.2	4180	22	123	171.3
16	560,000	12.9	Commercial	31	0.70000	19.5	150	0.5	3.0	8511	28	170	677.5
17	7,000,000	160.7	Residential 1/4 acre lots/Open Space	31	0.35000	9.8	75	0.4	2.2	26598	142	780	171.3
18	5,000,000	114.8	Commercial/Open Space	31	0.35000	9.8	100	0.4	2.2	25332	101	557	226.4
19	NOT IN STUDY												
20	NOT IN STUDY												
Totals		595								169387	697	3931	

As one would expect, the highest concentration of annual pollutant load per acre occurs in the drainage areas categorized as industrial or commercial land use. These drainage zones, with their higher concentrations of impervious surface, appear to contribute the majority of the study area's Total Annual Pollutant Load. An important and effective, yet relatively simple and inexpensive method to significantly decrease many of the pollutants in these areas and others is through a semi-annual municipal street sweeping program. By sweeping sediment from City Streets and other impervious areas, the pollutants associated with the road sediment are kept from washing into the City storm sewer system and eventually making their way to the river and creeks.

Physical sampling and testing of storm water discharge and receiving waters was not included as part of this study. However, both dry weather and wet weather sampling would be beneficial to the Storm Water Committee, in their effort to better understand the storm water issues specific to West Branch and the surrounding area. The goal of wet weather monitoring is to sample for pollutants in the municipal storm sewer system during a rain storm. When it rains, pollutants such as oil, pesticides, sediment, and bacteria are picked up from streets, parking lots, and lawns and carried into the storm drain system. These pollutants then flow straight to the Rifle River and its tributaries. Through a wet weather monitoring program, samples would be collected and delivered to a laboratory for analysis. Dry weather sampling (perhaps once a year) is an effort to isolate potential illicit discharges. Dry weather sampling can also be used to develop a baseline of dry weather surface water quality data against which future changes can be measured.

CHAPTER 3

STORM WATER TREATMENT OPTIONS

STORM WATER TREATMENT OPTIONS

The ultimate goal of the Ogemaw Storm Water Committee is to effectively manage storm water and reduce the impact of polluted runoff to surface waters, such as the Rifle River and its tributaries. Storm water management has a direct impact on the quality of life and recreational water use, as well as on the area residents' health, safety, and overall welfare. Through the implementation of a Storm Water Management Plan, and perhaps a future Storm Water Management Ordinance, the Storm Water Committee will be positioned to not only improve water quality of runoff, and ultimately, the quality of receiving water bodies, but also protect and enhance property values within the City of West Branch and surrounding area.

The specific objectives of a storm water management plan can typically be summarized into the following three topics: Water Quality, Water Quantity and Municipal Responsibilities and Actions. Below is a general list of storm water treatment options relevant to each objective topic:

Water Quality

- Prioritize the "first flush" of runoff for treatment and management.
- Use and preserve natural systems and vegetation.
- Control erosion during construction.
- Optimize and encourage infiltration.
- Improve areas that are undergoing redevelopment.
- Use "Best Management Practices" (BMPs).

Water Quantity

- Address acceptable runoff rates from various land cover types.
- Address allowable discharge rates from a development.
- Refer to the 100-year storm event as the basis for managing runoff – an ultimate goal.
- Optimize and encourage infiltration.
- Monitor quantity controlled by subtracting allowable discharge from acceptable runoff.
- Use "Best Management Practices" (BMPs).

Local Units of Government Responsibilities and Actions

- Educate and inform the public.
- Address maintenance and improvement of existing storm water systems.
- Review existing ordinances to determine compatibility.
- Address long-term ownership and maintenance of any new facilities.

In an effort to achieve the goals and objectives outlined above, both non-structural and structural practices must be considered. The non-structural component would include educating the public on their responsibilities with storm water management, addressing maintenance throughout the City and surrounding area, and a future Storm Water Management Ordinance, which the Storm Water Committee may consider further in Phase II of their Storm Water Management Project. The structural element includes the use of Best Management Practices (BMPs) to both control storm water management for future developments and retrofit existing storm water discharge situations.

Non Structural

The most important aspect of protecting the water resources of the area is to "educate the public." The public must realize and understand how critical they are to storm water management. Two areas where public education is imperative are the use of fertilizers/pesticides and the disposal of household hazardous waste. It is very important not to over-apply or misuse fertilizers and pesticides in the area being that the Rifle River and several tributaries flow through the City. The "first flush" of the storm event could easily drain these fertilizers and pesticides into the storm sewer system and/or directly into the water way. The community should implement a Household Hazardous Waste Disposal program as soon as possible. The proper disposal of hazardous materials will minimize the amount of hazardous materials that may enter surface waters and contaminate groundwater supplies. Again, being that the Rifle River and several tributaries flow through the City, household hazardous waste could easily drain into the storm sewer system and/or directly into the waterway. However, this program must provide convenient drop off options to the residents or it will not be successful.

Another non-structural storm water management practice that can play an important role in protecting surface waters is best described as a Municipal BMP. Municipal BMPs are practices that can be performed throughout the City and surrounding area by municipal employees, perhaps by establishing a storm water maintenance program. The following elements should be included in such a maintenance program:

- Street Sweeping

  Street sweeping will remove litter, loose gravel, soil, pet waste, vehicle debris and pollutants, dust, de-icing chemicals, and industrial debris from road surfaces. Sweeping, when done regularly, can remove 50%-90% of street pollutants that can enter surface waters through the storm sewers. Sweeping in the spring is imperative.
- Storm Sewer, Manhole and Catch Basin Maintenance

  Storm sewer systems, especially catch basin sumps should be cleaned regularly to insure they are able to function as intended.
- Maintenance of Equipment Storage and Maintenance Areas

  Equipment maintenance and storage areas should properly control runoff to prevent oil, grease, solvents, hydraulic fluids, sediment, wash water, and other pollutants from being carried off the area and entering surface waters. Proper use of this practice will also prevent pollutants from filtering into the ground.
- Winter Road Management

  Winter Road Management suggests a reduction in the salt application rates as well as encouraging proper salt storage.
- Education of DPW personnel, grounds workers and other Municipal Employees

  Reference materials including videos, books and brochures can be obtained through the Michigan Department of Environmental Quality and other governmental agencies.

A future non-structural storm water management practice that should be considered for implementation in the study area is a storm water management ordinance. Ultimately, the Storm Water Committee's storm water management plan and a future ordinance could serve as guidance and the legal framework to minimize pollution from land usage within designated boundaries of the local watersheds. Although the boundaries of the Rifle River Watershed extend beyond the limits of this study, the Committee's plan and ordinance would likely serve as a model for other entities within the watershed to take similar action in hope that a holistic watershed approach to improving water quality might ultimately be implemented.

Structural

One of the most effective structural methods for reducing the impact of polluted runoff to surface water is through the use of Best Management Practices or BMPs. BMPs are techniques used to control storm water runoff, sediment control, and soil stabilization, as well as management decisions to prevent or reduce nonpoint source pollution. The EPA defines a BMP as a "technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of storm water runoff in the most cost-effective manner." Three of the most common and widely used technologies considered feasible for storm water treatment to reduce pollutants, scour conditions and elevated river water temperatures include: storm water wetlands (a.k.a. constructed wetlands), mechanical removal and infiltration basins. Each technology has unique advantages and often performs best when used in combination with other BMP's.

Storm water wetlands (a.k.a. constructed wetlands) are structural practices that incorporate wetland plants into the design. As storm water runoff flows through the wetland, pollutant removal is achieved through settling and biological uptake within the practice. Wetlands are among the most effective storm water practices in terms of pollutant removal and they also offer aesthetic value. Although natural wetlands can sometimes be used to treat storm water runoff that has been properly pretreated, storm water wetlands are fundamentally different from natural wetland systems. Storm water wetlands are designed specifically for the purpose of treating storm water runoff, and typically have less biodiversity than natural wetlands in terms of both plant and animal life. Several design variations of the storm water wetland exist, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland (from the U.S. Environmental Protection Agency).

Figure 3.1
Storm Water Wetlands Detail

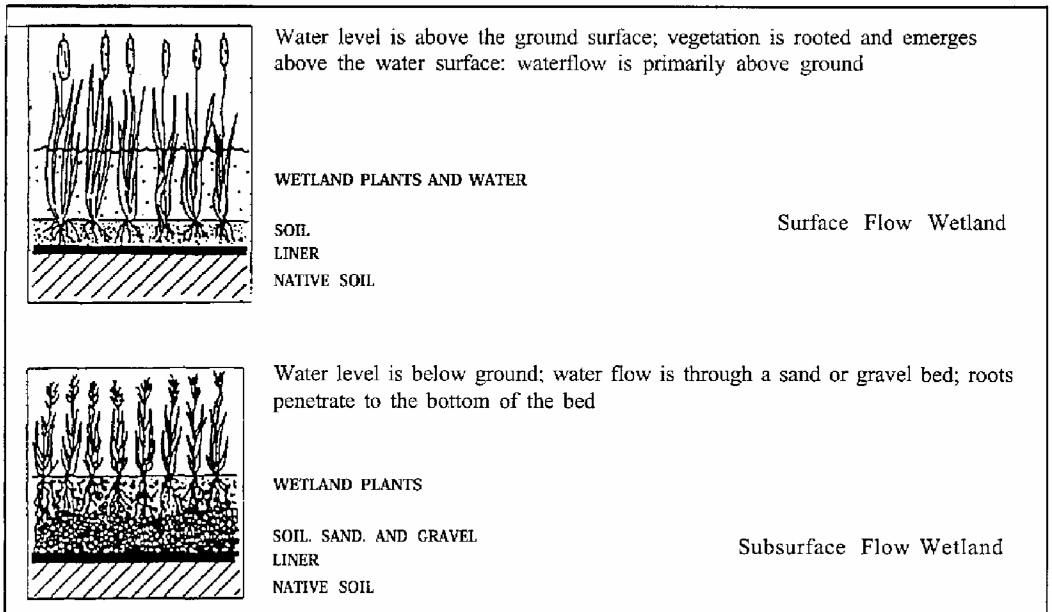
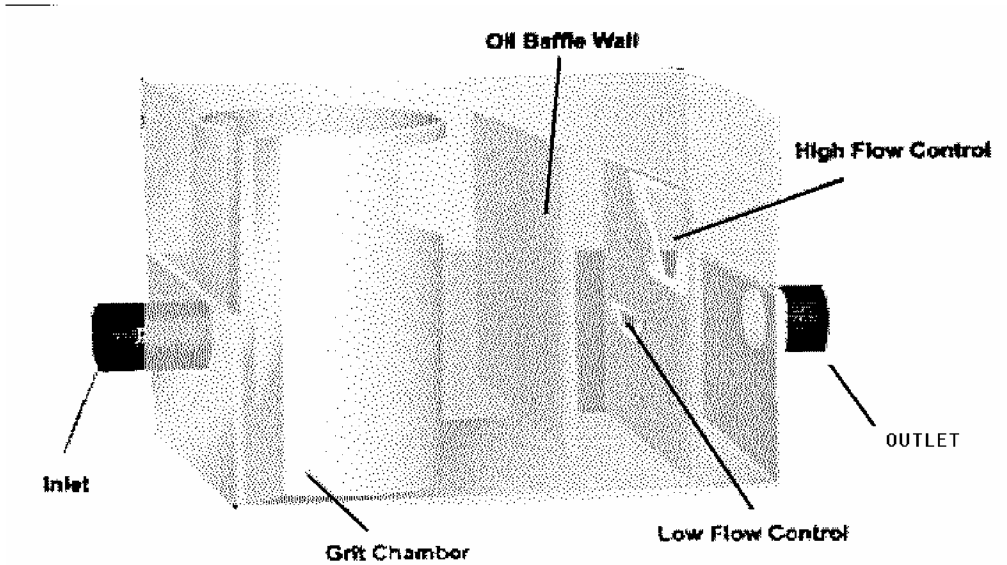


Figure 1. Surface flow and subsurface flow constructed wetlands (from Water Pollution Control Federation 1990).

Storm water wetlands are widely applicable storm water management practices. They do have a few restrictions that must be considered in determining their practicability in the City of West Branch and surrounding areas. First, wetlands need sufficient drainage area to maintain the characteristics of a "wetland" without drying out. In humid regions, this is typically about 25 acres, but a greater area may be needed in regions with less rainfall. Second, the surface area of wetlands should be at least 1 percent of the drainage area. And third, during the spring snowmelt, a large volume of water runs off in a short time, carrying a relatively high pollutant load. In addition, cold winter temperatures may cause freezing of the shallow, permanent pool or freezing at inlets and outlets. Finally, high salt concentrations in runoff resulting from road salting during the winter months, as well as sediment loads from road sanding, may impact wetland vegetation.

Mechanical removal through structures such as hydrodynamic separators is another increasingly popular practice for storm water management. Hydrodynamic separators are flow-through structures with a settling or separation unit to remove sediments and other pollutants that are widely used in storm water treatment. No outside power source is required, because the energy of the flowing water allows the sediments to efficiently separate. Hydrodynamic separators come in a wide size range and some are small enough to fit in conventional manholes (depending on the flow requirements). This makes hydrodynamic separators ideal for areas where land availability is limited. The need for hydrodynamic separators is growing as a result of decreasing land availability for the installation of storm water BMPs.

Figure 3.2
Hydrodynamic Separator Detail

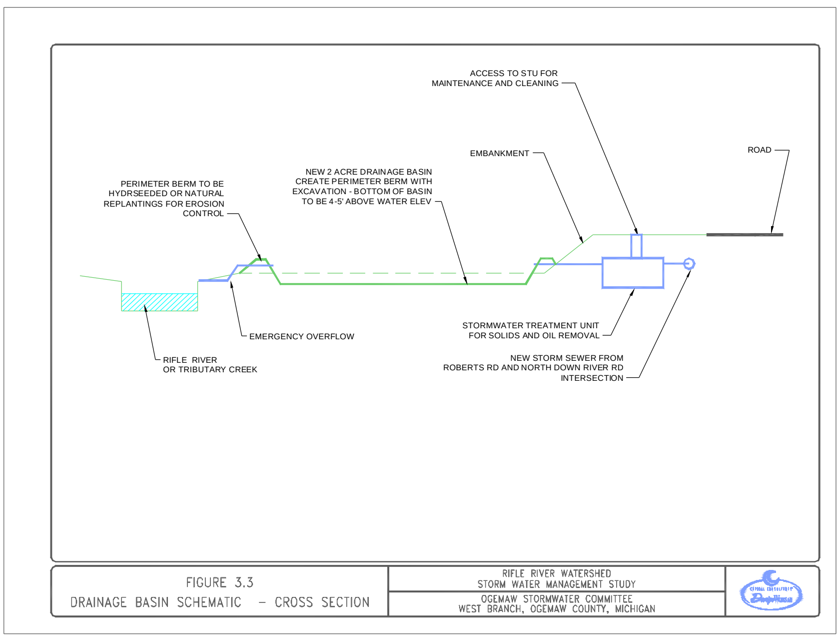


The use of hydrodynamic separators as wet weather treatment options may be limited by the variability of net solids removal. While some data suggests excellent removal rates, these rates often depend on site-specific conditions, as well as other contributing factors. Pollutants such as nutrients, which adhere to fine particulates or are dissolved, will not be significantly removed by this type of unit (from the U.S. EPA). Hydrodynamic separators are designed primarily for removing floatable materials and they may have difficulty removing the less-settleable solids generally found in storm water. The reported removal rates of sediments, floatables and oil and grease differ depending on the vendor. Proper design and maintenance also affect the unit's performance. Appendix D includes product information from Vortechnics, a widely used dealer of mechanical removal units.

Infiltration basins are designed to collect storm water from impervious areas and provide pollutant removal benefits through detention and filtration. An infiltration basin is a shallow impoundment which is designed to infiltrate storm water into the ground water. This practice is believed to have a high pollutant removal efficiency and can also help recharge the ground water, thus restoring low flows to stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

Figure 3.3

Drainage Basin Schematic Detail



Although infiltration basins can be useful practices and they have been successfully implemented in northern Michigan, they have some limitations. First, infiltration basins are best applied to relatively small drainage areas. While this may seem as though it would limit their use for the purpose of this study, on the contrary they can be effectively used to treat a “smaller” storm such as our 10-year/24-hour design storm. Infiltration basins also are not generally aesthetic practices, particularly if they clog. If they clog, the soils become saturated, and the practice can be a source of mosquitoes. In addition, these practices are challenging to apply because of concerns over ground water contamination and sufficient soil infiltration. Finally, maintenance of infiltration practices can be burdensome, as they require periodic cleaning to prevent clogging and maintain their effectiveness.

The rain garden is an alternative storm water BMP that is becoming increasingly popular, especially in the West Branch area. A rain garden is a shallow, constructed depression that is planted with deep-rooted native plants & grasses. It is located to receive runoff from hard surfaces such as a roof via a downspout, a sidewalk and driveway. Rain gardens slow down the rush of water from these hard surfaces, hold the water for a short period of time and allow it to naturally infiltrate into the ground. Rain gardens are a beautiful and colorful way for homeowners, businesses and municipalities to help ease storm water problems. There is a growing trend by municipalities and homeowners to incorporate natural processes to help relieve flooding and pollution.

Additional BMPs to consider for retrofitting an existing storm sewer system or for implementation in future development areas include:

- Decrease Number of Storm Water Discharge Points

  Decreasing the number of discharge points by combining two or more drainage zones into one zone, will provide much more control over discharges, and thus pollutants, into the area surface waters. Even as future street improvement projects are planned throughout the City and surrounding area, designs should aim to eliminate direct storm water discharge points to the river and creeks, instead re-routing them into an adjacent drainage zone. Without exception, any future direct discharges should be prohibited.
- Grassed Waterways

  Grassed waterways (also channels & swales) can be implemented to reduce runoff velocity prior to entering the storm sewer system, filter sediment and absorbed chemicals from sheet erosion, and deliver intermittent flows to streams and rivers. These grassed waterways may also provide grazing or habitat opportunities for wildlife.
- Oil/Grit Separators

  Oil/Grit separators can be retro-fit near drainage outlets that have a high probability of seeing oil and course sediments. These separators provide little or no treatment of fine sediments and soluble pollutants. Pollutants are permanently removed only after the separator chambers are cleaned. Therefore, routine clean-outs are essential in order to gain any benefit from this BMP.

- Buffer/Filter Strips

  Buffer/Filter strips are vegetated areas adjacent to a waterway that are used 1) as a buffer between human land use and the waterway and 2) as a filter to trap sediment and absorb sheet flow.
- Low Impact Development

  Through Low Impact Development (LID), rainfall is managed at the source using uniformly distributed decentralized micro-scale controls (such as pervious pavement, etc.). LID's goal is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source. Techniques are based on the premise that storm water management should not be seen as storm water disposal. Instead of conveying and managing / treating storm water in large, costly end-of-pipe facilities located at the bottom of drainage areas, LID addresses storm water through small, cost-effective landscape features located at the lot level.

Applicable Options for Study Area

Table 3.1, shown below, lists the twenty drainage zones (watersheds) identified in the study, and the storm water management practices or BMPs (described above) that appear most applicable for each of them.

Table 3.1
Recommended BMP's

Drainage Zone (Watershed)	Educate Public	Municipal BMPs	Stm Water Ordinance	Stm Water Wetlands	Mechanical Removal	Infiltration Basin	Decreased # of Discharge Points	Grassed Waterway	Buffer/Filter Strips
0	■	■	■		■		0+2		
1	■	■	■		■	■		■	
2	■	■	■		■		2+0		
3	■	■	■		■				
4	■	■	■		■	■			
5	■	■	■		■		5+6		
6	■	■	■	■	■	■	5+6+7	■	
7	■	■	■		■		7+6		■
8	■	■	■		■	■		■	
9	■	■	■		■	■			
10	■	■	■		■	■	■		
11	■	■	■	■	■	■			
12	■	■	■	■	■	■			
13	■	■	■		■				
14	■	■	■		■				
15	■	■	■						
16	■	■	■		■	■			
17	■	■	■					▲	
18	■	■	■					▲	
19	■	■	■					▲	■

■ = Proposed/Recommended
▲ = Existing
0+2 = Proposed/Recommended (zones to be combined)

As indicated in Table 3.1, all of the drainage zones included in the study would benefit from the non-structural BMPs, such as public education, municipal maintenance BMPs and a future storm water management ordinance. Also, the most applicable and beneficial BMP that could be implemented in drainage zones 0, 2, 5, 6 and 7 would be the decrease of discharge points. By modifying the City's storm water system in these areas, some of the existing direct discharges into the Rifle River and creeks could be eliminated. While there would be some considerable costs involved outside of the new storm pipe costs, the elimination of direct discharges along the river will provide more control over storm water and thus pollutants entering the surface waters. Drainage zones 17, 18 and 19 already employ a very useful BMP in the use of grassed waterways or ditches. By channeling water through grass-lined ditches, as opposed to storm pipe, prior to its discharge into a river or creek, it is able to undergo beneficial filtering and also infiltration is allowed to occur.

Structural BMPs, including storm water wetlands, hydrodynamic separators (mechanical removal) and infiltration basins are recommended for use in the remaining drainage zones in the study area. Proposed locations for these recommended BMPs are shown in Figures 3.1, 3.2, 3.3 and 3.4, which are the four quadrants of the study area. These proposed locations were determined based on aerial photographs and land that appeared vacant or useable. Existing ownership of the land was not determined. During the future design of these storm water management projects, land acquisition or perhaps alternate locations for construction may need to be considered.

Cost Estimates

Based on the recommendations for drainage zone BMPs, preliminary project cost estimates were developed and are included in Table 3.2. These estimates include engineering and contingencies but do not include land acquisition or permitting costs.

It is important to consider the removal efficiencies of the different recommended BMPs when comparing their costs. Although the Infiltration Basin and Storm Water Wetlands options appear to be more costly than a Mechanical Removal unit, it is worth noting that an Infiltration Basin or Storm Water Wetland will likely have higher nutrient/chemical removal efficiency than a Mechanical Removal Unit such as a hydrodynamic separator. Hydrodynamic separators are primarily utilized for the removal of sediment, floatables, oil and grease. While these recommendations and cost estimates will serve as a reference and first step in determining priorities and obtaining funding, the most cost effective option for treatment will need to be determined on a case by case basis.

Table 3.2
Preliminary Project Cost Estimates

Zone #	Recommended BMP	CFT of storage for 3 hours	CYD storage	A. Eliminage Discharge Point Approx. Costs	B. Infiltration Basin Approx.Costs	C. Mechanical Removal Approx. Costs	D. Storm Water Wetlands Approx. Costs	Apparent Least Cost
0	Eliminate Discharge Point or Mechanical Removal	600144	22228	$32,500.00		$130,000.00		A. $32,500.00
1	Mechanical Removal or Infiltration Basin	471070	17447		$227,000.00	$104,000.00		C. $104,000.00
2	Mechanical Removal	335352	12420			$78,000.00		C. $78,000.00
3	Mechanical Removal	675322	25012			$156,000.00		C. $156,000.00
4	Eliminate Discharge Point or Mechanical Removal	459423	17016		$221,000.00	$104,000.00		C. $104,000.00
5	Eliminate Discharge Point or Mechanical Removal	460548	17057	$58,500.00		$104,000.00		A. $58,500.00
6	Infilt. Basin or Stm Water Wetlands or Mech. Removal	333731	12360		$161,000.00	$78,000.00	$260,000.00	C. $78,000.00
7	Eliminate Discharge Point or Mechanical Removal	326798	12104	$78,000.00		$78,000.00		A. or C. $78,000.00
8	Mechanical Removal or Infiltration Basin	570687	21137		$275,000.00	$130,000.00		C. $130,000.00
9	Infiltration Basin or Mechanical Removal	575190	21303		$277,000.00	$130,000.00		C. $130,000.00
10	Infiltration Basin or Mechanical Removal	277100	10263		$133,000.00	$71,500.00		C. $71,500.00
11	Mechanical Removal or Infilt. Basin or Stm Water Wetlands	108540	4020		$52,000.00	$39,000.00	$97,500.00	C. $39,000.00
12	Mechanical Removal or Infilt. Basin or Stm Water Wetlands	362263	13417		$174,000.00	$78,000.00	$286,000.00	C. $78,000.00
13	Mechanical Removal	224563	8317			$65,000.00		C. $65,000.00
14	Mechanical Removal	121063	4484			$39,000.00		C. $39,000.00
15	No Recommended Change	243210	9008					
16	Infiltration Basin or Mechanical Removal	549980	20370		$265,000.00	$130,000.00		C. $130,000.00
17	No Recommended Change	782562	28984					
18	No Recommended Change	1295721	47990					
19	Rehabilitate existing Grassed Waterways	0						

Note: 1. All costs are based on providing treatment for a 10-year/24-hour storm.

2. The most cost effective option for treatment will need to be determined on a case by case basis, as it is contingent on suitable land availability.

CHAPTER 4

POTENTIAL FUNDING MECHANISMS

POTENTIAL FUNDING MECHANISMS

Limited funding is available for nonpoint sources controls through federally funded programs such as Sections 319, 604(b)(1), 314 of the Federal Clean Water Act, or the State Revolving Fund (SRF).

The mission of the Michigan Department of Environmental Quality (DEQ), Nonpoint Source (NPS) Program is to protect and enhance the quality of the state's surface waters for the benefit of present and future generations through the elimination or prevention of nonpoint source pollution. In an effort to fulfill this mission they offer funding opportunities to projects implementing elements of approved watershed management plans which control nonpoint sources of pollution. Selected projects are funded under Section 319 of the federal Clean Water Act. Up to $2.9 million was available for the 2005 grant cycle.

The SRF is an environmental protection program that provides low interest financing to assist qualifying communities that have documented their water quality needs. The revolving nature of the fund will enable Michigan to finance water pollution control projects for years to come. The DEQ and the Michigan Municipal Bond Authority (MMBA) jointly administer the SRF. Each agency lends its particular expertise for efficient operation of the program.
Any municipality, county, village, township, or intermunicipal agency is eligible to borrow from the Clean Water Revolving Funds. All SRF projects are either publicly-owned treatment works or nonpoint source pollution control projects. Examples of NPS pollution control projects include storm water treatment, runoff control, and stream bank management.

APPENDIX A

PHOTOGRAPHS OF DISCHARGE POINTS

APPENDIX B

STORM WATER CALCULATIONS
REFERENCES

APPENDIX C

POLLUTANT CONCENTRATION TABLES
FOR USE IN SCHUELER'S SIMPLE METHOD

APPENDIX D

MECHANICAL REMOVAL UNITS
PRODUCT INFORMATION