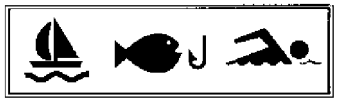
THE ROUGE RIVER PROJECT
A WORLD CLASS EFFORT



BRINGING OUR RIVER BACK TO LIFE

Rouge River National Wet Weather Demonstration Project

Wayne County, Michigan

TECHNICAL MEMORANDUM

Middle 1 Subwatershed Management Study

RPO-NPS-TM23.00

January 1998

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Rouge River National Wet Weather Demonstration Project

MISSION STATEMENT

The mission of the Rouge River National Wet Weather Demonstration Project is to demonstrate effective solutions to water quality problems facing an urban watershed highly impacted by wet weather and develop potential solutions and implement projects which will lead to the restoration of water quality in the Rouge River. The project will address both conventional and toxic pollutants to:

- provide a safe and healthy recreational river resource for present and future generations;
- re-establish a healthy and diverse ecosystem within the Rouge River Watershed;
- protect downstream water resources such as the Detroit River and Lake Erie; and
- help ensure compliance with federal, state and local environmental laws which protect human health and the environment.

This will be accomplished through the development, implementation and financial integration of technical, social and institutional frameworks leading to cost-efficient and innovative watershed-based solutions to wet weather problems. This watershed-based national demonstration project will provide other municipalities across the nation facing similar problems with guidance and potentially effective solutions.

PREFACE

The Rouge River and its watershed are a primary source of pollution to the Great Lakes. The Clean Water Act of 1972 intended to make waterways "fishable and swimmable" by 1972. Although that goal has not been reached, great progress has been made in improving water quality in most waterways. The Rouge River Remedial Action Plan (RAP) provided a basis for which The Rouge River National Wet Weather Demonstration Project (Rouge Project) efforts were created: it identified the major sources of pollution and measured the relative contributions of each. The RAP is the continuing foundation for the Rouge Project and presents a framework for addressing the problems within the Rouge River by looking beyond treatment and focusing instead on prevention methods.

The Rouge Project was established under the initial Rouge Grant 1 from the United States Environment Protection Agency, Region 5, and enabled Wayne County to initiate a comprehensive watershed-wide pollution-control approach that addresses combined sewer overflow (CSO), stormwater management, and other nonpoint source controls through the application of innovative technologies, progressive financial and institutional arrangements, and creative public involvement and education programs.

Rouge Grant 2 provides the framework for the progression and implementation of Project goals as Wayne County continues its mission to develop potential solutions and implement projects which will lead to the restoration of water quality in the Rouge River. The Project will address both conventional and toxic pollutants to:

- provide a safe and healthy recreational river resource for present and future generations;
- re-establish a healthy and diverse ecosystem within the Rouge River Watershed;
- protect downstream water resources such as the Detroit River and Lake Erie; and
- help ensure compliance with federal, state, and local environmental laws which protect human health and environment.

This will be accomplished through the development, implementation, and financial integration of technical, social, and institutional frameworks leading to cost-efficient and innovative watershed-based solutions to wet weather problems. This watershed-based national demonstration project will provide other municipalities across the nation facing similar problems with guidance and potentially effective solutions.

Under Rouge Grant 2, the Rouge Project will build on lessons learned from Grant 1 efforts and focus on further integration of the goals of the overall Mission. To this end, Rouge Grant 2 concentrates on the following key Project areas:

- •• **Watershed Management** will continue under Rouge Grant 2 with the development and evaluation of wet weather and stormwater alternatives, the planning of long-term monitoring

programs, and the ongoing efforts to enhance instream water quality, monitor rain and flow levels, interpret data analysis, and present recommendations.

- **Nonpoint Source Pollution Control** will provide for the stormwater management, permit applications, and development of financial and institutional alternatives for wet-weather watershed management in concert with enhanced efforts to establish institutional partnerships. Toward the goal of institutional partnering, several community projects will be undertaken with watershed communities. Additional efforts include the inventory of wetlands and measurement of pollutant loads from abandoned dumps and air deposition with possible remediation of some sites.

- **CSO Construction Coordination** will continue to monitor the construction of CSO demonstration projects established under Grant 1. Additional planning and assistance will allow project coordinators to make additional recommendations on the design criteria of future CSO abatement facilities.

- **Public Involvement and Information** will reach and interact with more stakeholders, institutions, and regulatory agencies, thus fostering a renewed understanding and continued commitment to reducing pollution, and continuing the transfer of watershed management approaches way beyond the project. It will be the central mechanism for transmittal of the Project's Decision Support System tools, processes, and information necessary for sustaining a watershed management support system directly to varied audiences both within and outside the Rouge watershed.

Additional information on the Rouge River Project is available from many sources, including the Wayne County Department of Environment (WCDOE) and the Rouge Program Office (RPO).

ABSTRACT

The Middle 1 Subwatershed Management Study, prepared by the Rouge Program Office (RPO) and funded by the Rouge River National Wet Weather Demonstration Project, describes and illustrates issues associated with the Subwatershed, including: 1) state of the Subwatershed; 2) vision and goals for the future; 3) current (1997) stormwater management activities within the Subwatershed; 4) alternative actions to preserve and protect the Subwatershed water quality and character; 5) anticipated benefits of the actions; 6) institutional and financing options; and 7) progress assessment and monitoring opportunities.

Communities located in the Subwatershed include Salem Township, Plymouth Township, City of Novi, Lyon Township, Walled Lake, Wixom, Northville Township and the City of Northville. The management study planning process brought together stakeholders from most of these communities, local and state resource agencies, and interest groups to help develop the study. The planning process involved as series of meetings held between January 1996 and November 1997.

TABLE OF CONTENTS

TABLE OF CONTENTS

Section Page

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This report was prepared for the communities in the Middle 1 Subwatershed by the Rouge Program Office (RPO) which was funded by the Rouge River National Wet Weather Demonstration Project. The communities located in the Subwatershed include Salem Township, Plymouth Township, City of Novi, Lyon Township, Walled Lake, Wixom, Northville Township and the City of Northville. In addition to participation by community representatives, there were invaluable contributions made by the South Lyon Community School District - Salem Elementary School, Natural Resources Conservation Service, Washtenaw and Oakland County Drain Commission, Wayne County Department of Health and Environment, Friends of the Rouge and the Michigan Department of Environmental Quality.

This subwatershed management study has been prepared to facilitate achievement of specific goals and objectives related to protecting and restoring the headwaters of the Middle Rouge River. The study has been prepared over a period of several months by community leaders and participants with technical assistance from the RPO. The final study represents a summary of existing conditions, projected conditions and management practices recommended to be implemented to protect water quality and habitat in the river.

Johnson Creek and the Middle Rouge River Subwatershed - Current Conditions

The Subwatershed encompasses the Cities of Northville, Wixom, Walled lake, and Novi and portions of Northville Township, Salem Township, Plymouth Township, and Lyon Township. The Subwatershed is 57 square miles and represents the headwaters of Johnson Creek and the Middle Rouge River.

The Middle 1 Subwatershed represents a developing area in the Rouge River Watershed with more than 50 percent of the total land area still open space and agricultural land. The eastern half of Subwatershed is developing with residential and commercial land uses.

The water quality of Johnson Creek and the Middle Rouge is among the highest in the Rouge River Watershed. Johnson Creek supports a diverse population of aquatic species, including a population of trout and one species of endangered fish. Unlike many segments of the Rouge River, dissolved oxygen concentrations in the streams are high enough to support sensitive aquatic species. Water quality impacts, however, have been recorded during precipitation events. When stormwater enters the river concentrations of nitrogen, phosphorus, total suspended solids, and fecal coliform bacteria are up to four times higher compared to concentrations in the river when it is not raining.

Problems and Concerns

During the preparation of the Subwatershed management study the work group identified the following water quality or water resource problems and concerns in the Subwatershed:

- streambank erosion/channelization
- high peak discharge rates, high runoff volumes and flooding
- failed septic systems and illicit connections
- failed detention basins
- loss of riparian vegetation
- rural road stormwater management
- projected increases in impervious surface
- loss of aquatic habitat
- poor agricultural practices impact on water quality
- illegal dumping in rural communities

The subwatershed study addresses these problems and provides a strategy for managing these concerns.

Goals

Ten goals were developed to guide future stormwater management actions, including potential preparation of a future Stormwater Management Plan. These goal include:

- Develop a stormwater management plan for compliance with the Clean Water Act.
- Develop a plan for preventing, minimizing and reducing pollutant loading and flow variability which produce adverse impacts.
- Maximize opportunities for recreational uses by inhabitants of the subwatershed.
- Enhance and preserve a healthy and diverse ecosystem compatible with land uses within the Middle-1 Subwatershed.
- Develop a plan to minimize the negative impacts of excessive flooding and erosion on adjacent property.
- Establish a water quality and runoff monitoring program to evaluate progress.
- Improve the public's understanding of the demonstration projects and stormwater pollution control in particular, and maximizing the opportunity for the public and private sectors to participate in pollution control planning and implementation.
- Protect downstream water resources.
- Maximize opportunity for agreement regarding what constitutes best management practices for the subwatershed by all stakeholders; improve the stakeholders understanding of what variables influence the optimum combination of water quality improvement and cost efficiency; and develop a new approach to planning that includes water quality management.
- Maximize cooperative arrangements between stakeholders to establish workable financial and institutional arrangements; and develop an enforceable stormwater management plan acceptable to regulatory agencies.

Proposed Management Actions

The proposed management actions are presented with an understanding that all of the Middle 1 communities are actively managing stormwater in one way or another. These practices include routine maintenance of existing storm sewers, source control from land uses, site plan and master plan review of stormwater management plans. The subwatershed management study was developed to provide uniformity among the communities in terms of stormwater management and to focus management practices on the goals identified in the previous section of the study.
The preferred actions include:

- Local master Plan Review
- Local Ordinance and Site Plan Approval Process
- Public Participation and Education Program
- Land Use management and Maintenance Practices:
  - pavement deicing program
  - catch basin cleaning
  - report all dumping programs
  - household hazardous waste management program
  - swale and grassed filter strips
  - channel restoration
  - soil erosion and sedimentation control enforcement
  - protection of riparian vegetation
  - soil testing for nutrients
  - Farm-A-Syst, Farmstead Assessment System
  - septic system maintenance program
- Stormwater management that consist of the following:
  - infiltration basins
  - wetland detention basins
  - extended dry detention basins
- Illicit Connection and On-site Wastewater Treatment Inspection and Maintenance

Institutional Arrangements

The working group determined that the most effective way to implement the actions in the subwatershed was within the existing framework of local government. By using a locally based institutional arrangement, local problems could be identified, appropriate solutions developed and local management used to solve local problems. Although this appears to be the most acceptable method for defining and implementing cost effective programs, a regional or watershed perspective is necessary to stop further degradation of the rouge water system. This entity would:

1. Insure that the component parts (actions of local governments) are working in a coordinated manner to effectuate a sound, consistent, cost effective watershed approach.
2. Supervise, assist and streamline monitoring.

3. Provide technical assistance in a cost effective manner, avoiding duplication.
4. Eliminate costly re-creation of various component parts and programs by every individual community.
5. Streamline and simplify the reporting efforts to the State.

1.0 INTRODUCTION.

The purpose for conducting a subwatershed management study is to provide specific information to community leaders which will enable them to better preserve and protect water resources from adverse impacts due to land development in the landscape. The adverse impact of land development and land use on water quality and water resources has been recognized for many years. This study is an attempt to integrate into land use planning and development decisions, management practices that mitigate the impact of certain land uses on water resources. Eventually, the subwatershed management study may be used by local municipalities to prepare a subwatershed management plan that can be used to apply for a general permit from the Michigan Department of Environmental Quality (MDEQ) for the discharge of stormwater.

1.1 PILOT SUBWATERSHED MANAGEMENT STUDIES.

As the first step toward developing the future watershed management plan process, the Rouge Project selected three subwatersheds within the Rouge River Watershed as pilot areas for development of subwatershed management studies. The Middle 1 Subwatershed is one of these pilot areas and represents a newly developing area (*Figure 1-1*). The other two subwatersheds, the Upper 2 and the Middle 3, represent subwatersheds with older and more densely developed areas.

Community representatives within the Middle 1 Subwatershed have been meeting regularly since winter of 1996 to gain a better understanding of the characteristics of the Middle 1 Subwatershed and to identify cost-effective stormwater management actions and programs. The work of the Middle 1 Subwatershed Advisory Group is summarized in this management study. Similar activities have been conducted by the Upper 2 and Middle 3 Subwatershed Advisory Groups and documented in their respective management studies.

In addition to the subwatershed management studies, numerous community stormwater pilot projects are being conducted with the Rouge River Watershed. *Figure 1-2* illustrates the locations and types of projects currently being considered for funding or which have been approved and are now underway.

1.2 OUTLINE OF MANAGEMENT STUDY.

The Middle 1 Subwatershed Management Study is divided into nine sections, beginning with this introduction. Section 2 provides a summary of the Subwatershed's condition, including existing stormwater related problem areas and potential future problems. Section 3 identifies goals developed by the Advisory Group. Section 4 summarizes current stormwater management activities being followed within the Middle 1 Subwatershed. Section 5 describes the minimum watershed wide actions required by the general permit. Section 6 suggests additional management actions tailored to the Middle 1 Subwatershed and Section 7 describes the anticipated benefits of these actions. Section 8 identifies alternative institutional and financing options to develop a management plan and implement recommendations, and Section 9 indicates a process for assessing future progress of implementing stormwater management actions and programs.

Figure 1-1
Drainage Subwatersheds and Main Branches

Figure 1-2
Community Stormwater Pilot Projects

2.0 STATE OF THE MIDDLE 1 SUBWATERSHED.

The total Rouge River drainage area is approximately 467 square miles. The Rouge River Watershed has been further divided into eleven subwatersheds. The Middle 1 Subwatershed is 56.6 square miles and is located in the northwest corner of the Watershed. Several tributaries drain the headwaters of the Subwatershed including Johnson Creek, the only cool water stream in the Rouge River system, and the Walled Lake Branch (*Figure 2-1*). The Middle 1 Subwatershed encompasses the City of Northville and Novi Township, and portions of the City of Novi, Northville Township, Salem Township, Plymouth Township, Walled Lake, Wixom, and Lyon Township.

The Middle 1 Subwatershed is unique within the Rouge River Watershed because it represents a developing area with more than fifty percent of the total land area still attributed to open space and agricultural land use *(Table 2.1)*. New residential and commercial development, however, is occurring at a fast pace, especially within the eastern half of the Subwatershed *(Figure 2-2*). Several recreational facilities are located within the Middle 1 Subwatershed including Maybury State Park, Wayne County's Middle Rouge Parkway, Northville Downs Race Track, five golf courses, and several parks within the Cities of Northville and Novi. Recreational activities offered by these facilities include fishing, picnicking, golfing, walking, biking and exploring. Activities such as boating, wading and swimming occur only in lakes and impoundments with sufficient depth and acceptable water quality. Most of the streams within the Middle 1 are too shallow and/or have *E. Coli* bacterial levels above guidelines established for body contact.

The quality of surface waters within the Middle 1 has been good compared to other downstream subwatersheds; although, increased sediment laden and nutrient rich runoff is becoming more of a problem as new development occurs. The RPO has prepared a *State of the Rouge River - Middle 1 Subwatershed* report (known as the Indicator Report) which illustrates in color the general conditions of the Middle 1 streams in regards to three use categories: 1) fishing; 2) wading and body contact; and 3) aesthetics. The report is useful as a quick reference and for comparison purposes with other subwatersheds. A more detailed description of existing and potential future conditions of the Middle 1 Subwatershed's water resources are described below.

2.1 WATER QUALITY / RESOURCES.

For the purposes of this study, water quality in the Middle 1 is described by water quality parameters, streamflow, fisheries and aquatic life. Information is also provided regarding soils and permeability characteristics because they indirectly influence water quality. Historical data, plus data collected during 1993-1995 by the Rouge Program Office (RPO), and reconnaissance surveys of Johnson Creek performed in August 1996 form the basis for this summary. Additional information is available for review in the Technical Memorandum entitled, *Existing Conditions of the Middle 1 Rouge River Subwatershed; RPO-NPS-TM13* and the *Johnson Creek Reconnaissance Survey; RPO-WMGT-TPM44.02*.

Figure 2-1
The Middle 1 Subwatershed

Table 2.1
Land Use Distributions for the Middle 1 Rouge River Subwatershed

	Percentage of Total Drainage Area					
Land Use Category	Middle 1 (56.6 sq. mi)	Upper Rouge (64 sq mi)	Middle Rouge (113 sq mi)	Lower Rouge (95 sq mi)	Main Rouge (194 sq mi)	Total (466 sq mi)
Forest/Rural Open	33	18.7	24.1	24.4	10.4	17.7
Urban Open	3.5	5.7	4.4	1.8	4.7	4.2
Agricultural	22.5	2.7	12.9	27.1	1.2	9.5
Low Densitry Residential	15	11	10	3.3	6.4	7.3
Medium Density Residential	4.9	39.9	23.3	26.4	49.7	37.2
High Density Residential	2.5	4.1	3.2	1.4	2.8	2.8
Commercial	4.6	10.7	7.9	5.3	12.5	9.6
Industrial	5.2	3.7	8.3	8.7	7.8	7.5
Highways	1.8	2.2	1.9	1.2	2.4	2
Water/Wetlands	7	1.4	3.9	0.5	2.1	2.1
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

NOTE: Existing land use was compiled from information provided by the RPO GIS as of June 1994. RPO GIS data are based on the MIRIS mapping system.

Figure 2-2
New Developments in the Middle 1 Subwatershed
New Development Information Collected Between
December 1996 - February 1997

Water Quality Parameters. Seven sampling stations in the subwatershed were monitored for water quality from 1993-1995. Dissolved oxygen, bacteria, nutrients and metals were some of the parameters measured because they are important indicators of water quality. Data collected within the Middle 1 portion of the Middle Rouge River during early stages of wet weather events indicate that ambient concentrations of nitrogen, phosphorus, total suspended solids and fecal coliform are substantially higher (one to four times higher) than during dry weather conditions. Limited data collected for E. Coli bacteria indicates a similar pattern for wet weather verses dry weather conditions.

Some water quality parameters were collected continuously in the Middle 1 Subwatershed. These included Dissolved Oxygen (DO), water temperature, pH and conductivity. Of the four continuous monitoring parameters, DO and pH are the most critical with respect to water quality. To protect aquatic life, the MDEQ has set a minimum DO standard of 5.0 mg/l and pH standard values within the range of 6.5 to 9.0 for all waters of the state. With few exceptions, the Middle 1 Rouge River generally supports DO above the MDEQ standard with only six percent of samples not meeting the 5.0 mg/l DO standard. A review of pH values recorded indicates that pH within the Middle 1 Rouge River falls within the acceptable range to support aquatic life.

Metals data show that nickel, lead and zinc were detected above the in-stream water quality standards at three of the sampling stations. In sediment lead, nickel, zinc, and organic hydrocarbons were measured in excess of Michigan State Guidelines for Aquatic Chronic Values (RPO, December 1996) at the Middle 1 Rouge River between Seven and Eight Mile Roads just upstream of the confluence with Johnson Creek in the City of Northville. A number of unclassified outfalls (i.e., not positively identified as either stormwater or CSO outfalls) are located near the Northville site, and a landfill is located downstream of the site.

Two reports (MDNR, 1975; MDNR, 1993) document sediment sampling data for five locations along Johnson Creek. These samples were analyzed for the presence of arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc, total solids, and volatile solids. Data for Johnson Creek were well below Michigan Department of Natural Resources (MDNR) In-Stream standards and not considered to be a major cause for concern from an environmental health standpoint (RPO, May 1996).

Streamflow. The average streamflows at the Johnson Creek and Middle Rouge main stem stations range from 0.46 to 0.67 cfs/sq mi. The highest flow in the Subwatershed was calculated in the Middle Rouge River at the Phoenix Lake Outlet.

Fisheries and Aquatic Life. The Fisheries Division of the MDNR have completed several surveys of fish populations and aquatic habitat within the Rouge River Watershed. The study completed in 1995 was funded in part by the Rouge River National Wet Weather Demonstration Project. The following summarizes the results of that and the other MDNR studies.

Fisheries. The fish community of the Middle 1 Rouge River was observed to be dominated by creek chubs, white suckers and pumpkinseed sunfish. Other common species included the central mudminnow, stoneroller, blacknose dace, fathead minnow, brown bullhead, black crappie, green sunfish, and bluegill. With the exception of blacknose dace and stoneroller minnows, species collected from the Middle -1 Rouge River are commonly associated with warmwater streams and impoundments. In general, qualitative sampling of fish populations revealed "Fair" populations of fishes within the Middle 1 Rouge River.

In contrast, samples from Johnson Creek supported greater numbers of species indicative of high water quality including blacknose dace, redside dace, mottled sculpin, and rainbow darters. These species prefer cool, clear, flowing streams. Overall, qualitative sampling of the Johnson Creek fish populations revealed "Good to Fair" populations of fishes. Currently, MDNR Fisheries Division conducts yearly planting of brown trout at five locations along the Johnson Creek, with the goal of providing a put-grow-and-take trout fishery. The Johnson Creek fishery is dependent on maintenance of cold water conditions and high water quality.

The redside dace is listed as a state-threatened fish species existing in the Middle 1 Subwatershed. Redside dace are highly sensitive to turbidity preferring clear, cool, flowing water with gravel or stoney bottom. Throughout its distribution it has become increasingly rare. The redside dace may soon be listed as a state-endangered species (Hay, 1996). The redside dace was collected at two locations within the Middle 1 Subwatershed: Johnson Creek in 1972 (MDNR, 1987) and in the Middle Rouge Walled Lake Branch in 1994 (MDNR, 1994).

Macroinvertebrates. Animals living in or on the bottom of streams, such as aquatic insects, clams, snails, worms, scuds, sow bugs, and crayfish, are excellent indicators of stream quality. Since macroinvertebrates are relatively immobile, the presence and absence of a family or genera of organisms can indicate long term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to different types of water quality impairment. Generally, a natural, unpolluted stream reach supports many different kinds of macroinvertebrates with relatively few individuals of any given species. In high quality streams insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream few of these microinvertebrate groups exist.

The macroinvertebrate communities within the upstream reaches of the Middle 1 Subwatershed appeared to show some variability. These communities were composed of leeches, snails, crayfish, damselfly naiads, true bugs, beetles, and midges. Communities of this type are indicative of warm fertile streams and are usually tolerant to moderate organic enrichment. An improvement in the quality of the macroinvertebrate community of the Middle 1 Rouge River coincides with the discharge of higher quality water from Johnson Creek. Greater numbers of caddisflies and mayflies inhabit the Middle 1 Rouge River downstream of its confluence with Johnson Creek.

In general, qualitative sampling of Johnson Creek macroinvertebrate populations revealed "Good to Fair" populations of macroinvertebrates. Mayflies and caddisflies inhabit sections of the Creek. The surveys indicate that alteration of physical habitat and fluctuating flow regimes is the factor having the greatest impact on the macroinvertebrate community.

Soils. The soils of the Middle 1 Subwatershed are unique for the Rouge River Watershed; they include sand, silt and clay loams characterized by differing permeability rates *(Figure 2-3)*. The area of Middle 1 within Wayne County is divided between a loam with a moderately low permeability and a loamy sand with a high permeability rate. The area of high permeability is also closely associated with Johnson Creek. The distribution of the highly permeable soils is critical to the characterization of Johnson Creek as a cold water stream. These highly permeable areas by and large surround Johnson Creek and intercept runoff from other less permeable upland areas. Runoff, once in these areas, infiltrates into the ground water, where it is cooled to the ambient ground water temperature before it enters the stream.

Permeability. The ability of runoff to infiltrate into the groundwater is a function of both soil characteristics and land use cover. Areas with highly permeable soils and vegetated cover types have the highest rates of ground water recharge. The soils around Johnson Creek have moderate to high permeability rates. There is also relatively modest urban development in this area and therefore few impervious surfaces. These factors contribute to the higher water quality of Johnson Creek compared to streams located in more developed areas of the watershed.

Areas with low soil permeability rates have lower ground water recharge rates. Areas with impervious surfaces (i.e., paved areas) have essentially eliminated ground water recharge. In the northern section of the Subwatershed, there are few areas which exhibit highly impermeable soils. This section is also more urbanized and comprised of more impervious surfaces. The combination of low soil permeability rates and more impervious surfaces helps to explain the lower water quality of the Walled Lake Branch of the Middle Rouge.

2.2 PROBLEMS OF THE MIDDLE 1 SUBWATERSHED.

Existing problems which affect water quality within the Middle 1 Subwatershed tend to occur at many locations and include streambank erosion, sedimentation, highly variable flow regime, channelization, reduction in riparian vegetation buffer zones, nonpoint source pollution, impoundments, and illicit connections. To a lesser degree, illicit connections within residential and commercial areas exist as sources of impairment. The following description of existing problems begins with a general description of each issue followed by an indication of relevance in the Middle 1.

Streambank Erosion. Streambank erosion is a process that occurs when the forces of flowing water exceed the ability of the soil and vegetation to hold the streambank in place. This process adds turbity to the water, covers the stream bottom habitat with sediment and changes the channel configuration of the stream (or river). Instead of a narrow, relatively deep stream, erosion causes the stream to become wide and shallow. This condition has a

Figure 2-3
Soils of the Middle 1 Subwatershed

detrimental effect on stream ecology by increasing water temperature, increasing the effect of the sediment oxygen demand, and altering both diversity and population dynamics of instream organisms. Natural rates of streambank erosion vary with stream size, amount and type of vegetative cover, and the type of soil on the streambank. The Middle 1 Subwatershed contains streams ranging in size from small intermittent tributaries to a medium sized river.

On small and medium sized streams, natural erosion is largely a function of size and frequency of storm flows. However, land practices or uses such as deforestation, agriculture, and urbanization increase the size of floods, the frequency of flooding, and contribute to streambank erosion. All stream systems within the Middle 1 have undergone some modification including channel modifications for flood control and drainage; increase of surrounding impervious surface area; increase in storm sewer discharge; removal of riparian vegetation; and reduction of wetlands. These changes increase the rate and intensity of instream storm flows resulting in widespread erosion problems, especially in areas where soils are easily erodible. In urbanized areas of the Middle 1 Subwatershed, various types of erosion occur including toe of bank erosion *(Figure 2-4)* and upper bank failure, overbank runoff, streambank, and streambed scour. When the channel begins to erode, structures, trees and property located near the channel may become unstable or undermined. In rural areas, drainage from tiled fields can cause sharp flow fluctuations within channelized streams, which lead to erosion of steep streambanks. Unrestricted access to streams by livestock reduces streambank vegetation and create ruts and gullies in streambanks causing erosion during wet weather events. All of the above sources of streambank erosion are creating problems to the Middle 1 water quality.

Sedimentation. Sedimentation is a process where soils from streambank, stream bottom, and over land flow are carried by water until the velocity of the water slows, at this point the stream loses energy needed to carry the soil, and the soil (sand and silt) is deposited on the stream bottom or floodplain. When a natural river floods, a large amount of sediment is deposited in the floodplain. Consequently, the floodplain ecosystem is recharged with fertile soil and existing instream habitat is protected from being buried under excess sediment.

Segments of streams within the Middle 1 Subwatershed contain excessive sedimentation on bottom substrates. Construction within the floodplains, construction along tributaries, streambank erosion, road runoff, and active agriculture are the primary sources of excessive sedimentation. Storm drains, tiles and non-vegetated ditches discharge silt and sediment laden water into waterways during wet weather events. Areas of sediment deposition within the Middle 1 Rouge River, in the form of shifting sand bars and silt deposits, can be observed downstream of active construction sites and severely eroded banks. Excessive sedimentation has decreased the amount and quality of gravel and cobble substrate within the Middle 1 Rouge River, which is preferred by mayflies, caddisflies, rainbow and greenside darters, blacknose dace, redside dace, sculpin and brown trout for foraging and reproduction.

Highly Variable Flow Regime. Increases in impervious surfaces, increased soil imperviousness due to compaction associated with urbanization, and a reduction of floodplain wetlands result in increased amount and rate of surface water entering streams during a wet

Figure 2-4
Photographs of Existing Problems within the Middle 1 Subwatershed

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Photographs of Existing Problems within the Middle 1 Subwatershed

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weather event. These conditions lead to highly variably flow regimes, marked by increased intensity and frequency of flood flows and lower base flows, stream widening and temperature variability. Response to rain events at selected flow guages in the Middle Rouge River clearly demonstrates the impact of urbanization. Less than one inch of rain caused a change in flow from 28 cubic feet per second (cfs) to 530 cfs in four hours (Beam Braunscheidel, 1996). These extreme flow variations are degrading to natural systems. They destabilize banks, create abnormally large moving sediment bedloads, disrupt habitat, strand organisms and interfere with recreational use of the River.

A highly variable flow regime reduces diversity of aquatic organisms. During an intense flood, aquatic organisms and their habitats can be displaced from sections of a stream, reducing diversity of aquatic fauna to a few hardy species.

Streams exhibiting highly variable flow regimes experience widely fluctuating temperature regimes, limiting fauna to those organisms capable of surviving events of rapid temperature elevation. Reduction of the amount of water being cooled by percolation through soils and increased surface water runoff over warm impervious surfaces cause increased stream temperature.

In the Middle 1, drain tiles in agricultural areas, storm drains and impervious surfaces in commercial and residential areas have increased the rate and amount of surface water entering tributaries and decreased the amount of groundwater input. Streamflow becomes more variable as the number of stormwater inputs discharging to the stream increases. Impoundments located at intervals along the Middle 1 Rouge River serve to attenuate flow variability by slowing movement of water through the River.

Channelization. Stream gradients in the Rouge River basin are relatively steep except in the lower reaches where they are low. The average slope for the Rouge River is 4.9 feet per mile. The average slope of the Middle Rouge River is 11.2 feet per mile (Beam, Braunscheidel, 1996). Channelization of streams with steep slopes impacts the natural characteristics of these streams from a regular riffle-pool sequence with excellent hydraulic diversity to a mostly run habitat with low hydraulic diversity. The artificial straightening and deepening of streams to enhance drainage and reduce flooding risks occurs in areas undergoing intense urbanization or agricultural development. Often, the process of channelization requires removal of aquatic habitat and streambank vegetation to provide a smooth hydraulic surface to facilitate drainage. Frequently, headwater streams are straightened, enclosed and converted into storm drains.

Channelization prevents a river from interacting with its floodplain. This interaction is essential for sustaining floodplain wetlands, reducing instream sedimentation and streambank erosion, recharging the stream with nutrients and supporting organisms that depend on floodplains during some phase of their life history.

In the Middle 1 Subwatershed, most of the tributaries located within agricultural areas have stream sections exhibiting varying degrees of channelization. In general, these sections exhibit lower diversity of aquatic organisms than unchannelized sections due to poor aquatic habitat. In tributaries within the Subwatershed, streambank vegetation, gravel, cobble and woody debris have been removed from channelized sections to increase channel efficiency which also increases the velocity of water moving through the channel during wet weather events. Consequently, lack of habitat diversity and extreme velocities result in low diversity and low abundance of aquatic organisms.

Some of the streams are beginning to naturally return to a more sinuous configuration; however, severe streambank erosion is associated with this process if the flow regime is highly variable.

Riparian Vegetation Buffer Zone. Riparian buffer zones are the vegetated areas bordering a stream course. Riparian buffer zones may consist of herbaceous or woody vegetation. Healthy riparian buffers reduce the amount of nutrients and sediment entering bodies of water. Removal of high concentrations of nutrients present in agricultural and urban runoff prevents eutrophication. Large riparian vegetation buffer zones greatly reduce the amount of sediment, nutrients, warm surface water, and trash entering a stream. This vegetation also helps to dissipate energy, thereby reducing erosive forces. In agricultural and urbanized areas within a watershed, riparian buffer zones are often nonexistent or reduced to an intermittent strip of trees and shrubs.

In the Middle 1 Subwatershed, removal of riparian vegetation is commonly practiced near commercial, residential, and agricultural land uses. Much of the impact to riparian vegetation buffer zones along the Middle 1 River Rouge is associated with the Chesapeake & Ohio Rail Road, which flanks the River for much of its length within the Subwatershed. The railroad fragments the riparian buffer zone and creates an artificial barrier between the River and its floodplain. In rural areas, damage to riparian buffer zones by vehicles and livestock is common. If left unrestricted, livestock will spend more time near riparian areas. Eventually, livestock can overgraze the understory flora and reduce soil permeability by soil compaction. Mechanical impacts to buffer zones by tractors and other heavy equipment can be observed on streams separating farm fields. Many tributaries are bordered by areas of low density, large lot residential development, which exhibit traditional lawn maintenance and landscaping practices. These practices involve removal of the riparian buffer zone for improved views of a creek or stream.

Removal of riparian vegetation buffer zones lead to reduced rates of surface water infiltration into groundwater, increased instream temperatures, increased turbidity, sedimentation and siltation of bottom substrate. Degradation of aquatic habitat and reductions in diversity of associated fauna and algal blooms can occur as a result of removal of riparian vegetation buffer zones. Riparian buffer zones also serve as areas of refuge, forage and travel corridors for many birds and mammals.

Nonpoint Source Pollution. Nonpoint source pollution is a diffuse source of contaminants or pollution with no specific outfall or origin. Sediment, oil, pesticides, herbicides, bacteria, nutrients and heavy metals are only a few forms of nonpoint source pollution. Several pathways exist for nonpoint source pollution inputs into streams and may include soil runoff from construction and agriculture, animal wastes, contaminants from vehicle emissions, herbicides and fertilizers from lawns, streambank erosion, and paint and dust from cleaning of building facades. Discharges from failing septic systems and illegally dumped trash along road sides are also examples of nonpoint source pollution. Since nonpoint source pollution is not confined to a specific outfall, it is extremely difficult to control once it becomes a component of surface water runoff. The best management practice is to control the pollutants at their source.

Within the Middle 1 Subwatershed, nonpoint source pollution is reflected in observations of contaminated sediment, sedimentation and siltation of aquatic habitat, algal blooms and high levels of bacteria during wet weather events.

Nonpoint source pollution can have a myriad of effects on aquatic communities resulting in reduced diversity and abundance of aquatic organisms. Nonpoint source pollution may reduce aesthetics and recreational quality of streams within the Subwatershed.

Impoundments. Impoundments are areas of ponded water within a river caused by an obstruction of flow (dam or weir) within a river channel. Historically, impoundments were created as a source of hydropower to generate electricity for commercial, industrial, and residential development. Presently, impoundments are used for recreation and stormwater retention.

Impoundments may have beneficial and/or negative effects on the aquatic resources within a riverine ecosystem. Benefits of impoundments include scenic views, moderation of storm flow velocity, collection of sediment, areas of deep water habitat for fish, and development of recreational fisheries. Negative impacts include accumulation of contaminants in sediments, increased water temperature, barrier to fish migration, reduction of quality spawning habitat for fish, and increased nutrient inputs associated with development of property fronting an impoundment and the feeding of waterfowl.

The Middle 1 Subwatershed contains several impoundments including Phoenix Lake, Meadow Brook Lake, Waterford Pond, Northville Mill Pond, and Ford Pond. These impoundments are warm and shallow. Excessive sedimentation and nuisance growth of aquatic plants are common. High bacterial counts preclude swimming. Insufficient depth limit recreational activities such as fishing and boating. Typically, aquatic communities immediately downstream of these impoundment are more representative of warmer water species than would otherwise be associated with this section of the river. However, the outlets of the impoundments are designed such that reaeration of the water occurs, which is a benefit to water quality.

Illicit connections. Illicit connections are any physical connection to the storm sewer system that convey flows other than stormwater. Illicit connections can occur in new as well as existing development. These improper physical connections can occur in a number of ways, such as overflow cross-connections from sanitary sewers or floor drains of auto shops and restaurants. Petroleum products, raw sewage, automobile fluids, and heavy metals are a few of the pollutants found in illicit discharges.

Illicit discharges may result in short term and long term impacts to aquatic communities. For example, an illicit connection discharging copious quantities of raw sewage during a period of low flow may cause deficits in dissolved oxygen in the receiving stream at the location of the storm sewer outfall. If organisms are mobile, and there are no barriers to prevent escape, they will vacate the area. Sessile organisms are less fortunate and will likely suffocate. Long term buildup of contaminants in sediments from a chronic, low level illicit discharge can drastically reduce the diversity and abundance of aquatic organisms within a stream section, as well as cause a human health threat.

Illicit connections and discharges are known to occur within the Middle 1 Subwatershed. Efforts are underway within Middle 1 communities to detect and address illicit connections. Such efforts include the construction of a new sanitary treatment facility and sanitary sewer system in a portion of Salem Township.

Site Specific Problems of the Middle 1 Subwatershed. The Middle 1 Subwatershed is experiencing water quality degradation typically associated with an urbanizing watershed. Site specific problems within the Subwatershed have been identified by the Middle 1 Stormwater Advisory Group during various stakeholder meetings. These specific problems are organized by an assigned number, identified on *Figure 2-5* and illustrated by the following photographs *(Figure 2-6)*.

2.3 PRIORITIZATION OF EXISTING PROBLEMS.

The Middle-1 Subwatershed Advisory Group meetings have included discussions regarding existing problems in the Subwatershed, as previously described. As defined in the *Watershed Approach Framework* (EPA, 1996), it is important for the Subwatershed stakeholders (i.e., members of the Advisory Group) to establish jointly a set of priorities of existing problems to assist in the decision-making process for evaluating resources, cost and benefits. The stakeholders have identified the following problems as priorities that need to be addressed:

- streambank erosion/channelization
- high peak discharge rates, high runoff volumes and flooding
- failing septic systems/illicit connections
- loss of riparian vegetation
- rural road stormwater control
- increased impervious surfaces
- loss of aquatic habitat

Figure 2-5
Location Map of Site Specific Problems Within the Middle 1 Subwatershed

Figure 2-6
Photographs of Site Specific Problems Within the Middle 1 Subwatershed

Figure 2-6
Photographs of Site Specific Problems Within the Middle 1 Subwatershed

Figure 2-6
Photographs of Site Specific Problems Within the Middle 1 Subwatershed

Figure 2-6
Photographs of Site Specific Problems Within the Middle 1 Subwatershed

Figure 2-6
Photographs of Site Specific Problems Within the Middle 1 Subwatershed

- poor agricultural practices
- illegal dumping in rural communities

2.4 FUTURE STATE OF THE WATERSHED AND POTENTIAL PROBLEMS. The Middle 1 Subwatershed is characterized by many headwater streams. Johnson Creek, for example, is the only cool water stream in the Rouge River system. This stream benefits from high soil permeability associated with open space, agricultural, forest and water/wetlands land uses, as shown in *Table 2.1*. New development, however, is increasing impermeable surfaces such as building roofs, parking lots, and roads, and reducing riparian vegetation buffer zones. *Figures 2-7* and *2-8* compare impervious cover for "existing conditions", based on 1994 land use data, with potential future impervious cover, based on projected land use for the year 2020. The projected land use map was developed by the RPO based on long-range community land use master plans. It is important to note that the accuracy of projected land use, based on community master plans, is limited to providing a sense of long-range trends. Population projections provide another means of predicting trends; however, such projections were not used in the development of the impervious cover map for "planned conditions". Potential problems associated with the increase in impervious cover and loss of riparian vegetation buffer zones are described below.

Impervious Cover. The ability for surface runoff to infiltrate into the ground water, as opposed to directly entering a stream, is critical to the water quality of the associated stream. Water quality of streams becomes significantly degraded when 10 to 15 percent of a watershed is covered with impervious surfaces (e.g., pavement, buildings, etc.) (Schueler, 1995). The diversity of aquatic insects and fish drops significantly at this level of development. Currently, 17 percent of the total surface of the Middle 1 Subwatershed is impervious. Impervious areas typically drain into storm sewers and then directly into the surface water system. A level of imperviousness of 10 percent is identified (Schueler, 1995) as the point at which detrimental changes in water quality occur. Based on future planned conditions, total impervious cover in the Middle 1 Subwatershed may increase to 36.2 percent.

Another factor that is likely to influence future water quality and aquatic resources is temperature. The water temperature of a stream is directly related to the percentage of impervious surfaces in the subwatershed. In subwatersheds with moderately to highly permeable soils and low percentages of impervious surfaces (less and 10 percent), rain water infiltrates into the ground water. Infiltrated water is cooled below ground before it enters a surface water system. Impervious surfaces can be 6 to 7 degrees Celsius (10 to 12 degrees Fahrenheit) warmer than the forest and meadow cover types they replace (Schueler, 1995). When rain water comes in contact with impervious surfaces it is warmed. Most urban stormwater management systems accumulate and discharge this warm water directly into the nearest stream or river raising the water temperature.

Table 2.2
Middle 1 Subwatershed Development Rates

Figure 2-7
Middle 1 Subwatershed, Percent Impervious by Subarea - Existing Conditions

Figure 2-8
Middle 1 Subwatershed, Percent Impervious by Subarea - Planned Conditions

Temperature is the most critical water quality variable in cool water aquatic ecosystems such as Johnson Creek (Barton, et al., 1985). Species typical of cool water streams die off and are replaced by species more tolerant of higher temperatures when average stream temperature rises to greater than 22 degrees Celsius (71 degrees Fahrenheit). When 10-15 percent of a watershed is converted to impervious surfaces, stream water quality becomes negatively impacted and shifts in species composition occur (Schueler, 1995).

Riparian Vegetation Buffer Zones. Riparian buffer zones are at risk by urban development. The riparian zones are the link between streams and their terrestrial catchment. These vegetation zones can modify, incorporate, dilute or concentrate substances carried in runoff and groundwater before they reach the surface water system. Riparian buffers are vital in controlling floods and groundwater levels, and they are important habitats for all forms of wildlife, aquatic and terrestrial. Riparian areas have been shown to be important travel routes for migratory species and plant dispersal. Wildlife species spend more time in riparian areas than all other habitats combined. Average bird densities are twice as high in riparian areas as opposed to adjacent uplands (Hawkins, 1994). Healthy riparian plant communities lower water velocity during high flows, reducing erosion and increasing sediment deposition. Riparian vegetation stabilizes stream banks and adds organic matter (leaf litter) which is the base food source for many stream ecosystems (Osborne and Kovacic, 1993; Schueler, 1995). Up to 98 percent of all instream organic matter is supplied by the surrounding riparian areas (Gregory, 1991).

Riparian vegetation improves aquatic habitat and water quality by shading streams, lowering water temperature, and by removing sediment and nutrients carried in runoff and groundwater. Introduction of woody plant debris provides a diversity of habitat for aquatic species and further helps dissipate water velocity, reducing erosion. Riparian buffer strips modify stream temperatures in two ways: 1) forested strips shade streams, directly reducing the amount of solar radiation (Barton et al., 1985); and, 2) both forested and grass buffer strips provide areas for surface runoff to infiltrate into, and be cooled by, the groundwater. Cold water stream species, such as trout, are dependent on groundwater discharge into their streams to maintain cool temperatures.

Healthy riparian buffers help reduce the amount of nutrients and sediments entering bodies of water. Removal of high concentrations of nutrients present in agricultural and urban runoff prevents eutrophication. Riparian buffers composed of native vegetation have repeatedly been shown to reduce the amount of nutrients moving through them (Barton, et al., 1985; Osborne and Wiley, 1988; Osborne and Kovacic, 1993; Gilliam, 1994; Schultz, et al., 1995). Forested riparian buffer strips can remove 68-100 percent of the nitrogen from groundwater and 78-98 percent of the nitrogen from surface runoff flowing through them. Likewise, grass buffer strips can remove 50-85 percent of the phosphorous from surface waters moving through them (Osborne and Kovacic, 1993).

3.0 VISION OF MIDDLE 1 SUBWATERSHED.

The vision for the Middle 1 Subwatershed protects and preserves existing natural features, including headwater streams and their associated aquatic life, riparian buffer zones, floodplains, wetlands, and other open spaces. The protection and preservation of these natural features will minimize impacts from increases in impervious cover.

The vision for the Middle 1 Subwatershed includes preservation of recreational enjoyment of many small streams with moderate base flow. These streams are capable of supporting between five and 17 fish species, and are used by anglers today. If water temperatures are kept cool, there is potential for long-term survival of stocked brown trout in Johnson Creek and continued fishing on this stream.

The vision for the Middle 1 also includes protection and enhancement of the scenic quality associated with local streams. Maintaining or enhancing the riparian buffer zones with native vegetation, protecting streambanks from erosion, and supporting other efforts to protect water quality are all important to high scenic quality.

Related to the vision of high scenic quality is the issue of improved recreational opportunities. Enjoyment of recreational activities such as bird watching, photography, nature walks, and fishing is influenced by scenic quality and water quality. The Middle 1 vision proposes enhanced opportunities for recreational activities associated with the local waterways.

To accomplish this vision, the communities within the Middle 1 Subwatershed will develop new methods to improve public understanding and appreciation of watercourses and open space within the Subwatershed. The communities will work towards protecting, and in some instances restoring, stream water quality and enhancing the aesthetic character and recreational opportunities associated with the surface waters within the Middle 1 Subwatershed.

The Middle 1 Subwatershed Advisory Group has begun the process of implementing the above vision by identifying and prioritizing goals for short term and long term management of the Middle 1 Subwatershed. These goals are described as follows.

3.1 BENEFICIAL USE, PROTECTION AND RESTORATION GOALS.

Community representatives within the Middle 1 Subwatershed have met regularly since the winter of 1996 to direct the development of this management study. Initial meetings focused on the identification of goals to improve opportunities for public enjoyment and understanding of water resources, and to protect and restore surface water quality within the Subwatershed. Ten goals were identified during these meetings; the first six of these goals were considered to be of highest priority and include:

- Develop a stormwater management plan for compliance with the Clean Water Act**.**

- Develop a plan for preventing, minimizing and reducing pollutant loading and flow variability which produce unacceptable impacts.
- Maximize opportunity for recreational uses by inhabitants of the Subwatershed.
- Enhance and preserve a healthy and diverse ecosystem compatible with land uses within the Middle 1 Subwatershed.
- Develop a plan to minimize the negative impacts of excessive flooding on adjacent property, including erosion.
- Establish water quality/quantity monitoring program to evaluate progress.
- Improve the public's understanding of the demonstration projects, and stormwater pollution control in particular, and maximize the opportunity for the public/private sectors to take an active role in pollution control planning and implementation.
- Protect downstream water resources.
- Maximize opportunity for agreement regarding what constitutes best management practices for the Subwatershed by all stakeholders; improve the stakeholders understanding of what variables influence the optimum combination of water quality improvement and cost efficiency; and develop a new approach to planning that includes water quality management and is accepted by all stakeholders.
- Maximize cooperative arrangements between stakeholders to establish workable financial and institutional arrangements; and develop an enforceable subwatershed management plan acceptable to regulatory agencies.

The ten above goals essentially include all of the objectives established by the Rouge Program for the entire Rouge River Watershed. They have been tailored, however, to specifically address issues associated with the Middle 1 Subwatershed.

4.0 CURRENT STORMWATER MANAGEMENT ACTIVITIES.

Communities within the Middle 1 Subwatershed are currently providing stormwater management activities through various departments *(Table 4.1*). The following section summarizes existing infrastructure items and management responsibilities, and existing source control measures, being conducted by the City of Novi, City of Northville, Northville Township, Salem Township, and Plymouth Township.

4.1 EXISTING INFRASTRUCTURE ITEMS AND MANAGEMENT RESPONSIBILITY.

City of Novi. The City of Novi Department of Public Works is responsible for the maintenance of all City roads, sewers, catch basins, cleaning of streets and soil erosion control. The Department uses a Geographic Information System (GIS) for detailing infrastructure such as roads, storm sewers and utilities. Defined policies regarding maintenance activities include:

- a four-year rotation for catch basin cleanout and maintenance;
- a four-year rotation program for CSO maintenance;
- street sweeping rotation is programed for four times per year; and
- snow and ice removal includes both salt and sand on a need basis.

City of Northville. The City of Northville Department of Public Works is responsible for the maintenance of all City roads, sewers, catch basins, and cleaning of streets. Oakland and Wayne counties share responsibility for soil srosion and sedimentation control programs. Defined policies regarding maintenance activities include:

- a rotation for catch basin clean out and maintenance;
- an annual hazardous waste collection program;
- street sweeping rotation is programed for 12 times per year;
- snow and ice removal includes both salt and sand on a need basis; and
- fall curbside leaf collection twice each year, also weekly collection with use of special bags.

Northville Township. Wayne County is responsible for the maintenance of all Township roads, storm sewers, and public areas. Wayne County is responsible for the maintenance of catch basins and CSO facilities, and soil erosion and sediment control within Northville Township. All developments are required to detain stormwater. Defined policies regarding maintenance activities include:

- a solid waste program in place to provide leaf collection and composting;
- annual hazardous waste collection program; and
- snow and ice removal includes both salt and sand on a need basis.

Table 4.1
Existing Stormwater Management Practices within the Middle 1 Subwatershed

Stormwater Management Practice		City of Novi	City of Northvillle	Northville Township	Plymouth Township	Salem Township
Maintenance for Roads & Public Areas	Roads	Yes	Yes	Wayne County	Wayne County	Washtenaw County
	Road Medians	Yes	Yes	Wayne County	Wayne County	Washtenaw County
	Parks	Yes	Yes	Wayne County	Yes	Washtenaw County
	Golf Courses	N/A	No	Wayne County	Yes	Washtenaw County
Snow and Ice Treatment	Salt	Yes	Yes	Yes	Yes Township grounds	Yes Township grounds
	Sand	Yes	Yes	Yes	Yes	Yes
Street Sweeping Frequency		Quarterly	Monthly	No	Quarterly	No
Leaf Collection/ Yard Waste		No	Yes Fall curbside & weekly w/ special bag	Yes Curbside collection composting prog.	Yes Curbside collection composting prog.	No
Hazardous Waste Collection		N/A	Yes Annual program	Annual program to begin in 1997	Yes (one-two years, stop at location)	N/A
Catch Basin and CSO Maintenance	Catch Basins	4-year rotation	Yes	Wayne County & Homeowners	Yes	Washtenaw County & Residential Assoc.
	CSO Maintenance	N\A	N\A	N\A	N\A	N\A
Erosion/Sediment Control Program		Yes	No	Wayne County	Wayne County	Washtenaw County
Stormwater or other detention requirements for new developments		Yes	Oakland County methods	All developments are required to detain stormwater	Community stormwater ordinance	Township ordinance Washtenaw County to review before site plan approval
Certification at time of sale that septic and sanitary systems are operating correctly		N/A	No	Yes Well and septic logs are required for new homes	No	N/A
Ability to verify RPO water quality data		JCK	No	Yes	No	Washtenaw County or Zoning Admin.

Salem Township. The Washtenaw County Department of Public Works is responsible for the maintenance of all Township roads. Washtenaw County Building Department administers the soil erosion and sedimentation control program. Washtenaw County Drain Commission is responsible for Township drainage, sewers, catch basins, and review of site plans before Township site plan approval. Currently there is no cleaning of streets or leaf pickup in the Township. Defined policies regarding maintenance activities include:

- salting and snow removal at Township buildings.

Plymouth Township. Wayne County is responsible for maintenance of all Township roads, sewers, and soil erosion and sediment control programs. Plymouth Township Department of Public Works is responsible for the maintenance of catch basins and cleaning of streets. Defined policies regarding maintenance activities include:

- street sweeping rotation is programed on a quarterly basis;
- snow and ice removal on township grounds, includes salt on a need basis; and
- household hazardous waste collection.

4.2 EXISTING SOURCE CONTROL.

City of Novi. The City of Novi has taken a very proactive approach to stormwater management through its Master Drainage Plan. The City of Novi provides water protection through the following ordinances:

- Chapter 12, Drainage and Flood Damage Prevention protects the public health, safety, and general welfare of the residents of the City from flooding and damage to property as a result of uncontrolled stormwater;
- Article III and Article IV, Stormwater Management Ordinance, improve water quality by reducing soil erosion and sedimentation and require stormwater detention fees to provide for the construction and maintenance of stormwater drainage facilities within the City;
- Article V, Wetlands and Watercourse Protection, establishes standards and procedures for the review of proposed activities in wetland and watercourses through permitting, to protect the water quality functions provided by these natural resources; and
- Code Sections 29-41, Division 2, requires an erosion control permit that disturbs one or more acres of land or is within five hundred feet of a lake or stream. There is also an ordinance for fertilizer/pesticide use in the City.

The City is providing regional stormwater control. One regional flood control basin has been designed and constructed near Eleven Mile Road and Taft, while a second is being designed to increase flood water storage capacity. The basin designs have incorporated features such as sediment forebays and wetland filters, to specifically improve water quality.

The City of Novi provides a Recycling Drop-Off Center behind the Novi Civic Center that accepts newspaper, plastics, glass, motor oil, steel/tin cans, aluminum, and large appliances.

In addition, the City provides fact sheets regarding the proper disposal of and periodic recycling/disposal of household hazardous waste.

City of Northville. The City of Northville provides protection of water resources through the following ordinances:

- Chapter 10, Title 6, Soil Erosion Ordinance to prevent soil erosion and the resulting sediment within the City by requiring proper provision for water disposal and the protection of spoil surfaces;
- Chapter 5, Title 7, Storm Water Ordinance prohibits surface or stormwater from any source to enter a sanitary sewer system; downspouts must be directed onto the ground; and
- Chapter 11, Title 4, Phosphate Compounds regulates the use of detergents containing more than 8.7 percent of phosphorus by weight.

Northville Township. Northville Township provides protection of water resources through the following ordinances:

- Chapter 80 of the Northville Township Code, Design and Construction Standards;
- Wayne County, Department of Health, Act 347, Public Acts of 1972, Soil Erosion and Sedimentation Control;
- Article XVIII, Section 18.31; Floodplain and Watercourse Control;
- Ordinance Number 94-05-92, Section 18.34 of Article XVIII; Tree and Woodlands Protection; and
- Chapter 61.754 of the Township Code Solid Waste provides for a Recycling Drop-Off Center that accepts newspaper, plastics, glass, motor oil, steel/tin cans, aluminum, and large appliances. In addition, the Township provides fact sheets regarding the proper disposal of and periodic recycling/disposal of household hazardous waste.

Salem Township. Salem Township has taken a proactive approach to the protection of water resources through assistance from the Washtenaw County Drain Commissioner and through the following planning tools and/or ordinances:

- Article XXII, Section 22.09, Greenbelt Buffer requires a 20-foot minimum natural vegetation buffer for commercial/industrial development adjacent to residential areas;
- Article XXII, Section 22.08, Preservation of Environmental Quality requires that construction/activity cannot obstruct or alter any water course, or alter banks/shore unless approved by site plan review process (Ordinance references Inland Lakes and Stream Act); and
- Land Filling and Alteration permit required to fill in excess of 300 cubic yards, land disturbance in excess of one acre, or less than 500-feet from lake or stream.

In addition to the above items, the *Rules of the Washtenaw County Drain Commissioner, Procedures and Design Criteria for Subdivision Drainage* (Bobrin, 1996) manage both

water quantity and quality. Salem Township has adopted these rules which require detention basins to be designed to capture and treat three different storm events:

1. 100- year storm event;
2. bankfull flood: the 1.5 year / 24 hour storm event; and
3. "first flush": the first 0.5 inch of runoff from the entire contributing watershed.

Plymouth Township. Plymouth Township provides protection of water resources through the following planning tools and/or ordinances:

- Community Storm Water Ordinance.

5.0 ADDITIONAL BEST MANAGEMENT PRACTICES.

There are a number of best management practices (BMPs) designed to improve water quality or are critical in maintaining the biological integrity of a subwatershed. When employed individually, these BMPs may not have a measurable impact on water quality; however, when combined, they can offer significant water quality protection value and are important tools in stormwater management. Many of the BMPs incorporate techniques that preserve, protect, or imitate natural systems. BMPs appropriate for implementation within the Middle 1 Subwatershed are described below.

5.1 LOCAL MASTER PLAN REVIEW.

Land use planning is considered to be a type of BMP. Many issues are incorporated into the development of community master land use plans. Among these issues, transportation, utilities, tax base, and existing land use generally provide a cultural framework within which natural features such as water bodies, floodplains, wetlands, and woodlands are accommodated. The intent of initiating a local master plan review is to evaluate the consistency of the proposed future land uses with maintaining the functions of land cover and features which contribute to the protection of water resources. Ideally, the master plan review should occur following the completion of studies which have identified land cover units and features which should be protected. One of the most significant considerations for each land use is the relative amount of impervious cover per acre. Some examples of land cover and features which are important to water quality include:

- subwatersheds with sensitive stream quality;
- areas of porous soils which contribute to ground water infiltration:
- floodplains and wetlands;
- wooded riparian habitats; and
- restorable, former wetland areas.

Additional considerations include opportunities to plan for the preservation of corridors linking natural features which will contribute to water quality, wildlife habitat and the aesthetic appeal of the community. Critical habitats remaining in the Middle 1 should be inventoried and their functions identified. Preserving and protecting these habitats will help maintain biodiversity and water quality.

5.2 LOCAL ORDINANCE AND SITE PLAN APPROVAL PROCESS REVIEW.

The implementation of development projects is influenced by local ordinances and site plan reviews which determine the amount and location of impervious surfaces (i.e., parking lots, driveways, buildings, etc.) to be constructed as well as other aspects of a site's layout and orientation. The site plan approval process provides opportunities for public input and refinement of a proposed project's design. A review of these articles and procedures would serve to determine if revisions are needed to contribute to the protection of water resources. Ordinance revisions which may be appropriate could include:

- providing incentives for the protection of selected natural features;

- increasing the ratio of site acreage to commercial, office or industrial building size;
- decreasing the ratio of required parking to building size;
- providing or requiring the opportunity to construct less parking than required if "banked" land is provided for future paved parking if determined to be necessary;
- providing for the use of non-traditional parking lot materials such as porous pavements;
- reducing road widths where feasible;
- encouraging site drainage through open ditches and swales rather than storm sewers; and
- developing new ordinances such as wetlands, woodlands, setbacks, etc.

The Site Plan approval process can be expanded to include the following measures:

- require applicants to inventory and document presence of natural features on their site;
- require pre-application meetings with community staff and existing planning/engineering consultants to evaluate compatibility of proposed site plan with local water quality objectives and identify negotiation opportunities for mutual benefit; and
- reference a single Integrated Resource Map for the subwatershed.

Ordinances and the Site Plan Review process should, to the extent possible, encourage and reward actions which help protect, preserve or enhance water quality. Similarly, planning commissions which implement ordinances and site plan reviews would benefit from training programs designed to educate commissioners on the benefits of various stormwater management actions which may be recommended to applicants.

5.3 PUBLIC PARTICIPATION / EDUCATION PROGRAMS. The Rouge Project has been involved with public education activities since the beginning of the project. Continued public involvement and information will reach and intereact with more stakeholders, institutions, and regulatory agencies, thus fostering a renewed understanding and continued commitment to reducing pollution, and continuing the transfer of watershed management approaches way beyond the project. Education programs are currently being developed for use by communities within the Rouge River Watershed. Communities are encouraged to work with the Rouge Project, Friends of the Rouge, and the Rouge River Remedial Action Council to develop programs which are tailored to their community's needs. The following paragraphs describe ongoing public education efforts in this and other subwatersheds.

Rouge Friendly Business Program. The Rouge Friendly Business Program uses outreach and incentives to small business owners in the watershed to encourage businesses to implement source controls. This program recognizes and promotes local businesses which demonstrate nonpoint source "Rouge Friendly", pollution prevention practices. The goal of the Rouge Friendly Business Program is to educate small businesses about preventing pollution and to decrease the amount and volume of pollutant in stormwater runoff. This can be accomplished by providing materials describing stormwater pollution and available source controls. Materials include brochures, posters, and videotapes, and are distributed directly to businesses. Recognition to those businesses that effectively practice source controls is given

by providing them with promotional materials to be used to attract customers. Incentives may include decals, bumper stickers, certificates, and awards.

Rouge Friendly Neighborhood Program. The Rouge Friendly Neighborhood Program is a pollution prevention initiative stressing environmental awareness to the general public within the Watershed. Under this program, an appropriate organization, such as a homeowner association, sponsors nonpoint pollution source controls within each neighborhood. The objectives of this program are to: 1) educate the general public regarding the Rouge River and how their daily activities affect the health of the River; 2) motivate them to change their behavior; and 3) involve local neighborhood groups, organizations and individuals in helping educate themselves and their neighbors regarding actions that they can take to help restore and protect the Rouge River. The following activities may be incorporated into the Friendly Neighborhood Program:

- workshops/community meetings;
- educational programs/curricula coordination with neighborhood schools;
- neighborhood "patrols" searching for evidence of pollution;
- neighborhood cleanup days;
- distribution of educational materials (directly or though articles in existing neighborhood newsletters);
- storm drain inlet stenciling programs;
- displays/presentations at neighborhood events; and
- participation in the Rouge River Watch and annual Rouge Rescue cleanup.

Rouge River Watch. The Rouge River Watch "Adopt-A-Stream" program allows individuals and community groups to take year-round responsibility for the health and appearance of a section of the Rouge River or one of its tributaries. Groups may include concerned neighbors, civic organizations, service clubs, conservation groups, sports and outdoor recreation clubs, garden clubs, school groups, Scout troops, and businesses. Through this program the group can conduct stream cleanup, monitor stream health, learn how to prevent water pollution, and develop stream protection or enhancement projects.

Rouge Education Project. The Rouge Education Project is a program used to integrate chemical testing, stream surveys, and calculation of pollution tolerance indices using benthic macroinvertebrates for all school grade levels according to their abilities. Data is shared between schools via a computer network and all schools are invited to the Rouge River Youth Congress each year to display the results of their efforts. In the Middle 1 Subwatershed three schools participated in this program during the 1996-97 school year *(Figure 5-1*).

Other Outreach Methods. A number of other outreach methods are available to reach the general public. Methods of outreach may include workshops, flyers, radio, newspaper, television and school programs. Some of these programs include:

- Healthy Garden Tours and friendly lawn care programs;

Figure 5-1
Rouge Education Project Schools

- a turf/golf course maintenance program;
- agricultural runoff abatement program to address farming practices and woodlot management;
- outdoor educational lab and interpretive trail system to teach best management practices;
- kiosk and computer model of the Rouge watershed for interactive display;
- advertisements shown in theaters;
- Rouge Fact Sheets, DemoBulletins, Rouge Activity Book and restaurant placemats;
- storm drain stenciling including door hangers;
- Rouge Project Home Page: http://www.great-lakes.net/partners/rouge/rpo.html; and
- Master Composters (healthy lawn and garden practices) training.

5.4 LAND USE MANAGEMENT AND MAINTENANCE PRACTICES. A variety of land use management and maintenance practices are known to be beneficial to stormwater management and water quality. Practices appropriate within the Middle 1 are summarized below. More detailed information regarding these practices may be found in the report titled, *Cost Estimating Guideline, Best Management Practices and Engineered Controls* (RPO, 1997).

- **Pavement Deicing Programs**. These programs limit the application of salt and deicing chemicals and abrasives to the minimum amount necessary for effective snow and ice control. The proper use and storage of deicing materials minimize the negative impacts on fresh-water ecosystems, surface water and groundwater. Training programs and clearly defined operation and maintenance programs in the proposed use of deicing materials to local authorities would reduce the impact of deicing chemicals on water quality.

- **Catch Basin Cleaning**. Cleaning catch basins on a regular basis removes pollutants, reduces high pollutant slugs during the first flush of storms, prevents clogging of downstream systems and restores basin sediment trapping capacity. Develop a regular maintenance program for catch basin cleaning prioritizing basins and inlets that discharge the highest pollutant loading. Recommended requirements include: annual inspections, clean sumps when 40 percent full, keep accurate operation logs to track the program, stenciling of catch basin inlets and train crews in spill tracking measures and illegal dump controls.

- **Report All Dumping Program**. This program would raise the public awareness of illegal dumping. Train municipal employees and the general public to recognize dumping violations and how to report an illegal dumping, particularly along rural roads. Establish a system for tracking incidents.

- **Household Hazardous Materials Management**. The purpose of this program is to raise public awareness of hazardous waste materials commonly found in the home.

Communities can promote participation in collection and recycling of household waste by providing a list of collection days and collection centers.

- **Swale and Filter Strip Use**. These stormwater management practices that utilize vegetation to slow and filter flows can significantly reduce pollutant loading to surface waters. Encourage swales along rural roads and in residential developments to remove suspended materials by up to 90 percent.

- **Channel Restoration**. Channel restoration along rural roads will stabilize erosion that contribute sedimentation to surface waters. Municipal employees should inventory and prioritize severe streambank and swale erosion. A professional engineer could design appropriate restoration designs based on discharge velocities, soil types, and outlet requirements. A annual budget allocated to channel and swale stabilization of the highest priority problems would help reduce sediments and pollutants to surface waters.

- **Erosion and Sedimentation Control Enforcement**. These control measures can substantially reduce sedimentation to surface water. Increase enforcement of local ordinances and state regulations can have a significant impact on reducing pollutant loading to drains, streams and rivers. Minimizing disturbed soils, immediate planting of vegetation on disturbed soils, use of mulch, preservation of vegetation and diversion of runoff away from exposed areas will reduce sedimentation to surface water.

- **Streambank Protection of Riparian Vegetation**. In agricultural areas, riparian vegetation zones help maintain aquatic ecosystems while reducing the levels of sediment, crop nutrients, pesticides, and other pollutants. In some agricultural areas of the Middle 1, cattle and horses have direct access to the streams and drains. Through public education and one to one contact with farmers, protection of riparian vegetation will protect the aquatic ecosystem and water quality. The Natural Resources Conservation Service (NRCS) has initiated a program in Washtenaw County to contact local farmers and provide guidance on conservation practices.

- **Soil Testing for Nutrients**. Soil testing could have a significant benefit on reducing the amount of fertilizer that is applied for residential, commercial and agricultural practices. Excess nutrients are the primary cause of "cultural eutrophication" or poor water quality of impoundments and lakes. A program to inform homeowners and farmers of the appropriate amount of fertilizer for their specific application could reduce the impact to surface waters.

- **Farm-A-Syst Program (Farm Assessment System).** Programs sponsored by the Michigan State University Extension (MSUE) assess the potential risks to groundwater associated with farming practices including methods of fuel storage, pesticide storage, handling and application. These methods, if employed, protect the area's ground and surface waters.

- **Tracking Development.** Communities in the Middle 1 Subwatershed keep track of where new developments (residential, commercial, industrial, etc.) are occuring within their municipal boundaries. This task could be expanded to not only track the location, type and size of each major development, but also the type(s) of stormwater management activities being implemented. Such a program would benefit long-term monitoring of different BMPs being used in a community and assist with identifying guidelines for future developments. *Table 5.1* provides an example of how this program could be documented.

5.5 ILLICIT DISCHARGE ELIMINATION PLAN. The draft General Permit for discharge of stormwater and non-stormwater from separate storm drainage systems requires an Illicit Discharge Elimination Plan (Part I, Section A. 2.b.). It states, "The applicant shall submit a plan for effective elimination of illicit discharges, including discharge of sanitary wastewater, to the applicant's separate stormwater drainage system. At a minimum, the illicit Discharge Elimination Plan shall include the following: 1) a description of a program to find, prioritize, and eliminate illicit discharges and illicit connections identified during dry weather screening activities and 2) a description of a program to minimize infiltration of seepage from sanitary sewers and septic systems into the applicant's separate stormwater drainage system."

Estimates of illicit connections and their impact on surface water in the subwatersheds have been made in the RPO memo dated February 26, 1997, "Estimated Total Pollution Delivered to Rouge River by Illicit Connections." It is estimated that about 50 million gallons of waste are discharged each year to the Rouge River by illicit connections.

Finding Illicit Connections. Phase I Stormwater Permitted Communities have used two basic methods to find illicit connections. They are the trace dye method and the color metric test method. Both methods require maps of the storm sewer system. These are described in numbers one and two below. Other methods that have been used are described in numbers three, four, and five.

1. The trace dye method relies on dye being placed in the plumbing fixtures of a building. If dye appears in the storm sewer, then there is an illicit connection.
2. The color metric test kit method uses field sampling and observations to identify potential illicit connections. Observations are made of color, odor, clarity, oil, scum and stains. Sampling in the field consists of pH, total chlorine, total copper, potassium, phenols, detergents (or surfactants). Sewage can be expected if there is ammonia, surfactants and potassium in the sample.
3. Public/government education to advocate reporting of suspicious material being discharged to surface water. Complaint and referrals can be used to find illicit connections.
4. Use of other indicators than those listed in number two above that have been tried. They are:

Table 5.1
Tracking Development, Example Data Form

Development Name	Use Category	Location	Stormwater Protection Proposed/Practice Used	Comments
Woods of Edenderry	Residential	Northville Township Six Mile east of Beck south of Edenderry	Wetland Preservation Roads: 27'B-B Sedimentation Ponds 100 Yr. Dry Detention Ponds Catch Basins	Total Lots 132 Permitted (April 97) 32 Remaining Lots 71
Hickory Creek	Residential	Northville Township Northwest corner of Six Mile and Beck	Wetland Preservation Sedimentation Ponds Wet Detention Ponds Catch Basins	188 Site Condominiums
Paramount Estates	Residential	Northville Township Six Mile west of Beck	100 Yr. Dry Detention Ponds Sedimentation Ponds	Total Lots 33 Permitted (April 97) 14 Remaining Lots 19
Cascades of Northville (Waterford Pond)	Residential	Northville Township Six Mile east of Northville Road	Restoration of Pond Wetland Preservation Partial Sedimentation Ponds Catch Basins	Total Lots 63 Permitted (April 97) 0 Remaining Lots 63
Crestwood Manor Subdivision	Residential	Northville Township Northeast Corner of Beck and Six Mile	Perforated Riser Pipe Outlet Extended Dry Detention Basin Catch Basins	Total Lots 174 Permitted (April 97) 147 Remaining Lots 71
Fox Hollow	Residential	Northville Township Beck Road south of Seven Mile	Wet Detention Basin Catch Basins	Total Lots 37 Permitted (April 97) 8 Remaining Lots 29
Oaks of Northville	Residential	Northville Township Seven Mile west of Edenderry	Wetland Preservation Multiple Sedimentation Ponds Wet Detention Ponds Catch Basins Prsservation of Native Veg	Total Lots 17 Permitted (April 97) 12 Remaining Lots 5
Ravines of Northville (Not Approved)	Residential	NorthvilleTownship east of Sheldon	Perforated Riser Pipe Outlet Extended Dry Detention Basin Catch Basins	Total Lots 111 Permitted (April 97) 0 Remaining Lots 111

- Testing outfalls for ammonia. A result of 1 ppm of ammonia or higher was found to relate to problem areas in studies done in Toronto, Ontario.
- Testing for stable isotopes of oxygen and hydrogen to determine the existence of illicit connections and to narrow the area that needs further investigation.
- Testing for whiteners that are in laundry detergents to identify possible sewage connections to storm sewers.
- Documentation of dry weather flow at outfalls to prioritize areas for further investigation.
- Infrared and/or thermal photography to identify locations for further investigation.
- Smoke tests.

The EPA has indicated that "estimates of outfall flow rates, and noting the presence of oil, sheens, floatables, coarse solids, color, odors, etc., will probably be the most useful indicators of outfall problems.

5. Televising of storm sewers can find illicit connections and can be useful for other maintenance concerns.

The Urban Source Control BMPs manual developed by the RPO includes a description of an Illicit Connection Control Program and costs from a few programs.

Illicit Connection Program. An illicit connection program relies on several important components:

- a method to find an illicit connection (screening methodology);
- authority to require an illicit connection program and correction of illicit connections;
- financial resources to pay for the correction; and
- a method to evaluate the effectiveness of a program.

Detection of an Illicit Connection. A practical way to find illicit connections is to require dye testing of the plumbing at the time of transfer of the property to a new owner. By keeping a permanent record of this inspection, a dye test would not need to be done when the premise is sold again unless there are changes to the building. Dye testing can be made a requirement when a building addition is made to a structure that has not had a dye test.

Washtenaw County property transfers approximately five percent of the total parcels in the county each year. Theoretically, it would take 20 years for all parcels to transfer and be evaluated for illicit connections. A similar estimate would be helpful for communities considering this approach. Since there are some parcels that are not likely to transfer for a long period of time, it is necessary to have another approach to evaluate premises that may not transfer for a long period of time. Such buildings as schools, industrial plants and government facilities should have a program to evaluate or certify their property for illicit connections. Certifications as part of an environmental audit could be provided by commercial/industrial properties. Evaluation by a private or government inspection program,

such as the Wayne County Department of Environment program, could be used for private residences, government, commercial, industrial and institutional facilities.

Monitoring the river and outfalls can be helpful in identifying problem areas for prioritizing where to investigate further for illicit connections.

Another effective method of finding illicit connections is the encouragement of reporting of suspicious discharges by the public and field workers. The state has had in effect for may years a telephone reporting system called Pollution Emergency Reporting System (PEAS). A local number for reporting could be effective in allowing a quick response to pollution problems. Contractors, road crews, drain inspectors and others that are involved in construction can provide important information on illicit discharges.

Authority. The authority to require investigation of illicit connections and their correction, if necessary, is important to an effective program. Ordinances and regulations that have been used in other areas are available from the Rouge Program Office. A county regulation is under development in Washtenaw County to require inspection of properties at the time of sale for illicit connections. When this is completed, it will be made available.

Financial Resources. At the time of sale of a property or transfer of title, the correction of an illicit connection can be made part of the financing of the property or adjusted in the sale price. This could provide the resources to correct the problem. The Benzie County Environmental Health Regulations require that the correction be completed at the time of sale or that there is a written contract, surety or performance bond and a covenant to complete the correction within 150 days of the sale of the property.

Other financial arrangements to correct illicit connections include private loans, federal assistance through programs like Farmers Home Administration or Federal Housing Administration, or special assessment districts where a problem is more widespread.

Evaluation. Evaluation of the impact of an illicit connection should include the number of illicit connections, the number corrected and the results of monitoring of outfalls and/or the river, for evidence of problems or improvements that have been made. Monitoring can include E. Coli testing and visual observations of oil sheens and debris. Monitoring should be done at the start of the program and every two to three years.

On-site Sewage Systems. On-site sewage systems (OSS) become illicit connections when they fail and the waste reaches surface water or when they are purposely connected to a drain or ditch to relieve a backup of sewage. Oakland, Washtenaw and Wayne Counties have had in place a program to inspect OSS at the time of transfer of a property. Oakland County found failure rates of 39-52 percent in a special study of septic systems in 1994-95. Washtenaw County found 24-30 percent of the properties were in an imminent state of failure or failing during inspections done in 1994. Wayne County found 11 percent malfunction in their evaluation program.

Regular inspection and maintenance of OSS has prevented their failure and allowed for detection and connection of problems before they become illicit discharges. Regular inspection programs are in place in Thurston County, Washington; Benzie County, Michigan; Cuyahoga County, Ohio; and the State of Massachusetts. These programs include review of OSS at the time of transfer of a parcel, operating permits, certification of OSS every five years and notifications on deeds.

Much of the Rouge River Watershed is urbanized, having municipal water and sewers available. Where sanitary or combined sewers exist, OSS should be eliminated and connection made to these sewers. An illicit connection program at the time of sale of a property that evaluates OSS, would identify those premises that have sewers available. Connections could be made in the same manner as described in eliminating an illicit connection.

Where sewers do not exist, but could be extended, the use of State Revolving Funds or a special assessment district could help in extending sewers to areas that have problem septic systems. When OSS are to be kept in use for more than five years, there should be in place a program for the regular inspection and maintenance of OSS. A program could include operating permits, certification of OSS every five years and documentation of maintenance of the system.

5.6 RIPARIAN ZONE LANDSCAPE DESIGN ALTERNATIVES. Protection of riparian zone vegetation is an important issue within the developing Middle 1 Subwatershed and is a key component of several goals identified in Section 3.1. Programs designed to protect and restore streambank vegetation in agricultural areas are discussed above in Section 5.4. Other programs are needed, however, to address landscape design and maintenance of riparian lands in residential areas, especially in areas were new residential development is occurring. Such programs need to reach out to planners, landscape architects, urban foresters, engineers, builders, and homeowners to explain how typical landscape practices create problems to water quality, and they need to offer alternative landscape solutions for riparian areas. The following text summarizes this new approach to riparian landscape design.

Design Problem. Riparian residents, those who live next to a stream or lake, typically remove most of the existing native vegetation between their house and the water's edge. Lawn grasses and a few, scattered ornamental trees are planted as a replacement to the native shrubs and ground cover. The problem with this practice is that lawn grasses typically have shallow root systems which are ineffective in preventing streambank erosion. The root structures of plants native to riparian zones are typically very fibrous and deeply rooted; thereby, creating an effective erosion barrier. Designers, builders and homeowners often resort to placing riprap along streambanks in an effort to stop erosion, which in many cases, could be prevented by retaining the existing native vegetation.

Homeowners also spend a great deal of time and money trying to attract wildlife to their backyards, especially songbirds. Native trees, shrubs and ground covers are beneficial to

desired songbirds for nesting and perching. By keeping the native vegetation in place, homeowners receive the benefits of increased wildlife activity, decreased erosion and higher water quality, and lower lawn maintenance costs. By removing the native plants, wildlife habitat is diminished and wildlife diversity is reduced.

Alternative Landscape Designs. New and existing lawns can be redesigned to mitigate or minimize the water quality and wildlife impacts of residential development. New landscape design ideas are being promoted by landscape design professionals, environmental organizations, and conservation-minded agencies to create outdoor spaces which benefit both the homeowner and the environment. Three alternative landscape design practices are recommended for further consideration: 1) riparian buffer zones; 2) wetland gardens; and 3) use of a cistern irrigation system for flower and vegetable gardens. These three design ideas are combined within a single residential property (*Figure 5-2*) as an example of how they may be implemented. They should also, however, be considered as individual elements which may be incorporated into a particular landscape either singularly or in combination, as appropriate.

Riparian Buffer Zones. Vegetated buffer zones near streams can be designed to create useable outdoor areas which do not require routine mowing, fertilizing or watering. These zones may be planted primarily with native trees and ground covers to create an open character and maintain views of the stream, or planted with shrubs to create additional wildlife value, especially for songbirds.

The buffer zones help trap sediments and nutrients in stormwater runoff, preventing the pollutants from entering streams and lowering water quality. The vegetation also reduces the rate of runoff flow, thereby helping to address the problem of highly variable flow regime as discussed in Section 2.2. Shade provided by overhanging trees helps to maintain cool water temperatures in summer. Trees also provide leaf litter in the fall which is an important food source for many stream insects which are then eaten by fish and birds.

Wetland Gardens. Wetland gardens are shallow excavated areas which have been planted with species tolerant of saturated soil conditions. The depressions are used to temporarily hold surface runoff, allowing sediments and nutrients to settle out before they have a chance to enter a stream. Many of the plant species adapted to these conditions have showy flowers and are of benefit to wildlife.

Cistern Irrigation System. The gutter system around the house shown in *Figure 5-2* collects rain water and holds it in an above-ground cistern, instead of letting it run directly onto the lawn and ultimately into the stream. The captured rain water slowly drains out of the cistern through a drip irrigation system into the vegetable and flower gardens shown near the house. The water quality benefits of this system are two fold: 1) the quantity of runoff released into the stream is decreased by the volume of the cistern; and 2) the homeowner is not using water from the city drinking water supply to water the garden. A spigot can be connected to the cistern to control the timing of irrigation.

Figure 5-2
Riparian Zone Landscape Design Alternative

6.0 MIDDLE 1 SUBWATERSHED ACTIONS.

In addition to the BMPs described in Section 5 above that will protect and preserve the water resources of the Middle Rouge River and its tributaries, especially Johnson Creek, there are a series of specific actions that can be undertaken to mitigate the impact of certain land use practices. The distinction between these actions and the other BMPs described above is that the effect of certain combinations of management practices on water quality and the flow regime of rivers and streams in the watershed can be predicted by use of a computer model. This model is a useful tool to compare the effectiveness of various combinations of management practices and to envision the cumulative impact of a series of small decisions made over a long period of time. In preparing the subwatershed study for the Middle 1 Subwatershed, three action programs were developed and the results of each action on water quality in Johnson Creek and the Middle Rouge River were modeled.

In preparing the action programs it was assumed that the BMPs described in Section 5 would be implemented. Many of these management practices contribute to protecting water quality and provide for a healthy aquatic ecosystem, but the impact on water quality is not amenable to modeling and was not included in the model results.

6.1 FUTURE PLANNED LAND USE WITH STANDARD ENGINEERING PRACTICES.

To establish a basis for comparison, a scenario was developed that assumes that future planned land use will occur and that as the land is developed, standard engineering practices will be implemented to manage stormwater runoff. This scenario assumes that stormwater management will be accomplished using 100-year stormwater detention basins. This scenario assumes that the detention basins remove pollutants to levels reported for these types of stormwater management facilities. It also assumes that the Walled Lake Wastewater Treatment Plant (WWTP) discharge would increase from 2 mgd to 3.5 mgd, and that the Salem Township WWTP will be operational and discharge 0.05 mgd to Johnson Creek.

The results of implementing the planned land use on the flow characteristics of Johnson Creek and the Middle Rouge River is significant *(Figure 6-1)*. The results show substantial increases in flow volume, peak discharge rate, and average velocity.

The impact of the future planned land use on pollutant loads is shown in *Figure 6-2* and *Table 6.1*. The increase in pollutant load is substantial and will degrade the aquatic resources of the Middle Rouge River and Johnson Creek, as well as the impoundments on the Middle Rouge River such as Northville Mill Pond, Waterford Pond, Newburgh Lake, and Nankin Mill Pond. The change in water quality and stream flow characteristics is sufficient to eliminate desirable species such as trout and redside dace in the streams, and game fish in the impoundments.

6.2 FUTURE PLANNED LAND USE WITH ACTION 'A'.

To mitigate the adverse impact of future land development on the pollutant load to the watercourses and lakes of the

Figure 6-1
Impact of Planned Land Use on Flow Characteristics

Figure 6-2
Impact of Planned Land Use and Alternative Actions on Pollutant Loading

Figure 6-2
Impact of Planned Land Use and Alternative Actions on Pollutant Loading

Table 6.1
Comparison of Pollutant Loads for the Middle 1 Subwatershed

Subwatershed, an action program was developed that is intended to control the pollutant load. Action 'A' has the following features:

- All future development is controlled with extended dry detention basins that provide improved pollutant removal compared to 100-year detention basins.

- Illicit connections and failing septic systems are repaired or replaced so that 75 percent of the pollutants due to these sources are corrected.

The result of implementing this nonpoint pollution control program is shown in *Table 6.1*. The impact of Action 'A' on total suspended solids, fecal coliform and lead pollutant load is significant with reductions predicted to result in less pollutant load than occurs under baseline conditions. Some of the other pollutants, such as total and dissolved phosphorus are not reduced by this program and remain significantly above the baseline condition.

6.3 FUTURE PLANNED LAND USE WITH ACTION 'B'. In Action 'B' the management measures include the following features:

- All future development is controlled with wetland detention basins instead of the extended dry detention or 100-year stormwater detention basins.

- There is an assumption that 60 percent of the agricultural land in the Subwatershed will to use conservation tillage, thus maintaining a reduction in the pollutant load (total suspended solids, total Kjeldahl nitrogen, nitrite+nitrate nitrogen, total dissolved phosphorus, and total phosphorus) from agricultural land by 60 percent.

- There is an assumption that 50 percent of new low density residential development uses a cluster style of development compared to traditional residential site plans. This type of development would reduce the impervious area by approximately 30 percent and result in a 30 percent reduction in total suspended solids, total phosphorus, and total dissolved phosphorus compared to traditional residential site plans.

- There is an assumption that illicit connections and failed septic systems are repaired so that 100 percent of the pollutant load attributable to this source is eliminated.

The impact of Action 'B' on pollutant loading to the lakes and streams of the Subwatershed is greater than Action 'A'. Fecal coliform, total phosphorus, dissolved phosphorus, lead, and cadmium loading decrease under Action 'B', but the increase in pollutant loading compared to baseline conditions, especially phosphorus, remains at a level that will degrade the aquatic resources of the Subwatershed.

6.4 FUTURE PLANNED LAND USE WITH ACTION 'C'. In Action 'C', the management measures include the following features:

- All future development will control stormwater runoff by using wetland detention basins, except for two areas in Salem Township where infiltration is suitable. In those areas, it is assumed that infiltration basins will be implemented to abate the pollutant load due to development.

- Illicit connection and septic system repair is effective at removing 75 percent of the pollutant load due to these sources.

The impact of Action 'C' on pollutant loading is shown in *Table 6.1*. Of the action programs prepared in this analysis, Action 'C' is the most effective at reducing the increase in pollutant load caused by future land use. Pollutant loads for total suspended solids and fecal coliform will decrease to below baseline conditions in both the Johnson Creek and the Middle Rouge River, while nitrite+nitrate load will decrease to below baseline conditions only in the Johnson Creek area. In the Middle Rouge River, lead and cadmium loading will decrease to below baseline condition. The phosphorus loading under Action 'C' will decrease significantly and approach the pollutant loading under the baseline conditions.

6.5 PREFERRED MIDDLE 1 SUBWATERSHED ACTIONS. A variety of features were selected from the above alternative actions to create a preferred subwatershed management action program for the Middle 1. The preferred actions are consistent with the goals of the Middle 1 Stormwater Management Study as stated in Section 3.0 - Vision of the Middle 1 Subwatershed. The preferred actions are effective at reducing the pollutant load to the Subwatershed by a minimum of 50 percent, although it is recognized that further reductions than this minimal amount are feasible. The preferred actions address new development and do not include retrofitting existing water resource management facilities to improve nonpoint source pollution abatement.

The preferred actions are as follows:

- Local Master Plan Review.

- Local Ordinance and Site Plan Approval Process Review.

- Public Participation / Education Programs.

- Land Use Management and Maintenance Practices:
  - pavement deicing program;
  - catch basin cleaning;
  - report all dumping program;
  - household hazardous materials management;
  - swale and filter strip use;
  - channel restoration;
  - erosion and sedimentation control enforcement;

- streambank protection of riparian vegetation;
- soil testing for nutrients;
- Farm-A-Syst, Farmstead Assessment System; and
- septic system maintenance program.

- Riparian Zone Landscape Design Alternatives.

- Land development projects will use either extended dry detention basins, wetland detention basins, or infiltration basins when site conditions are appropriate. The order of preference for these techniques is infiltration basins, wetland detention basins, and extended dry detention basins. Another option to consider is the development of regional detention basins.

- Cluster site plans should be used to the greatest extent practical, especially when a site plan involves an area of riparian vegetation along a stream or river.

- Illicit connections and septic systems are inspected and corrected with a goal of 75 percent reduction in this source of pollutant loading.

- Conservation tillage should be used as long as agricultural land use remains.

7.0 ANTICIPATED BENEFITS OF THE STORMWATER MANAGEMENT ACTIONS.

The results of the modeling effort described in Section 6.0 of this study clearly demonstrate that the water quality and aquatic ecosystem of the Middle 1 portion of the Rouge River will continue to degrade as the Middle 1 Subwatershed develops. The vision and goals established by the Middle 1 Subwatershed Advisory Group demonstrate that it is important to strive to preserve and protect this valuable resource. To advance these goals, the study presents a watershed approach as the primary mechanism to achieve anticipated water quality protection. The approach pulls together communities with a common vision to prioritize and implement a "best management practices" strategy.

The benefits of the watershed approach can be realized for financial, environmental and community-wide reasons. In 1992, the EPA estimated that the cost to meet the federal requirements for stormwater, water reclamation and reuse has doubled since 1986 to exceed $145 billion dollars nationally (*Watershed Management:Clean Water's Next Act, September 9, 1996)*. Just ten years ago, 70 percent of wastewater capital costs were being met by federal and state grants. Today, most of the cost of complying with federally mandated clean water standards is being left to local communities. This means that costs to local taxpayers are increasing dramatically, causing local political concerns. A watershed-wide compliance program represents the best opportunity to meet the future federal stormwater requirements in a cost-effective manner. The program will allow communities to reduce the time and cost of monitoring compliance, reduce reporting requirements, and simplify permitting requirements. By prioritizing problems on a watershed-wide basis, resources can be targeted to the most critical problems. Water quality issues can be addressed on a regional basis.

The watershed-wide approach can allow water resource decisions to be made on sound scientific data utilizing ecological principles that preserve and protect water quality and biological integrity. Environmental science provides the rationale for establishing priorities, determining the maximum environmental benefit, and optimizing the use of financial resources. Traditionally, complex impacts to streams and water quality issues have been addressed by communities adopting a series of regulations and criteria that regulate a single impact issue. The watershed-wide approach takes a comprehensive protection strategy that identifies significant natural features then master plans and zones appropriate uses within a water quality protection context. Coordinating efforts across various programs (pollution control, fish and wildlife habitat protection, water supply, and drinking water protection) allows for a comprehensive evaluation of all the environmental issues related to water quality protection. By identifying and protecting sensitive areas from development, establishing techniques to reduce peak flows and pollutant loadings, and maintaining the integrity of stream habitat, the goals for preserving the ecological integrity can be met.

Encouraging community participation, public education, and public involvement gives residents a meaningful role in undertsanding and managing their water resources. Use of a watershed-wide program identifies the role of individuals in managing water resources and empowers the public to participate in the decision-making process.

8.0 INSTITUTIONAL ARRANGEMENTS AND FINANCIAL OPTIONS.

Traditionally, water pollution control programs at the national and state level have focused on command and control regulations, and permits for point source discharges. A new watershed-based approach to the regulation of stormwater, however, has been proposed within Michigan. The proposed National Pollutant Discharge Elimination System (NPDES) general permit is for discharges of stormwater from separate stormwater drainage systems owned or controlled by governmental entities. The permit focuses on control of stormwater discharges based on a long-term management plan similar to this Middle 1 Subwatershed Management Study. Documentation of the financial resources necessary to implement the illicit connection detection plan, public participation/education program, and other coordinated management activities is also likely to be required.

This section of the Middle 1 study summarizes options for institutional arrangements available to communities and other public agencies to work together to accomplish the proposed actions presented above in Section 6.5. Potential funding sources available to ensure the long-term implementation of a future subwatershed management plan are also summarized.

8.1 ALTERNATIVES FOR INSTITUTIONAL ARRANGEMENTS. The Middle 1 Study proposes that various local community leaders, schools, civic organizations, environmental groups, and citizens organize efforts to protect and restore the headwaters of the Middle Rouge River. The institutional arrangement for organizing these groups and citizens can be achieved by several strategies. The options discussed by the Middle 1 Subwatershed Advisory Group included loosely organized cooperative groups to more formal organizations. The following approaches were discussed:

- Non-profit organization or non-governmental group in an advisory role.
- Council of governments organization with representatives from each government within the Subwatershed, functioning in an advisory role.
- Council of governments, functioning as a commission or authority. A civil contract, interagency agreement or other legally binding contract between jurisdictions would be needed.
- Inter-County Drainage Board.
- Rouge River Watershed Authority.

In general, the Middle 1 Subwatershed stakeholders recommended an institutional arrangement for the Middle 1 which involves cooperation among existing local units of government to develop local solutions for protecting the headwaters of the Middle Rouge River. This locally (or community) based approach is considered advantageous because past experience indicates that the most effective programs are those developed by local governments with local control, local accountability, and local solutions. There may be certain types of water resource problems that are more efficiently solved through regional or watershed-wide approaches, but the regional approach should be used only after local solutions have been exhausted. Although the institutional arrangement should be locally

based, there is a need for some form of organization that monitors the condition of the Rouge River, reports on activities in other parts of the Watershed and provides technical expertise to assist local programs to protect the Middle Rouge River.

Several reasons were offered for an institutional arrangement that is based on local cooperation. First, the study of water quality in the Middle Rouge River indicates that the greatest risk to the River is future land development. Implementing controls on land development and management measures for water quality protection occurs at the local level through the planning and zoning process. In order to coordinate land planning and water resource protection activities, the decision-making process should remain at the local level. Second, improving public understanding of water resource protection efforts can be accomplished by using local resources and programs that reflect the nature of the communities in a subwatershed. In the Middle 1 Subwatershed, there are some communities where agriculture is an important land use, and public education programs need to reflect that fact. Those same programs, however, may not be appropriate in communities without agricultural land use. Third, support for protecting the Middle Rouge River may be more widespread if the program is developed at a local level compared to the state or federal level.

Formation of a commission or authority for local communities and other local groups to jointly undertake watershed management activities is an option for institutional arrangements possible under several Michigan laws and statutes such as the Michigan Drain Code of 1956 (MCL 280.1 et seq), the Urban Cooperation Act (MCL 124.501 et. seq.), and the Municipal Sewage Disposal Act (MCL 124.281 et. seq). Some of these options, such as formation of an inter-county drainage board under the Michigan Drain Code, also provide a mechanism for financing activities within a subwatershed. Similarly, a watershed authority can be incorporated to administer stormwater management activities and any authority can fund public improvements such as maintenance and control of stormwater systems by issuing serial bonds or term bonds under the Revenue Bond Act (MCL 141.101 et. seq.).

8.2 ALTERNATIVE FINANCIAL OPTIONS. There are several approaches to financing the management activities recommended to achieve the long-term goals for the Middle 1 Subwatershed as outlined in this study. How the money will be spent may limit the availability of some funding sources; for example, some funding sources may only be applied to capital improvement projects. Examples of funding sources within a given community include:

- General Fund - Ad Valorem Base - Property Tax
- Special Assessments - by hydrologic unit (e.g., Drain Code), property tax, etc.
- User fees (e.g., stormwater utility)
- Gasoline tax (limited to drainage needs related to transportation)
- Debt financing (e.g., loans and bonds)

In addition, there are several programs designed to assist communities and other public agencies meet water quality standards for their water resources. The following programs are administered by the Michigan Department of Environmental Quality (MDEQ):

- Clean Water Assistance Revolving Loan Fund. The Clean Water Revolving Loan Fund is a program to provide low-interest loans to help communities and other public agencies meet water quality standards. Eligible borrowers include: municipalities, counties, villages, townships and inter-municipal agencies, and eligible projects include stormwater treatment and non-point source pollution control (to be funded, however, projects must appear on Michigan's project priority list.) Furthermore, the entity that receives funding must show that it can collect revenue to operate and maintain the water pollution control project as well as retire the debt.

- Nonpoint Source Program and Water Quality Management Planning Program Grants The Michigan Department of Environmental Quality (MDEQ) received federal funding through Section 319 and Section 604(b) of the Clean Water Act to fund grants to local units of government and agencies under Michigan's Nonpoint Source Program. The program focuses on pollution prevention and on minimizing water quality problems on a watershed basis. The program emphasizes the development and implementation of best management practices, technical assistance and information/education programs.

  There are three Requests for Proposals (RFPs) for grants available. Planning grants are available up to $120,000 over two years with a 10 percent local match to develop a comprehensive nonpoint source watershed management plan. Implementation grants are available up to $100,000 per year with a three year, $300,000 maximum and a 30 percent local match to implement the plan. A third RFP solicits proposals for specific program priorities with up to $40,000 over a one to three year period available. For this grant, a minimum of 50 percent of the cost of programs or practices must be provided by sources other than this program or other federal programs.

  RFPs are mailed out on an annual basis with the grant funding period running from January 1st through December 31st of each year. The deadline for submitting a completed application for this round of funding is February 2, 1998. Funding would begin on January 1, 1999 for the projects that are selected.

- Storm Water Fund. This fund is part of the state treasury that may receive money or assets from any source, but receives substantially all of its monies from stormwater discharge fees collected from persons applying for and obtaining stormwater discharge permits. The fund is primarily used to allocate monies to the MDEQ stormwater activities; however, monies may also be allocated to cover stormwater monitoring costs. Although, this has never been requested by a local community.

Additional funding from the Rouge Project may be available for a few more years to assist with implementation of the future management plan for the Middle 1 Subwatershed. Rouge Project funds are also likely to be continued for watershed-wide activities such as the Rouge River Watershed Geographic Information System (GIS) and the comprehensive monitoring and sampling program. Regional financing approaches are also available to the Rouge River Watershed communities and other public agencies through inter-local agreements.

9.0 PROGRESS ASSESSMENT AND MONITORING.

Monitoring is an integral part of a subwatershed management program and is critical in tracking progress towards watershed objectives. Watershed-based monitoring can provide opportunities to reduce costs and collect more environmentally relevant data compared to traditional monitoring. Other benefits may include more efficient prioritization of pollution prevention, reduction, or minimization efforts. A long-term monitoring and sampling program is critical to the success of a subwatershed management program because it provides information necessary to demonstrate to local decision-makers, regulators, and the public whether the management measures (pollution controls) are achieving the desired effects in the resource. A baseline assessment of water quality and environmental conditions is essential to the tracking progress. Periodic review of the data provides an opportunity to modify subwatershed management activities (including the monitoring program) as necessary over time as the subwatershed plan is implemented.

It is important that the objectives of a monitoring program be clearly defined. Listed below are recommended objectives for a monitoring and sampling program to support a subwatershed management program:

- characterize water quality and ecosystem health in a watershed over time;
- determine causes of existing and future water quality and ecosystem health problems in the subwatershed and develop a subwatershed management program;
- assess progress of the subwatershed management program or the effectiveness of pollution prevention and control practices; and
- support documentation of compliance with permit conditions and/or water quality standards and criteria.

Monitoring data are also useful for:

- analyzing long-term trends;
- establishing a baseline from which progress can be tracked;
- identifying sources of pollution and use impairments in receiving waters;
- identifying pollutants of concern;
- prioritizing subwatershed management program (e.g., pollution controls);
- providing data to calibrate and verify watershed/water body models;
- providing public information;
- providing performance monitoring of subwatershed management activities; and
- refining existing monitoring programs.

Environmental data (particularly data collected during wet weather events) are generally highly variable, typically require a relatively long time frame to collect an adequate database, and can be expensive to obtain. For these reasons, the progress of a subwatershed program should not be based on water chemistry sampling results alone but should be based on a combination of sampling results, surrogates, and/or other indicators. Examples of other indicators of management program progress include percentage of the drainage area served

by best management practices (BMPs), types and quantities of materials prevented from entering receiving waters, biologic indicators (e.g., increase in fish number and diversity), land use characteristics or trends (percent imperviousness), or increase in number of river miles achieving designated usages (e.g., wading). Integration of computer modeling of subwatershed characteristics with a limited monitoring program is an example of a method to supplement or reduce monitoring requirements for watershed management.

The comprehensive monitoring program the entire Rouge River Watershed conducted under the Rouge Project is likely to continue for the next few years. Use of applicable, available monitoring data collected by the Rouge Project can be used by the Subwatershed Advisory Group to continue refinement of subwatershed management. In addition, Rouge indices for public uses can be utilized for planning and evaluating subwatershed management programs. The computer models of the Middle 1 Subwatershed and Johnson Creek developed by the Rouge Project can also be utilized to prepare and refine a future subwatershed management plan as management programs are implemented and as new data become available. Implementation of the subwatershed management program should be coordinated with the Rouge Project monitoring efforts to maximize the usefulness of the information collected. The needs and uses for monitoring data will change over time as pollution controls or subwatershed management programs are implemented. Periodic review of the monitoring program objectives and protocols are recommended to ensure that the monitoring program is providing timely, relevant data.

As discussed above, communities and agencies within the subwatershed should also track other indicators of progress, such as numbers of failing septic systems remediated or eliminated, numbers of illicit connections removed, miles of tributaries "adopted" under the RiverWatch program, and use of riverside recreational facilities and parks. These measurements are a relatively low cost method of charting progress of the river restoration efforts and easily demonstrate benefits of community water quality expenditures to the public.

10.0 REFERENCES.

Barton, D., Taylor, W., Biettw, R. "Dimensions of Riparian Buffer Strips Required to Maintain Trout Habitat in Southern Ontario Streams ," *North American Journal of Fisheries Management*, 5:364-378, 1985.

Beam, J. Braunscheidel, J. (MDNR Fisheries Division) . Rouge River Watershed Assessment, 1996.

Bobrin, J.A. "Rules of the Washtenaw County Drain Commissioner: Procedures and Design Criteria for Subdivision Drainage," April 1996.

U.S. Environmental Protection Agency , *Waterfront Approach Framework*, EPA 840-S-96-001.

Gilliam, J.W. "Riparian Wetlands and Water Quality," Journal of Environmental Quality, 23, September - October, p896-900, 1994.

Gregory, S., Swanson, F., McKee, W., and Cummins, K. "An Ecosystem Perspective of Riparian Zones," *Bioscience*, 41(8):540-549, 1991.

Hawkins, C. "What Are Riparian Ecosystems and Why are We Worried About Them?,"in Riparian Resources: A Symposium, Utah State University, Logan, Utah, April 18-19.

Hay, E. MDNR Fisheries Division, Personal Communication with JJR Incorporated (G. Crawford) July 1996.

Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems, a User's Guide, EPA/600/R-92/238, January 1993.

MDNR. A Biological Investigation of the Rouge River, Wayne and Oakland Counties, May 17 to October 19, 1973. 1975.

MDNR. Rouge River Water Quality: 1973-1986, 1987.

MDNR. River Rouge Nonpoint Source Pollution Demonstration Project: Chemical Analyses and Aquatic Toxicity Tests of the Bell Branch of the Rouge River, Fellows Creek, Johnson Drain and Tonquish Creek, 1993.

MDNR. An Investigation and Evaluation of the Biological Communities Inhabiting the Rouge River Tributaries in Wayne County, June-July 1992, 1994a.

MDNR. An Investigation and Evaluation of the Biological Communities Inhabiting the Rouge River Tributaries in Wayne County-Oakland Counties, August - Septmber 1994, 1994b.

Osborne, L., Kovacic, D., "Riparian Buffer Strips in Water-quality Restoration and Stream Management," *Freshwater Biology*, 29:243-258, 1993.

Osborne, L., Wiley, M., "Empirical Relationships Between Land Use/Cover and Stream Water Quality in an Agricultural Watershed," *Journal of Environmental Management*, 26:9-27, 1988.

Rouge Program Office. Technical Memorandum: Existing Conditions of the Middle 1 Rouge River Subwatershed. RPO-NPS-TM 15.00 - In Press, 1997.

Rouge Program Office. Technnical Memorandum: Baseline Data Summary for the Rouge River. RPO-WMD1A-TM03.03, May 1996.

Rouge Program Office. Technical Memorandum: Baseline Data Summary for the Rouge River. RPO-WMOG-TM12.00, December 1996.

Rouge Program Office. Technical Report: Johnson Creek Reconnaissance Survey. RPO-WMGT-TPM 44.02, 1997.

Rouge Program Office. Cost Estimating Guidelines - Best Management Practices and Engineered Controls, April 1997.

Schueler, T. "Site Planning for Urban Stream Protection," Center for Watershed Protection, Silver Springs, MD, 1995.

Schueler, T. "Crafting Better Urban Watershed Protection Plans," Center for Watershed Protection, Silver Springs, MD, 1996.

Schultz, R. et al,. "Design and Placement of a Multi-species Riparian Buffer Strip System," *Agroforestry Systems*, 29:201-226, 1995.

Technical Memorandum Summary of Illicit Connection Detection Programs in Michigan. RPO-NPS01A-TM01.00, February 1996.