THE ROUGE RIVER PROJECT
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Rouge River National Wet Weather Demonstration Project

Wayne County, Michigan

TECHNICAL MEMORANDUM
1995 Streambank Erosion Reconnaissance Survey

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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.

ABSTRACT

A reconnaissance survey of the magnitude and extent of streambank erosion on the four major branches of the Rouge River and selected tributaries was conducted in December 1995. Measurements of eroded bank height and slope, as well as several other observations, were made at 38 stations throughout the watershed. Highly erodible sandy or gravel/sand soils were observed throughout the watershed. Bare, eroded banks are prevalent throughout the four river branches and common on the branch tributaries. Overall, 76 percent of the locations inspected exhibited bare, eroded banks at least three feet in height. Eroded banks at least three feet high were observed more frequently on the four major branches of the river (86 percent of locations) than on the tributaries inspected (50 percent of locations). A rough estimate of the extent of river bank exhibiting eroded banks at least three feet high for each branch, assuming that the erosion conditions observed are continuous between locations, is: Main Branch = 60 percent; Upper Branch = 70 percent; Middle Branch = 80 percent; and Lower Branch = 90 percent. Eroded bank heights were greatest (> 5 feet) on the lower parts of the Main and Lower Branches, as well as at certain locations on the Middle Branch, Tonquish Creek and the Bell Branch. The wide floodplain and presence of impoundments on the Middle Branch seemed to reduce erosion by dampening the increase in river flow during flood events. Eroded banks were smallest on the Upper Branch. A procedure is described for a more quantitative evaluation of the contribution of streambank erosion to the total suspended solids load of the river.

PREFACE

The Rouge River has historically suffered and continues to suffer from the combined stress of pollutant loadings from various sources. The vast majority of continuous point sources have been eliminated through the issuance and enforcement of National Pollutant Discharge Elimination System (NPDES) permits for municipal and industrial dischargers. Yet, as established in the Rouge River Remedial Action Plan (RAP), the river remains polluted primarily because of sources associated with wet weather flow.

The Rouge River National Wet Weather Demonstration Project (Rouge Project) is intended to evaluate each of the various sources of wet weather pollution; implement alternative remedial measures; investigate wet weather waste load allocations; establish associated pollutant load reductions; examine the financial and institutional impediments to wet weather pollution control; and recommend a plan and procedure for watershed-wide pollution control which is "implementable" in the Rouge and can be readily transferred to similar urban watersheds throughout the country.

The effort is not being conducted in isolation. The Rouge RAP provides a baseline from which Rouge Project efforts have begun. In fact, the Rouge Project can be viewed as the key component of the initial implementation of the RAP. In addition, ongoing regulatory efforts aimed at controlling Combined Sewer Overflow (CSO) discharge have also been integrated into the Rouge Project and all construction facilities will be in accordance to NPDES permits.

It is widely recognized, and reinforced by RAP recommendations, that CSO control by itself will not be sufficient to restore water quality to acceptable levels in the Rouge River and other similar urban rivers. The project has established a watershed-wide concept as its focus. Within the Rouge River Watershed, a range of pollution sources have been identified. They include: traditional urban runoff, illicit connections to drainage facilities, abandoned dumps within the river flood plain, wet fall and dry fall air deposition, and contaminated sediments within the river channel and impounded lakes.

The Rouge Project has incorporated efforts to develop analysis tools, organize existing and future data, conduct field surveys, collect and analyze water quality samples, develop and implement water quality models, design and test structural and nonstructural best management practices (BMPs), and establish loadings from nontraditional wet weather sources. Additionally, it includes components that will involve watershed residents in pollution control planning, and will study the institutional structure and financial capabilities of those entities responsible for long term implementation of the recommended watershed plan.

To efficiently manage an effort with diverse objectives, the project has been divided into ten program elements. Each of these has a specifically defined technical or operational purpose. Within each of these elements, work plans are developed to define specific activities to be performed as part of the project. These work plans define the Tasks and level of effort.

The program elements that have been established are as follows:

Geographic Information System (GIS) and Mapping
Data Collection and Management
Sampling and Analytical Program
Modeling and Decision Support System (DSS)
Nonpoint Source Best Management Practices (BMPs)
Combined Sewer Overflow (CSO) Design, Build and Test Facilities
Value Engineering
Public Information and Involvement
Financial and Institutional
Project Management, Coordination and Reporting

This document has been generated under the Modeling Element. Its purpose is to present data on streambank erosion from the 1995 reconnaissance survey, and to recommend a follow-up assessment of watershed conditions and quantitative erosion measurements.

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1.0 INTRODUCTION.

Streambank erosion is an important indicator of watershed condition. It can directly affect several important stream functions and designated uses, including fish and benthic invertebrate habitat and recreational use. Actively eroding streambanks support little or no riparian vegetation. This adversely affects a wide variety of wildlife species, including fish, through a reduction in cover, reduced inputs of organic matter into the aquatic ecosystem, and higher summer water temperatures due to increased solar radiation. Eroding banks also contribute sediment to the stream channel via soil slumps and surface erosion. This increased sediment load impairs aquatic habitat by siltation of fish spawning areas and benthos habitat, and adversely effect the perceived recreational potential of the water body. The adverse impacts of streambank erosion can be much greater than the adverse effects of a comparable area of eroding hillslope, because all of the material from an eroding streambank is delivered directly into the stream channel (U.S. EPA, 1991).

While streambank erosion is a natural process, it may be a significant source of particulate solids to the Rouge River, given its extremely variable discharge, water velocity and water level due to stormwater and combined sewer overflow inputs. Loss of riparian habitat due to bank erosion also contributes to the low diversity of fish and benthic invertebrates found in the river. Finally, excessive turbidity often impairs recreational use of the river in many areas.

To investigate the magnitude and extent of streambank erosion in the Rouge River Watershed, a reconnaissance survey was conducted during December 1995. Streambank condition was inspected at a total of 38 locations; 28 locations on the four major branches of the river and 10 locations on seven major tributaries (*Table 1.1*; *Figure 1-1*). The results of this reconnaissance survey are reported below.

Table 1.1
Summary of Streambank Erosion Reconnaissance Stations - 1995

Map No.	Location	City	Map No.	Location	City
	Main Branch			***Middle Branch***	
1	Long Lake Rd.	Troy	22	Novi Rd., N of 8 Mile Rd.	Novi
2	Big Beaver Rd.	Bloomfield Twp.	23	6 Mile Rd.	Northville Twp.
3	13 Mile Rd.	Beverly Hills	24	Hines Dr., ~ 0.2 mile D/S of Phoenix Lake	Plymouth Twp.
4	10 Mile Rd.	Southfield			
5	Beech Daly Rd.	Southfield	25	Hines Dr., ~ 200 yards D/S of Wilcox Lake	Plymouth
6	Grand River Ave.	Detroit			
7	Outer Dr.	Detroit	26	Hines Dr., ~ 0.3 mile D/S of Newburgh Lake	Livonia
8	Spinoza Rd.	Detroit			
9	Warren Rd.	Dearborn Heights	27	Hines Dr., ~ 0.2 mile D/S of Nankin Lake	Westland
10	Brady St.	Dearborn			
			28	Hines Dr., @ Middlebelt Rd.	Westland
	Tributaries to Main Branch		29	Hines Dr., @ Warren Rd.	Detroit
11	Franklin Drain; 14 Mile Rd. & Franklin Rd.	Franklin		***Tributaries to Middle Branch***	
12	Pebble Creek; 10 Mile Rd.	Southfield	30	Johnson Drain; Beck Rd.	Northville Twp.
			31	Tonquish Creek; Hix Rd.	Westland
	Upper Branch			***Lower Branch***	
13	Old Homestead, off Drake Rd.	Farmington Hills	32	Denton Rd.	Canton Twp.
14	Powers Rd.	Farmington	33	Lilley Rd.	Canton Twp.
15	8 Mile Rd.	Farmington Hills	34	Hannan Rd.	Wayne
16	Pomona Dr. & Beech Daly Rd.	Redford Twp.	35	Henry Ruff Rd.	Inkster
			36	John Daly Rd.	Inkster
	Tributaries to Upper Branch		37	Military Rd.	Dearborn
17	Tarabusi Creek; 8 Mile Rd.	Farmington Hills		***Tributary to Lower Branch***	
18	Tarabusi Creek; Merriman Rd.	Livonia			
19	Bell Branch; 7 Mile Rd.	Livonia	38	Fellows Creek; Palmer Rd.	Canton Twp.
20	Bell Branch; Merriman Rd.	Livonia			
21	Bell Branch; 5 Mile Rd.	Redford Twp.			

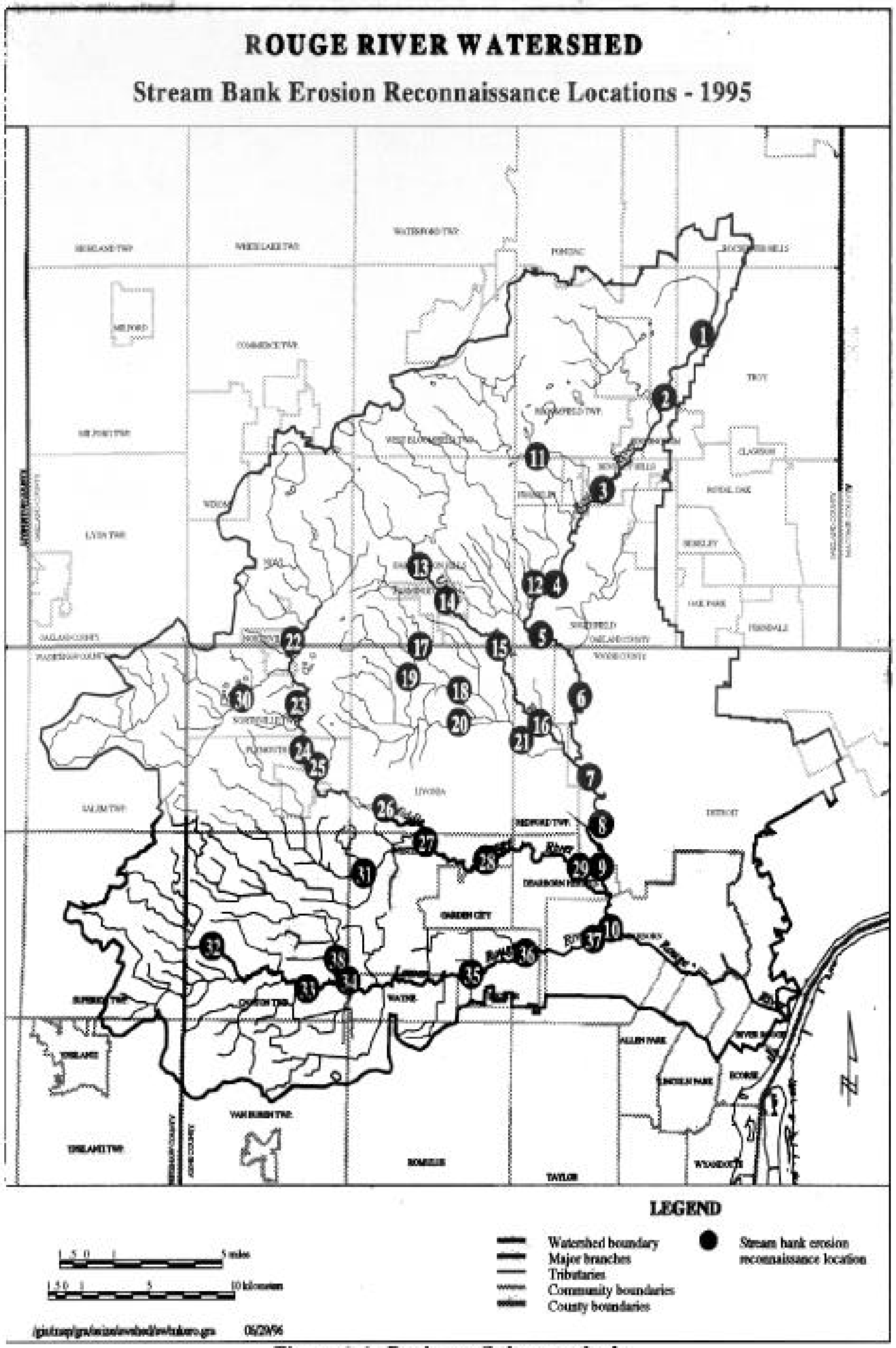

Figure 1-1: Drainage Subwatersheds

2.0 INVESTIGATIVE APPROACH. Individual stations were selected as being representative of a specific river reach based on observations made during previous RPO field activities. The measurements and observations made at each station (described in Section 3.0) were intended to provide a preliminary evaluation of the occurance and magnitude of streambank erosion in the watershed. Bank erosion was not evaluated in the stretch of the Main Branch between the confluence with the Middle Branch to its mouth at the Detroit River, because most of the river bank in this stretch is either concrete channel or steel bulkhead. All field work was performed in an 11-day period in late December 1995, to provide a synoptic evaluation of the extent of streambank erosion under low-water conditions, after the autumn floods.

3.0 METHODS.

3.0 METHODS. Thirty-eight locations in the Rouge River Watershed were inspected, on both the four major branches and on seven tributaries (*Table 1.1* and *Figure 1-1*). Most stations were near the intersections of the river and a particular road. Stations are identified throughout this report by the road crossing and city.

In the field, a stretch of river (usually 100 to 200 yards long and at least 100 feet from the road crossing) was walked to identify typical bank conditions, and to select representative locations for making the following measurements and observations:

- Estimated average eroded bank height
- Bank angle (measured with a clinometer)
- Estimated stream width
- Observable flood height (determined by visible flood debris above the river channel)
- Soil type
- Bank vegetative cover

Information was recorded on a field data sheet, and photographs of the bank were also taken. Where possible, the following observations were also made:

- Water depth
- Stream sediment type adjacent to the eroded bank
- Similarity of sediment to the adjacent soil
- Probable sediment resuspension potential

All field work was performed between December 12 and December 22, 1995.

4.0 RESULTS AND DISCUSSION.

4.0 RESULTS AND DISCUSSION. Bank heights were measured from the top of the bank to the river water surface. Mentions of right or left bank in the following text assume the observer is facing in a downstream direction. The phrase "eroded bank" implies a streambank of bare soil, devoid of vegetation, regardless of height or slope.

4.1 GENERAL CONDITIONS. Bare, eroded banks with exposed tree roots were widespread throughout the Rouge River Watershed. Overall, 29 of 38 (76 percent) locations inspected exhibited bare, eroded banks at least three feet in height (*Table 4.1*). Eroded banks at least three feet high were observed more frequently on the four major branches of the river (86 percent of stations) than on the tributaries inspected (50 percent of stations).

Assuming the locations inspected were representative of the river branches in general, and that the eroded banks observed are continuous between stations (which seemed to be the case), eroded streambanks are present along the majority of each branch. A rough estimate of the extent of river bank exhibiting eroded banks at least three feet high for each branch, assuming that the observed erosion conditions are continuous between locations, is as follows:

- Main Branch = 60 percent
- Upper Branch = 70 percent
- Middle Branch = 80 percent
- Lower Branch = 90 percent

Table 4.1
Summary of the Eroded Banks Observed on the Rouge River Watershed; December 1995

River Branch	Number of Stations with Eroded Banks 3'	Percentage of Stations with Eroded Banks 3'
Main	9 of 10	90 %
Upper	2 of 4	50 %
Middle	7 of 8	88 %
Lower	6 of 6	100 %
All Branches Combined	**24 of 28**	**86 %**
Tributaries (All Branches)	5 of 10	50 %
Entire Watershed	**29 of 38**	**76 %**

The eroded bank height observed at a particular station was often considerably greater than the water depth, usually by a factor of two to five. This implies a comparable or greater increase in stream water level under high water conditions.

Stream meanders (sinuous bends in the stream channel), where present, exhibited consistently steep bank slopes (80 to 90) on the outside of the meander bends and lower slopes (20 to 40) on the inside of the meander bends, regardless of bank height or stream width. Bank slopes on straight stream reaches were quite variable, ranging from 20 to 90 , and also did not seem to be related to bank height or stream width.

The eroded banks observed were typically devoid of any vegetation, and usually exhibited exposed tree roots up to four inches to six inches in diameter and several feet in length. In some locations bank erosion has undercut mature trees, causing them to fall across or into the stream channel.

Bank "slumping" (the collapse of bank soil into the river, often due to undercutting) seemed more common where the streamside vegetation was grass, rather than trees or shrubs. This may be due to the difference in root mat depths; grasses form a shallow-rooted sod, while the roots of woody plants penetrate the soil to greater depths. Beeson and Doyle (1995) found that stream bends lacking tree cover were five times more likely to experience significant erosion during flood events than forested banks. They also reported that bank vegetation is ineffective in preventing erosion unless it is at the water surface-bank interface.

The surficial soil type observed throughout the entire watershed was either a light-colored sand or silty sand. These soils were occasionally mixed with gravel along the Middle Branch. These soil types are known to be highly erodible. River sediment immediately adjacent to the eroded banks (where visible) was usually either similar to the bank soil (i.e., sand) or of greater grain size (i.e., a mix of sand and gravel). This matches the sediment types observed in the 1995 Sediment Oxygen Demand Studies (RPO, 1996). The potential for resuspension of these sediments during flood events is probably moderate to low.

Debris from previous high water events was seldom visible outside of the river channel (*Tables 4.2* through *4.5*), although considerable debris was observed well above the river channel at certain locations visited during other field studies in 1994 and 1995. The general absence of flood debris in December 1995 is likely due to the lack of floods in the previous couple of months, and to the decay of debris from earlier flood events.

It should be noted that much of the Rouge River Watershed was covered by one to three inches of snow during the field surveys, which partly obscured the streambank at some stations. Ice cover on the river prevented observations of river sediment characteristics and water depth at 12 of the 38 stations (32 percent). The water was too deep or turbid at another two locations. There had been no significant rain for several weeks prior to the survey, and the river water (where visible) was usually clear and the river level was relatively low.

Branch-specific observations of the extent and degree of streambank erosion are discussed in the following subsections. Tables 4.2 to 4.5 contain the streambank and channel observations and measurements.

4.2 MAIN BRANCH AND ITS TRIBUTARIES. Streambank erosion was quite variable at the 10 stations and two tributaries in the Main Branch (*Table 4.2*). Eroded bank heights ranged from one foot at Big Beaver Road (Bloomfield Township) to eight feet to 10 feet at Warren Road (Dearborn Heights). Bare banks and exposed plant roots were common downstream of 13 Mile Road (Beverly Hills). The height of the eroded banks increased as the river width increased, down to Beech Daly Road (Southfield). Downstream of Beech Daly Road the river (and floodplain) continued to widen, but the height of the eroded bank was more variable. This might have been due to changes in stream gradient in the lower part of the Main Branch.

Stream meanders at 10 Mile Road (Southfield) and Beech Daly Road (Southfield) exhibited typically near-vertical banks on the outside of the bend and lower slopes (30 to 40) on the inside of the bend. Eroded bank slopes on straight stream reaches varied from 20 to 90 . Soil slumping was observed at 13 Mile Road and at Spinoza Road (Detroit), and bank undercutting was observed at 10 Mile Road (Southfield) and Brady Street (Dearborn).

The river sediment within a few feet of the eroded banks was seldom visible due to ice cover on the river. Where visible, it did not resemble the silty sand that was present as soil along the entire branch, in that it contained significant amounts of gravel and cobble. These river sediments should not resuspend easily.

4.3 UPPER BRANCH AND ITS TRIBUTARIES. Relatively small eroding banks (0.5 to 4 feet) were observed at three of the four stations inspected on the Upper Branch, and eroding banks of more variable heights (1 to 8 feet) were observed at all five stations on the two Upper Branch tributaries, Tarabusi Creek and Bell Branch (*Table 4.3*). The most upstream Upper Branch location, at Old Homestead Road off of Drake Road in Farmington Hills, was very near the branch headwaters and had no real bank or bank erosion. Further downstream, eroded banks 2.5 to 4 feet high were observed between Power Road (Farmington) and Beech Daly Road (Redford Township). This was half of the maximum eroded bank heights observed on the other three branches, and could be caused by lower peak flow rates in the Upper Branch. Streambank slumping was observed at Power Road (Farmington) and Beech Daly Road (Redford Township), and undercut banks were observed on Tarabusi Creek (Farmington Hills) and the Bell Branch (both Livonia [Seven Mile Road] and Redford Township). It should be noted that during the 1995 Sediment Oxygen Demand Studies, the recreational activities of local children were observed to result in the collapse of the streambank into the river at the Beech Daly Road station; this may partly explain the soil slumping at this location.

Stream meanders at Power Road, Eight Mile Road (Farmington Hills), Tarabusi Creek (Livonia), and Bell Branch (Livonia and Redford Township) exhibited typically near-vertical

Table 4.2
Results of Rouge River Streambank Erosion Survey
Main Branch; 12/13/95.

Location (City; Map No.)	River Width (Ft)	Eroded Bank Height (Ft)	Bank Angle (Degrees)	Height of Observable Flood Debris (Ft)
Long Lake Rd. (Troy; 1)	10 - 12	Slight (2 - 3) erosion, on bends	20	0.5
Big Beaver Rd. (Bloomfield Twp.; 2)	10	1 (slightly higher in bends)	25 - 80	1 - 2
13 Mile Rd. (Beverly Hills; 3)	20	3	60 - 90	3
10 Mile Rd. (Southfield; 4)	30	3 - 5	Outside bend = 90; Inside bend = 30 - 40	7
Beech Daly Rd. (Southfield; 5)	30	7 - 8	Outside bend = 80; Inside bend = 35	7 - 8
Grand River Ave. (Detroit; 6)	50	4	40	4
Outer Drive (Detroit; 7)	60	7	50	8
Spinoza Rd. (Detroit; 8)	60	6	30	8
Warren Rd. (Dearborn Heights; 9)	60	8 - 10	40 - 80	8 - 10
Brady St. (Dearborn; 10)	70	2 - 3	50	2 - 3
Tributaries to the Main Branch				
Franklin Drain; 14 Mile Rd. & Franklin Rd. (Franklin; 11)	10	1	30	2
Pebble Creek; 10 Mile Rd. (Southfield; 12)	2	1	30 - 70	1

banks on the outside of the bend, and lower slopes (30 to 50) on the inside of the bend. Eroded bank slopes on straight stream reaches varied from 45 to 90 .

The river sediment within a few feet of the eroded banks, where visible, resembled the sandy soil present along the entire branch, except at the upstream locations of Tarabusi Creek (Farmington Hills) and Bell Branch (Livonia), where the sediment was a mix of sand and gravel. These sediments should not easily resuspend.

While the height of the eroded bank on Tarabusi Creek was a fairly consistent 2 to 3 feet, the eroded bank on Bell Branch increased from 1 foot at Seven Mile Road (Livonia) to 7 to 8 feet at Five Mile Road (Redford Township), the highest eroded bank observed anywhere on the Upper Branch. These high, bare banks may be a significant source of solids to the lower end of the Upper Branch.

4.4 MIDDLE BRANCH AND ITS TRIBUTARIES. Bare, eroded banks were observed at all eight stations inspected on the Middle Branch, as well as at single stations on both of its tributaries, Johnson Creek and Tonquish Creek. Both stream width and eroded bank height were fairly consistent along most of the branch (*Table 4.4*). Exceptions were:

- The station farthest upstream (Novi Road, in Novi). Here the river was narrower than elsewhere and the eroded bank was only 1 foot to 2 feet high, and;

- The station farthest downstream (Hines Drive at Warren Road, in Detroit). Here the right bank of the river was a 20 foot ridge that was eroded to a height of 12 feet, while the left bank was only four feet high, which allows flood waters to regularly escape the river channel and flood Hines Drive.

The eroded bank heights observed along most of the Middle Branch were lower than expected, given its channel width and discharge. This is probably due to the flow-dampening effects of the wide floodplain on this branch, and the five impoundments; Meadowbrook Lake, Phoenix Lake, Wilcox Lake, Newburgh Lake, and Nankin Lake; which together reduce and delay high water levels during flood events.

Streambank slumping was observed downstream of Newburgh Lake (Livonia) and at Hines Drive at Middlebelt Road (Westland). Bank undercuts were observed downstream of Wilcox Lake.

Stream meanders at Six Mile Road (Northville Township) and Hines Drive at Middlebelt Road (Westland) exhibited typically near-vertical banks on the outside of the bend, and lower slopes (30) on the inside of the bend. Eroded bank slopes on straight stream reaches varied from 35 to 90 .

Table 4.3
Results of Rouge River Streambank Erosion Survey
Upper Branch; 12/20/95

Location (City; Map No.)	River Width (Ft)	Eroded Bank Height (Ft)	Bank Angle (Degrees)	Height of Observable Flood Debris (Ft)
Old Homestead, off Drake Rd. (Farmington Hills; 13)	2	0.5 (Not real erosion visible)	Not measurable	0.5
Power Rd. (Farmington; 14)	10 - 12	3	Inside of bend = 30 Outside of bend = 80	2.5
8 Mile Rd. (Farmington Hills; 15)	15	2.5	Inside of bend = 30 Outside of bend = 80	2.5
Pomona Dr. & Beech Daly (Redford Twp.; 16)	10	3 - 4	50 - 90	3 - 4
Tributaries to Upper Branch				
Tarabusi Creek; 8 Mile Road (Farmington Hills; 17)	8 - 10	Banks = 2 - 3, but no erosion visible	60 - 90	2 - 3
Tarabusi Creek; Merriman Rd. (Livonia; 18)	2 - 3	3	Inside of bend = 30 - 40 Outside of bend = 80 - 90	3 - 4
Bell Branch; 7 Mile Rd. (Livonia; 19)	15 - 17	1	Inside of bend = 50 Outside of bend = 90	1
Bell Branch; Merriman Rd. (Livonia; 20)	12	4 - 6	45 - 70	4 - 6
Bell Branch; 5 Mile Rd. (Redford Twp.; 21)	20 - 25	7 - 8	Inside of bend = 30 - 40 Outside of bend = 80 - 90	7 - 8

Table 4.4
Results of Rouge River Streambank Erosion Survey
Middle Branch; 12/22/95

Location (City; Map No.)	River Width (Ft)	Eroded Bank Height (Ft)	Bank Angle (Degrees)	Height of Observable Flood Debris (Ft)
Novi Rd., N of 8 Mile (Novi; 22)	15	1 - 2	50 - 60	1 - 2
6 Mile Rd. (Northville Twp.; 23)	25	3 - 6	Outside bend = 90 Inside bend = 30	3 - 6
Hines Dr., ~ 0.2 mile D/S of Phoenix L. (Plymouth Twp.; 24)	35	2 - 3	40 - 75	2 - 3
Hines Dr., ~ 200 yds. D/S of Wilcox L. (Plymouth; 25)	20	3	40 - 90	3
Hines Dr., ~ 0.3 mile D/S of Newburgh L. (Livonia; 26)	25	3	35 - 90	3
Hines Dr., ~ 0.2 mile D/S of Nankin L. (Westland; 27)	25	6 - 8	40	6 - 8
Hines Dr., @ Middlebelt Rd. (Westland; 28)	30	2 - 3	Outside bend = 90 Inside bend = 30	4
Hines Dr., @ Warren Rd. (Detroit; 29)	30 - 35	4 - 12	30 - 50	4 - 12
Tributaries to the Middle Branch				
Johnson Creek; Beck Rd. (Northville Twp.; 30)	15	2	40 - 50	2
Tonquish Creek; Hix Rd. (Westland; 31)	15	5 - 6	50 - 90	5 - 6

The river sediment within a few feet of the eroded banks, where visible, resembled the sand or sand/gravel soil that is present along the entire branch. These sediments should not resuspend easily.

Bank erosion at the Tonquish Creek location was substantially greater than on Johnson Creek, although their stream widths were similar. Banks at the Tonquish Creek location have eroded to the point that mature trees had been undercut and fallen into the river.

4.5 LOWER BRANCH AND ITS TRIBUTARIES. Bare, eroding banks were observed at all six stations inspected on the Lower Branch, and at its tributary, Fellows Creek (*Table 4.5*). The height of the eroded bank increased as the river width increased, from 3 feet at Denton Road (Canton Township) to 8 feet at Henry Ruff Road (Inkster). Downstream of Henry Ruff Road the river and floodplain continued to widen, but the slope of the eroded bank remained constant and the height of the eroded bank decreased slightly.

Stream meanders at Lilley Road (Canton Township), Hannan Road (Wayne), John Daly Road (Inkster) and Military Road (Dearborn) exhibited typically near-vertical banks on the outside of the bend and lower slopes (20 to 35) on the inside of the bend. Eroded bank slopes on straight stream reaches varied from 40 to 90 .

The river sediment immediately adjacent to the eroded banks, where visible, resembled the light-colored sandy soil that is present along the entire branch. This sediment should be moderately resuspendable.

Fellows Creek in Canton Township has been channelized for at least part of its length, and dredge spoil mounds line the right bank at the location inspected. Dredging apparently occurred approximately 20 years ago, judging from the size of the trees growing on the spoil heaps. The spoil mounds are completely vegetated, and should not be subject to erosion from current stream discharges.

Table 4.5
Results of Rouge River Streambank Erosion Survey
Lower Branch; 12/12/95

Location (City; Map No.)	River Width (Ft)	Eroded Bank Height (Ft)	Bank Angle (Degrees)	Height of Observable Flood Debris (Ft)
Denton Rd. (Canton Twp.; 32)	10 - 12	3	40	3
Lilley Rd. (Canton Twp.; 33)	30	7	Outside bend = 80 - 90; Inside bend = 30	7
Hannan Rd. (Wayne; 34)	30	8	Outside bend = 90; Inside bend = 30; Straight sections = 90	3 - 4
Henry Ruff Rd. (Inkster; 35)	40	8	40	8
John Daly Rd. (Inkster; 36)	40 - 45	5 - 6	Outside bend = 90; Inside bend = 35	4 - 5
Military Road (Dearborn; 37)	50	6	Outside bend = 50 - 90; Inside bend = 20 - 30	6
Tributary to Lower Branch				
Fellows Creek; Palmer Rd. (Canton Twp.; 38)	10 - 12	2.5	90	6

5.0 CONCLUSIONS AND RECOMMENDATIONS.

Highly erodible sandy or sand/gravel soils were observed throughout the watershed. Bare, eroded streambanks that were devoid of vegetation and usually exhibited exposed tree roots were prevalent throughout the four major branches of the Rouge River, and were also common on the seven tributaries inspected.

Overall, 76 percent of the locations examined in this study exhibited eroded streambanks at least three feet in height. Eroded banks of this height were more common on the four major branches (86 percent of locations) than on the tributaries inspected (50 percent of locations).

A rough estimate of the extent of river bank exhibiting eroded banks at least three feet high for each branch, assuming that the erosion conditions observed are continuous between locations, is as follows:

- Main Branch = 60 %
- Upper Branch = 70 %
- Middle Branch = 80 %
- Lower Branch = 90 %

Stream meanders are common on the Rouge River, and where present exhibited near-vertical bank slopes on the outside of the meander bends and lower slopes (20 to 40) on the inside of the bends. Bank slopes on straight stream reaches were quite variable, ranging from 20 to 90 .

Eroded bank heights were greatest (> 5 feet) on the lower parts of the Main Branch (downstream of Beech Daly Road, in Southfield), the Middle Branch (downstream of Nankin Lake, in Westland), the Lower Branch (downstream of Lilley Road, in Canton Township), Tonquish Creek (at Hix Road, in Westland), and the Bell Branch (downstream of Merriman Road, in Livonia). Eroded banks along the Middle Branch were lower than might be expected given its discharge, probably due to its wide floodplain and the presence of five impoundments along the branch. These impoundments may reduce potential erosion in certain locations by dampening the increase in river flow during flood events. Eroded banks were lowest on the Upper Branch, probably due to its smaller discharge.

The prevalence of eroded streambanks along much of the Rouge River Watershed is probably due to increased flow rate and velocity during and after precipitation events. Increased storm flows are the result of continuing development and urbanization throughout the watershed. Increased impervious surface area, decreased infiltration of precipitation, more rapid delivery of runoff to the river and loss of floodplain area are features of an urbanizing watershed. These factors accentuate the magnitude of instream stormwater "pulses" (i.e., river depth and velocity) resulting from precipitation events. Over time, elevated stormwater pulses result in a broader river channel, shallower water depths at base flow, loss of riparian vegetation, and more homogenous stream bottom types. These changes in stream characteristics have a number of undesirable consequences, including decreased invertebrate and fish habitat, altered riparian and aquatic vegetation, and increased water temperature, as well as adversely affecting recreational uses.

Given the extent of streambank erosion throughout the Rouge River Watershed, it may be desirable to perform a more quantitative evaluation of the mass of soil eroded from the streambanks during high wet-weather flows. This could be accomplished by combining a U.S. Forest Service protocol with a method developed by Rosgen (both in USFS, 1994), as summarized below:

- Drive multiple rods horizontally into the streambank, flush with the soil surface, in a grid pattern.
- Measure the distance from the end of the rod to the soil surface after a precipitation event.
- Calculate the volume of soil eroded from the area of the study grid.
- Measure the bulk density of the soil.
- Calculate the mass of soil removed from the study grid by multiplying the soil volume by its density.
- Calculate the mass of soil eroded from a reach of river by extrapolation from the study grid, assuming a specific bank height and length.

These quantitative measurements could be made at selected stations on each branch and tributary, after individual storms and/or after seasonal flood cycles. Properly positioned, they could also provide an evaluation of the impact of the Rouge Project's management practices on streambank stability. At a minimum, this measurement should be made at the long-term monitoring stations to be established later in the Rouge Project.

Another procedure, developed by Pfankuch (1978), could also be used to quantitatively evaluate the stability of the entire stream channel (flood plain, streambank, and river bottom). This procedure uses field inspections of the river channel to evaluate and calculate site-specific scores for 15 factors (*Table 5.1*), based on comparisons of the field conditions to established narrative descriptions. Scores for all of the factors are summed, and the total score is used to rate channel stability as excellent, good, fair, or poor. Some of the factors may have to be modified, or even eliminated, to adapt the procedure to the Rouge River. Alternately, one could monitor just those factors applying to the condition of the streambank. It should be noted that to properly evaluate stream channel stability it is also necessary to identify the stream channel geomorphological classification. Rosgen's classification procedure (Rosgen, 1994) is most commonly used.

Table 5.1
Parameters and Range of Scoring Values Used for Evaluating Stream Channel Stability (Pfankuch, 1978)

[Channel Location] **Factor**	**Range of Scoring Values**
[Upper Bank]	
Sideslope gradient	0-8
Mass wasting potential	0-12
Debris jam potential	0-8
Vegetative cover	0-12
[Lower Bank]	
Channel capacity	0-4
Bank rock content	0-8
Obstructions and flow deflectors	0-8
Bank cutting	0-16
Sediment deposition	0-16
[Channel Bottom]	
Angularity of bed particles	0-4
Brightness of bed particles	0-4
Consolidation of bed particles	0-8
Stability and size of bed particles	0-16
Amount of scour and deposition	0-24
Aquatic vegetation	0-4
Stability score: 38 = Excellent; 39-76 = Good; 77-114 = Fair; 115 = Poor	

Data from either, or both, of these more quantitative procedures would complement the information obtained from this reconnaissance survey, and with it could be used for the following purposes:

- To estimate the contribution of streambank erosion to the total solids load in the ouge River.
- To evaluate the impact of the Rouge Project's water flow management practices on streambank stability.
- To evaluate the impact of stream channel stability and erosion on fish and benthos habitat and on recreational uses.
- To identify areas that might benefit from riparian habitat restoration.

The widespread bank erosion found in this study undoubtedly has a number of adverse affects on the riparian and instream habitat. Consequently, the river's ecosystem would benefit from restoration of riparian and instream habitat, including bank stabilization, revegetation of bare banks, wetland restoration, etc. The presence of substantial bank erosion in areas bordered by wide bands of mature riparian forest, however, indicates that, ideally, stream flow modifications will precede riparian habitat restoration. If the magnitude and timing of stormwater inputs to the river are not returned to more natural conditions (lower and slower post-storm stream discharge peaks), riparian habitat restoration efforts may not be successful. In lieu of fully controlled stormwater flows, habitat restoration efforts should focus on techniques that are less sensitive to changing water levels and velocities; perhaps stone-protected stilling basins or stone spur dikes (Shields et al., 1995 a & b); and should include plans for periodic maintenance of the restored area(s).

A pertinent example is on the Main Branch of the Rouge River in Southfield. The City of Southfield has placed several rock-filled single-wing deflectors in the river upstream of Telegraph Road, and stabilized selected banks with concrete rip-rap and 6" geoweb material. This has resulted in an increase in some small pool habitats for fish, and stabilized previously eroding banks (Bill Zikewich, Southfield Parks and Recreation, personal communication). The long-term effectiveness of this restoration effort is unknown, however, partly because stormwater discharges upstream of this location remain uncontrolled. Similar projects will undoubtedly be undertaken elsewhere in the watershed.

6.0 REFERENCES

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