APPENDIX A

Jackson Citizen Patriot Article Describing the Watershed Planning Effort

A course of ACTION

Groups work to preserve Grand River watershed

By Paul Overeiner
Staff Writer

A watershed that serves hundreds of thousands of Michigan residents would be a terrible thing to waste.

That's why government officials, citizens and other interested people in Jackson and several surrounding counties are trying to prevent it.

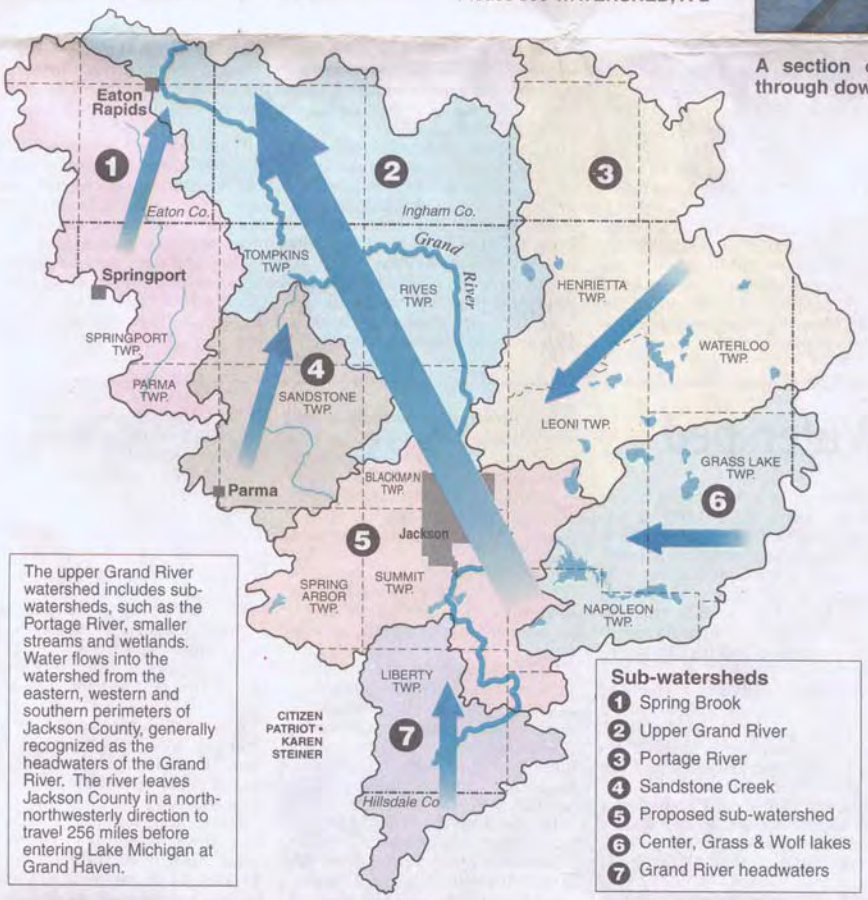
A coalition of groups is taking a closer look at the upper reaches of the Grand River watershed to develop a course for preservation and, where needed, restoration.

"A watershed is an area of land that draws water, sediments and dissolved material to a common outlet," said Kathleen Herrman. "The upper Grand is the headwaters to the whole Grand River watershed."

Please see **WATERSHED, A-2**

CITIZEN PATRIOT • MARCIA BUTTERFIELD

A section of the Grand River runs through downtown Jackson.



The upper Grand River watershed includes sub-watersheds, such as the Portage River, smaller streams and wetlands. Water flows into the watershed from the eastern, western and southern perimeters of Jackson County, generally recognized as the headwaters of the Grand River. The river leaves Jackson County in a north-northwesterly direction to travel 256 miles before entering Lake Michigan at Grand Haven.

CITIZEN PATRIOT • KAREN STEINER

Sub-watersheds

1. Spring Brook
2. Upper Grand River
3. Portage River
4. Sandstone Creek
5. Proposed sub-watershed
6. Center, Grass & Wolf lakes
7. Grand River headwaters

"A watershed is an area of land that draws water, sediments and dissolved material to a common outlet. The upper Grand is the headwaters to the whole Grand River watershed."

— KATHLEEN HERRMAN
A watershed scientist for Tetra Tech MPS

Reprinted from the Jackson Citizen Patriot, Wednesday, May 1, 2002

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Watershed

Herrman is a watershed scientist for Tetra Tech MPS, a national engineering consulting firm that's providing technical support for the "Upper Grand River Watershed Initiative," a $300,000 study funded by a state grant to catalog assets and identify problems in Jackson and Ingham counties.

Geoffrey Snyder, Jackson County drain commissioner, said the effort is an "unprecedented" example of intergovernmental cooperation. Representatives from at least eight townships, six villages, and Hillsdale, Calhoun and Eaton counties are on the study's steering committee.

The initiative lists a number of goals:

- Reduce introduction of bacteria and other substances that rob the water of oxygen.
- Reduce input of pollutants, particularly phosphorous, nitrogen, eroded soils and metals.
- Improve aquatic habitat and increase abundance and diversity of native flora and fauna.
- Identify critical wetland areas.
- Develop the upper Grand River as a recreational asset.
- Foster a stewardship ethic among watershed residents.

The study to identify problems, which is the first phase of the initiative, began late last year and is expected to be finished by the end of May. The second phase will start shortly thereafter and focus on the final goal: developing a capacity to implement monitoring and improvement programs.

"One of the major spin-offs will be the so-called (Jackson) County 'GeoBook,' " Snyder said.

The GeoBook is a computerized book on CD Rom that is being developed by Space Imaging Solutions, an Ann Arbor firm that is collating existing watershed data that will serve as a toolbox for analysis and decision making. The GeoBook contains everything from information on soil types and property identification maps to aerial photos along the river's course and information on ground cover.

The GeoBook will be distributed later this spring to area townships and libraries so it will be available to the public, Snyder said.

Information from the initiative will be incorporated into the county's master plan, which is under development, Snyder said.

Michigan's longest river has its humble beginnings in the wetlands and lakes of southern Jackson County.

By the time the Grand empties into Lake Michigan at Grand Haven, the 256-mile long river has flowed through Jackson, Lansing, Grand Rapids and dozens of smaller communities along the way.

In Jackson County, the river passes through areas that seem as pristine and natural as an Upper Peninsula wilderness. Other sections are punctuated with drains, pollution from sediments and other materials and, in developed areas, the castoffs of urban society.

Ron Hoffman, a wildlife biologist with the Jackson County Conservation District, has focused his attention on the Portage River, a "sub-watershed" that empties into the Grand in northern Blackman Township near Bunkerhill Road.

"The Portage has the most agricultural activity and a history of the most flooding," Hoffman said.

The Portage is loaded with sediment from farm runoff — three to seven feet deep in some places — and that material makes its way into the Grand.

Hoffman would like to see buffer zones of vegetation along the Portage to reduce sedimentation and the restoration of wetlands, which serve as natural controls to flooding and absorb nutrient runoff from agricultural land and septic systems.

"Indirectly we end up paying for that one way or another … either through the loss of cropland or flood damage," Hoffman said.

Dan Ashton, director of the Dahlem Environmental Education Center and a member of the initiative steering committee, said Jackson County is blessed with abundant fresh water.

"We happen to sit on one of the nation's biggest aquifers," Ashton said.

Jackson's underground water aquifers, most notably the Marshall Formation, are interconnected with countless lakes and streams.

The Grand, Kalamazoo, Raisin and Huron rivers all draw water either directly or indirectly from the area, as do branches of the St. Joseph, Ashton said.

"The area around here is like a giant sponge," Ashton said. "The amount of fresh water we have under here is huge."

Jackson's fortune is largely a fluke of geology and geography.

Branches of the Lurentide glacier that moved into Michigan from Canada about 20,000 years ago pushed along huge amounts of rock, gravel and sand. When the glacier retreated from the state, much of that material was left behind to form moraines, outwash plains and other porous formations that are very conducive to the flow of water.

"The till, the moraine we sit on, is very good for forming an aquifer," Ashton said. "All the lakes around here, all the ponds, are like pores on (the surface of) a sponge."

Ancient glacial formations also gave southern Michigan some elevation.

"The highest point in the Lower Peninsula is down in Hillsdale County, near Lake Wilson," Ashton said.

Those formations help set up the drainage patterns for the Grand and other rivers.

Data prepared by Space Imaging shows that water draining into the Upper Grand River Watershed moves toward the central portion of Jackson County from the south, east and west, then flows in a northwesterly direction into Ingham County.

That puts Jackson County in the "catbird's seat" in determining the quality and quantity of water that flows downstream, Snyder said, and pollution or sedimentation problems here can have adverse impacts on communities miles downstream.

The study also has relevancy for Jackson because surface pollution problems in the watershed can impact the quality of well water, the primary source of area drinking water.

"To date, we do have some problems," Snyder said.

Some sections have oxygen levels that are too low to support aquatic invertebrates and the fish populations that feed on them while other portions of the river are beset by sedimentation problems that adversely impact the river's ability to support aquatic life and degrade esthetic qualities that would make it attractive for recreation.

"My goal … is to determine methods to keep those problems from growing and cleaning up those that exist," Snyder said.

Downstream issues aside, there also are implications for Jackson County. Surface conditions in the watershed affect the quality of the groundwater, which supplies most, if not all, drinking water in the county.

"It's a quality of life issue," Ashton said. "Why would you want to live in Jackson County? We have a good school system. But we have great water. And water is the key to life."

— Reach reporter Paul Overeiner at povereiner@citpat.com or 768-4917.

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APPENDIX B

Jackson County Health Department Report
Bacteriological Analysis Sampling

Jackson County Health Department

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GRAND RIVER WATERSHED INITIATIVE
WATER QUALITY REPORT
October 24, 2002

Project Description

Data collected from water sampling will be utilized in the development of the Grand River Watershed Management Plan. This plan is envisioned to better manage the watershed in a sustainable, equitable, and cost-effective manner in order to ensure compliance with water quality criteria and achieve the goals of NPDES Phase II storm water regulations. Over the course of four months, (May through August) water quality samples were taken on a weekly basis for E. coli from 2 sites in Ingham County, one site in Eaton County, one site in Hillsdale County and eight sites in Jackson County.

Sample locations were chosen in an attempt to measure the effect of large tributaries upon the main branch of the Grand River. Sites are located at or near the confluences of the tributaries and the main branch, villages, as well as the upper stretches of the tributaries.

Sampling Procedures

Matrix: Surface Water

Analyte: Bacteriological sampling for E. coli

1. Equipment needed

a. MDEQ Drinking Water Laboratory sterile sample bottles # 30/ D & A sterile bottles
b. Workshop produced sample bottle holder
c. Large capacity cooler with ice for preservation
d. Latex gloves
e. Antiseptic towelettes / distilled water

f. MDEQ sample forms/D & A sample forms
g. Field log book

2. Sampling procedures

a. sample bottles shall be labeled as follows:
   site location
   date
   bottle ID number
   stream placement (i.e. Left, middle, right, up, facing downstream)
b. field log book shall contain the following information:
   weather conditions
   any other unusual conditions at the sample site
   sample collector name
   date
   time of collection
   site location
   bottle ID number
   analyte tested for
c. observe safety procedures concerning parking, bridge safety, traffic, reflective vests, and use of hazard blinkers
d. sample collector shall wear fresh pair of latex gloves with each sample taken
e. if only single grab sample is called for (small tributary), take it from the center of the flow and at mid depth where the greatest mixing occurs.
f. if a sample set is called for (main branches of Grand River); take three samples at equal distance across the flow at mid depth. Label these samples as left, middle, and right as one looks downstream
g. where possible, use the ICHD manufactured stainless steel stream sampler for collecting samples from bridge crossings. To avoid obtaining floatables, the sampler should be suspended 12 inches above the water surface and plunged through the surface so that the mouth of the sample container ends up at mid depth.
h. Wash the stainless steel sampler in the stream prior to placing a sample bottle in the holder.
I. Remove the sterilized cellophane bottle wrap after the bottle has been placed in the sample collector. Recap the bottle prior to removing from the sampler.

j. Sample forms must be filled out clearly. Good penmanship is important to minimize any lost samples due to an inability to read forms by lab personnel.
k. Once samples are obtained, place them in an insulated cooler with ice. Transport the samples to the D & A Environmental laboratory within 6 hours of the first sample obtained.
l. Do not eat or drink while collecting samples.
m. Refer to chapter 4 of MDEQ field sampling procedures for further details

Grand River Watershed Sample Sites

Site Name	Site Code	E.Coli	Comments
Sharp/Grand Confluent	A-1, A-2, A-3	Weekly	Collected May-August 2002
Michigan Center Confluent	B-1, B-2, B-3	Weekly	Same
Portage Confluent	C-1, C-2, C-3	Weekly	Same
Sandstone Confluent	D-1, D-2, D-3	Weekly	Same
Springbrook Confluent	E-1, E-2, E-3(Eaton Co)	Weekly	Same
Rives Village	F-1, F-2, F-3	Weekly	Same
Batese/Portage Confluent	G-1, G-2, G-3	Weekly	Same
Portage drain	H-1, H-2, H-3	Weekly	Same
Summerset/Lk Leann	I-1, I-2, I-3 (Hillsdale Co)	Weekly	Same
McCreedy Confluent	J-1, J-2, J-3	Weekly	Same
Leslie Village	K-1, K-2, K-3(Ingham Co)	Weekly	Same
Dimondale Village	L-1, L-2, L-3 (Ingham)	Weekly	Same

Sample collection and delivery to the respective laboratories was coordinated between the two County Health Departments. The results are as follows:

Site Code	Date/Time Sampled	Date/Time Received	Results (Ecoli)
A-1	5/22/02 11am	5/22/02 2:30pm	34
	5/30/02 12pm	5/30/02 1:45pm	70
	6/03/02	06/03/02	92
	06/12/02	06/12/02	196
	06/17/02	06/17/02	150
	06/24/02	06/24/02	142
	07/01/02	07/01/02	506
	07/08/02	07/08/02	500
	07/15/02	07/15/02	340
	07/22/02	07/22/02	240
	07/29/02	07/29/02	480
	08/05/02	08/05/02	440
	08/12/02	08/12/02	160
	08/19/02	08/19/02	280
	08/27/02	08/27/02	180
A-2	5/22/02 10:55 am	5/22/02 2:30pm	54
	5/30/02	5/30/02	22
	06/03/02	06/03/02	42
	06/12/02	06/12/02	68
	06/17/02	06/17/02	50
	06/24/02	06/24/02	64
	07/01/02	07/01/02	286
	07/08/02	07/08/02	82
	07/15/02	07/15/02	94
	07/22/02	07/22/02	92
	07/29/02	07/29/02	360
	08/05/02	08/05/02	200
	08/12/02	08/12/02	128
	08/19/02	08/19/02	242
	08/27/02	08/27/02	240
A-3	5/22/02 11:15am	5/22/02 2:30pm	0
	5/30/03	5/30/02	4
	06/03/02	06/03/02	2
	06/12/02	06/12/02	4

	06/17/02	06/17/02	2
	06/24/02	06/24/02	0
	07/01/02	07/01/02	30
	07/08/02	07/08/02	204
	07/15/02	07/15/02	6
	07/22/02	07/22/02	0
	07/29/02	07/29/02	48
	08/05/02	08/05/02	12
	08/12/02	08/12/02	6
	08/19/02	08/19/02	2
	08/27/02	08/27/02	8
B-1	5/22/02 11:50am	5/22/02 2:30pm	3
	5/30/02	5/30/02	22
	06/03/02	06/03/02	no sample
	06/12/02	06/12/02	32
	06/17/02	06/17/02	62
	06/24/02	06/24/02	32
	07/01/02	07/01/02	132
	07/08/02	07/08/02	168
	07/15/02	07/15/02	136
	07/22/02	07/22/02	88
	07/29/02	07/29/02	92
	08/05/02	08/05/02	220
	08/12/02	08/12/02	44
	08/19/02	08/19/02	44
	08/27/02	08/27/02	27
B-2	5/22/02 11:36am	5/22/02 2:30pm	50
	5/30/02	5/30/02	26
	06/03/02	06/03/02	40
	06/12/02	06/12/02	70
	06/17/02	06/17/02	86
	06/24/02	06/24/02	92
	07/01/02	07/01/02	264
	07/08/02	07/08/02	240
	07/15/02	07/15/02	220
	07/22/02	07/22/02	240

	07/29/02	07/29/02	108
	08/05/02	08/05/02	680
	08/12/02	08/12/02	136
	08/19/02	08/19/02	124
	08/27/02	08/27/02	162
B-3	5/22/02 11:40am	5/22/02 2:30pm	44
	5/30/02	5/30/02	48
	06/03/02	06/03/02	32
	06/12/02	06/12/02	36
	06/17/02	06/17/02	114
	06/24/02	06/24/02	33
	07/01/02	07/01/02	108
	07/08/02	07/08/02	128
	07/15/02	07/15/02	360
	07/22/02	07/22/02	106
	07/29/02	07/29/02	144
	08/05/02	08/05/02	280
	08/12/02	08/12/02	52
	08/19/02	08/19/02	58
	08/27/02	08/27/02	64
C-1	5/22/02 12:52pm	5/22/02 2:30pm	30
	5/29/02	5/29/02	46
	06/05/02	06/05/02	50
	06/10/02	06/10/02	16
	06/19/02	06/19/02	160
	06/24/02	06/24/02	128
	07/03/02	07/03/02	162
	07/10/02	07/10/02	260
	07/17/02	07/17/02	78
	07/24/02	07/24/02	60
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	240
	08/14/02	08/14/02	180
	08/19/02	08/19/02	68
	08/29/02	08/29/02	122
C-2	5/22/02 12:45pm	5/22/02 2:30pm	38

	5/29/02	5/29/02	64
	06/05/02	06/05/02	52
	06/10/02	06/10/02	70
	06/19/02	06/19/02	512
	06/24/02	06/24/02	124
	07/03/02	07/03/02	180
	07/10/02	07/10/02	88
	07/17/02	07/17/02	62
	07/24/02	07/24/02	84
	07/24/02	07/24/02	No sample
	08/07/02	08/07/02	64
	08/14/02	08/14/02	480
	08/21/02	08/21/02	200 State sample
	08/21/02	08/21/02	102 State sample
	08/29/02	08/29/02	66
C-3	5/22/02 1pm	5/22/02 2:30pm	30
	5/29/02	5/29/02	84
	06/05/02	06/05/02	56
	06/10/02	06/10/02	26
	06/19/02	06/19/02	96
	06/24/02	06/24/02	116
	07/03/02	07/03/02	234
	07/10/02	07/10/02	400
	07/17/02	07/17/02	88
	07/24/02	07/24/02	38
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	60
	08/14/02	08/14/02	220
	08/14/02	08/15/02	6000 State sample
	08/14/02	08/15/02	120
	08/21/02	08/21/02	64
	08/29/02	08/29/02	82
D-1	5/24/02 11:45am	5/24/02 12:30pm	24 Grab sample
	5/29/02	5/29/02	44
	06/07/02	06/07/02	36
	06/10/02	06/10/02	66

	06/19/02	06/19/02	136
	06/26/02	06/26/02	122
	07/03/02	07/03/02	144
	07/10/02	07/10/02	760
	07/17/02	07/17/02	98
	07/24/02	07/24/02	100
	07/29/02	07/29/02	No Sample
	08/07/02	08/07/02	88
	08/14/02	08/14/02	128
	08/14/02	08/15/02	240
	08/21/02	08/21/02	60
	08/29/02	08/29/02	48
D-2	5/24/02 11:50am	5/24/02 12:30pm	48 Grab sample
	5/29/02	5/29/02	42
	06/07/02	06/07/02	68
	06/10/02	06/10/02	38
	06/19/02	06/19/02	118
	06/26/02	06/26/02	90
	07/03/02	07/03/02	90
	07/10/02	07/10/02	480
	07/17/02	07/17/02	120
	07/24/02	07/24/02	132
	07/29/02	07/29/02	No Sample
	08/07/02	08/07/02	74
	08/14/02	08/14/02	480 State sample
	08/14/02	08/15/02	2000 State sample
	08/21/02	08/21/02	68
	08/29/02	08/29/02	78
D-3	5/24/02 12pm	5/24/02 12:30pm	68 Grab sample
	5/29/02	5/29/02	62
	06/07/02	06/07/02	52
	06/10/02	06/10/02	44
	06/19/02	06/19/02	46
	06/26/02	06/26/02	80
	07/03/02	07/03/02	144
	07/10/02	07/10/02	260

	07/17/02	07/17/02	142
	07/24/02	07/24/02	86
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	32
	08/14/02	08/14/02	140
	08/14/02	08/15/02	280
	08/21/02	08/21/02	48
	08/29/02	08/29/02	92
E-1	5/24/02	5/24/02	30
	5/29/02	5/29/02	10
	06/07/02	06/07/02	20
	06/10/02	06/10/02	18
	06/19/02	06/19/02	30
	06/26/02	06/26/02	44
	07/03/02	07/03/02	58
	07/10/02	07/10/02	72
	07/17/02	07/17/02	104
	07/24/02	07/24/02	36
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	52
	08/14/02	08/14/02	120
	08/14/02	08/15/02	120 State sample
	08/21/02	08/21/02	44
	08/29/02	08/29/02	46
E-2	5/24/02	5/24/02	14
	5/29/02	5/29/02	14
	06/07/02	06/07/02	28
	06/10/02	06/10/02	18
	06/19/02	06/19/02	102
	06/26/02	06/26/02	64
	07/03/02	07/03/02	80
	07/10/02	07/10/02	90
	07/17/02	07/17/02	62
	07/24/02	07/24/02	76
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	62

	08/14/02	08/14/02	48
	08/14/02	08/15/02	110 State sample
	08/21/02	08/21/02	50
	08/29/02	08/29/02	58
E-3	5/24/02	5/24/02	28
	5/29/02	5/29/02	30
	06/07/02	06/07/02	26
	06/10/02	06/10/02	34
	06/19/02	06/19/02	56
	06/26/02	06/26/02	34
	07/03/02	07/03/02	112
	07/10/02	07/10/02	42
	07/17/02	07/17/02	90
	07/24/02	07/24/02	74
	08/07/02	08/07/02	90
	08/14/02	08/14/02	76
	08/14/02	08/15/02	160
	08/14/02	08/15/02	800
	08/21/02	08/21/02	90
	08/29/02	08/29/02	83
F-1	5/24/02	5/24/02	122
	5/29/02	5/29/02	146
	06/05/02	06/05/02	50
	06/10/02	06/10/02	64
	06/19/02	06/19/02	800
	06/26/02	06/26/02	64
	07/03/02	07/03/02	720
	07/10/02	07/10/02	280
	07/17/02	07/17/02	No sample
	07/24/02	07/24/02	140
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	110
	08/14/02	08/14/02	440
	08/14/02	08/15/02	1300 State sample
	08/21/02	08/21/02	90
	08/29/02	08/29/02	46

F-2	5/24/02	5/24/02	98
	5/29/02	5/29/02	46
	06/05/02	06/05/02	36
	06/10/02	06/10/02	20
	06/19/02	06/19/02	256
	06/26/02	06/26/02	76
	07/03/02	07/03/02	144
	07/10/02	07/10/02	720
	07/17/02	07/17/02	280
	07/24/02	07/24/02	116
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	182
	08/14/02	08/14/02	426
	08/14/02	08/15/02	700 State sample
	08/21/02	08/21/02	32
	08/29/02	08/29/02	70
F-3	5/24/02	5/24/02	82
	5/29/02	5/29/02	78
	06/05/02	06/05/02	40
	06/10/02	06/10/02	294
	06/19/02	06/19/02	448
	06/26/02	06/26/02	416
	07/03/02	07/03/02	576
	07/10/02	07/10/02	280
	07/17/02	07/17/02	560
	07/24/02	07/24/02	234
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	78
	08/14/02	08/14/02	438
	08/14/02	08/15/02	900 State sample
	08/21/02	08/21/02	66
	08/29/02	08/29/02	240
G-1	5/22/02	5/22/02	20
	5/30/02	5/30/02	16
	06/05/02	06/05/02	54
	06/10/02	06/10/02	120

	06/19/02 06/26/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/14/02 08/21/02 08/29/02 08/29/02	06/19/02 06/26/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/15/02 08/21/02 08/29/02 08/29/02	288 116 432 240 162 144 No sample 160 362 700 92 460 State sample 222
G-2	5/22/02 5/30/02 06/05/02 06/10/02 06/19/02 06/26/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/14/02 08/21/02 08/29/02 08/29/02	5/22/02 5/30/02 06/05/02 06/10/02 06/19/02 06/26/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/15/02 08/21/02 08/29/02 08/29/02	10 40 92 150 352 78 504 420 106 142 No sample 82 244 800 State sample 280 840
G-3	5/22/20 5/30/02 06/05/02 06/10/02 06/19/02 06/26/02	5/22/02 5/30/02 06/05/02 06/10/02 06/19/02 06/26/02	15 42 50 82 224 60

	07/03/02	07/03/02	432
	07/10/02	07/10/02	360
	07/17/02	07/17/02	126
	07/24/02	07/24/02	126
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	92
	08/14/02	08/14/02	128
	08/21/02	08/21/02	180
	08/29/02	08/29/02	172
H-1	5/22/02	5/22/02	37
	5/29/02	5/29/02	102
	06/05/02	06/05/02	26
	06/10/02	06/10/02	no sample
	06/19/02	06/19/02	544
	06/26/02	06/26/02	598
	07/03/02	07/03/02	342
	07/10/02	07/10/02	180
	07/17/02	07/17/02	480
	07/24/02	07/24/02	242
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	320
	08/14/02	08/14/02	186
	08/14/02	08/15/02	900 State sample
	08/21/02	08/21/02	86
	08/29/02	08/29/02	198
H-2	5/22/02	5/22/02	62
	5/29/02	5/29/02	122
	06/05/02	06/05/02	248
	06/10/02	06/10/02	536
	06/19/02	06/19/02	192
	06/26/02	06/26/02	234
	07/03/02	07/03/02	160
	07/10/02	07/10/02	188
	07/17/02	07/17/02	320
	07/24/02	07/24/02	170
	07/29/02	07/29/02	No sample

	08/07/02	08/07/02	102
	08/14/02	08/14/02	218
	08/14/02	08/15/02	800 State sample
	08/21/02	08/21/02	186
	08/29/02	08/29/02	264
H-3	5/22/02	5/22/02	112
	5/29/02	5/29/02	98
	06/05/02	06/05/02	72
	06/10/02	06/10/02	516
	06/19/02	06/19/02	384
	06/26/02	06/26/02	198
	07/03/02	07/03/02	120
	07/10/02	07/10/02	520
	07/17/02	07/17/02	322
	07/24/02	07/24/02	128
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	96
	08/14/02	08/14/02	98
	08/14/02	08/15/02	1400 State sample
	08/21/02	08/21/02	220
	08/29/02	08/29/02	244
I-1	5/22/02	5/22/02	8
	5/30/02	5/30/02	28
	06/03/02	06/03/02	122
	06/12/02	06/12/02	78
	06/17/02	06/17/02	98
	06/24/02	06/24/02	312
	07/01/02	07/01/02	814
	07/10/02	Not enough water	to take sample
	07/15/02	07/15/02	No sample
	07/22/02	07/22/02	360
	07/29/02	07/29/02	220
	08/05/02	08/05/02	34
	08/12/02	08/12/02	740
	08/19/02	08/19/02	128
	08/27/02	08/27/02	68

I-2	5/22/02	5/22/02	No sample
	5/30/02	5/30/02	No sample
	06/03/02	06/03/02	No sample
	06/12/02	06/12/02	No sample
	06/17/02	06/17/02	No sample
	06/24/02	06/24/02	No sample
	07/01/02	07/01/02	No sample
	07/08/02	07/08/02	No sample
	07/15/02	07/15/02	No sample
	07/22/02	07/22/02	No sample
	07/29/02	07/29/02	No sample
	08/05/02	08/05/02	No sample
	08/12/02	08/12/02	No sample
	08/19/02	08/19/02	No sample
	08/27/02	08/27/02	No sample
I-3	5/22/02	5/22/02	4
	5/30/02	5/30/02	6
	06/03/02	06/03/02	6
	06/12/02	06/12/02	12
	06/17/02	06/17/02	54
	06/24/02	06/24/02	16
	07/01/02	07/01/02	18
	07/08/02	07/08/02	46
	07/15/02	07/15/02	64
	07/22/02	07/22/02	116
	07/29/02	07/29/02	54
	08/05/02	08/05/02	420
	08/12/02	08/12/02	64
	08/19/02	08/19/02	26
	08/27/02	08/27/02	26
J-1	5/22/02	5/22/02	12
	5/30/02	5/30/02	14
	06/03/02	06/03/02	130
	06/17/02	06/17/02	242
	06/24/02	06/24/02	1274
	07/01/02	07/01/02	682

	07/08/02	07/08/02	1220
	07/15/02	07/15/02	720
	07/22/02	07/22/02	820
	07/29/02	07/29/02	720
	08/05/02	08/05/02	340
	08/12/02	08/12/02	122
	08/19/02	08/19/02	108
	08/27/02	08/27/02	200
J-2	5/22/02	5/22/02	14
	5/30/02	5/30/02	32
	06/03/02	06/03/02	116
	06/12/02	06/12/02	68
	06/17/02	06/17/02	84
	06/24/02	06/24/02	116
	07/01/02	07/01/02	330
	07/08/02	07/08/02	560
	07/15/02	07/15/02	362
	07/22/02	07/22/02	170
	07/29/02	07/29/02	620
	08/05/02	08/05/02	380
	08/12/02	08/12/02	440
	08/19/02	08/19/02	264
	08/27/02	08/27/02	128
J-3	5/22/02	5/22/02	44
	5/30/02	5/30/02	56
	06/03/02	06/03/02	34
	06/12/02	06/12/02	30
	06/17/02	06/17/02	30
	06/24/02	06/24/02	108
	07/01/02	07/01/02	374
	07/08/02	07/08/02	210
	07/15/02	07/15/02	280
	07/22/02	07/22/02	320
	07/29/02	07/29/02	262
	08/05/02	08/05/02	440
	08/12/02	08/12/02	302

	08/19/02 08/27/02	08/19/02 08/27/02	128 84
K-1	5/24/02 5/29/02 06/05/02 06/10/02 06/19/02 06/24/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/14/02 08/21/02 08/29/02	5/24/02 5/29/02 06/05/02 06/10/02 06/19/02 06/24/02 07/03/02 07/10/02 07/17/02 07/24/02 007/29/02 08/07/02 08/14/02 08/15/02 08/21/02 08/29/02	270 162 66 128 256 264 576 78 328 340 No sample 620 282 900 212 112
K-2	5/24/02 5/29/02 06/05/02 06/10/02 06/19/02 06/24/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/21/02 08/29/02	5/24/02 5/29/02 06/05/02 06/10/02 06/19/02 06/24/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/21/02 08/29/02	206 360 66 232 768 88 396 84 252 108 No sample 98 152 36 126
K-3	5/24/02 5/29/02 06/05/02	5/24/02 5/29/02 06/05/02	562 172 60

	06/10/02	06/10/02	194
	06/19/02	06/19/02	352
	06/24/02	06/24/02	132
	07/03/02	07/03/02	450
	07/10/02	07/10/02	136
	07/17/02	07/17/02	286
	07/24/02	07/24/02	228
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	72
	08/14/02	08/14/02	248
	08/21/02	08/21/02	240
	08/29/02	08/29/02	116
L-1	5/24/02	5/24/02	26
	5/29/02	5/29/02	36
	06/05/02	06/05/02	30
	06/10/02	06/10/02	34
	06/19/02	06/19/02	25
	06/26/02	06/26/02	30
	07/03/02	07/03/02	46
	07/10/02	07/10/02	420
	07/17/02	07/17/02	60
	07/24/02	07/24/02	146
	07/29/02	07/29/02	No sample
	08/07/02	08/07/02	74
	08/14/02	08/14/02	34
	08/14/02	08/15/02	100 State sample
	08/21/02	08/21/02	52
	08/29/02	08/29/02	64
L-2	5/24/02	5/24/02	14
	5/29/02	5/29/02	36
	06/05/02	06/05/02	22
	06/10/02	06/10/02	22
	06/19/02	06/19/02	64
	06/26/02	06/26/02	52
	07/03/02	07/03/02	49
	07/10/02	07/10/02	440

	07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/14/02 08/21/02 08/29/02	07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/15/02 08/21/02 08/29/02	85 94 No sample 76 24 120 92 86
L-3	5/24/02 5/29/02 06/05/02 06/10/02 06/19/02 06/26/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/14/02 08/21/02 08/29/02	5/24/02 5/29/02 06/05/02 06/10/02 06/19/02 06/26/02 07/03/02 07/10/02 07/17/02 07/24/02 07/29/02 08/07/02 08/14/02 08/15/02 08/21/02 08/29/02	36 108 18 32 30 104 96 426 62 84 No sample 68 37 100 State Sample 68 86

APPENDIX C

GeoBook Analysis Report

Upper Grand River Watershed Initiative

Prioritization Analyses
Final Report

Prepared for:

Jackson County Drain Commissioner

May 10, 2002

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Ann Arbor, Michigan 48108

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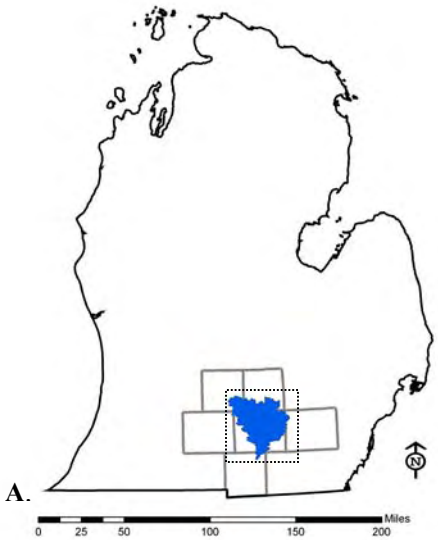
1.0 Introduction

1.1 Background

There are many issues confronting agencies and local government concerned about the quality of their water resources. These issues are complex and interrelated. Everyone who lives, works, and travels through the watershed influences these issues. The Upper Grand River Watershed drains approximately 700 square miles of Southern Michigan flowing North out of Hillsdale County to Eaton Rapids and Lansing, where it continues on as the Grand River, flowing west to Lake Michigan (Figures 1 & 2).



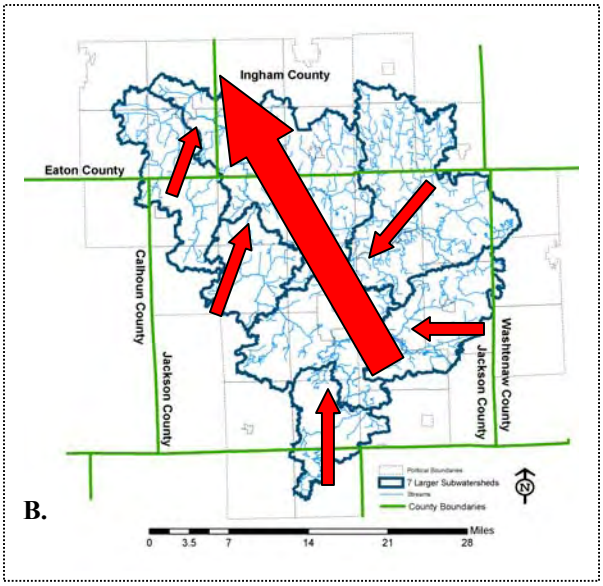


Figure 1A: Location of the Upper Grand River Watershed, as defined by the Upper Grand River Watershed Initiative, within the state of Michigan.

Figure 1B: Stream flow direction through the Upper Grand River Watershed.

The Upper Grand River Watershed Planning Initiative was awarded a 319 grant funding to develop a watershed management plan for the Upper Grand River Basin. This watershed encompasses areas in Hillsdale, Jackson, Eaton, Ingham, Washtenaw, and Calhoun Counties. Partners involved in this project include the Jackson County Drain Commission, City of Jackson, Grand River Inter-county Drainage Board, the Region 2 Planning Commission, the Jackson County Conservation District, the Ingham and Jackson County Health Departments, Dahlem Environmental Education Center, the Grand River Environmental Action Team (GREAT), Tetra Tech MPS, Space Imaging, municipalities, contractors, and other partners. The major components of this project include:

- Development of a Watershed Management Plan
- Development of a GeoBook: an interactive, user-friendly geographic information tool tailored to the Upper Grand Watershed

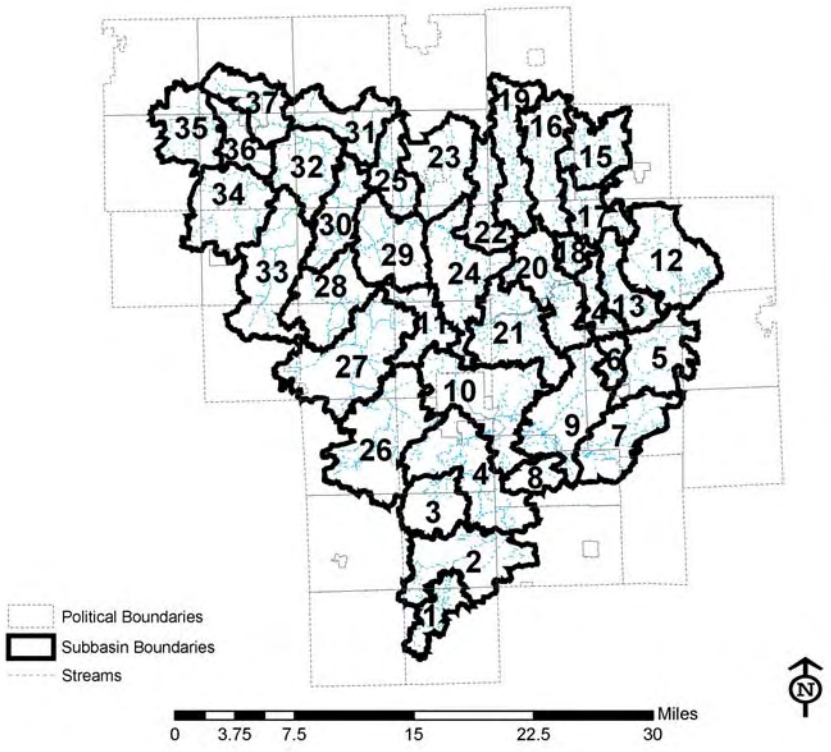
- Development of a regional watershed information and education strategy and workshops
- Creation of a volunteer monitoring program
- Analysis of institutional capacity for sustained watershed management
- Bacteriological sampling by Health Departments
- Analysis of riparian farmland for buffer and wetland programs

Within this planning initiative, Space Imaging was contracted to perform several GIS analyses to identify areas of concern throughout the watershed and to create the GeoBook. These GIS analyses were based on the following issues of concern outlined by the Upper Grand River Watershed Initiative Steering Committee:

1) Percent of riparian area that is grassland, wetland or forest.
2) Extent of the river valley bottom and land use within that valley bottom, including areas where agricultural flooding would be expected.
3) Loss and fragmentation of wetlands compared to circa 1800.
4) Undeveloped areas for preservation or purchase factors including:
    i. Areas of contiguous natural open space
    ii. Areas that of high potential for a rails to trails
    iii. Areas along the Portage River linking Pinckney - Waterloo - Jackson
5) Estimates of potential peak flow
6) Potential of streambank erosion, soil erosion resulting from high peak flows
7) Potential of soil erosion from agricultural fields
8) Biological Integrity
    i. Records of historic fish communities within each subbasin
    ii. Macro-invertebrate community health
    iii. Threatened and endanger species
9) Potential impact of septic failure
10) Potential impact of manure application runoff
11) Potential non point source nitrogen and phosphorus loads

The above issues of concern were examined in each subbasin across the watershed (Figure 2). Results from individual subbasins were compared with each other in order to identify hotspots within the watershed for each issue.

The watershed names were based on local knowledge, therefore, subbasins may be known by other names. Those subbasins with 2 - 3 drains were named by a combination of the drain names. Subbasins with >3 drains were named by the most downstream drain. The watershed boundaries may or may not match legally established drainage districts, however, they do match the official subbasin boundaries used by the State of Michigan.



1 Lake LeAnn
2 Southern Liberty Township Drains
3 Sharp Creek
4 Pierce Drain
5 Grass Lake Drain
6 Grass Lake Outlet
7 Wolf Lake and Drain
8 Cranberry Lake Drain
9 Huttenlocker and Crittenden Drains
10 Grand River Drain - Upstream
11 Tobin Snyder Drain
12 Portage River - Source
13 Portage River - Middle Branch 1
14 Portage River - Middle Branch 2
15 Pickett and Jacobs Drains
16 Cahaogen Creek
17 Wild Drain
18 Orchard Creek
19 Batteese Creek
20 Portage River - Middle Branch 3
21 Portage River - Lower Branch
22 Western Creek
23 Huntoon Creek
24 Grand River Drain - Downstream
25 Perry Creek
26 Sandstone Blackman Drain
27 Sandstone Creek - Middle Branch
28 Sandstone Creek - Lower Branch
29 Darling-Christie Drain
30 Bromly Tile Drain
31 Willow Creek
32 Baldwin and Puffenberger Drains
33 Spring Brook - Source
34 Spring Brook - Middle Branch
35 Mills and Post Drain
36 Spring Brook - Lower Branch
37 Unnamed Tributary

Figure 2: The subbasins of the Upper Grand River Watershed.

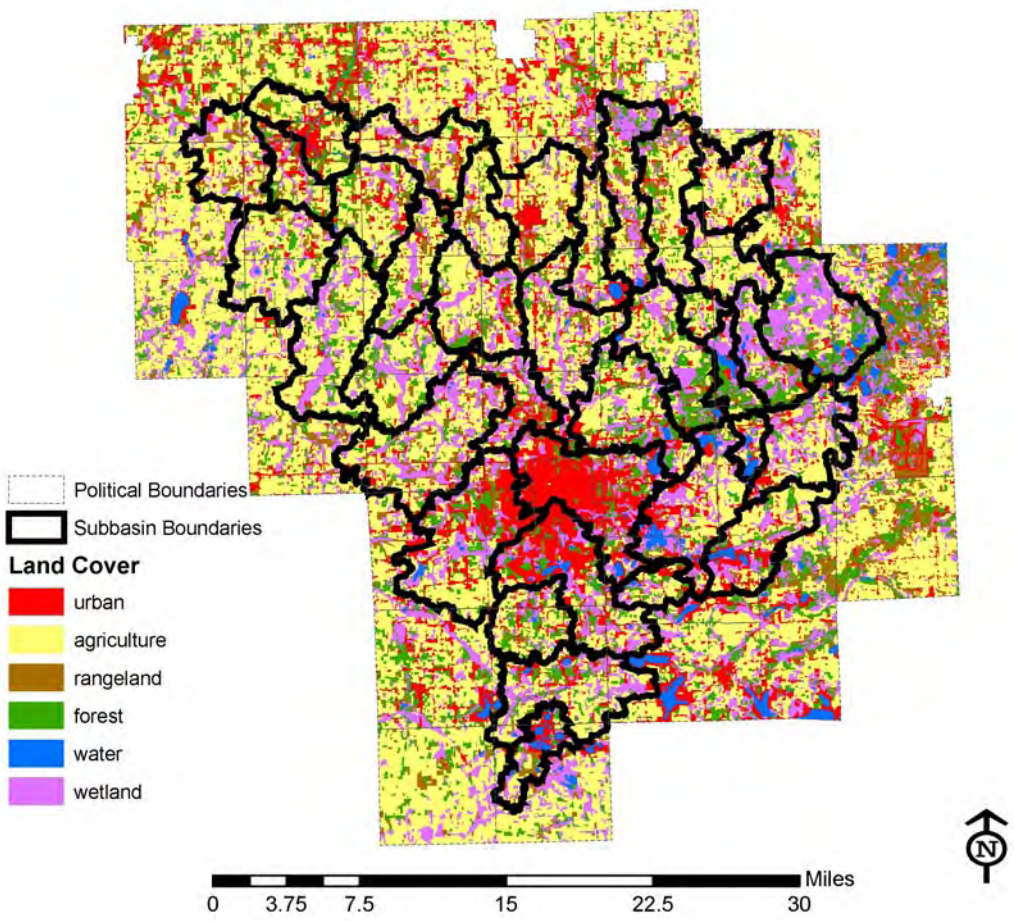


Figure 3: Land cover map of the townships completely or partially within the Upper Grand River Watershed.

1.2 Purpose of the Document

This report summarizes the watershed prioritization analyses performed by Space Imaging for the Upper Grand River Watershed. It is meant to explain the methods and results of the analyses performed to address the issues of concern stated above using a series of text, tables, and figures. While the results will be broadly available in the Upper Grand River Watershed GeoBook™, this report provides more discussion of the relationship of some of the analyses to each other and to spatial patterns found in the field assessments performed by the Michigan Department of Environmental Quality, Surface Water Quality Division. This report is intended to serve as a starting point for future watershed planning and restoration initiatives.

1.3 Definition of Terms and Abbreviations

A number of technical terms and acronyms are used throughout this document. To aid the reader in interpreting these, and to minimize the use of footnotes, the following table provides definitions for the terms used in this document.

Term	Description
100-year storm	A rainfall event with a 0.01 probability of occurring.
CSO	Combined Sewer Overflow
EMC	Event mean concentration, or the concentration of a pollutant in stormwater runoff.
FEMA	The Federal Emergency Management Agency is an independent branch of the federal government responsible for floodplain management, among other disaster prevention and relief duties.
Level 1	The highest tier of land cover classification. Categories are: urban, agriculture, grassland, forest, water, and wetland.
MDEQ	Michigan Department of Environmental Quality
NRCS	Natural Resources Conservation Service
Potential contributing source area	All topographic areas upslope of connected portions of the stream network. This is a subset of the watershed, eliminating areas that are internally drained. (Richards and Brenner 2001)
Townshed	The boundaries of all townships that entirely or partially drain to the Upper Grand River. All prioritization analyses were calculated for the full extent of this coverage.

Table 1: Definition of terms

1.4 Content of the Report

This report contains the results of the ten analyses performed by Space Imaging for the Upper Grand River Watershed Initiative. These results are explained in the text of the report and displayed graphically in tables and figures. The methods and results of each analysis are described in detail in Section 2 of this report; also indicated are the five highest scoring subbasins and five lowest scoring subbasins for each analysis.

Each analysis has a map that compares the subbasins. For each analysis, the subbasins are grouped into 5 categories,

1) very low
2) low
3) moderate
4) high, and
5) very high.

These categories are represented in the maps with a color scheme that ranges from red to blue. In all analyses, the 'healthier' or less impacted subbasins are in blue and the most severely impacted subbasins are in red with the spectrum in between. For Riparian Buffers (Analysis 1), Valley Bottom – Natural (Analysis 2 Part 1), and Remaining Wetlands (Analysis 3),

1) very low is in red
2) low is in orange
3) moderate is in yellow
4) high is in green , and
5) very high is in blue.

For the remaining analyses the color scheme is reversed so that the reader can see the healthiest subbasins remaining in blue and the most severely impacted subbasins will still be in red. However, now

1) very low is in blue
2) low is in green
3) moderate is in yellow
4) high is in orange, and
5) very high is in red.

In addition to the coloring of the subbasin, the resulting numeric values of each analysis are displayed inside the subbasin. In many cases these values have been rounded within their resulting severity category for ease of display. These numeric values are presented for comparative reasons so the differences between subbasins can be assessed. These numbers are not calibrated and should not be considered as absolute numbers, but rather as a basis for comparison among the 37 subbasins of the Upper Grand River Watershed.

Due to the amount of information displayed in each of the analysis comparison maps, minimal but consistent location references are given on these maps. The first map of the set (Figure 2) displays all of the subbasins and their unique identification number with the political boundaries of all cities and townships completely or partially within the watershed.

In Section 3 multiple issues are overlain. This analysis enables the reader to identify those subbasins that are severely impacted by multiple issues. This section also contains tables listing the subbasins on the highest scoring and lowest scoring lists.

Additional tables for specific analyses and scores of each subbasin are given in Appendix 1. Appendix 2 lists historical species information as well as Michigan's threatened and endangered species, while Appendix 3 contains soil maps of the townshed area.

2.0 Prioritization Analyses

2.1 Riparian Buffers

Methods

This analysis examined the area of intact natural riparian buffer within each subbasin. Although we have acknowledged that very little of the landscape in SE Michigan is natural, we have termed this grouping of land covers "natural" land cover to differentiate it from intensively managed uses such as urban and agriculture. Here, two buffer widths were examined in each watershed: 100 ft and 500 ft. The natural land cover was defined using the most current land cover dataset available (Figure 3). The buffers themselves were measured from the digitized streamlines in the Michigan Base Map files. Streams represented as a single line were buffered from the centerline of the stream. Streams represented as polygons were buffered from the edge of the polygon, or the stream bank.

In order to calculate the percent of riparian area in natural land cover for each subbasin, the land cover dataset was intersected with the each of the two riparian buffers. These data were then summarized by subbasin. The percent of natural land was used to rank the 37 subbasins from least disturbed to most disturbed.

Each subbasin was categorized with respect to the amount of natural land within the riparian buffer. Categories were determined by assessing the means and standard deviations of the resulting data from the 100 ft and 500 ft buffers and the river valley natural area analysis. The categories are:

very low (0-45%);
low (45-55%);
moderate (55-65%);
high (65-80%);
and very high (80-100%).

Results

The percentage land cover that was natural within a 100 ft riparian buffer in an individual subbasin ranges from 37% to 92%, with a mean of 69% (Table 2). The percentage of land cover that was natural within a 500 ft riparian buffer was slightly less, with ranges from 32% to 82% and a mean of 58% (Table 3).

Rankings of individual subbasins were similar with both riparian buffer widths (Figures 4 & 5). Many subbasins in Jackson County had a higher percent of natural area in the 100 ft riparian buffer than the 500 ft riparian buffer -- indicating that although some natural riparian areas were left intact, the human disturbance increased with lateral distance from the stream. On average, this trend also held when comparing the 100 ft riparian buffer with the natural areas in the river valley bottom (Figure 7).

RANK	NAME	100 ft Buffer Percent Natural Area
1	Portage River – Middle Branch 1	92
2	Sandstone Creek – Lower Branch	90
3	Portage River - Source	89
4	Spring Brook - Source	89
5	Southern Liberty Township Drains	85
33	Cahaogen Creek	46
34	Lake LeAnn	46
35	Huntoon Creek	45
36	Wild Drain	39
37	Pickett and Jacobs Drain	37

Table 2: Highest and lowest percent of land cover that is natural within 100 ft riparian buffer

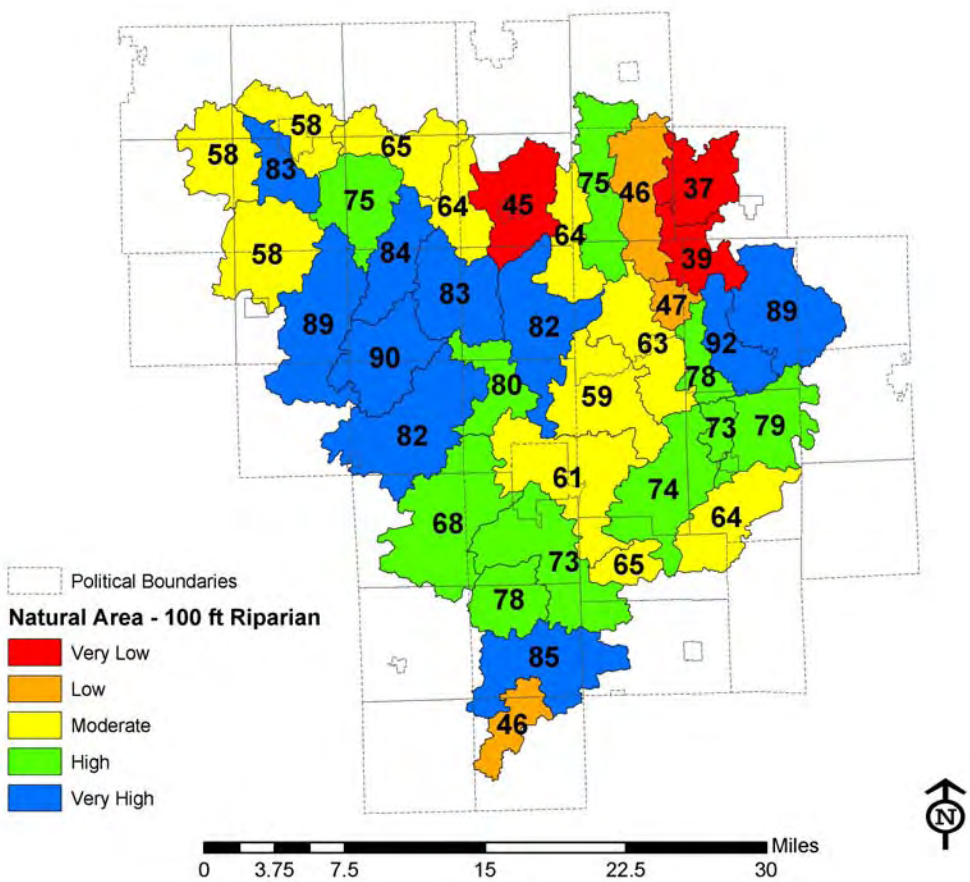


Figure 4: Percent of 100 ft riparian buffer that is natural land.

RANK	NAME	500 ft Buffer Percent Natural Area
1	Portage River – Source	82
2	Portage River – Middle Branch 1	82
3	Spring Brook - Source	77
4	Sandstone Creek – Lower Branch	75
5	Portage River – Middle Branch 2	74
33	Orchard Creek	41
34	Cahaogen Creek	39
35	Huntoon Creek	35
36	Wild Drain	33
37	Pickett and Jacobs Drain	32

Table 3: Highest and lowest percent of land cover that is natural within 500 ft riparian buffer.

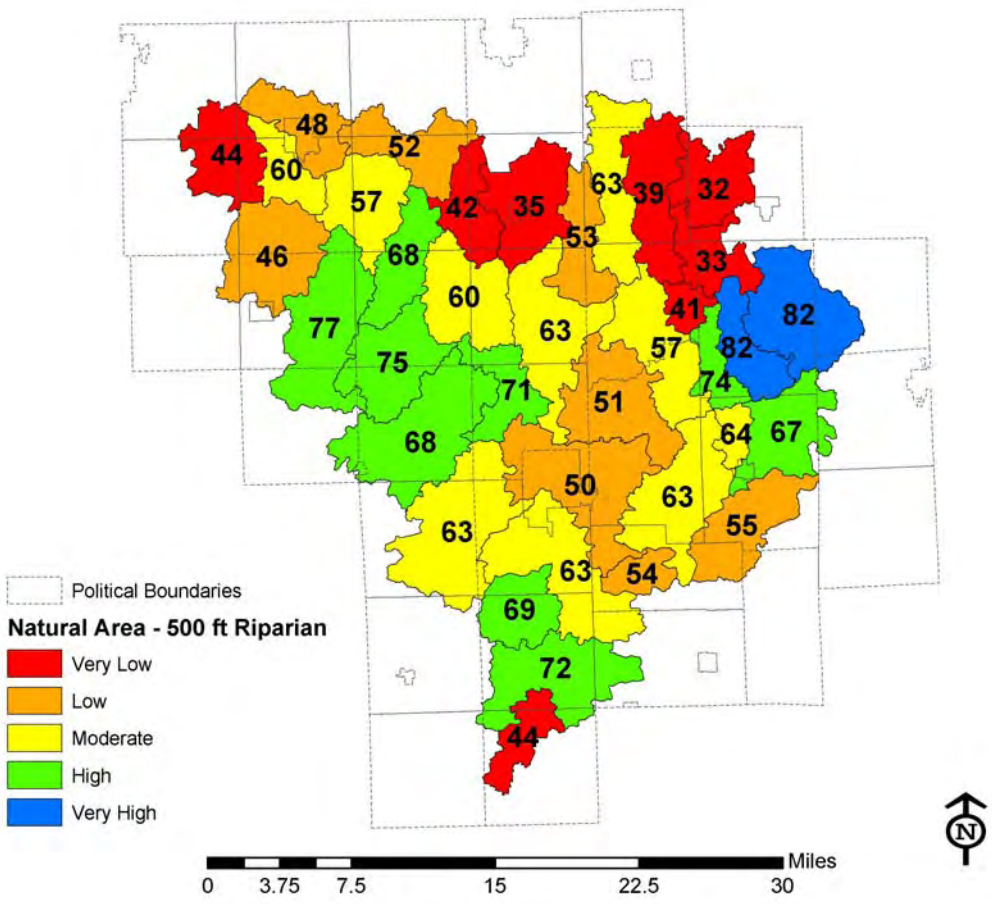


Figure 5: Percent of 500 ft riparian buffer that is natural land.

2.2 River Valley Bottom

Methods

The valley bottom analysis examined the percent of natural area in the Upper Grand River's valley bottom -- defined as an area adjacent to the stream with the same elevation as the stream. Elevation was defined using the currently available, 1:24,000 scale digital elevation model, obtained from the Michigan Department of Natural Resources. Variations in river valley bottom width throughout the watershed resulted from actual variations in elevation as well as variation in resolution of the digital elevation model (Figure 6). This area is referred to as the river valley bottom instead of a floodplain because it did not conform to the floodplains as defined by the Federal Emergency Management Agency (FEMA). Additionally, the resolution of the digital elevation model used was not sufficient to delineate floodplains in this way.

The valley bottom analysis differed from the riparian analysis in that it examined areas of land with the same elevation as the stream regardless of their lateral distance from the stream. The percent of natural area in the river valley bottom of each subbasin was calculated and placed into one of the following:

very low (0-45%);
low (45-55%);
moderate (55-65%);
high (65-80%);
and very high (80-100%).

The percentage of the valley bottom with agricultural land cover was also examined. This was done using the same land cover data set as the natural areas and the river valley bottom as defined above. The percent of agricultural area in the river valley bottom of each subbasin was calculated and placed into one of the following:

very low (0-20%);
low (20-35%);
moderate (35-45%);
high (45-55%);
and very high (55-100%).

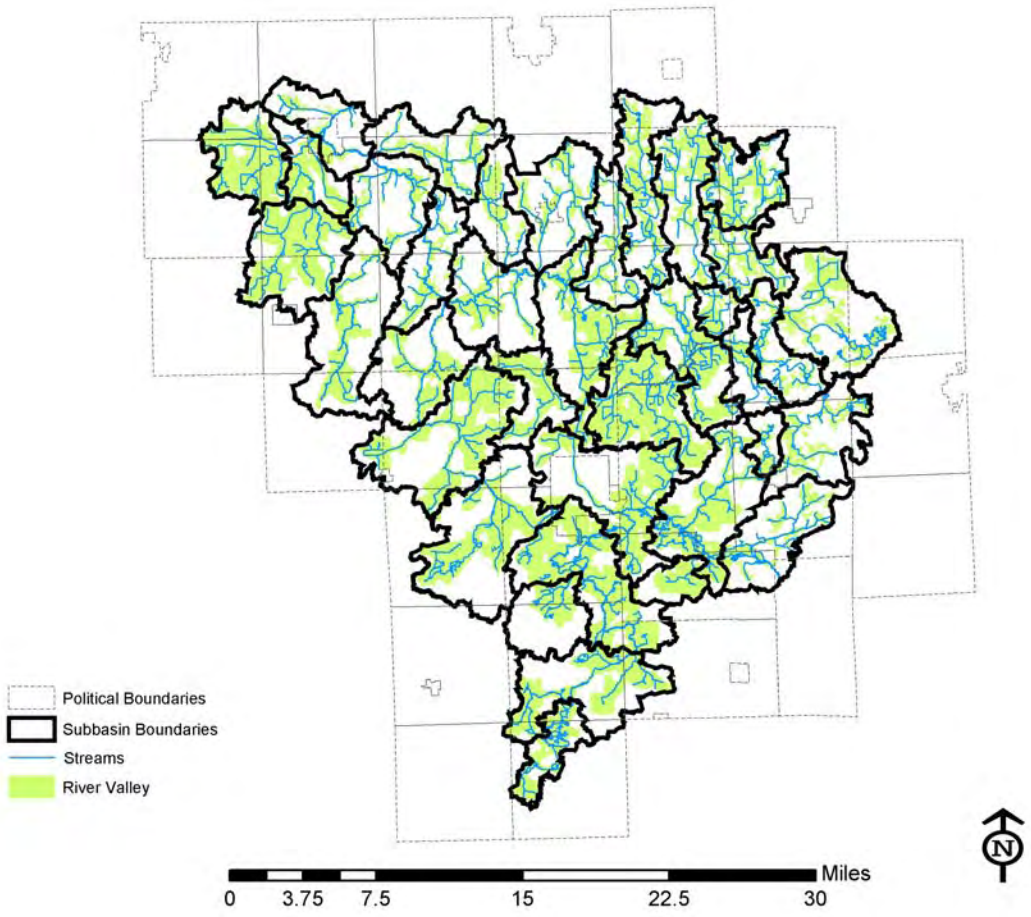


Figure 6: Extent of valley bottom

Results

The percent land cover that was natural (grassland, forest, wetland) within the valley bottom of each subbasin ranged from 33% to 89%, with a mean of 52% (Table 4). The percentage land cover in agriculture in the valley bottom of each subbasin ranged from 8% to 60% with a mean of 35% (Table 5). The subbasins in the watershed with the highest percentage of natural area in the valley bottom were located in Northeast Jackson County (Figure 7), in and near the Pinckney and Waterloo Recreation Areas, managed by the Michigan Department of Natural Resources. Similarly, these subbasins also had the least amount of agriculture in their valleys bottoms, as they have been primarily natural areas managed for recreation.

According to the current land cover data, the areas with the highest percentage of their valley bottoms in agriculture were in Southern Ingham County (Figure 8A), an area dominated by agriculture. However, when examining what portion of the total agriculture in a subbasin falls within the river valley, the hotspot subbasins changed (Figure 8B). These subbasins, Portage River - Lower Branch, Unnamed Tributary, and Spring Brook – Middle Branch had most of their subbasin-wide agriculture at the same elevation as the stream.

Because this analysis used the most current land cover data available to locate agricultural land, it has not captured the historical flooding trends throughout the watershed. For example, as a part of the larger Upper Grand River Watershed Initiative, the Jackson County Conservation District examined areas in the watershed historically known for agricultural flooding. They have found numerous studies (Abbey 1954, Anonymous 1954, USDA 1958 and USDA 1968) describing substantial agricultural damage from flooding, particularly in the lower portions of the Portage River.

RANK	NAME	Valley Bottom Percent Natural Area
1	Portage River - Source	89
2	Portage River – Middle Branch 1	84
3	Portage River – Middle Branch 2	78
4	Grass Lake Outlet	68
5	Bromly Tile Drain	67
34	Wild Drain	38
34	Spring Brook – Middle Branch	38
34	Unnamed Tributary	38
35	Perry Creek	36
36	Huntoon Creek	34
37	Pickett and Jacobs Drain	33

Table 4: The 5 subbasins that have that have the highest and lowest percent natural area in their valley bottom.

RANK	NAME	Valley Bottom Percent Agricultural Area
1	Pickett and Jacobs Drain	60
2	Wild Drain	59
2	Perry Creek	59
3	Spring Brook Middle Branch	58
4	Unnamed Tributary	54
4	Cahaogen Creek	54
33	Portage River – Middle Branch 2	14
34	Grass Lake Outlet	13
35	Portage River – Middle Branch 1	12
36	Portage River - Source	9
37	Grand River Drain - Upstream	8

Table 5: The 5 subbasins that have that have the highest and lowest percent agricultural area in their valley bottom.

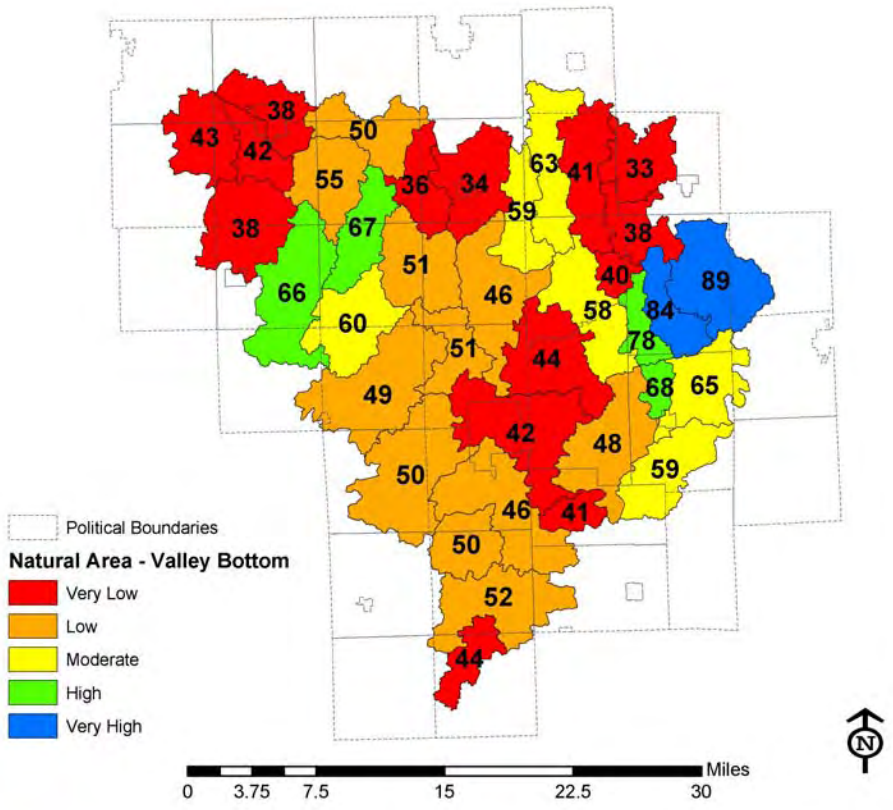


Figure 7: Percent of valley bottom that has natural land cover

Not surprisingly, a strong relationship was evident between the subbasins with the most agriculture in their valley bottoms and those with the least amount of natural area and vice versa. Comparing the results, five of the six subbasins having the most agriculture in their valley bottoms also scored the lowest for their lack of natural areas (Tables 4 & 5). The opposite held true, apart from the Grand River Drain – Upstream (Tables 4 & 5), where the non-natural areas are generally urban.

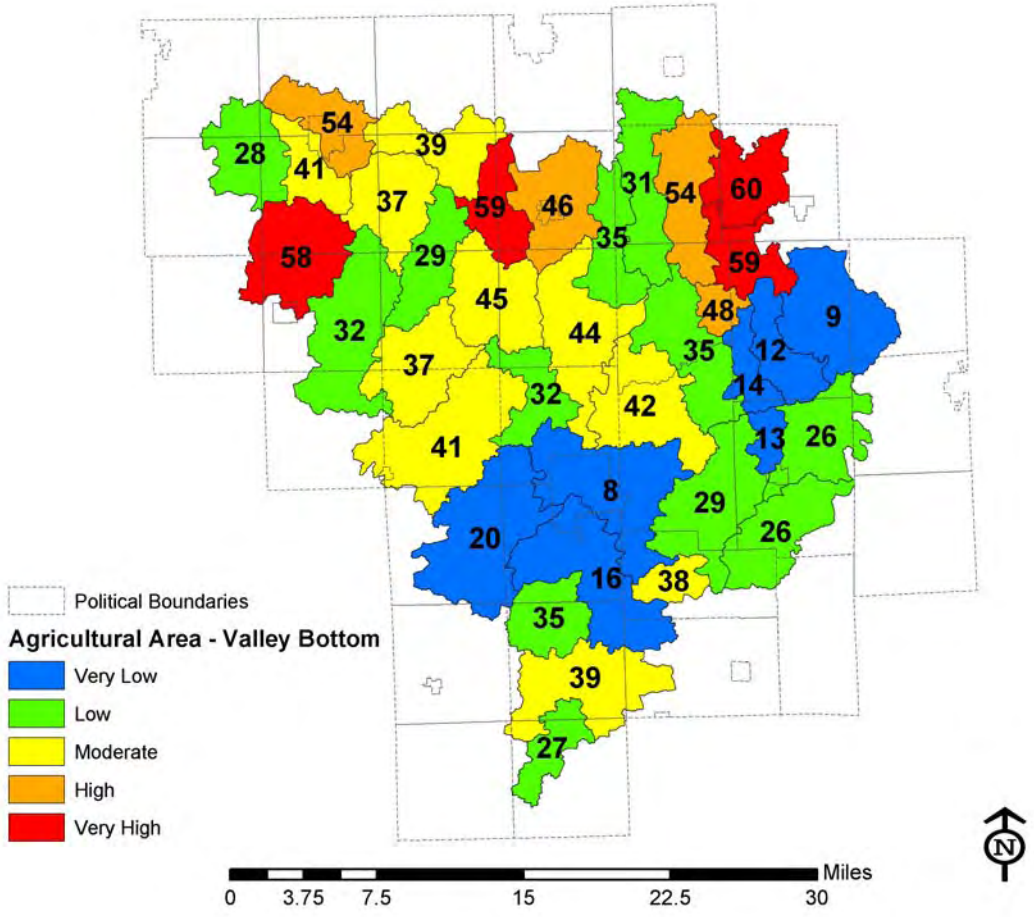


Figure 8A: Percent of the river valley bottom (Figure 6) that has agricultural land cover

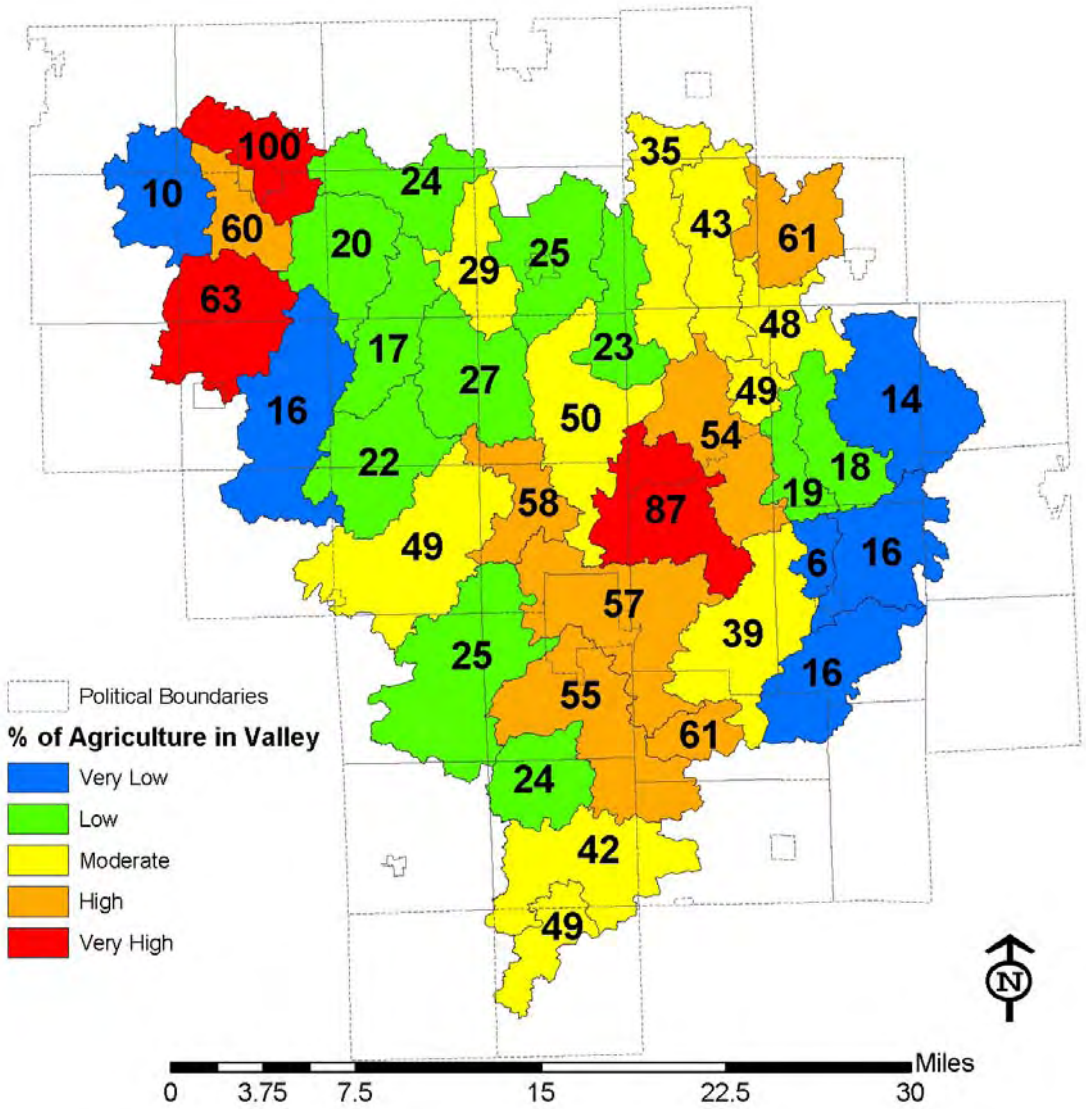


Figure 8B: Percent of total subbasin agricultural area that is within the river valley bottom as shown in Figure 6.

2.3 Wetlands

Methods

Current wetland locations were modeled using a weighted average of the following datasets:

- national wetlands inventory data (60%)
- current land cover (25%), and
- digital county soil survey (15%).

Hydrology, as defined by the State of Michigan base maps was also added to this model. The output of this model is illustrated in Figure 9. Additionally, this model identified areas that were not permanent wetlands, but had a high potential to be wet (Figure 9). Wetland areas were also taken from the Circa-1800 land cover data set and summarized by subbasin. The percent of the area in each basin that was wetland in 1800 was compared with the percent of the subbasin area that was modeled to be permanent wetland. Results from individual subbasins were categorized into the following based on the mean and standard deviation of the subbasin results:

very low (0-24%),
low (24-35%),
moderate (35-56%),
high (56-66%), and
very high (>66%).

The size of individual wetlands was also examined. Each subbasin was evaluated to determine the extent of wetlands, as determined by the wetlands model, that fell into three size categories < 5 acres, 5 – 50 acres and > 50 acres.

Results

The percent of the area in each basin that was wetland in 1800 compared with the percent of the area in each basin in the current wetlands model ranged from 11% to 97%, with a mean of 45% (Table 6). Subbasins with the greatest wetland loss since 1800 are those with the most agriculture. While, those subbasins in Northwest Jackson County have experienced the least amount of wetland loss since 1800. It should be emphasized that the location of wetlands may not be the same between the two data sets.

RANK	NAME	Percent Remaining Wetland
1	Sandstone Creek – Lower Branch	97
2	Darling – Christie Drain	79
3	Spring Brook - Source	78
3	Bromly Tile Drain	78
4	Sandstone Creek – Middle Branch	73
33	Huntoon Creek	20
34	Pickett and Jacobs Drain	18
35	Cahaogen Creek	16
36	Orchard Creek	14
37	Unnamed Tributary	11

Table 6: Highest and lowest subbasin percent of wetlands existing in 1800 that currently exist.

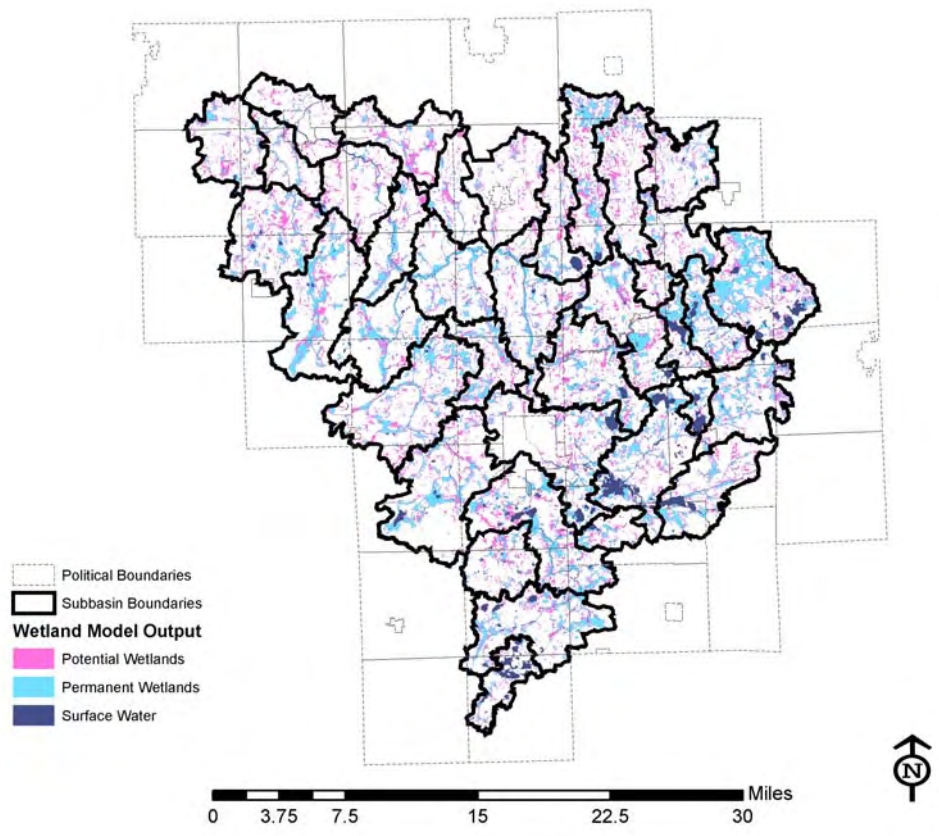


Figure 9: Predicted locations of wetlands and temporarily flooded areas.

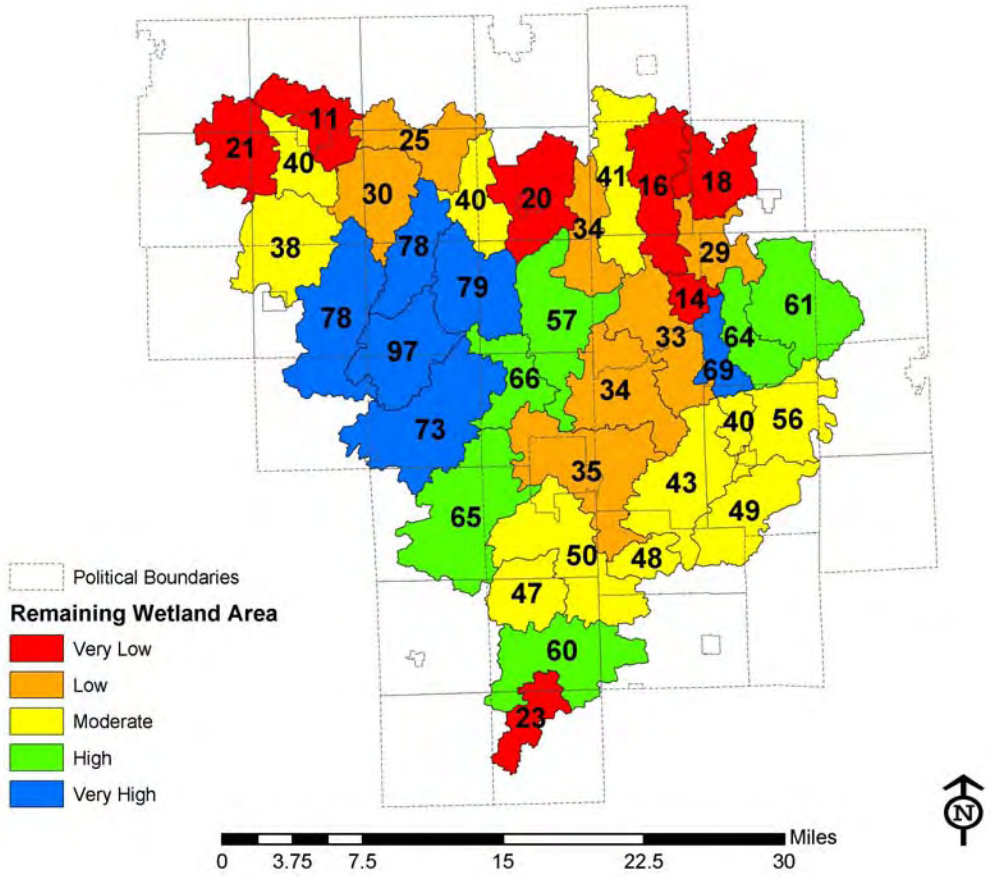


Figure 10: Percent remaining wetland area. Remaining wetland area is defined as the percent of subbasin area currently in wetlands divided by the percent of subbasin area that was wetlands in 1800.

The size distribution of wetlands was also examined in order to approximate the portion of wetlands in those counties of Upper Grand River Watershed with a population of greater than 100,000 people that are more likely to escape regulation. The Michigan DEQ regulates all wetlands, regardless of size, that are contiguous with lakes and streams with at least one acre of surface water. Of those wetlands that are not contiguous with surface water, it regulates those larger than 5 acres. Regulation of unconnected wetlands less than five acres in size occurs only if the DEQ has determined the wetland is of ecological significance. Therefore, unconnected wetlands less than 5 acres in size are more likely to escape regulation. It was found that wetlands less than 5 acres comprise 10% of the entire wetland area in the watershed. These 7,855 wetlands totaled 5,165 acres in size. Eight subbasins in the watershed have greater than 20% of their total wetland area in wetlands less than 5 acres in size (Table 7).

	Wetlands less than 5 acres in area			*Wetlands between 5 and 50 acres in area*			*Wetlands greater than 50 acres in area*			**percent of wetland area under 5 acres**
Subbasin Name	**# wet-lands**	**average area (acres)**	**total area (acres)**	**# wet-lands**	**average area (acres)**	**total area (acres)**	**# wet-lands**	**average area (acres)**	**total area (acres)**	
Baldwin and Puffenberger Drains	240	0.48	114.39	25	12.31	307.63	1	64.54	64.54	24%
Batteese Creek	199	0.75	149.80	43	13.68	588.45	8	149.46	1195.71	8%
Bromly Tile Drain	169	0.75	127.26	26	17.75	461.62	4	112.86	451.43	12%
Cahaogen Creek	140	0.96	134.63	31	14.94	463.20	2	71.97	143.94	18%
Cranberry Lake Drain	70	0.57	40.24	12	12.93	155.12	2	130.82	261.63	9%
Darling - Christie Drain	244	0.74	179.46	50	16.68	833.91	7	87.37	611.60	11%
Grand River Drain - Downstream	338	0.79	267.43	76	16.18	1229.89	3	101.91	305.72	15%
Grand River Drain - Upstream	373	0.55	204.60	76	13.65	1037.06	6	80.18	481.06	12%
Grass Lake Drain	234	0.69	160.65	51	20.93	1067.41	7	90.02	630.14	9%
Grass Lake Outlet	47	0.35	16.38	11	16.98	186.81	1	71.19	71.19	6%
Huntoon Creek	144	0.76	109.87	31	11.56	358.30	0	0.00	0.00	23%
Huttenlocker and Crittenden Drains	610	0.45	272.64	74	16.32	1207.74	8	90.81	726.48	12%
Lake LeAnn	195	0.45	87.24	14	13.56	189.90	0	0.00	0.00	31%
Mills and Post Drain	155	1.03	159.94	27	15.54	419.71	1	176.20	176.20	21%
Orchard Creek	41	0.90	36.91	7	9.95	69.66	1	58.03	58.03	22%
Perry Creek	118	0.80	94.13	27	10.90	294.33	1	83.19	83.19	20%
Pickett and Jacobs Drains	135	1.05	142.01	44	12.66	556.93	1	65.06	65.06	19%
Pierce Drain	304	0.69	208.82	68	14.38	977.69	16	91.70	1467.19	8%
Portage River - Lower Branch	260	0.79	206.53	67	16.24	1087.75	8	70.58	564.67	11%
Portage River - Middle Branch 1	226	0.63	142.68	26	15.03	390.80	8	143.24	1145.93	8%
Portage River - Middle Branch 2	99	0.57	56.64	16	16.69	267.09	4	140.65	562.59	6%
Portage River - Middle Branch 3	205	0.73	149.02	43	13.37	574.99	7	145.77	1020.38	9%
Portage River - Source	361	0.60	215.09	45	14.43	649.39	11	318.79	3506.73	5%
Sandstone Blackman Drain	228	0.77	175.64	60	14.98	898.90	12	107.04	1284.42	7%
Sandstone Creek - Lower Branch	225	0.56	125.93	36	15.84	570.36	7	123.10	861.67	8%
Sandstone Creek - Middle Branch	409	0.76	310.92	80	14.85	1188.25	13	104.01	1352.18	11%
Sharp Creek	195	0.62	121.25	35	13.46	471.02	1	77.79	77.79	18%
Southern Liberty Township Drains	383	0.56	215.22	57	16.29	928.77	11	92.78	1020.61	10%
Spring Brook - Lower Branch	199	0.62	122.53	23	15.28	351.36	0	0.00	0.00	26%
Spring Brook - Middle Branch	220	0.88	193.47	43	18.15	780.27	6	95.65	573.87	13%
Spring Brook - Source	173	0.67	116.24	36	14.59	525.12	15	136.02	2040.28	4%
Tobin Snyder Drain	143	0.59	84.37	32	18.58	594.55	4	92.92	371.69	8%
Unnamed	132	0.26	34.44	8	12.36	98.86	0	0.00	0.00	26%
Western Creek	137	0.57	77.89	27	14.02	378.47	3	84.73	254.18	11%
Wild Drain	116	0.70	80.66	22	15.05	331.19	4	81.69	326.76	11%
Willow Creek	138	0.71	97.30	36	12.72	457.77	1	53.19	53.19	16%
Wolf Lake and Drain	250	0.53	132.93	36	16.29	586.35	5	120.05	600.26	10%

Table 7: Wetland size class distribution throughout subbasins.

2.4 Land for Preservation

Methods

Natural open space, defined in this project as an area of grassland, forest or wetland, was examined for potential preservation. In order to create a natural open space data set, three Level 1 land cover classes were extracted from the current land cover classification: grassland, forest and wetland. Once these areas were selected, their boundaries were dissolved. By dissolving their boundaries, all forests, grasslands and wetlands were treated as the same land cover type. All natural open space polygons with an area of greater than 1,000 acres were selected for examination (Figure 11). The natural open space data set was also examined in conjunction with other information, such as railroad lines and currently existing state recreation areas to target the natural area preservation.

Results

These areas were mapped and can be analyzed further when other datasets, such as ownership and other criteria, become available (Figure 11).

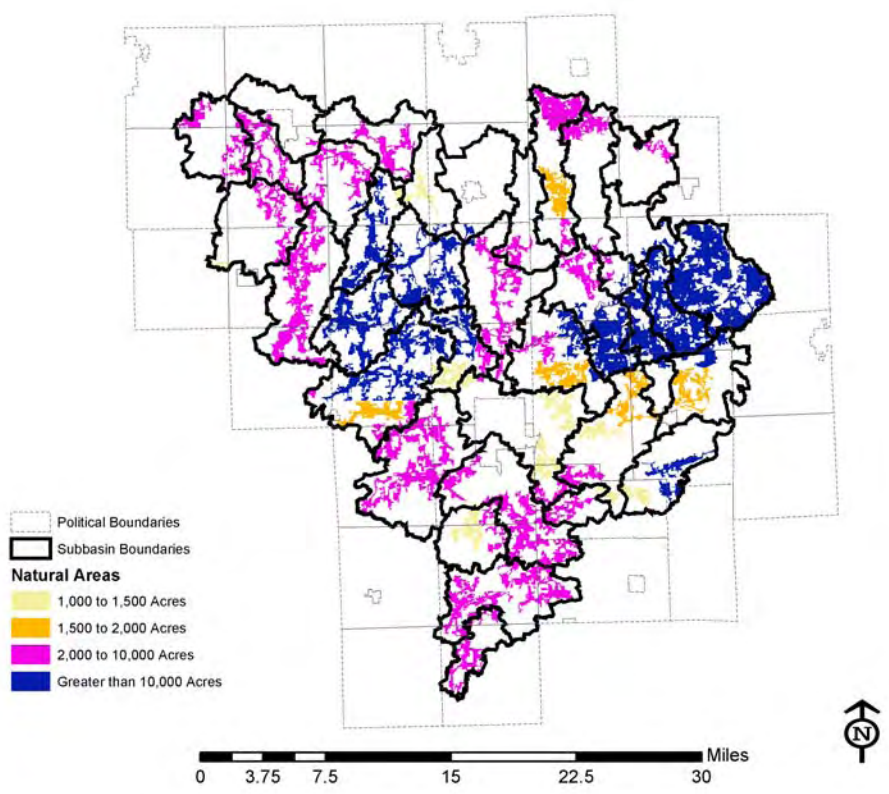


Figure 11: Contiguous natural lands greater than 1,000 acres

When comparing currently existing railroad lines, taken from the State of Michigan base maps, with the natural areas, multiple areas with potential for rails to trails opportunities became evident near the City of Jackson (Figures 12 & 13). Trail opportunities have also been assessed for Jackson County in an independent trail ways plan (Figure 14).

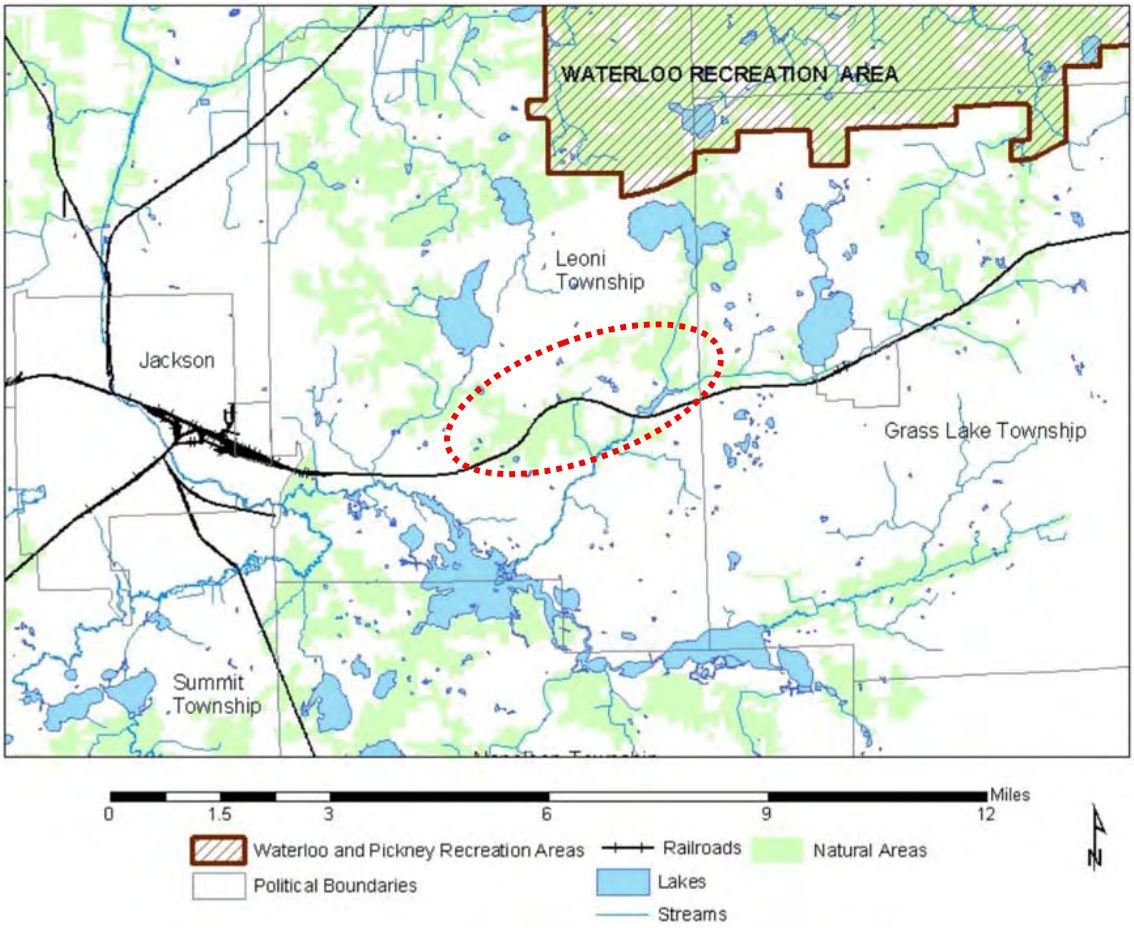


Figure 12: Rails to trails opportunity in Leoni Township, between the City of Jackson and the Waterloo and Pinckney Recreation Areas.

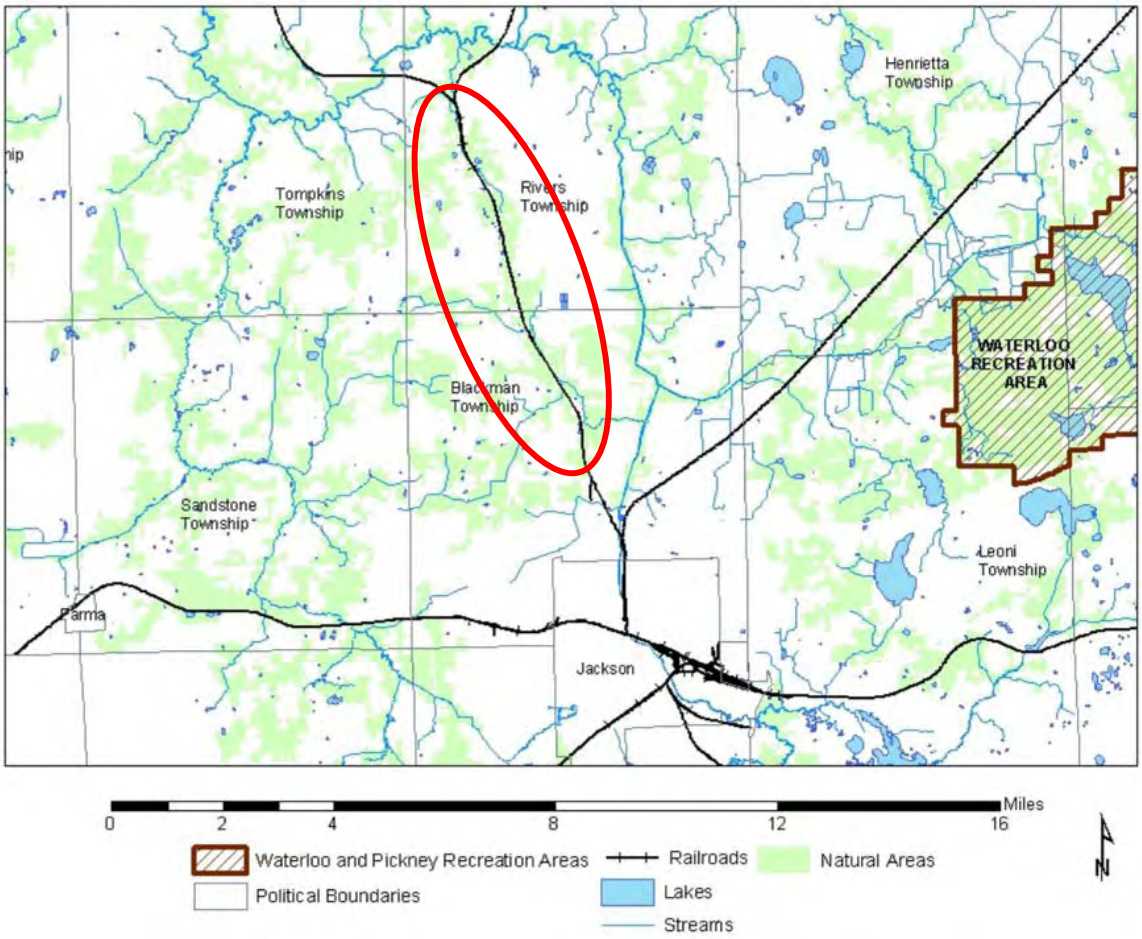


Figure 13: Rails to trails opportunity in Blackman and Rivers Township, North of the City of Jackson.

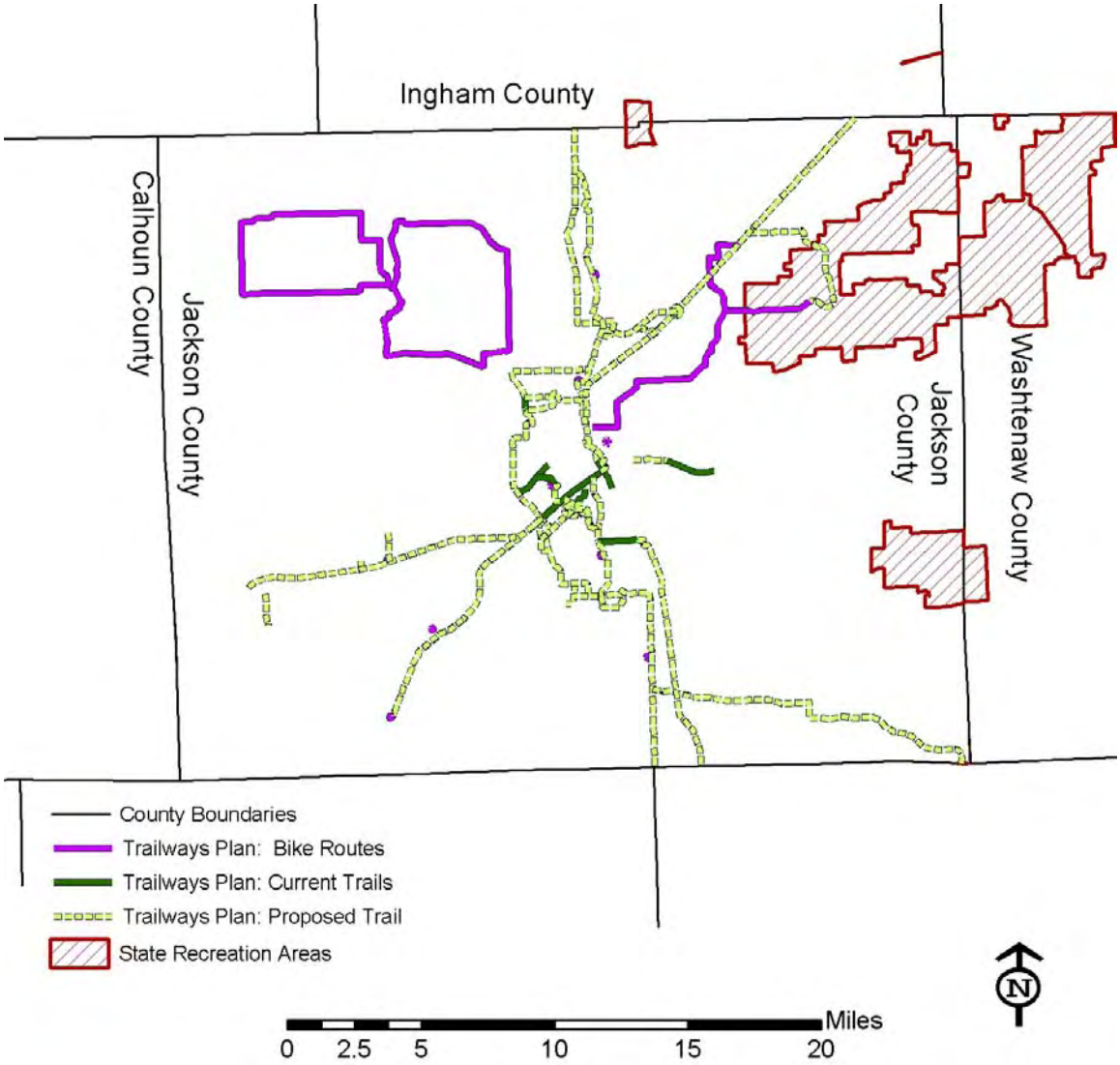


Figure 14: Current and proposed trails taken from the Jackson County Trailways plan, conducted by Landscape Architects and Planners Inc.

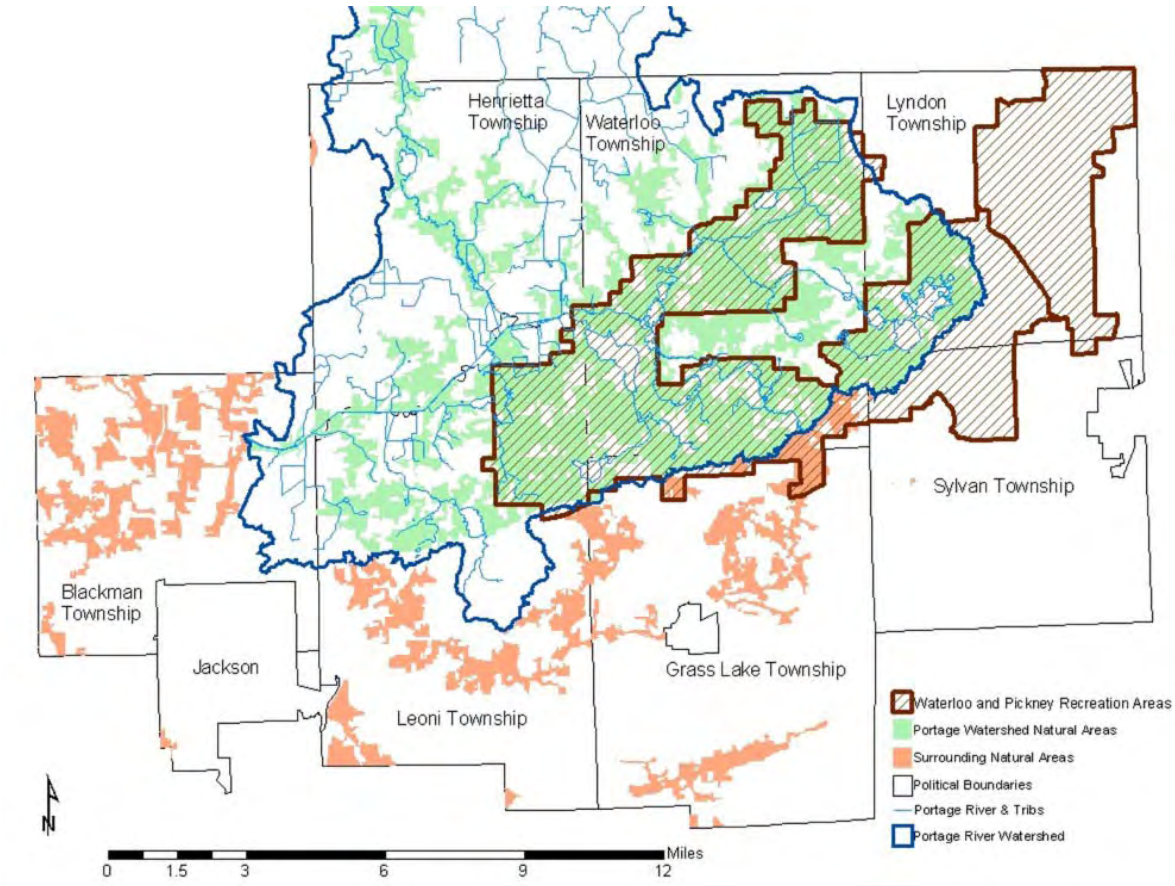


Figure 15: Natural areas near the Portage River between the City of Jackson and the Waterloo and Pinckney Recreation Areas.

The areas of natural land between the City of Jackson and the Waterloo and Pinckney State Recreation Areas were also of interest in the community. Figure 15 highlighted the natural areas that are 100 acres or larger between the City of Jackson and the State Recreation Areas. As before, this information could be used with additional datasets as they become available in the future, such as parcel ownership information, to prioritize land for preservation.

2.5 Overland Runoff

Methods

Overland runoff was evaluated using the SCS model (Soil Conservation Service, 1975) as modified to best fit Southern Michigan by Richards et al. (1999). The SCS model was based upon the 100-year storm, soil type, and land cover. Curve numbers were calculated from soil type and land cover for 100 m^2 (328 ft^2) cells across the landscape. The input rainfall was based on a 100-year storm, calculated to be 5.2 in of rainfall for Southeastern Michigan (Sorrell, 2000).

Runoff intensity was calculated based upon areas in the potential contributing source area of the watershed (Richards and Brenner, 2001). The potential contributing source area contained only those areas from which surface runoff drains to the stream. It did not include areas of internal drainage, where runoff pools on the surface before infiltrating directly to the groundwater. The calculation of surface runoff from the potential contributing source area gave a more realistic estimation of surface runoff for Southern Michigan conditions (Richards and Brenner, 2001).

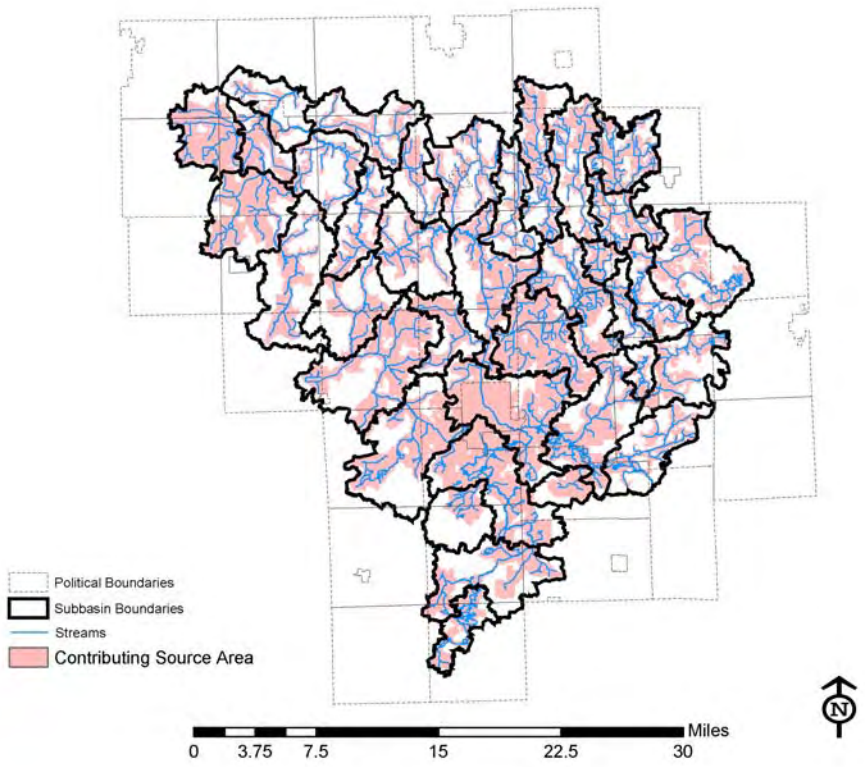


Figure 16: Location of the contributing source area as modeled by elevation for the Upper Grand River Watershed

Results

Surface runoff intensity values for individual cells ranged between 0.04 in and 5.12 in. These values represented the depth of water running off a cell during a 100-year storm. The maximum possible runoff from any given cell would be 5.2 in, the total amount that had fallen on any given area during the 100-year storm.

The runoff values were averaged for the contributing source area of each subbasin in order to make comparisons between subbasins. These averaged values ranged from 3.06 in to 3.82 in (Table 8), with a mean of 3.44 in. Subbasins were separated into five categories based on the average runoff values within their contributing source area (Figure 17). These categories were determined by their distance from the mean of all subbasins within the watershed and are as follows:

Class	Relative to Mean (s.d.)	Average runoff from the contributing source area of each subbasin (inches)
Very Low	> - 1	Below 3.24
Low	-1 - -0.5	3.24 – 3.34
Moderate	-0.5 – 0.5	3.34 – 3.54
High	0.5 – 1.0	3.54 – 3.64
Very High	> 1.0.	Above 3.64

RANK	NAME	Mean Runoff Intensity (inches)
1	Unnamed Tributary	3.06
2	Cahaogen Creek	3.07
3	Orchard Creek	3.14
3	Pickett and Jacobs Drain	3.14
4	Cranberry Lake Drain	3.22
33	Huttenlocker and Crittenden Drains	3.67
33	Tobin Snyder Drain	3.67
34	Spring Brook - Source	3.76
35	Grass Lake Drain	3.78
36	Grass Lake Outlet	3.79
37	Portage River - Source	3.82

Table 8: Highest and lowest average subbasin runoff values

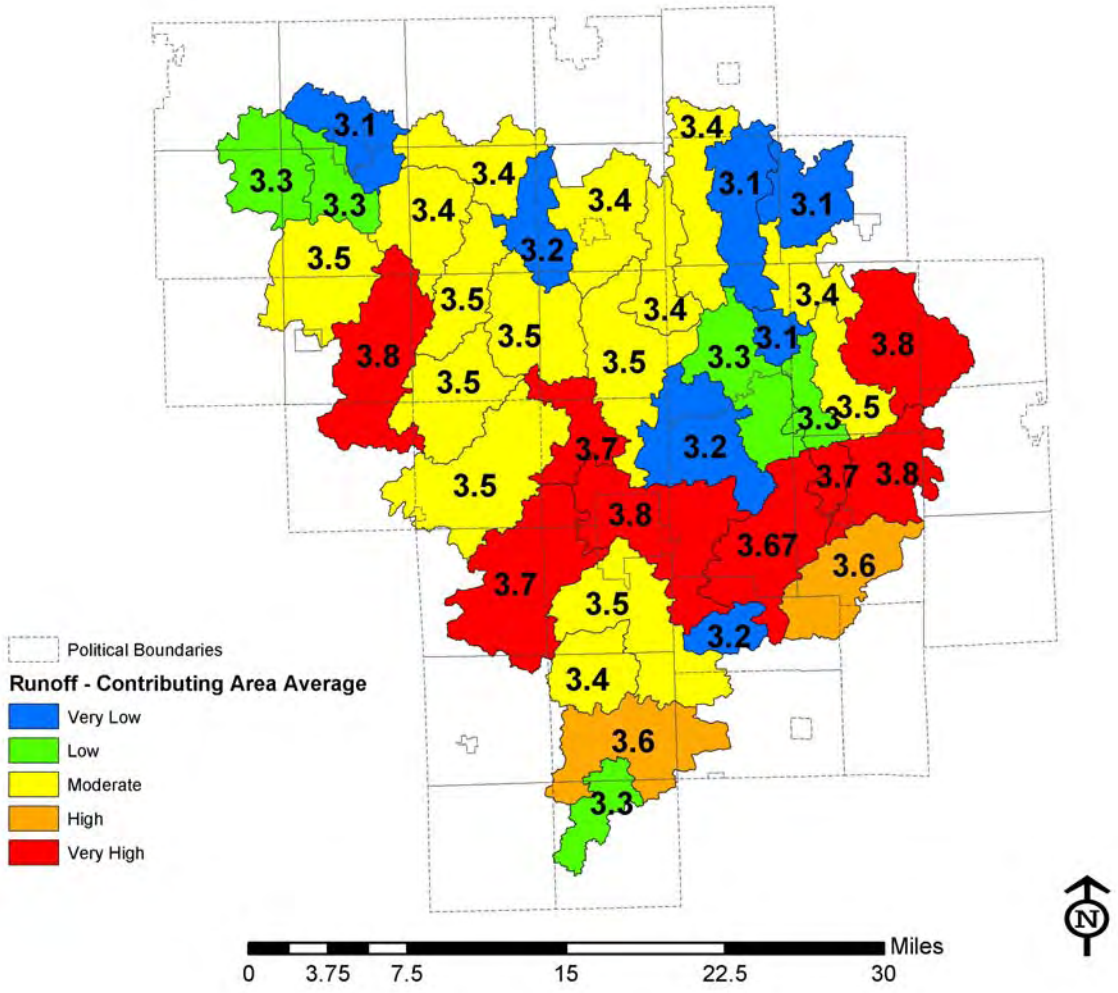


Figure 17: Average surface runoff from land within the contributing source area of each subbasin.

Subbasins with the highest average surface runoff received those scores for one of two reasons. First, in the case of subbasins such as Grand River Drain – Upstream, Tobin Snyder Drain, and Sandstone Blackman Drain, there was a high percentage of urban impervious land in the subbasin contributing source area (Figure 18).

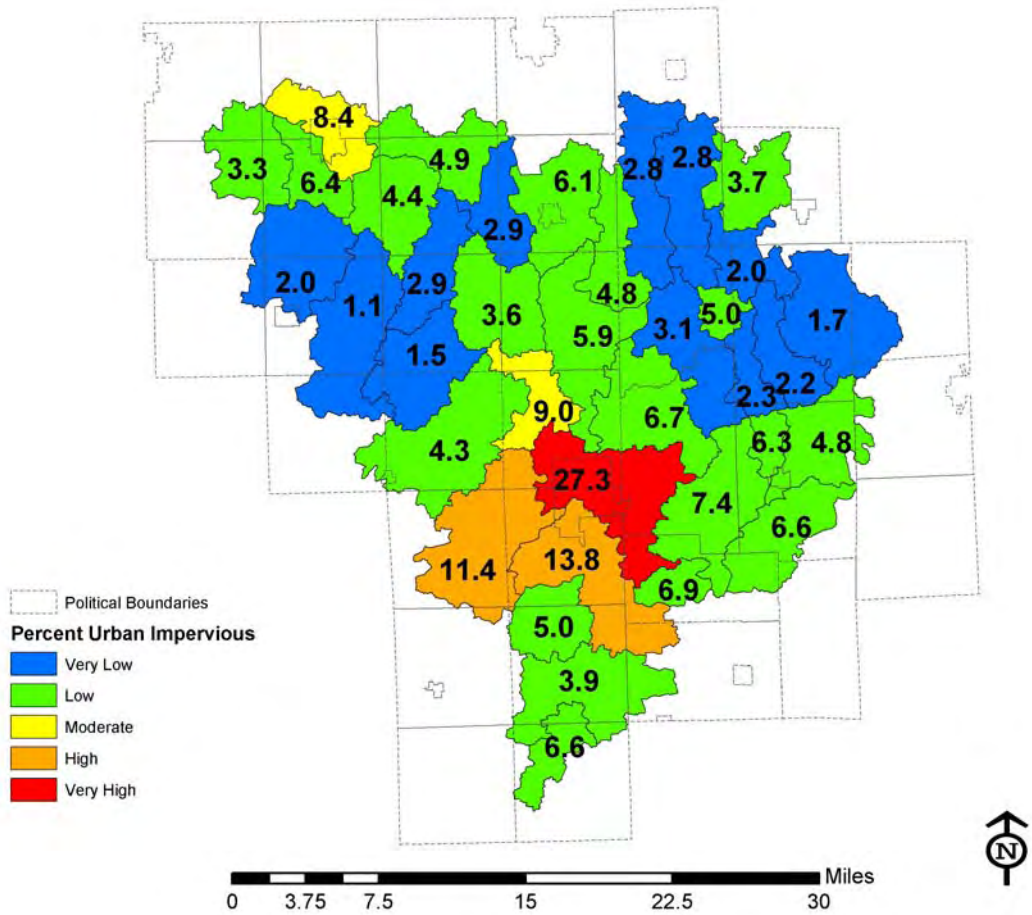


Figure 18: Percent of subbasin with urban impervious land cover.

Urban imperviousness is categorized as follows:

Class	Relative to Mean (s.d.)	Average urban imperviousness (% imperviousness)
Very Low	> - 0.5	Below 3.2
Low	-0.5- 0.5	3.2 – 7.8
Moderate	0.5 – 1.0	7.8 – 10.1
High	1.0 – 2.0	10.1 – 14.6
Very High	> 2.0.	Above 14.6

The opposite is the case for subbasins such as Portage River – Source, Portage River – Middle Branch 1, Portage River – Middle Branch 2, and Spring Brook – Source. The contributing source areas in these subbasins had a considerable amount of wetland area. The parameters of the SCS Runoff Model assigned a high runoff value to permanent wetlands, to account for runoff from a completely saturated wetland. However, in reality, few wetlands were completely saturated throughout the entire year. The method of modeling undertaken in this study examined the worst-case-scenario of highly impervious (low storage capacity) wetlands. Further studies and models would be necessary to model the storage capacity of the wetlands in the Upper Grand River Watershed.

2.6 Streambank and Shoreline Erosion

Methods

Streambank erosion potential was calculated for each subbasin from runoff intensity, soil K-factor, and riparian vegetation. Runoff intensity provided the base score for this ranking system because it was the primary driver for the streambank erosion process. Using the classification scheme from the subbasin mean runoff (see 2.5 Overland Runoff – Section 2 Page 20), each subbasin was assigned a base value from which streambank erosion potential was calculated. The runoff categories categories were assigned numeric values: very low = 2, low = 4, moderate = 6, high = 8, very high = 10. This classification of overland runoff took all of the biases of the runoff calculations into account. For further information on these biases and their implications, please see section 2.5 of this report.

The base score was modified according to soil K-factor and vegetation conditions in the 500 ft riparian buffer. First, adjustments were made according to soil erodibility (K-factor). If the average K-factor within the 500 ft buffer was less than 0.22, the base score was lowered by one. If the K-factor was between 0.22-0.28 the base score remained the same. If the K-factor was between 0.28-0.32, the base score was increased by one (Tom Van Wagner, Lenawee County NRCS, personal communication). The score was modified again by the percent of natural area in the 500 ft riparian buffer. The score was increased by one if there was less than 40% natural area in the 500 ft riparian buffer and decreased by one if the buffer was more than 70% natural area. The score remained the same if there was between 40% and 70% natural area in the riparian buffer.

Results

Streambank erosion potential final values ranged from 1 to 10. Based upon their distribution, they were aggregated into the following categories: very low (1-2), low (3-4), moderate (5-6), high (7-8), and very high (9-10) (Figure 19). Subbasins with the highest and lowest potential for streambank erosion are summarized in Table 10. The subbasins ranking in the highest and lowest streambank erosion potential categories are very similar to those ranking in the runoff intensity categories (Table 9).

The high runoff from the subbasins on the East of the watershed in addition to their erodible soils, suggest they have a high potential for erosion. Furthermore, these subbasins have been affected by the intrinsic bias within the runoff model (see section 2.5). Since some of these subbasins retain a good riparian buffer, their actual erosion rates are probably lower than this map would indicate. However, it does emphasize that removal of these buffers would have a large detrimental impact on the streambank conditions.

Only three subbasins, Southern Liberty Township Drains, Portage River Middle Branch 2, and Wild Drain changed severity categories based on factors that were not related to runoff. Southern Liberty Township Drains and Portage River Middle Branch 2 both

decreased one category due to their amount of riparian vegetation and their soil properties. Wild Drain increased one severity category because of its lack of riparian vegetation and higher soil erosivity factor. Appendix 1, Table 1 summarizes these streambank erosion calculations for each subbasin.

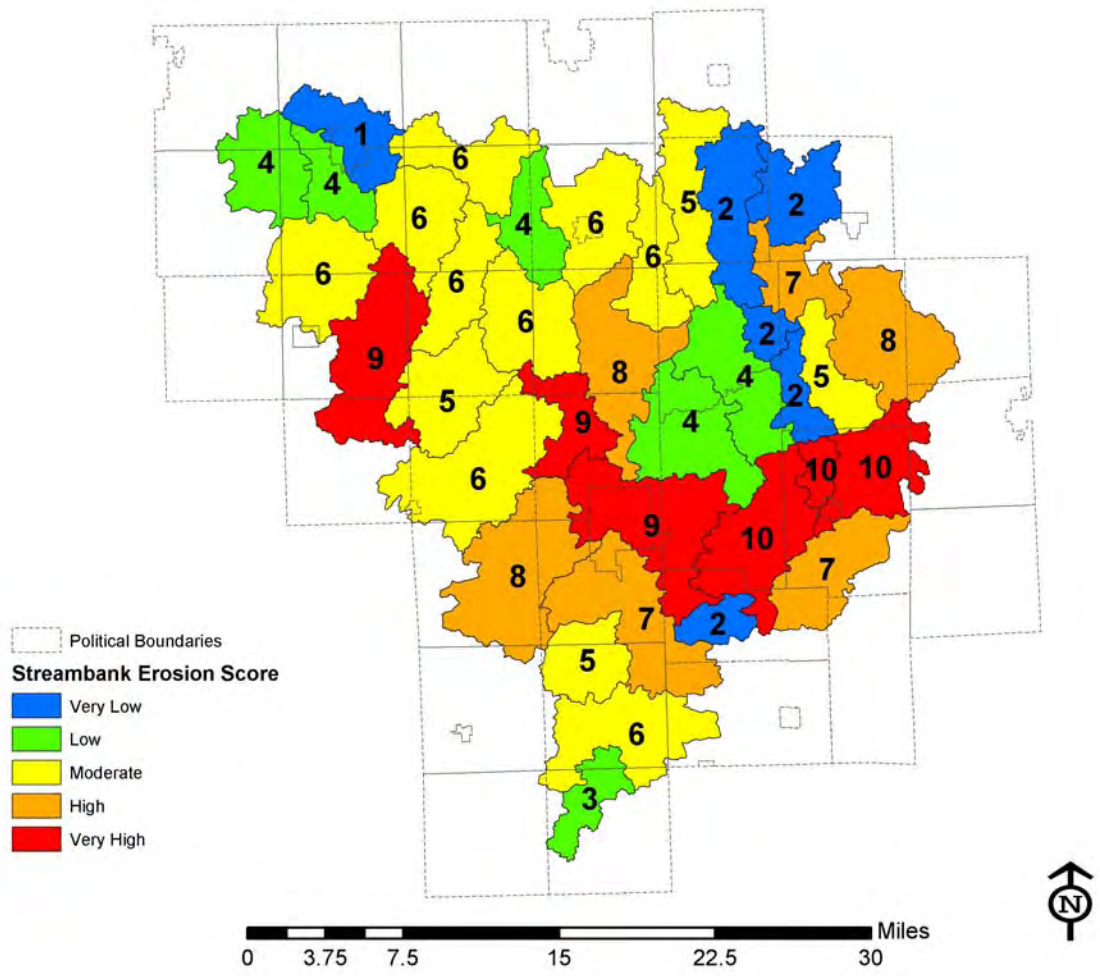


Figure 19: Streambank erosion potential by subbasin

NAME	Streambank Erosion Score
Unnamed Tributary	1
Cahaogen Creek	2
Orchard Creek	2
Cranberry Lake Drain	2
Pickett and Jacobs Drains	2
Portage River – Middle Branch 2	2
Grand River Drain - Upstream	9
Tobin Snyder Drain	9
Spring Brook - Source	9
Grass Lake Drain	10
Grass Lake Outlet	10
Huttenlocker and Crittenden Drains	10

Table 9: Highest and lowest streambank erosion potential scores for subbasins.

2.7 Off-field Soil Erosion

Methods

Off-field soil erosion was calculated for all agricultural areas in the contributing source area of the Upper Grand River Watershed. Areas outside the contributing source area were not included in this analysis because any off-field erosion from such areas would not enter the Upper Grand River drainage system. Non-agricultural areas were not included in this calculation because they are not parameterized in the USDA Technical Guide upon which the calculations were based. Calculations were made using resampled raster data sets with a cell size of 46 m (150 ft) by 46 m (150 ft). This approximated the length used for slope length calculations in the USLE. Annual soil erosion calculations were performed on the areas of the Upper Grand River Townshed that were classified as agriculture or pasture using the universal soil loss equation with the following parameters:

Equation 1 $A = R\ K\ LS\ C\ P$

Where

A was predicted average annual soil loss (tons acre^{-1} year^{-1}).

R was the rainfall-runoff erodibility factor; this number was based on an average annual sum of a normal year's rain. These values have been published for each county. Here, calculations were based on values published in the USDA NRCS Technical Guide Section 1 – C: Water Erosion Prediction and Control.

K represented the soil erodibility factor; this was a measure of how erodible a soil was under the standard condition (USDA-NRCS 1995). These values have been published for each soil series in the county soil survey. The values used for this set of calculations were for the surface soil horizon of each soil series. Mucks did not have published K-factor values. In this analysis, mucks were given a K-factor of zero, because they have usually been found on flat areas and were not considered prone to water erosion.

LS was the slope length and steepness factors; these values were based on the slope dataset computed from the digital elevation model. The slope data set is in raster format with a cell size of 46 m (150 ft) and approximates published LS values for cropland and pasture (USDA –NRCS 1995). The final LS value was selected from either a cropland or pastureland look up table.

C was the cover-management factor; these values represented the effect of crops or vegetation on soil erodibility. Julius Pigott (Jackson County NRCS, personal communication) provided C-factor values for specific cropping patterns based on his knowledge of the cover management practices in the Upper Grand River Watershed.

P was the support practice factor; this factor represented the impact of strip cropping practices compared with row crops. This factor was eliminated from the equation because of insufficient information.

Results

The final cell values for annual soil loss fell between 0 tons acre^{-1} and 68.56 tons acre^{-1} with a mean of 3.19 tons acre^{-1}. These results were averaged by subbasin. The subbasin mean annual soil loss values were compared (Figure 20). The mean subbasin soil loss values were between 8.05 tons acre^{-1} year^{-1} and 46.61 tons acre^{-1} year^{-1} (Table 9), with a mean of 21.4tons acre^{-1} year^{-1}. These numbers represent the average annual soil loss from pasture and cropland in the contributing source area. They were the mean final cell value from the USLE calculation in each subbasin. These calculations revealed the hotspot individual agricultural field areas with high potential average annual soil loss.

Average soil loss in tons acre^{-1} year^{-1} was calculated based only upon the agricultural area in that subbasin. These calculations showed the highest soil loss coming from the subbasins along border between Jackson and Washtenaw Counties (Figure 20), an area with less overall agriculture as compared to others in the watershed. Although this area had less farm fields than much of the rest of the watershed, the fields existing there had high potential for erosion. Most likely, this was due to the comparatively higher slopes and more erosive soils in the Waterloo area.

RANK	NAME	Average Off-field Soil Loss (tons acre^{-1} year^{-1})
1	Grand River Drain - Upstream	8.05
2	Mills and Post Drain	8.82
3	Mills and Post Drain	9.02
4	Sharp Creek	9.80
5	Spring Brook – Lower Branch	10.89
33	Grass Lake Drain	33.09
34	Grass Lake Outlet	35.91
35	Portage River – Middle Branch 1	40.26
36	Portage River – Source	46.32
37	Bromly Tile Drain	46.61

Table 10: Highest and lowest average annual soil loss (tons acre^{-1} year^{-1}) from the contributing source area of each subbasin. Calculations were performed only on agricultural areas.

Average potential off-field erosion calculations (Figure 20) were placed into the following categories:

Class	Relative to Mean (s.d.)	Soil Loss over Contributing Agriculture Fields (tons acre^{-1} year^{-1})
Very Low	> - 1	Below 11.14
Low	-1 - -0.5	11.14 – 16.26
Moderate	-0.5 – 0.5	16.26 – 26.50
High	0.5 – 1.0	26.50 – 31.62
Very High	> 1.0.	Above 31.62

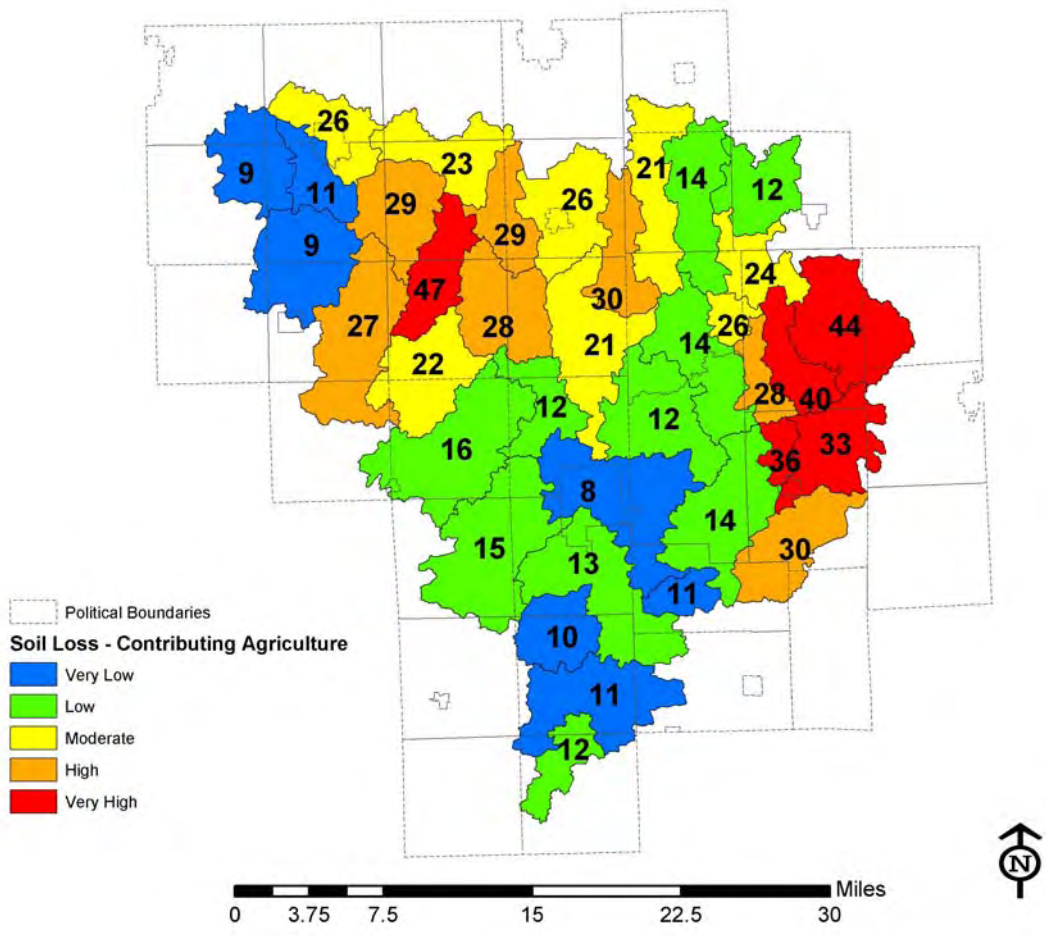


Figure 20: Annual estimated subbasin off-field erosion (tons acre^{-1} year^{-1}) from agricultural fields in the contributing source area

However, when these potential soil loss calculations (Table 10, Figure 20) were averaged over the entire subbasin area, the rankings change (Table 11, Figure 20). In order to arrive at the overall potential soil loss from agricultural areas over the subbasin, the sum of all final cell values within each subbasin was divided by the contributing source area of that subbasin. Essentially, these values (Table 11, Figure 21) represent the average annual soil loss over the contributing source area within each subbasin. This information illustrates which subbasins are hotspots for potential off-field erosion.

RANK	NAME	Off-field Soil Loss averaged by Subbasin Area (tons acre^{-1} year^{-1})
1	Grand River Drain - Upstream	0.14
2	Pierce Drain	0.63
3	Sandstone Blackman Drain	0.92
4	Lake LeAnn	1.06
5	Sharp Creek	1.16
34	Orchard Creek	4.19
35	Huntoon Creek	4.38
36	Darling – Christie Drain	4.57
36	Wild Drain	4.89
37	Bromly Tile Drain	6.36

Table 11: Highest and lowest potential annual agricultural soil loss (tons acre^{-1} year^{-1}) averaged over subbasin contributing source area

Mean potential annual subbasin soil loss values (Figure 21) were placed into the following categories based on their mean and standard deviation:

Class	Relative to Mean (s.d.)	Average Soil Loss over Subbasin (tons acre^{-1} year^{-1})
Very Low	> - 1	Below 1.16
Low	-1 - -0.5	1.16 – 1.84
Moderate	-0.5 – 0.5	1.84 – 3.21
High	0.5 – 1.0	3.21 – 3.90
Very High	> 1.0.	Above 3.90

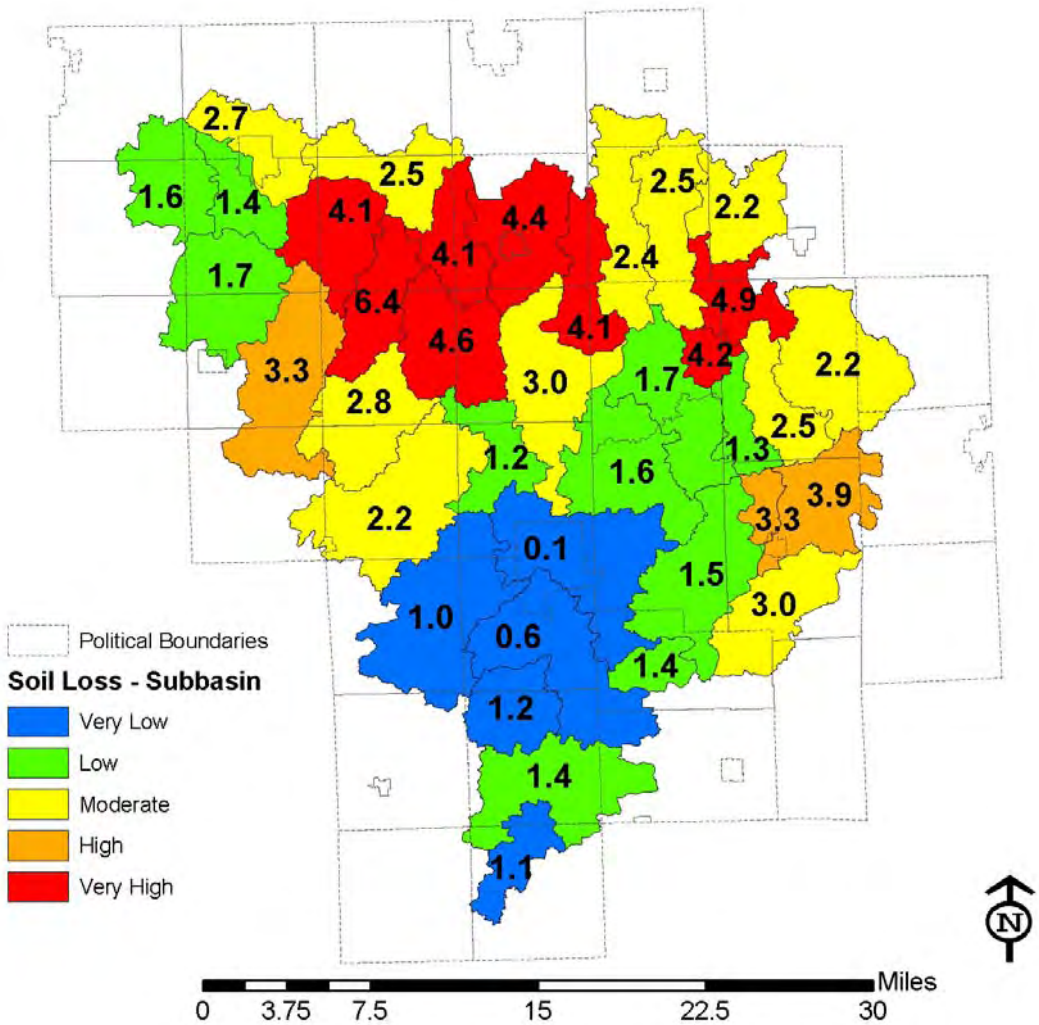


Figure 21: Annual potential agricultural off-field erosion (tons acre^{-1} year^{-1}) averaged over the contributing source area of each subbasin.

2.8 Biological Indices

Methods – Fish Communities

The database of historical fish samplings on the Upper Grand River and Portage River originated from the University of Michigan Museum of Zoology records. These records, now distributed through the Michigan Department of Natural Resources Institute for Fisheries Research, have been summarized by subbasin. A list of all fish species in this database was compiled (Appendix 2).

The data presented in this report was as complete as the data maintained at the University of Michigan Museum of Zoology and Michigan Department of Natural Resources Institute for Fisheries Research. Their records did not include every study conducted by the University, only those conducted by the Institute for Fisheries Research; Nor did they include every fish ever seen in the Upper Grand River and Portage River, only those caught and identified in the Institute for Fisheries Research studies. Although not comprehensive, this is the largest single fish database available.

These studies included in the Institute for Fisheries Research database dated back to 1900. Until the 1990's, site location was described by township, range and section, therefore, sampling locations were approximate and when plotted in GIS required some adjusting for all sample points to fall on waterways.

Results – Fish Communities

The interpretation of the meaning of the presence and absence of fish species would have been a very complex and multidimensional analysis. We have not attempted to determine what the presence or absence of fish species meant in terms of biological diversity for this project. However, the information presented allows a fisheries biologist to determine suitable stream segments for fish habitat restoration for game species or species of interest. It also enables conservationists to determine which subbasins contain rare or endangered species, justifying the protection of these subbasins.

Methods – Michigan Department of Environmental Quality Indices

The currently available river monitoring data from the Michigan Department of Environmental Quality (DEQ) for the Upper Grand River and its tributaries was summarized as a description of biological quality of the Upper Grand River. Currently, only the 1991 and 1996 biological sampling data are available for public distribution. The Michigan DEQ, Surface Water Quality Division, has summarized data from these sampling sites. Paul Rentschler of Tetra Tech MPS has assigned labels (excellent, good, fair, poor) to the data from the Michigan DEQ, Surface Water Quality Division.

Results – Michigan Department of Environmental Quality Indices

The results of the Michigan DEQ monitoring sites have been published in three categories: Fish Score, Invertebrate Score, and Habitat Score. These data are shown respectively in Figures 21, 22, and 23. The DEQ sampling data has been represented by large points in the figures to show general spatial trends throughout the watershed

without showing exact locations. Because the points were not evenly distributed across all 37 subbasins, these data have been represented as points as opposed to shaded subbasins.

The fish scores ranged from excellent to poor, with all of the poor sites falling in Batteese and Cahaogen Creeks, in the Northeast corner of the watershed. Three sites received excellent fish scores. Two of these three, Pierce Drain and the Grand River Drain – Upstream fell upstream of the Jackson urban area, while the site in Darling Christie Drain fell downstream of the intense urbanization. The remainder of the sites received fair scores (Figure 22).

These sites were all sampled in 1996. These subbasins have comparatively high wetland area loss (Figure 10), low riparian buffers (Figures 4 & 5), and high potential nitrite-nitrate (NO_2 -NO_3) loads (Figure 25). Cahaogen Creek falls on top five list of most concerned subbasins for five analyses: 100 and 500 ft riparian buffers, agricultural area in river valley bottom, remaining wetlands, and potential nitrite-nitrate (NO_2 -NO_3) loads. While, Batteese Creek does not fall on any of the lists of most concern, it has scores of more than average concern for several issues including 500 ft riparian buffer, remaining wetlands, average runoff from the contributing source area, and potential nitrite-nitrate (NO_2 -NO_3) loads.

Of the three sites receiving an excellent score, two were sampled in 1991 and one was sampled in 1996, with the most downstream site being the one sampled in 1996. The upstream sites with excellent fish scores were both upstream of the City of Jackson, in Pierce Drain and the far upstream area of the Grand River Drain – Upstream. Pierce Drain had a good 100 ft riparian buffer (Figure 4) and at least moderate remaining wetlands and potential nitrite-nitrate (NO_2 -NO_3) loads. The sampled portion of the Grand River Drain – Upstream was upstream of the highly urbanized and impacted area of that subbasin. The downstream site with a good fish community is in Darling-Christie Drain, a subbasin with one of the top five levels of remaining wetland area. Furthermore, it had very good 100 ft riparian buffers.

Overall, the fish scores based on the Michigan Department of Environmental Quality samples coincided with the results from the riparian buffers, remaining wetlands and potential nitrite-nitrate (NO_2 -NO_3) load analyses. Sampling of each subbasin within the watershed would be needed to further investigate the relationships between the results of the prioritization analyses and the fish communities of the Upper Grand River Watershed.

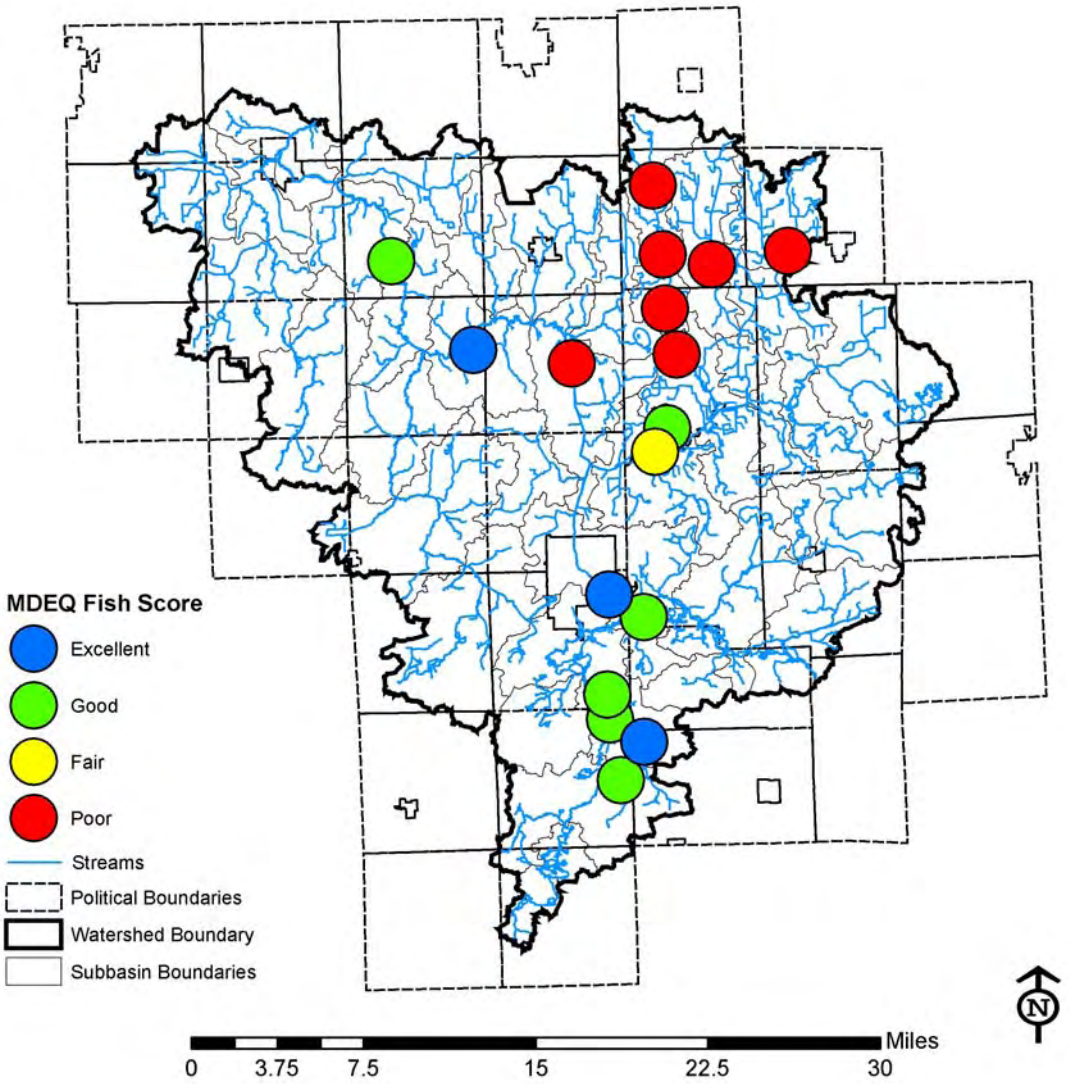


Figure 22: Michigan Department of Environmental Quality sampling sites scored based on fish sampling data.

The invertebrate scores ranked from good to poor, with the majority of the good sites located in the more upstream portion of the Upper Grand River Watershed. The majority of the poor sites in Batteese Creek, in the Northeastern portion of the watershed, and the fair sites spread across the watershed (Figure 23). No sites received an excellent invertebrate score.

Again, the majority of the poorly scoring sites were located in Batteese Creek, with one additional poor site in the Grand River Drain – Downstream. The Grand River Drain –

Downstream received scores across the spectrum from very good (100 ft riparian, remaining wetland) to very poor (streambank erosion potential, valley bottom natural areas) on the other analyses. However, it is the first subbasin downstream of the confluence of the Portage River and the Upper Grand River. At the location of the invertebrate sample, the conditions from the Portage River and its tributaries (namely Batteese and Cahaogen Creeks) could have been an influence on the invertebrate community.

The majority of the sites receiving invertebrate scores are upstream of the City of Jackson, in the Grand River Drain – Upstream, Pierce Drain, and Southern Liberty Township Drains. These subbasins tend to have moderate to good scores on the other prioritization analyses.

Overall, the relationship between the invertebrate scores and the other prioritization analyses is not as straightforward as the one with the fish scores. Again, sampling of each subbasin within the watershed would be needed to further investigate the relationships between the results of the prioritization analyses and the invertebrate communities of the Upper Grand River Watershed.

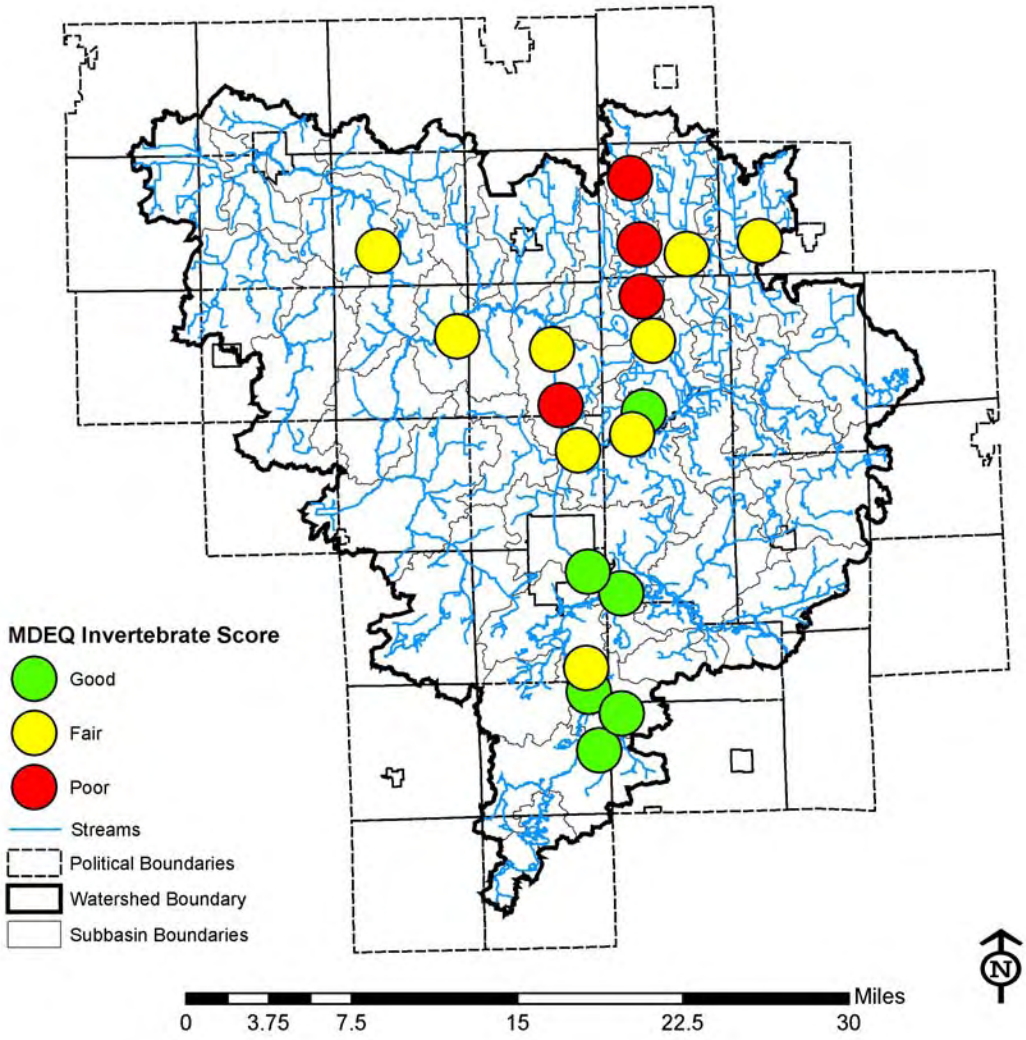


Figure 23: Michigan Department of Environmental Quality sampling sites, scored based on invertebrate sampling data

The habitat scores are all fair and poor, with the majority of the sites throughout the watershed receiving a ranking of fair. Although the scoring ranges from excellent to poor, no sites received excellent or good habitat scores. The four poor scores were geographically distributed across the watershed in Pierce Drain, Grand River Drain – Upstream, Grand River Drain – Downstream, Batteese Creek, and Pickett and Jacobs Drain (Figure 24). Sampling of each subbasin within the watershed would be needed to further investigate the relationships between the results of the prioritization analyses and the habitat conditions of the Upper Grand River Watershed. It would also be helpful to

examine the prioritization analyses against the individual metrics within the habitat scores, such as streambank and substrate conditions.
Only one site in the entire watershed received poor rankings in all three categories. One other site had fair rankings in all three categories. The remainder of the 19 sites had mixed rankings for the three metrics.

Further information on the MDEQ sampling data can be obtained from the Michigan Department of Environmental Quality, Surface Water Quality Division.

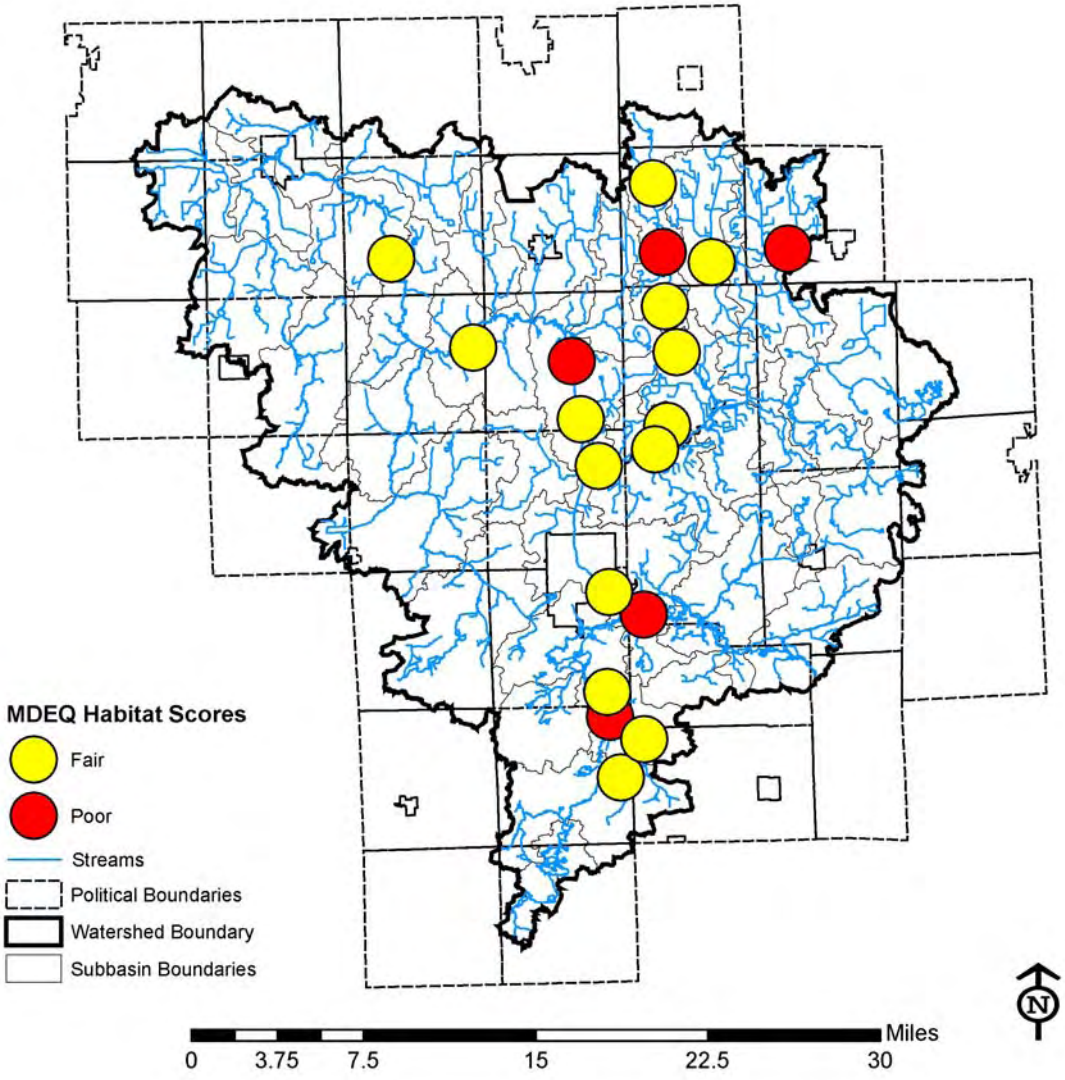


Figure 24: Michigan Department of Environmental Quality sampling sites, scored based on habitat sampling data.

2.9 Nutrient Contamination Risk

Methods

The mean nutrient load for each subbasin was calculated using the runoff calculation based on a two-year storm event and the event mean concentration of each nutrient. Runoff was calculated according to the parameters outlined in section 2.5 of this report, using the precipitation from a two-year storm event. Precipitation values were published by R.C. Sorrell (2001). The event mean concentration was calculated based on land cover and a look up table of nutrient values specific to the land cover (Cave et al 1994). The nutrient look up table values resulted from a series of studies in Southeastern Michigan's Rouge River Watershed (Cave et al 1994) and modified for areas with tile drainage according to the specifications in Richards (1999). Tile drain locations were taken from soil survey information (Appendix 3, Figures 1 & 2). The adjustment of the EMC values for tile-drained areas resulted in an increase in the nitrates EMC and a decrease in the phosphorus EMC in areas that were tile drained (Richards, 1999).

Calculations were made using raster data sets with a pixel size of 26.3 m by 26.3 m. This pixel resolution was chosen to match the other raster data sets in this project, including the digital elevation model. Nutrient load calculations were performed only within the contributing source area of the watershed. Separate calculations were performed for nitrites/nitrates (NO_2 & NO_3) and total phosphorus (TP).

Once the nitrates and phosphorus loads were calculated for the individual pixels, the information was summarized by subbasin. These loads were summarized over the contributing source area of each subbasin to show average nutrient load intensity. By comparing average nutrient loads independent of subbasin area subbasins of all sizes could be compared with each other.

Results – Nitrites and Nitrates Load

Nitrite and nitrate loads were shown for each individual cell in Appendix 3-3.

The average NO_2 & NO_3 values measured over the potential contributing source area in each subbasin fell between 0.33 lb acre^{-1} and 0.88 lb acre^{-1} (Table 12). NO_2 & NO_3 load classes of very low, low, moderate, high, and very high were determined by the mean and standard deviation (s.d.) as described below:

Class	Relative to Mean (s.d.)	NO_2 & NO_3 average intensity from contributing source area (lb acre^{-1})
Very Low	> - 1	Below 0.46
Low	-1 - -0.5	0.46 – 0.53
Moderate	-0.5 – 0.5	0.53 – 0.66
High	0.5 – 1.0	0.66 – 0.72
Very High	> 1.0.	Above 0.72

Rank	Name	NO_2 & NO_3 Intensity (lb acre^{-1})	NO_2 & NO_3 Intensity (g * ha^{-1})
1	Portage River – Middle Branch 1	0.33	373.93
2	Portage River – Middle Branch 2	0.36	404.82
3	Portage River – Source	0.38	423.91
4	Pierce Drain	0.46	517.56
5	Lake LeAnn	0.48	534.65
5	Grass Lake Outlet	0.48	537.53
33	Cahaogen Creek	0.78	875.61
34	Pickett and Jacobs Drains	0.79	886.71
35	Huntoon Creek	0.83	926.99
36	Wild Drain	0.87	972.60
37	Spring Brook – Middle Branch	0.88	980.86

Table 12: Highest and lowest average NO_2 & NO_3 intensities from within the contributing source area of each subbasin for a 2-year storm event

The subbasins with the highest average NO_2 & NO_3 within their contributing source area were all in the Northern portion of the watershed (Figure 25), a trend that can be accounted for by soils (Appendix 3) and land cover (Figure 2). This area of the watershed had a considerable amount of agriculture on wetter hydric soils, which must have some artificial drainage in place (Julius Pigott, Jackson County NRCS personal communication). This artificially drained agriculture has by far the highest event mean concentration of NO_2 & NO_3 to enter the stream (Richards 2000).

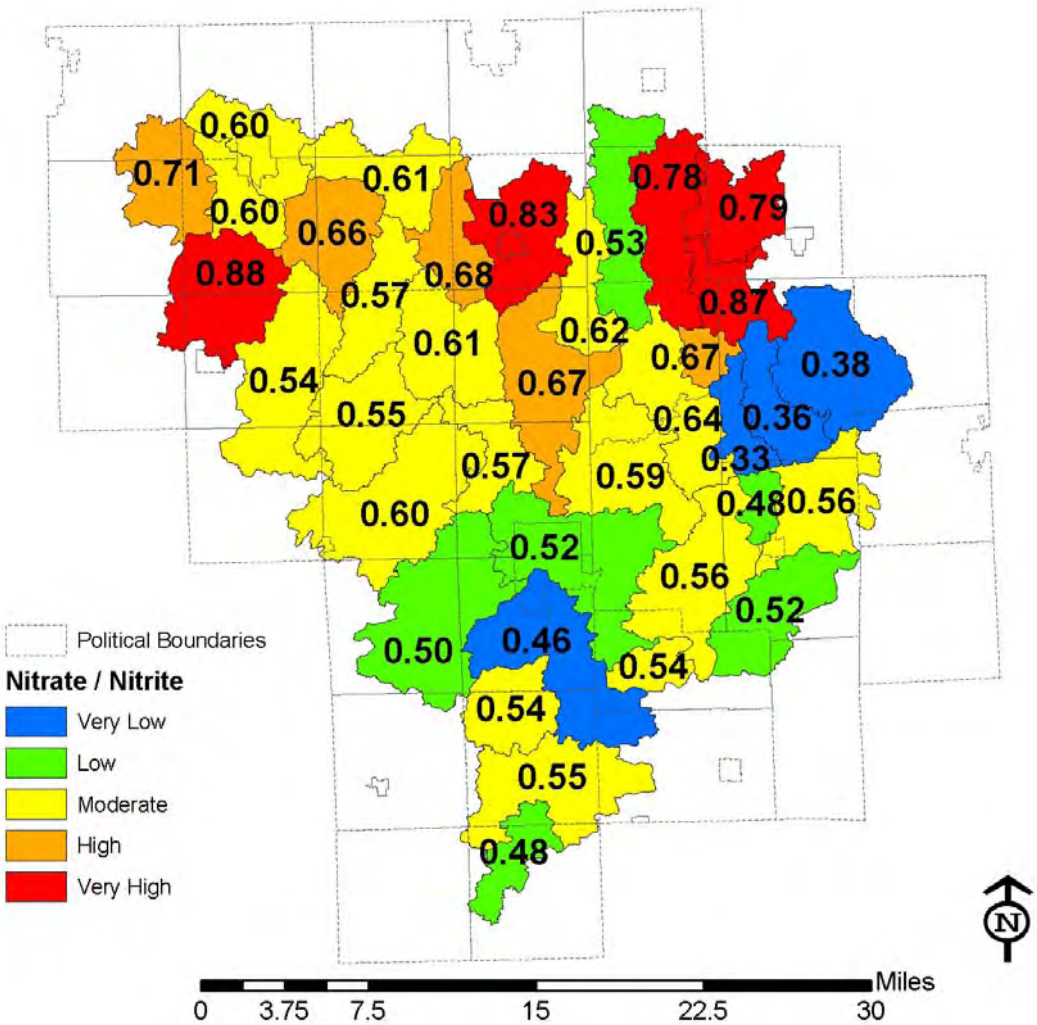


Figure 25: NO_2 & NO_3 average intensity within the contributing source area of each subbasin for a 2-year storm event.

Average subbasin nitrite/nitrate load values calculated for 5, 10, and 100-year storm events were reported in Appendix 1.

Results – Phosphorus Load

Total phosphorus was calculated over the entire contributing source area of the Upper Grand River Watershed (Appendix 3 - Figure 4). Phosphorus loads were calculated within the contributing source area of each subbasin and compared across subbasins (Figure 25). Subbasin average phosphorus load values were between 0.04 lb acre^{-1} and 0.12 lb acre^{-1}, with a mean of 0.06 lb acre^{-1} (Table 13). Load classes of very low, low, moderate, high, and very high were determined by the mean and standard deviation (s.d.). These classes are outlined below:

Class	Relative to Mean (s.d.)	TP average intensity from contributing source area (lb acre^{-1})
Very Low	> - 1	Below 0.05
Low	-1 - -0.5	0.05 – 0.055
Moderate	-0.5 – 0.5	0.055 – 0.065
High	0.5 – 1.0	0.065 – 0.07
Very High	> 1.0.	Above 0.07

Rank	Subbasin	TP Intensity (lb acre^{-1})	TP Intensity (g ha^{-1})
1	Portage River - Middle Branch 2	0.04	40.91
2	Portage River – Source	0.04	46.35
3	Portage River - Middle Branch 1	0.04	48.07
4	Portage River - Middle Branch 3	0.05	51.24
5	Cahaogen Creek	0.05	52.38
33	Lake LeAnn	0.07	82.57
34	Huttenlocker and Crittenden Drains	0.08	84.27
35	Sandstone Blackman Drain	0.08	93.18
36	Pierce Drain	0.09	97.83
37	Grand River Drain - Upstream	0.12	134.93

Table 13: Highest and lowest average phosphorus intensities from the contributing source area of each subbasin for a 2-year storm event.

Tile drained agriculture had the opposite outcome with regards to phosphorus loads than it did with regard to nitrite and nitrate loads (Figures 25 & 26). As a result of this, many of the subbasins with very high and high average nitrates loads had low phosphorus loads and vice versa. Urban subbasins surrounding the City of Jackson had, for the most part, the highest levels of phosphorus (Figure 26), as urban areas have the highest event mean concentration for total phosphorus (Cave et al 1994).

Average subbasin total phosphorus load values calculated for 5, 10, and 100-year storm events were reported in Appendix 1.

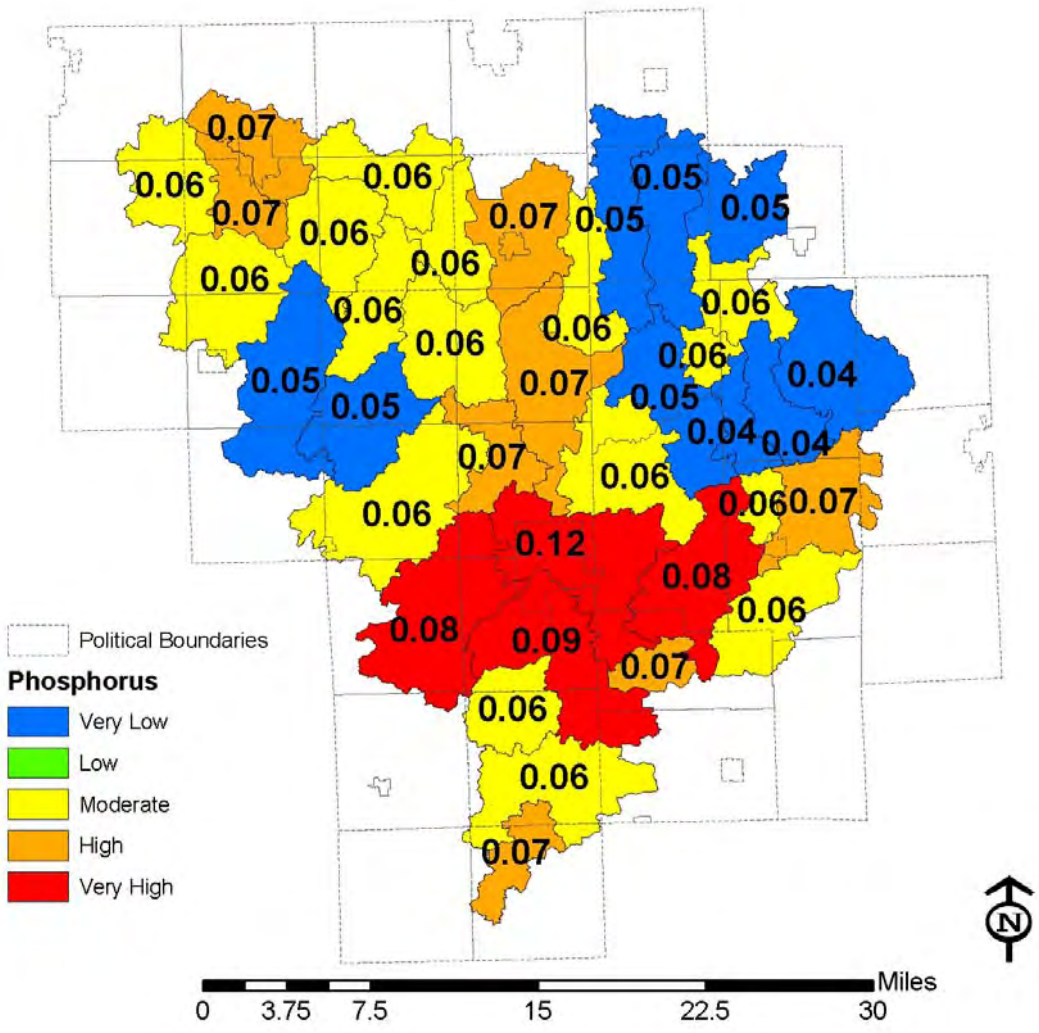


Figure 26: Average phosphorus load (lb acre^{-1}) per subbasin for a 2-year storm event

2.10 Bacterial Contamination Risk

Methods – Septic Failure Analysis

Risk of residential septic failure was calculated for the Upper Grand River Watershed. In order to calculate this, a point coverage approximating the locations of septic fields was compiled from two sources. Residences within the watershed known not to be serviced by a sanitary sewer approximated septic locations. Within Ingham and Eaton Counties, Tri-County Regional Planning Commission provided Ingham County and Eaton County sewer service areas and digitized locations of residences outside these service areas from 1995. In the remainder of the watershed, residences outside of sanitary sewer service areas were digitized from 1998 digital ortho-photography available from the Michigan DNR. OMM Engineering and Ripstra & Scheppelman provided sewer service areas in Jackson County; Washtenaw County provided their areas serviced by sanitary sewers.

Density of septic systems was computed from the septic point coverage. This density dataset was calculated by determining the number of septic systems per acre within a search radius of 610 m (~ 2000 ft) (Bemish, 2001). The final grid was reclassified to represent the United States Environmental Protection Agency (USEPA) ranges for risk of septic failure based on density (Figure 27). The USEPA (Yates, 1985) bases its risk categories on septic density as follows:

- < 0.016 septic systems per acre = low risk,
- 0.016 – 0.063 septic systems per acre = moderate risk, and
- > 0.063 septic systems per acre = high risk

Surface water risk was assessed through a modification of the USEPA risk category and summarized by subbasin. The initial USEPA risk of failure classes were assigned the following numeric values:

- low risk = 2,
- moderate risk = 6, and
- high risk = 10.

These numbers provided the base scores for the risk to surface water assessment. The base scores were altered based on mean runoff value of the subbasin [0-3.32 = subtract one, 3.32-3.52 = retain base score, 3.52-3.8 = add one]. The scores were further adjusted based on slope [0-3 = subtract one, 3-6 = retain previous value, above 6 = add one]. The scores were adjusted a third time based on the percent of natural land cover in the 500 ft riparian buffer [0-40% = add one, 30-70% = retain previous score, 70-100% = subtract one].

This analysis did not address the approximate locations of residential septic systems relative to soil type due to the possibility of septic field engineering. While some soils

were better able to accommodate septic fields than others, systems could have been engineered to exist on soil that would not tolerate a conventional system. Because information on system engineering was not broadly available for this study, approximated septic field locations were not compared with soil septic suitability.

Results – Septic Failure Analysis

The higher the density of the septic systems, the higher their likelihood was that their failure would have contributed to surface water contamination. The USEPA has categorized the risk of septic failure based on the density of septic systems. In the Upper Grand River Watershed, approximately 203,000 acres fell into the low risk category, approximately 199,000 acres fell into the moderate category, and approximately 44,000 acres fell into the high-risk category. When averaged over the watershed, septic field density of failure ranged from 0.013 systems acre^{-1} to 0.057 systems acre^{-1} (Table 14).

Rank	Name	Number of Septic Systems Acre^{-1}
1	Spring Brook - Source	0.013
1	Perry Creek	0.013
1	Spring Brook – Middle Branch	0.013
4	Mills and Post Drain	0.015
4	Pickett and Jacobs Drains	0.015
33	Grand River Drain - Downstream	0.044
34	Cranberry Lake Drain	0.051
35	Grand River Drain - Upstream	0.053
36	Western Creek	0.054
37	Orchard Creek	0.057

Table 14: Septic field density per acre summarized by subbasin

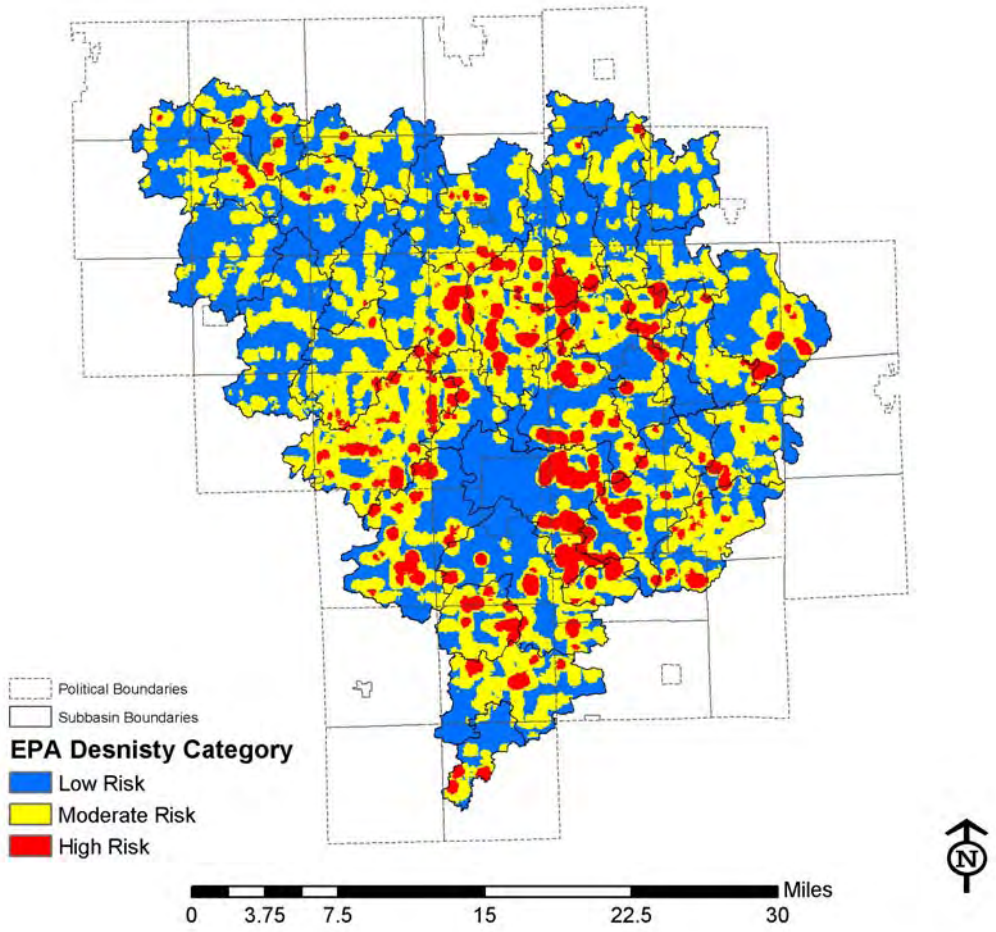


Figure 27: Risk of septic failure. This risk is calculated from septic field density and grouped according to USEPA guidelines.

After these risk categories were used to calculate overall subbasin risk to surface water contamination, the subbasins were compared to each other (Figure 28). Although sanitary sewers covered much of the Jackson Urbanized Subwatershed (Sandstone Blackman Drain, Grand River Drain – Upstream, and Pierce Drain), this area had a very high risk of surface water contamination from septic systems. This was attributed to the high concentration of residences throughout the Jackson Urbanized Subwatershed that fell outside delineated sanitary sewer districts. Furthermore, these areas often had a high runoff factor, increasing the risk to surface water score (Appendix 1, Table 17).

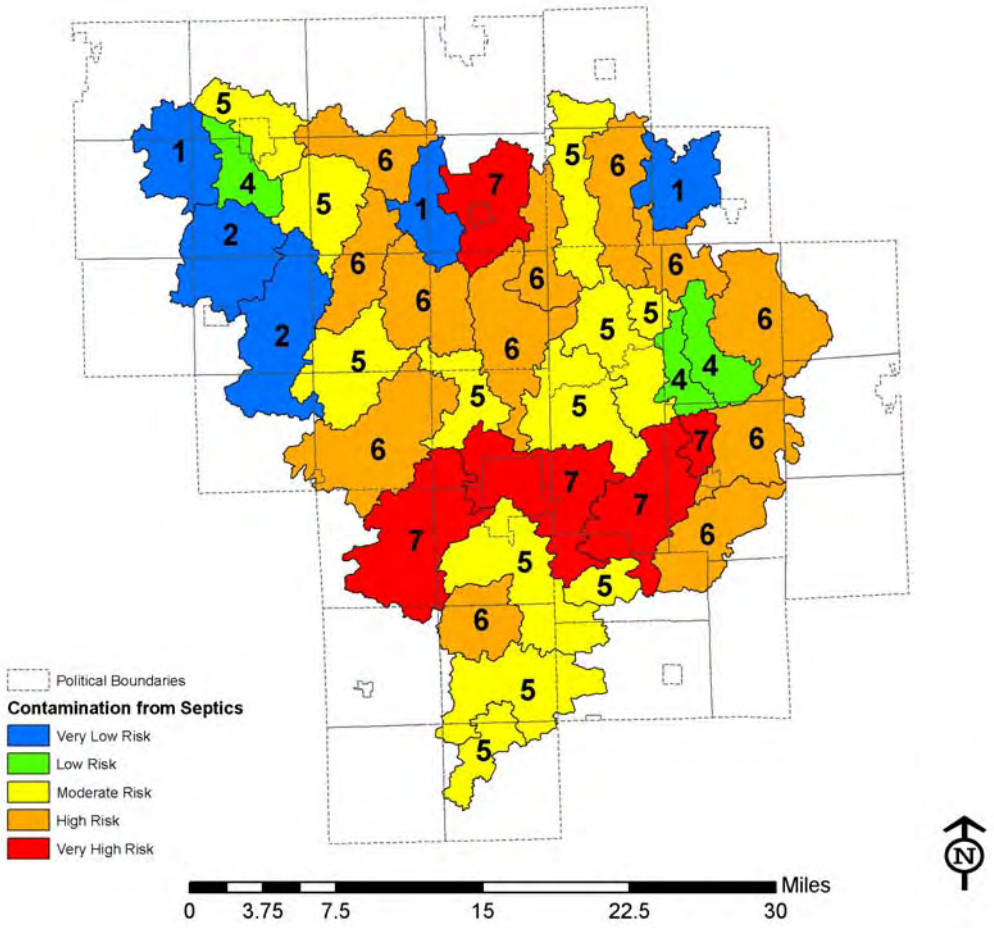


Figure 28: Risk of surface water contamination from septic failure summarized by subbasin

Methods – Feedlot Manure Spread

This analysis was based on the location of feedlots and the number of animal units on that feedlot. Locations of feedlots were provided. The animal units on each feedlot were approximated based on countywide data for Jackson County and based on local knowledge of the NRCS staff in Ingham and Eaton Counties. Given this information, feedlot locations and their respective animal units were digitized by quarter-quarter section. Only feedlots in the contributing source area of the watershed were examined. The number of animal units on each feedlot was indicated in the attribute table of the feedlot dataset. It was assumed that the amount of manure available for spreading was directly related to the number of animal units in a particular area. It was also assumed

that the manure was spread on agricultural land within two miles of the feedlot where it was produced.

A density grid was calculated based on the total number of animal units over a circular area with a two-mile radius. This density grid became the base layer for analysis of bacterial contamination from manure spread. The mean density of animal unit spread was computed for each subbasin and classified into the following groups and assigned respective base scores:

Class	Relative to Overall Mean (standard deviation)	Animal Unit Density Range (units $acre^{-1}$)	Base Score
Very low	> - -0.5	Below 37	2
Low	-0.5 - Mean	37 – 87	4
Moderate	Mean - 0.5	87 – 137	6
High	0.5 - 1.0	137 – 198	8
Very High	> 1.0	Above 198	10

The base scores for each of these categories were adjusted based on mean surface runoff, slope, and riparian buffer quality. The base scores were altered based on mean runoff value of the subbasin [0-3.3 = subtract one, 3.3-3.55 = retain base score, above 3.55 = add one]. The scores were further adjusted based on slope [0-3 = subtract one, 3-6 = retain previous value, 6-20 = add one]. The scores were adjusted a third time based on the percent of natural land cover in the 500 ft riparian buffer [0-40% = add one, 40-70% = retain previous score, 70-100% = subtract one].

Base data for this analysis was only available for Jackson County; Ingham County and Eaton County, therefore results were only computed for these areas. The final rankings have been computed for all subbasins, because all subbasins flowed, at least partially, through Jackson, Ingham, or Eaton County.

Results – Feedlot Manure Spread

The density of feedlots and the number of animal units on those feedlots influenced the risk to surface water from manure spreading most heavily (Table 15). Many of the subbasins with a low number of animal units had a low risk to surface water from manure spreading (Figures 29 and 30). However, in some cases, the risk to surface water increased or decreased based on the other factors affecting risk to surface water, namely status of riparian vegetation and subbasin runoff intensity (Appendix 1, Table 18). The final scores for the risk to surface water from feedlot manure spread ranged from 0-10 with the following severity groupings:

Very low = 0-2
Low = 3-4
Moderate = 5-6
High = 7-8, and
Very High = 9-10.

Rank	Name	Average Animal Unit Density
1	Spring Brook – Lower Branch	0
1	Portage River – Middle Branch 3	0
1	Portage River – Lower Branch	0
1	Wolf Lake and Drain	0
1	Sharp Creek	0
28	Sandstone Creek – Lower Branch	228
29	Spring Brook - Source	238
30	Southern Liberty Township Drain	278
31	Grass Lake Drain	343
32	Portage River - Source	397

Table 15: Highest and lowest ranked subbasins for average number of animal units per acre.

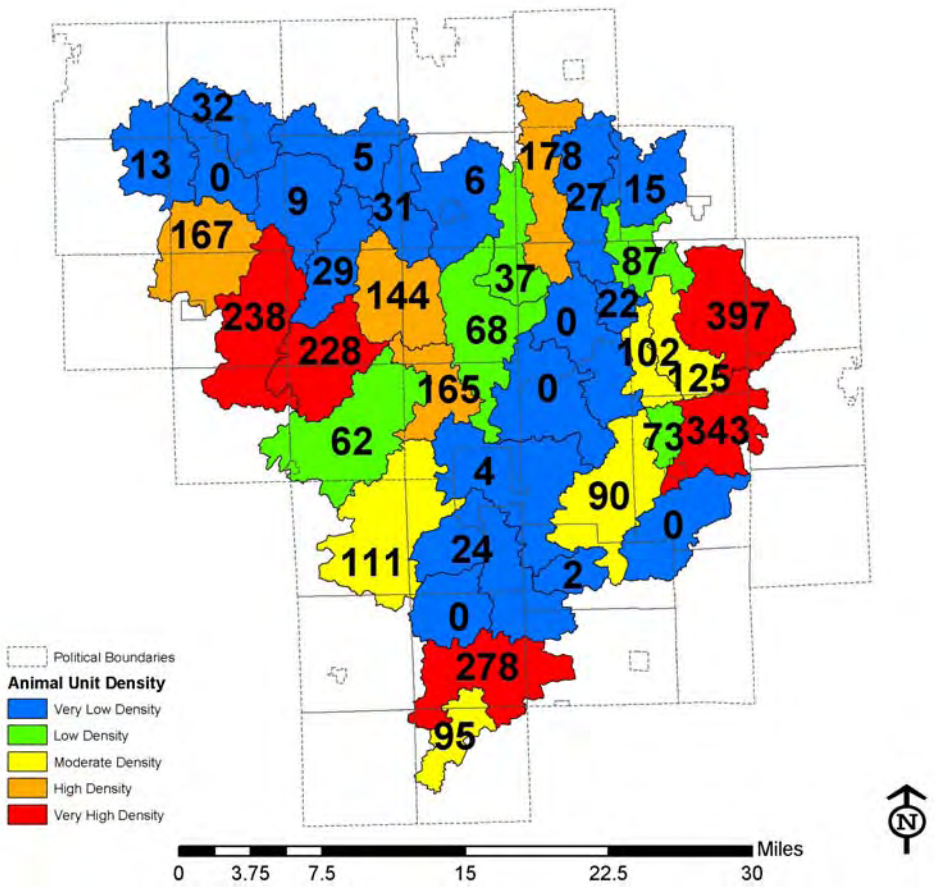


Figure 29: Average number of animal units per acre, summarized by subbasin. Only subbasins in Lenawee County were examined for this analysis.

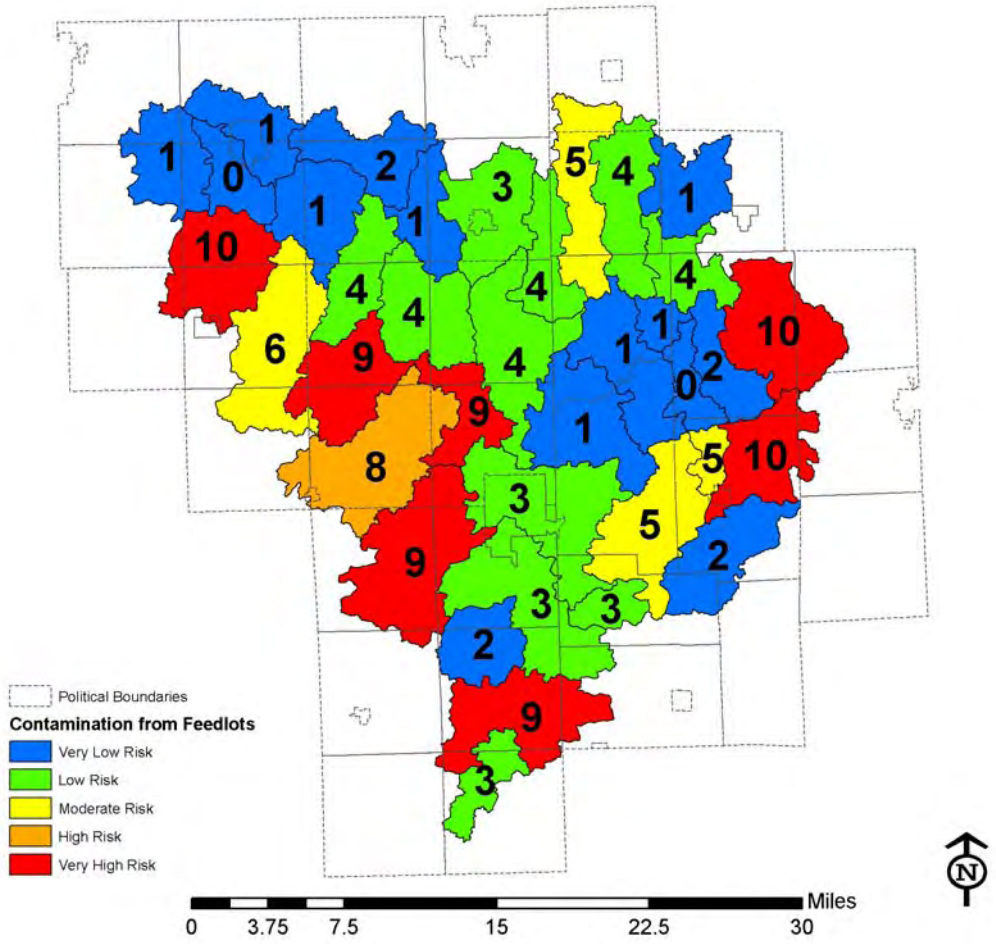


Figure 30: Risk to surface water contamination from manure spreading summarized by subbasin. Only subbasins in Lenawee County were examined for this analysis.

Of the thirty-seven subbasins examined in this analysis, six of them had a lower risk to surface water than their density of animal units indicated. In Spring Brook – Source, Portage River – Source, and Portage River – Middle Branch 1 the lower risk was attributed to the presence of riparian vegetation. In Batteese Creek and again in Portage River - Middle Branch 1 the low slope decreased the risk to surface water score. In Lake LeAnn, the decreased risk to surface water was attributed to low subbasin runoff intensity, and in Darling – Christie Drain the risk category decreased due to the spread of the manure.

Conversely, nine of the thirty-seven subbasins have a higher risk to surface water category than an animal unit density category. In two subbasins, Cahaogen Creek and Huntoon Creek, this increased risk was attributed to lack of riparian vegetation. In Grand River Drain – Upstream and Grass Lake Outlet the increased risk was attributed to high subbasin runoff intensity. In the remaining five subbasins (Bromly Tile Drain, Spring Brook – Middle Branch, Sandstone Creek – Middle Branch, Pierce Drain, Cranberry Lake Drain) the increased risk was not due to any of the modifying factors, but to the amount of manure, once it is spread on farm fields adjacent to the feedlot. These subbasins tend to have clusters of feedlots in close proximity to each other.

APPENDIX D

Jackson County Conservation District Reports

1. **An Inventory of Streambanks Needing Conservation Practices**
2. **Wetland Inventory of 2 Subbasins in the Portage River Watershed**
3. **Agricultural Flood Damage in the Portage River Watershed**

AN INVENTORY OF STREAMBANKS NEEDING CONSERVATION PRACTICES IN THE PORTAGE RIVER WATERSHED

By
Ronald Hoffman
Jackson County Conservation District
November 5, 2002

AN INVENTORY OF STREAMBANKS NEEDING CONSERVATION PRACTICES IN THE PORTAGE RIVER WATERSHED

By
Ronald Hoffman, Jackson County Conservation District
November 5, 2002

Numerous studies by the Grand River Inter-County Drainage Board have identified significant sedimentation and other geomorphologic changes that have resulted in log jams and channel restrictions along the Portage River. A 1999 study concluded that a majority of the Portage River Inter-County Drain is affected by sedimentation (Hubbell et al. 1999). Sediment depths 3 - 7 feet were found at 15 of 60 sediment probes taken in a 21-mile stretch of the Portage River ending at the Grand River (ibid.). Abbey 1954, Anonymous 1954, USDA 1958, USDA 1968, etc. described substantial flooding that damaged crops and pasture. This inventory of riparian agricultural areas along 4 main watercourses of the Portage River Watershed was initiated to identify streambank areas that are contributing sediment.

PURPOSE

Reducing streambank erosion and sedimentation with riparian conservation practices will improve water quality and reduce agricultural flood losses. Identifying the sources of sediment is the first step of the process. Specific purposes of riparian conservation practices are to:

- Remove sediment runoff from croplands, grazing lands, and disturbed areas.
- Remove nitrogen, phosphorus, pesticide, and pathogen runoff from cropland, grazing land, and disturbed areas.
- Recharge groundwater and reduce flooding by increasing infiltration.
- Provide wildlife habitat.

OBJECTIVES

- Identify and prioritize riparian lands in agricultural production that may benefit from conservation practices (e.g. filter strips, riparian buffers, etc.).
- Contact landowners that might benefit from government programs that help with the cost of implementing conservation practices e.g. Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP).

PROCEDURE

An inventory of the need for riparian conservation practices in the Portage River Watershed focused on 1) farming activity near waterways, 2) unrestricted livestock access to waterways, and 3) streambank erosion from disturbed areas.

Agricultural activity within 180 ft. of a streambank was determined from USDA 1993-94 black and white aerial photographs (scale 1 in. = 660 ft.), USDA 2001 aerial color slides, and Portage River Inter-County Drain 2000 maps (scale 1 in. = 250 ft.). Four watercourses Orchard (Plum Orchard) Creek, Cahaogen Creek, Pickett and Jacobs Drain, and Wild Drain (Thornapple Creek) were chosen because they were at the headwaters of the Portage River and had the highest agricultural activity. Conditions were confirmed with field visits to 75% of the sites identified from aerial photos and maps.

A data-entry form (Table 1) was completed for each site and used to derive a prioritize list of those needing conservation practices.

The need for conservation practices was based on three factors within 180 ft. of the streambank: soil slope, erosion factor K (USDA 1980:78) and the width of vegetation. Soil characteristics affecting sedimentation were derived from county soil books (USDA. 1979, USDA. 1981). Two factors, percent slope (s) and soil erosion factor K, were placed in one of 4 categories and points assigned to each category as follows:

% Slope (s)	Points	K value	Points
0-3	1	0.00 - 0.17	1
4-5	2	0.20 - 0.24	2
6-12	3	0.28 - 0.32	3
13-18	4	0.37 - 0.43	4

An index of surface runoff for each soil type was based on a formula that included the degree of soil slope and erosion factor K:

$R = s + K$

R = index of surface runoff

s = soil slope class

K = soil erosion factor

Soil types and their surface runoff indices used in this inventory are listed in Table 2. For example, Spinks sand has a 6-12% slope and a K value of 0.17 so the surface runoff index is 4 (3 + 1). The width of vegetation (V) within 180 ft. of the waterway was also assigned index points:

Width of Streambank Vegetation	Index
>180 ft.	0
100 - 180 ft.	1
30 - 100 ft.	5
< 30 ft.	10

The need for riparian conservation practices (N) was calculated using the formula:

$N = R + V$

N = need for riparian conservation practices

R = surface runoff index

V = streambank vegetation index

The N value at sites could range from 0 to 17. The need for conservation practices based on the N values was classified as a very high need if the score was 14-17, high need if 10-13, medium need if 6-9, low need if 2-5; and very low need if 0-1.

Data from each site was entered into a geographic information system (ArcView) for digital presentation and data analysis. A copy of the data is available on a CD-ROM disk at the Jackson County Conservation District and the Jackson County Drain Commissioner Office.

Direct mailing will be used to advise landowners that have the highest need for riparian conservation practices. Information about conservation practices, cost-sharing programs, and agencies to contact for additional information will be included in the letter.

RESULTS

More than 30 miles (158,250 ft.) of agricultural land along streambanks were inventoried in 4 watercourses of the Portage River Watershed (Figure 1. Table 3). Areas with woody vegetation or wetlands made up most of the non-agricultural land along the ditches so these areas were not inventoried. About 2/3's of the inventoried area was in Ingham County. Ninety-four sites were identified with agricultural activity (Layouts 1-8). Beans, corn, sod, hay and idle fields were the most common agricultural uses. Only two sites were being used for pasture and a dooryard bordered a watercourse at two other inventoried locations. All of the watercourses were channeled ditches.

The areas with the highest risk of erosion (N = 14-17) extended along 31 % (50,300 ft.) of the inventoried area (Table 3). Sites 7 & 8 (Figure 2) were typical of areas with a very high need (N = 14) because the surface runoff index, R = 4, and permanent vegetation extended less than 30 ft from the streambank (V = 10). Even though these two sites bordered 4,800 ft. of the Cahaogen Creek (ditch), sediment entered the stream in only a few locations because a berm separated the fields from the ditch. Sediment depth was 4.2. ft downstream from these two sites (Hubbell, et al. 1999).

Areas with a high need (N = 10-13) extended along about 43% (67,554 ft.) of the inventoried area (Table 3). Figure 4 shows an example of a field with high need (N = 12) for conservation practices because corn was planted to within 30 ft. of the ditch (V = 10), but the soil, Palms Muck, has a Surface Runoff Index (R) of 2.

Nearly 75% (117,900 ft.) of the inventoried area has a very high or high need of conservation practices that would reduce erosion (Table 3). Most of these areas were in Ingham County where corn or beans were grown on muck soils within 30 ft. of the streambank. A berm often separated the fields from the stream so not all of the 117,900 ft. probably will need conservation practices.

Site 11 (Figure 4) is an example of a site (N = 8) with medium need of conservation practices because the Gilford-Colwood complex of soils hand a Surface Runoff Index equaled 3 and woody plants extended about 50 ft. from the edge of the stream (V = 5). About 12% (19,000 ft.) of the inventoried area scored in the medium category (N = 6-9) Table 3.

About 13% (21,300 ft) of the inventoried area had a low or very low need for conservation practices. A golf course, a site enrolled in the Conservation Reserve Program, and two idle fields made up the very low group. Areas of low need included 4 sites of idle fields and 5 sites with row crops but woody vegetation extended at least 100 ft. from the edge of the streambank.

RECOMENDATIONS

The recommendations presented here to reduce soil erosion and sedimentation are general in nature and apply to the 4 watercourses as a whole rather than for specific sites. This inventory identified potential sources of riparian erosion. A program to implement conservation practices for a specific site should follow this study. Those practices will depend on in-depth analysis of the conditions at each site and the landowner's wishes. It is recommended that:

- Landowners should to be informed of the extent and severity of soil erosion and sedimentation in the Portage River Watershed.

- Landowners should be encouraged to participate in riparian conservation practices that will control soil erosion and sedimentation.
- Soil Rental Rates approved for Conservation Reserve Program practices should be raised as an incentive for landowners to participate in cost-sharing practices. Soil Rental Rates are based on the average rental rate for cropland in a county. Then the rate is adjusted based on the productivity of the soil. Approved soil rental rates for similar soils in Jackson County are lower than the rates in the surrounding counties. Present rates for conservation practices can not compete with income earned from farming erosion prone areas.
- Designating the Grand River Watershed, or at least the Portage River portion, a Conservation Reserve Enhancement Program (CREP) area would increase payment rates for practices such as riparian buffers, filter strips, etc.
- Implementing conservation management practices (USDA 2001) such as those listed below will significantly reduce erosion and sedimentation. Some of these practices deal with the stream channel, others with streambank, and some with the area beyond the riparian zone; but all reduce soil erosion.
  - **Cover Crops** – Grasses, legumes, forbs or other herbaceous plants established for seasonal cover reduces erosion from wind and water.
  - **Conservation Crop Rotation** – Growing crops in a recurring sequence on the same field reduces sheet and rill erosion.
  - **Conservation Cover** – Establishing and maintaining perennial vegetation cover on land retired from agriculture reduces erosion and sedimentation and improves water quality.
  - **Critical Area Planting** – Planting vegetation such as trees, shrubs, vines, grasses or legumes on high erodible or critical areas stabilizes the soil and thereby reduces damage from sediment and runoff to downstream areas..
  - **Cross Wind Trap Strip–Filter** – Herbaceous cover resistant to wind erosion, established adjacent to surface drainage ditches across the prevailing wind erosion direction will entrap windborne sediment to improve water quality.
  - **Filter Strips** – Narrow bands of grass or other permanent vegetation adjacent and parallel to streams will intercept undesirable contaminants from runoff before they enter a waterbody preventing pollution of surface water and groundwater.
  - **Grade Stabilization Structure** – A structure (earth embankments and mechanical spillways and full-flow or detention-type structures) used to control the grade and head cutting in natural or artificial channels will stabilize the grade and control erosion and prevent the formation or advance of gullies.
  - **Grass Waterways** - Channels, usually constructed where natural watercourses occur, that are shaped and planted to suitable vegetation to protect soil from erosion, protect surface and groundwater, and improve wildlife habitat.
  - **Pasture And Hayland Planting** – Establishing and re-establishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants will reduce erosion.
  - **Residue Management, -No-Till and Strip Till** – Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year-round, while growing crops in previously untilled soil and residue will reduce sheet, rill and wind erosion.
  - **Residue Management, Mulch Till** - Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year-round, while growing crops where the entire field is tilled prior to planting will reduce sheet, rill and wind erosion.

- **Residue Management, Seasonal** - Managing the amount, orientation and distribution of crop and other plant residue on the soil surface during part of the year, while growing crops in a clean tilled seedbed will reduce sheet, rill and wind erosion.
- **Riparian Forest Buffers** – Areas with trees and shrubs adjacent to water and up-gradient from watercourses will filter out pollutants, create shade, and provide wildlife habitat.
- **Riparian Herbaceous Cover** – Herbaceous cover will improve and protect water quality by reducing the amount of sediment and other pollutants, intercept solar radiation, create shade and increase the depth to width ratio of streams where it is not feasible or desirable to establish wood vegetation. Planting native grasses will provide long-term vegetative cover, but are slower to establish than introduced species. Native plants are usually better adapted to our local conditions, are more resistant to diseases and insect problems. Introduced grasses and legumes will live for 10-30 years, grow fairly fast and are usually easier to establish than native grasses. Introduced species should be used only when there are no alternative native species and the introduced species are not invasive.
- **Sediment Basin** – A basin constructed to collect and store debris or sediment will preserve the capacity of waterways, prevent undesirable deposition on bottom lands and developed areas, trap sediment originating from construction sites, and facilitate deposition and storage of silt, sand, gravel, stone, agricultural wastes and other detritus.
- **Side Inlet Structures (Bubble Filter Strips)** –, Rock riprap, grade stabilization structures, etc. trap pollutants before they can enter the stream where runoff is funneled into a waterbody by embankments, dikes, or spoil.
- **Streambank Protection** – Planting and maintaining trees, shrubs, and grasses, bank covers, riprap, etc. will help maintain the capacity of the channel, control channel meander that would adversely affect downstream facilities, and reduce sediment loads.
- **Stream Crossing and Livestock Access** – A constructed stable area extending either into or across streams will minimize sediment and nutrient delivery where livestock need access to streams.
- **Tree and Shrub Establishment** – Establishing woody plants by planting or seeding will provide erosion control.
- **Use Exclusion** – Excluding animal, people or vehicles from sensitive riparian areas will reduce erosion.
- **Vegetative Barrier** – Permanent strips of stiff, dense vegetation along the general contour of slopes or across concentrated flow areas will reduce sheet and rill erosion, reduce ephemeral gully erosion, mange water flow, stabilize steep slopes and trap sediment.
- **Water and Sediment Control Basin** – An earth embankment or combination ridge and channel generally constructed across the slope and minor watercourse to form a sediment trap and water detention basin will reduce watercourse and gully erosion, trap sediment reduce and mange onsite and downstream runoff and improve water quality.
- **Wetland Restoration** - Wetland acreage will improve ground and surface water quality, act as a flood control device by slowing water flow, and replenish groundwater and provide wildlife habitat.

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ACKNOWLEGEMENTS

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Table 1. Riparian Conservation Need Inventory Data Entry Form

Site Number:_____ Need Score_____ Investigator:_____
Determination Method: B&W Aerial Photo_____ Color Slide_____ Field_____
Status: Soil map_____ Sub-basin _____ Portage R. Evaluation Map_____
Designated Drain Y N _____
Location:
General:_____
Township Name_____ Twp. _____ Range _____ Sec._____
Township Name_____ Twp. _____ Range _____ Sec._____
Latitude_____ Longitude_____
Owner:
Name:_____ Farm Number_____ Tract Number_____
Addresses:_____
Phone:_____

Identification	Soil Type	Streambank Veg.	Streamside	Land	Length	Score
	Symbol : Pts.	Width (ft) : pts.	Cover Type[1]	Use[2]	(ft)	

Best Management Practice Recommendations (forest buffer, filter strips, fencing, wetland restoration, preservation, etc.):

Comments:

[1]H - Herbaceous
S - Shrub
T - Trees

[2] B - Bare ground
I - Idle
P - Pasture
R - Row crops

Table 3. Length (ft.) of riparian areas along 4 watercourses of the Portage River Watershed that need conservation practices.

Watercourse Name, Subbasin Number	Conservation Need Index (Score, Class) 14-17 Very High Length (ft.)	Conservation Practice Need Index (score, class) 10-13 High Length (ft.)	6-9 Medium Length (ft.)	2-5 Low Length (ft.)	0-1 Very Low Length (ft.)	Total Length (ft.)
Cahaogen Creek, 1221	25,738	25,696	5,236	4,767	-	61,437
Pickett & Jacobs Drain, 1227	8,727	31,378	4,409	2,039	7,980	54,533
Wild Drain, 1262	13,007	5,603	1,127	480	-	20,217
Orchard Creek, 1294	2,902	4,877	8,249	6,039	-	22,067
Total	50,374	67,554	19,021	13,325	7,980	158,254

Table 4. Description of 94 riparian sites inventoried for the need (N) of riparian conservation practices.

Site	Layout Map	Subbasin*	N	Township	Range	Section	Length (ft.)
1	4	1262	14	1s	2e	12	3,153
2	3	1221	9	1s	1e	2	675
3	3	1221	9	1s	1e	2	1,521
4	3	1221	14	1s	1e	2	759
5	3	1221	14	1s	1e	2	562
6	3	1221	14	1s	1e	2	1,727
7	3, 4	1221	14	1s	1e	2, 11	1,877
8	3, 4	1221	14	1s	1e	2, 11	1,743
9	3	1221	14	1s	1e	2	1,996
10	4	1221	14	1s	1e	11	1,259
11	4	1221	9	1s	1e	11	716
12	4	1221	9	1s	1e	12, 13	2,099
13	4	1294	14	1s	1e	13	2,902
14	4	1294	8	1s	1e	13	1,360
15	4, 5	1294	13	1s	1e	13	1,360
16	4	1294	8	1s	1e	13	923
17	4, 5	1294	9	1s	1e	24	1,110
18	5	1294	12	1s	1e	24	3,517
19	5	1294	2	1s	1e	24	802
20	5	1294	2	1s	1e	24	2,801
21	5	1294	3	1s	1e	24	680
22	5	1294	3	1s	1e	24	1,056
23	5	1294	7	1s	1e	25	3,265
24	4	1294	2	1s	1e	13	700
25	5	1294	7	1s	1e	24	670
26	3	1221	14	1n	1e	35	1,070
27	3	1221	14	1n	1e	35	1,320
28	3	1221	5	1n	1e	35	200
29	3	1221	5	1n	1e	35	775
30	2, 3	1221	14	1n	1e	35	2,175
31	2, 3	1221	14	1n	1e	26	755
32	2	1221	14	1n	1e	26	3,025
33	2	1221	14	1n	1e	26	2,650
34	2, 3	1221	14	1n	1e	26	862
35	2	1221	14	1n	1e	26	775
36	1, 2	1221	12	1n	1e	23, 26	5,345
37	1, 2	1221	14	1n	1e	14, 23	1,245
38	1	1221	12	1n	1e	14	650
39	1	1221	12	1n	1e	14	2,095
40	1	1221	12	1n	1e	14	1,929
41	1	1221	12	1n	1e	14	2,725
42	1	1221	12	1n	1e	11, 14	4,437
43	1	1221	12	1n	1e	11	1,005

Site	Layout Map	Subbasin*	N	Township	Range	Section	Length (ft.)
44	1	1221	2	1n	1e	11	2,722
45	1	1221	12	1n	1e	11	876
46	5	1294	8	1s	1e	24	921
47	3	1221	14	1s	1e	2	279
48	3	1221	14	1s	1e	2	807
49	2	1221	12	1n	1e	23, 26	444
50	1	1221	12	1n	1e	11	1,766
51	1	1221	12	1n	1e	11, 14	2,671
52	2	1221	12	1n	1e	23, 26	1,753
53	3	1221	5	1n	1e	35	1,070
54	3	1221	9	1n	1e	35	225
55	3	1221	14	1n	1e	35	852
56	7	1227	0	1n	2e	29	1,245
57	7	1227	0	1n	2e	29	3,174
58	7	1227	12	1n	2e	29	1,628
59	7	1227	12	1n	2e	29	1,312
60	7	1227	3	1n	2e	29	1,312
61	8	1262	13	1n	2e	32	476
62	7	1227	7	1n	2e	28	2,406
63	8	1262	14	1s	2e	5, 6	1,866
64	8	1262	14	1s	2e	6	2,406
65	8	1262	5	1s	2e	6	480
66	8	1262	14	1s	2e	5, 6	5,582
67	8	1262	13	1n	2e	32	1,428
68	8	1262	12	1n	2e	32	1,676
69	8	1262	12	1n	2e	32	1,565
70	8	1262	13	1n	2e	32	458
71	6	1227	14	1n	2e	7	1,517
72	6	1227	9	1n	2e	7	291
73	6	1227	0	1n	2e	7	3,561
74	6	1227	4	1n	2e	7	727
75	6	1227	8	1n	2e	7	606
76	6	1227	14	1n	2e	18	2,670
77	6	1227	12	1n	2e	18	3,710
78	6, 7	1227	12	1n	2e	18	7,190
79	6	1227	14	1n	2e	18	600
80	7	1227	12	1n	2e	19	2,600
81	7	1227	15	1n	2e	19	1,885
82	7	1227	12	1n	2e	19	931
83	7	1227	12	1n	2e	30	1,980
84	7	1227	12	1n	2e	30	722
85	7	1227	12	1n	2e	29, 30	4,104
86	7	1227	12	1n	2e	19	387
87	7	1227	9	1n	2e	19	388
88	6	1227	9	1n	2e	7	718

Site	Layout Map	Subbasin*	N	Township	Range	Section	Length (ft.)
89	4	1262	9	1s	1e	12	1,127
90	7	1227	12	1n	2e	21	2,739
91	7	1227	12	12	2e	21	1,441
92	7	1227	12	1n	2e	21	2,634
93	7	1227	14	1n	2e	16	2,055
94	7, 8	1262	13	1n	2e	32	1681

*Subbasin

1221 Portage River (Cahaogen Creek)

1227 Pickett & Jacobs Drain (Thornapple Creek)

1262 Wild Drain (Orchard Creek

1294 Orchard Creek (Portage River)

WETLAND INVENTORY
OF
TWO SUB-BASINS IN THE
PORTAGE RIVER WATERSHED

By
Ronald Hoffman
Jackson County Conservation District
August 19, 2002

WETLAND INVENTORY OF TWO SUB-BASINS IN THE PORTAGE RIVER WATERSHED

By
Ronald Hoffman, Jackson County Conservation District
August 19, 2002

Wetlands in the Portage River Watershed have experienced dramatic changes during the past 180 years. Historically, the Portage River carried much of the water in northeastern Jackson County and southeastern Ingham County to the Grand River north of Jackson after filtering through extensive complex of wetlands. A variety of wildlife flourished in undisturbed marshes along the Portage. First to affect the watershed were early settlers who harvested marsh hay. Further changes occurred when the Portage River was straighten and deepened in 1921-22 and renamed the Portage River Drain. With most of the wetlands drained, farmers were able to grow onions, lettuce, peppermint, sod and a variety of other specialty crops on the rich muck soils.

In recent times a combination of factors have reduced farming along the Portage. Fallen trees, sediment, and other debris now clog not only the drain, but also the Grand River in many locations causing widespread flooding, especially in the spring (Hubbell, Roth & Clark, Inc. 1999). A US Army Corps Engineer 1972 study concluded that cleaning the Grand and Portage Rivers was prohibitive because the cost far exceeded agricultural benefits. Now much of the farmland along the lower portions of the Portage River Drain now is abandoned because of flooding, late spring and early fall frosts, crop depredation by wildlife, and depressed crop prices.

Restoring and preserving these former wetlands is a viable alternative to farming.

There are several reasons for restoring and/or preserving wetlands. Some of the most important functions of wetlands are that they:

- Prevent floods by temporarily storing and retaining water, allowing the water to be slowly released, evaporate or percolate into the ground, and recharging groundwater.
- Help prevent the movement of sediment into lakes and streams by filtering out water borne sediment.
- Offer opportunities to watch and enjoy a wide variety of wildlife.
- Improve water quality by filtering pollutants out of water.
- Provide habitat for a wide diversity of plants, amphibians, reptiles, fish, birds and mammals.
- Support approximately 50% of Michigan's Endangered or Threatened species.

OBJECTIVES

- Identify and prioritize candidate agricultural areas for wetland restoration and/or preservation in the lower regions of the Portage River Watershed.
- Contact landowners that may benefit from government programs that provide financial assistance for restoring wetlands e.g., Wetland Reserve Program, Partners for Fish and Wildlife.

PROCEDURE

Hydric soils (Table 1) identified in the Soil Survey of Jackson County (USDA 1981) were used to locate potential wetlands in two sub-basins, Portage River Lower Branch and Portage River Middle Branch 3. Soils with minor inclusions of hydric soils were not inventoried (Table 1). USDA 1993-94 black and white aerial photographs (scale 1 in. = 1/8 mi. = 660 ft.) and USDA 2001 aerial, color slides were also helpful. Upland soils, roads, dikes and other elevated barriers were used to determine the boundary of a wetland e.g. each field was considered a separate wetland if a dike separated it from adjacent drained fields, or when a road bisected a wetland complex, each side was considered a separate wetland. Large wetlands were split into separate units because 1) it is easier to restore a small wetland owned by only one landowner than dealing with several property owners, and 2) a landowner may wish to restore only some of his wetlands.

Wetland status was categorized as being **destroyed**, degraded but candidates for **restoration**, or relatively undisturbed and should be **preserved**. Hydric soil areas were considered degraded if there was evidence of drainage ditches, agricultural activity, or drainage tile. Field visits were made to more than 1/2 of the sites to confirm their classification.

Data sheets (Table 2) were completed for each wetland and they are on file at the Jackson County Conservation District. Ronald Parker entered data for each site into a geographic information system (ArcView) for digital presentation and data analysis. A copy of the data is available on a CD-ROM disk at the Jackson County Drain Commissioner Office and Jackson County Conservation District.

Each wetland was evaluated for its potential restoration based on 7 characteristics (e.g. size, present land use, etc.). Points were assigned to each of the 7 characteristics based on a modification of the 2001 Wetland Reserve Program Michigan Ranking System (USDA NRCS 2001). The scale of points for each site feature is as follows:

A. Wetland size, 1 point per acre (maximum pts. 20)
B. Present land use
   - 50% tilled within last 4 yrs. — 15 pts.
   - 50% pastured or hayed within last 4 yrs. — 10 pts.
C. Unique saturated area - fens, bogs, organic soils
   - At least 51% converted muck land — 10 pts.
D. Landscape significance
   - >40 acres of emergent wetland types within ½ mi. — 10 pts.
   - >40 acres of emergent wetland types within 1 mi. — 6 pts.
   - >40 acres of any wetland types within ½ mi. — 4 pts.
E. Within floodplain — 30 pts.
F. Degraded by ditches, tile — 20 pts.
G. Number of landowners
   - 1 — 10 pts.
   - 2 or 3 — 5 pts.

A **restoration score** was then calculated based the sum of the points.

RESULTS AND DISCUSSION

Table 3 summarizes the results of this inventory. Two sub-basins, Portage River Lower Branch and Portage River Middle Branch 3 were completely inventoried for wetlands. We found 335 wetlands in those two sub-basins. Incidental to the work in the two sub-basins, 7 additional wetlands are described from three adjacent sub-basins. Figure 1 and Figure 2 show the location of wetlands in the sub-basins with complete coverage.

This inventory does not include wetlands located in the four soils that had a minor inclusion of hydric soils (Table 1). For example in Brady Sandy Loam, the hydric soil (Gilford) is a minor inclusion and can not be identified on the soil maps. Typically, these hydric soil inclusions are small, seasonally flooded depression which are easily drained, tiled and/or farmed. Laws generally do not regulate wetlands less than 5 acres in Michigan so it is likely that this inventory underestimated the number and acreage of wetlands less than 5 acres.

Data for individual wetlands are reported Table 4, Table 5, and Layout Maps 1-61. In Table 4, wetlands are arranged sequential based on their wetland identification number. Information includes restoration score, status (restorable, preserve, or destroyed), location, size, sub-basin, and layout map for each wetland. Individual wetlands are identified on Layout Maps covering one-square mile. Figure 3 provides an index to the 61 Layout Maps if the township, range, and section of a wetland are known. In Table 5, wetlands are ranked according to their restoration score.

The following discussion is confined to the two sub-basins with completed coverage (Table 3).

At least 17 areas covering 120 acres were once wetlands based on hydric soil locations and now are destroyed. Most were filled leaving no trace that once a wetland was located at that site. Several of these destroyed wetlands are located on State of Michigan (Prison) property. As stated above, soils with minor hydric soil inclusions were not identified so the amount of destroyed wetlands is underestimated.

We were able to identify 198 wetlands (5,032 acres) that appeared to be in a relative natural state and therefore should be preserved. Some of these may be affected by ditches located some distance from the wetland boundary or by undetected drain tile. Seven of these wetlands totaling 719 acres are being preserved that once were degraded but have been or soon will be restored through either the Wetland Reserve Program (WRP) or the U.S. Fish & Wildlife Service Partners for Fish & Wildlife Program. Wetlands are also being preserved at 447 acres owned entirely by the State of Michigan, Dept. of Natural Resources and the ownership of an additional 299 acres is shared with one or more other landowners. The Michigan Audubon Society protects 541 acres and an unknown number of private landowners that wish to preserve their wetlands. In addition, various state and federal wetland laws require a permit to drain or fill wetlands larger than 5 acres.

At least 34% of the 5,032 acres of that are recommended for preservation are being protected now.

We found 120 wetlands (6,412 acres) had been degraded and have potential for restoration. Restoration scores ranged from 0 to 115 points. Those with the highest score are the best candidates for restoration (Table 5). The Portage River Drain, smaller drainage ditches and drain tile most often changed hydrology. The State of Michigan (Prison) is the sole owner of the largest block of degraded wetlands (1,022+ acres) with high potential for restoration. The State of Michigan prison shares ownership with one or more landowners of an additional 906 acres of wetlands. In 2002, two landowners applied to restore 1,134 acres as part of the WRP. WRP funds are available to restore that acreage and if accepted into the program, will further add to the wetlands that are preserved.

RECOMMENDATIONS

The recommendations presented here to restore and preserve wetlands are general and apply to the watershed as a whole rather than for specific sites. This inventory identified potential restoration sites and was not intended to make recommendations for a specific site. Those will depend on in-depth analysis of the conditions at each site and the landowner's wishes.

- Landowners should to be informed of benefits of wetlands and the problems caused by wetland degradation.
- Landowners should be encouraged to participate in restoration and preservation of wetlands.
- Land Conservancies or Trusts have proliferated across Michigan, but none is specific for Jackson County. A Jackson County land conservancy should be formed that would hold conservation easements on special interest lands (e.g. wetlands, farmland, forestland, etc.), to permanently prevent future development, while leaving the land in private ownership.
- Landowners should be informed about opportunities to participate in wetlands programs and assistance that various agencies provide e.g. USDA Wetland Reserve Program, US Fish & Wildlife Service Partners for Fish & Wildlife, Ducks Unlimited MARSH program.
- Designating the Portage River Watershed a Conservation Enhancement Program (CREP) area would increase payments for restoration, enhancement, preservation, and other conservation practices.
- Wetlands in additional sub-basins should be inventoried for restoration potential. Only two of 37 sub-basins have been surveyed. Priority should be given to inventory sub-basins with cropland subject to flooding e.g. Unnamed Tributary, Orchard Creek, Cahaogen Creek, etc.
- Local units of government adopting ordinances regulating wetlands smaller than 5 acres would help protect areas most susceptible to degradation.
- Wetland Mitigation – Michigan Wetland Protection law authorizes the MDEQ to require actions to mitigate the loss of wetland area and function. Landowners with restorable wetlands can sell development easements for those wetlands to developers needing mitigation.
- Wetland Mitigation Banking – A wetland mitigation bank is a site where wetlands are restored, created, or in exceptional circumstances, preserved expressly for the purpose of providing an off-site alternative to compensate for authorized wetland loss. MDEQ may authorize the use of credits from an established mitigation bank. Landowners with wetlands that qualify for banking may sell credits to developers.
- Implementing conservation management practices (USDA 2001) such as those listed below will significantly help with restoring and enhancing wetlands degraded by past activities.

- **Conservation Cover** – Planting herbaceous cover in uplands surrounding wetlands will improve and protect water quality by reducing the amount of sediment and other pollutants, and provide wildlife habitat where it is not feasible or desirable to establish woody vegetation. Planting native, warm-season grasses will provide long-term vegetative cover, but are slower to establish than introduced species. Native plants are usually better adapted to our local conditions, are more resistant to diseases and insect problems, and provide better nesting and winter cover than introduced species. Introduced grasses and legumes (cool-season) will live for 10-30 years, grow fairly fast and are usually easier to establish than native grasses. Introduced species should be used only when there are no alternative native species and the introduced species are not invasive.
- **Riparian Forest Buffers** – Areas with trees and shrubs adjacent to water and up-gradient from watercourses and wetlands will filter out pollutants, create shade, and provide wildlife habitat.
- **Tree and Shrub Establishment** – Establishing woody plants by planting or seeding will provide erosion control and provide wildlife habitat.
- **Wetland Enhancement** – Enhancement includes the modification or rehabilitation of an existing or degraded wetland, where specific functions or values are modified for the purpose of favoring a specific wetland functions or values. Examples include managing hydrology for waterfowl or amphibian use, or managing plant community composition to favor native plants.
- **Wetland Restoration** – A rehabilitation of drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the natural conditions to the greatest extent possible.
- **Wetland Wildlife Habitat Management** – Retaining, developing or managing habitat for waterfowl, fur-bearers, or other wetland associated flora and fauna.

REFERENCES

Hubbell, Roth & Clark, Inc. 1999. Portage River Inter-County Drain Drainage District evaluation and corridor study. 54 pp.

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USDA. Soil Cons. Serv. 1981. Soil survey of Jackson County, Michigan. 178 pp.

USDA NRCS. 2001. Conservation practice standards field office technical guide, Section IV, Vol. I., Lansing, MI

Table 1. Hydric soils inventoried for wetlands.

Map Symbol	Name	Inclusion
Hydric Soils Inventoried		
17	Barry Loam	
18	Gilford-Colwood Complex	
20	Houghton Muck	
22	Cohoctah Fine Sandy Loam	
30	Edwards Muck	
37	Palms Muck	
39A	Ypsi-Wauseon Complex	Wauseon
40	Lenawee Silt Loam	
45	Martisco Muck	
46	Sebewa Loam	
47	Histosols & Aquents, Ponded	
48	Napoleon Muck	
63	Henrietta Muck	
Hydric Soils Not Inventoried		
16A	Brady sandy Loam	Gilford
43A	Dixboro Very Fine Sandy Loam	Colwood
62A	Del Rey Silt Loam	Lenawee
65A	Capac Loam	Barry

Table 2. Data Sheet For Wetland Site Inventory

Site Number:_____ Map_____ Total Points_____ Preserve Restore Destroyed
Date:_____ Field Checked _____Observer:_____
Location: Sub-basin: _____
Township Name_____ Twp. ____Range ____ Sec._____
Township Name_____ Twp. ____ Range ____Sec._____
Latitude_____ Longitude_____
Owner(Principal Ones):
Name:_____ Farm Number_____ Tract Number_____
Addresses:_____
Phone:_____
Name:_____ Farm Number_____ Tract Number_____
Addresses:_____
Phone:_____
Name:_____ Farm Number_____ Tract Number_____
Addresses:_____
Phone:_____

A. Wetland size _____acres, 1 point per acre (maximum pts. 20) _____
B. Present land use (PC, FW)
50% tilled within last 4 yrs. 15 pts. _____
50% pastured or hayed within last 4 yrs. 10 pts. _____
C. Unique saturated area - fens, bogs, organic soils
At least 51% converted muck land _____ 10 pts. _____
D. Landscape significance
>40 acres of emergent wetland types within ½ mi. 10 pts. _____
>40 acres of emergent wetland types within 1 mi. 6 pts. _____
>40 acres of any wetland types within ½ mi. 4 pts. _____
E. Within floodplain 30 pts. _____
F. Degraded by ditches, tile 20 pts. _____
G. Number of landowners
1 10 pts. _____
2 or 3 5 pts _____
>3 0 pts. _____

Total Points

Table 3. Categories of wetlands inventoried in sub-basins of the Portage River Watershed.

	Destroyed		Restorable		Preserve		Total	
Sub-Basin Name/Number	No.	Acres	No.	Acres	No.	Acres	No.	Acres
Portage River Lower Branch, 1319	13	74	60	3,720	101	2,038	174	5,832
Portage River Middle Branch 3, 1286	4	46	60	2,692	97	2,994	161	5,732
Total	17	120	120	6,412	198	5,032	335	11,564
Orchard Creek, 1294			2	87	1	14	incomplete	
Grand River Upstream, 1278	2	5					incomplete	
Huttenlocker & Crittenden Drain, 1353					2	18	incomplete	

AGRICULTURAL FLOOD DAMAGE IN THE PORTAGE RIVER WATERSHED

By
Ronald Hoffman, Jackson County Conservation District
April 8, 2002

The Portage River Watershed (PRW) includes 106,432 acres of northeast Jackson County, southeastern Ingham County and northwestern Washtenaw County. About 69,000 acres are in Jackson County. The outlet of the Portage River is north of the City of Jackson where it enters the Grand River.

Extensive wetlands occurred in the watershed prior to European settlement. Emergent marshes, wet prairie, fens, bogs, conifer swamps, lowland hardwoods and shrub/scrub were the most common wetlands (Comer 1995). They stored and retained floodwater, allowing the water to be slowly released, evaporate or percolate into the ground thereby recharging groundwater.

Between 1917 and 1920 the Portage River was straightened and deepened and renamed the Portage River Drain. The Portage Drain is 20 miles long with a grade of about 0.02% per 100 feet (USDA 1963b). Because of the flat stream gradient throughout the area, floodwater in the Grand River often backs up into the PRW. Numerous ditches and tiling drained adjacent wetlands creating some of the most productive farmland in Jackson County. It was designated an inter-county drain during the 1900's. Since its construction, it has been cleaned several times. The lower portion was last cleaned in 1944 (Ibid). An USDA 1972 study concluded that a solution to the flooding problems would require channel improvements to 11.5 miles of the Portage River and Orchard Creek and 10 miles of the Grand River.

Flooding and inadequate drainage have plagued 8,360 acres of the watershed for many years (US Army Corps Engineer report 1972:188). Early reports of flooding in 1937 and 1945 contained no estimates of damage (USDA 1963a). The next reported flood in 1954 was probably one of the worst, when more than 150 farms affecting 7,000 acres received damage in excess of $3,500,000.00 (Abbey 1954, USDA 1963b). An USDA 1976 report describes a Grand River flood that reached the 100-year flood elevation in Jackson after a 6.36" rainfall on June 20-21, but it does include information about the extent of damage in PRW. These reported flood events are summarized in Table 1, but certainly there were additional years with less severe damage. Many of these farmers used pumps to help their drainage problems (USDA 1958:4). Much of the flooded area was highly productive cropland, especially 4,940 acres of organic soils (US Army Corps Engineer report 1972:188). Because many specialty crops such as onions, potatoes, carrots, cabbage, radishes, peppermint, spearmint, sod and lettuce have been grown, the cost per acre of flood damage is high.

METHODS

Records from the USDA Farm Service Agency (FSA) were searched for crop damage due to flooding. Farmers reported their crop losses to the FSA for determination if they are eligible for compensation. Farmers who believe they would not qualify for compensation often not report

their losses. Only reports of crop damage caused by excessive moisture within the 8,260-acre Portage floodplain were analyzed for this report.

RESULTS

Flooding caused damage to crops at least 5 times during the 1990-2001 period based on FSA records from 1990 – 2001 in Jackson County (Table 1). Crops were probably affected by flooding between 1969 and 1989, but FSA no longer has those records. The Jackson County Emergency Board minutes for June 6, 1989 mention a 5" rainfall that caused flash flooding, but it is not certain if there was crop damage because the county had been experiencing a drought. The last flooding occurred in the fall of 2001 when high water prevented the harvest of some crops (Fig. 1) and restricted use of pasture (Fig. 2).

It appears that flooding was more frequent in the 1990-2001 period than in previous years, but affected few farmers. Many farmers along the Portage Drain went bankrupt in the late 1970s and their land was taken out of cultivation. Sedimentation and other geomorphologic changes resulting from log jams and channel restrictions along the Portage Drain (Hubbell, Roth & Clark, Inc. 1999) restrict the flood carrying capacity. Now, much of the former cropland lies idle because of flooding, low crop prices, and wildlife damage. Only 3 larger farming operations exist in 2002 where once there were many.

CONCLUSIONS

Flooding of cropland along the Portage Drain will get worse. The last study of the Portage Drain determined that the benefit-cost ratio did not justify making improvements (USDA 1972). As a result, more land will be taken out of cultivation and revert back to degraded wetlands. Restoring these degraded wetlands by plugging ditches and breaking tile will decrease flooding downstream on the Grand River and improve wildlife habitat.

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_____. 1963b. Letter to Russell G. Hill by George Salsbury, Soil Conservation Service. 2 pp.

_____. 1968. Portage River Watershed investigation report evaluation Unit P-1, 2, 3, 4; UG-5, 6. 18 pp.

_____. 1972. Technical report: Portage River and Upper Grand River Watersheds.

_____. 1976. Flood hazard analyses: upper Grand River Jackson County, Michigan. 14 pp.

Table 1. Summary of flood damage to crops in the Portage River Watershed.

Flood Year	Number of Farms	Acres Flooded	Crops Affected/Description	Amount of Damage	Source
Literature					
1937			June 20-21, 6.36" rainfall	*	USDA 1963
1945				*	USDA 1963
1954	150	7,000	beets, corn, cabbage, onions, mint, potatoes, radishes, wheat	$3,500,000.00	Abbey 1954
1968			June 23-26 4.8" rainfall	*	USDA 1976
1989			May 30-31, 5" rainfall	*	Jackson Co. Emergency Bd.
This study					
1992	2	821	corn, onions, peppermint, spearmint	$ 266,701.00	FSA files
1993	1	147	carrots, onions	$ 260,939.00	FSA files
1998	1	46	carrots	$ 100,829.00	FSA files
2000	3	1014	carrots, corn, soybeans	$ 440,757.00	FSA files
2001			October flooding prevented harvest	*	
			This study total	$ 1,069,226.00	

* These records were not available.

APPENDIX E

Region 2 Planning Commission Report
Land Use Policy Analysis

Improving Water Quality

Addressing Non-Point Pollution
Through Land Use Planning

Upper Grand River Watershed Initiative

Final Report

This report is intended to provide local governments with a variety of non-point source pollution issues that they may want to include within the next update to their land use plans and zoning ordinances.

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1 Introduction

In his article, Environmental Challenges: Storm water permitting requirements will soon be arriving in your town, George B. Davis points out that:

> "... [non-point source water pollution] is a leading source of pollution of our streams, rivers and lakes. Development in urban and suburban areas results in a concentration of surfaces, such as streets, driveways, parking lots, lawns and construction sites, on which pollutants from human activities settle and remain until rain washes them untreated into waterways via storm sewer systems.
>
> Common pollutants include salt, oil and grease from roadways; pesticides and fertilizers from lawns; chemicals, solvents, acids and sediment from construction sites; and general trash. If left uncontrolled, these polluted storm water discharges can seriously impact aesthetic values, discourage recreational use, contaminate drinking water supplies, interfere with habitat for fish, aquatic organisms, and wildlife, and otherwise threaten public health...."
>
> *Mr. Davis's article can be found online at* www.mml.org. *Just click on 'Publications' in the 'Member Services' box; 'Michigan Municipal Review' on the left-hand side of the web page; 'Archived Issues' under the header; 'August 1999' in the '1999' box; and 'Environmental Challenges: Storm water permitting requirements will soon be arriving in your town' under 'Featured Articles.'"*

An aim of the Upper Grand River Watershed Initiative is to address the issue of non-point source pollution. Good water quality contributes to a high quality of life for the residents of the watershed. Changes must be made to the way society manages land use in order to achieve the goal of improved water quality. There are three main components to land use change:

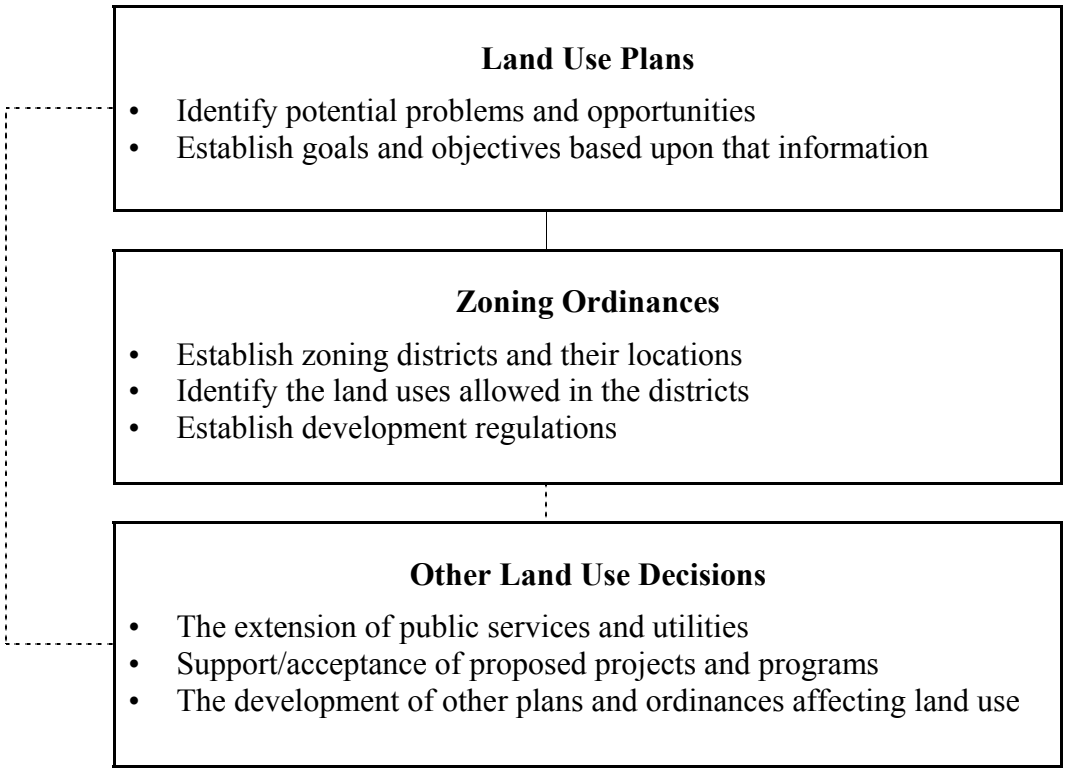
- education of the public, developers, and public officials
- public policy and regulation
- addressing existing problems (e.g., retrofitting existing development)

All of these components must be fostered and implemented in order to implement effective land use change. For the sake of simplicity, this report centers upon public policy and regulation.

1.1 Land Use Policy and Regulation

There are two main land use tools available to local governments: land use plans and zoning ordinances. Land use plans are used to establish local governmental policy. The zoning ordinance is the main regulatory document. It is utilized to implement the goals established within the land use plan. Local governments must also make other land use decisions. Those decisions must be based upon the goals of the land use plan as well. When pertinent, they should also be coordinated with the zoning ordinance. Table 1 illustrates that relationship.

Table 1
Land Use Planning



1.2 Methodology

There are 39 local units of government in six counties with land within the Upper Grand River Watershed – 21 of the local governmental units are located in Jackson County, 9 in Ingham, 4 in Eaton, 2 in Hillsdale, 2 in Washtenaw, and 1 in Calhoun County (please see Table 2). The local governments include cities, villages, and townships, all of which have the responsibility of regulating land use.

The staff of the Region 2 Planning Commission (R2PC) reviewed and analyzed the land use plans and zoning ordinances of a number of local governments within Jackson and Hillsdale counties in order to examine the potential effect of those policies and regulations on non-point source pollution. Those counties were chosen because the R2PC has easy access to the land use plans and zoning ordinances of the local governments located within its service area. As Table 3 indicates, 2 villages were selected along with a mix of 9 rural and urban townships.

Please note that the majority of this report is comprised of that analysis. Most of the text is comprised of passages from those documents. Some of those passages are used verbatim – altered only to fit the context of the report. R2PC also added information when if was felt to be necessary (based upon professional opinion). Because it is a common practice to 'cut and paste' from other planning documents, no further effort to source the material within the body of the document has been made.

Table 2

Local Governments and Sub-watersheds

	Sub-watersheds					
	Spring Brook	Upper Grand River	Sandstone Creek	Portage River	Center, Grass & Wolf Lakes	Grand River Headwaters
Calhoun County	***X***					
Clarence Township	*X*					
Eaton County	***X***	***X***				
City of Eaton Rapids	*X*	*X*				
Brookfield Township	*X*					
Eaton Township	*X*					
Hamlin Township	*X*	*X*				
Hillsdale County						***X***
Moscow Township						*X*
Somerset Township						*X*
Ingham County	***X***	***X***		***X***		
City of Leslie	*X*					
Aurelius Township	*X*					
Bunkerhill Township	*X*			*X*		
Ingham Township				*X*		
Lansing Township	*X*					
Leslie Township	*X*					
Onondaga Township	*X*	*X*				
Stockbridge Township				*X*		
Vevay Township	*X*					

	Sub-watersheds					
	Spring Brook	Upper Grand River	Sandstone Creek	Portage River	Center, Grass & Wolf Lakes	Grand River Headwaters
Jackson County	***X***	***X***	***X***	***X***	***X***	***X***
City of Jackson			*X*			*X*
Village of Grass Lake					*X*	
Village of Parma			*X*			
Village of Springport	*X*					
Blackman Township		*X*	*X*	*X*		*X*
Colombia Township						*X*
Grass Lake Township				*X*	*X*	
Hanover Township			*X*			
Henrietta Township		*X*		*X*		
Leoni Township				*X*	*X*	*X*
Liberty Township						*X*
Napoleon Township					*X*	*X*
Norvell Township					*X*	
Parma Township	*X*		*X*			
Rives Township		*X*				
Sandstone Township	*X*	*X*	*X*			
Spring Arbor Township			*X*			
Springport Township	*X*					
Summit Township			*X*			*X*
Tompkins Township	*X*	*X*	*X*			
Waterloo Township				*X*	*X*	
Washtenaw County				***X***	***X***	
Sylvan Township				*X*	*X*	
Lyndon Township				*X*		

Figure 1
Upper Grand River Watershed Boundary and Municipalities

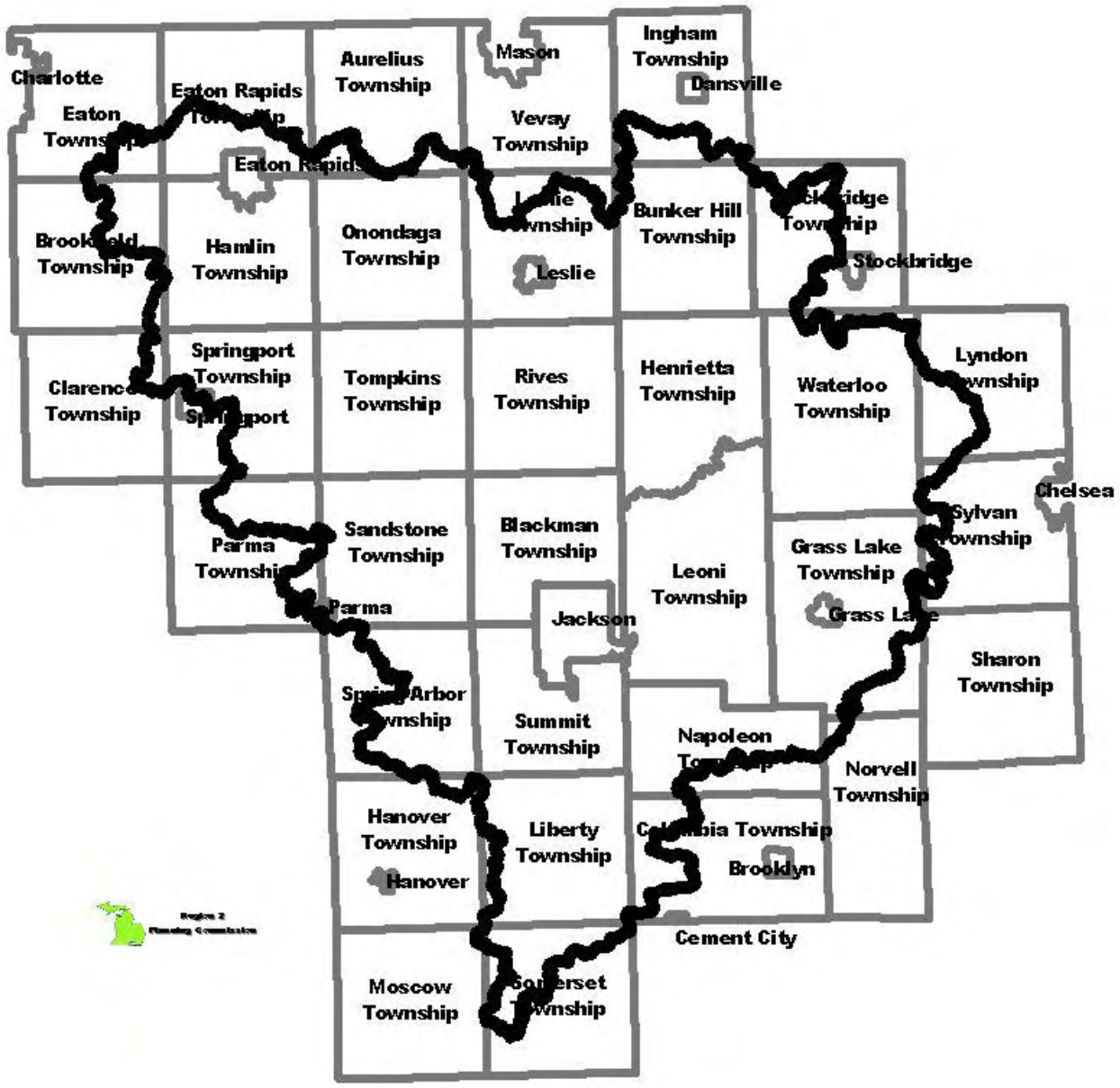


Table 3
Review of Local Governmental Land Use Plans (LUP) and Zoning Ordinances (ZO)

	LUP	ZO		LUP	ZO
Jackson County			Sandstone Township	X	X
Village of Parma	X	X	Springport Township	X	
Village of Springport	X	X	Tompkins Township	X	X
Blackman Township	X		Waterloo Township	X	X
Henrietta Township		X			
Leoni Township	X	X	**Hillsdale County**		
Rives Township	X	X	Somerset Township	X	X

This report is intended to provide local governments with a variety of issues that they may want to include within the next update to their land use plans and zoning ordinances. It must be remembered that the Upper Grand River Watershed covers a large and diverse area. Because of this, some of the suggestions made may not be applicable to all of the local governments within the watershed. Each local governmental unit will have to decide the validity of each suggestion for use within its jurisdiction.

The way the recommended actions are worded within the text of the report may strike some as too prohibitive or too permissive. Local governments should feel free to adapt the language according to their viewpoint. In order to be effective, each municipality must develop plans and ordinances that will be accepted by their constituents.

Municipalities may find it more effective to enact some of these suggestions at the county level. Groups of contiguous municipalities may also want to amend the same provisions into their plans and ordinances. The more uniformity there is among the various local governmental plans and ordinances within the same sub-watersheds, the more effective those policies will be. Local governments must decide what is best for them and the constituents they serve.

The report is essentially a compendium of ideas garnered from existing plans and ordinances. Because of this, ***all recommended language and standards must go through appropriate legal and technical review prior to implementation***.

The report contains the following sections:

- 2 Land Use Plans
- 3 Agriculture
- 4 Zoning Ordinances

Agriculture is an important component of many of the rural local governmental units within the Upper Grand River Watershed. Because of that factor, it will be addressed separately. It also provides a practical example of a bridge between land use plans and zoning ordinances.

1.3 Plan Opportunities and Deficiencies – A Summary Analysis of the Documents

- It is important to have up-to-date land use plans and zoning ordinances. As Table 4 indicates, of the 10 land use plans reviewed, only 4 of them have been passed/updated within the past five years. However, 7 of the 9 zoning ordinances reviewed were enacted/amended in that time period.

Table 4
Planning Document Dates of Publication

Passed/Amended	Land Use Plans	Zoning Ordinance
1997- 2002	4	7
1991 – 1996	2	1
Pre 1991	4	1

Practical experience leads the R2PC to believe that this is likely to be typical across the entire watershed. The Initiative should encourage all local governments to update their land use plans and zoning ordinances every five years. New state regulations mandate that land use plan be updated every 5 years. (It should also be noted that the most up-to-date documents might not have been available to R2PC staff at the time the documents were reviewed.)

- There needs to be a connection between a local government's land use plan and zoning ordinance (as well as other policies, ordinances, and programs). In order to accomplish this in an efficient manner, the land use plan should be developed before the zoning ordinance. The R2PC reviewed both the land use plans and zoning ordinances of 8 local governments. Of those communities, 4 enacted a zoning ordinance after developing a land use plan.

  Practical experience leads the R2PC to believe that this is likely to be typical across the entire watershed. The Initiative should encourage all local governments to update their zoning ordinances after updating their land use plans.

- The goals and objectives sections of land use plans reviewed include a wide variety of goals concerning environmental protection. Some of those goals are tied to quality of life objectives and open space and recreation preservation. Others are included under goals such as residential and industrial development.

- Zoning ordinances should include an environmental protection provision to the 'purposes section.' The purposes sections of some of the zoning ordinances reviewed often hint at or infer environmental protection, but do not come right out and state that purpose.

- Buffer strips were mentioned by at least one local unit of government as a way to reduce the visual and noise impacts that one land use can have on another. Those buffer strips could also be utilized as filter strips where land and water meet.

- The land use plans and zoning ordinances often make a connection between agricultural and open space preservation and natural resource protection. Although interrelated, those goals would be more effective if they were not so intimately linked. Separate districts should be created for agricultural preservation and open space preservation. One of the reasons for zoning an area for open space preservation would be natural resource protection. The main objective for agricultural districts should be the preservation of prime and unique farmland.

- Many of the zoning ordinances attempt to regulate 'intensive livestock feeding operations.' The Michigan Right to Farm Act, however, preempts this ability.

- The zoning ordinances reviewed list single-family detached homes as a permitted use by right in agricultural districts. This permitted right perpetuates sprawl. In order to curb sprawl, single-family homes could be reduced to a conditional use in agricultural districts.

- Land use plans that take the time/opportunity to educate readers about the impacts of development and the importance of environmental protection were more interesting to read. This practice should include identifying pertinent laws, web sites, and other sources. As a result they may be more likely to make an impact.

- A number of the zoning ordinances require information about the area surrounding the proposed site to be included in the information recorded on site plan maps. This information is very helpful to decision-makers. Some of the zoning ordinances also addressed certain aspects of the environment as part of a site plan review. This action is also helpful.

- Land use plans should include background information on the number of households served by central water and sewer systems –vs. – well and septic. This information can help local governments to establish appropriate density patterns.

- Follow-through from the land use plan to the zoning ordinance is often missing. Several local governments, however, included an implementation section in their plans.

- The effects that development can have on the health of lakes was included in the land use plan of at least one local government.

- The inventory of environmental features listed in land use plans should include environmentally sensitive corridors, ground water recharge areas, open space, wetlands, floodplains, and soils.

- There seems to be a movement to protect natural resources through large lot development. This well meaning practice can lead to greater land consumption. Open space developments and preserves may be better ways to preserve those resources.

2 Land Use Plans

Clean water is important. Land use plans can affect water quality both overtly and inadvertently through the policies they espouse and the types and form of development they project for the future. The staff of the Region 2 Planning Commission (R2PC) reviewed the land use plans produced by 11 local governments within Jackson and Hillsdale counties for the purpose of examining the potential effect of their policies on non-point source pollution. The following section summarizes those findings, which can be divided into the following categories:

- Common Land Use Issues
- Goals and Objectives
- Specific Policy Guidelines
- Plan Implementation

2.1 Common Land Use Issues

In order to minimize the possible negative impacts of development, potential problems must be identified. The following is a listing of those potential issues that most of the municipalities within the watershed have in common. All of the issues impact the non-point source pollution. The list is not in any particular order (unless otherwise noted), nor is it intended to be exhaustive.

Sprawl. Perhaps the most important land use issue is the self-perpetuating problem of sprawl. The dispersed linear roadside nature of sprawl tends to land-lock agricultural parcels and open space, making the development of that land more costly. Sprawl results in a host of unintended problems such as (but not limited to):

- An increase in the percentage of land covered by impervious surfaces (e.g., wider roads and streets, large parking lots, and an increasing number of rooftops and driveways), increasing the quantity and quality of storm water runoff.
- The installation of sewer and water, (when needed) is often economically infeasible, causing environmental problems to be ignored and endangering public health.
- The abandonment of existing urban places where water and sewer and other essential services are already in place.

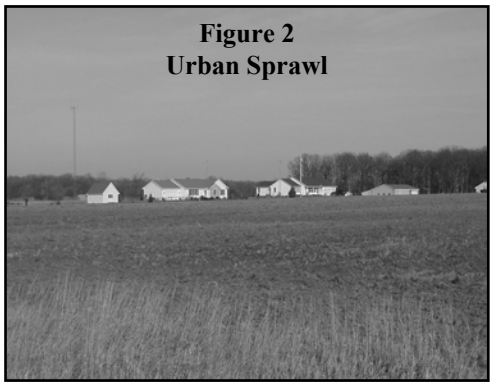


Figure 2
Urban Sprawl

Revitalizing Urban Areas. An antidote to sprawl is the redevelopment of existing urban areas. By continually investing in existing urban areas – by making them attractive places to live and work – the pressure to develop rural areas may subside. This includes reintroducing natural features back into the urban environment. Those features can also be utilized to treat and store storm water runoff.

Floodplains. Floodplains serve as storage areas for flood waters during times of flooding. Structures within floodplains can be damaged during flooding and also impair the ability of the floodplain to store and absorb floodwaters. While current and future technological advances may make it feasible to develop in those areas, long term damage to the environment and the development itself still makes development undesirable.

- Municipalities should participate in the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program. Floodplain areas should be mapped as a part of that program. According to their website, flood maps "are the tool FEMA uses to determine the flood risk homeowners face. Prior to the enactment of the National Flood Insurance Program (NFIP), homeowners had no mechanism to protect themselves from the devastation of flooding and in many parts of the United States unchecked development in the floodplain was exacerbating the flood risk."
- At the very least, floodplains should be mapped (the 100 year floodplain is recommended.) Development within those areas should be limited and dispersed. Permitted land uses should be reserved for agricultural, recreational, and open space residential uses.
- Don't allow floodplains to be filled-in for development.

Information on FEMA's National Flood Insurance Program can be found online at www.fema.gov. *Just click on the 'National Flood Insurance' button, which is located on the left-hand side of the web page.*

Wetlands. Wetlands serve as storage areas for surface water runoff. They also filter groundwater. Wetlands provide habitat. Michigan currently regulates wetlands that are greater than 5 acres in size. The [city/village/township] may want to consider regulating smaller wetlands. In any case, wetlands should be identified, mapped, and protected.

Soils. The limitations that soil types have when it comes to supporting certain types of development must play an important role in the determination of development patterns within the [city/village/township]. For example, areas that have sandy or gravely soils and which are situated adjacent to lakes or streams should not be considered suitable for intensive development due to the likelihood of phosphates and nitrates leaching into those bodies of water. Peat and muck soils (also known as histisols) are not suitable for septic systems. Because of this, development involving building should be restricted on peat and muck soils. The suitability of each soil type within the jurisdiction can be mapped for different types of development using the county soil surveys prepared by the Natural Resource Conservation Service (formerly the Soil Conservation Service) of the United States Department of Agriculture.

Soil Erosion. Soil erosion continues to be a problem, impairing the health of water bodies due to an increase in turbidity. Construction sites are a major contributor to soil erosion. Road and bridge erosion is also a concern. Each county has a soil erosion and sedimentation control officer. It is important that this individual be active in administering Part 91 – Soil Erosion and Sedimentation Control – of the Natural Resources and Environmental Protection Act. Municipalities may also want to pass a local soil erosion and sedimentation control ordinance.

Part 91 – Soil Erosion and Sedimentation Control – of the Natural Resources and Environmental Protection Act is listed in the Michigan Compiled Laws as MCL 324.9101 - MCL 324.9123a. The law can be reviewed online at www.michiganlegislature.org/law**.** *Just enter '324.9101' into the 'MCL Section' box under the 'Michigan Compiled Laws Information' heading and press the 'Go!' button. Use the 'Navigation' bar to access the different sections of the statute.*

Lakes and Streams. The water quality of lakes and streams is dependent, in part, upon the type of development along its shores and banks. For example, effluent from septic systems can seep into water bodies, degrading water quality and the health of those in contact with it. Nutrient rich storm water runoff resulting from agricultural and lawn fertilization practices can accelerate eutrophication (the natural filling in of the water body).

Lakeshores are often very desirable for suburban development. Because lakeshore developments are often located away from urban centers, they are most likely served by wells and septic systems. This was less of an issue in the past when lake cottages were used seasonally. Conversion of those second homes into primary residences, however, can cause septic systems to fail.

Care must be taken to ensure that new residential development on the desirable land surrounding lakes and streams do not degrade the quality of those resources. Banks can become unstable because of vegetation removal. Unstable banks lead to mass wasteage (e.g., creeping, slumping, slides), bank instability, stream migration, and the collapse of structures. Steps must also be taken to improve existing water quality. Included below are some potential tools:

Figure 3
Lakefront Development

- Delineate lake residential districts as a subset of the existing residential districts.
- Tighten up on the regulation of septic systems in those districts.
- Establish filter areas at appropriate places along lakeshores (e.g., low areas and other places where concentrated runoff flows into the water body).
- Construct municipal wastewater collection systems.

Industrial developments often located next to streams in the past. New industrial and commercial developments often create ponds and other impoundment areas into their designs for practical as well as aesthetic reasons (this practice should be encouraged). Care must be taken to ensure that new industrial and commercial development along streams and by ponds do not degrade the quality of those resources. Steps must also be taken to improve existing water quality. Included below are some potential tools:

- Tighten up on the discharge of gray water into streams and other impoundments.

- Establish filter areas at appropriate places along stream banks and by ponds (e.g., low areas and other places where concentrated runoff flows into the water body).
- Do not zone property for industrial uses unless central water and sanitary sewer systems serve it.

Water and Sewer. Central water, storm sewer, and sanitary sewer systems are often necessary to ensure that development in environmentally sensitive areas is benign. Those essential services also make more intensive development of an area feasible, possibly preserving other land from development. Conversely, water and sewer may have to be extended in order to ensure a quality water source for an area because of past poor development practices.

The provision of central water and storm and sanitary sewer systems can be used as a tool to guide development. They should not be extended to areas that a local government wants to preserve. Municipalities should also be careful of extending water lines without complimentary sanitary and storm sewer service. Increased development could necessitate the extension of sewer lines in the future, at an increased cost. In the meantime, that increased development could be harming water quality.

Municipalities may want to consider the following:

- Include background information on the number of households that depend on water and sanitary sewer -vs.- well and septic.
- Enterprises that use a lot of water should dispose of water in a sanitary sewer or on-site in some type of detention/filtration system before entering a storm sewer, stream, or body of water.

Illegal Dumping and Littering. Illegal dumping and littering can have an effect upon water quality. Runoff and floodwaters can pick up trash and other contaminants when flowing through discarded materials, whether it is the occasional candy wrapper, an old refrigerator, or a hazardous substance. Municipalities may want to consider enacting littering and dumping ordinances through which fines can be levied upon violators.

Tourism. Nature based tourism is becoming increasingly important. Everything that can be done to protect and enhance the unique environmental features of the watershed will help to attract tourists to the area. Those tourists, however, will also impact the watershed. Steps must also be taken to protect the watershed from the negative environmental impacts of tourism.

2.2 Goals and Objectives

A goal of the Upper Grand River Watershed Initiative is to manage water quality and quantity prior to its discharge from the watershed. In order to meet this goal, it is important to develop land use plans acceptable to the general citizenry and the business community. The goals and objectives sections of local land use plans should include goals that promote the health of the watershed while still allowing for new investment. Watershed goals and objectives should be

included in the general goals. To be truly successful, however, they should also be included in other categories.

Listed below are some examples of goals obtained from the land use plans reviewed for this report. Municipalities may want to adopt some of them into their own land use plans. The repetitive nature of the section is intentional. A wide variety of goals are included in order to address issues throughout the entire watershed. Some of them may not be applicable for your municipality. None of them should be adopted verbatim. They should be altered to fit within the context of the community's plan.

2.2.1 General Goals. General statements about environmental protection should be included in the goals and objectives portion of a land use plan because they lend credence to more specific goals and objectives.

- Protect and preserve the natural resources/features of the [city/village/township].
- Preserve and conserve the abundance and quality of the many natural resources with which the [city/village/township] is blessed and acknowledge resulting limitations to development.
- Encourage the protection and preservation of the [city/village/township]'s natural resources for the purpose of maintaining the quality of the local environment.
- Provide adequate safeguards to minimize the negative impacts of development on roads and other civic infrastructure, adjacent land uses and the environment.
- Maintain and enhance the character of the community through land use policies that protect the environmentally sensitive features which remain in the [city/village/township].
- Use the resources of the [city/village/township] to:
  - Promote the highest degree of public and environmental health, safety, efficiency, and well being for all areas of the community.
  - Increase the opportunities of its people.
- Lands that are sensitive to development, that have scenic value in the [city/village/township], that offer recreational opportunities, or that contribute in a critical manner to the local or regional drainage system, the ground water system, or the wildlife system should be protected and preserved wherever possible.
- Require new development proposals to conform to the environment instead of altering the environment to conform to the proposed development.
- Areas identified as environmentally sensitive on the soils, wetlands, and floodplain maps should be preserved from incompatible and unnecessary urban development.
- The soils in the area should be capable of supporting the proposed development. At a minimum the county soil survey should be referenced. A more comprehensive analysis may be needed for certain projects, however.
- Areas located within designated "Flood Hazard Areas" on the floodplain map should be discouraged for the purpose of development.
- Encourage the protection of the [city/village/township]'s groundwater resources.
  - Encourage proper maintenance of on-site septic systems.
  - Regulate the above ground storage of hazardous substances and underground storage tanks.

- Development is to be encouraged only where the possibility of polluting the water resources is minimal in order to protect public health.
- Illegal dumping should be discouraged.
- Certain development should be prohibited in delineated wellhead areas.

2.2.2 Essential Services. The provision of essential public services can be a powerful tool in shaping the development patterns within a community.

- Delay approving future annexations of the [city/village] until essential services can be upgraded to serve the new area.
- Encourage new housing development in neighborhoods only after essential services have been upgraded to meet the additional demand.
- The [city/village/township] shall require new development to have adequately engineered water, sanitary sewer and storm water sewer systems in place. Those systems must have the capability to handle the projected flows from the new development.
- The [city/village/township] should evaluate and amend its site plan review process to ensure that new development does not overload its water, sanitary sewer, and storm water sewer systems.
- Discourage uses with high essential service capacity requirements until water and sanitary sewer and storm sewer systems are upgraded.
- The [city/village/township] should develop minimum standards for storm water management that would be required for all new development.

2.2.3 Protection of Open Space and Natural Resources

Natural resource protection, recreation, and the protection of open space are often tied together. While often compatible, they are all important enough goals to be considered separately.

Natural Resource Protection

Effective natural resource preservation goals concentrate on the preservation of those resources for environmental reasons.

- Preserve unique features, wetlands, woodlands, and wildlife habitats by restricting development to areas that can tolerate such activity without environmental conflicts.
- Preservation of watershed areas, marshlands, and woodlands by discouraging building and development unless sufficient physical features are present to ensure that such building or development can function without damage to the environment.
- Lands that are environmentally sensitive should be protected and preserved for their natural assets, which are valuable to the community's present and future well being.
- Encourage the preservation of areas identified as environmentally sensitive from incompatible and unnecessary urban development.
- Encourage only low residential densities in environmentally sensitive areas.
- Encourage the preservation of wetlands.
- Inform [city/village/township] residents about the value of wetlands and the need to obtain the pertinent permits prior to dredging or filling any protected wetland.

- Require that the proper state and federal permits have been obtained prior to the issuing of local permits for developing in a wetland.
- Explore the use of the zoning ordinance and other land use policies in regulating the development of wetlands.

Open Space Protection and Recreation

Ties between open space preservation and recreation and the protection of natural resources are still very important. Open space protection can help to curb urban sprawl and the effects that phenomena can have on the watershed. Recreational facilities can also be used to educate the public about the importance of natural resources.

- Protect wetlands and floodplains within the [city/village/township] for educational and outdoor recreational uses.
- Encourage development of recreational lands in areas having environmentally sensitive characteristics, as long as those features are not harmed.
- Provide and protect open space and recreational opportunities for current and future needs.
- Attempt to connect recreation areas whenever possible with open space corridors to provide a network of recreational and natural enjoyment areas.
- Preserve existing recreational lands and provide for new recreational lands, appropriately located, to meet the changing needs of the community.
- Encourage development of recreational lands in areas accessible to area neighborhoods and the [city/village/township] population at large.
- The [city/village/township] shall encourage developers of rural areas to utilize the Planned Unit Development and the Cluster Development options for purpose of preserving open space.

2.2.4 Residential Development

Goals can be constructed which allow for the continued development of residential neighborhoods (where appropriate) while still protecting the environment. These goals should address on-site and community-wide essential services.

- Encourage new residential development to be clustered in subdivisions and neighborhoods located where appropriate community services and utilities can be feasibly provided.
- Encourage the development of a variety of housing types and subdivision design that will promote an efficient use of space and preserve environmentally sensitive areas.
- New subdivision development should be encouraged in areas where adequate utilities and services exist or can feasibly be extended.
- Provide alternatives such as cluster development in moderate and medium density areas.
- Encourage the subdivision of land so as to provide for a reasonable degree of choice in housing location. At the same time, however, discourage the over-subdivision of land beyond the market demand and before areas are provided with necessary services (i.e., central water, sanitary sewer, and storm sewer systems) to compliment concentrated residential development.
- In areas not served by central sanitary sewer and water systems, encourage residential growth in areas with soils that are suitable for septic systems.

- Protect floodplains, marshlands, and other unsuitable soils from residential encroachment, but utilize the scenic potential of these areas in residential site design.
- Encourage new residential development to be clustered in subdivisions and neighborhood areas located near appropriate utilities (e.g., central water, sanitary sewer, and storm sewer systems) or where those supportive services may be feasibly provided to promote efficient utilization of land and discourage dispersed strip development.
- Encourage the development of a variety of housing types and subdivision design that will promote an efficient use of space, and preserve the integrity of rural areas.
- Single-family and two-family subdivision developments should be encouraged in areas where adequate services exist or will be extended in the near future.
- Subdivision development should be encouraged in areas adjacent to existing subdivision developments having central sewer (e.g., storm and sanitary) and water services in order to allow for the expansion of those services.
- Encourage the development of residential areas to meet population increases, while conserving prime and unique agricultural and environmentally sensitive lands.
- Encourage low-density residential developments on sites having good physical characteristics including those conducive to on-site sewage disposal, appropriate soils, slopes, and water table.
- Low-density residential development should be located on sites having good physical characteristics, including those conducive to onsite sewage disposal, appropriate soils, slopes, and water tables.
- Multiple-family residential developments should be encouraged to locate in areas having adequate soils for development, available municipal or central water and sewer (e.g., storm and sanitary) as well as adequate recreation and transportation facilities and services, and should be located where compatibility with other land uses can be assured.
- High density residential land uses such as mobile home parks, and multiple-family developments should be in areas having or expected to have necessary services and facilities including major roads and central sewer (e.g., storm and sanitary) and water facilities.

2.2.5 Commercial Development

Intensive commercial development (i.e., big box, stores, shopping plazas and malls, etc) can have a negative impact upon the environment. It is also important, however, to the economic health of the watershed.

- Encourage the development of a variety of commercial businesses clustered in commercial areas that will diversify the local economy, provide a stable tax base, and protect the local environment from degradation
- Encourage intensive commercial development to locate in well-planned locations where these uses can be clustered and assure a high degree of compatibility with surrounding land uses.
- Mandate the installation of storm water management facilities that will mitigate the additional runoff caused by intensive commercial development (e.g., parking lots, roofs, etc.).
- Encourage industrial development in areas where soils are suitable and potential for groundwater contamination is minimized.

- Encourage the location of intensive commercial uses where sufficient infrastructure can support these uses.

2.2.6 Industrial Development

Industrial development tends to have negative impacts upon the environment. It is also important, however, to the economic health of the watershed.

- Encourage the development of light and clean industry clustered in industrial parks that will diversify the local economy, provide a stable tax base, and protect the local environment from degradation
- Encourage industrial development to locate in well-planned locations where these uses can be clustered and assure a high degree of compatibility with surrounding land uses.
- Encourage industrial development in areas where soils are suitable and potential for groundwater contamination is minimized.
- Encourage the location of industrial uses where sufficient infrastructure can support these uses.
- Favor uses that do not pollute the air, soil, water, or are offensive to neighboring land uses because of noise, sight, or odor.
- Encourage the location of industrial activities in areas of compatible land uses and where major thoroughfares, rail service, and sewer and other public facilities can serve such activities, preferably in or near existing developed areas.
- Encourage industrial development in areas that are not environmentally sensitive.
- Industrial land uses should relate to the overall character of the community and to its specific land use patterns, and should provide employment in locations readily accessible to regional transportation facilities, in areas having compatible land uses, and in areas having or expected to have appropriate utilities.
- Encourage industrial development in areas having or expected to have facilities and services.
- Encourage the development of industrial uses to diversify the local economy and to provide a stable tax base for the [city/village/township], at locations that will allow the quality of the local environment to be maintained.
- Industrial areas should be encouraged in sections of the [city/village/township] where a high degree of compatibility with surrounding land uses can be assured.
- Encourage industrial development in areas where soils are suitable and potential for groundwater contamination is minimized.

2.3 Specific Policy Guidelines

Goals and objectives can be further refined by developing policy guidelines for certain policies on which your [city/village/township] wishes to concentrate. These guidelines may be utilized by the planning commission in the development of the future land use and zoning maps as well as when reviewing zoning requests and other proposals. A wide variety of goals are included in order to address issues throughout the entire watershed. Some of them may not be applicable for your municipality. None of them should be adopted verbatim. They should be altered to fit within the context of the community's plan.

2.3.1 Land Use Intensity. Guidelines governing the intensity of land use are dependent on the natural capability of the land to support various degrees of development.

- Locate less intensive land uses (e.g., low-density residential development, agricultural activities, and recreational land) where natural resource conditions are least capable of supporting development and existing low-density land use patterns exist. In order to be competitive, farms should be located in areas with better soils.
- Locate medium intensity uses (e.g., medium-density residential with complementary local commercial, office, public and quasi-public uses) where natural resource conditions are moderately capable of supporting development, adequate roads are available, and existing medium density land use patterns exist.
- Locate high intensity uses (e.g., high-density/intensity residential, office, industrial, and general commercial) in areas with relatively direct access to major thoroughfares and expressways, existing medium- to high-density land use patterns, and natural resource conditions most capable of supporting development.

2.3.2 Natural Resource Capability. All development should be mandated to respect the following natural characteristics and constraints:

Wetlands. Protection of wetlands is essential in order to preserve water quality, stabilize storm water runoff, recharge groundwater and provide fish and wildlife habitat. Wetland types include marshes, swamps, and bogs.

- The highest priority should be for the preservation of wetlands in their natural state.
- Wetlands should be identified and delineated by the [city/village/township] and then protected by local ordinance (in addition to existing state and federal regulations).

It is important to define what a wetland is (along with set criteria) before they are mapped. One way to define wetlands is to utilize USGS topographic maps, the county soil survey, aerial photographs, and other materials. Examine those materials for the following characteristics, which identify the presence of wetlands:

- The presence of shallow groundwater (as opposed to a 'perched' water table) on the surface, all or part of the year.
- The presence of soils with high organic content clearly different from upland soils.
- The presence of plant species adapted to wet soils, surface water, and/or flooding.

USGS maps can be ordered online at http://mapping.usgs.gov. *Just click on the 'USGS Topographic Maps' button on the left-hand side of the web page.*

- The boundaries and the significance of specific wetland areas must be determined at the time of development review. Three aspects of wetland protection should be recognized in reviewing proposed development within and in proximity to wetlands.
- The wetland area itself.
- The adjacent fringe or buffer area.
- The remainder of the watershed which drains into and out of the wetland area, beyond the fringe or buffer area.

Woodlands. The conservation of woodlands is imperative to the absorption of storm water runoff as well as for other environmental and aesthetic reasons.

- Development in and around wooded areas should be planned, constructed, and maintained so that the maximum numbers of healthy trees and other native vegetation may be preserved.
- The objective should be to preserve native trees rather than to rely on removal and subsequent mitigation by replanting. Managed forestry should be considered essential.

Slopes. Existing topographic conditions are important to the function of the watershed. They should be made an integral component of land use planning and design.

- The primary objective should be preservation of the natural land contours, rather than severe alteration through mass grading.
- Careful preservation of slopes is necessary in order to reduce erosion, maintain stability, and control amounts and velocities of runoff.

Groundwater Protection and Recharge. Groundwater recharge areas restore water levels in aquifers and supply water to lakes, rivers, streams, and private drinking water sources. Because of the reliance on individual wells in part or all of many municipalities, preservation and protection of groundwater resources is important.

- Recharge areas should be mapped. It is important, however, to define what a groundwater recharge area (along with set criteria) is before they are mapped.
- Since recharge areas extend beyond the boundaries of the [city/village/township], regional cooperation is needed to effectively manage groundwater conditions.
- Recharge areas are best preserved as open space, and/or confined to low-density uses, to maintain as much permeable surface as possible. Land grading should be controlled to retain natural water holding characteristics of the land. Vegetation essential to preservation of the water holding characteristics should be preserved, and enhanced, where necessary.
- Recharge areas should be protected from pollution by rigorously controlling all uses which discharge wastes into the hydrological cycle. Especially critical for monitoring are uses which handle hazardous materials which might leak or spill.
- The vulnerability of an area can be determined by three main factors: soil type, depth to aquifer and general aquifer condition and type. Sandy soils offer considerably less protection from surface impacts than heavier clay soils. Confined aquifers are safer than unconfined ones. Through a better understanding of the nature of groundwater, more effective protection measures are possible. [Cities/Villages/Townships] must have a working knowledge of this information in order to make good land use decisions.
- [Cities/Villages/Townships] must also contend with hidden sources of soil and groundwater contamination from such things as landfills and aging septic systems.
- Shallow injection wells should be prohibited.

Drainage. The protection and renovation of slopes, woodlands, and wetlands within the watershed, as well as the wise management of land use and development are essential to maintaining the quantity and quality of storm drainage.

- Natural vegetation and topographical features along and within streams and other waterways should be preserved and/or restored.
- Uses should be restricted to those that represent no danger of topographical disturbance to the corridor, degradation of water quality, increased runoff, sedimentation, or stream channel alteration. Adequate buffer/filter strips should be installed between existing uses and the drainage channel.
- Surface water runoff should not exceed the rate that occurs under existing, undeveloped conditions. Control of runoff prevents overloading of streams and long-term erosion from uncontrolled, high velocity discharges. Retention and detention ponds can be used to regulate the rate of runoff.
- Agricultural, commercial and industrial, and residential practices should respect stream corridors and waterways, and the natural drainage and runoff patterns associated with them.
- Do not grade property to prevent the natural flow of water onto your property.

2.3.3 Residential Land Use. Residential densities are dependent on the capability of the natural resource base and availability of public services. Existing residential neighborhoods will be preserved by preventing the intrusion of incompatible land uses and disruptive traffic patterns. Residential land use is broken down into four density classifications:

- **Very Low Density Residential.** Very low residential densities should be planned for those portions of the [city/village/township] with prime and unique agricultural lands and other open space, wetlands, and/or major wooded areas, in order to preserve the function they provide in maintaining a healthy ecosystem.
- **Low Density Residential.** Low residential densities should be planned for areas compatible with existing low-density development and capable of accommodating additional development (due to natural resources and the level of essential public services). The maintenance of low densities in those areas is intended to provide for the continued preservation and health of open spaces and natural areas.
- **Suburban Residential.** Suburban residential densities should be planned for areas with existing medium density development and moderately capable of supporting additional development without impairing the health of natural resources.
- **Urban Residential.** Urban residential densities should be planned for areas considered most capable of supporting additional development due to current and/or potential availability of essential public services and natural resource conditions.

2.3.4 Open Space and Environmental Preservation. Significant assets of the [city/village/township] include the availability of quality unimproved, informal open spaces, including wetlands, streams, and wooded sites. Every effort should be made to enhance and preserve those assets for their environmental benefits as well as for outdoor recreational functions.

- Intergovernmental cooperation between [the city/village/township], neighboring units of government, and county, regional, state and federal authorities is essential to the development of recreation systems which balance the preservation of open space and environmental amenities and the provision of active recreation programs and facilities.

- The role of the [city/village/township] should be to encourage the preservation of unique features and woodlands by ordinance and to encourage private developers to preserve their most unique lands in proposed developments.

2.3.5 Sanitary Sewer and Water. The extension of sanitary sewer and water facilities should be limited to areas where existing population densities and natural resource conditions indicate they are necessary to assure the public health, safety and welfare of the community. Cost of implementation, maintenance, and repairs of municipal utilities should be borne by benefiting property owners.

2.3.6 Lake Area Development. Nutrient loading of lakes is a serious byproduct of lakeside residential development. An increase in nitrogen and phosphorus, for example, spurs the growth of aquatic plants such as algae and bacteria (a process known as eutrophication), which lead to the following conditions:

- Increased rate of basin infilling by dead organic matter.
- Poor water clarity.
- A shift in the composition of fish species to rougher types such as carp.
- The presence of unpleasant odors which lead to a decline in the recreational value of the lake.

Municipalities should educate the general public about those conditions in order to garner the support needed to implement the policies and projects necessary to prevent/address (fix) them.

2.3.7 Impervious Surfaces. More buildings, parking lots, roads, and other types of development covering the land in a watershed result in increased storm water runoff. Increased storm water runoff results in changes to the morphology of the river or stream (e.g., erosion and scouring) and more flooding. The additional runoff also carries more pollutants. Municipalities may want to identify the amount of impervious surfaces within the different sub-watersheds in their boundaries. This baseline information can be used to measure the effect future land use decisions will have upon the river or stream.

2.4 Plan Implementation

The land use plan provides the broad framework within which the [city/village/township] will guide future land use and development activities that ensure reasonable and orderly growth. Implementation of this plan will require the ongoing efforts of elected officials, planning commissioners, boards of appeal members, neighboring municipalities, and the citizenry. The effectiveness of the plan is dependent upon the diligence with which its goals, policies, and long-range land use recommendations are acknowledged.

Specific tools and strategies are available to the [city/village/township] for implementation of the Land Use Plan and its policies. Those tools must be enacted and/or reviewed and updated to meet the environmental objectives of the Land Use Plan. Those tools include – but are not limited to – the following:

- **Primary Local Ordinances.**
  - **Zoning.** Ordinances should include the formulation of provisions to allow for flexibility in development that may produce positive environmental results. For example, there seems to be a movement to protect natural resources through large lot development. That mandate, however, can have the unintended effect of increasing sprawl. A flexible approach to large-lot developments will also include the following alternatives to large-lot zoning:
    - **Open Space Residential Zoning.** Landowners are allowed to cluster development on small parcels with common open space areas. Using this development option allows developers to build on small size lots without increasing the density established by the zoning district. Conservation easements are used to assure that future land use in the open space areas of the development remain in their natural state. Recent changes to the state enabling legislation mandate the inclusion of this tool in all zoning ordinances.
    - **Planned Unit Developments.** Allows for flexibility of land uses allowed and density bonus incentives for good design. The environment should be a part of PUD reviews and industrial site plans.
  - **Subdivision Control.**
  - **Land Division Ordinance.**
- **Site Plan Review.** Updates to those processes may include the mandate to review all new development. Municipalities may want to delegate the environmental review of site plans to an environmental review board separate from the planning commission.
- **Building Code Provisions.** This should include the process and requirements for the issuance of a building permit. (See Appendix B.)
- **Adoption of other Ordinances.** Including but not limited to:
  - **Wetlands Floodplains, and/or Woodlands Preservation**
  - **Soil Erosion and Sedimentation Control**. Soil Erosion and Sedimentation Control plans should be required for every proposed development prior to the issuance of a building permit.
  - **Sewage/Septage Ordinances and/or the Sanitary Code.** Evaluate quality of existing septic tank systems and the need for regulation and the investment in public facilities.
  - **Ground and Surface Water Protection.** A wellhead delineation study is needed.
  - **(Roadside) Dumping Ordinances**
  - **Storm Water Management**
  - **Private Road Standards**
- **Best Management Practices.** Develop, identify, and distribute best management practices. Tie them to ordinance requirements.
- **"Development Guide" Information Handbook.** Publish an informational handbook on development guidelines aimed at the development community that explains the "Why" as well as the regulation.
- **Capital Improvements and/or Planning Expenditure Program.** Develop a capital improvements program (CIP) and/or a planning expenditure program which fund the projects and environmental planning initiatives called for within the land use plan. These plans are usually cover five-years and are updated annually. Those annual updates should include a

progress report on the completion of the projects and initiatives included in the Plan and what needs to be done to complete them.

- **Other Tools/Initiatives**
  - Cooperative efforts with adjacent communities and other agencies
  - Public/private acquisition of easements and/or property for view sheds, greenways, etc.
  - Millages or special assessments to finance desired improvements
  - Training (initial and continuing) for elected and appointed officials in water quality
  - Make sure the Soil Erosion and Sedimentation Control Officer in your county is active.

It should be noted that this list of strategies does not pretend to be definitive. These strategies are the most common and feasible options currently available. As new legislation and court actions occur it is entirely possible that new options will become available, while some existing options may be altered or eliminated entirely.

The land use plan must be flexible in design and adaptable to changing circumstances without weakening its established goals and policies. The effective implementation of the plan will require long-term cooperation and effort on the part of [city/village/township] officials and staff, developers, landowners, and citizens. An informed and involved citizenry is, therefore, essential to the success of the plan. In addition, the plan should be reviewed and updated (if necessary) every five years.

Please refer to Appendix C for online examples of some of these implementation tools.

3 Agriculture

Figure 4
Farm

Agriculture is an important component of many communities. The impact that evolving and evermore intensive farming practices have on the environment, however, is of great concern. Local governments have taken many approaches to agricultural regulation. Of particular interest are "animal livestock facilities." The Michigan Right to Farm Act, however, preempted those efforts.

3.1 The Michigan Right to Farm Act

The Michigan Right to Farm Act (Public Act 93 of 1981), according to the Michigan Department of Agriculture website, was enacted to "provide farmers with protection from nuisance lawsuits. This statute makes it very hard for local governments to enact any environmental protections that would negatively impact farming operations." Section 4 (6) of the statute states:

> Beginning June 2, 2000, except as otherwise provided in this section, it is the express legislative intent that this act preempt any local ordinance, regulation, or resolution that purports to extend or revise in any manner the provisions of this act or generally accepted agricultural and management practices developed under this act. Except as otherwise provided in this section, a local unit of government shall not enact, maintain, or enforce an ordinance, regulation, or resolution that conflicts in any manner with this act or generally accepted agricultural and management practices developed under this act.

The online synopsis of the Act defines "certain farm uses, operations, practices, and products; to provide certain disclosures; to provide for circumstances under which a farm shall not be found to be a public or private nuisance; to provide for certain powers and duties for certain state agencies and departments; and to provide for certain remedies for certain persons." It includes the following sections:

- Short title.
- Definitions.
- Farm or farm operation as public or private nuisance; review and revision of practices; finding; conditions.
- Recovery of costs and expenses.
- Property subject to disclosure
- Contents of statement.
- Investigation of complaints involving farm or farm operation; memorandum of understanding; generally accepted agricultural and management practices; unverified complaints; applicability of other statutes; preemption of local ordinance, regulation, or resolution; ordinance proposed by local unit of government; generally accepted agricultural and management practices for site selection and odor controls at new or expanding animal

livestock facilities; advisory committee; manure management plan; duties of department; definitions.

The Michigan Right to Farm Act is listed in the Michigan Compiled Laws as MCL 286.471 - MCL 286.474. It can be reviewed online at www.michiganlegislature.org/law. *Just enter '286.471' into the 'MCL Section' box under the 'Michigan Compiled Laws Information' heading and press the 'Go!' button. Use the 'Navigation' bar to access the different sections of the statute.*

3.1.1 Generally Accepted Agricultural and Management Practices

Public Act 93 of 1981, according to the Michigan Department of Agriculture website, also "authorizes the Michigan Commission of Agriculture to develop and adopt Generally Accepted Agricultural and Management Practices (GAAMPS) for farms and farm operations in Michigan. These voluntary practices are based on available technology and scientific research to promote sound environmental stewardship and help maintain a farmer's right to farm." GAAMPS listed on the Department's website include the following:

- Manure Management and Utilization
- Pesticide Utilization and Pest Control
- Nutrient Utilization
- The Care of Farm Animals
- Cranberry Production
- Site Selection and Odor Control for New and Expanding Livestock Production Facilities

The Generally Accepted Agricultural and Management Practices (GAAMPS) can be accessed on the Michigan Department of Agriculture's website which is located online at www.michigan.gov/mda. *Just click on the following buttons: 'Farming,' 'Environment,' and 'GAAMPS,' which are located in the upper left-hand corner of the webpages. The box listed 'Jump to a category . . .' can be used to jump to any one of the six GAAMPS.*

3.1.2 Procedure for Investigating Complaints

The Michigan Right to Farm Act established a procedure for the Department of Agriculture to follow when investigating complaints against farms or farm operations. That procedure is summarized below. (The procedure should be followed, however, as stated in the statute).

- All complaints involving a farm or farm operation, including, but not limited to, complaints involving the use of manure and other nutrients and surface water or groundwater pollution shall be investigated.
- An on-site inspection of the farm or farm operation will be conducted within 7 business days of receipt of the complaint by the Department.
- The [city/village/township] and the county shall be notified of the complaint (all notifications are to be in writing).

- If the Department finds that the person responsible for a farm or farm operation is using generally accepted agricultural and management practices, it shall notify that person, the complainant, and the [city/village/township] and the county of this finding.
- If the Department identifies that the source (or potential sources of the problem) was caused by the use of other than generally accepted agricultural and management practices (GAAMPS), it shall advise the person responsible for the farm or farm operation that necessary changes should be made to resolve or abate the problem and to conform with generally accepted agricultural and management practices. If those changes cannot be implemented within 30 days, the person responsible for the farm or farm operation shall submit an implementation plan, including a schedule for completion of the necessary changes to the Department.
- When a follow-up on-site inspection is conducted to verify whether those changes have been implemented, the Department shall notify the [city/village/township] and the county of the time and date of the follow-up on-site inspection and shall allow a representative of the [city/village/township] and the county to be present during the follow-up on-site inspection.
- If the changes have been implemented, the Department shall notify the person responsible for the farm or farm operation, the complainant, and the [city/village/township] and the county of this determination.
- If the changes have not been implemented, the Department shall notify the complainant and the [city/village/township] and the county that the changes have not been implemented and whether a plan for implementation has been submitted.
- Upon request, the Director shall provide a copy of the implementation plan to the [city/village/township] and the county.

3.2 Local Land Use Planning and Zoning Techniques

The impact that the Michigan Right to Farm Act has on the ability of a local unit of government to regulate agricultural practices highlights the need to separate the regulation of agriculture from other uses as much as possible. Open spaces and natural features are often placed in agricultural zones/districts within local land use plans and zoning ordinances. Agricultural land could be separated from significant open spaces and natural features in policy documents and ordinances. This action helps to preserve and enhance the agricultural and open space and natural feature protection aims of a municipality. The county soil survey can be utilized to identify areas of prime and unique farmlands.

Agricultural Zoning Districts

It is recommended that the following provisions be reviewed and adapted for amendment into the Agricultural District of a community.

> **Statement of Intent.** This district is composed of areas of the [city/village/township] suited to active agriculture. The regulations governing this district are designed to preserve farmland and farm dwellings.

- All farm and farming operations are allowed within this district as long as they adhere to the generally accepted agricultural and management practices.
- The [city/village/township] will take advantage of the opportunities provided to it by the Michigan Right to Farm Act:

- The [city/village/township] will be participate in follow-up on-site inspections by the Michigan Department of Agriculture to verify whether the changes recommended by the Department have been implemented.
- If an implementation plan is required by the Department of Agriculture, the [city/village/township] request a copy.

Conditional Uses.

- Single family homes as long as one of the occupants of the home is involved in the cultivation of the land. The density shall be one dwelling unit per 40 acres. (Municipalities need to set a maximum density for themselves – the lesser the density, however, the more effective land preservation is.)

4 Zoning Ordinances

A source of clean water is important to obtaining a high quality of life. Zoning ordinances affect water quality both overtly and inadvertently through the development regulations they mandate and the placement of permitted and conditional uses allowed within the municipality. The staff of the Region 2 Planning Commission (R2PC) reviewed the zoning ordinances of 9 communities within Jackson and Hillsdale counties for the purpose of examining their potential effect on water quality. The following report summarizes those findings, which can be divided into the following categories:

- Definitions
- Zoning Districts
- Supplemental Regulations for Districts
- Conditional or Special Land Uses
- Planned Unit Developments
- Condominiums/Apartments
- Site Plan Review

4.1 Definitions

In order to minimize confusion, it is important to define the terms used in a zoning ordinance. This section contains a number of terms used in the remainder of this report. Local governments may want to amend their ordinances to include pertinent terms. (Make sure that the definitions in your regulatory documents are in agreement.)

Active Recreation Facilities. Sports fields, gymnasiums, playgrounds, multi-purpose non-motorized trails, motorized trails and other similar facilities.

Central Sanitary Sewer System. A sanitary sewer system furnished from a central location or plant, but not including septic tanks, by any person duly authorized to furnish such a system in accordance with federal, state, or local regulations.

Central Water System. A water supply system furnished from a central location or plant by any person duly authorized to furnish such a system, in accordance with federal, state, or local regulations.

Farm. (As defined in the Michigan Right to Farm Act.) The land, plants, animals, buildings, structures, including ponds used for agricultural or aquacultural activities, machinery, equipment, and other appurtenances used in the commercial production of farm products.

Farm Operation. (As defined in the Michigan Right to Farm Act.) The operation and management of a farm or a condition or activity that occurs at any time (as necessary) on a farm in connection with the commercial production, harvesting, and storage of farm products, and includes, but is not limited to:

- Marketing produce at roadside stands or farm markets.
- The generation of noise, odors, dust, fumes, and other associated conditions.
- The operation of machinery and equipment necessary for a farm including, but not limited to, irrigation and drainage systems and pumps and on-farm grain dryers, and the movement of vehicles, machinery, equipment, and farm products and associated inputs necessary for farm operations on the roadway as authorized by the Michigan Vehicle Code (MCL 257.1 to 257.923).
- Field preparation and ground and aerial seeding and spraying.
- The application of chemical fertilizers or organic materials, conditioners, liming materials, or pesticides.
- Use of alternative pest management techniques.
- The fencing, feeding, watering, sheltering, transportation, treatment, use, handling and care of farm animals.
- The management, storage, transport, utilization, and application of farm by-products, including manure or agricultural wastes.
- The conversion from a farm operation activity to other farm operation activities.
- The employment and use of labor.

Farm Product. (As defined in the Michigan Right to Farm Act.) Those plants and animals useful to human beings produced by agriculture and includes, but is not limited to, forages and sod crops, grains and feed crops, field crops, dairy and dairy products, poultry and poultry products, cervidae, livestock, including breeding and grazing, equine, fish, and other aquacultural products, bees and bee products, berries, herbs, fruits, vegetables, flowers, seeds, grasses, nursery stock, trees and tree products, mushrooms, and other similar products, or any other product which incorporates the use of food, feed, fiber, or fur, as determined by the Michigan commission of agriculture.

Generally Accepted Agricultural and Management Practices (GAAMPS). Voluntary practices based on available technology and scientific research to promote sound environmental stewardship and help maintain a farmer's right to farm. GAAMPs include the following:

- **Manure Management/Utilization.**
- **Pesticide Utilization/Pest Control.**
- **Nutrient Utilization.**
- **Care of Farm Animals.**
- **Cranberry Production.**
- **Site Selection Checklist.**

Log onto the Michigan Department of Agriculture's website to view the GAAMPS – http://www.michigan.gov/mda.

Hazardous Substances. Any hazardous substances as defined by state and federal agencies, including but not limited to, hazardous chemicals, flammable and combustible liquids, hazardous materials, and hazardous waste as defined by state and federal regulatory agencies and laws. Sources include, but are not limited to:

- PA 188 of 1965, the Michigan Hazardous Substances Act (MCL 286.451 - 286.463) – www.michiganlegislature.org/law
- Michigan Department of Environmental Quality – www.michigan.gov/deq
- Michigan State Police – www.msp.state.mi.us

Junkyard. A structure or parcel of land where junk, waste, discard, salvage, or similar materials such as old iron or other metal, wood and lumber, glass, paper, rags, cloth, leather, rubber, bagging, cording, barrels, or containers. This includes autos and other inoperative machines, structural steel materials, and other equipment. It also includes establishments where those materials are bought, sold, exchanged, stored, baled, packed, disassembled, or handled for any 30 consecutive days. This should include the storage of inoperable vehicles and other white trash (i.e., appliances, etc.) on land with a primary use other than junkyard.

Kennel. The land and/or structure where five or more cats, dogs, and/or other small domesticated animals are boarded. (Municipalities must codify the maximum number of animals allowed as they see fit.)

Michigan Right To Farm Act (MCL 286.471 - 286.474). Public Act 93 of 1981 was enacted to provide farmers with protection from nuisance lawsuits. The statute authorizes the Michigan Commission of Agriculture to develop and adopt Generally Accepted Agricultural and Management Practices (GAAMPs) for farms and farm operations in Michigan.

Mobile Home Park. A tract of land prepared and approved according to the procedures in this ordinance and state law to accommodate mobile homes on rented or leased lots.

Person. An individual, corporation, partnership, association, or other legal entity.

Planned Unit of Development (PUD). A form of development usually characterized by the flexible application of zoning district regulations and unified site design for a number of housing units, clustering buildings, providing common open space and a mix of building types and land uses. It permits the calculation of densities over the entire development, rather than on an individual lot-by-lot basis. It also refers to a process, mainly revolving around site plan review, in which the [city/village/township] will have considerable involvement in determining the nature of the development.

Quarry. Any pit, excavation, or mining operation for the purpose of searching for or removing from the premises any earth, coal, rock, sand, gravel, clay, stone, slate, marble, or other non-metallic mineral in excess of fifty (50) cubic yards in any calendar year, but shall not include an excavation preparatory to the construction of a structure or public highway.

Riding Academy. Any establishment where horses are kept for riding, driving, or stabling for compensation or incidental to the operation of any club, association, ranch, or similar establishment.

Site Plan Review. A review by the [planning commission/zoning board] and the [city council/village council/township board] of certain buildings and structures that can be expected to have a significant impact on natural resources, traffic patterns, and on adjacent land use.

4.2 Zoning Districts

Different land uses create different non-point source pollution concerns. Those concerns should be addressed. The following listing addresses those issues by land use.

4.2.1 Agricultural and Open Space Districts

Many zoning ordinances create a single district for agriculture and open space. This action recognizes the often-complementary environmental benefits of preserving open space and agricultural land. There are enough differences, however, to justify the separation of these districts under the general heading of agricultural and open space districts.

- The main aim of agricultural districts should be to preserve valuable agricultural land – environmental protection is an important, but secondary outcome.
- Open space districts are aimed at environmental protection and the preservation of important natural features.

Agricultural District

Please see the section on 'Agriculture and Water Quality'

Open Space District

Statement of Intent. This district is composed of areas of the [city/village/township] well suited to open space, passive recreational, and extremely low-density residential land uses. The regulations governing this district are designed to retain lands that are environmentally sensitive or provide for the recreational pursuits of township residents. Permitted land uses are generally those in support of public interests of open space, environmental protection and education, and recreation.

The conditional uses allowed should be limited and based at least in part on their potential impact upon ground and surface waters.

Developments should also be maintained in an environmentally responsible fashion:

- Maintain appropriate filtration strips along the shorelines of bodies of water (i.e., lakes, streams, and wetlands, etc.).
- Limit the amount of impervious surfaces (i.e., parking lots, roofs, drives, etc.).
- Maintain on-site essential services such as wells and septic tanks to ensure that ground and surface water is not polluted.

4.2.2 Residential Districts

The primary purpose of residential districts is to house the population of the [city/village/township]. The main difference between the different residential districts is the density of development allowed and the essential service requirements for new developments.

Rural Residential District

Statement of Intent. The district is intended to permit single family residential uses on large lots in order to conserve and protect natural features, and the rural character of the [city/village/township]. It also minimizes the demand for public utility services and infrastructure by limiting the district's population density. (Municipalities need to set a maximum density for themselves – the lesser the density, however, the more effective land preservation is.)

Suburban Residential District

Statement of Intent. This district is intended to permit single family residential uses at higher densities than the rural residential districts.

- The district shall be located in areas where there is central water and sanitary sewer service.

Multiple Family Residential Districts

Statement of Intent. This district is intended to allow for multiple family dwellings at a higher density than single family developments.

- The districts shall be located in areas where there is central water and sanitary sewer service.

Mobile Home Park District

See the Section on 'Conditional or Special Land Uses'

4.2.3 Commercial Districts

The primary purpose of commercial districts is to service the population of the [city/village/township]. The main difference between the different commercial districts is the size of the service area.

'Neighborhood' and 'Community' Commercial Districts

Statement of Intent. This district is designated to service the daily and weekly household or personal needs of abutting residential neighborhoods.

- 'Neighborhood' and 'community' commercial establishments should be served by the same essential services as the homes in the abutting neighborhoods (i.e., if any of the

homes in the surrounding neighborhoods are served by water and sewer, so should the businesses.)

- Commercial establishments or plazas without water and sewer service or compatible onsite utilities should not exceed 10,000 square feet (just a guess – municipalities must set this threshold for themselves).

'Central' and 'General' Commercial District

Statement of Intent. This district is designated to service the household or personal needs of the entire community and its surrounding area.

- Adequate central water and sanitary sewer systems should serve all 'central' and 'general' commercial establishments.

4.2.4 Industrial Districts

The primary purpose of industrial districts is to provide suitable space for industrial uses. The main difference between the different industrial districts is the intensity of the industrial operation. These standards, however, should be applied to all industrial districts.

- In order to prevent loose materials from blowing into adjacent properties and impairing water quality, all storage of goods, supplies, or material shall be within an enclosed building. (At a minimum, a fence, tarpaulin or obscuring wall of no less than six (6) feet should be required around the stored material.)
- The emission of gases, smoke, dust, dirt, and fly ash shall in no manner be unclean, destructive, unhealthful, hazardous, or deleterious to the general welfare. Such emission shall be in strict conformance with all applicable State and County health laws as pertaining to air pollution, water pollution, and smoke abatement.
- Retention and/or detention ponds to handle the increased runoff from parking lots. (The [city/village/township] could enact an ordinance codifying this regulation).

4.3 Supplemental Regulations for Districts

This section of a zoning ordinance is comprised of regulations that may or may not apply to all zoning districts. It is a good place to add non-point source pollution regulations.

4.3.1 District Area, Yard, Height, and Bulk Regulations

Each local government develops this section as it sees fit based upon a wide variety of issues and concerns. There is too much variability to make any concrete recommendations. The following guidelines, however, might prove helpful.

The availability of essential services such as central water and sanitary sewer systems should have an effect upon the allowable density of development in order to protect ground and surface water and the health of the people who utilize those resources (see Table 5).

Central water and sanitary sewer systems do not have to be municipally owned or operated. Technology is continually evolving that will allow for private and/or communal utilities to serve developments. If public services are available, however, hookup should be required.

Table 5
Determining Minimum Lot Sizes and Widths

Is the property —	***Smaller/ Narrower***	***Bigger/ Wider***
Served by central sanitary sewer and water systems?	YES	NO
For properties without those services, is the parcel —		
Adjacent to or nearby surface water (e.g., pond, lake, stream, wetland, etc.) or a groundwater recharge area?	NO	YES
Comprised of poor soils in relation to water percolation and drainage?	NO	YES

4.3.2 Floodplains

- Land within the 100-year floodplain should be reserved for agricultural, recreational, and open space residential uses.
- Structures, parking lots, and other impervious surfaces should be limited in floodplain areas because of the potential damage to those structures during flooding and the resultant impairment of the floodplain to absorb floodwaters. The construction of residences and primary commercial and industrial buildings should be prohibited.
- The location and boundaries of the 100-year floodplain should be determined by reference to the U.S. Natural Resource Conservation Service, the U.S. Corps of Engineers, or other official authority.

4.3.3 Lakeshores, River and Stream Banks, and Wetlands

- The contamination of any public waters within the [city/village/township] is expressly prohibited. The diversion or obstruction of any public waters within the jurisdiction is expressly prohibited without the written approval of the [city council/village council/ township board].
- No person shall alter, change, transform, or otherwise vary the edge, bank, or shore of any lake river, stream, or wetland except in conformance with the following:
  - PART 301 – Inland Lakes and Streams – of the Natural Resources and Environmental Protection Act (MCL 324.30101 to 324.300113).
  - A site plan shall be submitted to the [zoning board/planing commission]. This does not relieve the applicant from complying with requirements of other regulatory agencies.
- No structure shall be placed within fifty (50) feet of a lake, river, stream, or wetland. (Each local government must make its own decision as to the width (based on legally defensible reason)). Some local governments are beginning to use the height of the climax trees native to the area (multiplied by some factor) as the standard.

- A buffer and/or filter strip should be constructed based on stream width and depth, depth of canopy, and relative position of the sun along the course of the stream. Larger 'bubbles' of filter strips should be installed at the points where concentrated amounts of runoff enter a body of water (e.g., low areas) in order to improve water quality. The filter strips should be wide enough to provide adequate shade and filtration for the protection of fisheries and wildlife in other areas.

4.3.4 Outdoor Storage and Waste Disposal

- Any hazardous substances used or generated by medical procedures and/or examinations shall be stored in accordance with all applicable state and federal regulations. Additional measures must be taken to ensure that the accidental leakage or discharge of those materials will not pollute the water table. Notification of the [city/village/township] is required when spills occur.
- All vehicles placed in a storage yard shall be drained of all liquids and oil and the waste materials shall be disposed of in a proper manner so that no unintentional discharges into the soil or groundwater shall occur. All batteries shall be removed from all stored vehicles and disposed of in a proper manner.
- A pollution incident prevention plan shall be required to be submitted to the county health department and given written approval before a building permit can be issued.
- All salvage operations and storage area shall be conducted wholly within an enclosed building or within an enclosed area..

4.3.5 Sanitary Sewage

- Septic tanks or privately operated central sanitary sewer systems must meet standards and specifications prescribed by the county health department and the Michigan Department of Environmental Quality. A letter or document of approval from both levels of government must be submitted by the proprietor to the [city/village/township].
- Disposal of sanitary sewage from septic tanks, cesspools or dry wells shall have the written approval of the property owner and shall adhere to applicable best management practices. Notification of the [city/village/township] is also required.

4.3.6 Storm Water Management

Storm water management standards can be divided among several different concerns:

Drainage

- The [city/village/township] should develop minimum standards for storm water management that would be required for all new development:
- If a limited outlet is available, detain a 50 year storm with a 1 hour duration
- If no outlet is available, retain a 100 year storm with a 3 hour duration
- All storm water management systems shall be built to federal, state, county and municipal standards.

- A letter or document of approval from the county drain commissioner shall be submitted by the proprietor to the [city/village/township] when county drains are included in the proposed plat.
- All thoroughfares shall provide for storm drainage in accordance with the standards and specifications prescribed by the [city/village], the county road commission, or the Michigan Department of Transportation (depending upon who owns and maintains the roadway).

Drainage Easements

- Drainage easements shall conform substantially to the lines of any natural watercourse, drainage ditch, channel or stream.
- Easements shall be of adequate width for the particular conditions of the site.
- Open drainage easements should be constructed of natural materials which encourage absorption of storm water runoff and which also impede the velocity of the runoff.

Private Roads

- Private roads should incorporate drainage and erosion control in their design.
- Drainage plans shall show that runoff shall be conveyed to existing water courses or water bodies via a retention or detention pond system that will slow the velocity of the runoff and improve the quality of water entering the water courses.
- Underground crossroad drainage shall be provided where the proposed right-of-way crosses a stream or other drainage course. Necessary culverts and treatments shall be provided in accordance with the specifications of the county drain commission.
- The discharged water shall not be cast upon the land of another property owner. The county road commission prior to the issuance of a permit shall approve connection to roadside ditches within public road rights-of-way.

Off-Street Parking Areas

- Parking lots and off-street loading spaces shall be constructed of materials that will have a dust-free surface resistant to erosion. The paving of parking lots, however, significantly increases storm water run-off and create a potential for flooding and/or soil erosion. (Municipalities may want to consider allowing little-used parking lots to be utilized as retention ponds)
- Parking lots and loading spaces shall be drained so as to prevent drainage to abutting properties.
- Retention and/or detention ponds are required to handle the increased runoff from parking lots. (Municipalities could enact an ordinance codifying this regulation.)

Other Hard Surfaced or Impervious Surfaced Areas

- Driveways, patios, roofs, and other hard surfaced or impervious surfaced structures should incorporate drainage and erosion control in their design.

- Retention and/or detention ponds are required to handle the increased runoff from hard surfaced areas. (Municipalities could enact an ordinance codifying this regulation.)

4.3.7 Water System

Each lot or unit shall be served by an adequate public or private water supply. Private sources of water shall be subject to the standards and specifications of the county health department. Written approval of private water supplies shall be submitted to the [city/village/township].

4.4 Additional Development Standards

Some land uses are so potentially disruptive that additional requirements are often mandated before permission is granted. The following development standards are beneficial to water quality.

4.4.1 General development standards for conditional or special land uses

The following development standards should be applied to all conditional or special land uses:

- The use shall be served adequately by essential public facilities and services such as highways and streets, police and fire protection, drainage structures, and refuse disposal. If not, the persons responsible for the establishment of the proposed use shall provide adequately any such services.
- The use shall not create excessive additional requirements at public costs for environmental protection or remediation.
- The use shall not be hazardous to adjacent properties. Nor shall it involve activities, uses, materials or equipment which will be detrimental to the environment or the health, safety, or welfare of persons or property through the excessive production of traffic, noise, smoke, odor, storm water or gray water runoff, fumes, glare, or dust.
- Protect the natural environment and conserve natural resources and energy.
- The development should follow the existing topography of the land as much as possible. Care must be taken to ensure that storm water runoff is not increased when the terrain is altered.
- Filtration strips shall be maintained along the shoreline of lakes and streams and wetlands.
- Water runoff offsite cannot be increased because of the development.
- The [city/village/township] shall be copied on any reports the operators/developers are required to submit to state and/or federal regulatory agencies during the construction and operation of the development.
- The applicant must show that the proposed special land use shall not result in a probable impairment, pollution, and/or destruction of the air, water, or other natural resources, or the public trust therein.
- All roads, driveways, parking lots, and loading-unloading areas shall be paved, watered, or chemically treated so as to limit the nuisance caused to adjoining lots and public roads by wind borne dust. No applications that impair water quality and/or quantity, however, shall be employed.

- Single family dwellings and/or any accessory structures shall be located at least fifty (50) feet from any designated floodplain or wetland.
- No cutting of natural climax trees within one tree height from any water course.

4.4.2 Development standards applied to specific conditional uses

Other development standards are directed at a specific conditional or special land use. The following development standards are organized by land use:

Active recreation facilities

- Trails for use by motorized vehicles and bicycles shall be designed to limit erosion and its resultant impact on water quality.

Automobile repair and service stations

- Oil, gas, and other hazardous substances used to service and/or repair motorized vehicles shall be stored, administered, and disposed of in accordance with state and federal regulations.
- Additional steps shall be taken to ensure that those materials do not infiltrate into ground and surface waters.

Automobile washes

- Gray water cannot be directly discharged into ponds, lakes, streams, wetlands, or other water bodies.
- Gray water cannot be discharged directly into the public storm water sewer system.
- The use of detention and/or retention ponds may be used to regulate the release of gray water.

Cemeteries and golf courses

- The application of fertilizers on cemeteries and golf courses should not contribute to the eutrophication of ponds, lakes, and/or streams.

Hospitals and medical clinics

- Any hazardous substances used or generated by medical procedures and/or examinations shall be stored in accordance with all applicable state and federal regulations. Additional measures will be taken to ensure that the accidental leakage or discharge of those materials will not pollute the water table.
- Methods used to transport hazardous substances shall not leak or discharge onto public rights-of-way or discharge on public or private property. If leaks or discharges occur, they

shall be cleaned up according to state and federal laws and regulations. The [city/village/township] will be notified of any leaks or discharges.

Junk yards

- All roads, driveways, parking lots, and loading/unloading areas within any yard of a junkyard shall be paved, oiled, watered, or chemically treated so as to limit the nuisance caused to adjoining lots and public roads by wind borne dust. It should also be determined that the treatment chosen to limit dust shall not impair water quality.
- All vehicles placed in the storage yard shall be drained of all liquids and oil and the waste materials shall be disposed of in a proper manner so that no unintentional discharges into the soil or groundwater shall occur. All batteries shall be removed from all stored vehicles and disposed of in a proper manner.
- A pollution incident prevention plan shall be required to be submitted to the county health department and given written approval before a building permit can be issued.
- All salvage operations and storage areas within junkyards shall be conducted wholly within an enclosed building or within an enclosed area. Runoff from that storage area will be detained onsite and allowed to filter through the soil.
- Notification of the [city/village/township] is required when spills occur.

Kennels and stables

- The [kennel/stable] shall be established and maintained in accordance with all applicable state, county and [city/village/township] sanitation regulations.
- The premises shall be kept so that animal waste is disposed of in an expedient, sanitary manner and to eliminate odor and insect problems.
- There shall be proper sewage/septage facilities on site, including an adequately sized holding tank for waste materials with minimum yearly pumping maintenance. If public central sanitary sewer service is available, hook-up is required.
- Methods used to transport animal waste shall not leak or discharge onto public rights-of-way or discharge on public or private property without the owner's account and in adherence with any applicable regulations and laws. The [city/village/township] shall be notified of the incident.

Mobile home parks

- Every mobile home park or subdivision shall be served by a central water supply system and a central sanitary sewer system – onsite or connected to a public utility.
- All mobile homes within such parks shall be suitably connected to sewer and water services provided at each mobile home site, and shall meet the requirements and be approved by the county health department.
- All central sanitary sewer facilities, including plumbing connections to each mobile home site, shall be constructed so that all facilities and lines are protected from freezing, from bumping or from creating any type of nuisance, health hazard, or environmental damage.

- Storm drainage facilities shall be so constructed as to protect the residents of the mobile home park as well as the property owners adjacent to the park.
- Any method used for the disposal of garbage and trash shall be approved by the State and inspected periodically by the county health department.
- Any fuel oil and gas storage shall be centrally located. All fuel lines shall be underground and so designed as to conform to the [city/village/township] building code and any state code that is found to be applicable.

Open space residential and planned unit developments

- The design of the development should respect wooded areas and floodplains which are important to the recharge of aquifers and which help to absorb flood waters.
- The common open-space, common properties, individual properties, and all other elements shall be so planned that they will achieve a unified environmental scheme, with open spaces and all other elements in appropriate locations, suitably related to each other, the site, drainage, and surrounding land.

Quarries – mining and extractive operations

- All roads, driveways, parking lots, and loading-unloading areas within a quarry operation shall be paved, oiled, watered, or chemically treated so as to limit the nuisance caused to adjoining lots and public roads by wind borne dust. It should also be determined that the treatment chosen to limit dust shall not impair water quality.
- The removal, processing or storage shall not be conducted as to cause the pollution by any material of any surface or subsurface, watercourse, or body outside the lines of the lot on which such use shall be located.
- Such removal, processing or storage shall not be conducted as to cause or threaten to cause the erosion by water of any land outside of the lot or of any land on the lot so that earth materials are carried outside of the lines. Such removal shall not be conducted as to alter the drainage pattern of surface or subsurface waters on adjacent property, and that in the event that such removal, processing, or storage shall cease to be conducted it shall be the continuing responsibility of the owner or operator thereof to assure that no erosion or alteration of drainage patterns, as specified in this paragraph, shall take place after the date of the cessation of operation.
- The operator of the mining operation shall file with the Planning Commission and the Zoning Inspector a detailed plan for the restoration of the land once the mining operation is finished. The plan shall include the steps that shall be taken to conserve topsoil; proposed and final landscaping; and the location of future roads, drives, drainage courses, and/or other contemplated improvements.

Sanitary landfills

- The proposed landfill must comply with the county solid waste plan and any state and/or federal regulations.

Self-storage facilities

- The storage of any toxic, explosive, corrosive, flammable, or hazardous material is prohibited.
- All roads, driveways, parking lots, and loading-unloading areas shall be paved, oiled, watered, or chemically treated so as to limit the nuisance caused to adjoining lots and public roads by wind borne dust. Those applications shall not impair water quality.

Veterinary clinics and hospitals

- The veterinary clinic or hospital shall be established and maintained in accordance with all applicable state, county and [city/village/township] sanitation regulations.
- The premises shall be kept so that animal waste is disposed of in an expedient, sanitary manner and to eliminate odor and insect problems.
- There shall be proper sewage/septage facilities on site, including an adequately sized holding tank for waste materials with minimum yearly pumping maintenance.
- Methods used to transport animal waste on shall not leak or discharge onto public rights-of-way or discharge on public or private property without the owner's account and in adherence with any applicable regulations and laws.

4.5 Planned Unit Developments

Planned Unit Developments (PUD) can be utilized for the long-term protection and preservation of natural resources and natural features of a significant quantity and/or quality, where such benefit would otherwise be unfeasible or unlikely to be achieved without application of the planned unit development regulations.

- General Design Standards:
  - To the maximum extent feasible, the development shall be designed so as to preserve the natural resources and natural features.
  - Thoroughfare, drainage, and utility design shall meet or exceed the standards otherwise applicable in connection with each of the respective types of uses served.
- PUD requests must go through the site plan review process.

4.6 Condominiums/Apartments

- A person, firm or corporation intending to develop a site condominium project shall provide the following information with respect to the project:
  - Whether or not a community water system is contemplated
  - Whether or not a community septic system is contemplated
- Condominium/Apartment requests must go through the site plan review process.
- Developers must develop a storm water management program

4.7 Site Plan Review

4.7.1 Standards for Review

- The use shall not be hazardous to adjacent property, or involve uses, activities, materials, or equipment which will be detrimental to the health, safety, or welfare of persons or property or the environment through the excessive production of ground and surface water pollution.
- The use shall be adequately served by essential public facilities and services, or it shall be demonstrated that the person responsible for the proposed use shall be able to continually provide adequately for the services and facilities deemed essential to the use under consideration.
- The use shall not place demands on public services and facilities in excess of current capacity.
- The applicant shall provide proof of approvals by all county, state and federal agencies having jurisdiction over improvements (including but not limited to the county road commission, county drain commissioner, county health department, the Michigan Department of Natural Resources, Michigan Department of Environmental Quality, and the U.S. Environmental Protection Agency). The [planning commission/zoning board] shall not approve a final site plan until each county, state or federal agency, having such jurisdiction has approved that portion of the site plan that is subject to its jurisdiction.
- The developer shall file with the [city/village/township] a performance bond payable to the municipality and conditioned on the faithful performance of all requirements contained in the approved site plan. The amount of the required bond which will reflect the anticipated cost of restoration shall be fixed upon written certification of the zoning inspector that the restoration is complete and in compliance with the restoration plan.

4.7.2 Developments requiring a site plan

The following developments shall be required to submit a site plan, because of their potential impact upon surface and ground water quality.

- Conditional or special land uses.
- Planned unit development
- Condominiums/apartments
- Developments that will alter the edge, bank, or shore of any lake, river, stream, or wetland.
- Developments that use, generate, handle, or store hazardous substances.

4.7.3 Required Data on Site Plan Maps

The following maps should be required:

- vicinity map
- site plan

Vicinity maps shall show the following information:

- The location of all private water supply wells within a one-mile radius of the property.
- The location of existing drainage courses and associated bodies of water (including wetlands), on and off site and their elevations within a one mile radius of the property.
- Adjacent properties and their existing use.

Site plans shall show the following information:

- Existing topography with a maximum contour interval of two feet, both on the site and beyond the site for a distance of 100 feet in all directions.
- A grading plan, showing finished contours at a maximum interval of two feet, correlated with existing contours so as to clearly indicate required cutting, filling and grading.
- Location of natural resource features, including woodlands and areas with slopes greater than 6 percent (1 foot of vertical elevation for every 6 feet of horizontal distance).
- Streams, rivers, lakes, drains, flood plains, and wetlands.
- Existing man-made features such as buildings, structures, high tension towers, and pipelines
- Soil characteristics of the parcel to at least the detail provided by the county soil survey.
- Well sites
- Septic systems and other wastewater treatment systems. The location of the septic tank and the drainfield (soil absorption system) should be clearly distinguished.
- Existing utilities such as water and sanitary sewer lines (including pump stations), water main hydrants, bridges, culverts, and drains.
- Storm water control facilities and structures including storm sewers, swales, retention and detention basins, drainage ways, and other facilities, including calculations for sizes.
- location of easements
- Storage, loading, and disposal areas for chemicals, hazardous substances, salt, and fuels.
- trash receptacle pad location and design
- If the proposed development is not to be served by public sewer and water systems, a site report (in a form acceptable to the county health department) shall be submitted as described in the rules of the State of Michigan Department of Public Health. If available, such report shall also include boring and percolation test data for a representative portion of the development.

All maps should include the following information:

- The scale; north point; boundary dimensions, date, and map maker.

4.7.4 Letters of Recommendations

Letters of recommendation needed from the following agencies:

- Road Commission
- Health Department
- Drain Commissioner

4.7.5 Final Site Plan Review Criteria

Final site plans will be reviewed based upon these criteria:

- It provides for proper development of roads, easements and public utilities and protects the general health, safety, welfare and character of the [city/village/township].
- It meets the requirements and standards for grading and surface drainage and for the design and construction of storm sewers, storm water facilities, parking lots, driveways, water mains, sanitary sewers as determined by [city/village/township] engineers and set forth in the [city/village/township]'s design and construction standards.
- The grading of the property does not prevent the natural flow of water onto it.
- Natural resources will be preserved to the maximum extent possible in the site design by developing in a manner which will not detrimentally affect or destroy or pollute natural features such as lakes, ponds, streams, wetlands, steep slopes, groundwater and woodlands.
- The proposed development will not cause soil erosion or sedimentation off site.
- Storm water management systems and facilities will preserve the natural drainage characteristics and enhance the aesthetics of the site to the maximum extent possible, and will not substantially reduce or increase the natural retention or storage capacity of any wetland, water body or water course, or cause alterations which could increase flooding or water pollution on or off site.
- Wastewater treatment systems, including on-site septic systems, will be located and designed to minimize any potential degradation of surface water or groundwater quality.
- Sites which include storage of hazardous materials or waste, fuels, salt, or chemicals, will be designed to prevent spills and discharges of polluting materials to the surface of the ground, groundwater, or nearby water bodies.

Appendix A
References

Land Use Plans

- Village of Parma Land Use (July 28, 1980)
- Village of Springport Land Use Plan Community Development Goals (June 4, 1997)
- Blackman Township Land Use Plan (July 10, 1995)
- Leoni Township Master Plan (1996)
- Rives Township Land Use Guide (March 31, 1977)
- Sandstone Township Master Future Land Use Plan (June 22, 1998)
- Somerset Township Comprehensive Community Land Use Plan (Revised 1997)
- Springport Township Land Use Plan (Date Unknown)
- Tompkins Township Land Use – 2000 (September 3, 1980)
- Waterloo Township Master Plan (Revised June 13, 2000)

Zoning Ordinances

- Village of Parma Zoning Ordinance (April, 1999)
- Village of Springport Zoning Ordinance (2/7/2000)
- Henrietta Township Zoning Ordinance (May 29, 2001)
- Leoni Township Zoning Ordinance (Revised March 26, 2001)
- Rives Township Zoning Ordinance (April 2, 2001)
- Sandstone Township Draft Zoning Ordinance (June, 1999)
- Somerset Township Zoning Ordinance (Amended March 17, 1999)
- Tompkins Township Zoning Ordinance (2/6/1990)
- Waterloo Township Zoning Ordinance With Land Development Regulations (Amended, May 17, 1994)

Online Sources

- www.fema.gov -- FEMA's National Flood Insurance Program.
- http://mapping.usgs.gov – USGS maps
- www.michiganlegislature.org/law – Michigan Compiled Laws (including: Part 91 – Soil Erosion and Sedimentation Control – of the Natural Resources and Environmental Protection Act, Michigan Right to Farm Act, Michigan Hazardous Substances Act)
- www.michigan.gov/mda, Michigan Department of Agriculture (Generally Accepted Agricultural Management Practices (GAAMPS))
- www.michigan.gov/deq, Michigan Department of Environmental Quality
- www.msp.state.mi.us, Michigan State Police

Appendix B
Building Inspection Checklist

If a municipality does not want to enact a local soil erosion and sedimentation control ordinance, the addition of certain water quality provisions to the building inspector's checklist may be the preferred alternative. At a minimum, the following items should be included on the building inspection checklist:

- Graded or filled areas on the site must be encircled with properly installed silt fencing, excepting points of egress (i.e., driveways, etc).
- Driveways, and any other points of egress from the site, must be "topped" by a minimum of 20 feet of crushed stone or slag – as measured from the pavement (i.e., asphalt, concrete, gravel, etc.) of a roadway – in order to prevent the mud from being tracked onto the road(s).
- Silt socks must be placed in any catch basins to be constructed on the site, and any catch basins immediately downstream from the site.
- A Soil Erosion Permit must be acquired prior to any earthmoving activity being undertaken.

Prior to issuing an Occupancy Permit, require the architect or builder to certify the following:

- The requirements of [list pertinent municipal and/or county storm water management policies here] have been met or exceeded (if pertinent).
- The site plans have been reviewed and approved by the [place the name of your county here] County Drain Commissioner.
- Approvals have been obtained from the [place your county name here] County Health Department for a well and septic system (if pertinent).

In addition to the standard items required on a site plan (i.e., exact location and dimensions of all buildings and their distance from each property line and each other, scale, north arrow, etc.), the location of the following should also be mandated:

- Graded or filled areas.
- Driveways and any other points of egress.
- Catch basins to be constructed on the site and any catch basin(s) immediately downstream.
- Well and septic system (if pertinent).

These minimum requirements should be applied to all building permit applicants, regardless of the size of the proposed project.

Appendix C
Online Resources

The following websites provide background information on non-point source pollution issues:

- **Rouge River National Wet Weather Demonstration Project**, Improving Community Storm Water Management – A Summary Guide of Ordinances for River Rouge Communities, http://www.wcdoe.org/rougeriver/pdfs/stormwater/sr17.pdf

  The document provides background information on, and suggestions for, the development of a storm water ordinance (or a series of ordinances) covering:
  - Controlling Storm Water Quantity and Quality
  - Soil Erosion and Sedimentation Control
  - Managing Septic Systems
  - Protecting Wetlands
  - Maintaining Vegetative Buffer Zones and Stabilizing Streambanks
  - Floodplain/Watercourse: Maintaining Docks and Other Water Dependant Structures
  - Establishing Wildlife Corridors

- **NEMO**, http://nemo.uconn.edu/publications/pubs.htm

  NEMO – "The Nonpoint Education for Municipal Officials Project is an educational program for local land use officials that addresses the relationship of land use to natural resource protection." The website provides a wide variety of fact sheets, videos, technical papers, and other resources that address nonpoint source pollution issues.

The following websites provide model ordinances that can be adapted for your jurisdiction:

- **Carl Vinson Institute of Government – Water Management Planning – Publications and Reports,** http://www.cviog.uga.edu/water/publications/

  The Water Management Planning page of the Institute's website provides a link to a report entitled "Protecting Streams and River Corridors: Creating Effective Local Riparian Buffer Ordinances," http://www.cviog.uga.edu/water/publications/protecting.pdf. Although the report is aimed at communities in Georgia, where buffers are mandated in state law, it is designed to help a local community to craft buffer ordinances that is appropriate for its jurisdiction. The report is also aimed at limiting the claims of property 'takings.' It is also scientifically based. A model ordinance for developing a fixed width riparian buffer is contained in the report.

- **The River Network**, http://www.rivernetwork.org/

  The River Network – Helping People Understand, Protect and Restore Rivers and their Watersheds – supports grassroots river and watershed conservation groups. The web page,

http://www.rivernetwork.org/library/librivissbuf_rvsp98tech.cfm, provides "Technical Factors for Riparian Buffer Information Through Local Ordinances." The web page, http://www.rivernetwork.org/library/librivissbuf_ordinances.cfm, provides a number of "on-line resources and model ordinances to help you establish policies that will protect existing riparian buffers in your watershed."

- **The Storm Water Manager's Resource Center**, http://www.stormwatercenter.net/

  The Stormwater Manager's Resource Center (SMRC) "is designed specifically for stormwater practitioners, local government officials and others that need technical assistance on stormwater management issues." The website provides 30 model ordinances. (Just click on 'Ordinance Selector' on the home page.)

The following websites provide information on other tools:

- **Center for Watershed Protection**, *Site Planning Model Development Principals*, http://www.cwp.org/22_principles.htm,

  "The twenty-two model development principles [displayed on the web page] provide design guidance for economically viable, yet environmentally sensitive development. Our objective is to provide planners, developers, and local officials with benchmarks to investigate where existing ordinances may be modified to reduce impervious cover, conserve natural areas, and prevent stormwater pollution. These development principles are not national design standards. Instead, they identify areas where existing codes and standards can be changed to better protect streams, lakes and wetlands at the local level. The development principles are divided into the three following areas:
  - Residential Streets and Parking Lots (Habitat for Cars)
  - Lot Development (Habitat for People)
  - Conservation of Natural Areas (Habitat for Nature)"

- **Low Impact Development Center Inc.**, *Low Impact Development (LID) Urban Design Tools*, http://www.lid-stormwater.net/

  The website "has been developed through a Cooperative Assistance Agreement under the US EPA Office of Water 104B(3) Program in order to provide guidance to local governments, planners, and engineers for developing, administering, and incorporating **Low Impact Development (LID)** into their aquatic resource protection programs. LID technology is an alternative comprehensive approach to stormwater management." (Just click on 'Enter Interactive Design Page Here' on the home page.)

APPENDIX F

Education Strategy for the Upper Grand River Watershed

Upper Grand River Watershed Communications Plan

Marketing Campaign

Goal: To reduce non-point source pollution to the Upper Grand Watershed by seeking to reinforce and/or change target audiences behaviors as indicated below:

1. Target audiences and behaviors

The Upper Grand River Watershed marketing campaign will target household residents. The determination to target households was based on both the impact this audience has on non-point source pollution and on the high probability of successfully reaching this audience through a marketing campaign. Other target audiences - agricultural producers, businesses, land developers, and local decision-makers - may be targeted through parallel outreach efforts.

- **Urban residents**
  1. Increase awareness of the Grand River Watershed community and the water cycle within in it
  2. Reduce the irresponsible use of and increase the responsible use of fertilizers and pesticides
- **Rural residents**
  1. Increase awareness of the Grand River Watershed community and the water cycle within in it
  2. Reduce the irresponsible use of and increase the responsible use of fertilizers and pesticides
  3. Proper septic system maintenance
- **Riparian residents**
  1. Increase awareness of the Grand River Watershed community and the water cycle within in it
  2. Reduce the irresponsible use of and increase the responsible use of fertilizers and pesticides
  3. Installation and maintenance of buffer strips along water bodies and changing mowing practices that will result in increased water quality

2. Tactical approach:

This campaign will consist of a program utilizing the following media channels:

- Print advertising
- Direct mail
- Radio advertising
- Point of contact
- Publicity

3. Materials required:

The following materials will be required in support of this campaign:

- Print advertising pieces aimed at
  1. Increasing the awareness of the Grand River Watershed community and the water cycle within in it
  2. Reducing fertilizer use as well as increasing the proper use of fertilizer (for example, not fertilizing right before a rain, sweeping up and disposing of fertilizer spread on hard surfaces, applying the proper amount, finding out what fertilizer is needed by testing soil before application)
  3. Proper septic system maintenance
  4. Installation and maintenance of buffer strips along water bodies and changing mowing practices that will result in increased water quality
- Direct mail pieces aimed at:
  1. Increasing the awareness of the Grand River Watershed community and the water cycle within in it
  2. Reducing fertilizer use as well as increasing the proper use of fertilizer (for example, not fertilizing right before a rain, sweeping up and disposing of fertilizer spread on hard surfaces, applying the proper amount, finding out what fertilizer is needed by testing soil before application)
  3. Proper septic system maintenance
  4. Installation and maintenance of buffer strips along water bodies and changing mowing practices that will result in increased water quality
- Radio advertising aimed at:
  1. Increasing the awareness of the Grand River Watershed community and the water cycle within in it
  2. Reducing fertilizer use as well as increasing the proper use of fertilizer (for example, not fertilizing right before a rain, sweeping up and disposing of fertilizer spread on hard surfaces, applying the proper amount, finding out what fertilizer is needed by testing soil before application)
  3. Proper septic system maintenance
- Point of contact
  Opportunities exist to further the reach of the campaign by implementing a point of contact campaign. This effort would target audiences at various locales where the above mentioned behaviors are realized. Examples include, a soil testing promotion done in conjunction with Michigan State University Extension (MSUE) and local retailers and supported by print and radio advertising pieces as well as direct mail and watershed/creek crossing signs.
- Website
  The website will be an invaluable method of supporting, reinforcing, and evaluating the marketing campaign. A website should be developed that supports the information delivered through the above approaches. It can also contain a short survey that can be used for evaluation – As the webpage opens, a survey appears that asks how did you hear about this web page – a newspaper ad, a brochure I received in the mail, …?

All material developed should include a contact phone number and web site address for further information.

- Publicity*
  Publicity is press that you don't pay for, but there is a "cost" in terms of your time. Public service announcements (PSAs) and press releases are the main avenues of seeking publicity. (Publicity also comes when a media outlet – newspaper, radio, etc. – covers your activities without your using PSAs or press releases.) You can use PSAs and press releases to further your message. Time these so that they will drop when your paid pieces are in the media. This furthers the reach of your message. In order to successfully get publicity spend some time getting to know the reporters at the papers and the radio station managers. Ask them in what format they prefer to receive information (email is often preferred), and suggest that you can provide photos, maps, and/or photo opportunities (such as notice of one of your events). Developing these relationships up front will save you a lot of time in the future and will help to ensure that your information is given to the public.

4. Services needed

- Professional graphic artist
  An individual or firm will need to be contracted to handle the creation of the materials as required by this campaign. Ideally it will be someone who can both handle the design and the writing or editing of all materials. This person will deal with the production process through delivery of print-ready materials. If this person/firm can only handle graphic design you will need to contract with a copywriter as well.
- Photography
  A professional photographer should be contracted to provide photographs for use in the various advertising and collateral pieces. Fees for one-time use of a photograph will be less than those for blanket use of a photograph. For example, a photographer will charge less to shoot a photograph and have it used in a specific print ad. This same photographer will charge more to have this photograph used in print ads as well as direct mail pieces and/or a newsletter.
- Mail house
  A mail house should be contracted to address, post, and mail the direct mail pieces for this campaign. Considering the quantities of the pieces the campaign will be mailing it really is more cost effective to contract out this service. They will be able to help you take advantage of the lowest postage rate (for example, bulk rate with bar coded labels).
- Web designer and master
  A web designer will need to be contracted to design the web site. A webmaster will also need to be designated (whether that is a staff person or someone with whom you contract) to maintain the web site.
- Additional contractual personnel
  Additional contracting of specific personnel may be required depending on the expertise of the campaign staff. For example, staff may be able to write radio

* from the Huron River Watershed Council

advertising material and then seek feedback on it from radio station managers or this may need to be contracted out to a professional.

5. Evaluation

Evaluation will take place on many levels.

- Pre and post survey re: direct mail
- Tracking responses to phone number listed on pieces
- Tracking hits on web site
- Follow-up on point of contact (e.g., number of people participating in soil test promo)
- Focus groups
- Photo monitoring points along water bodies that have been targeted for buffer installation

6. Budget Allocation

The following budget is for the first year of the campaign. It is anticipated that this campaign will be ongoing and that the while budget may be adjusted from year to year it will be similar to the annual budget below.

Staffing/Benefits	$24,960
(20 hours/week @$20/hr + 20% fringe)	
Contractual	
Copy, Design	$11,000
Photography	$2,500
Web design	$10,000
Evaluation	$10,000
Travel	$300
Print Ad Materials	$500
Mailers/Newsletters	$15,000
Point of Contact	$7,000
Media Buys	$45,000
Other direct (phone, mtgs, etc.)	$3,500
Total	**$129,760**

Detail on budget allocation by item:

Staffing/Benefits
This line item allows for an individual to coordinate the implementation of this marketing campaign. This person's primary responsibilities include media negotiation and placement of ad material; management of the media schedule; coordination of the development of all materials required to implement and evaluate the program; coordination with any program partners such as retail operations and other agencies/groups; and development and maintenance of targeted mailing lists. This staff

person should have significant marketing experience and be familiar with the concept of social marketing.

Contractual
Individuals will need to be contracted to handle the creation of materials as required by the campaign, as well as the implementation of evaluation mechanisms (focus groups, surveys, etc.). It will be imperative that materials are pre-tested with the target audience. The feedback provided will be invaluable to the development of your materials, the effectiveness of the campaign, and the wise use of budget resources. Do not spend money to produce materials that have not been tested at least informally with the target audience!

Travel
This is an allocation for traveling to coordinate the implementation of this marketing strategy.

Print Ad Materials
The development of ad "slicks" or other camera-ready print advertising materials will need to be developed throughout the duration of the campaign and provided to the print publications.

Mailers/Newsletters
Direct mail pieces will be developed and printed for direct mail to targeted households.

Point of Contact
Graphic material and signs may be developed for the point of contact portion of this campaign. For example, in store displays promoting and explaining the soil test offer may be developed for placement in local retail outlets. Signs carrying the marketing campaign logo and creek/river/watershed names may be developed and placed at road crossings so as to increase the awareness of the Upper Grand River Watershed community.

Media Buys
This line item is set aside to pay for the cost of placing print ads and mailing direct mail pieces. If paid radio spots are part of this campaign (as well as radio PSAs) these will come out of this line item as well. The placement cost is expected to be negotiated. For example, you should rarely pay the listed price for an ad placement. Print publications often have nonprofit and government rates, as well as a bulk rate (a discounted price for purchasing a certain amount of space over a designated time). A nonprofit bulk mail account should be set up by the nonprofit administering this campaign. Partners should be developed who participate in paying for media buys. For example, many communities will have to provide stormwater education under their Phase II NPDES permits. These communities can make use of the material developed as part of this campaign and can pay for the mailing of brochures or the placement of ads. The total under this line item is meant to be supplemented through the use of partners.

Other direct
This figure is set aside to cover office expenses necessary to administer this marketing campaign. For example, phone and photocopy costs would fall under this line item.

7. Media Schedule

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Evaluation **In one sense evaluation is ongoing (responses tracked, etc.), but a pre- and post-survey is conducted regarding the effectiveness of the spring marketing campaign.**												
Print Advertising **Ad placement begins end of March and continues through beginning of May to address fertilizer & pesticide issues. In the fall an ad campaign is begun to target septics & watershed awareness.**												
Radio Advertising **Radio PSAs re: fertilizer /pesticides run from the end of March and continue through beginning of May. A September campaign of PSAs target septics & watershed awareness.**												
Direct Mail **Direct mail pieces drop in March and again in May to target fertilizer /pesticide and buffer issues. A fall campaign is begun to target septic systems & watershed awareness.**												
Point of Contact **A soil test promotion is run in March and April. Watershed boundary and river/stream crossing signs are installed in the fall.**												
Publicity **Press releases are sent regarding the soil test promotion and the installation of signs.**												

Appendix A
General market data

Further market research will need to be undertaken to:

- Further focus target audiences
- Determine target audience preferred outlet

This research can be built into the pre- and post-survey re: the effectiveness of the spring marketing strategy.

Population Statistics

From Census 2000

Note: racial or ethnic origin percentages may not always add up to 100% due to the fact that people may have more than one racial or ethnic origin.

Municipality	County	total pop	%female	%male	%white	%african amer	%asian	% hispanic/ latino	%amer indian	avg age	%home owners	#owner occupied units
City of Leslie	Ingham	2,044			96	<1	<1	3.4	<1	32	77	565
Aurelius Twp.	Ingham	3,318			98	<1	<1	3.6	<1	38	93.5	1,056
Bunker-Hill Twp.	Ingham	1,979			96	<1	<1	2	<1	35	91.4	631
Ingham Twp.	Ingham	2,061			96	<1	<1	1.4	<1	37	94	679
Leslie Twp.	Ingham	2,327			96	<1	<1	2	<1	38	88.2	754
Onadaga Twp.	Ingham	2,958			95	<1	<1	3	<1	35	89	884
Stockbridge Twp.	Ingham	3,435			96	<1	<1	1.5	<1	37	81.6	995
Vevay Twp.	Ingham	3,614			96	1	<1	2	<1	38	94.1	1,189
Brookfield Twp.	Eaton	1,429			96.5	<1	<1	2.4	<1	39	90	484
Eaton Twp.	Eaton	4,278			95.2	<1	1	2.6	<1	38	93.5	1,432
Eaton Rapids Twp.	Eaton	3,821			95.3	1	<1	2.5	1	38	91.9	1,220
Hamlin Twp.	Eaton	2,953			96	<1	<1	1.8	<1	37	92.5	967
City of Eaton Rapids	Eaton	5,330			94.4	<1	1	3	<1	32	68.7	1,421

Municipality	County	total pop	%female	%male	%white	%african amer	%asian	% hispanic/ latino	%amer indian	avg age	%home owners	#owner occupied units
Clarene Twp.	Calhoun											
Somerset Twp.	Hillsdale	4,277	49.6	50.4	97.9	0.4	0.2	1.4	0.2	42.2	93.5	1,578
Moscow Twp.	Hillsdale	1,445	51.1	48.9	98.4	0.6	0.3	1	0.1	37	86.6	452
City of Grass Lake	Jackson	1,082	50.6	49.4	98.8	0.3	0.2	0.6	0.4	34.6	70.8	298
City of Jackson	Jackson	36,316	52.3	47.7	73.9	19.7	0.5	4	0.6	31.3	57.6	8,181
City of Parma	Jackson	907	48.8	51.2	96.1	0.6	0.9	1.7	0.9	32.7	75.8	235
Blackman Twp.	Jackson	22,800	36.8	63.2	79.5	17.2	0.4	2.5	0.4	37.7	67.3	4,483
Columbia Twp.	Jackson	7,234	50.5	49.5	97.8	0.1	0.4	1.4	0.3	41.5	85.3	2,470
Grass Lake Twp.	Jackson	4,586	50.9	49.1	99.2	0.5	0.1	1.1	0.3			
Hanover Twp.	Jackson	3,792	49.5	50.5	98	0.3	0.2	0.9	0.2	37.7	90.2	1,240
Henrietta Twp.	Jackson	4,483	49.1	50.9	97.5	0.4	0.1	1.9	0.5	36.1	90	1,453
Leoni Twp.	Jackson	13,459	50.4	49.6	97	0.8	0.3	1.6	0.3	37.7	86.2	4,518
Liberty Twp.	Jackson	2,903	49.2	50.8	98	0.1	0.4	1.1	0.3	40.4	92.7	995
Napoleon Twp.	Jackson	6,962	50	50	96.6	0.9	0.4	1.6	0.3	37.2	84.1	2,180
Norvel Twp.	Jackson	2,922	48.3	51.7	97.3	0.6	0.1	0.7	0.5	41.2	92.7	1,052
Parma Twp.	Jackson	2,696	49.7	50.3	93.6	3.6	0.1	1.9	0.9	37.5	87	820
Rives Twp.	Jackson	4,725	50.7	49.3	97.1	0.2	0.1	1.8	0.6	36.4	93.7	1,571
Sand Stone Twp.	Jackson	3,801	50	50	97.4	0.5	0.4	1	0.4	37.5	87.6	1,157
Spring Arbor Twp.	Jackson	7,577	52.2	47.8	97	0.8	0.5	1.7	0.4	35	80.5	2,070
Springport Twp.	Jackson	2,182	48.5	51.5	97.7	0.3	0.1	1.1	0.5	35.3	79	608
Summit Twp.	Jackson	21,534	52.2	47.8	91.7	4.2	1.5	1.8	0.3	40	80.8	7,018
Tompkins Twp.	Jackson	2,758	50.3	49.7	96.7	0.5	0.1	1.3	0.2	37.2	89.8	885
Waterloo Twp.	Jackson	3,069	47.1	52.9	95.5	2.9	0.1	0.7	0.4	35.9	91.4	990

Appendix B
Media Mix

Community newspapers:

Dailies:

Publication	Ad deadline	Column width/number/pg	Circulation
Albion Recorder 111 West Center Street Albion, MI 49224 517/629-3984 Fax 517/629-5790	Noon day before publication	2-1/16" 6 columns per page	2,000
Jackson Citizen Patriot 214 South Jackson Jackson, MI 49201-2282 517/787-2300 Fax 517/789-1249	8:30am same day, Sunday: 5pm Friday	2-1/16" 6 columns per page	40,920 daily 35,936 Sun
Lansing State Journal 120 East Lenawee Street Lansing, MI 48919 517/377-1000 Fax 517/377-1298	4 days prior	2-1/16" 6 columns per page	70,453 daily 93,295 Sun
Marshall Chronicle 115 South Grand Marshall, MI 49068 616/781-3943 Fax 616/781-4012	2 days prior to publication	2-1/16" 6 columns per page	1,550

Weeklies:

Publication	Ad deadline	Circulation
Blazer News 235 West Prospect Street Jackson, MI 49203 517/788-4600 Fax 517/788-5300	Monday, tabloid paper is published on Wednesday	2,200 mailed
Community News/Town Courier 2111 Haslett Road, Suite C Haslett, MI 48840 517/339-1177 Fax 517/339-6177	5pm Wednesday, tabloid paper is published on Sunday	24,068

The County Press P.O. Box 279, 123 West Main Street Parma, MI 49269 517/531-4542 Fax 517/531-3576	4:30pm Friday, tabloid paper is published on Wednesday	1,500
The Exponent 160 South Main Brooklyn, MI 49230 517/592-2122 Fax 517/592-3241	5pm Friday, tabloid paper is published on Tuesday	6,000
Leslie Local Independent P.O. Box 617 Leslie, MI 49251 517/589-8228 Fax 517/589-8526	5pm Tuesday, tabloid paper is published Thursday	7,500 (includes shopper)
Springport Signal 144 East Main, P.O. Box 157 Springport, MI 49824 517/857-2500 Fax 517/857-2887	Noon Monday, paper published Thursday	1,200
The Town Crier P.O. Box 548 Stockbridge, MI 49285 517/851-7833 Fax 517/851-4641	2pm Thursday, tabloid paper is published Tuesday	9,950 (includes shopper)

Press releases should also be sent to groups with similar target audiences (e.g., lakefront homeowners) and similar missions (e.g., G.R.E.A.T. and Michigan Lakes and Streams).

Direct Mail
To directly reach members of households in the target communities, a direct mail campaign to area homes will enable us to put a specific behavioral message into individual's hands at the optimum point of impact. The mailer could be a more detailed piece or could be a flighted campaign of postcards which impart an awareness and behavioral message. For example, a "It begins here!" postcard series featuring the many ways that homeowners can begin to change behaviors can be sent and then followed with a more detailed piece.

Mailing lists:
Your list may come from a professional mailing list company (such as Burnett Direct in Southfield, Michigan 248/932-7100). Professional mailing list companies can provide you with counts of how many addresses exist in a zip code or a census block tract. This

can help determine how many direct mail pieces to print. Professional mailing list companies can also help you target your mailing list even further. For example, you could request mailing labels for a specific zip code to target homeowners who have lived in the area for more than 15 years. Because the cost of mailing is expensive, targeting mailings to those individual with whom we will have the most impact will be more cost-effective.

Your list may also come from a municipal database. Municipal databases may not be able to accommodate the mailing label format that a mail house requests and so may result in a higher postage rate than would result from a professional list serve mailing list.

Wherever your list comes from the label should say to "Mr. Walter Body or current resident" or "To the homeowner at" so as to prevent returned mail. Under the bulk mail rate, you need to pay for each piece of returned mail.

Local radio:
Radio provides the communication plan with a reinforcement channel; it has the ability to reach a very broad number of people within the target communities and provide additional impact to the message they are receiving through other media. While highly detailed information is not effective through radio, the broadcast media will attract mass awareness to the campaign. Each time you contact a station about a paid piece or a public service announcement (PSA) you should check the information regarding its format and audience as ownership of radio stations change frequently. The information below is from the year 2000 Finder Binder.

Stations

Station	**Frequency**	**Format**
WABJ-AM WQTE-FM 121 West Maumee Street Adrian, MI 49221 517/265-1500 Fax 517/263-4525	1490 AM 95.3 FM	AM – News/Talk Host John Sebastian interviews in-studio and telephone guests from 6-10am Monday – Friday. Live. FM – Contemporary Country Host/producer Joanas Meyers and Tami Wass conduct interviews with a variety of guests at 6:30am Saturday. Taped.
WCRS-AM/FM 170 North West Street Hillsdale, MI 49242 517/437-4444 Fax 517/437-7461 Email wcsr@radiohillsdale.com	1340 AM 92.1FM	Adult Contemporary, Information

WFMK-FM P.O. Box 991 East Lansing, MI 48826 517/394-3999 Fax 517/394-9910 Email wfmk@voyager.net	99.1	Adult contemporary
WGUV 301 West Fulton Street Grand Rapids, MI 49504-6492 800/442-2771 martinof@gvsu.edu	1480 AM & 88.5 FM 850 AM & 95.3 FM	Public Radio
WITL-FM P.O. Box 303084 Lansing, MI 48909 517/393-1010 Fax 517/393-3650 Email witl@acd.com	100.7	Country Scott Miller and Stephanie McCoy conduct interviews and discuss topics of local interest. Monday – Friday 6-10am Live.
WJIM-AM/FM 3420 Pinetree Road Lansing, MI 48911 517/394-7272 Fax 517/394-3391 Email WJIM-AM wjim@voyager.net WJIM-FM oldies975@voyager.net	1240 AM 97.5 FM	AM - ? FM - Oldies

WJKN-AM 1092 Jackson Crossing Jackson, MI 49202 517/784-1510 Fax 517/782-2234	1510	News-Talk Frequent interviews during the day.
WJXQ-FM P.O. Box 26007 Lansing, MI 48909 517/699-0111 Fax 517/699-1880	106.1	Rock and Roll

WKAR-FM/AM 283 Communication Arts Michigan State University East Lansing, MI 48824-1212 517/432-wkar (9529) mail@wkar.org	90.5 FM 870 AM	Public Radio
WKHM-AM/FM 1700 Glenshire Drive Jackson, MI 49201 517/787-9546 Fax 517/787-7517	970 AM 105.3 FM	AM – News-Talk Jackson Today – News and current affairs Monday – Friday from 6-9am Midday Jackson – Host/producer Christine Ferrell discusses news and current affairs Monday – Friday 11am – noon PM Jackson – Host/producer Mike Krompf discusses news and current affairs Monday-Friday 5-6pm FM – Adult Contemporary
WMMQ-FM P.O. Box 30384 Lansing, MI 48910 517/393-1010 Fax 517/394-3391 Email wmmq@voyager.net	94.9	Classic rock "Tim and Deb" conduct interviews with a variety of guests from 6-10am Monday – Friday. Live.
WMUK-FM Western Michigan University 1903 West Michigan Ave Kalamazoo, MI 49008 616/387-5715 psa@wmuk.org	102.1 FM	Public Radio
WMXE-FM P.O. Box 275 Hillsdale, MI 49242 517/437-1025 Fax 517/437-0243	102.5	Adult Contemporary Interviews - Mix of topics Sunday 9am

WUNN-AM WUFN-FM 13799 Donovan Road Albion, MI 49224 517/531-4478 800/776-1020 Fax 517/531-5009 Email wunn@flc.org	1110 AM 96.7 FM	AM/FM – Inspirational FM – Host/producer David Jones discusses community affairs. Saturday. Taped.
WUOM-FM 5000 LSA Building 500 South State Street Ann Arbor, MI 48109-1382 734/764-9210 Michigan.radio@umich.edu	91.7 FM Ann Arbor /Detroit 104.1 FM West MI 91.1 FM Flint	Public Radio
WXIK-FM P.O. Box 26007 Lansing, MI 48909 517/699-0111	94.1	Country

Point of contact:
Materials should be placed in venues which directly correspond to the message being communicated to the audience. For example, once adequate household hazardous waste drop-off facilities are established, to achieve a behavioral change in the way households dispose of hazardous products establish a partnership with local retailers that would allow you to place stickers in their stores that can be placed on household hazardous items that indicate how to dispose of the product when the time comes. These stickers could be available at registers and whenever someone buys a product that should be disposed of at a household hazardous materials drop-off facility the cashier could ask if they would like to take a sticker to place on this product to remind them how to dispose of it. Another example of a point of contact effort is to increase awareness of the watershed in general you may place signs on all tributaries and the watershed boundaries at road crossings. This effort should be paralleled with a publicity effort to inform residents about the new signs and the signs should have a graphic appearance that links them to this campaign.

Television:
While television is not a part of the media mix identified in this campaign (due to financial constraints and the potential effectiveness of the campaign without television) there was a request to include television contact information as a part of this appendix.

Station	**Public Service Anncts**	**Local news**
WILX-TV 10 500 American Road	Prefer typed copy or 1” tape two weeks in	Monday – Friday 5-7am, 5,6, and 11pm

Lansing, MI 48911 517/393-0110 Fax 517/393-8555	advance.	Saturday and Sunday 1/2 hour at 6 and 11pm; 1 hour 7-8am
WLAJ-TV 53 5815 South Pennsylvania Lansing, MI 48911 517/394-5300 Fax 517/887-0077	Send Beta videotapes, 30-60 seconds in length, 2-3 weeks in advance.	6 and 11pm
WSYM-TV 47 600 West Joseph St., Suite 47 Lansing, MI 48933 517/484-7747 Fax 517/484-3144	3 weeks in advance, 1" or ¾" tape or Beta.	10-10:37pm Sunday – Thursday, 10-10:30pm Friday - Saturday

Upper Grand River Watershed Communications Plan:

Outreach Campaign

Goal: To reduce non-point source pollution to the Upper Grand Watershed by seeking to reinforce and/or change target audiences behaviors.

An outreach campaign will be developed with the same goal as the marketing campaign. In all likelihood this campaign will target agricultural producers, businesses, land developers, local decision-makers, and watershed residents.

The education subcommittee of the Upper Grand River Watershed Steering Committee will identify target behaviors and prioritize the list as we did for the marketing campaign. The outreach campaign will seek to open a dialogue with the target audiences and work with them to change and reinforce the identified behaviors. The outreach program may make use of:

- Community talks and a speakers network;
- The adopt-a-stream program developed as part of the Upper Grand River Watershed planning initiative;
- Training and networking sessions;
- Needs assessments;
- Development of household hazardous waste drop-off days; and
- Event attendance.

Evaluation and assessment will be a critical component for the continual improvement of this program. The outreach strategy will need to include elements that examine the impact the campaign is having on behavior change and track the physical resources used to achieve the goal. It will be important to track information regarding activities; participation; reaction; the change in knowledge, skills, attitudes, and aspiration of the target audience; and the change in behaviors.

APPENDIX G

Outline for an “Adopt-A-Stream” Volunteer Monitoring Program

Upper Grand River Watershed Initiative

Organizational Information

The Upper Grand River Watershed Initiative (UGRWI) will need a formal organizational structure to ensure long-term viability of the water-quality monitoring program. A watershed coordinator and/or a resource coordinator will be required for successful implementation. The Dahlem Center is prepared to work with other stakeholders to facilitate successful implementation of the watershed plan as well as taking major roles in the information and education strategy and the water-quality monitoring program. A key issue will be funding sources for implementation. An accepted watershed plan can facilitate Section 319 funding, but other funding also will be required. The organizational structure for the Upper Grand would likely work best as a non-profit organization or in conjunction with a local institution.

Two positions are anticipated during the early stages of implementation of the Watershed Management Plan (WMP). The first is the watershed manager/coordinator; the second is a resource manager/coordinator. The watershed coordinator (WC) would be responsible for implementing the management plan, and maintaining the Geobook. This coordinator would identify the impaired and threatened uses and develop the means to correct any problems.

Additional responsibilities for the WC would be for implementation of best management practices - responding to public inquiries, presentations, interacting with local government officials (drain commissioner, township trustees etc.), and grant writing. The WC also should be well versed in land use planning. A full description of this position is being developed separately in another part of the WMP.

The resource coordinator (RC) would be responsible for implementing the Adopt-A-Stream volunteer monitoring program. This would involve training in stream sampling (data collection), macro invertebrate identification, visual stream monitoring, web site updates, chemical monitoring and the development of a riparian network. Lakes also would be included in the sampling as the program grows. The RC also would coordinate the overall I & E strategy. This includes a fair amount of marketing support, development of brochures and other media components. The education side would include teaching courses, and developing workshops.

The initial position would likely include many elements of both of these positions, but would be split later as the programs and funding grow. Current estimates of wages, benefits, taxes, support and travel for the watershed coordinator range from $75,000 to $100,000 annually. Costs associated with the resource coordinator position would be near the same level ($65,000 to 90,000).

Mission and Vision

> The **Dahlem Environmental Educational Center** is an organization whose mission is to help educate our community toward maintaining a balanced approach to resource and environmental stewardship. It is a resource center for improving our environment through science, education, leadership and conservation and a place where members of our community can experience, study and enjoy nature.

The Dahlem Center is an auxiliary operation of Jackson Community College. The College and Center community focus is in Jackson, Hillsdale and Lenawee Counties, but also includes portions of Calhoun and Ingham Counties. Consequently, the Upper Grand River Watershed is largely within the Community College area of service.

The Dahlem Center, as an auxiliary operation of the College, functions like a non-profit organization. We are responsible for developing funding for our operations, but receive administrative support from the college. The Dahlem Center also is connected to two non-profits organizations, The Jackson Community College Foundation and the Friends of Dahlem, both 501©(3)'s.

The Grand River is one of the largest river basins in Michigan and the Upper Grand River area covers most of Jackson County and parts of Hillsdale and Ingham counties. This basin receives un-permitted pollution discharges on a regular basis. The quality of its headwaters, primarily located in Jackson County, has been improving in recent years. For example, since year 2000 the City of Jackson has eliminated sewer overflows by correcting all combined sewers. The continued improvement of water quality in the upper Grand River will benefit the entire length of the Grand River watershed and will impact significantly on surface water quality in Michigan. However, Jackson County also is an area of growth in Michigan. Portions of the county are undergoing significant development and major sewer projects are underway. There is a need for an organization that can react to the community needs, provide education and resources on watershed and water-quality issues, and enhance community involvement in maintaining the ecological integrity of the area. One example is communicating the need for and reasoning behind the southwestern regional sewer extension project. Develop will soon follow sewer and other infrastructure improvements and that development will impact on the water-quality of the area.

The Upper Grand River Watershed Management plan is to become part of the countywide development plan and issues of land use and water quality are becoming hot button items. How citizens deal with these issues will play a key role in determining the type, placement, desirability and limits to development. All of these issues and many others, reflect the "Quality of Life" we desire for our community.

The Volunteer Water Quality Monitoring Program

Goals

- Increase public awareness of the watershed's non-point source pollution and water quality issues
- Provide citizens with the tools and training to evaluate and protect their local waterways
- Encourage partnerships between citizens and their local government
- Collect quality baseline water quality data.

The data collected from the Volunteer Monitoring Water Quality Project will be part of a comprehensive upper Grand River monitoring effort which involves a collaboration between the County Drain Commissioner, Grand River Environmental Action Team (GREAT), Dahlem Environmental Education Center, Jackson Community College, Jackson County Health Department, City of Jackson sewage treatment plant, Grand River Watershed Management Steering Committee, Jackson County Conservation District and MSU Extension – Jackson County, numerous townships, lake and stream associations and other interested parties. This particular component will help identify seasonal and/or year-round pollution problems within the watershed and with its arbitration. Also the activities associated with the Water Quality Monitoring program are directly related to the information and education strategy for the UGRWI and results of the monitoring program will be distributed throughout the community in a variety of media forms.

Sampling Area

A total of 20 locations within the Grand River watershed have been identified as potential sampling areas. Initially, eight locations will be sampled twice per year for benthic macroinvertebrates. Additional sampling sites will be added as the program grows. This will depend on the recruitment of volunteers to participate in the water quality program and the establishment of an Adopt-A-Stream Program. (These sampling sites also correspond to those currently in use by the Environmental Health Department relating to bacteriological sampling).

Initial Water bodies to be monitored:

1.	Grand River @ the Mill Pond	3 locations
2.	Crouch/Sharp Confluence	3 locations
3.	Sharp/Grand Confluence	3 locations
4.	Michigan Center Confluence	3 locations
5.	Portage Confluence	3 locations
6.	Sandstone Confluence	3 locations
7.	Springbrook Confluence	3 locations
8.	Rives Drain Confluence	3 locations

Secondary water bodies (to be added in later years as the program grows)

9.	Batese/Portage Confluence	3 locations
10.	Portage Lakes	3 locations
11.	Portage/Wild Inter-County Drain	3 locations
12.	Upstream of Little and Big Portage	
13.	Between Little and Big Portage Lakes	

Additional areas for possible samples

14.	Summerset/Lake LeAnn	3 locations
15.	Mirror Lake	3 locations
16.	Above Michigan Center Lake	
17.	Wildwood Drain	
18.	Orchard Creek	
19.	Cahaogan Creek	
20.	Pickett & Jacobs Drain	

If pollution or other water quality problems are found, further investigation will be carried out to determine the source of the problem and take appropriate enforcement or educational action (such as teaching use of Generally Accepted Agricultural Practices or Best Management Practices). Because of the comprehensive team of collaborators various strategies for enforcement and education can be crafted to help insure resolution of identified problems. Spot-checking of targeted areas also is anticipated. `

Project Objectives

Objective *1* -

- Evaluate the benthic invertebrate communities in wadable streams and rivers, to assess ecosystem health, to inventory species and their distribution.
    1. Identify and inventory the proposed sampling sites listed above.
    2. Test samples twice a year.
    3. Identify potential indicators species for pollution.
    4. Map distribution of species.

Objective 2 -

- Improve water quality in the Upper Grand River and the entire watershed by eliminating sources of pollution.
    1. Identify water-sampling points with surface water confluences with the Upper Grand River, up to the Red Cedar River in Ingham County.
    2. At each confluence collect water samples at 1-3 sites near the confluence.
    3. At each site test for:
        - Dissolved Oxygen

- Fecal Coliform (to be conducted by Environmental Health Dept)
- Ph
- Biochemical Oxygen Demand (BOD's)
- Temperature
- Total Phosphorus
- Nitrates
- Turbidity
- Total Solids

Objective 3 – Develop a Citizen Riparian Network

- Provide hands-on real life options for citizen action
- Provide activities to make a difference in the health of the adopted stream, river, lake or wetland.

Adopt-A-Stream

The Adopt-A-Stream program will be an adult volunteer program that is to be guided and continually developed by a volunteer advisory board and coordinated by the Initiative (or Dahlem Center) staff. Volunteers will be recruited to participate in and help develop the Adopt-A-Stream Program. During the year volunteers, with assistance and training from the project coordinator, will conduct water quality tests. The activities are intended to become a major study of the Upper Grand River and its tributaries.

The project coordinator will develop a variety of coursework, workshops, and seminars to train potential volunteer staff. Training will discuss topics such as "Getting to Know Your Watershed" and "Visual Stream Monitoring". Additional hands-on work will include training in sampling for and identification of benthic macroinvertebrates. Initial data collection will focus on benthic macroinvertebrates with the sampling program growing to include collection and testing of water samples for chemical analysis. Once trained, the initial volunteers will become team leaders for conducting the water quality sampling and testing. The important component is to have reliable, quality data and to develop the database necessary to monitor and assess the quality of the river.

Team of 2-6 people will conduct activities. Additional sites will be added to the program as volunteer involvement increases and wherever necessary. For example, we may identify a pollution source and desire to pinpoint the location.

Several educational/training activities already have been developed and will be rolled out beginning in January 2003. A new Jackson Community College course, Environmental Science 142, will be offered at the Dahlem Center beginning in January and a watershed management short course is planned for March 2003 and will be held on the campus of

Albion College. A workshop on sampling and identification of benthic macroinvertebrates is being planned for April/May 2003.

Local residents also will be offered a workshop in the collection and identification of benthic macroinvertebrates. We will encourage potential volunteers to participate in one or more of the training programs. Likewise, we will recruit workshop participants to become active volunteer in the Adopt-A-Stream program.

Data collected from sampling conducted by staff members and volunteers will be collated in a database. A report form will be developed that includes presentation and analysis of the data. The data collection techniques and reports will be compatible with other state and local stream organizations and the State DEQ. Reports will be made available over the Internet. (The I & E committee will establish a web site for the ”Initiative” as soon the organizational structure is clarified and work proceeds with implementation.

DEQ

Michigan Department of Environmental Quality
Surface Water Quality Division (SWQD)

Volunteer Monitoring Grant Application Cover Sheet

(Authorized by 1994 P.A. 451)

Project Name: Upper Grand River Volunteer Monitoring Project

Project Location (Primary County): Jackson

Watershed Impacted by Project: Grand River

Organization Name: Dahlem Nature Center / Jackson Community College

Organization FAX #: 517-782-3441 Organization Phone: 517-782-3453

Contact Person: Dan Ashton (Name), Executive Director, Dahlem Nature Center (Title)

Contact Person's E-Mail (if available): Dan_Ashton@JCCMI.edu

Organization Address: (Street name and #) 7117 S. Jackson Road

(City, zip code) Jackson, MI 49201

Duration of Project: Years: 2 Months: _____ Preferred start date: September 2003 (Month/year)

Grant Amount Requested: $ 11,992.85 + Local Match: $ 7,455.80 = Project Total: $ 19,448.65

Person w/Grant Acceptance Authority: Dan Ashton (Name) Executive Director (Title)

Signature: _____

Statement of Volunteer Monitoring Water Quality Concerns and Issues

The Grand River is the second largest river basin in Michigan. This basin receives unpermitted pollution discharges on a regular basis. The quality of its headwaters, primarily located in Jackson County, has been continuously improved in recent years. For example, since year 2000 the City of Jackson has eliminated sewer overflows by correcting all combined sewers.

The continued improvement of water quality in the upper Grand River will benefit the entire length of the Grand River watershed and will impact significantly on surface water quality in Michigan.

It is important to note that this Volunteer Quality Monitoring application is coordinated with the existing DEQ grant funded programs and activities of the Upper Grand River Watershed Management project and a separate application for a Local Water Quality Monitoring grant.

The data collected from this Volunteer Monitoring Water Quality Project will be part of a comprehensive upper Grand River monitoring effort which involves a collaboration between the County Drain Commissioner, Grand River Environmental Action Team (GREAT), Dahlem Nature Center, Jackson Community College, Jackson County Health Department, City of Jackson sewage treatment plant, Grand River Watershed Management Steering Committee, Jackson County Conservation District and MSU Extension – Jackson County.

This particular component will help identify seasonal and/or year-round pollution problems within the watershed and with its arbitration. A total of 9 confluences with the Grand River have been identified for sampling. Eleven other locations have been identified for random investigation-time permitting.

Water bodies to be monitored:

1. Sharp/Grand Confluence	3 locations (up river, down river, etc.)
2. Michigan Center Confluence	3 locations
3. Portage Confluence	3 locations
4. Sandstone Confluence	3 locations
5. Springbrook Confluence	3 locations
6. Rives Drain Confluence	3 locations
7. Portage/Wild Inter-County Drain	3 locations
8. Batese/Portage Confluence	3 locations
9. Sharp/Crouch Confluence	3 locations

Additional sampling sites/time permitting

10. Portage Lakes
11. Summerset/Lake LeAnn
12. Red Cedar Confluence
13. Mirror Lake
14. Above Michigan Center Lake
15. Between Little and Big Portage Lakes
16. Upstream of Little and Big Portage Lakes
17. Wildwood Drain
18. Orchard Creek
19. Cahaogan Creek
20. Pickett & Jacobs Drain

If pollution or other water quality problems are found, further investigation will be carried out to determine the source of the problem and take appropriate enforcement or educational action (such as teaching use of Generally Accepted Agricultural Practices). Because of the comprehensive team of collaborators various strategies for enforcement and education can be crafted to help insure resolution of identified problems.

Project Goals and Objectives

Goal 1 –

Evaluate the benthic and invertebrate communities in wadable streams and rivers, to assess ecosystem health, to inventory species and their distribution.

a. Identify and inventory 9 principal sites.
b. Test samples at least twice a year.
c. Identify potential indicators species for pollution.
d. Map distribution of species.
e. Inventory amphibian species, as appropriate, as indicators of water quality.

Goal 2 –

Improve water quality in the Upper Grand River and the entire watershed by eliminating sources of pollution.

a. Identify 9 primary water-sampling points with surface water confluences with the Upper Grand River, up to the Red Cedar River in Ingham County.
b. At each confluence collect water samples 1-3 sites near the confluence.
c. At each site test for:
   ~ temperature
   ~ phosphates
   ~ Ph
   ~ dissolved oxygen
   ~ nitrates
   ~ nitrites
   ~ turbidity

The coordinator intern will have primary responsibility to assure the samples are collected according to acceptable protocol. Volunteers will be recruited and trained in the methods for sampling and recording data. Volunteers will sample the supplemental test sites, with assistance and training from the project coordinator.

Goal 3 –

Development of a Quality Assurance Project Plan

a. Based on guidelines offered by the DEQ the plan will be developed and implemented to assure the quality of data collected by volunteers and staff.
b. Provide protocols for sampling techniques and development of the volunteer training manual.

Organizational Information

Mission

The **Dahlem Environmental Educational Center** is an organization whose mission is to help educate our community toward maintaining a balanced approach to resource and environmental stewardship. It is a resource center for improving our environment through science, education, leadership and conservation and a place where members of our community can experience, study and enjoy nature.

Relevant Programs

Dahlem Center sponsors an annual **Groundwater Fest**, in cooperation with the Jackson I.S.D. for 1,800 5th graders in Jackson County. The students do hands-on activities in water quality, and water organisms, and pollution. The Dahlem Center also provides a school program for 4-6 graders titled "Our World of Water". The Center also provides leadership for the information and education committee of the Upper Grand River Watershed Council and is working to develop educational school programs for the 8th and 10th grades. Additional programming at the Center includes a recent "Pond" workshop, sponsored by the Jackson County Conservation District. The Center also provides a wide variety of other environmental education programs and workshops on a year-round basis.

Project Sustainability

After the first year of the project, volunteers will continue collecting water samples, and carry out on-site tests. Additional lab testing will be arranged for as in-kind contributions. Any bacteriological testing will be conducted through the Jackson Co. Environmental Health Department. The Watershed Management Steering Committee has approved formation of The Upper Grand River Watershed Council. The specific details of the Council structure and its enforcement capabilities are ongoing. The Dahlem Center also is organizing a coalition of partners to work on environmentally related projects; the Watershed Council is expected to be part of this coalition.

The collaborative partners in this project will continue to meet on a regular basis under the leadership of the Drain Commission while the Information and Education committee will meet regularly under the leadership of the Dahlem Center. Volunteer recruitment and training for water sampling is projected to continue for at least 10 years under Dahlem Center leadership.

Organization Information

Dahlem Center is a part of Jackson Community College and operates a 280+-acre nature preserve and environmental education center in Jackson County. Over 20,000 visitors attend programs, events and activities at the center each year. The Center sponsors a variety of environmentally related workshops, programs and special events throughout the year, including the annual Bluebird Festival. The Center also provides stewardship for other lands within the county. The evolving Dahlem Center Coalition includes organizations such as G.R.E.A.T (Grand River Environmental Action Team), Recycle Jackson, Jackson Co. Conservation District and Jackson Audubon Society to name a few. The Center also has teamed with the U.S. Fish and Wildlife Service in the "Partners for Wildlife Program".

Partners

Name	***Role***
Jackson County Drain Commission GREAT	Enforcement, planning, permitting, convene meeting, collecting samples, recruiting volunteers, planning team, inspection of specific sites
Jackson County Conservation District	Volunteer recruitment and training, collecting samples, inspection of specific sites
MSU Extension – Jackson County	Education on GAAMPs and BMPs to riparian landowners and Ag producers
Jackson County Conservation District	Educate monitoring and enforcement of BMPs and GAAMPs for riparian land owners
Jackson County Health Department	Enforcement, monitoring, permitting, water quality testing.
City of Jackson Water Treatment Plant	Technical assistance, planning, water quality testing
Dahlem Center	Project coordination and management, volunteer recruitment and training, data collection and data base management

Other Relevant Grants

Grand River Watershed Management Phase II (I.& E)
Knight Family Foundation mini-grant for equipment purchase

Evaluation

Outcome Evaluation

1. The actual changes in water quality, a quarterly basis, will be charted, based on the sampling results.
2. The number of sites and locations, which are remediated, to reduce or eliminate water pollution will be documented, as well as the quantity of remediation.

Process Evaluation

The specific deliverables detailed in the project plan will be monitored and documented including record of initiation and completion of each activity, documentation record for each activity, such as completed volunteer manuals and worksheets, training sessions, number of samples properly recorded and charting of testing results.

Project Timeline

Start Date	End Date	Activity
Sep 15, 2003	Nov 15, 2003	Develop coordinator job description and post position availability
	April 15, 2004	Hire coordinator/Intern
Oct 15, 2003	June 1, 2004	Develop volunteer job description and post will JCC Science Department, Jackson County Nonprofit Resource Center and MSU Extension newspaper
May 1, 2004	Sep 30, 2004	Train volunteers and assign schedules for taking samples
Apr 20, 2004	May 1, 2004	Coordinator starts taking samples
May 15, 2004	May 31, 2004	Volunteers start taking samples
June 15, 2004	July 15, 2004	Sample results recorded (GIS format, if possible)
Sept 15, 2003	Jan 31, 2004	Develop QAPP
	Sep 30, 2003	First quarterly report submitted (other quarterly reports submitted 12/31/03, 3/31/05 and 6/30/05)
August 1, 2004	Sep 1, 2004	Recruit additional volunteers as required
September 1, 2004	Sep 30, 2004	Volunteer training for new volunteers
Aug 1, 2004	Sep 30, 2005	Begin process of identifying pollution sources, based on outcomes of testing
June 1, 2004	May 31, 2005	Enter data from collected samples
July 1, 2004	December 31, 2004	Analysis of samples for invertebrates complete electronic and printed formats to show results of water quality findings over time for each sampling site
August 1, 2004	May 31, 2005	Begin process of identifying erosion source based on outcomes of testing
February 1, 2004	Aug 31, 2005	Develop volunteer management manual with volunteer recruitment plan, volunteer job description, review, evaluation tools for volunteer training, etc.
	Sep 30, 2005	**Final report submitted**

Budget Detail

1. **Volunteer Time**
   162 hours to collect 3 samples at 9 sites
   198 hours training time
   36 hours summary discussion/future planning
   396 total volunteer hours

A training workshop will be offered to potential volunteers during May 2004. The current plan includes a morning lecture followed by field training. The training will take place at the Dahlem Environmental Education Center. Initially, at least 18 volunteers are anticipated to begin the stream-monitoring program. Volunteers will be assigned streams to sample at that time. A follow-up training program will be held for volunteers prior to the fall collection. A final summary and review sessions is currently planned for November 2004. The nine primary confluences will be surveyed at least once in the spring and once in the fall. A second sampling of these nine areas will be considered pending volunteer support, but is not included in volunteer time calculations.

Volunteers also will be encouraged to participate in collecting samples at the other locations listed above. However, the coordinator will be responsible for these collections regardless of volunteer support, and additional volunteer time is not included in the current match calculation. The volunteer hours listed above represent a base for support, while the actual total number of volunteer hours during the grant period will provide a measure of community acceptance/support for this project.

2. **Mileage**
   a. 150 miles travel to 9 sites once per month (six months) at $.365/mile for volunteers = 900 = **$328.50**
   b. 250 miles travel to 20 sites once per month at $.365/mile for project coordinator = 1500 = **$547.00**
   c. Other travel for project staff 150 miles/week x 3 weeks at $.365 = **$164.25**

The College reimbursement rate for mileage is $.365/mile with $.305/mile from grant and $.06/mile from Dahlem Center budget or other potential grant funds
.

3. **Staffing**

Major Tasks

1.	Program/Workshop development	= 7.5
2.	Training/Volunteer manual	= 31.4
3.	Data Collection/record keeping/	= 46.0
4.	Report processing and quality assurance	= 15.1
5.	Total	=100.0

The Dahlem Center staff time will devote time as indicated for training and report processing. Costs for the director and staff time will be incurred from the Dahlem Center budget (Jackson Community College).

4. **Indirect Costs =** Utilities (Electric, phone, heat), supplies, materials, computer support, & facilities maintenance.

Michigan Department of Environmental Quality
Surface Water Quality Division

GRANT APPLICATION BUDGET INFORMATION
(Authorized by 1994 P.A. 451)
(Completion of this form is required in order to receive grant consideration)

Applicant's Name Dahlem Nature Center / Jackson Community College

Project Name Upper Grand River Volunteer Monitoring Project

BUDGET CATEGORIES	GRANT FUNDS	LOCAL MATCH	CATEGORY TOTAL
STAFFING COST: (# hours x rate of pay)			
Project Coordinator 40 hrs/wk x $ 7.50 X26 weeks	$7,800.00		$7800.00
Executive Director 60 hrs x $50.00		$ 3,000.00	3,000.00
Secretary 4 hrs x #20.00		80.00	80.00
Staffing Cost Subtotal	7,800.00	3,080.00	10,880.00
FRINGE BENEFITS: 20%	1,560.00		1,560.00
Fringe Benefits Subtotal:	1,560.00		1,560.00
CONTRACTUAL SERVICES:			
Volunteer Monitors 396 hrs @ $10.00/hr	0.00	3,960.00	3960.00
Contractual Services Subtotal:	0.00	3,960.00	3,960.00
PROJECT SUPPLIES AND EQUIPMENT Project Supplies and Materials (itemize)			
Hach Kit and chemicals for water testing	500.00	0.00	500.00
Other equipment (GPS, Misc.)?	0.00		
Project Equipment (itemize): (Over $1000 remains property of the State of Michigan			
Project Supplies and Equipment Subtotal:	500.00	0.00	500.00
TRAVEL:			
450miles x $.305 for staff	137.25		137.25
900 miles x $.305 for volunteers	274.50		274.50
1500 miles x $.305 for coordinator	457.50		457.50
Travel Subtotal:	869.25		869,25
PROJECT SUBTOTAL	$10,729.25	$7,040.00	17,769.25
INDIRECT COSTS (Rate ___13.5_____%)	1, 263.60	$415.80	1,679.40
GRAND TOTAL (add subtotals)	$11,992.85	$7,455.80	$19,448.65

SOURCES OF MATCH:
Dahlem Environmental Education Center /
Jackson Community College

DOLLAR VALUE COMMITTED:
$7,455.80

SOURCE OF O & M
Indirect = Utilities (Electric, phone, heat), supplies, materials, computer support, & facilities maintenance

APPENDIX H

Michigan Department of Environmental Quality Reports on Total Maximum Daily Load for Dissolved Oxygen, Biota, and *Esherichia coli* for the Grand River Jackson County

Michigan Department of Environmental Quality

Water Division

June 2003

Total Maximum Daily Load for Dissolved Oxygen for the Grand River

Jackson County

INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources (NPS) to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the sources of dissolved oxygen (DO) standard nonattainment in the Grand, north branch Grand, and Portage Rivers near Jackson (Figure 1), and to quantify reductions in these sources necessary for attainment of the standard. The Grand, north branch Grand, and Portage Rivers near Jackson are designated as warmwater streams with a DO standard of 5 milligrams per liter (mg/l) as a minimum.

All Grand, north branch Grand, and Portage River DO TMDL reaches are located in Jackson County and are highlighted in Figure 1. Table 1 defines the extent of each TMDL reach and lists their respective lengths. Note that the reach start locations are downstream on the reaches, while the end locations are upstream. A total of 41.4 river miles are addressed by this TMDL. Approximately 16 river miles located within the city of Jackson are included in the 33.7 miles of the Grand River TMDL reach.

TABLE 1

Grand, north branch Grand, and Portage River DO TMDL reaches

River	Reach Start	Reach End	Distance (mi.)
Grand River	Tompkins Road (T1S, R2W, Section 15)	Brown Lake Road (T3S, R1W, Section 22)	33.7
N. Br. Grand River	Grand River confluence (T3S, R1E, Section 7)	Hoyer Road (T3S, R1E, Section 8)	2.6
Portage River	Grand River confluence (T2S, R1W, Section 11)	Wooster Road (T2S, R1E, Section 3)	5.1

The Grand River has a drainage area of approximately 185 square miles at the Jackson Wastewater Treatment Plant (WWTP) point of discharge (Figure 1). Summer season 50 and 95% exceedance flows (cubic feet per second [cfs]) for the Grand River at this location are 47 and 23 cfs, respectively. The north branch Grand River joins the Grand River in Section 7, T3S, R1E, of Jackson County. Summer season 50 and 95% exceedance low flows at the outlet of Center Lake are 1.7 and 0.4 cfs, respectively. The Portage River joins the Grand River in

Section 11, T2S, R1W of Jackson County, and has summer 50 and 95% exceedance low flows of 39 and 12 cfs, respectively, at M106. Grand River low flows were computed from a United States Geological Survey (USGS) Grand River flow gage (04109000) located on the property of the Jackson WWTP. North branch Grand River low flows were calculated using that gage and additional flow measurements in the north branch Grand River at the outlet of Center Lake. Portage River low flows were computed using the Grand River at Jackson gage, and additional USGS gages on the Portage River near Munith (04109500), Orchard Creek at Munith (04110000), and the Grand River at Eaton Rapids (04111000).

PROBLEM STATEMENT

The Grand and Portage River TMDL reaches appear on the 2002 Section 303(d) list as:

GRAND RIVER AND PORTAGE RIVER WBID# **082816H**
County: JACKSON HUC: 4050004 Size: 25 M
Location: Grand River from Tompkins Road upstream to the city of Jackson
and Portage River from the Grand River confluence upstream to Wooster Road.
Problem: **Untreated sewage discharge, pathogens (Rule 100); WQS exceedances for DO; Macroinvertebrate and fish communities rated poor.**
TMDL YEAR(s): 2003 RF3RchID: 4050004

This TMDL addresses only the DO standard nonattainment in the Grand and Portage Rivers near Jackson. Other TMDLs addressing the biota and pathogen concerns have been developed by the Michigan Department of Environmental Quality (MDEQ) (Alexander, 2003 and Wuycheck, 2003).

A number of water quality surveys conducted in the Grand River near Jackson have revealed significant and continuing DO standard nonattainment in reaches below the city. Intensive surveys conducted in the summers of 1962 (Water Resources Commission, 1963) and 1977 (no report published) determined that approximately ten miles of the Grand River downstream of Jackson had severely depressed levels of DO.

Continuous DO monitoring conducted at Lansing Avenue (Station 15 in Figure 1) in 1988 (Argiroff, 1999) and in 1991 (Argiroff, 1995) documented periods of standard nonattainment in dry weather. Severe DO depressions during wet weather events were also documented. From wet weather chemistry sampling conducted on the Portage River and on the Grand River upstream of the confluence with the Portage River in 1991, it was concluded that the city of Jackson Combined Sewer Overflows (CSOs) were the likely cause of the DO depressions in the Grand River and not pollutant inputs from the Portage River. The last of these Jackson CSOs was eliminated in 2000.

Continuous and instantaneous measurement of DO was conducted in the Grand, north branch Grand, and Portage Rivers in the summers of 2001 and 2002. Full details of this work are contained in Sunday (2002) and Limno-Tech (2003). The monitoring showed that periods of dry weather nonattainment and significant wet weather DO depressions continue to occur in each river in the vicinity of Jackson despite the removal of CSOs.

The 2001 and 2002 monitoring revealed there are additional reaches on the Grand and north branch Grand Rivers near Jackson, which are appropriate for inclusion in this TMDL due to DO standard nonattainment. The Grand River DO TMDL reach should be extended from Tompkins Road (Station 19) upstream through the city of Jackson to Brown Lake Road (Station 2). The north branch Grand River should be included from its confluence with the Grand River upstream to the Center Lake outlet (Station 20). Most instances of DO standard nonattainment in these reaches occurred in the early morning.

NUMERIC TARGETS

Rule 100 of the WQS Part 4 Rules requires that the TMDL reaches are to be protected for warmwater fish, other indigenous aquatic life and wildlife, agriculture, navigation, industrial water supply, public water supply at the point of intake, partial body contact recreation, and total body contact recreation from May 1 to October 31. The impaired designated use for the Grand, north branch Grand, and Portage Rivers addressed by this TMDL is the warmwater fish and other indigenous aquatic life and wildlife use. The DO standard was developed to provide protection of these designated uses. Attainment of the warmwater DO standard of 5 mg/l as a daily minimum will be the target of this TMDL. The DO WQS is defined by Part 4 WQS Rule 64:

> R 323.1064 Dissolved oxygen in Great Lakes, connecting waters, and inland streams.
> Rule 64. (1) A minimum of 7 milligrams per liter of dissolved oxygen in all Great Lakes and connecting waterways shall be maintained, and, except for inland lakes as prescribed in R 323.1065, a minimum of 7 milligrams per liter of dissolved oxygen shall be maintained at all times in all inland waters designated by these rules to be protected for Coldwater fish. In all other waters, except for inland lakes as prescribed by R 323.1065, a minimum of 5 milligrams per liter of dissolved oxygen shall be maintained. These standards do not apply for a limited warmwater fishery use subcategory or limited Coldwater fishery use subcategory established pursuant to R 323.1100(10) or during those periods when the standards specified in subrule (2) of this rule apply.
>
> (2) Waters of the state which do not meet the standards set forth in subrule (1) of this rule shall be upgraded to meet those standards. For existing point source discharges to these waters, the Director of the Department may issue permits pursuant to R 323.2145 which establish schedules to achieve the standards set forth in subrule (1) of this rule. If existing point source dischargers demonstrate to the Director of the Department that the dissolved oxygen standards specified in subrule (1) of this rule are not attainable through further feasible and prudent reductions in their discharges or that the diurnal variation between the daily average and daily minimum dissolved oxygen concentrations in those waters exceeds 1 milligram per liter, further reductions in oxygen-consuming substances from such discharges will not be required, except as necessary to meet the interim standards specified in this subrule, until comprehensive plans to upgrade these waters to the standards specified in subrule (1) of this rule have been approved by the Director of the Department and orders, permits, or other actions necessary to implement the approved plans have been issued by the Director of the Department. In the interim, all of the following standards apply:
>
> …(b) For waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(4), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified-in this subdivision.
>
> …(3) The Director of the Department may cause a comprehensive plan to be prepared to upgrade waters to the standards specified in subrule (1) of this rule taking into consideration all factors affecting dissolved oxygen in these waters and the cost effectiveness of control measures to upgrade these waters and, after notice and hearing, approve the plan. After notice and hearing, the Director of the Department may amend a comprehensive plan for cause. In undertaking the comprehensive planning effort the Director of the Department shall provide for and encourage participation by interested and impacted persons in the affected area. Persons directly or indirectly discharging substances which contribute towards these waters not meeting the standards specified in subrule (1) of this rule may be

required after notice and order to provide necessary information to assist in the development or amendment of the comprehensive plan. Upon notice and order, permit, or other action of the Director of the Department, persons directly or indirectly discharging substances which contribute toward these waters not meeting the standards specified in subrule (1) of this rule shall take the necessary actions consistent with the approved comprehensive plan to control these discharges to upgrade these waters to the standards specified in subrule (1) of this rule.

This TMDL will be considered the Comprehensive Plan for this water body referred to in Rule 64(3).

SOURCE ASSESSMENT

Potential sources of DO demanding pollutants, such as carbonaceous biochemical oxygen demand (CBOD), ammonia nitrogen, sediments, and nutrients include point and NPS. CBOD and ammonia can be oxidized in the water column, depleting levels of DO. Decay of deposited organic sediments can also negatively affect in-stream DO concentrations. This is known as sediment oxygen demand (SOD). Nutrients such as phosphorus and nitrogen, can stimulate plant growths, which in turn can reduce DO levels through respiration.

There are 11 individual National Pollutant Discharge Elimination System (NPDES) permitted discharges and 11 general permitted discharges to the Grand and Portage River Watersheds in the vicinity of Jackson. There are also 90 industrial storm water permitted facilities and 40 notices of coverage for construction sites. See Appendix A, Tables A.1 – A.4 for a listing of all NPDES permittees. Figure 2 indicates the location of individual, general, and storm water discharges. Of these facilities, seven are known to be relatively significant point sources of conventional pollutants in the study reaches. Three are individually permitted, continuously discharging municipal WWTPs, while the remaining four are seasonal municipal Wastewater Sewage Lagoons (WWSLs) covered under the WWSL general permit (MIG5800000).

The Jackson WWTP (MI0023256), with a design flow of 19 million gallons per day (MGD), is permitted to discharge treated municipal wastewaters to the Grand River in Section 22, T2S, R1W of Jackson County. The facility's NPDES permit requires advanced waste treatment (AWT) in the summer season. See Table B.1 of Appendix B for Jackson WWTP's NPDES permit effluent limits. This facility's summer season effluent is of a very good quality. Reported summer and fall season effluent five-day $CBOD_5$ and ammonia nitrogen levels are consistently at or below levels that the Water Division's (WD's) Surface Water Quality Assessment Section (SWQAS) typically assumes to be present in unpolluted natural streams.

The Leoni Township (Twp) WWTP (MI0045942), with a design flow of 2.6 MGD, discharges treated municipal wastewater to the Grand River via the north branch Grand River. The discharge to the north branch Grand River is located in Section 8, T3S, R1E of Jackson County, below the Center Lake spillway (Figure 1). The facility's NPDES permit requires AWT from May through November. See Table B.2 of Appendix B for Leoni Twp WWTP's NPDES permit effluent limits. Facility discharge monitoring reports (DMRs) indicate that since October 2000, the Leoni Twp WWTP has discharged only during the months of September 2001 and August 2002. During this time, the facility was undergoing conversion from a seasonally discharging WWSL to a continuously discharging mechanical WWTP.

The Leslie WWTP (MI0020796) is permitted to discharge treated municipal wastewater to the Grand River via Huntoon Creek in Section 28, T1N, R1W of Ingham County. The design flow is 0.47 MGD, and this facility's NPDES permit requires secondary treatment limits year round. See Table B.3 of Appendix B for Leslie WWTP's NPDES permit effluent limits. Huntoon Creek joins the Grand River approximately 2.7 miles downstream of this discharge. DO levels below 5 mg/l were documented in Huntoon Creek during the summer of 2002 monitoring.

The four seasonal WWSLs discharging to the Grand or Portage Rivers near Jackson are permitted to discharge only during the spring and fall months at times of high background flow in accordance with the WWSL general permit. See Table 2 for details of these WWSL discharges. Note that the WWSL general permit contains limits and associated monitoring for biochemical oxygen demand (BOD_5), total suspended solids (TSS), and DO. The MDC-SPSM-Dale Foltz WWSL has not discharged since the mid-1990s according to WD district staff.

TABLE 2

General permitted WWSLs in the vicinity of Jackson

Facility	Receiving Water	Location	Annual Discharge Volume (MGY)
Sherman Oaks MHP WWTP (MI580274	Grand River	Section 33, T1S, R1W, Jackson County	34
MDC-Waterloo WWSL (MIG580001)	Unnamed tributary to Portage River	Section 11, T2S, R2E, Jackson County	10.95
MDC-SPSM-Wing WWSL (MIG580258)	Portage River	Section 12, T2S, R1W, Jackson County	3.0
MDC-SPSM-Dale Foltz TC WWSL (MIG580259)	Wildcat Creek (tributary to Portage River)	Section 17, T2S, R1E, Jackson County	0.5

Table 3 contains permitted annual conventional pollutant loads for the listed primary point sources. The loads are calculated from the facilities' maximum daily NPDES permit limits and design flows. Estimated loads from other unlisted individual and general permittees, which are not required to monitor for the indicated parameters, are included. These estimated loads are from the facilities listed under General NPDES Permits, Grand River, in Table A.5 of Appendix A (except for the Sherman Oaks WWSL which appears separately in Table 3). Loads from these facilities were estimated from the annual design flow and the following assumed discharge concentrations: $CBOD_5$, 2 mg/l; TSS, 55 mg/l; ammonia nitrogen, 0.1 mg/l; and total phosphorus (TP), 0.1 mg/l.

TABLE 3

Grand and north branch Grand River non-storm water permitted point source conventional pollutant loadings

Annual load (lbs/yr)	Jackson WWTP	Leoni Twp WWTP	Leslie WWTP	Sherman Oaks WWSLs	Other individual, non-storm water general permittees *
$CBOD_5$	584,827	100,158	35,770	8,507	8,172
TSS	1,288,800	190,170	42,922	15,603	221,988
Ammonia nitrogen	327,678	RPT	RPT	RPT	408
TP	57,838	7,915	1,431	RPT	408

RPT - facility's NPDES permit contains only a reporting requirement
* - Facilities not required to monitor for the listed parameters. Loads are estimated.

Table 4 contains estimates of Grand River TSS loads from areas that will be covered by Phase II municipal storm water permits and from existing industrial storm water permitted facilities. No such facilities discharge to the Portage River. Storm water loads in Table 4 were estimated based on land use data contained in the USEPA's BASINS 3.0 software package (USEPA, 2001a) and urban land use loading data from the Rouge River National Wet Weather Demonstration Project (Cave et al., 1994).

TABLE 4

Estimated Grand and north branch Grand Rivers conventional pollutant loads, storm water permittees

Annual load (lbs/yr)	Industrial and Phase II storm water permittees (from land use data)
BOD	1,430,000
TSS	4,590,000
Ammonia nitrogen	90,000
TP	20,000

Table 5 lists permitted loads from three general permitted WWSLs discharging to the Portage River.

TABLE 5

Portage River permitted point source conventional pollutant loadings

Annual load (lbs/yr)	MDC-Waterloo, Wing, Dale Foltz WWSLs
$CBOD_5$	3,627
TSS	6,626
Ammonia nitrogen	RPT
TP	RPT

RPT – facility's NPDES permit contains only a reporting requirement

Potential NPS of pollutants were evaluated based on land uses in the drainage basin (Table 6). north branch Grand River basin land uses are similar to those of the Grand River. Note that this land use data is approximately 25 years old, and it is possible that the urban land use proportions are in fact higher than indicated in Table 6 due to increased residential development. The WD district staff indicate no knowledge of concentrated animal feeding operations or problematic agricultural operations in the affected basins.

TABLE 6

Grand and Portage River basin land use categories as percentages

Land use category	Grand River	Portage River
Urban or built up	16	3
Agricultural	56	65
Forest	14	18
Water	3	2
Wetland	9	12
Barren land	1	0
Unclassified	0	0

The 2001 and 2002 summer DO surveys indicate that certain pollutants contribute toward DO standard nonattainment in the Grand, north branch Grand, and Portage Rivers near Jackson. Land use-related inputs cause the documented wet weather-related DO depressions in the Grand River below Jackson and likely contribute toward DO standard nonattainment through SOD (sediment loads) and plant respiration from plant growths (phosphorus loads). Estimates of land use-related annual loads of BOD ($CBOD_5$ + nitrogenous BOD), TSS, TP, and total nitrogen to the Grand and Portage Rivers near Jackson were estimated using geographic information system land use and meteorological data, and the USEPA's Simple Method approach (USEPA, 2001b). Estimates of loads to the Grand River at its confluence with the Portage River and to the Portage River at its confluence with the Grand River, appear in

Table 7. These estimates are based on non-site-specific data and represent a best approximation using literature values (Cave et al., 1994). The land use Grand River pollutant loadings in Table 7 include the estimated loads from storm water permitted facilities as described in Table 4.

TABLE 7

Estimated annual land use conventional pollutant loads, including Grand River storm water permitted facilities

Annual load (lbs/yr)	Grand River at Portage River Confluence	Portage River at Grand River Confluence
BOD	1,730,000	640,000
TSS	9,400,000	7,071,000
Total nitrogen	243,000	212,000
TP	36,000	24,000

Other estimates of sediment and nutrient loadings from sub-watersheds of the Grand River in the vicinity of Jackson are included in the Upper Grand River Watershed Management Plan (Tetra Tech MPS, DRAFT 2003), developed for the Grand River Inter-County Drainage Board (GRICDB) under a CWA Section 319 grant. The Watershed Management Plan recognizes that the urban areas in and around the city of Jackson are likely to contribute significantly more TP loads during wet weather events than areas with other land uses. This is consistent with previous studies in the Rouge River Watershed of southeast Michigan (Cave et al., 1994).

The city of Jackson and surrounding urban communities (Jackson County, the city of Jackson, and Blackman, Leoni, Napoleon, Rives, Spring Arbor, and Summit Twps), are subject to the CWA's Section 402(p)(2) Phase II storm water regulations. Urban runoff from Jackson will be considered in the wasteload allocation (WLA) portion of this TMDL. Industrial storm water permitted facilities and construction sites with certificates of coverage will also be considered in the WLA portion of the TMDL.

LINKAGE ANALYSIS

The observed DO standard nonattainment in the Grand, north branch Grand, and Portage Rivers can be attributed to a number of factors. These factors were assessed using mathematical DO models of the reaches of concern. The model chosen was the SWQAS's O'Connor-DiToro multireach, steady-state DO model (O'Connor and DiToro, 1970), based on the modified Streeter-Phelps equation. This model has the capability of simulating diurnal DO variation resulting from plant photosynthesis and respiration. The respiration term includes DO depletion due to SOD. The O'Connor-DiToro model is considered appropriate for use in the TMDL as it can represent the system without being unnecessarily complex or too data-intensive. Model input parameters were based on water quality studies and modeling guidance described in MDEQ 1995. The rate of reaeration downstream of the Jackson WWTP was estimated based on data collected in 2002. The models were calibrated to data collected in the summer of 2002.

Separate O'Connor-DiToro models (O'Connor and DiToro, 1970) of the main branch Grand, north branch Grand, and Portage Rivers were constructed. The Grand River model is an expansion of a model of Grand River reaches below the Jackson WWTP that was previously calibrated and verified based on water quality studies. That calibrated model has been used in the development of water quality-based effluent limits (WQBELs) for the Jackson WWTP. DO TMDL modeling has revealed that SOD and plant respiration are two major sinks of DO in the Grand and Portage Rivers. DO standard nonattainment in the north branch Grand River appears to be primarily due to plant respiration.

SOD: Solids present in the water column of a flowing water body can settle to the stream bed, forming layers of sediments with variable depths and compositions. Organic solids on the surface layer of the bottom deposit in direct contact with the water can undergo aerobic decomposition. This causes diffusion of DO from the water column into the sediment layer, depleting DO levels in the overlying river water. High levels of TSS in a water body can potentially cause high SOD rates if the solids settle to the bottom and decompose.

Substrates in nonattaining reaches of the Grand River within and downstream of the city of Jackson are characterized primarily by fine sediments. In 2001, black, anoxic sludge beds, approximately 2.5 feet deep, were encountered in the Grand River at Lansing Avenue, indicating that SOD is likely a contributing factor in DO standard nonattainment in the Grand River in the vicinity of Jackson. The same is true for the Portage River from Wooster Road to its confluence with the Grand River where deep muck deposits prevail. The Grand River below Jackson and the Portage River are characterized by low channel slopes and resulting low velocities. This appears to cause deposition of sediments from the water column, exacerbating SOD. The low velocities also result in relatively low rates of reaeration.

SOD was measured in 2002 at transects at Berry Road and Lansing Avenue. SOD ranged from 0.9 to 2.3 g/m^2-d, with an overall average of 1.6 g/m^2-d. These values are near literature values of SOD for aged sediments downstream of a treated municipal sewage discharge (Chapra, 1997). City of Jackson CSOs, which previously discharged to the Grand River, likely contributed to higher levels of SOD downstream of Jackson. SOD and sediment deposits are typically highly variable spatially and temporally due to varying flow regimes affecting deposition and scour (Bowie et al., 1985).

In 2002, wet weather event chemistry sampling was conducted at three stations (Table 8). Two of these stations (Grand River at Cooper Street Prison and Portage River at M106), were sampled during the 1991 study that implicated Jackson CSOs in wet weather DO standard nonattainment below Jackson. Sampling results show that the Grand River below Jackson but upstream of the Portage River (Grand River at Cooper Street Prison, Station 13) generally contained significantly higher levels of conventional pollutants than the Portage River at M106, near its confluence with the Grand River. Significantly higher levels of TSS were found in the Grand River at the Cooper Street Prison Station as compared to TSS levels found in the Portage River at M106. These results suggest that despite the elimination of Jackson CSOs, urban runoff from the city of Jackson is a prime source of solids that may contribute to elevated SOD in the Grand River in and below the city.

TABLE 8

Summer 2002 wet weather sample data: minimum, maximum, and arithmetic average concentrations (mg/l)

Parameter	Wet Weather Event Date (Rainfall, In.)	N. Br. Grand River at Falahee Road (Station 21)	Grand River at Cooper St. Prison (Station 13)	Portage River at M106 (Station 22)
$CBOD_5$ (mg/l)	July 9-10 (0.93)	No data	2 – 17 (6.71)	3 – 4 (3.14)
	July 18-19 (0.16)	No data	3 – 6 (4.2)	2 – 2 (2)
	July 26-29 (4.93)	2 – 3 (2.39)	2 – 4 (2.71)	2 – 3 (2.25)
Total organic carbon (mg/l)	July 9-10 (0.93)	No data	8.35 – 22 (11.79)	10.3–12.7 (11.79)
	July 18-19 (0.16)	No data	9 – 15 (11.88)	9.5 – 12 (7.76)
	July 26-29 (4.93)	8.56 – 10.40 (9.36)	4.5 – 7.6 (6.29)	3.19 – 12 (7.76)
TSS (mg/l)	July 9-10 (0.93)	No data	10 – 140 (64.9)	10 – 37 (19.93)
	July 18-19 (0.16)	No data	30 – 170 (79)	11 – 26 (15.75)
	July 26-29 (4.93)	5 – 12 (8.17)	13 – 400 (175.9)	9 – 190 (59.25)
Total ammonia nitrogen (mg/l)	July 9-10 (0.93)	No data	0.03 – 0.14 (0.08)	0.04 – 0.15 (0.09)
	July 18-19 (0.16)	No data	0.1 – 0.2 (0.14)	0.03 – 0.29 (0.13)
	July 26-29 (4.93)	0.01 – 0.07 (0.03)	0.04 – 0.18 (0.09)	0.04 – 0.2 (0.08)
Nitrate + nitrite (mg/l)	July 9-10 (0.93)	No data	1.76 – 4.29 (2.9)	0.18 – 2.41 (0.61)
	July 18-19 (0.16)	No data	2.9 – 6 (4.9)	0.19 – 0.52 (0.30)
	July 26-29 (4.93)	0.07 – 0.37 (0.22)	1.41 – 4.58 (3.17)	0.24 – 3.5 (0.94)
Orthophosphate (mg/l)	July 9-10 (0.93)	No data	0.01 – 4.2 (0.72)	0.02 – 0.10 (0.04)
	July 18-19 (0.16)	No data	0.06 – 0.29 (0.21)	0.01 – 0.02 (0.02)
	July 26-29 (4.93)	0.02 – 0.09 (0.04)	0.04 – 0.3 (0.16)	0.01 – 0.11 (0.03)
TP (mg/l)	July 9-10 (0.93)	No data	0.28 – 0.65 (0.42)	0.1 – 0.19 (0.12)
	July 18-19 (0.16)	No data	0.45 – 0.72 (0.57)	0.09 – 0.12 (0.10)
	July 26-29 (4.93)	0.09 – 0.15 (0.12)	0.31 – 2.04 (0.75)	0.06 – 0.45 (0.19)

Wet weather event loads of TSS were calculated at the Grand River Cooper Street Prison Station and at the Portage River M106 Station. Much higher loads of TSS were found at the Grand River Cooper Street Prison Station (Table 9). The listed event load of 72,476 pounds (lbs) for the July 26-29 event at the Grand River Cooper Street Prison site is likely an underestimate of actual values due to incomplete flow data.

TABLE 9

Wet weather event TSS loads

	Wet Weather Event Date (Rainfall, In.)	Grand River at Cooper St. Prison	Portage River at M106
TSS (lbs/event)	July 9-10 (0.93)	30,062	4,902
	July 18-19 (0.16)	63,592	3,377
	July 26-29 (4.93)	72,476	37,397

Observations made during the 2001 and 2002 surveys, as well as observations from other surveys (Tetra Tech MPS, 2003 DRAFT), indicate that stream bank erosion contributes a substantial amount of sediments and SOD to the Grand and Portage River systems. Numerous log jams, formed from fallen riparian trees, were noted in the Grand River below Jackson. Many trees with exposed roots were documented. Soil surveys by the Soil Conservation Service indicate that poorly drained, highly erodable organic soils pervade the banks of the Portage River and the Grand River below Jackson (United States Department of Agriculture (USDA), 1981).

No wet weather event sampling has been conducted in the reaches of concern during any season other than summer. It is possible that agricultural lands in the Portage River basin may contribute much higher solids loads in other seasons, such as spring, when compared to Portage River summer TSS loads.

Plant Respiration: The presence of aquatic plants in a water body can have a very significant affect on levels of DO. Plants, such as rooted macrophytes and algae, use photosynthesis during daylight hours to convert carbon dioxide and water into glucose, a process that releases oxygen. The oxygen is released to the surrounding water increasing levels of DO. Throughout the day and night, plants also respire aerobically. This process removes DO from the water column. DO concentrations vary throughout the day in response to photosynthesis and respiration. Since the photosynthetic contribution of DO occurs only with sunlight and respiration is relatively constant, levels of DO are most often lowest just before sunrise. Plant growth can be encouraged by the addition of nutrients, such as phosphorus, to a water body. This increased growth causes increases in photosynthesis and respiration rates, resulting in exaggerated daytime DO concentration peaks and potentially problematic early morning lows.

Phosphorus is an important nutrient of concern in aquatic systems, such as the Grand River. Phosphorus can exist in dissolved and particulate forms. When dissolved, some of the phosphorus is available for use by aquatic plants and increased growth can result. Phosphorus in the particulate form in river sediments can be released to the water column as dissolved phosphorus under certain conditions, contributing to increased plant growth. Solids that run off of land into water bodies or that are discharged directly to a stream typically have particulate phosphorus associated with them. Substantial loads of TSS can therefore result in substantial inputs of phosphorus available for plant use to a stream.

Very dense growths of macrophytes were observed in reaches of the Grand River, especially in the north branch Grand River in 2001 and 2002. This growth results in high rates of plant photosynthesis and respiration. DO standard nonattainment in the north branch Grand River appears primarily due to plant respiration. Summer macrophyte growth in the north branch at Falahee Road was so dense that bottom substrate could often not be seen, and plant growth prohibited flow measurements with a Gurley meter. Similar growths were observed in tributaries to Center Lake, the outlet of which is the headwaters of the north branch Grand River. Diurnal DO variation at Falahee Road (average minus minimum concentration) exceeded 5 mg/l during

the 2002 monitoring. This was the highest diurnal variation documented in any reach. Study period DO ranged from 0.0 (early morning) to greater than 20.0 mg/l (afternoon). The low early morning DO levels appear to cause or exacerbate DO standard nonattainment in the Grand River below its confluence with the north branch.

The dense plant growths observed in the north branch Grand River are typically found below lake outlets, especially in streams with a stable, cobble substrate, such as that of the north branch Grand River. Other factors favoring macrophyte growth, such as intermingling with a wetland area and a relatively wide, unshaded stream are present in the river (Wuycheck, 2003). Similar dense growths occur in streams connecting other lakes upstream of Center Lake (Price, Moon, Alcott, and Wolf chain of lakes). Wet weather sampling of the north branch Grand River at Falahee Road showed that TP did not exceed 0.15 mg/l. One round of dry weather chemistry sampling on November 1, 2001, showed that TP did not exceed 0.1 mg/l in the Grand, north branch Grand, or Portage Rivers (Sunday, 2002). This limited data suggests that several factors contribute to the dense plant growths in the north branch Grand River.

Plant photosynthesis and respiration influence DO levels in the Grand and Portage Rivers as evidenced by relatively high diurnal DO variations in some reaches. However, macrophyte densities matching those of the north branch Grand River were not noted in the Grand or Portage Rivers. Wet weather sample concentrations of TP and orthophosphate (Table 8) are significantly higher at the Cooper Street Prison Station (Station 13) compared to the two other sampled locations (Stations 21 and 22). One sample from the Cooper Street Prison Station during the July 26-29, 2002, event contained TP at 2.04 mg/l. This indicates that urban runoff from the city of Jackson is a significant source of TP loads to the Grand River.

Modeling calibration runs have shown that in-stream oxidation of $CBOD_5$ and ammonia nitrogen account for a relatively small amount of oxygen demand during critical conditions. Elevated levels of $CBOD_5$ and ammonia nitrogen have not been documented in the rivers at low flows. The high quality summer season effluent of the Jackson and Leoni Twp WWTPs is expected to have a minimal impact on river DO levels.

TMDL DEVELOPMENT

The TMDL represents the maximum loading of oxygen demanding substances, or other parameters that can indirectly cause oxygen demand (sediments and nutrients), that can be assimilated by the water body while still achieving WQS. As indicated in the Numeric Target section, the target for this DO TMDL is the WQS of 5 mg/l minimum DO. TMDL development also defines the environmental conditions that will be used when defining allowable levels.

The “critical condition” is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. For example, the critical conditions for the control of point sources in Michigan are given in R 323.1082 and R 323.1090. In general, the lowest monthly 95% exceedance flow and 90% occurrence temperature for streams are used as design conditions for conventional pollutant loadings.

Wet weather-related loadings of pollutants appear to play a significant role in the Grand River near Jackson’s DO standard nonattainment. This TMDL follows a phased approach due to inherent uncertainties in estimating loadings from wet weather-related sources. Under the phased approach, load allocations (LAs) and WLAs are calculated using the best available data and information, recognizing the need for additional monitoring data to determine if the load reductions required by the TMDL result in WQS attainment. The phased approach provides for the implementation of the TMDL, while additional data are collected to reduce uncertainty.

DO models were used to quantify reductions in river DO sinks necessary to attain the DO standard at critical conditions. Calibration data shows that along the entire 33.7-mile length of the Grand River, on average, SOD is responsible for approximately 60% of the DO deficit at design conditions, while plant respiration is responsible for approximately 40% of the deficit. There are reaches in the Grand River where the DO deficit is due entirely to either plant respiration or to SOD. The calculated relative contributions to the DO deficit from plant respiration and SOD will vary depending on the conditions to which the models are calibrated.

Modeling analysis indicates that approximately 80% of the DO deficit in the Portage River is due to plant respiration, while approximately 20% of the DO deficit is due to SOD. The north branch Grand River's DO standard nonattainment is assumed to be due primarily to plant respiration as per visual observations of very dense plant growth and hard or sandy bottom substrates.

In order to decrease SOD and nutrient loads, the loading of suspended sediments to the rivers must be reduced. Summer 2002 monitoring and sampling has documented that in-stream conventional pollutant loads increase significantly during wet weather events. It is likely that most nutrient inputs to the system are transported with the suspended sediment load. This is supported by the wet weather sampling data in Table 8, where except for one wet weather event, TP concentrations are significantly higher than orthophosphate concentrations. Suspended solids reduction is therefore the best overall strategy to improve DO in the stream.

ALLOCATIONS

TMDLs are comprised of the sum of individual WLAs for point sources and LAs for NPS and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for NPS, and the MOS.

This phased-approach DO TMDL will target a 50% reduction in land use-related TSS loads to the Grand, north branch Grand, and Portage Rivers in the vicinity of Jackson. The 50% TSS load reduction was chosen, in part, due to the results of DO modeling, which indicates that SOD and plant activity in the reaches of concern should be reduced by approximately 30 to 85%, depending on the reach under consideration, in order to achieve the DO standard. According to the modeling with its inherent uncertainties in parameter estimation, some (and likely most) reaches will attain the DO standard after an overall 50% reduction of TSS loads, while other reaches may not achieve standard attainment. Overall, however, the TMDL water body segment is expected to meet WQS with this reduction. The existence of further uncertainties that make it difficult to quantify the effects of TSS loads on in-stream DO levels make the proposed 50% reduction a reasonable objective for the initial phase of the TMDL. Subsequent phases of the TMDL may lead to changes in this target, and additional attention may be directed towards any reaches that remain in nonattainment. In addition, a wet weather event in-stream target of 80 mg/l TSS has been established in the biota TMDL for the Grand River near Jackson (Wuycheck, 2003). Monitoring indicates that in-stream TSS levels exceed this level significantly during wet weather events. The primary cause of this appears to be land use-related TSS loads rather than continuous point source discharges.

Table 10 contains total estimated existing TSS loads to the Grand (including the north branch Grand) and Portage Rivers at their confluences with each other. The total load for the Grand River includes point source loads from the Leslie WWTP and Sherman Oaks WWSL, both of

which actually discharge to the Grand River below its confluence with the Portage River. The initial phase of this TMDL will focus on land use TSS load reductions, as monitoring data and load estimates indicate that land use-related pollution is the primary cause of DO standard nonattainment in the affected reaches. Land use TSS loads include those from Phase II municipal and industrial storm water permittees, which will be treated as point sources in the WLA. Phase II municipal and industrial storm water discharges were assumed to comprise 100% of the urban or built-up land uses in the Grand River basin at its confluence with the Portage River (16% of the total Grand River basin land cover at that point) in order to compute land use-related TSS loads.

WLAs

DO standard nonattainment in the relevant water bodies has been documented during the summer months only. During the summer months (May through September), the two most significant point sources of oxygen demanding substances to nonattaining reaches, the Jackson and Leoni Twp WWTPs, are required by their NPDES permits to treat their effluent at AWT limits. These effluent limits are the most restrictive limits, which the state of Michigan imposes on municipal wastewater treatment facilities, and effluent of this quality is considered to exert no oxygen demand in-stream (stable effluent). Further reductions in conventional parameters ($CBOD_5$, ammonia nitrogen, and TSS) will not impact DO levels in the critical summer months. The high levels of treatment required by the Jackson and Leoni Twp WWTPs lead to high conventional pollutant removal rates throughout the year. The Leoni Twp WWTP also has AWT limits in the fall season, while the Jackson WWTP's limits are near AWT (Appendix B).

See Table 10 for proposed WLAs and LAs for the Grand (including the north branch Grand) and Portage Rivers. No reductions in municipal wastewater treatment facility (WWTP or WWSL) point source loadings are proposed for this DO TMDL's WLA, nor are reductions proposed for non-storm water general permitted facilities. TSS loads from these facilities are allocated as described in Appendix A, Table A.5.

All land use-related loads have been reduced by 50% in both the WLA (Phase II municipal and industrial storm water permittee loads, attributed to urban land uses) and the LA (all nonurban land use loads) as compared to existing loads outlined in Table 10. No permitted storm water dischargers are known to exist in the Portage River Watershed, so the Portage River WLA is the currently permitted annual TSS load from the three WWSLs.

TABLE 10

Annual TSS load source allocations and numeric targets

Water Body	Current Annual TSS Load (million lbs)	Annual TSS Load Numeric Target (million lbs)	WLA Annual TSS Load (million lbs)	LA Annual TSS Load (million lbs)
GRAND RIVER:				
Industrial/Municipal Storm Water Permitted Outfalls*	4.59	2.30	2.30	-
Other Land Use Related Sources**	4.81	2.41	-	2.41
Existing Ind./Gen NPDES Permitted Facilities	1.76	1.76	1.76	-
Grand River Total Annual Loads	11.16	6.47	4.06	2.41
PORTAGE RIVER:				
Land Use Related Sources***	7.07	3.54	-	3.54
Existing Ind./Gen NPDES Permitted Facilities	0.01	0.01	0.01	-
Portage River Total Annual Loads	7.08	3.55	0.01	3.54
Total:	18.24			
Annual TSS Load Numeric Target To Biota TMDL Reach	-	10.02	4.07	5.95

* Primarily attributed to urban or built-up land uses in the city of Jackson; ** Attributed to nonurbanized/built-up land uses in the townships of Leoni, Blackman, and Summit; *** Attributed to nonurban or built-up land uses in the Portage River basin.

LAs

TSS inputs resulting from land use-related sediment loads will be the primary targets for reduction in the Grand, north branch Grand, and Portage Rivers in this TMDL. Table 10 lists the land use source LAs for the Grand (including the north branch Grand) and Portage Rivers. The LA values in Table 10 do not include land use loadings due to industrial and municipal Phase II storm water permittees discharging to the Grand River, which are addressed in the WLA. The target LA values in Table 10 represent 50% of the loads of the existing estimated TSS loads contributed by those land uses classified as nonurban and not covered under storm water permits. Lands contributing TSS loads to the Grand River are located in Leoni, Blackman, and Summit Twps. Lands in Leoni, Henrietta, and Waterloo Twps contribute TSS loads to the Portage River.

MOS

The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into the TMDL analysis thorough conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS with conservative assumptions incorporated in DO modeling. Background flows and tributary inflows are

represented at the 95% exceedance summer low flow as determined by the MDEQ, Geological and Land Management Division. The summer 95% exceedance flow is a stream flow that would be expected only during periods of severe drought. Stream flows would be expected to be this low for only 5% or less of the time during the summer season. Michigan water quality rules (Rule 90) specify that WQS apply at all flows equal to or exceeding the 12-month 95% exceedance low flow. This is the stream flow employed in the modeling of the critical summer season, the very minimum flow at which WQS are to be applied. Similarly, river temperatures are represented at the highest monthly 90% occurrence temperature for the summer season as defined in the SWQAS effluent limit coordination Procedure 15. This temperature would be expected to be exceeded only 10% of the time during the summer months. This design temperature is derived from protective water quality rules (Rule 1075). Such high temperatures result in lower DO saturation concentrations and increased rates of in-stream oxygen utilization. The conservative assumptions regarding stream flow and water temperature are the same as those employed in the determination of WQBELs in NPDES WLAs at critical design conditions.

Note again that the large, continuous point source discharges during the critical summer period are required to treat effluent to AWT standards, a level of treatment considered by the WD to exert little, if any, in-stream oxygen demand.

SEASONALITY

Monitoring and modeling indicates that design conditions occurring during the summer season represents the most critical conditions for DO standard attainment in the Grand, north branch Grand, and Portage Rivers. Modeling of the Grand and Portage Rivers in other seasons using appropriate 95% exceedance low flows and 90% occurrence temperatures shows no predicted instances of DO standard nonattainment.

The very large diurnal variations documented in the north branch Grand River are likely to persist into the fall season, possibly leading to early morning DO standard nonattainment. Preliminary modeling shows fall season nonattainment, though there is uncertainty regarding the magnitude of photosynthesis and respiration rates in that season. The reduction in TSS loads and resulting reduction in phosphorus loads recommended in this TMDL should result in decreased plant activity and DO diurnal variations in the north branch Grand River during all seasons.

MONITORING

This TMDL's phased approach requires that future monitoring be conducted to assess whether activities implemented under the TMDL result in water quality improvements. This monitoring will be conducted as resources allow. Typically, the WD monitors watersheds in accordance with the five-year NPDES permit review process. The Grand, north branch Grand, and Portage Rivers will be reevaluated in 2006, when the Grand River basin is next scheduled for monitoring. Limited DO monitoring (instantaneous measurements similar to those of the 2001 and 2002 surveys) may be conducted in the meantime.

Future monitoring should be conducted after recommendations outlined in this TMDL are implemented. DO standard attainment will result in the water bodies being removed from the Section 303(d) list, while continued nonattainment will result in further evaluation under the TMDL process. Monitoring during the fall season may be included to assess standard attainment during that season.

REASONABLE ASSURANCE ACTIVITIES

Under the NPDES permit program, point sources in the vicinity of Jackson are responsible for meeting their effluent limits for oxygen demanding substances. Compliance is determined based on review of DMR data by the MDEQ. Existing DMR data reviewed by the MDEQ indicates these facilities are meeting those permit limits. Under the Phase II, Storm Water Regulations, the city of Jackson will be required to evaluate and implement best management practices to reduce urban land use pollutant loadings to the Grand, north branch Grand, and Portage Rivers, regardless of the findings of this TMDL. Compliance with these regulations will be overseen by the MDEQ.

The GRICDB has developed and published the draft regional Upper Grand River Watershed Management Plan under a CWA Section 319 grant. Planning efforts have included the development of geographical information system tools for the analysis of land use, and the development of specific management recommendations for six tributary or sub-basins under the regional, umbrella watershed plan. The plan includes provisions for the development of a regional watershed information and education campaign, including Adopt-A-Stream volunteer monitoring and stewardship activities. Ultimately, the watershed planning process will result in the creation of a stable organization for the planning and management of watershed activities, such as a watershed council (Tetra Tech MPS, 2003).

The Upper Grand River Watershed Planning Initiative Steering Committee, advising GRICDB on the development of the plan, includes representatives of numerous local agencies and stakeholder groups. The WD will work with these entities to ensure effective implementation of the TMDL. Efforts to reduce land use loads in the Grand River should focus on the city of Jackson and associated urban areas in accordance with the findings of the 2002 wet weather sampling.

DO standard nonattainment in the north branch Grand River is apparently primarily due to plant growths, which may result in part from nutrient enrichment. Subsequent phases of this TMDL will examine whether point source loads of nutrients to the north branch Grand River from the Leoni WWTP are in need of reduction.

The summer 2002 DO survey documented DO concentrations below 5 mg/l in Huntoon Creek near its confluence with the Grand River. WQBELs for the Leslie WWTP, which discharges to Huntoon Creek, will be reevaluated using site-specific DO modeling data when this facility's NPDES permit is to be reissued. The Leslie WWTP's effect on Grand River DO levels is insignificant according to past WQBEL modeling.

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June 20, 2003

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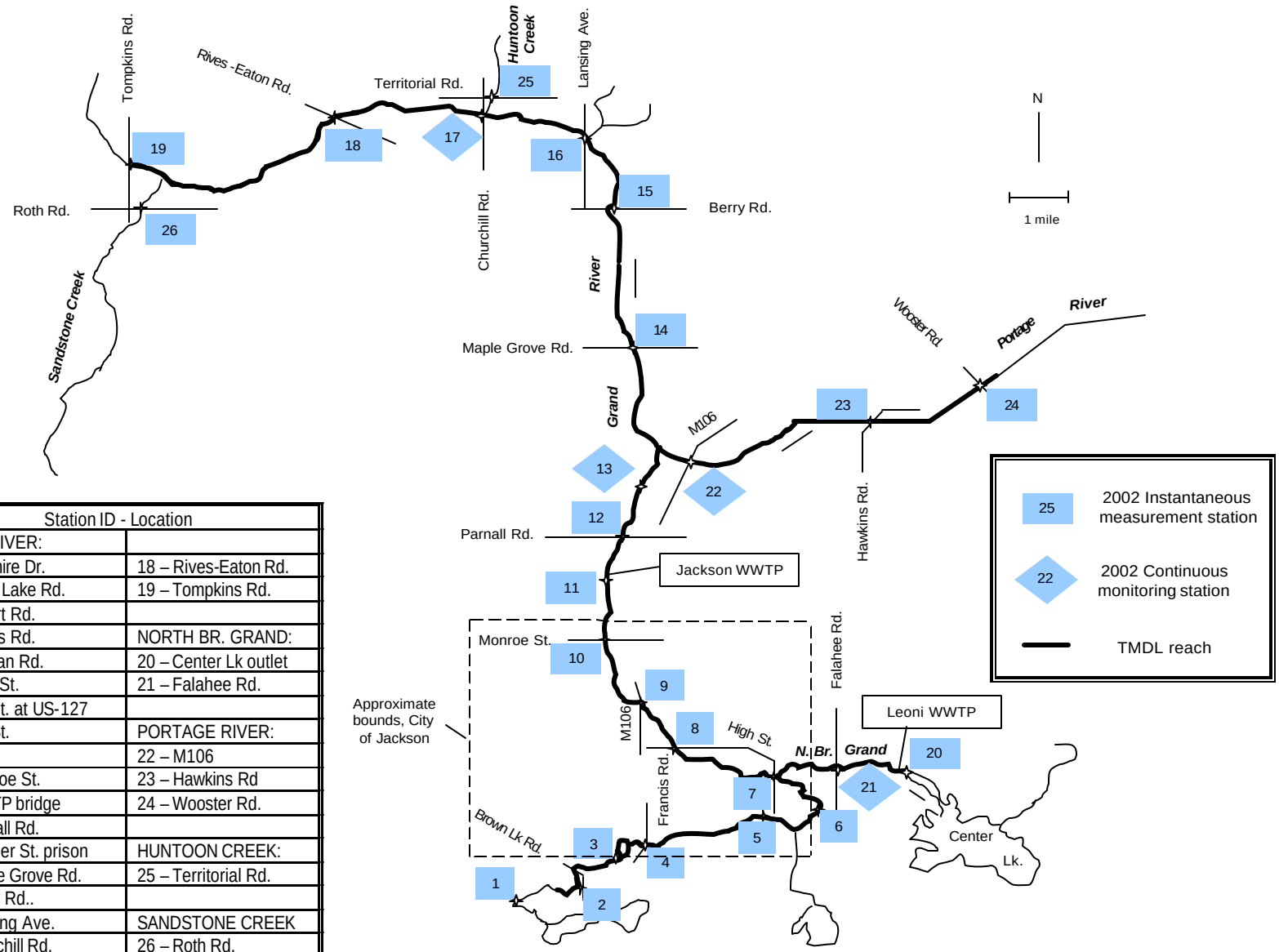

Station ID - Location	
GRAND RIVER:	
1 – Glenshire Dr.	18 – Rives-Eaton Rd.
2 – Brown Lake Rd.	19 – Tompkins Rd.
3 – Probert Rd.	
4 – Francis Rd.	NORTH BR. GRAND:
5 – Meridian Rd.	20 – Center Lk outlet
6 – South St.	21 – Falahee Rd.
7 – High St. at US-127	
8 – High St.	PORTAGE RIVER:
9 – M106	22 – M106
10 – Monroe St.	23 – Hawkins Rd
11 – WWTP bridge	24 – Wooster Rd.
12 – Parnall Rd.	
13 – Cooper St. prison	HUNTOON CREEK:
14 – Maple Grove Rd.	25 – Territorial Rd.
15 – Berry Rd..	
16 – Lansing Ave.	SANDSTONE CREEK
17 – Churchill Rd.	26 – Roth Rd.

FIGURE 1 – Grand River study sampling stations

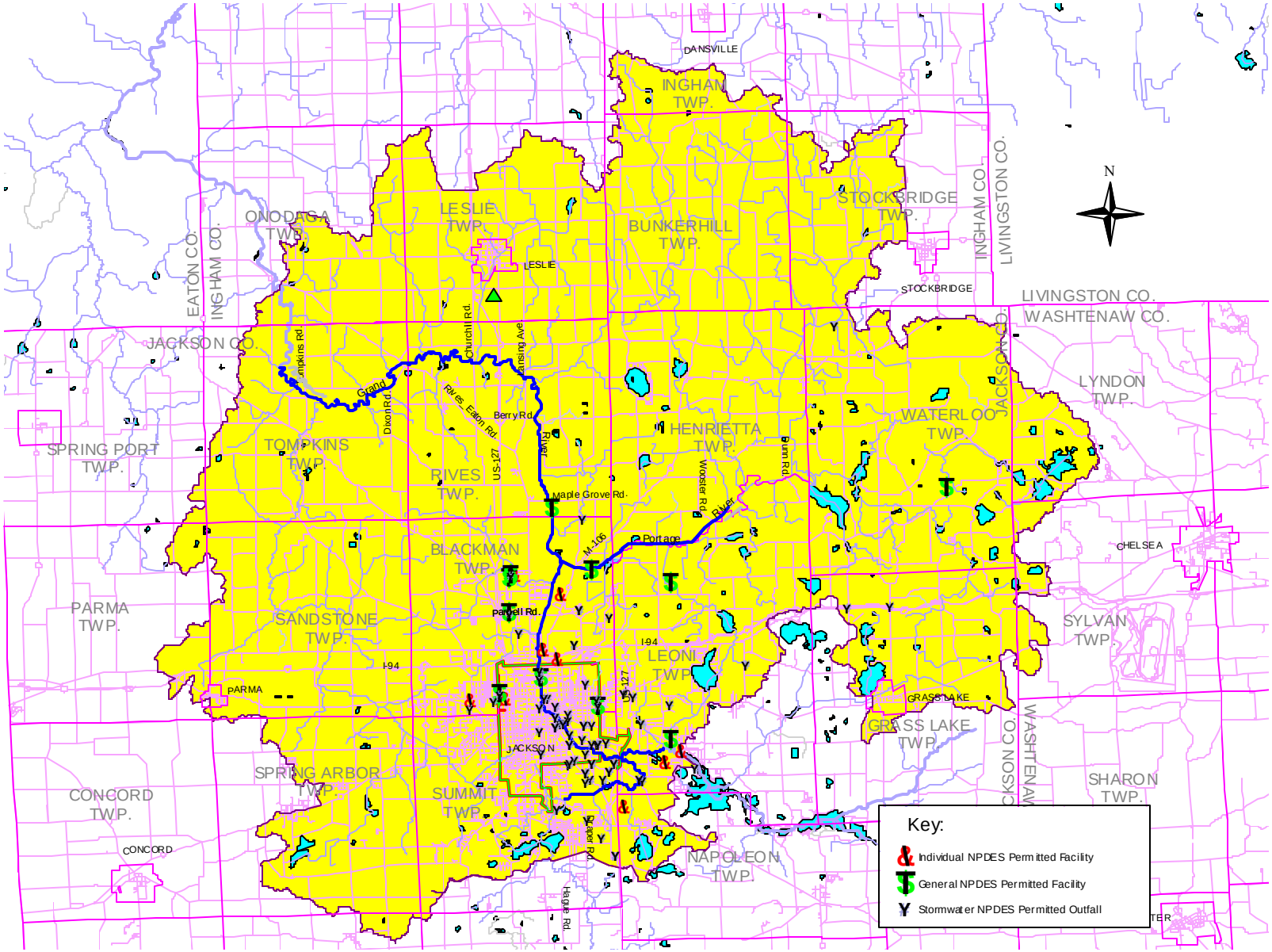

FIGURE 2 – Grand River DO TMDL drainage area and point source discharges

APPENDIX A – PERMITTED OUTFALLS TO THE GRAND AND PORTAGE RIVER WATERSHEDS IN THE VICINITY OF JACKSON

TABLE A.1

Individual and general NPDES permitted outfalls to the Grand River and Portage River watersheds in the vicinity of Jackson. Source: MDEQ/WD's NPDES Permit Management System (NMS); *MGY = million gallons per year.

PERMIT NUMBER	FACILITY	RECEIVING WATERS	DESIGN FLOW (MGY*)	LATDD	LONGDD
Individual NPDES Permits:					
MI0023256	Jackson WWTP	Grand River	6935.00	42.27611	-84.40611
MI0028461	Quanex Corp-Mac Steel Division	Grand River via wetland and Akerson Drain	55.00	42.20556	-84.36222
MI0041998	Mich Center School District	Murray Lake	0.12	42.22444	-84.33694
MI0045403	Marathon Ashland Petro-Jacks	Grand River via Tobin Snyder Drain	39.00	42.31028	-84.42361
MI0045942	Leoni Twp WWTP	Grand River at Center Lake outlet	949.00	42.23860	-84.25750
MI0046809	Citgo Corp-Jackson	Grand River via Tobin Snyder Drain	171.00	42.30889	-84.42250
MI0051683	Mechanical Products	Grand River via storm sewer	33.00	42.27167	-84.39861
MI0054976	MDC-SPSM-GWCU	Grand River	26.00	42.30000	-84.39583
MI0055042	Plastigage Corp	Hurd Marvin Drain via storm sewer	64.00	42.25417	-84.45000
MI0056006	TRW Inc-Jackson	Grand River	18.30	42.25417	-84.42917
MI0020796	Leslie WWTP	Huntoon Creek	171.60	42.44305	-84.42861
		Total Design Discharge (mgy):	**8462**		
General Permits:					
MIG080265	Wolverine Pipeline Co-Jackson	Tobin Snyder Drain	10.50	42.30722	-84.42528
MIG250042	Industrial Steel Treating Co	Grand River	100.40	42.25583	-84.43194
MIG250355	ADCO Products Inc	Grand River	27.40	42.23417	-84.33389
MIG250360	Lefere Forge & Machine	Grand River	4.40	42.25000	-84.37500
MIG250365	Mid-American Products	Grand River	21.90	42.26250	-84.40833
MIG250396	B & H Machine Inc	Tobin Snyder Drain	18.30	42.29167	-84.42556
MIG580001	MDC-Waterloo WWSL	unnamed trib. to Portage River	10.95	42.34361	-84.17000
MIG580258	MDC-SPSM-Wing WWSL	Portage River	3.00	42.30972	-84.37778
MIG580259	MDC-SPSM-Dale Foltz TC WWSL	Wildcat Creek	0.50	42.30417	-84.33194
MIG580274	Sherman Oaks MHP WWSL	Grand River	34.00	42.33750	-84.40000
MIG670278	Equilon Enterprises-Jackson	Rives-Blackman Drain	307.00	42.30861	-84.42444
		Total Design Discharge (mgy):	**538**		

TABLE A.2
NPDES permitted industrial storm water outfalls to the Grand River and/or Portage River watersheds in the vicinity of Jackson.

PERMIT NUMBER	FACILITY	TYPE	LATDD	LONGDD
Storm Water NPDES Permits:				
MIR0 11159	Eaton Hydraulics Inc	Industrial Storm Water Only	42.20000	-84.38333
MIR011220	Wolverine Vinyl Siding	Industrial Storm Water Only	42.24417	-84.39250
MIR011324	Jackson County Airport	Industrial Storm Water Only	42.25972	-84.45917
MIR011327	Thompson-McCully Co -Jackson	Industrial Storm Water Only	42.27722	-84.38833
MIR011332	Legends Mfg Inc	Standard	42.25389	-84.47583
MIR011338	Tenneco Auto Grass Lk	Industrial Storm Water Only	42.29167	-84.22917
MIR011339	Midbrook Inc	Industrial Storm Water Only	42.22444	-84.39306
MIR011340	Camshaft Machine Co	Industrial Storm Water Only	42.28306	-84.41972
MIR011341	Fourway Machine	Industrial Storm Water Only	42.25528	-84.36028
MIR011342	Hydraulic Systems Inc	Industrial Storm Water Only	42.22611	-84.38917
MIR011343	USF Holland Inc-Jackson	Industrial Storm Water Only	42.25222	-84.47833
MIR011344	C & K Box Company	Industrial Storm Water Only	42.25306	-84.43528
MIR011345	Production Engr Inc	Industrial Storm Water Only	42.21778	-84.38083
MIR011347	Worthington Specialty Proc	Industrial Storm Water Only	42.19167	-84.37500
MIR011348	Mich Auto Compressor Inc	Industrial Storm Water Only	42.26722	-84.54167
MIR011350	Blu-Surf Inc	Industrial Storm Water Only	42.25833	-84.55000
MIR011351	Pioneer Foundry Co Inc	Industrial Storm Water Only	42.24278	-84.39750
MIR011352	O' Briens Trading Post	Industrial Storm Water Only	42.22139	-84.31944
MIR011353	Edscha Jackson	Industrial Storm Water Only	42.25306	-84.37611
MIR011405	UPS-Jackson	Industrial Storm Water Only	42.21667	-84.38333
MIR011418	United Metal Technology Inc	Industrial Storm Water Only	42.26750	-84.28861
MIR011419	Willbee Transit Mix	Industrial Storm Water Only	42.25417	-84.50833
MIR011441	Crankshaft Machine Group	Industrial Storm Water Only	42.24972	-84.40833
MIR011445	Michner Plating-Angling Road	Industrial Storm Water Only	42.22917	-84.38333
MIR011447	Elm Plating Co Plt 2	Industrial Storm Water Only	42.23333	-84.37639
MIR011448	Elm Plating Co-Plt 1	Industrial Storm Water Only	42.22500	-84.39167
MIR011449	H & M Welding & Fab	Industrial Storm Water Only	42.24167	-84.35000
MIR011450	McGill Road Landfill	Industrial Storm Water Only	42.28944	-84.36750
MIR011451	Jackson Co Dalton Road LF	Industrial Storm Water Only	42.29306	-84.38472
MIR011452	Jackson Co RRF	Industrial Storm Water Only	42.29306	-84.38472
MIR011453	Conway Central Express-XJA	Industrial Storm Water Only	42.25000	-84.33333
MIR011455	Mich ARNG Jack Armory OMS12	Industrial Storm Water Only	42.25000	-84.40000
MIR011456	American Tooling Center Inc	Industrial Storm Water Only	42.29167	-84.20417
MIR011457	Miller Tool & Die Co	Industrial Storm Water Only	42.23333	-84.39167
MIR011458	Clarklake Machine Inc	Industrial Storm Water Only	42.18333	-84.36667
MIR011459	Allied Chucker & Engr Co	Industrial Storm Water Only	42.27500	-84.48750

TABLE A.2. (cont.)

PERMIT NUMBER	FACILITY	TYPE	LATDD	LONGDD
MIR011460	Way Bakery Div	Industrial Storm Water Only	42.23333	-84.37083
MIR011461	Dawn Food Products	Industrial Storm Water Only	42.22500	-84.36667
MIR011462	Advance Packaging Corp-Jac	Industrial Storm Water Only	42.23333	-84.37500
MIR011464	Michner Plating-N Mechanic	Industrial Storm Water Only	42.25417	-84.40417
MIR011465	Worthington Steel	Industrial Storm Water Only	42.24167	-84.38333
MIR011466	TAC Manufacturing	Industrial Storm Water Only	42.27500	-84.47917
MIR011467	Wolverine Metal Specialties	Standard	42.25417	-84.48333
MIR011468	Dawlen Corp	Industrial Storm Water Only	42.22500	-84.36667
MIR011469	John Crowley Inc	Industrial Storm Water Only	42.24167	-84.40000
MIR011470	Mich Extruded Aluminum	Industrial Storm Water Only	42.25417	-84.35417
MIR011471	C & H Stamping Inc	Industrial Storm Water Only	42.41667	-84.23333
MIR011472	Storey Stone Co	Industrial Storm Water Only	42.20417	-84.40000
MIR0 11473	Michigan Seat Co	Industrial Storm Water Only	42.22083	-84.38333
MIR011474	Chemical Technologies	Industrial Storm Water Only	42.23333	-84.37917
MIR011475	Liberty Environmentalists	Industrial Storm Water Only	42.18333	-84.36667
MIR011476	Jackson Iron & Metal #1	Industrial Storm Water Only	42.24167	-84.37917
MIR011477	Jackson Iron & Metal #2	Industrial Storm Water Only	42.23750	-84.39167
MIR011478	Andys Airport Auto Parts	Industrial Storm Water Only	42.25000	-84.45000
MIR011482	Miller Truck & Storage	Industrial Storm Water Only	42.24167	-84.38333
MIR011483	Boone's Welding & Fab	Industrial Storm Water Only	42.22917	-84.40833
MIR011484	Mag-Tec Casting Corp	Industrial Storm Water Only	42.21667	-84.35000
MIR011485	Norfolk Southern Jackson	Industrial Storm Water Only	42.24583	-84.40000
MIR011486	Jackson Auto Salvage	Industrial Storm Water Only	42.25417	-84.50000
MIR011491	International Foam & Trim	Industrial Storm Water Only	42.25000	-84.47917
MIR011512	Riverside Grinding Co	Industrial Storm Water Only	42.22472	-84.37917
MIR011513	Specialty Castings Inc	Standard	42.37500	-84.69583
MIR011520	Lefere Forge & Machine	Standard	42.25000	-84.37500
MIR011526	B & H Machine Inc	Standard	42.29167	-84.42556
MIR011527	Mid-American Products	Standard	42.26250	-84.40833
MIR011563	Jackson Iron & Metal-Elm Div	Industrial Storm Water Only	42.23556	-84.38417
MIR011609	Orbitform	Industrial Storm Water Only	42.22139	-84.36861
MIR011610	South Street Automotive	Industrial Storm Water Only	42.21778	-84.35250
MIR011617	Emmons Service Inc	Industrial Storm Water Only	42.23972	-84.40972
MIR011618	Linear Automatic Systems	Industrial Storm Water Only	42.25389	-84.40639
MIR011619	Industrial Steel Treating Co	Standard	42.25583	-84.43194
MIR011641	Bailey Sand & Gravel Co	Industrial Storm Water Only	42.25000	-84.51278
MIR011659	Sams Iron & Metal Co	Industrial Storm Water Only	42.26583	-84.40833
MIR011673	Kaneka Texas Corp	Industrial Storm Water Only	42.27417	-84.48056
MIR011710	Eaton Aeroquip Inc	Industrial Storm Water Only	42.24694	-84.39250

TABLE A.2 (cont.)

PERMIT NUMBER	FACILITY	TYPE	LATDD	LONGDD
MIR011712	Miller Industrial Products	Industrial Storm Water Only	42.24278	-84.39583
MIR011718	Professional Assembly Corp	Industrial Storm Water Only	42.21750	-84.37333
MIR011727	D-CO Limestone LLC	Industrial Storm Water Only	42.33292	-84.38182
MIR020005	Equilon Enterprises-Jackson	Standard	42.30861	-84.42444
MIR020014	Koch Materials Co -Jackson	Industrial Storm Water Only	42.24583	-84.40000
MIR020032	Jackson Power Facility	Industrial Storm Water Only	42.26022	-84.38192
MIS310004	Allied Chucker & Engr Co	Industrial Storm Water Only	42.27500	-84.48750
MIS310007	International Foam & Trim	Industrial Storm Water Only	42.25000	-84.47917
MIS310010	Miller Tool & Die Co	Industrial Storm Water Only	42.23333	-84.39167
MIS310012	Riverside Grinding Co	Industrial Storm Water Only	42.22472	-84.37917
MIS310013	Orbitform	Industrial Storm Water Only	42.22139	-84.36861
MIS310022	Willbee Transit Mix	Industrial Storm Water Only	42.25417	-84.50833
MIS310023	Jackson Auto Salvage	Industrial Storm Water Only	42.25417	-84.50000
MIS310030	Thompson-McCully Co -Jackson	Industrial Storm Water Only	42.27722	-84.38833
MIS310032	John Crowley Inc	Industrial Storm Water Only	42.24167	-84.40000
MIS310033	Michigan Seat Co	Industrial Storm Water Only	42.22083	-84.38333

TABLE A.3

Active NPDES permit notice of coverage for construction site in Jackson County, Michigan.

PERMIT NUMBER	FACILITY	LOCATION	TWP.	RANGE	SECTION	DATE RECEIVED	EFFECTIVE DATE
MIR102805	SCHOTT-HICKORY HILLS GOLF CLUB	2540 PAR VIEW DR, JACKSON				01/30/1998	01/30/1998
MIR102912	MDOT-M60-JACKSON COUNTY	SPRING ARBOR, SUMMT, AND BLACKMAN TWPS				03/24/1998	03/24/1998
MIR103006	IPL TOLEDO-HANNAWALD STRG YD	M-52, WATERLOO	T1S	R2E	1	05/11/1998	05/11/1998
MIR103095	WATERLOO GOLF COURSE EXPANSION	11800 TRIST RD, GRASS LAKE	T1S	R2E	33	06/17/1998	06/17/1998
MIR103498	KARVOL-TIMS LAKE PRESERVE	KNIGHT RD - MT HOPE RD, GRASS LAKE	T2S	R2E	21	12/15/1998	12/15/1998
MIR103980	GILLESPIE-GALLERY PLACE	PARNALL RD, NE CORNER OF PARNALL AND LANSING RD	T2S	R1W	15	08/11/1999	08/11/1999
MIR104072	STERLING-ASHTON RIDGE APTS	2905 BLAKE RD, JACKSON BETWEEN N ELM AND DETTMAN RD	T2S	R1W	25	09/28/1999	09/28/1999
MIR104174	JMK-ART MOEHN CHEVROLET/HONDA	SEYMOUR RD N OR I-94				11/29/1999	11/29/1999
MIR104208	NORFOLK-SUMMIT GLEN/RIDGE CNDO	BETWEEN MC CAIN AND MORRELL ST NEAR ROBINSON	T3S	R1E	5	11/17/1999	12/29/1999
MIR104362	JCRC-BOARDMAN ROAD EXTENSION	LONGFELLOW TO MAYNARD TO AIRPORT RD				03/08/2000	03/20/2000
MIR104382	JCRC-WILDWOOD/GANSON RECONST	MICHIGAN AVE TO BROWN	T2S	R1W	32,33	03/24/2000	03/24/2000
MIR104492	SUMMIT GLEN/SUMMIT RIDGE	MCCAIN RD, JACKSON	T3S	R1E	5	04/19/2000	05/15/2000
MIR104558	COLBROOK-COLBROOK MEADOWS	JEFFERSON RD AND TIFFANY RD	T4S	R1E	24	06/05/2000	06/05/2000
MIR104644	MOLTON GROUP-CORONADO	NAPOLEON RD & DORRELL RD	T3S	R1E	14	07/07/2000	07/11/2000
MIR104814	BULLINGER/WANDERING CK CONDO	S JACKSON RD S OF FERGUSON	T3S	R1W	21	09/19/2000	09/19/2000
MIR104943	KIRK MERCER	8049 S JACKSON RD	T4S	R1W	3	11/17/2000	11/29/2000
MIR105057	KINDER MORGAN-ORION PLANT	2219 CHAPIN ST, JACKSON	T3S	R1W	36	01/22/2001	01/22/2001
MIR105198	JACKSON CON ENRGY HEADQUARTER	BETWEEN FRANCIS ST ON AIRLINE DR	T3S	R1W	2	03/28/2001	03/28/2001
MIR105197	PENMARK GOODYR TIRE DEMOLITION	1304 PAGE ST, JACKSON	T2S	R1W	36	03/28/2001	03/28/2001
MIR105238	ECCLESIA RIDGE VIEW ESTATES	MICHIGAN AVE, MT. HOPE ROAD, GRASS LAKE TWP	T2S	R2E	33	04/24/2001	04/24/2001
MIR105297	MDOT CS 38111	JN 55900A				05/17/2001	05/17/2001
MIR105301	SCENIC HILLS	SCENIC HILLS DRIVE	T2S	R1E	29	05/18/2001	05/21/2001
MIR105498	DRS-MYSTIC HILLS-GRANDE GOLF	FLOYD RD NEAR US-127			24, 25	07/30/2001	08/24/2001
MIR105566	GANTON'S-TERRACE HILLS 1A & 1B	ROBINSON & SPRING ARBOR RD, JACKSON	T3S	R1W	7	09/21/2001	09/21/2001
MIR105586	LEFERE-SPEEDWAY-KART TRACK	PAGE AVE, JACKSON	T3S	R1E	6	09/17/2001	10/03/2001
MIR105614	MDOT-US127 RECONSTRUCTION		T3S	R1E		10/17/2001	10/17/2001
MIR105665	SUN COMM-WINDHAM HILLS	COUNTY FARM RD, JACKSON	T2S	R1W	19	11/20/2001	11/20/2001
MIR105695	JACKSON CO-FRANCIS ST RECONST	FRANCIS ST MCDEVITT TO SOUTH ST, JACKSON	T3S	R1W	10,11,14,22,23	11/26/2001	12/04/2001
MIR105704	TAC-MFG PLANT ADDITION	4111 COUNTY FARM RD	T2S	R1W	30	11/30/2001	12/07/2001
MIR105886	MJ FARMS-GREENBRIAR PH 2	KING RD, SPRING ARBOR	T3S	R2W	9	03/25/2002	03/25/2002
MIR105925	MDOT-M50 / US127 BL	NORTH ST TO BOARDMAN RD	T2S	R1W	27,28,33,4	04/05/2002	04/05/2002
MIR105996	VISTA GRANDE VILLA EXPANSION	2251 SPRINGPORT RD	T20S	R1W	28	05/08/2002	05/08/2002
MIR106096	HOME DEPOT-INSTALLMENTS	1400 W MONROE ST	T2N	R1W	28	06/14/2002	06/14/2002
MIR106113	SD-ARBORS @ THE WOODS	DETLMAN & AMOS, JACKSON	T2S	R1W	36	06/19/2002	06/19/2002
MIR106173	HOME DEPOT STORE 2770-JACKSON	NW CORNER OF MONROE & WISNER ST	T2N	R1W	28	07/18/2002	07/18/2002
MIR106172	NORFOLK-SUMMIT GLEN/OAK GROVE	BARRINGTON CIRCLE, JACKSON	T3S	R1E	5	07/18/2002	07/18/2002
MIR106194	SANCTUARY OF BRILLS LK PH 2	3650 WHIPPLE RD, JACKSON	T2S	R1E	22	07/30/2002	07/30/2002
MIR106265	WELLHOFF-BRENDAN ESTATES	M-50, NAPOLEON	T4S	R1E	1	08/21/2002	08/21/2002
MIR106529	MDOT-US127, JACKSON		T4S	R1W	13	01/16/2003	01/16/2003

TABLE A.4
City of Jackson identified municipal storm water outfall locations to the Grand River.
Provided as part of Phase II MS4 storm water permit program.

OUTFALL LOCATION DESCRIPTION	LATDD	LONGDD
E. of N. Blackstone St.	42.26925	-84.40983
E. Monroe St. (W. Price St.)	42.26576	-84.40851
W. Monroe St.	42.26495	-84.41011
Adams St. (W)	42.26243	-84.40997
Myrtle St. (W)	42.26102	-84.40969
North St. (NE)	42.25913	-84.40813
North St. (NW)	42.25892	-84.40859
North St. (SE)	42.25840	-84.40767
Mongomery St.	42.25739	-84.41426
Gauson St. (NE)	42.25475	-84.40725
Gauson St. (NW)	42.25460	-84.40771
W. Trail St. (NW)	42.25247	-84.40813
W. Trail St. (NE)	42.25268	-84.40754
N. Jackson St. (N of RR)	42.25040	-84.40822
Oak St. (N of Detroit St.)	42.24978	-84.40448
Mechanic St. (E) (N of Mich. Ave.	42.24806	-84.40541
Francis St. (@ W. Cortland Ave.)	42.24692	-84.40323
S. Airline Dr. (S. Louis Glick Hw	42.24630	-84.40134
Hupp Ave. (N)	42.24711	-84.40001
Hupp Ave. (S)	42.24396	-84.39608
Amur St.	42.24182	-84.39538
Bridge St. (NW)	42.24075	-84.39502
Bridge St. (NE)	42.24096	-84.39437
Mitchell St. (ext. W)	42.23854	-84.39040
Louis St. (SW)	42.23630	-84.39188
Louis St. (NE)	42.23692	-84.39105
High St. (W)	42.23320	-84.38994
High St. (SW)	42.23293	-84.38745
High St. (SE)	42.23282	-84.38615
S. Elm Ave.	42.23245	-84.38435
Losey Ave. (N)	42.23238	-84.38089
Losey Ave. (S)	42.23117	-84.38089
Gorham St.	42.23221	-84.37946
Clara St. (N)	42.23117	-84.37794
Clara St. (S)	42.22962	-84.37803
Research Ave. (NW)	42.23042	-84.37355
Research Ave. (SE)	42.23004	-84.37290
E. High St. (S)	42.23162	-84.37078
Dirlam Dr.	42.22856	-84.36653
Goodrich St. & W. South St. (S)	42.22515	-84.41094
S. Jackson St. & W. South St. (S)	42.22504	-84.40915
Oakwood Dr. (E) at Colfax St.	42.22270	-84.41288

TABLE A.5
Individual and non-storm water general NPDES permitted facilities in the upper Grand River watershed, with estimated TSS loadings.

Permit Number	Permitted Facility Name	Design Flow (mgy)	Maximum Monthly Limit TSS (mg/l)	Annual TSS Loadings (lbs)
Individual NPDES Permits, Grand River:				
MI0023256	Jackson WWTP	6935	20 and 25	1288800*
MI0028461	Quanex Corp-Mac Steel Div	55	25	11415
MI0041998	Michigan Center School Dist	0.1	30**	30
MI0045403	Marathon Ashland Petro-Jackson	39	30**	9758
MI0045942	Leoni Twp WWTP	949	20 and 30	190170*
MI0046809	Citgo Corp-Jackson	171	30**	42784
MI0051683	Mechanical Products	33	30**	8257
MI0054976	MDC-SPSM-GWCU	26	30**	6505
MI0055042	Plastigage Corp	64	30**	16013
MI0056006	TRW Inc-Jackson	18.3	30**	4579
MI0020796	Leslie WWTP	172	30	42922
	Total individual permittees:	**8462**		**1621233**
General NPDES Permits, Grand River:				
MIG080265	Wolverine Pipeline Co-Jackson	10.5	30**	2629
MIG250042	Industrial Steel Treating Co	100.4	30**	25135
MIG250355	ADCO Products Inc	27.4	30**	6860
MIG250360	Lefere Forge & Machine	4.4	30**	1102
MIG250365	Mid-American Products	21.9	30**	5483
MIG250396	B & H Machine Inc	18.3	30**	4581
MIG670278	Equilon Enterprises-Jackson	307	30**	76857
MIG580274	Sherman Oaks MHP WWSL	34	40 and 70	15603***
General NPDES Permits, Portage River:				
MIG580001	MDC-Waterloo WWSL	11	40 and 70	5049***
MIG580258	MDC-SPSM-Wing WWSL	3	40 and 70	1375***
MIG580259	MDC-SPSM-Dale Foltz TC WWSL	0.5	40 and 70	229***
	Total general permittees:	**538**		**144801**
			Overall Total:	**1,766,034**

- Total TSS loadings estimates for 5/1 to 11/30 plus 12/1 to 4/30; ** Not limited but assumed maximum monthly TSS concentration;
*** Combined total TSS loadings for permitted discharge periods 3/1 to 5/31 and 10/1 to 12/31 .

APPENDIX B – JACKSON, LEONI TWP, AND LESLIE WWTPs CONVENTIONAL PARAMETER NPDES PERMIT LIMITS

TABLE B.1

Jackson WWTP NPDES conventional parameter permit limits (design flow 19 MGD)

Parameter	Period	Maximum loading (lbs/d)		Maximum concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
$CBOD_5$ (mg/l)	6/1 – 9/30	630	1600	4	-	10
	10/1 – 11/30	1100	1600	7	-	10
	12/1 – 4/30	-	2700	-	-	17
	5/1 – 5/31	1100	1600	7	-	10
TSS (mg/l)	5/1 – 11/30	3200	4800	20	30	-
	12/1 – 4/30	4000	6300	25	40	-
Ammonia Nitrogen (mg/l)	6/1 – 9/30	79	320	0.5	-	2
	10/1 – 11/30	-	560	-	-	3.5
	12/1 – 4/30	1700	2400	10.6	-	15
	5/1 – 5/31	-	890	-	-	5.6
TP (mg/l)	Year round	-	-	1.0	-	-
DO (min., mg/l)	Year round	-	-	-	-	6.0

TABLE B.2

Leoni Twp WWTP NPDES conventional parameter permit limits (design flow 2.6 MGD)

Parameter	Period	Maximum loading (lbs/d)		Maximum concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
$CBOD_5$ (mg/l)	5/1 – 11/30	87	220	4	-	10
	12/1 – 4/30	540	870	25	40	-
TSS (mg/l)	5/1 – 11/30	430	650	20	30	-
	12/1 – 4/30	650	980	30	45	-
Ammonia Nitrogen (mg/l)	5/1 – 11/30	11	43	0.5	-	2
	12/1 – 4/30	-	-	(report)	-	-
TP (mg/l)	Year round	-	-	1.0	-	-
DO (min., mg/l)	5/1 – 11/30	-	-	-	-	7.0
	12/1 – 4/30	-	-	-	-	5.0

TABLE B.3

Leslie WWTP NPDES conventional parameter permit limits (design flow 0.47 MGD)

Parameter	Period	Maximum loading (lbs/d)		Maximum concentration (mg/l)		
		Monthly	7-day	Monthly	7-day	Daily
$CBOD_5$ (mg/l)	Year round	98	160	25	40	-
TSS (mg/l)	Year round	120	180	30	45	-
Ammonia Nitrogen (mg/l)	Year round	(report)	-	(report)	-	-
TP (mg/l)	Year round	-	-	1.0	-	-
DO (min., mg/l)	Year round	-	-	-	-	5.0

Michigan Department of Environmental Quality

Water Division

June 2003

Total Maximum Daily Load for Biota for the Grand River

Jackson County

INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting Michigan's Water Quality Standards (WQS). The TMDL process establishes the allowable loads of a pollutant to a water body based on the relationship between pollutant sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reduction necessary from both point and/or nonpoint sources (NPS) to maintain and/or restore the quality of their water resources.

The purpose of this TMDL is to establish a biota TMDL for the Grand River and its tributary, the Portage River, so as to restore the warmwater fish and other aquatic life designated use support of this stream, thereby resulting in WQS attainment.

PROBLEM STATEMENT

The Grand River and Portage River, a major tributary to the Grand River, are both warmwater designated water bodies and located in Jackson County due north of the city of Jackson (Figure 1). The TMDL reach is identified in Michigan's Year 2002 Section 303(d) report (Creal and Wuycheck, 2002) as follows:

GRAND RIVER AND PORTAGE RIVER WBID# **082816H**
County: JACKSON HUC: 04050004 Size: 25 M
Location: Grand River from Tompkins Road upstream to the city of Jackson
and Portage River from the Grand River confluence upstream to Wooster Road.
Problem: **Untreated sewage discharge, pathogens (Rule 100); WQS exceedances for DO; Macroinvertebrate and fish communities rated poor.**
TMDL Year(s): 2003 RF3RchID: 4050004

The presence of a poor rated fish and/or macroinvertebrate community in the TMDL reach was a basis for including the Grand River reach on Michigan's Year 2002 CWA Section 303(d) list of impaired water bodies requiring the development of a TMDL. In addition, dissolved oxygen (DO) and *Escherichia coli* bacteria TMDLs are being developed for about a 25-mile reach due to WQS exceedances in each case.

The Grand River is designated for the protection of a warmwater fishery and other indigenous aquatic life as provided by Michigan's WQS (Rule 100[1]). This document represents the basis for the development of a biota TMDL that focuses on the restoration of the biological communities of the impacted reach so as to meet Michigan's WQS designated uses. The biota

TMDL reach, as herein described, extends upstream about eight miles from US-127 to the confluence of Portage River (Figure 1).

The biota TMDL reach is defined based on results from the Great Lakes and Environmental Assessment Section Procedure 51 (May 2002, as revised) assessments of fish communities and/or macroinvertebrate communities of the upper Grand River Watershed during 1991, 1996, 2001, and 2002 (Oemke, 1992; Kosek, 1997; Goodwin, 2000; Rockafellow, 2003; and Wuycheck, 2003). The Procedure 51 protocol involves the assessment of nine specific metrics for either the fish and/or macroinvertebrate communities. Fish or macroinvertebrate community assessments with metric accumulative scores of 5 to 9 are rated as excellent; scores of 4 to -4 represent acceptable biological communities, and scores of -4 to -9 are rated as poor; the latter is classified as not attaining WQS.

A biological assessment of the Grand River in August 1977, using multi-plate artificial substrate samplers, defined a 14-mile zone of biological impairment that extended from Lewis Street (city of Jackson) downstream to about US-127 (Sylvester and Grant, 1979). The impairments were attributed to pollutant loads from industrial, municipal, storm water, and combined sewer overflow (CSO) discharges to the affected reach. CSOs (prior to 2000) and Jackson Wastewater Treatment Plant (WWTP) discharges (prior to 1985) once contributed to fish kills, solids loads, sediment contaminant buildup, and sediment oxygen demand (SOD) in sediments of the biota TMDL reach (Willson, 1970; Sylvester and Grant, 1979; Sunday, 2002; Argiroff, 1999; and Argiroff, 1995). The survey of August 1977 demonstrated improvement in river quality when compared to a 22-mile zone of degradation downstream of the city of Jackson during a 1970 survey (Willson, 1970). The reduction in the biologically impaired reach length to a 14-mile reach downstream of the city of Jackson indicated that pollution abatement efforts employed during the intervening years, between surveys, improved the water quality of the Grand River. CSOs eliminated in 2000 included those located at the Lewis Street and Bridge Street tributary to the Grand River at Jackson. Michigan Department of Environmental Quality (MDEQ) district staff indicate that there may continue to be illicit connections to storm sewers that discharge from the vicinity of Jackson.

A review of the Procedure 51 electrofishing community assessments of the Grand River conducted in September 1991 indicated an insufficient number of fish (four) at the Berry Road site and, therefore, the reach was rated poor (Oemke, 1992). The fish community at Dixon Road, located 8.6 miles further downstream, scored a -1 and was rated acceptable. The MDEQ also assessed the fish communities of the Portage River in August 1996 at Wooster Road (Root Station Road) and further downstream at Hawkins Road (Kosek, 1997). The fish communities scored a 2 and -1, respectively, both rated as acceptable. During October 2002, the integrity of the fish communities of the Grand River was assessed by the MDEQ at two sites, Maple Grove Road and Tompkins Road (Wuycheck, 2002). The fish community scores and ratings for these two sites were -5 (poor) and 1 (acceptable), respectively.

The September 1991 MDEQ macroinvertebrate community assessments of the Grand River scored -5 with a rating of poor at Berry Road and -1 with a rating of acceptable at Dixon Road (Oemke, 1992). A September 1996 MDEQ macroinvertebrate community assessment of the Grand River at the Maple Grove Road station scored a -5 and rating of poor (Goodwin, 2000). In August 2001, the macroinvertebrate communities were assessed at five sites on the upper Grand River that included sites within the defined TMDL reach (Rockafellow, 2003). The river locations assessed extended from the city of Jackson downstream and included High Street, West Monroe Street, Parnall Road, Maple Grove Road, and Churchill Road. The macroinvertebrate community assessment scores and (ratings) at each site were 5 (excellent), 1 (acceptable), 1 (acceptable), -7 (poor), and -1 (acceptable), respectively. The results

indicated continued impaired macroinvertebrate community in the Maple Grove Road reach of the Grand River.

The biological communities and habitat of the Portage River were assessed in August 1996 (Kosek, 1997). The Procedure 51 macroinvertebrate community assessment scores and ratings at Wooster Road (Root Station Road), Hawkins Road, and M-106 (0.5 miles upstream of the Grand River confluence) were 1, 0, and 0, all rated as acceptable. Fish communities of the Portage River assessed at Wooster Road and Hawkins Road had metric scores of 2 and -1 (acceptable), respectively.

Overall, the biological assessments of the upper Grand River collectively indicate improvement in river quality based on further reduction of the 14-mile zone of impairment of the biological community observed in 1977 (Sylvester and Grant, 1979). Findings from the 1977 survey and a 1996 habitat survey by Goodwin (2000), demonstrate 80% muck present at Maple Grove Road during the 1977 survey and low scores among specific metrics of the 1996 Procedure 51 habitat evaluation: Embeddedness with a very low score of 1 out of a possible maximum score of 20 and a Bottom Deposition metric low score of 3 out of a possible maximum score of 15. Both surveys indicated impaired habitat due to deposition.

Currently, the biological community impaired zone applies to a river reach that extends from the Portage River confluence downstream to US-127, an eight mile reach.

Numeric Targets: The impaired designated use for the Grand River is aquatic life. Michigan's WQS require, as a minimum, the protection of a variety of designated uses including aquatic life (Rule 100[1][f] - Other indigenous aquatic life and wildlife). Since the biota in the Grand River are impacted due to habitat loss by excessive sedimentation, achievement of WQS for the aquatic life designated use is to be demonstrated via assessments of the integrity of the fish and macroinvertebrate communities and habitat quality.

The "primary" numeric targets involve the use of Michigan's biological community and habitat quality assessment, Procedure 51. The biota TMDL targets are to achieve, for both the fish and macroinvertebrate communities, an acceptable, reproducible Procedure 51 score equal to or greater than -4. The fish and macroinvertebrate community scores will both be evaluated based on a minimum of two Procedure 51 biological assessments conducted in two consecutive years following the implementation of Best Management Practices (BMPs) to minimize sediment loads to the subject TMDL reach.

A stream habitat quality assessment will also be used. Historically, a minimum habitat quality score of 65 (approaching the upper end of the fair habitat score range of 35 to 70 out of a possible total of 135 points) would have been established as the minimum target for the habitat quality at all locations assessed. The habitat assessment target score of 65 was previously used in the TMDL development process to represent adequate control of anthropogenic sediment sources so as to improve habitat quality and the biological community. This targeted score is closely associated with macroinvertebrate community scores of -3 or greater, potentially providing better results than a minimally acceptable value of -4. This level of conservation is appropriately high enough to minimize both temporal and spatial variability within the watershed and buffer variability within the macroinvertebrate and habitat assessment protocol. A habitat score of 65 represents a 40% and 55% increase over the previous habitat quality assessment scores of 39 (poor) and 29 (poor) at Maple Grove Road during the September 1996 and August 2001 surveys (Goodwin, 2000 and Rockafellow, 2003), respectively. However, the MDEQ Procedure 51 stream habitat quality assessment procedure was updated and revised in 2002 (MDEQ, 2002). The Procedure 51 revised habitat target score of 96 approaches the upper

range of a marginal score range of 56 to 104 (out of a possible 200-point score), which equates to the 65-point score and 35 to 70 point-score range of the previous habitat rating system. Therefore, the habitat target score of 96 or greater will be used to demonstrate acceptable stream quality conditions and represent adequate control of anthropogenic sediment sources to assure improved habitat quality and the biological communities.

A "secondary" numeric target for total suspended solids (TSS) will be used to further assess improvements in the Grand River. The secondary target goal is applied as a mean annual value, in-stream TSS concentration of 80 milligrams per liter (mg/l), to be applied during wet weather and snow melt runoff/washoff events. The mean annual target concentration of 80 mg/l TSS is based on a review of existing conditions and published literature on the effects of TSS. Vohs et al. (1993) indicated that chemically inert suspended solids of 100 mg/l appears to separate those streams with a fish population from those without. The European Inland Fisheries Advisory Commission stated that, in the absence of other pollution, a fishery would not be harmed at suspended solids concentrations less than 25 mg/l. Good to moderate fisheries can be found at 25 to 80 mg/l suspended solids, good fisheries were unlikely to be found at 80 to 400 mg/l, while only poor fisheries would be found at 400 mg/l (Alabaster, 1972). Decreases were demonstrated in the standing crop of both fish and macroinvertebrates in an area receiving suspended solids load concentrations of no more than 40 mg/l (Gammon, 1970).

Sunday (2003), as part of the DO TMDL developed for the upper Grand River and Portage River Watersheds, estimated TSS loads based on various land use export coefficients. The current estimated annual TSS loads to the biota TMDL reach from the Grand River and Portage River Watersheds are 9.4 million pounds and 7.07 million pounds, respectively. As a phased approach, a 50% reduction of the 16.47 million pounds TSS annual loads to 8.25 million pounds plus 1.72 million pounds from individual and general permitted facilities (Table 5) is expected to restore conditions in the TMDL reach and meet WQS for both DO and biota.

This secondary numeric target may be overridden by achievement of the biological and habitat numeric targets. However, if the TSS numeric target is achieved but the biota or habitat numeric targets are not achieved, then the TSS target may have to be reevaluated. Achievement of the secondary numeric target will help guide proper control over industrial and municipal storm water runoff/washoff and NPS of excessive suspended solids loadings, as well as the runoff/washoff discharge rates and instantaneous runoff volumes that affect increased stream flow instability, stream bank erosion, and increased suspended solids concentrations. The achievement of the wet weather mean annual average value of 80 mg/l will require reductions in the stormwater runoff/washoff TSS loads to the Grand River from the municipal/industrial storm sewers in the city of Jackson, among other actions. Available wet weather monitoring data indicates in-stream TSS concentrations in the Grand River of 400 mg/l.

A numeric target of 5.0 mg/l (as a minimum daily value) for DO also applies to the biota TMDL reach in order to achieve Michigan's WQS Rule 64. A specific DO TMDL has been developed that addresses this issue (Sunday, 2003).

Source Assessment: Overall, the causes of impairment in the TMDL reach that contribute to impaired biological communities include the following: sedimentation; periodic DO violations and high SOD; and historic CSO discharges. The eight-mile biota TMDL reach represents a zone in the Grand River where the gradient declines from 3.4 feet per mile, upstream of the Portage River confluence, to 0.85 feet per mile, and velocities are typically reduced to less than 0.5 feet per second, thereby, fostering sedimentation of suspended solids on available habitat.

Sedimentation:

In 1977, the primary sources of TSS to the Grand River upstream of the Portage River confluence were the Jackson WWTP, CSOs, and industrial/municipal storm water outfalls at and upstream of Monroe Street (Willson, 1970). The Jackson WWTP was required to implement an industrial pretreatment program in April 1985 so as to collect and eliminate direct discharges of improperly treated industrial wastewater and solids to the Grand River.

The sources of elevated TSS loads to the biota TMDL reach are attributable to: 1) historical loadings of solids that have accumulated in the reach; 2) recent periods of urban/municipal and industrial storm water runoff/washoff from the city of Jackson during wet weather runoff events in the city of Jackson area; and 3) NPS-related loads from predominately agricultural landuse sources in the Portage River Watershed (LTI, 2003 draft).

Storm water runoff/washoff source loadings occur during major storm and runoff/washoff events that discharge to the Grand River from designed impervious surface area in the city of Jackson via the numerous industrial and municipal storm sewer outfalls. Results from urban runoff investigations confirm that urban areas can contribute substantial loads of solids, heavy metals, and other contaminants to receiving waters (USEPA, 1983; Novotny, 1991; and Novotny, 1992). The Grand River Inter-County Drainage Board initiated an assessment of the need for street sweeping in minimizing loadings of various solids and contaminants, primarily heavy metals, to the Grand River from the city of Jackson (Tetra-Tech, MPS, 2001). It was concluded that an annual reduction of 63 to 87% of annual washoff of total solids loads and contaminants could be achieved if street cleaning and clean catch basin management were conducted every 14 or 30 days. The washoff typically contained elevated levels of chemical oxygen demand (CBOD), total phosphorus, cadmium, chromium, copper, lead, and zinc.

The Portage River has been substantially dredged and channelized over the past 50 years in order to facilitate drainage and transform wetlands to agriculturally workable land. A drain district evaluation and corridor study of the Portage River inter-county drain was completed in 1999 by HRC (1999). Findings concluded that channelization, levees, and increased runoff have had hydraulic impacts on the river. It has become broader and shallower and prone to increased stream bank erosion, slower flow velocities, and extensive sedimentation. Logjam obstructions occur, suggesting the periodic, maybe seasonal, occurrence of substantially high flow events capable of transporting large woody debris downstream. Selective removal is proposed to facilitate flow that may facilitate the movement of sediment deposition.

Dissolved Oxygen:

CSOs in the city of Jackson discharged pollutants to the Grand River during storm events prior to their elimination in 2000 (MDEQ, Water Division District) as part of the city of Jackson's Phase 1 Storm Sewer Separation program. Willson (1970) documented the wet weather discharge of untreated sanitary waste and elevated bacterial counts from the CSOs of Jackson to the Grand River from locations between Losey Street and the Jackson WWTP. Such loadings of sanitary waste served as a source of oxygen demanding materials that degraded conditions in the biota TMDL reach, including biological communities and increased SOD. Wet weather discharges were responsible for a 1988 fish kill in the Grand River upstream of Lansing Avenue some 14 miles downstream of the city of Jackson. The fish kill prompted DO monitoring studies of the Grand River in 1988 and 1991 (Argiroff, 1999 and 1995). The 1988 study documented wet weather DO levels below 1.0 mg/l, while the 1991 study indicated wet weather DO minima below 3.0 mg/l downstream of the influence of the Jackson CSO discharges. It was

concluded that periodic wet weather runoff and CSO discharges from the city of Jackson were the major sources responsible for reductions in DO.

DO surveys of 2002 and 2003 indicate periodic WQS DO violations (minimum DO of less than 5.0 mg/l) do occur in the Grand and Portage Rivers (Sunday, 2002 and LTI, 2003 – in draft). Such violations occur within and beyond the biota TMDL reach. Historically, DO exceedances were in response to CSO discharges, point source and/or storm water discharges. Since the CSOs were reportedly eliminated and National Pollutant Discharge Elimination System (NPDES) permitted point sources are meeting their NPDES permit limits, recent DO standard exceedances in the Grand River appear to be related to precipitation and impervious surface washoff and resultant SOD within and beyond the biota TMDL reach. The discharge from the Portage River Watershed is also recognized as contributing to depressed DO conditions in the biota TMDL reach and beyond. Solids loadings and sedimentation contribute to a substantial zone of river where SOD increases, thereby contributing to DO WQS violations during portions of the summer months.

SOD that exists in the TMDL reach is substantial and is associated with characteristic deposits of fine sediment material that represents the major substrate in the reach (Sunday, 2002). Sources of the fine sediment accumulations in the biota TMDL reach appear to be associated with urban runoff and organic rich sediments from NPS within the watershed. Again, the slope or gradient within the TMDL reach is low ranging from 0.85 to 1.5 feet per mile with associated low flow velocities in the Grand River of less than 0.5 feet per second and even less in the Portage River base flow conditions during the summer months. Such languid conditions enhance the deposition of suspended solids discharged to the river from urban runoff, agricultural, modified wetlands, and/or construction sites during substantial precipitation and runoff events. The TMDL reach serves as a depositional zone for fine particulate solids resulting in a storage reach of homogeneous sediments that appears to be resistant to downstream transport.

The absence of acceptable fish and macroinvertebrate communities in the defined biota TMDL reach is attributable, in part, to: 1) excessive sedimentation of fine particulate organic materials; 2) sediment obscured and impaired habitat suitable for sustaining either an acceptable fish and/or macroinvertebrate community; and 3) summer minimum DO concentrations of less than the minimum WQS of 5.0 mg/l that is attributed to SOD and pollutant loadings during storm/runoff events at the city of Jackson. A low gradient (1.5 to 0.85 feet per mile) and associated low stream flow velocity (<0.5 feet per seconds) in the TMDL reach facilitate sedimentation of the pollutant loads that contribute to the impaired biological communities and habitat quality of the reach. The resulting conditions generally minimize the potential for suitable fish spawning areas, refugia habitat, and reduced habitat for feeding resources (macroinvertebrate community).

Wooded and emergent wetlands dominated the adjacent land use corridors of the upper Grand River and Portage River Watershed prior (circa 1800) to settlement and land use development (Michigan Resource Information Systems [MIRIS], 2003). Extensive reaches of both rivers have since been substantially channelized to facilitate drainage of the streams and foster settlement and agricultural land use development. The Portage River has been highly modified by dredging to maximize and facilitate upland drainage.

The 1978 land use inventory (MIRIS, 2003) indicates that the Grand River and Portage River corridors are dominated by wooded and/or emergent wetlands, agricultural and urbanized residential, industrial, and commercial areas associated with the city of Jackson. Runoff and washoff from the impervious surfaces of the city of Jackson serve as the major source of TSS

loads to the biota TMDL reach. Extensive use of structural features, including impervious surface areas (e.g., roads, roof, and parking lots), curb and gutter, and numerous direct storm water discharges contribute to rapid precipitation runoff rates to and flashy flow events in the Grand River. Therefore, the major contributing source of solids loads to the Grand River in the biota TMDL reach appears to be from urban, residential, industrial, commercial, suburban, and agricultural land uses, the latter primarily associated with the Portage River Watershed.

Monthly mean (50%) and 95% exceedance design flow estimates characterize the Grand and Portage Rivers as water bodies having sustained, perennial stream flows (Lesmez, 2002). The soil in the corridor adjacent to the biota TMDL reach of the Grand River is dominated by poorly drained, Cohoctah fine sandy loam common to this floodplain (McLeese, 1981 and MIRIS, 2003). The vegetative cover associated with the floodplain is mixed hardwood growth dominated by oak, hickory, beech, and silver maple. The Portage River corridor is dominated by hydric soils; including Palm muck, Houghton muck, and Edwards muck, that are all poorly drained soils subject to ponding and common to emergent wetlands and drainageways (McLeese, 1981). Extensive channelization of the Portage and Grand Rivers was completed over the past 50 years or more to facilitate agricultural, urban, and other landuse development.

Background TSS Loadings:

Background (upstream of the city of Jackson) TSS loadings were derived based on a review of available TSS monitoring data (Storage and Retrieval System [STORET] database since 1976) for the Grand River at Hague and Draper Roads in addition to results from a July 28-31, 2002, wet weather event monitoring of the north branch Grand River at Fahalee Road (LTI, 2003 - in draft). An overall average TSS concentration of 7 mg/l (range 1 to 27 mg/l, N=21) characterized the Hague and Draper Roads sampling sites. An average TSS concentration of 8.2 mg/l (range 5 to 12, N= 9) characterized stream conditions at Falahee Road that presumably had experienced a 4.93-inch rainfall during the sampling period of July 26-31, 2002 (Jackson Airport weather monitoring station database). Rockafellow (2003 - in draft) reports TSS concentrations during stable flow conditions (49 cubic feet per second [cfs] at the United States Geological Survey [USGS] Jackson gage) at High Street and Falahee Road of 11 and 8 mg/l, respectively. Overall, the TSS results for the reach of river upstream from the city of Jackson imply fairly stable flow conditions and slow response to storm events.

Background TSS concentrations are typically less than 15 to 20 mg/l during stable flow conditions (STORET database retrievals). For the wet weather events monitored during July 2002, the average background TSS concentration was assumed to be 15 mg/l (during the three monitored runoff events assessed) with pre-storm event stream flows, upstream of the city of Jackson of 45 (29.1 million gallons per day [mgd]), 44 (28.4 mgd), and 33 cfs (21.3 mgd). The resulting background estimates of TSS loads for the three storm runoff events are 3,640; 3,555; and 2,666 pounds per day.

Individual and General NPDES Permitted TSS Loadings:

The NPDES permitted sources of TSS contributing to the immediate watershed influencing the biota TMDL reach include: 10 facilities covered by individual permits; 11 facilities covered by general permits (Table 1); numerous (90) industrial storm water permits (Table 2); about 40 construction sites covered by notices of coverage (Table 3); and 42 municipal storm water outfalls (Table 4) that discharge to the upper Grand River Watershed (Figure 2). The municipal storm water outfall locations were provided by the city of Jackson as part of their Phase II Municipal Separate Storm Sewer Systems (MS4) application (Figure 3).

The 10 facilities with individual NPDES permits have a combined daily maximum design flow discharge volume of 23.0 mgd or 8,290 million gallons per year (mgy). Two of the facilities (Jackson WWTP - permit number MI0023256 and Leoni Township (Twp.) WWTP – permit number MI0045942) have two seasonal daily maximum TSS limits of 25 and 30 mg/l and 20 and 30 mg/l, respectively. These seasonal limits were used to estimate annual TSS loads for the seasonal dischargers (Table 5). For the other eight facilities, a worst-case estimate of total TSS loadings was made assuming a TSS monthly average concentration of 30 mg/l (Table 5). The estimated daily maximum total TSS loading from the ten facilities is 4,324 pounds or 1.58 million pounds per year. Facility daily monitoring reports indicate that monthly average TSS concentrations and loadings are substantially less. This is especially true of the Jackson WWTP, which is maintained and operated as an advanced wastewater treatment facility (currently discharges an average flow of 12 mgd and has for the years 2000, 2001, and 2002) and had effluent monthly average TSS concentrations that ranged from 3 to 10 mg/l.

Of the 11 facilities with general discharge permits, the four wastewater sewage lagoon (WWSL) dischargers have seasonal effluent limits of 40 and 70 mg/l TSS. The other seven permits are not required to measure TSS; however, an estimate of TSS loadings was derived using an assumed monthly mean of 30 mg/l TSS and a combined total design discharge (for the 11 facilities) of about 1.5 mgd. The estimated daily TSS loading is 397 pounds or 144,905 pounds per year (Table 5). The sum of estimated TSS loadings from the facilities with the individual NPDES permits and general permits combined represents a daily TSS loading of 4,721 pounds or 1.72 million pounds per year.

NPDES Permitted Construction Site TSS Loadings:

TSS loadings are unknown and in the absence of complaints are regarded minimal as far as TSS loadings to the Grand River and biota TDML reach. Therefore, in the absence of sufficient information to implicate in the TSS loadings to the Grand River, their collective loadings estimate equals zero. An alternative is to include these potential sources in with the storm water TSS loadings estimates for wet weather events (below).

Industrial and Municipal Storm Water TSS Loadings:

The influence on the Grand River by wet weather runoff events associated with industrial and municipal storm water runoff from the vicinity of the city of Jackson were assessed as follows: TSS monitoring data (Rockafellow, 2003) indicates that during stable flow conditions (instantaneous flow measure of 48 cfs) at the USGS Jackson gage, in-stream concentrations of TSS ranged from 9 to 15 mg/l (Monroe Street and Parnall Road, respectively) in the reach commonly influenced by storm water runoff/washoff from the city of Jackson and industrial sites. Available TSS monitoring data from several STORET stations located from Hague Road downstream to the Michigan Department of Corrections (MDC) Cooper Street prison site (380164, 380256, 380258, 380084, 380262, 380257, 380225, 380085, 380086, and 380259) indicates TSS concentrations commonly range from 10 to 27 mg/l during stable flow conditions.

A July 2002 wet weather assessment of the Grand River Watershed (LTI, 2003 - in draft) showed substantial increases in several parameters in the Grand River at the MDC Cooper Street prison site including TSS (Table 6). Substantial increases occurred in river flows measured at the USGS Jackson gage of 77 cfs (increase from 45 to 122 cfs) in response to a 0.93-inch rainfall (July 9, 2002); 106 cfs (increase from 44 to 150 cfs) in response to a 0.16-inch rainfall (July 18, 2002); and 370 cfs increase (increase from 33 to 403 cfs) in response to a 1.33-inch rainfall (July 26, 2002). Instantaneous TSS concentrations collected at the MDC Cooper Street prison site during these same wet weather, runoff events ranged (average) from

10 to 140 mg/l (65 mg/l), 30 to 170 mg/l (79 mg/l), and 14 to 400 mg/l (203 mg/l) for the first three rainfall events, respectively (Table 7).

Estimating the wet weather washoff/runoff influence from the city of Jackson on the Grand River TSS loads involved two major assumptions: 1) that background flow conditions and TSS concentrations (upstream of the city of Jackson) are relatively stable and slow in response to storm events, and 2) that the observed increases in Grand River flows and TSS increases measured at the MDC Cooper Street prison site during the three storm events assessed in July 2002, are 100% attributable to industrial and municipal storm water runoff/washoff sources in the vicinity of the city of Jackson and, in part, resuspension of in-place solids. Instantaneous river flows for the MDC Cooper Street prison site were based on the time of passage (2.5 to 3.0 hours) between the USGS Jackson gage values and the MDC Cooper Street prison site. TSS sample results from the MDC Cooper Street prison site were used to derive storm event-related response increases in Grand River flow and TSS loadings (Table 8). The Grand River response to wet weather events increased river flows at the USGS gage site by 77, 106, and 370 cfs, respectively, and daily mean TSS loads by 93% (64,191 pounds per day) on July 9, 2002; 90% (47,559 pounds per day) on July 18, 2002; and 99% (379,103 pounds per day) on July 26, 2002, respectively (Table 9). Additional wet weather runoff/washoff and river monitoring is required to better define the seasonal contributions of both runoff volume and washoff TSS loadings to the Grand and Portage Rivers that affect the biota TMDL reach.

Sunday (2003) estimated the annual loads of TSS to the Grand River reach from combined industrial and municipal storm water runoff of 4.6 million pounds.

In summary, excessive sedimentation of the Grand River is primarily associated with elevated levels of impervious surface runoff/washoff from industrial sites, the city of Jackson, other land development activities, soil erosion from agricultural sources in the Portage River Watershed, and stream bank erosion due to the erosive effects of excessive runoff rates. Upland development and channelization of the Grand River and Portage River reaches has disrupted the “natural” hydrology throughout the watershed resulting in periodic erosive, flashy flows following wet weather runoff events. These alterations to the Grand River Watershed have destabilized stream banks, increased sediment loads, and reduced or eliminated desirable fish and macroinvertebrate habitat.

Linkage Analysis: Linkage is defined as the cause and effect relationship between the selected sources and indicators. The linkage between the presence of acceptable fish and macroinvertebrate communities in the biota TMDL reach is related to improved habitat quality through the reduction in siltation and sedimentation.

The primary source of accumulated silts and sedimentation in the biota TMDL reach is attributed to the historic discharge of organic material from CSOs, eroded organic materials from the Portage River reach, point sources, and solids loadings from wet weather runoff/washoff from impervious surface areas in the urban area of the city of Jackson. Severe embeddedness and bottom deposition of fine organic/silt materials at Maple Grove Road have impaired habitat conditions. Siltation, sedimentation, and embeddedness of colonizable substrates have been demonstrated to impair the biological integrity of rivers by obscuring or reducing the suitability of colonizable or useable substrate by stream biota (Waters, 1995). With a reduction in sedimentation, the fish and macroinvertebrate communities typically respond with an increase in species diversity and an increase in the number of individuals of each species. This commonly results from increased habitat diversity as sedimentation rates decline. As a result, the Procedure 51 assessment scores and ratings for fish and macroinvertebrate communities and habitat quality are expected to increase as siltation and sedimentation rates decline,

embeddedness decreases, and habitat diversity increases. These latter characteristics will serve to demonstrate improvement in habitat conditions, WQS attainment, and overall stream quality as expressed through an acceptably rated biological community.

TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by a water body while still achieving WQS. Because the biotic community has been impaired by excessive sedimentation and flow instability, this TMDL will be based on the response of the fish and macroinvertebrate communities to the reduction of sedimentation. The TMDL is based on reducing sediment loads throughout the watershed to a level that supports a biological community of the stream that meets WQS. Using the metrics from Procedure 51, a numeric score of -4 for both fish and macroinvertebrate communities and a habitat score of 96 or greater will serve as primary targets for this biota TMDL.

Concurrent with the selection of numeric endpoints, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Some TMDLs are designed around the concept of critical condition. A critical condition is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other important conditions. For example, the critical conditions for the control of point sources in Michigan are provided in Rules 323.1082 and 323.1090 of Michigan's WQS. In general, the lowest monthly 95% exceedance flow for a stream is used to establish effluent limits for point sources. However, the primary sediment inputs to the Grand River and Portage River are attributable to wet weather driven discharges. As such, there is no single condition that is protective for all conditions but efforts will be directed towards wet weather runoff/washoff events.

The target of 80 mg/l TSS was used to develop a secondary TMDL loading goal for TSS loads during wet-weather runoff/washoff events, especially from the urban/industrial/built-up land use categories and agricultural land use source areas.

Allocations: TMDLs are comprised of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for NPS and natural background levels. A margin of safety (MOS), either implicit or explicit, is also a component or accounts for uncertainty in the relationship between pollutant loads and the quality of the receiving waters. Conceptually, this relationship is defined by the equation:

$$TMDL = S^{WLAs} + S^{LAs} + MOS$$

where the acronym TMDL refers to a maximum loading of a pollutant or stressor that can be discharged to a receiving water and still meet WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for NPS, and the MOS.

A phased-approach was selected to address both the biota TMDL and DO TMDL (Sunday, 2003) reaches with a target reduction in land use-related TSS loads of 50% to the Grand River in the vicinity of Jackson and Portage River. The 50% TSS load reduction was chosen in part due to the results of DO modeling, which indicates that SOD in the reaches of concern should be reduced by approximately 30 to 85%, depending on the reach under consideration, in order to achieve the DO standard. The existence of considerable uncertainties, which make it difficult to quantify the effects of TSS loads on in-stream DO levels, make the proposed 50% reduction a reasonable objective. Subsequent phases of the TMDL may lead to changes in this target. A

wet weather event in-stream numeric target of 80 mg/l TSS (as an annual average during wet weather events) is, herein, established to reduce TSS loads to the biota TMDL reach.

In preparation of a DO TMDL for the upper Grand River, Sunday (2003) estimated the total annual contribution of TSS from the various categories of land use in the immediate Grand River and Portage River Watersheds upstream of the biota TMDL to be 9.4 million pounds and 7.07 million pounds, respectively (Table 10).

Municipal and industrial storm sewer runoff/washoff to the Grand River (16% of the land use area) accounts for 49% or 4.59 million pounds of the annual TSS load contribution to the Grand River (Sunday, 2003). The NPS (84% of the land use area) accounts for 51% or 4.81 million pounds of the annual TSS load contribution to the Grand River reach. An annual permitted total TSS load of 1.7 million pounds represents contributions by the individual and general NPDES permitted facilities that discharge to the biota TMDL reach (Table 5).

Of the estimated 7.07 million pounds of TSS composing the annual load to the Portage River, less than 7,000 pounds (herein expressed as 0.01 million pounds) are annually discharged from the three WWSLs in the watershed (Table 5). Therefore, since there are no permitted industrial and municipal storm water discharges to the Portage River, approximately 100% of the storm water TSS loads to the Portage River are from NPS.

The proposed 50% reduction in the current estimated land use annual TSS loads for the Grand and Portage Rivers will result in total annual TSS load reduction targets of 6.42 and 3.55 million pounds (total of 9.97 million pounds), respectively (Table 10).

WLAs: The WLA defines the load capacity for a pollutant that are NPDES permitted in origin. This includes individual, general permitted facilities, and permitted industrial and municipal storm water outfalls (those as part of the Phase II MS4 storm water permitting program).

The annual TSS numeric target load for the Grand River reach is 4.01 million pounds for the WLA. This includes 1.71 million pounds for individual/general permitted facilities as allocated in Table 5 plus 2.3 million pounds for the industrial/municipal storm water sources. The storm water sources include both industrial outfalls and the city of Jackson's municipal Phase II MS4 outfalls (Tables 2 and 4).

LA: The LA defines the load capacity for a pollutant that is nonpoint in origin, including natural background sources.

The LA annual TSS allocation to the Grand River of 2.41 million pounds involves the townships of Summit, Blackman, and Leoni located in Jackson County (Table 10). This allocation includes storm water and snowmelt runoff from these townships to the Grand River Watershed primarily in the developed areas tributary to the reach north of the city limits of Jackson. This includes runoff drainage to the Hurd-Marvin and Tobin-Snyder Drains.

The annual LA TSS numeric target load for the Portage River is 3.54 million pounds. This is based on a 100% land use coverage that is NPS in origin that includes contributions from the following townships: Blackman, Leoni, Grass Lake, Waterloo, Henrietta, Bunkerhill, Ingham, Stockbridge, Lyndon, and Sylvan (Figure 2).

MOS: The MOS in a TMDL is used, in part, to account for variability of source inputs to the system and is either implicit or explicit. An MOS is implicit for a biota TMDL because the quality

of the biological community, its integrity, and overall composition represent an integration of the effects of the spatial and temporal variability in sediment loadings to the aquatic environment.

The habitat target score of 96 or greater will be used to demonstrate acceptable stream quality conditions and represent adequate control of anthropogenic sediment sources to assure improved habitat quality and the biological communities. This targeted score is closely associated with macroinvertebrate community scores of -3 or greater, potentially providing better results than a minimally acceptable value of -4.

For comparison of survey assessment with results from August 2001, follow-up biological and habitat quality assessments will be conducted during stable flow conditions within the months of June through September. The results will best reflect an MOS that is implicit and express an integration of the effects of the variability in sediment loads in the aquatic environment and minimize seasonal variability.

Seasonality: Seasonality is addressed in the TMDL in terms of sampling periods for fish and macroinvertebrate communities. To minimize temporal variability in the biological community, sampling will be conducted during June through September of each year during stable flow conditions. For assessing TSS loads to the Grand River, seasonal event monitoring will be conducted to define and characterize both hydraulic and TSS loads to the Grand River and Portage Creek Watersheds that influence the biota TMDL reach.

Monitoring Plan: Monitoring will be conducted by the MDEQ to assess progress towards meeting the biota TMDL targets, following implementation of applicable BMPs and control measures. Annual sampling of the macroinvertebrate community and habitat quality at High Street, Monroe Street, Parnall Road, Maple Grove Road, and US-127, as a minimum, will be conducted until assessment results from two consecutive years demonstrate attainment of TMDL targets at these sites. Fish communities will also be assessed at Maple Grove Road to assess response to TSS load reductions. For best comparative purposes, follow-up biological and habitat assessments will be conducted between June and September, during stable flow conditions. Every effort will be made to assess the same sampling locations and sample during similar river flow conditions.

Once the BMPs are in place to minimize the effects of urban and agricultural runoff rates and TSS loads, stream flow and TSS sampling can be implemented to measure progress towards the secondary numeric target of 80 mg/l as a mean annual TSS value during wet weather events. Multiple sampling during seasonal, critical high flow events, as well as low flow events, need to be conducted to better estimate TSS loads to the biota TMDL reach from both the Grand River and Portage River Watersheds.

Reasonable Assurance: The focus of the actions to protect the biota TMDL reach of the Grand River is directed toward installing BMPs and other control measures to reduce and minimize controllable source sediment loads and excessive runoff discharge rates. The actions are to reduce sedimentation impacts on available habitat and biological communities and minimize and stabilize flow conditions in the Grand River in response to wet weather runoff/washoff events. Overall control measures include: complete CSO elimination, individual and general NPDES permit limits maintained, and storm water permits that include BMPs and BMPs for areas not under any permit.

For the WLA, existing NPDES permit requirements will be adequate to meet the target. Storm water permits require the units of government to develop a plan that includes the detailing of short- and long-term goals and attainment actions; public education plans; illicit discharge

elimination plans; and the development of individual storm water pollution prevention plans by each local unit of government.

A watershed management plan for the upper Grand River Watershed has been developed by the upper Grand River Watershed Planning Initiative Steering Committee (Tetra-Tech, 2003 - in draft). The final plan is to be received by the MDEQ by September 2003 and reviewed to determine eligibility for funding by Michigan's Clean Michigan Initiative grant.

MDEQ Jackson District staff will continue to work with and assist interest groups in the upper Grand River Watershed. MDEQ involvement is to assist in defining and designing approvable actions and programs that assess, develop, plan, and implement BMPs and control measures that best minimize or prevent soil erosion and excessive runoff rates to the upper Grand River and Portage River Watersheds.

The MDEQ's Guidebook of BMPs for Michigan Watersheds (Peterson et al., 1993, as modified) can be used to develop BMP elements that should include:

- Upgrade and maintain the current vegetative riparian zone to reduce soil erosion and loads to the Portage River from farmland, subdivision, and urban sources. BMPs need to be employed within the riparian zone adjacent to the farmland to minimize the loss, through erosion and direct runoff, thereby minimizing habitat impairment and preserving farmland soils.

- Implementation of BMPs in the storm water permit program that reduces sediment loads and moderate runoff/washoff release rates and excessive runoff to the Grand River and Portage River Watersheds are expected to improve and protect designated use support throughout the watershed. The goals reduce solids loads and provide greater flow stability (reduced release rates) throughout the watershed so that WQS are restored and protected. Recent guidance regarding runoff detention and stream protection is provided by Fongers and Fulcher, 2001.

MDEQ approval of BMPs and implementation plans will be required prior to implementation of proposed structural improvements. These reasonable assurance actions will proceed to implement this TMDL under the phased approach. The collection of additional data is to determine if anticipated improvements in WQS are occurring or attained. If the numeric target is not met, the TMDL will be reevaluated and modified as appropriate.

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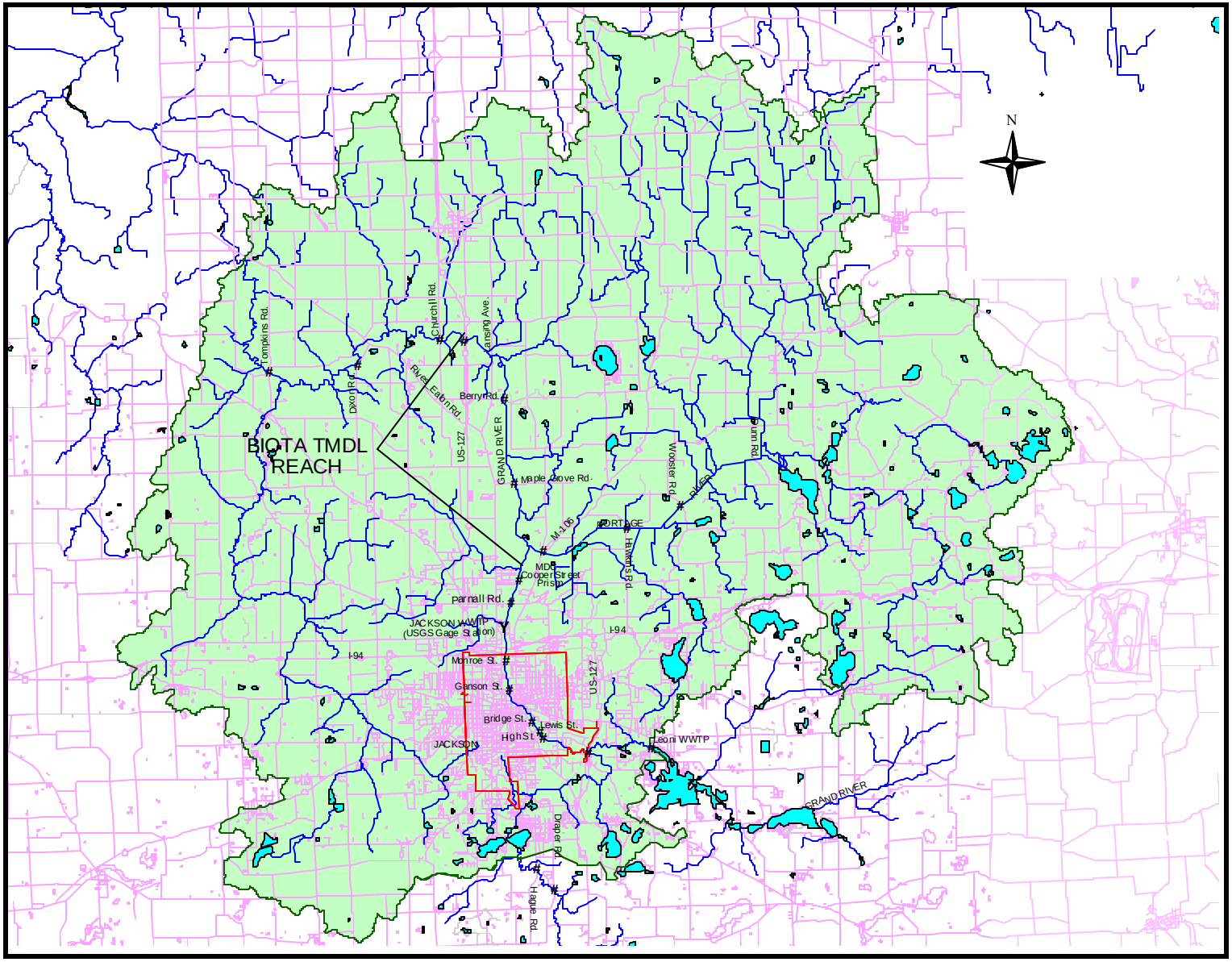

Figure 1. Biota TMDL reach in the vicinity of the city of Jackson and downstream of the confluence of the Grand River and Portage River, Jackson County, Michigan

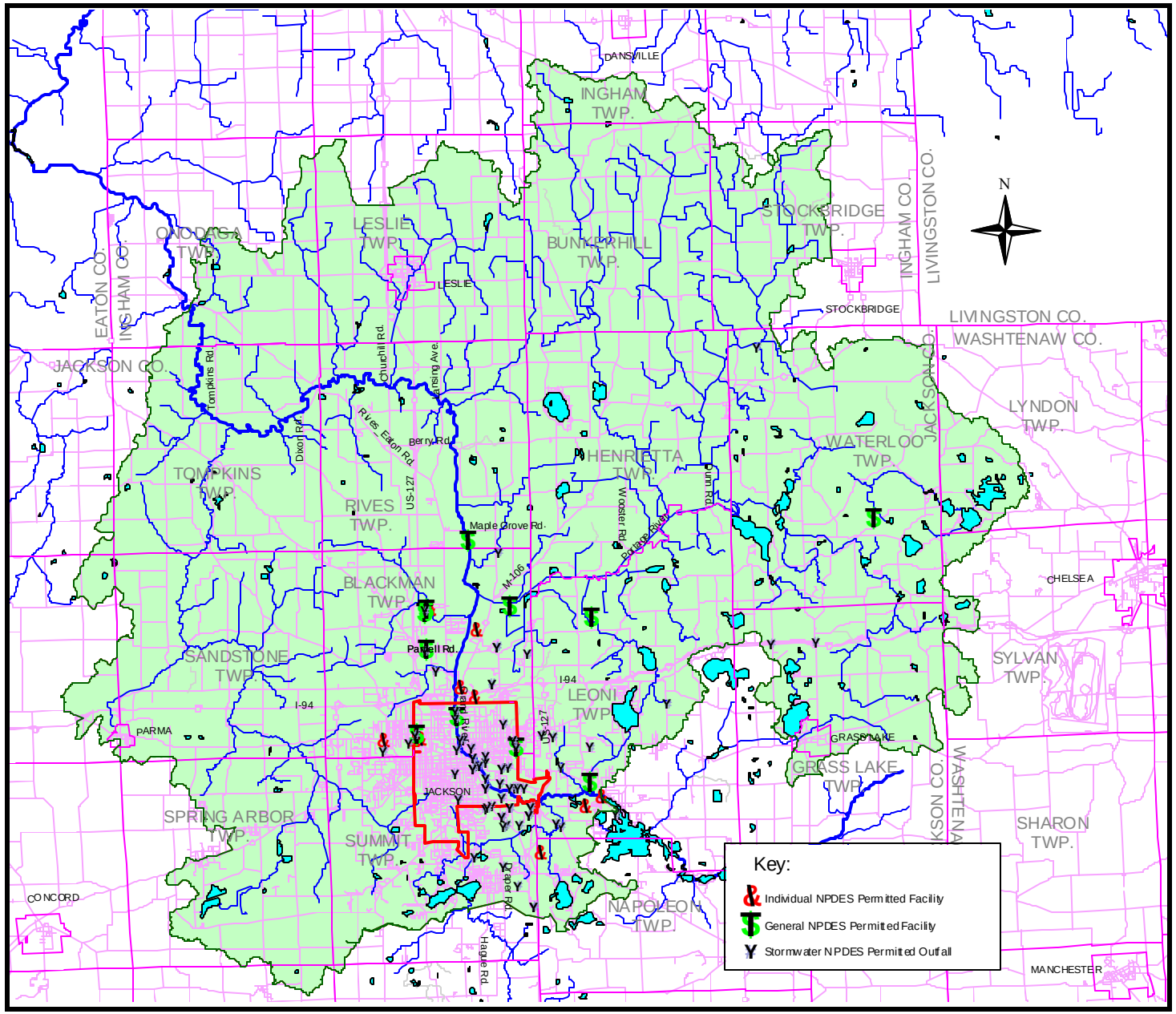

Figure 2. NPDES permitted (individual, general, and storm water) discharges in the upper Grand River Watershed, vicinity of Jackson, Michigan.

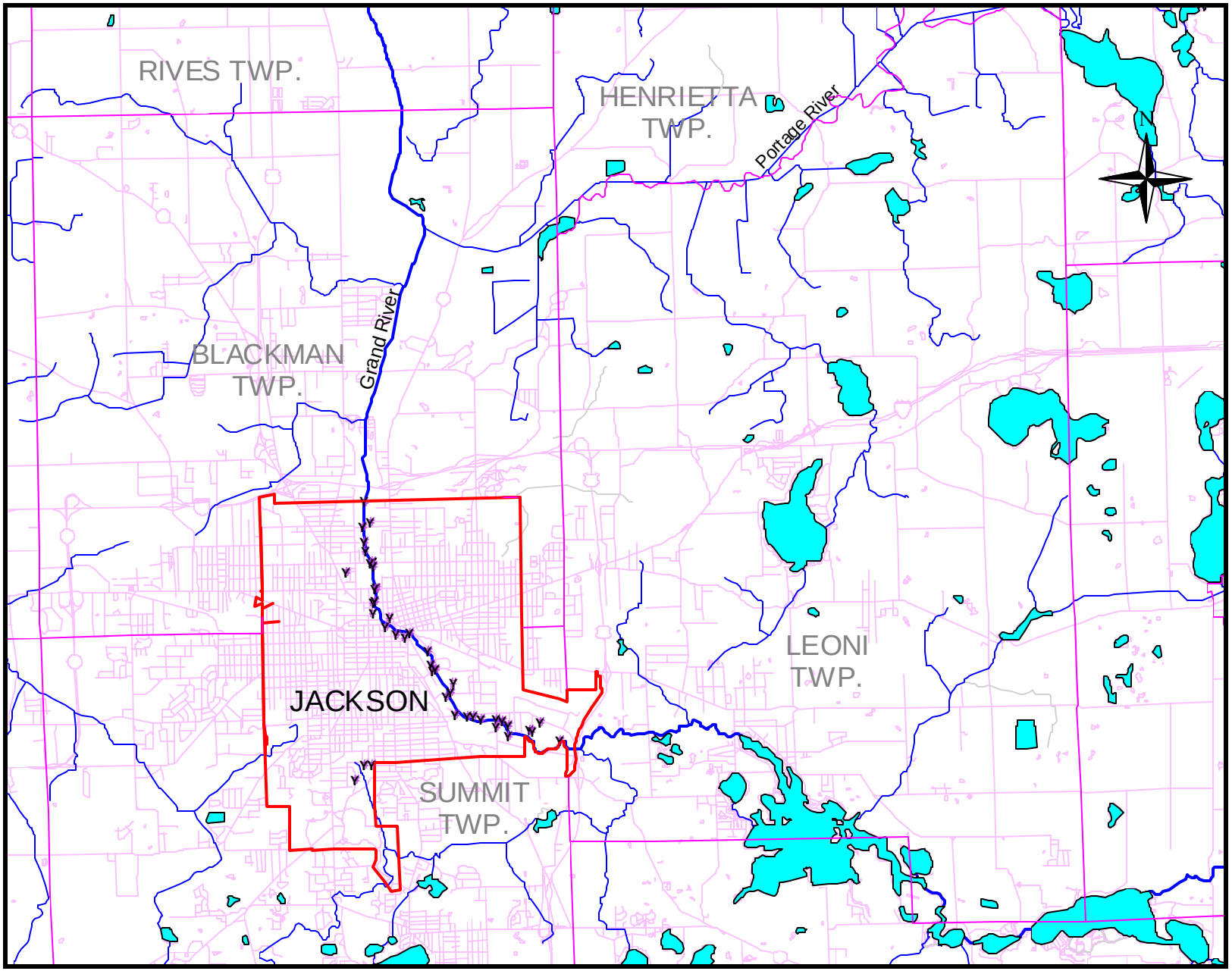

Figure 3. City of Jackson's municipal storm water outfalls to the upper Grand River Watershed, Jackson County, Michigan.

Table 1. Individual and general NPDES permitted outfalls to the Grand River and Portage River Watersheds in the vicinity of Jackson. Source: MDEQ/WD's NPDES Permit Management System (NMS); *MGY = million gallons per year.

PERMIT NUMBER	FACILITY	RECEIVING WATERS	DESIGN FLOW (MGY*)	LATDD	LONGDD
Individual NPDES Permits:					
MI0023256	Jackson WWTP	Grand River	6935.00	42.27611	-84.40611
MI0028461	Quanex Corp-Mac Steel Division	Grand River via wetland and Akerson Drain	55.00	42.20556	-84.36222
MI0041998	Mich Center School District	Murray Lake	0.12	42.22444	-84.33694
MI0045403	Marathon Ashland Petro-Jacks	Grand River via Tobin Snyder Drain	39.00	42.31028	-84.42361
MI0045942	Leoni Twp WWTP	Grand River at Center Lake outlet	949.00	42.23860	-84.25750
MI0046809	Citgo Corp-Jackson	Grand River via Tobin Snyder Drain	171.00	42.30889	-84.42250
MI0051683	Mechanical Products	Grand River via storm sewer	33.00	42.27167	-84.39861
MI0054976	MDC-SPSM-GWCU	Grand River	26.00	42.30000	-84.39583
MI0055042	Plastigage Corp	Hurd Marvin Drain via storm sewer	64.00	42.25417	-84.45000
MI0056006	TRW Inc-Jackson	Grand River	18.30	42.25417	-84.42917
		Total Design Discharge (mgy):	**8290**		
General Permits:					
MIG080265	Wolverine Pipeline Co-Jackson	Tobin Snyder Drain	10.50	42.30722	-84.42528
MIG250042	Industrial Steel Treating Co	Grand River	100.40	42.25583	-84.43194
MIG250355	ADCO Products Inc	Grand River	27.40	42.23417	-84.33389
MIG250360	Lefere Forge & Machine	Grand River	4.40	42.25000	-84.37500
MIG250365	Mid-American Products	Grand River	21.90	42.26250	-84.40833
MIG250396	B & H Machine Inc	Tobin Snyder Drain	18.30	42.29167	-84.42556
MIG580001	MDC-Waterloo WWSL	unnamed trib. to Portage River	10.95	42.34361	-84.17000
MIG580258	MDC-SPSM-Wing WWSL	Portage River	3.00	42.30972	-84.37778
MIG580259	MDC-SPSM-Dale Foltz TC WWSL	Wildcat Creek	0.50	42.30417	-84.33194
MIG580274	Sherman Oaks MHP WWSL	Grand River	34.00	42.33750	-84.40000
MIG670278	Equilon Enterprises-Jackson	Rives-Blackman Drain	307.00	42.30861	-84.42444
		Total Design Discharge (mgy):	**538**		

Table 2. NPDES permitted industrial storm water outfalls to the Grand River and/or Portage River Watersheds in the vicinity of Jackson.

PERMIT NUMBER	FACILITY	TYPE	LATDD	LONGDD
Storm Water NPDES Permits:				
MIR011159	Eaton Hydraulics Inc	Industrial Stormwater Only	42.20000	-84.38333
MIR011220	Wolverine Vinyl Siding	Industrial Stormwater Only	42.24417	-84.39250
MIR011324	Jackson County Airport	Industrial Stormwater Only	42.25972	-84.45917
MIR011327	Thompson-McCully Co-Jackson	Industrial Stormwater Only	42.27722	-84.38833
MIR011332	Legends Mfg Inc	Standard	42.25389	-84.47583
MIR011338	Tenneco Auto Grass Lk	Industrial Stormwater Only	42.29167	-84.22917
MIR011339	Midbrook Inc	Industrial Stormwater Only	42.22444	-84.39306
MIR011340	Camshaft Machine Co	Industrial Stormwater Only	42.28306	-84.41972
MIR011341	Fourway Machine	Industrial Stormwater Only	42.25528	-84.36028
MIR011342	Hydraulic Systems Inc	Industrial Stormwater Only	42.22611	-84.38917
MIR011343	USF Holland Inc-Jackson	Industrial Stormwater Only	42.25222	-84.47833
MIR011344	C & K Box Company	Industrial Stormwater Only	42.25306	-84.43528
MIR011345	Production Engr Inc	Industrial Stormwater Only	42.21778	-84.38083
MIR011347	Worthington Specialty Proc	Industrial Stormwater Only	42.19167	-84.37500
MIR011348	Mich Auto Compressor Inc	Industrial Stormwater Only	42.26722	-84.54167
MIR011350	Blu-Surf Inc	Industrial Stormwater Only	42.25833	-84.55000
MIR011351	Pioneer Foundry Co Inc	Industrial Stormwater Only	42.24278	-84.39750
MIR011352	O' Briens Trading Post	Industrial Stormwater Only	42.22139	-84.31944
MIR011353	Edscha Jackson	Industrial Stormwater Only	42.25306	-84.37611
MIR011405	UPS-Jackson	Industrial Stormwater Only	42.21667	-84.38333
MIR011418	United Metal Technology Inc	Industrial Stormwater Only	42.26750	-84.28861
MIR011419	Willbee Transit Mix	Industrial Stormwater Only	42.25417	-84.50833
MIR011441	Crankshaft Machine Group	Industrial Stormwater Only	42.24972	-84.40833
MIR011445	Michner Plating-Angling Road	Industrial Stormwater Only	42.22917	-84.38333
MIR011447	Elm Plating Co Plt 2	Industrial Stormwater Only	42.23333	-84.37639
MIR011448	Elm Plating Co-Plt 1	Industrial Stormwater Only	42.22500	-84.39167
MIR011449	H & M Welding & Fab	Industrial Stormwater Only	42.24167	-84.35000
MIR011450	McGill Road Landfill	Industrial Stormwater Only	42.28944	-84.36750
MIR011451	Jackson Co Dalton Road LF	Industrial Stormwater Only	42.29306	-84.38472
MIR011452	Jackson Co RRF	Industrial Stormwater Only	42.29306	-84.38472
MIR011453	Conway Central Express-XJA	Industrial Stormwater Only	42.25000	-84.33333
MIR011455	Mich ARNG Jack Armory OMS12	Industrial Stormwater Only	42.25000	-84.40000
MIR011456	American Tooling Center Inc	Industrial Stormwater Only	42.29167	-84.20417
MIR011457	Miller Tool & Die Co	Industrial Stormwater Only	42.23333	-84.39167
MIR011458	Clarklake Machine Inc	Industrial Stormwater Only	42.18333	-84.36667
MIR011459	Allied Chucker & Engr Co	Industrial Stormwater Only	42.27500	-84.48750

Table 2. (cont.)

PERMIT NUMBER	FACILITY	TYPE	LATDD	LONGDD
MIR011460	Way Bakery Div	Industrial Stormwater Only	42.23333	-84.37083
MIR011461	Dawn Food Products	Industrial Stormwater Only	42.22500	-84.36667
MIR011462	Advance Packaging Corp-Jac	Industrial Stormwater Only	42.23333	-84.37500
MIR011464	Michner Plating-N Mechanic	Industrial Stormwater Only	42.25417	-84.40417
MIR011465	Worthington Steel	Industrial Stormwater Only	42.24167	-84.38333
MIR011466	TAC Manufacturing	Industrial Stormwater Only	42.27500	-84.47917
MIR011467	Wolverine Metal Specialties	Standard	42.25417	-84.48333
MIR011468	Dawlen Corp	Industrial Stormwater Only	42.22500	-84.36667
MIR011469	John Crowley Inc	Industrial Stormwater Only	42.24167	-84.40000
MIR011470	Mich Extruded Aluminum	Industrial Stormwater Only	42.25417	-84.35417
MIR011471	C & H Stamping Inc	Industrial Stormwater Only	42.41667	-84.23333
MIR011472	Storey Stone Co	Industrial Stormwater Only	42.20417	-84.40000
MIR011473	Michigan Seat Co	Industrial Stormwater Only	42.22083	-84.38333
MIR011474	Chemical Technologies	Industrial Stormwater Only	42.23333	-84.37917
MIR011475	Liberty Environmentalists	Industrial Stormwater Only	42.18333	-84.36667
MIR011476	Jackson Iron & Metal #1	Industrial Stormwater Only	42.24167	-84.37917
MIR011477	Jackson Iron & Metal #2	Industrial Stormwater Only	42.23750	-84.39167
MIR011478	Andys Airport Auto Parts	Industrial Stormwater Only	42.25000	-84.45000
MIR011482	Miller Truck & Storage	Industrial Stormwater Only	42.24167	-84.38333
MIR011483	Boone's Welding & Fab	Industrial Stormwater Only	42.22917	-84.40833
MIR011484	Mag-Tec Casting Corp	Industrial Stormwater Only	42.21667	-84.35000
MIR011485	Norfolk Southern Jackson	Industrial Stormwater Only	42.24583	-84.40000
MIR011486	Jackson Auto Salvage	Industrial Stormwater Only	42.25417	-84.50000
MIR011491	International Foam & Trim	Industrial Stormwater Only	42.25000	-84.47917
MIR011512	Riverside Grinding Co	Industrial Stormwater Only	42.22472	-84.37917
MIR011513	Specialty Castings Inc	Standard	42.37500	-84.69583
MIR011520	Lefere Forge & Machine	Standard	42.25000	-84.37500
MIR011526	B & H Machine Inc	Standard	42.29167	-84.42556
MIR011527	Mid-American Products	Standard	42.26250	-84.40833
MIR011563	Jackson Iron & Metal-Elm Div	Industrial Stormwater Only	42.23556	-84.38417
MIR011609	Orbitform	Industrial Stormwater Only	42.22139	-84.36861
MIR011610	South Street Automotive	Industrial Stormwater Only	42.21778	-84.35250
MIR011617	Emmons Service Inc	Industrial Stormwater Only	42.23972	-84.40972
MIR011618	Linear Automatic Systems	Industrial Stormwater Only	42.25389	-84.40639
MIR011619	Industrial Steel Treating Co	Standard	42.25583	-84.43194
MIR011641	Bailey Sand & Gravel Co	Industrial Stormwater Only	42.25000	-84.51278
MIR011659	Sams Iron & Metal Co	Industrial Stormwater Only	42.26583	-84.40833
MIR011673	Kaneka Texas Corp	Industrial Stormwater Only	42.27417	-84.48056
MIR011710	Eaton Aeroquip Inc	Industrial Stormwater Only	42.24694	-84.39250

Table 2. (cont.)

PERMIT NUMBER	FACILITY	TYPE	LATDD	LONGDD
MIR011712	Miller Industrial Products	Industrial Stormwater Only	42.24278	-84.39583
MIR011718	Professional Assembly Corp	Industrial Stormwater Only	42.21750	-84.37333
MIR011727	D-CO Limestone LLC	Industrial Stormwater Only	42.33292	-84.38182
MIR020005	Equilon Enterprises-Jackson	Standard	42.30861	-84.42444
MIR020014	Koch Materials Co-Jackson	Industrial Stormwater Only	42.24583	-84.40000
MIR020032	Jackson Power Facility	Industrial Stormwater Only	42.26022	-84.38192
MIS310004	Allied Chucker & Engr Co	Industrial Stormwater Only	42.27500	-84.48750
MIS310007	International Foam & Trim	Industrial Stormwater Only	42.25000	-84.47917
MIS310010	Miller Tool & Die Co	Industrial Stormwater Only	42.23333	-84.39167
MIS310012	Riverside Grinding Co	Industrial Stormwater Only	42.22472	-84.37917
MIS310013	Orbitform	Industrial Stormwater Only	42.22139	-84.36861
MIS310022	Willbee Transit Mix	Industrial Stormwater Only	42.25417	-84.50833
MIS310023	Jackson Auto Salvage	Industrial Stormwater Only	42.25417	-84.50000
MIS310030	Thompson-McCully Co-Jackson	Industrial Stormwater Only	42.27722	-84.38833
MIS310032	John Crowley Inc	Industrial Stormwater Only	42.24167	-84.40000
MIS310033	Michigan Seat Co	Industrial Stormwater Only	42.22083	-84.38333

Table 3. Active NPDES permit notices of coverage for construction sites in Jackson County, Michigan.

PERMIT NUMBER	FACILITY	LOCATION	TWP.	RANGE	SECTION	DATE RECEIVED	EFFECTIVE DATE
MIR102805	SCHOTT-HICKORY HILLS GOLF CLUB	2540 PAR VIEW DR, JACKSON				01/30/1998	01/30/1998
MIR102912	MDOT-M60-JACKSON COUNTY	SPRING ARBOR, SUMMT, AND BLACKMAN TWPS				03/24/1998	03/24/1998
MIR103006	IPL TOLEDO-HANNAWALD STRG YD	M-52, WATERLOO	T1S	R2E	1	05/11/1998	05/11/1998
MIR103095	WATERLOO GOLF COURSE EXPANSION	11800 TRIST RD, GRASS LAKE	T1S	R2E	33	06/17/1998	06/17/1998
MIR103498	KARVOL-TIMS LAKE PRESERVE	KNIGHT RD - MT HOPE RD, GRASS LAKE	T2S	R2E	21	12/15/1998	12/15/1998
MIR103980	GILLESPIE-GALLERY PLACE	PARNALL RD, NE CORNER OF PARNALL AND LANSING RD	T2S	R1W	15	08/11/1999	08/11/1999
MIR104072	STERLING-ASHTON RIDGE APTS	2905 BLAKE RD, JACKSON BETWEEN N ELM AND DETTMAN RD	T2S	R1W	25	09/28/1999	09/28/1999
MIR104174	JMK-ART MOEHN CHEVROLET/HONDA	SEYMOUR RD N OR I-94				11/29/1999	11/29/1999
MIR104208	NORFOLK-SUMMIT GLEN/RIDGE CNDO	BETWEEN MC CAIN AND MORRELL ST NEAR ROBINSON	T3S	R1E	5	11/17/1999	12/29/1999
MIR104362	JCRC-BOARDMAN ROAD EXTENSION	LONGFELLOW TO MAYNARD TO AIRPORT RD				03/08/2000	03/20/2000
MIR104382	JCRC-WILDWOOD/GANSON RECONST	MICHIGAN AVE TO BROWN	T2S	R1W	32,33	03/24/2000	03/24/2000
MIR104492	SUMMIT GLEN/SUMMIT RIDGE	MCCAIN RD, JACKSON	T3S	R1E	5	04/19/2000	05/15/2000
MIR104558	COLBROOK-COLBROOK MEADOWS	JEFFERSON RD AND TIFFANY RD	T4S	R1E	24	06/05/2000	06/05/2000
MIR104644	MOLTON GROUP-CORONADO	NAPOLEON RD & DORRELL RD	T3S	R1E	14	07/07/2000	07/11/2000
MIR104814	BULLINGER/WANDERING CK CONDO	S JACKSON RD S OF FERGUSON	T3S	R1W	21	09/19/2000	09/19/2000
MIR104943	KIRK MERCER	8049 S JACKSON RD	T4S	R1W	3	11/17/2000	11/29/2000
MIR105057	KINDER MORGAN-ORION PLANT	2219 CHAPIN ST, JACKSON	T3S	R1W	36	01/22/2001	01/22/2001
MIR105198	JACKSON CON ENRGY HEADQUARTER	BETWEEN FRANCIS ST ON AIRLINE DR	T3S	R1W	2	03/28/2001	03/28/2001
MIR105197	PENMARK GOODYR TIRE DEMOLITION	1304 PAGE ST, JACKSON	T2S	R1W	36	03/28/2001	03/28/2001
MIR105238	ECCLESIA RIDGE VIEW ESTATES	MICHIGAN AVE, MT. HOPE ROAD, GRASS LAKE TWP	T2S	R2E	33	04/24/2001	04/24/2001
MIR105297	MDOT CS 38111	JN 55900A				05/17/2001	05/17/2001
MIR105301	SCENIC HILLS	SCENIC HILLS DRIVE	T2S	R1E	29	05/18/2001	05/21/2001
MIR105498	DRS-MYSTIC HILLS-GRANDE GOLF	FLOYD RD NEAR US-127			24, 25	07/30/2001	08/24/2001
MIR105566	GANTON'S-TERRACE HILLS 1A & 1B	ROBINSON & SPRING ARBOR RD, JACKSON	T3S	R1W	7	09/21/2001	09/21/2001
MIR105586	LEFERE-SPEEDWAY-KART TRACK	PAGE AVE, JACKSON	T3S	R1E	6	09/17/2001	10/03/2001
MIR105614	MDOT-US127 RECONSTRUCTION		T3S	R1E		10/17/2001	10/17/2001
MIR105665	SUN COMM-WINDHAM HILLS	COUNTY FARM RD, JACKSON	T2S	R1W	19	11/20/2001	11/20/2001
MIR105695	JACKSON CO-FRANCIS ST RECONST	FRANCIS ST MCDEVITT TO SOUTH ST, JACKSON	T3S	R1W	10,11,14,22,23	11/26/2001	12/04/2001
MIR105704	TAC-MFG PLANT ADDITION	4111 COUNTY FARM RD	T2S	R1W	30	11/30/2001	12/07/2001
MIR105886	MJ FARMS-GREENBRIAR PH 2	KING RD, SPRING ARBOR	T3S	R2W	9	03/25/2002	03/25/2002
MIR105925	MDOT-M50 / US127 BL	NORTH ST TO BOARDMAN RD	T2S	R1W	27,28,33,4	04/05/2002	04/05/2002
MIR105996	VISTA GRANDE VILLA EXPANSION	2251 SPRINGPORT RD	T20S	R1W	28	05/08/2002	05/08/2002
MIR106096	HOME DEPOT-INSTALLMENTS	1400 W MONROE ST	T2N	R1W	28	06/14/2002	06/14/2002
MIR106113	SD-ARBORS @ THE WOODS	DETLMAN & AMOS, JACKSON	T2S	R1W	36	06/19/2002	06/19/2002
MIR106173	HOME DEPOT STORE 2770-JACKSON	NW CORNER OF MONROE & WISNER ST	T2N	R1W	28	07/18/2002	07/18/2002
MIR106172	NORFOLK-SUMMIT GLEN/OAK GROVE	BARRINGTON CIRCLE, JACKSON	T3S	R1E	5	07/18/2002	07/18/2002
MIR106194	SANCTUARY OF BRILLS LK PH 2	3650 WHIPPLE RD, JACKSON	T2S	R1E	22	07/30/2002	07/30/2002
MIR106265	WELLHOFF-BRENDAN ESTATES	M-50, NAPOLEON	T4S	R1E	1	08/21/2002	08/21/2002
MIR106529	MDOT-US127, JACKSON		T4S	R1W	13	01/16/2003	01/16/2003

Table 4. City of Jackson identified municipal storm water outfall locations to the Grand River. Provided as part of Phase II MS4 storm water permit program.

OUTFALL LOCATION DESCRIPTION	LATDD	LONGDD
E. of N. Blackstone St.	42.26925	-84.40983
E. Monroe St. (W. Price St.)	42.26576	-84.40851
W. Monroe St.	42.26495	-84.41011
Adams St. (W)	42.26243	-84.40997
Myrtle St. (W)	42.26102	-84.40969
North St. (NE)	42.25913	-84.40813
North St. (NW)	42.25892	-84.40859
North St. (SE)	42.25840	-84.40767
Mongomery St.	42.25739	-84.41426
Gauson St. (NE)	42.25475	-84.40725
Gauson St. (NW)	42.25460	-84.40771
W. Trail St. (NW)	42.25247	-84.40813
W. Trail St. (NE)	42.25268	-84.40754
N. Jackson St. (N of RR)	42.25040	-84.40822
Oak St. (N of Detroit St.)	42.24978	-84.40448
Mechanic St. (E) (N of Mich. Ave.	42.24806	-84.40541
Francis St. (@ W. Cortland Ave.)	42.24692	-84.40323
S. Airline Dr. (S. Louis Glick Hw	42.24630	-84.40134
Hupp Ave. (N)	42.24711	-84.40001
Hupp Ave. (S)	42.24396	-84.39608
Amur St.	42.24182	-84.39538
Bridge St. (NW)	42.24075	-84.39502
Bridge St. (NE)	42.24096	-84.39437
Mitchell St. (ext. W)	42.23854	-84.39040
Louis St. (SW)	42.23630	-84.39188
Louis St. (NE)	42.23692	-84.39105
High St. (W)	42.23320	-84.38994
High St. (SW)	42.23293	-84.38745
High St. (SE)	42.23282	-84.38615
S. Elm Ave.	42.23245	-84.38435
Losey Ave. (N)	42.23238	-84.38089
Losey Ave. (S)	42.23117	-84.38089
Gorham St.	42.23221	-84.37946
Clara St. (N)	42.23117	-84.37794
Clara St. (S)	42.22962	-84.37803
Research Ave. (NW)	42.23042	-84.37355
Research Ave. (SE)	42.23004	-84.37290
E. High St. (S)	42.23162	-84.37078
Dirlam Dr.	42.22856	-84.36653
Goodrich St. & W. South St. (S)	42.22515	-84.41094
S. Jackson St. & W. South St. (S)	42.22504	-84.40915
Oakwood Dr. (E) at Colfax St.	42.22270	-84.41288

Table 5. Individual and general NPDES permitted facilities in the upper Grand River Watershed and estimated total suspended solids loads.

Permit Number	Permitted Facility Name	Annual Design Flow (mgy)	Maximum Monthly Average Limit TSS (mg/l)	Annual TSS Loads (pounds)
Individual NPDES Permits:				
MI0023256	Jackson WWTP	6935	20 and 25	1288800*
MI0028461	Quanex Corp-Mac Steel Div	55	25	11415
MI0041998	Michigan Center School Dist	0.1	30**	30
MI0045403	Marathon Ashland Petro-Jackson	39	30**	9758
MI0045942	Leoni Twp WWTP	949	20 and 30	190170*
MI0046809	Citgo Corp-Jackson	171	30**	42784
MI0051683	Mechanical Products	33	30**	8257
MI0054976	MDC-SPSM-GWCU	26	30**	6505
MI0055042	Plastigage Corp	64	30**	16013
MI0056006	TRW Inc-Jackson	18.3	30**	4579
	Total:	**8,290**		**1,578,311**
General NPDES Permits:				
MIG080265	Wolverine Pipeline Co-Jackson	10.5	30**	2629
MIG250042	Industrial Steel Treating Co	100.4	30**	25135
MIG250355	ADCO Products Inc	27.4	30**	6860
MIG250360	Lefere Forge & Machine	4.4	30**	1102
MIG250365	Mid-American Products	21.9	30**	5483
MIG250396	B & H Machine Inc	18.3	30**	4581
MIG670278	Equilon Enterprises-Jackson	307	30**	76857
MIG580001	MDC-Waterloo WWSL	11	40 and 70	5049***
MIG580258	MDC-SPSM-Wing WWSL	3	40 and 70	1375***
MIG580259	MDC-SPSM-Dale Foltz TC WWSL	0.5	40 and 70	229***
MIG580274	Sherman Oaks MHP WWSL	34	40 and 70	15603***
	Total:	**538**		**144,801**
			Grand Total:	**1,723,112**

- Total TSS loadings estimates for 5/1 to 11/30 plus 12/1 to 4/30; ** Not limited but assumed maximum monthly TSS concentration; *** Combined total TSS loadings for permitted discharge periods 3/1 to 5/31 and 10/1 to 12/31.

Table 6. Wet weather data: minimum-maximum range and (average) parameter concentrations (mg/l). (Source: excerpt from LTI, 2003 – in draft).

Parameter	Date (rainfall as inches)	North Branch Grand River at Falahee Rd.	Grand River d/s Parnall Rd. at Prison	Portage River at M -106
$CBOD_5$ (mg/l)	July 9-10 (0.93)	No data	2 – 17 (6.71)	3 – 4 (3.14)
	July 18-19 (0.16)	No data	3 – 6 (4.2)	2 – 2 (2)
	July 26-29 (4.93)	2 – 3 (2.39)	2 – 4 (2.71)	2 – 3 (2.25)
Total organic carbon (mg/l)	July 9-10 (0.93)	No data	8.35 – 22 (11.79)	10.3–12.7 (11.79)
	July 18-19 (0.16)	No data	9 – 15 (11.88)	9.5 – 12 (7.76)
	July 26-29 (4.93)	8.56 – 10.40 (9.36)	4.5 – 7.6 (6.29)	3.19 – 12 (7.76)
Total suspended solids (mg/l)	July 9-10 (0.93)	No data	10 – 140 (64.9)	10 – 37 (19.93)
	July 18-19 (0.16)	No data	30 – 170 (79)	11 – 26 (15.75)
	July 26-29 (4.93)	5 – 12 (8.17)	13 – 400 (175.9)	9 – 190 (59.25)
Total ammonia (mg/l)	July 9-10 (0.93)	No data	0.03 – 0.14 (0.08)	0.04 – 0.15 (0.09)
	July 18-19 (0.16)	No data	0.1 – 0.2 (0.14)	0.03 – 0.29 (0.13)
	July 26-29 (4.93)	0.01 – 0.07 (0.03)	0.04 – 0.18 (0.09)	0.04 – 0.2 (0.08)
Nitrate + nitrite (mg/l)	July 9-10 (0.93)	No data	1.76 – 4.29 (2.9)	0.18 – 2.41 (0.61)
	July 18-19 (0.16)	No data	2.9 – 6 (4.9)	0.19 – 0.52 (0.30)
	July 26-29 (4.93)	0.07 – 0.37 (0.22)	1.41 – 4.58 (3.17)	0.24 – 3.5 (0.94)
Orthophosphate (mg/l)	July 9-10 (0.93)	No data	0.01 – 4.2 (0.72)	0.02 – 0.10 (0.04)
	July 18-19 (0.16)	No data	0.06 – 0.29 (0.21)	0.01 – 0.02 (0.12)
	July 26-29 (4.93)	0.02 – 0.09 (0.04)	0.04 – 0.3 (0.16)	0.01 – 0.11 (0.03)
Total phosphorus (mg/l)	July 9-10 (0.93)	No data	0.28 – 0.65 (0.42)	0.1 – 0.19 (0.12)
	July 18-19 (0.16)	No data	0.45 – 0.72 (0.57)	0.09 – 0.12 (0.10)
	July 26-29 (4.93)	0.09 – 0.15 (0.12)	0.31 – 2.04 (0.75)	0.06 – 0.45 (0.19)

Table 7. Wet weather data: Minimum-maximum range (average) of TSS concentrations (mg/l). (Source: excerpt from LTI, 2003 – in draft).

Wet Weather Event (Date and Rainfall)	Grand River TSS (mg/l) u/s of Jackson Falahee Road	Grand River TSS (mg/l) MDC Cooper Street Prison	GrandRiver Flow Increase (cfs) MDC Cooper Street Prison	Portage River TSS (mg/l) M-106
July 9-10 (0.92 inches)	no data	10 to 140	77	10 – 37 (20)
July 18-19 (0.16 inches)	no data	30 to 170	106	11 – 26 (15.8)
July 26 – 29 (4.93 inches)	5 – 12 (8.17)	13 to 400	370	9 – 190 (59.3)

Table 8. Wet weather event increase in flow and TSS loadings to the Grand River at MDC Cooper Street location) as affected by storm water runoff/washoff events from the city of Jackson.

Wet Weather Event (Date and Rainfall)	Jackson USGS Gage Flow cfs (mgd)	MDC Cooper St. Prison Flow cfs (mgd)	MDC Cooper St. TSS Range (mg/l)	MDC Cooper St. TSS Loadings (pounds/day)	Background TSS Loads (pounds/day)	Percent TSS Load Increase
Pre-Storm Event	45 (29)	45 (29)	15*		3630	5
July 9 (0.93 inches)	45 to 179 (29 to 116)		16 to 140	64,191		95
Pre-Storm Event	44 (28)	44 (28)	15*		3505	7
July 18, 2002 (0.16 inches)	44 to 150 (28 to 97)		30 to 170	47,559		93
Pre-Storm Event	33 (21)	33 (21)	15*		2629	1
July 26, 2002 (1.33 inches)	33 to 403 (21 to 260)		14 to 400	365,638		99

* Typical background concentration during stable flow conditions; ** Includes storm water runoff loadings and resuspension of in-place TSS.

Table 9. Gross estimate of daily TSS loadings to the Grand River contributed by background, point sources, and storm water during the July wet weather monitoring of July 2002 (LTI, 2003 – in draft).

Wet Weather Event (Date and Rainfall Event and Sources)	Daily TSS Loadings (pounds/day)	Relative Percent Contribution
July 9 (0.93 inches)		
Background:	3630*	4
Facilities:	1,878**	3
Urban Stormwater/Resuspension	64,191	93
Total Loadings:	69,699	
July 18, 2002 (0.16 inches)		
Background:	3505*	6
Facilities:	1,878**	4
Urban Stormwater/Resuspension	47559	90
Total Loadings:	52,942	
July 26, 2002 (1.33 inches)		
Background:	2629*	<1
Facilities:	1,878**	<1
Urban Stormwater/Resuspension	374596	99
Total Loadings:	379,103	

* Derived based on TSS of 15 mg/l* pre-storm river flows*8.345; ** Jackson WWTP TSS loadings based on 13.2 mgd* 5 mg/l TSS*8.345 to characterize real loads. No TSS loads were applied to the Leoni WWTP or WWSLs since they were not discharging at the time. All other permitted point source contributions were based on daily facility design flows*30 mg/l TSS*8.345.

Table 10. Annual total suspended solids load source allocations and numeric targets.

Water body	Current Annual TSS Load (million pounds)	Annual TSS Load Numeric Target (million pounds)	WLA Annual TSS Load (million pounds)	LA Annual TSS Load (million pounds)
GRAND RIVER:				
Industrial/Municipal Storm Water Permitted Outfalls*	4.59	2.30	2.30	-
Other Land Use Related Sources**	4.81	2.41	-	2.41
Existing Ind./Gen NPDES Permitted Facilities	1.71	1.71	1.71	-
Grand River Total Annual Loads	11.11	6.42	4.01	2.41
PORTAGE RIVER:				
Land Use Related Sources***	7.07	3.54	-	3.54
Existing Ind./Gen NPDES Permitted Facilities	0.01	0.01	0.01	-
Portage River Total Annual Loads	7.08	3.55	0.01	3.54
Total:	18.19			
Annual TSS Load Numeric Target To Biota TMDL Reach	-	9.97	4.02	5.95

* Primarily attributed to urban or built-up land uses in the city of Jackson; ** Attributed to nonurbanized/built-up land uses in the Twps of Leoni, Blackman, and Summit; *** Attributed to nonurban or built-up land uses in the Portage River Watershed.

Michigan Department of Environmental Quality

Water Division

June 2003

Total Maximum Daily Load for *Escherichia coli* for the Grand River Jackson County

INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations [CFR], Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable levels of *Escherichia coli* (*E. coli*) that will result in the attainment of the applicable WQS in the Grand River located in Jackson County, Michigan.

PROBLEM STATEMENT

This TMDL listing addresses approximately 25 miles of the Grand River downstream of the city of Jackson. The TMDL reach is on the Section 303(d) list as:

GRAND RIVER AND PORTAGE RIVER WBID#: **082816H**
County: JACKSON HUC: 4050004 Size: 25 M
Location: Grand River from Tompkins Road upstream to the city of Jackson and Portage River from the Grand River confluence upstream to Wooster Road.
Problem: **Untreated sewage discharge, pathogens (Rule 100); WQS exceedances for DO; Macroinvertebrate and fish communities rated poor.**
TMDL YEAR(s): 2003 RF3RchID: 4050004

The current 303(d) listing for the Grand River includes a listing for pathogens, macroinvertebrate and fish communities, and WQS exceedances for dissolved oxygen. This TMDL only covers the pathogen portion of the listing. The remaining TMDLs will also be completed in 2003.

The Grand River (Figure 1) was placed on the Section 303(d) list (Creal and Wuycheck, 2002) due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli*. Recent monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) for the 2002 monitoring season documented exceedances of the WQS at several stations sampled. Grand River stations in the city of Jackson documented exceedances of the WQS at two of three stations (Table 1). Thirty-day geometric mean *E. coli* concentrations in this segment of the river ranged from 31 *E. coli* per 100 milliliters (ml) in July at east High Street to 582 *E. coli* per 100 ml in October at Ganson Street (Figure 2). The east crossing of High Street met WQS for the entire sampling season. The two remaining stations, Ganson Street and

Monroe Street, exceeded WQS consistently from mid-August through the end of sampling in October. Particularly high exceedances at these two stations include daily geometric mean *E. coli* concentrations of 13,737 *E. coli* per 100 ml and 5,076 *E. coli* per 100 ml on September 11, respectively (Table 1). Other high *E. coli* concentrations were noted on September 19, when concentrations greater than 2,000 *E. coli* per 100 ml were observed.

Sampling the Grand River downstream of the city of Jackson documented exceedances of the WQS at every location sampled (Table 2 and Figure 3). Thirty-day geometric means ranged from 44 *E. coli* per 100 ml at Rives/Eaton Road on June 26, to 790 *E. coli* per 100 ml at Berry Road on September 11. The three stations immediately downstream from the city of Jackson appear to respond to precipitation events. The Berry Road station had a daily geometric mean of greater than 11,000 *E. coli* per 100 ml on August 14, while all three stations exhibited elevated concentrations of *E. coli* during rain events. Later in the sampling season, the Maple Grove Road site had a daily geometric mean greater than 19,000 *E. coli* per 100 ml on September 11 – both of these exceedances occurred within 24 hours of a rain event. The stations furthest downstream from the city of Jackson, Churchill Road, Rives/Eaton Road, and Tompkins Road, exceeded standards beginning the end of July and continued through the end of the sampling season (Table 2).

The Portage River and Albrow Creek were also sampled as part of this TMDL monitoring. Albrow Creek contained the highest concentrations of *E. coli* (Table 3 and Figure 4) of the two tributaries. This stream exceeded the 30-day geometric mean on each sampling event with particularly high concentrations July through September. Thirty-day geometric means ranged from 204 *E. coli* per 100 ml on June 12, to 939 *E. coli* per 100 ml on August 14 (Table 2). Both locations on the Portage River met the 30-day geometric mean until early August. Sampling conducted after mid-August documented exceedances for the remainder of the season. Thirty-day geometric mean concentrations ranged from 42 *E. coli* per 100 ml at Cooper/M-106 on July 10, to 483 *E. coli* per 100 ml on September 11 at the same location.

NUMERIC TARGET

The impaired designated use addressed by this TMDL is total body contact recreation. Rule 100 of the Michigan WQS requires that this waterbody be protected for total body contact recreation from May 1 to October 31. The target levels for this designated use are the ambient *E. coli* standards established in Rule 62 of the WQS as follows:

> R 323.1062 Microorganisms.
>
> Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 *Escherichia coli* (*E. coli*) per 100 ml, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 ml. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area.

In addition, sanitary wastewater discharges have an additional target:

> Rule 62. (3) Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml, based on the geometric mean of all of 5 or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 ml, based on the on the geometric mean of all of 3 or more samples

taken during any period of discharge not to exceed 7 days. Other indicators of adequate disinfection may be utilized where approved by the department.

Sanitary wastewater discharges are considered in compliance with the WQS of 130 *E. coli* per 100 ml if their National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliforms per 100 ml as a monthly average is met. This is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). Fecal coliform is substantially higher than *E. coli* (Whitman, 2001) when the wastewater of concern is sewage. It can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent when the point source discharge is meeting its limit of 200 fecal coliform per 100 ml.

The WQS of 130 per 100 ml as a 30-day geometric mean is the target level for this TMDL reach from May 1 to October 31. The 2002 monitoring data indicated exceedances of WQS at all but one of the stations sampled as previously stated.

SOURCE ASSESSMENT

The Grand River Watershed covered by this TMDL is located in Jackson and Ingham Counties. The *E. coli* TMDL reach is the Grand River from Tompkins Road upstream to the city of Jackson (Figure 1). The Grand River has relatively high flows in this reach (Table 4). Municipalities in the TMDL watershed include the city of Jackson and Waterloo, Henrietta, Rives, Sandstone, Leoni, Bunkerhill, Blackman, Leslie, Tompkins, Spring Arbor, Summit, Grass Lake, Stockbridge, Onondaga, Ingham, Parma, and Napoleon Townships (Figure 5). It should be noted that both the city of Leslie and Springport Township have land in the TMDL watershed; however, their percentage of the watershed was much less than 1% each and was not considered a contributor. Table 5 shows the distribution of land for each municipality.

The primary pathogen sources for this waterbody are typical of urban and agricultural land uses. Storm water runoff, illicit connections, and agricultural inputs are all possible sources of *E. coli* to the Grand River. Elevated *E. coli* concentrations within the city limits of Jackson coincide with the rain events previously mentioned and may be due to storm water runoff.

There are 141 permitted point source discharges in the Grand River TMDL reach (Tables 6 and 7 and Figure 6). Eighty are covered by general storm water permits and 39 are active NPDES permit Notices of Coverage for construction sites in Jackson County. An additional 14 are covered by other general permits, 7 of which are noncontact cooling water discharges and 1 is a discharge containing gasoline and/or related petroleum products. Five of the remaining 6 general permits are for wastewater stabilization lagoons or land applications of biosolids. A lagoon discharge permit contains fecal coliform limits and allows for a seasonal discharge between March and May and October and December. The biosolid permit allows for bulk land application of treated wastes. The last of the general permits covers hydrostatic test waters.

There are eight individual NPDES permits in addition to the above permits in the Grand River TMDL Watershed for the following facilities: Leslie Wastewater Treatment Plant (WWTP) (MI0020796), Jackson WWTP (MI0023256), Marathon Ashland Petro-Jackson (MI0045403), Citgo Corp-Jackson (MI0046809), Mechanical Products (MI0051683), MDC-SPSM-GWCU (MI0054976), Plastigage Corp (MI0055042), and TRW Inc-Jackson (MI0056006). The discharges from these facilities, except those from the Leslie and Jackson WWTPs, generally consist of treated groundwater, noncontact cooling water, storm water, and hydrostatic test water and are not considered to contain treated or untreated human sewage. Therefore, the discharges are not a source of *E. coli* to the Grand River TMDL Watershed and the requirements of Rule 62(3) do not apply.

The city of Jackson had five Sanitary Sewer Overflows (SSOs) besides the WWTP outfall. Two have been bulk headed since 1995. Three were bulk headed under Administrative Consent Order SW98-004 and completed in January 2001. A heavy rain event in August 2002 caused basement flooding to several businesses in the downtown area of Jackson. The city of Jackson notified the DEQ of its intent to reestablish an overflow that had previously been closed since 2000 to alleviate the problem. Difficulties with removing the bulkhead prompted the city of Jackson to create a new overflow in September 2002 (Dowling, 2002). The city of Jackson's overflow correction plan will redirect wet weather flows to a sanitary sewer interceptor with more capacity eliminating the need to use the SSO by October 31, 2003. The city of Jackson has not reported a wet weather discharge to-date from the new SSO.

Other possible downstream source of pathogens to the TMDL reach could be agricultural, given the land use in the area, or illicit connections, such as those noted in Albrow Creek. Albrow Creek is a tributary to the Grand River downstream of Jackson. Rives Township has been cited by the MDEQ (NC-10-01-01-001J) for the discharge of raw sewage to Albrow Creek from the unincorporated village of Rives Junction - a documented problem since the late 1970s. As indicated in Table 3 and Figure 4, Albrow Creek exceeded the 30-day geometric mean WQS for *E. coli* on every sampling event.

LINKAGE ANALYSIS

The link between the *E. coli* concentrations in the Grand River and the potential sources is the basis for the development of the TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and the sources. This provides the basis for estimating the total assimilative capacity of the stream and any needed load reductions. A significant amount of the pathogen load for this TMDL likely enters the Grand River by both wet and dry weather sources such as storm water, agricultural run-off, and illicit connections.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in the Grand River depends on the control of *E. coli* from storm water, agriculture influences, and, to a lesser extent, illicit connections. Total body contact recreation in the Grand River will be protected if the *E. coli* inputs can be controlled.

TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving WQS. The target for this pathogen TMDL is the WQS of 130 *E. coli* per 100 ml as indicated in the Numeric Target section. TMDL development also defines the environmental conditions that will be used when defining allowable levels concurrent with the selection of a numeric concentration endpoint. Many TMDLs are designed around the concept of a "critical condition." The "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. The critical conditions for the control of point sources in Michigan are given in R 323.1082 and R 323.1090, for example. The lowest monthly 95% exceedance flow for streams in general is used as a design condition for point source discharges. However, levels are restricted to a monthly average limit of 200 fecal coliform per 100 ml regardless of stream flow for pathogens in point source discharges of treated or untreated human sewage. Therefore, the design stream flow is not a critical condition for determining the allowable loading of pathogen for WWTPs. Other sources to the Grand River arise from a mixture of wet and dry weather driven nonpoint sources. There is no single critical condition that is protective for all other conditions. There are a number of different allowable loads for these sources that will ensure compliance as long as they are distributed properly throughout the watershed.

TMDLs are expressed on a mass loading basis (e.g., pounds per day) for most pollutants. However, mass is not an appropriate measure for *E. coli.* The USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). Therefore, this pathogen TMDL is concentration-based consistent with R 323.1062, and the TMDL is equal to the target concentration of 130 *E. coli* per 100 ml in all portions of the TMDL reach for each month of the recreational season (May through October).

ALLOCATIONS

TMDLs are comprised of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. The TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving waterbody. This definition is denoted conceptually by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. This pathogen TMDL will not be expressed on a mass loading basis and is concentration based consistent with USEPA regulations in 40 CFR, Section 130.2(i), as previously indicated.

WLAs

There are a total of 141 permitted point source discharges to the listed reach of the Grand River as previously mentioned. Eighty are storm water permits and 39 are construction permits involving earth disturbances. Fifteen of the remaining 22 permits are not permitted to treat and discharge human waste and Rule 62(3) does not apply. The last seven, two WWTPs and five Wastewater Sewage Lagoons (WWSLs), are permitted to treat and discharge human waste. Each of these facilities has a limit for fecal coliform and, as previously stated, when the WWTPs are meeting their fecal coliform permit limit, it is assumed the WQS will be met in the discharge. The WWSLs are permitted to discharge during the months of March through May and October to December. The discharge period overlaps the recreational season in May and October only and will be considered in compliance with the WQS of 130 *E. coli* per 100 ml if their NPDES permit limit of 200 fecal coliform per 100 ml as a monthly average is met. The WLA for the above facilities, including the 80 storm water permits and 39 construction permits, will therefore be equal to 130 *E. coli* per 100 ml during the recreation season between May 1 and October 31. The city of Jackson has one temporary SSO. This SSO has not had a reported discharge since its creation in September of 2002; however, the WLA will be 130 *E. coli* per 100 ml until the closure of the SSO.

LAs

The LA incorporates the pathogen sources for this waterbody, including those typically associated with urban and suburban runoff, as well as illicit connections. This TMDL is concentration-based. Therefore, the LA is equal to 130 *E. coli* per 100 ml. The determination of individual LAs will be based on the assumption of equal bacteria loads per unit area for all lands in the watershed. Therefore, the relative responsibility for achieving the necessary reductions of bacteria and maintaining acceptable conditions will be determined by the amount of land under the jurisdiction the various units of local government in the watershed. This gives a clear indication of the relative amount of effort that will be required by each entity to restore and maintain the total body contact designated uses in the Grand River.

The government entity with the largest percent land area in the Grand River TMDL Watershed is Waterloo Township (11%). The remaining percentage of the watershed is made up of the city of Jackson (3%) and Henrietta (9%), Rives (9%), Leoni (9%), Sandstone (8%), Bunkerhill (8%), Blackman (8%), Leslie (7%), Tompkins (6%), Spring Arbor (5%), Summit (5%), Grass Lake (4%), Stockbridge (4%), Onondaga (1%), Ingham (1%), Napoleon (1%), and Parma Townships (1%).

MOS

This section addresses the incorporation of an MOS in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into the TMDL analysis thorough conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of decay is used. The MDEQ has determined that the use of the WQS of 130 *E. coli* per 100 ml is a more conservative approach, although pathogen organisms have a limited capability of surviving outside of their hosts and a rate of decay would normally be used. Applying a rate of decay could result in a discharge limit that would be greater than the WQS, thus no rate of decay is applied in order to provide for a greater protection of water quality. Applying the WQS to be met under all flow conditions also adds to the assurance of the MOS.

SEASONALITY

Seasonality in the TMDL is addressed by expressing the TMDL in terms of a total body contact recreation season that is defined as May 1 through October 31 by R 323.1100 of the WQS. There is no total body contact during the remainder of the year primarily due to cold weather. WQS will be met regardless of flow conditions in the applicable season because this is a concentration-based TMDL.

MONITORING

Pathogens were monitored at a total of 12 stations from May through September 2002. Nine of those stations were located on the Grand River, and 3 were on selected tributaries. Future monitoring will take place during the rotating, 5-year basin monitoring. When these results indicate that the waterbody may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml is being met.

REASONABLE ASSURANCE ACTIVITIES

The WWTPs and WWSLs are responsible for meeting their NPDES permit limits for fecal coliform. Compliance is based on review of Discharge Monitoring Report data by the MDEQ. The WWTPs are presently meeting their permit limits for fecal coliform. Progress on closing the SSO created by the city of Jackson to alleviate basement flooding is underway. The city of Jackson and the MDEQ have signed a District Compliance Agreement dated February 5, 2003, to resolve the SSO in the downtown area of Jackson. This agreement contains activities that will redirect flow from an overloaded interceptor to a higher capacity interceptor by March 31, 2003. This activity will greatly reduce the probability of an overflow due to low capacity in the interceptor. The main goal of the agreement is a plan that includes the closure of the SSO by October 31, 2003.

Rives Township has responded to their Notice of Noncompliance and several different treatment alternatives have been discussed. Potential funding of a new sewer system may be possible from a Rural Development Grant. The most likely alternative is a connection to the city of

Jackson's existing collection system. However, Rives Township may not be able to afford the project due to high costs of connecting to the existing collection system.

The city of Jackson, as well as Blackman, Leoni, Rives, Spring Arbor, and Summit Townships, are all entities that will be required to obtain a Phase II Storm Water permit. These permits will require activities that reduce *E. coli* inputs through the public education, storm water management plan, and illicit connection identification and elimination requirements.

The Jackson County Drain Commissioner's Office has been awarded a Section 319 Grant (#2000-0128) to develop an Upper Grand River Watershed Planning Initiative. This grant has multiple goals, one of which aims to reduce nonpoint sources of pathogenic materials to the Upper Grand River Watershed. The Jackson and Ingham County Health Departments have monitored 36 locations on the Grand River and its tributaries under this grant. The monitoring took place upstream and downstream of the city of Jackson in an effort to identify sources of pathogen input. This study, along with the other objectives of the watershed plan, will be incorporated in the Jackson County Master Plan currently under development.

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Michigan Department of Environmental Quality
June 20, 2003

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Whitman, R. Personal Communication. United States Geological Survey, October 2001.

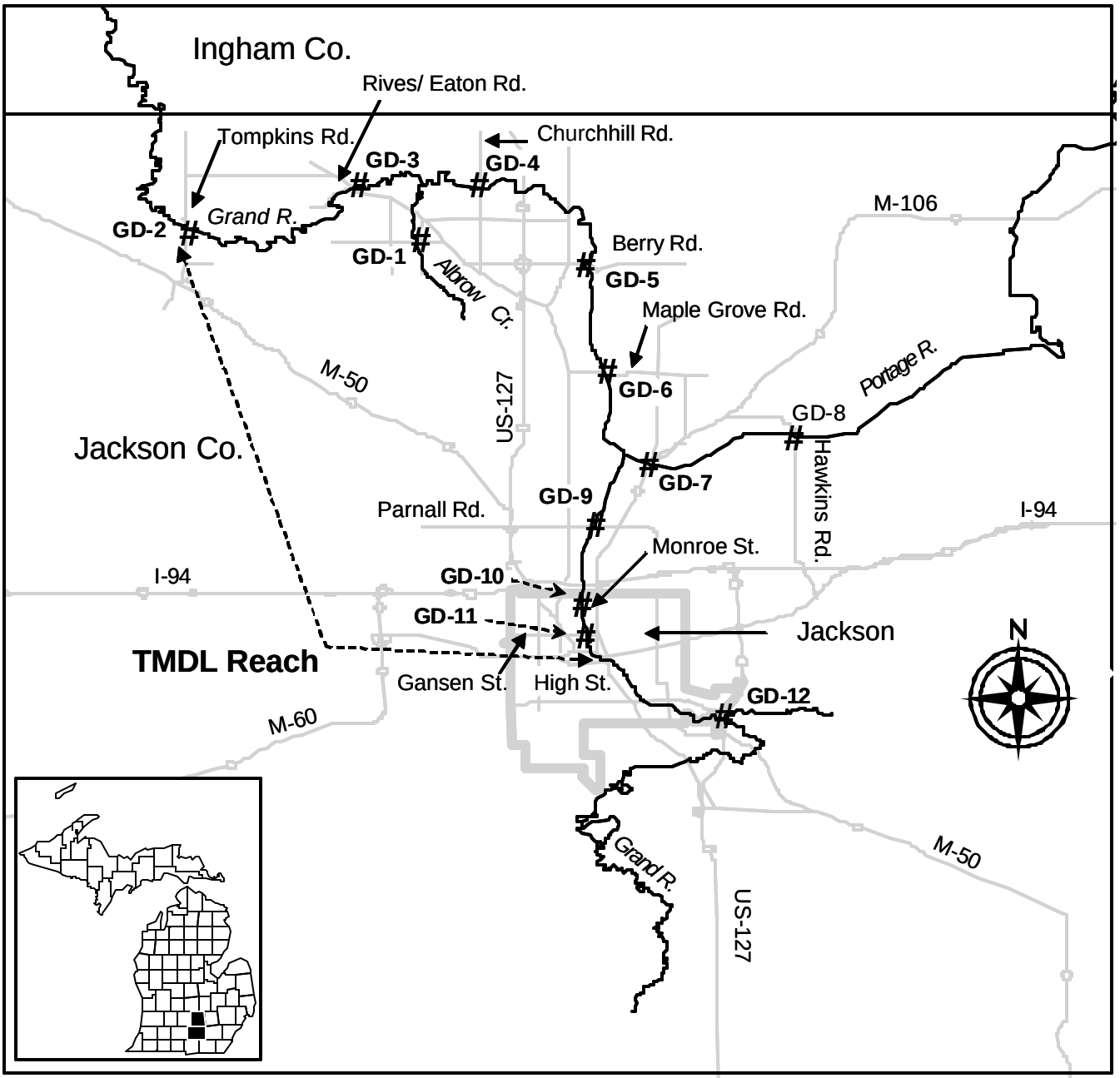

Figure 1. The Grand River *E. coli* sampling locations, vicinity of Jackson, Michigan, 2002.

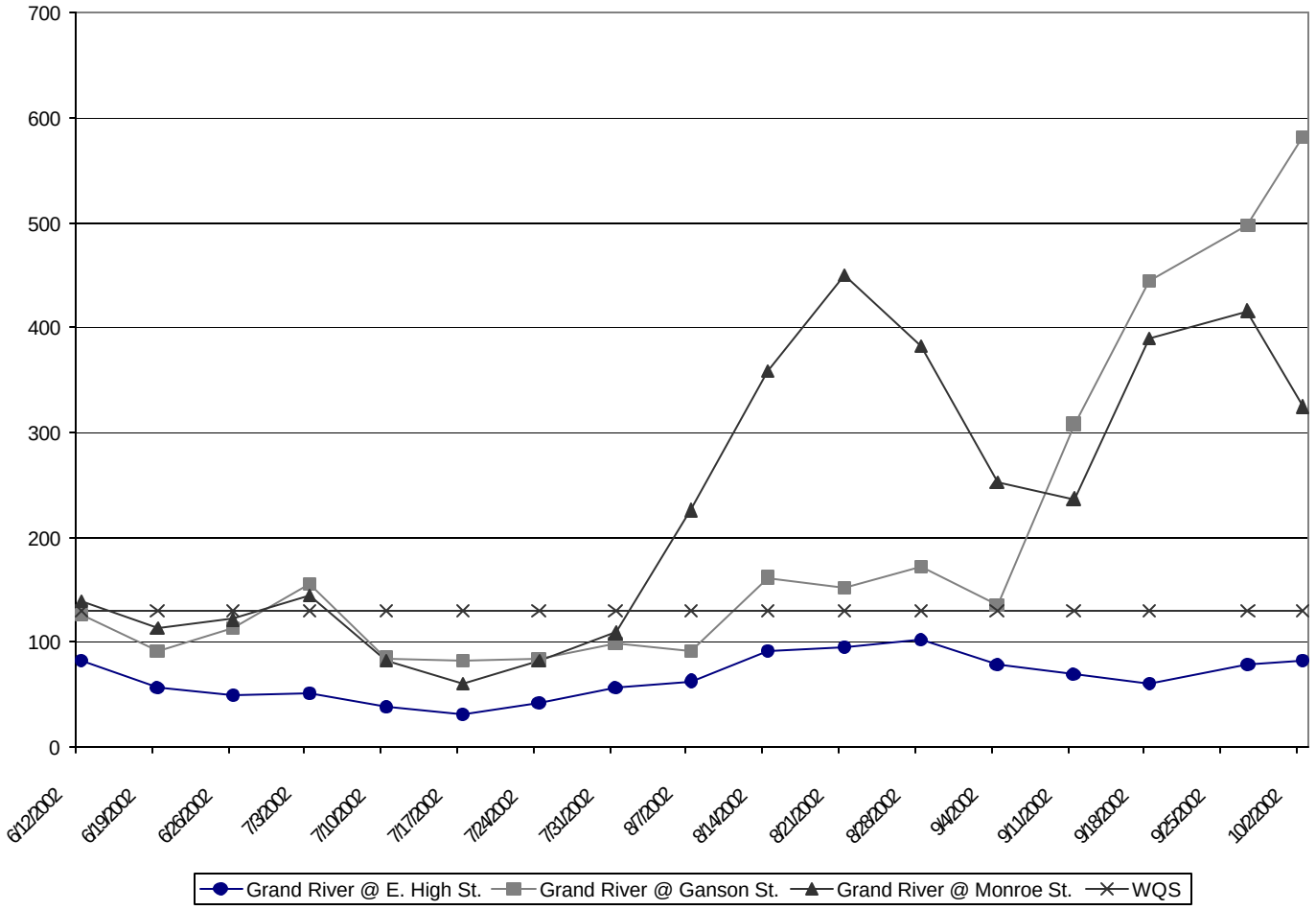

Figure 2. Thirty-day Geometric mean for *E. coli* in the Grand River in the city of Jackson, Michigan, 2002.

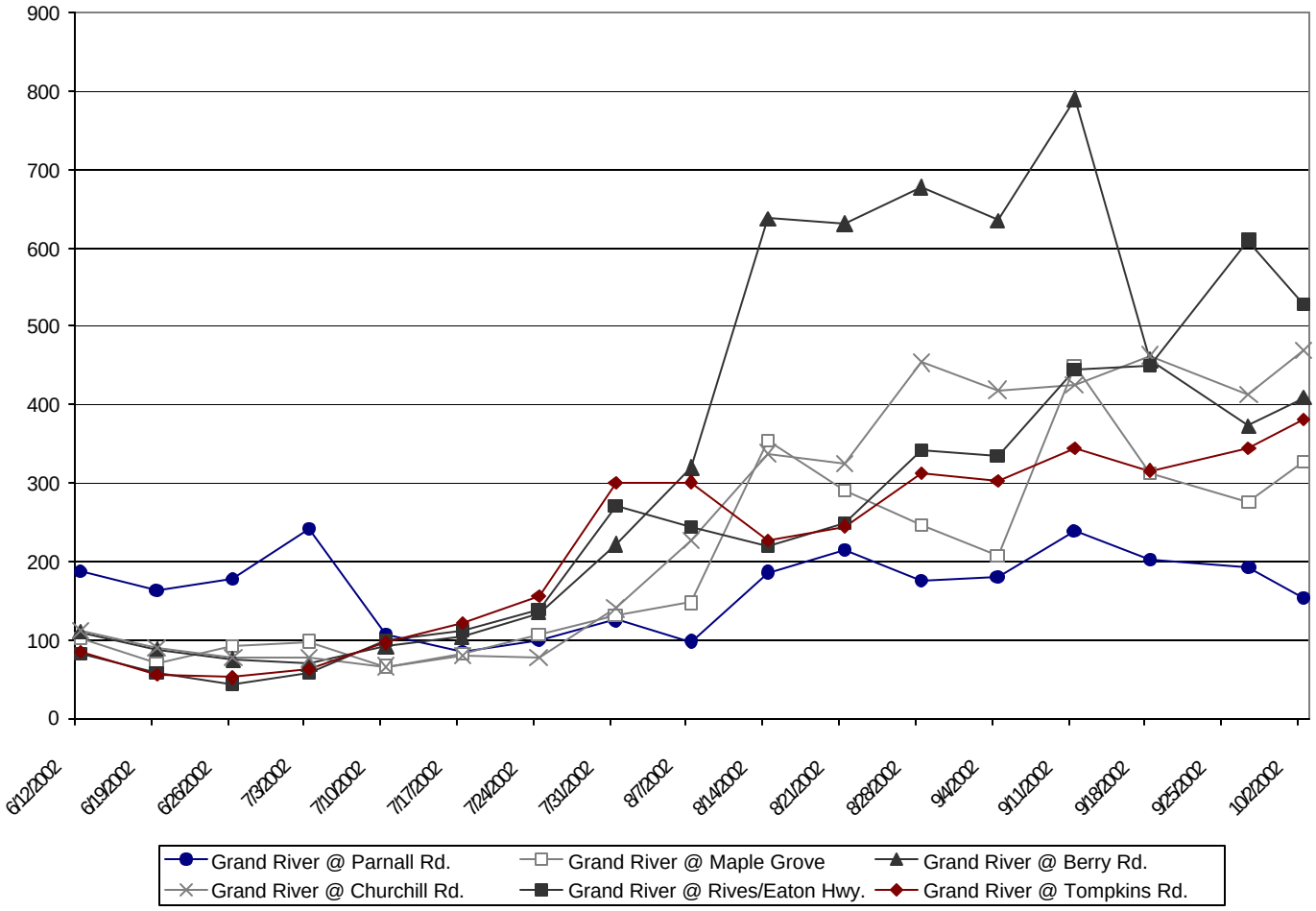

Figure 3. Thirty-day Geometric mean *E. coli* concentrations downstream of the city of Jackson, Michigan, 2002.

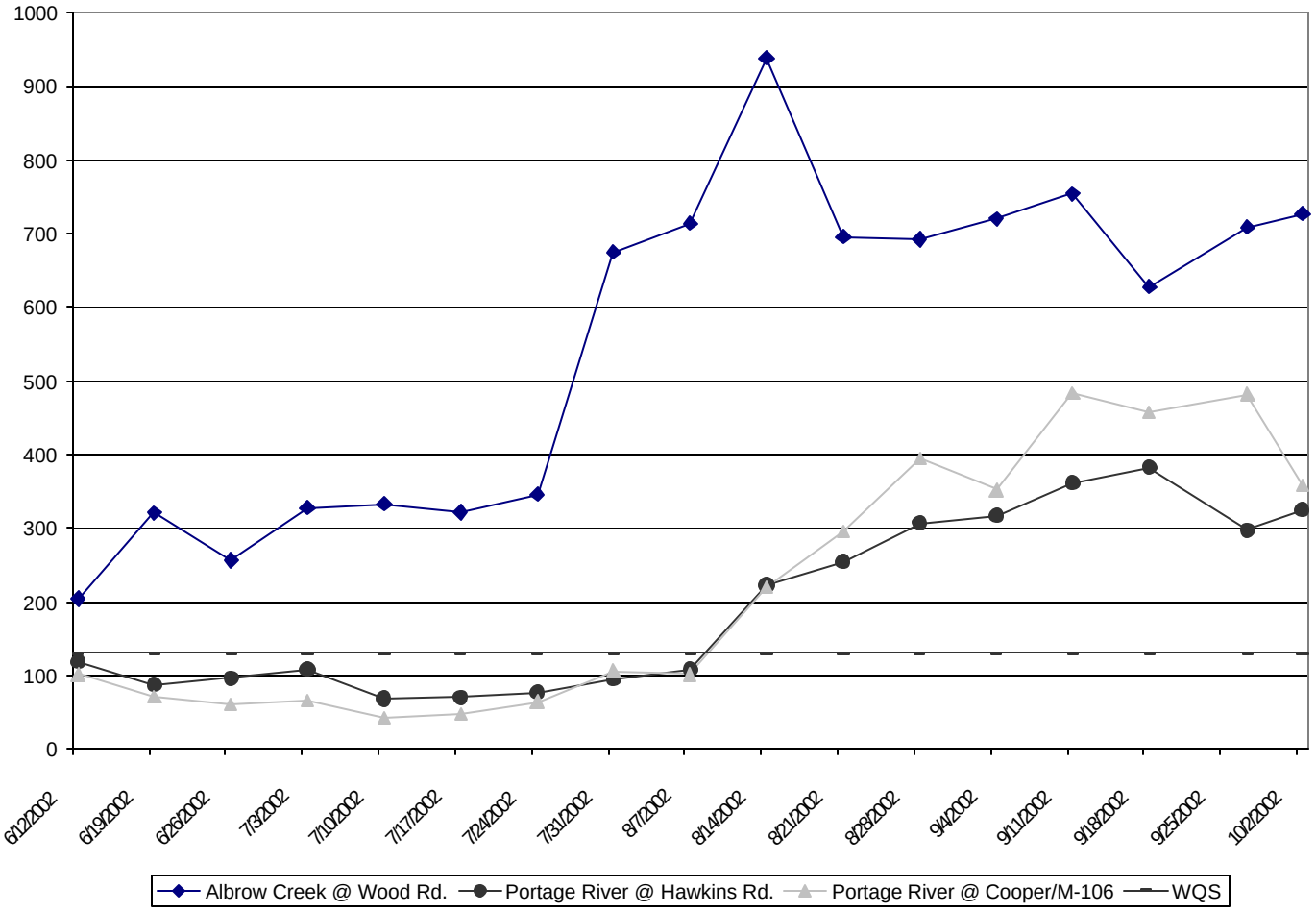

Figure 4. Thirty-day Geometric mean *E. coli* concentrations on selected tributaries of the Grand River, Jackson County, Michigan.

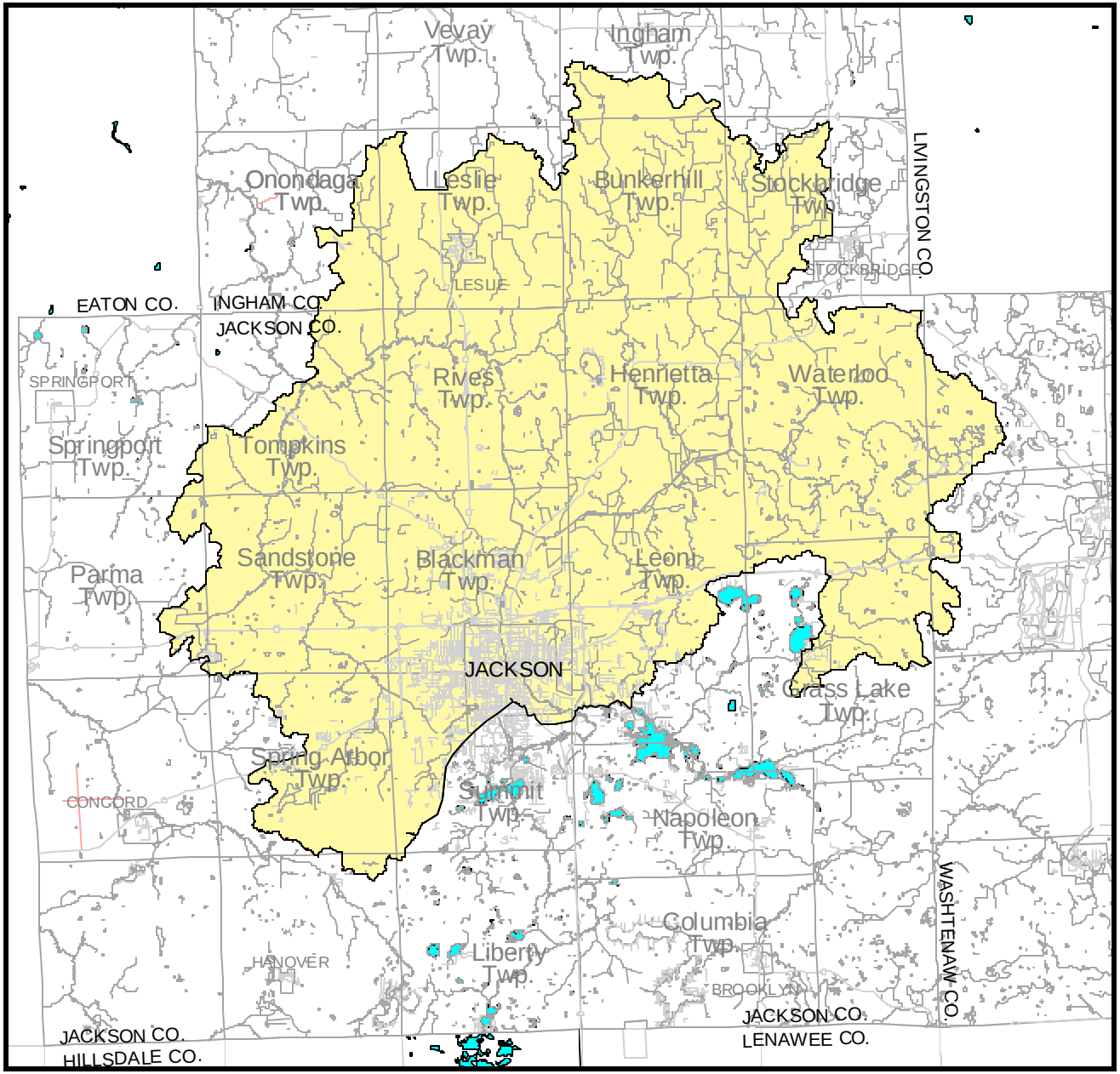

Figure 5. Shaded areas represent municipalities in the Grand River TMDL Watershed.

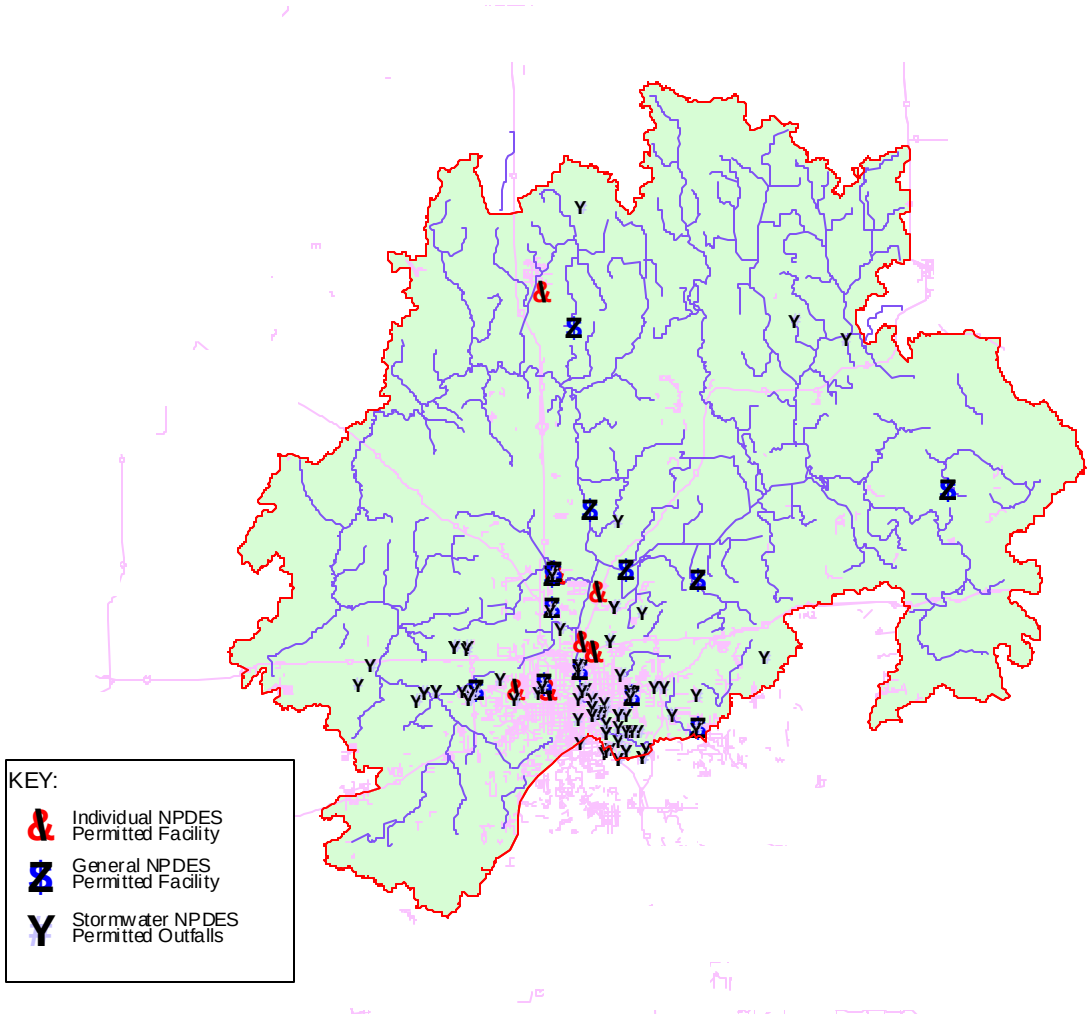

Figure 6. NPDES permitted (individual, general, and storm water) discharges in the Grand River TMDL Watershed, vicinity of Jackson, Michigan.

Table 1. MDEQ 2002 *E. coli* monitoring data for the Grand River in the city of Jackson (*E. coli*/100 ml). Shaded areas indicate exceedances of the Water Quality Standard. Data are presented upstream to downstream.

	Grand River @ E. crossing of High St. GD-12A			Grand River @ Ganson St. GD-11A			Grand River @ Monroe St. GD-10A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/15/2002	220	138	---	320	197	---	140	156	---	sunny, 60°
	200			100			80			
	60			240			340			
5/21/2002	60	66	---	20	34	---	80	58	---	sunny, 60°
	60			100			120			
	80			20			20			
5/29/2002	80	88	---	60	66	---	120	83	---	overcast, 65°
	60			80			80			
	140			60			60			
6/5/2002	20	85	---	600	416	---	400	312	---	rain, 70°
	140			200			380			
	220			600			200			
6/12/2002	20	58	83	180	179	127	260	218	139	overcast, 75°
	160			200			200			
	60			160			200			
6/19/2002	20	20	56	140	38	92	20	58	114	sunny, 70°
	20			20			20			
	20			20			500			
6/26/2002	20	32	49	20	100	114	40	82	122	overcast, 85°
	80			280			140			
	20			180			100			
7/3/2002	100	112	51	340	325	156	300	188	144	sunny, 85°
	100			280			100			
	140			360			220			

Table 1. continued (*E. coli*/100 ml).

	Grand River @ E. crossing of High St. GD-12A			Grand River @ Ganson St. GD-11A			Grand River @ Monroe St. GD-10A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/10/2002	20	20	38	20	20	85	20	20	83	sunny, 75°
	20			20			20			
	20			20			20			
7/17/2002	20	20	31	520	146	82	100	43	60	sunny, 80°
	20			100			20			
	20			60			40			
7/24/2002	280	96	42	220	44	84	440	294	83	sunny, 65°
	40			20			160			
	80			20			360			
7/31/2002	120	132	56	300	227	99	400	330	109	humid, 85°
	120			140			300			
	160			280			300			
8/7/2002	120	190	63	240	218	92	7200	7129	226	sunny, 70°
	260			180			6800			
	220			240			7400			
8/14/2002	560	135	92	480	346	162	480	197	358	rain, 75°
	20			360			200			
	220			240			80			
8/21/2002	40	25	96	20	105	152	280	135	450	sunny, 70°
	20			240			220			
	20			240			40			
8/28/2002	180	129	102	100	84	172	120	132	383	sunny, 70°
	100			100			120			
	120			60			160			

Table 1. continued (*E. coli*/100 ml).

	Grand River @ E. crossing of High St. GD-12A			Grand River @ Ganson St. GD-11A			Grand River @ Monroe St. GD-10A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
9/4/2002	20	34	78	120	66	135	60	42	253	sunny, 75°
	100			20			60			
	20			120			20			
9/11/2002	200	104	69	9000	13737	308	2800	5076	237	sunny, 70°
	20			16000			3200			
	280			18000			14600			
9/18/2002	20	71	61	1800	2175	445	7200	2400	390	cloudy, 75°
	100			4400			640			
	180			1300			3000			
9/27/2002	20	96	79	3800	183	497	400	186	416	cloudy, 65°
	100			80			40			
	440			20			400			
10/2/2002	100	165	83	180	185	582	20	38	325	sunny, 70°
	320			160			20			
	140			220			140			

Table 2. MDEQ 2002 *E. coli* monitoring data for the Grand River downstream of the city of Jackson (*E. coli*/100 ml). Shaded areas indicate exceedances of the Water Quality Standard. Data are presented upstream to downstream.

	Grand River @ Parnall Rd. GD-9A			Grand River @ Maple Grove Rd. GD-6A			Grand River @ Berry Rd. GD-5A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/15/2002	280	287	---	220	219	---	200	200	---	sunny, 60°
	280			200			200			
	300			240			200			
5/21/2002	20	54	---	80	32	---	100	78	---	sunny, 60°
	100			20			80			
	80			20			60			
5/29/2002	200	106	---	180	159	---	80	92	---	overcast, 65°
	100			160			80			
	60			140			120			
6/5/2002	960	1169	---	200	142	---	140	85	---	rain, 70°
	1040			80			20			
	1600			180			220			
6/12/2002	60	119	187	20	66	101	80	131	110	overcast, 75°
	200			120			200			
	140			120			140			
6/19/2002	160	142	163	100	34	70	20	66	88	sunny, 70°
	300			20			180			
	60			20			80			
6/26/2002	280	82	177	60	128	92	20	34	75	overcast, 85°
	100			160			100			
	20			220			20			
7/3/2002	1000	509	242	140	222	98	60	64	69	sunny, 85°
	600			300			20			
	220			260			220			

Table 2. continued (*E. coli*/100 ml).

	Grand River @ Parnall Rd. GD-9A			Grand River @ Maple Grove Rd. GD-6A			Grand River @ Berry Rd. GD-5A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/10/2002	20	20	107	20	20	66	580	354	92	sunny, 75°
	20			20			240			
	20			20			320			
7/17/2002	20	36	85	120	201	83	440	233	104	sunny, 80°
	20			280			360			
	120			240			80			
7/24/2002	180	331	100	40	115	106	340	239	134	sunny, 65°
	420			100			400			
	480			380			100			
7/31/2002	160	248	125	400	366	130	440	424	222	humid, 85°
	340			360			360			
	280			340			480			
8/7/2002	200	150	98	520	403	147	260	403	320	sunny, 70°
	140			420			600			
	120			300			420			
8/14/2002	400	500	186	600	1641	354	12000	11114	638	rain, 75°
	520			800			11000			
	600			9200			10400			
8/21/2002	20	76	215	120	76	291	240	221	631	sunny, 70°
	120			180			160			
	180			20			280			
8/28/2002	80	121	176	320	50	247	420	343	678	sunny, 70°
	80			20			300			
	280			20			320			

Table 2. continued (*E. coli*/100 ml).

	Grand River @ Parnall Rd. GD-9A			Grand River @ Maple Grove Rd. GD-6A			Grand River @ Berry Rd. GD-5A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
9/4/2002	280	278	180	300	148	206	420	304	635	sunny, 75°
	480			180			240			
	160			60			280			
9/11/2002	20	592	238	20000	19730	449	600	1200	790	sunny, 70°
	2000			24000			1600			
	5200			16000			1800			
9/18/2002	620	222	202	1800	269	313	860	721	457	cloudy, 75°
	880			20			640			
	20			540			680			
9/27/2002	20	59	192	20	40	275	60	80	373	cloudy, 65°
	20			40			60			
	520			80			140			
10/2/2002	20	40	154	280	119	327	520	546	409	sunny, 70°
	20			300			540			
	160			20			580			

Table 2. continued (*E. coli*/100 ml).

	Grand River @ Churchill Rd. GD-4A			Grand River @ Rives/Eaton Rd. GD-3A			Grand River @ Tompkins Rd. GD-2A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/15/2002	220	219	---	260	218	---	220	239	---	sunny, 60°
	200			200			260			
	240			200			240			
5/21/2002	100	43	---	100	68	---	20	29	---	sunny, 60°
	20			160			60			
	40			20			20			
5/29/2002	100	62	---	80	73	---	80	80	---	overcast, 65°
	60			80			80			
	40			60			80			
6/5/2002	360	226	---	180	93	---	160	142	---	rain, 70°
	160			20			60			
	200			220			300			
6/12/2002	220	125	111	40	40	83	40	58	85	overcast, 75°
	220			20			80			
	40			80			60			
6/19/2002	280	77	90	20	32	57	60	29	56	sunny, 70°
	80			20			20			
	20			80			20			
6/26/2002	20	20	77	20	20	44	20	20	52	overcast, 85°
	20			20			20			
	20			20			20			
7/3/2002	260	59	76	320	290	58	180	198	62	sunny, 85°
	40			380			240			
	20			200			180			

Table 2. continued (*E. coli*/100 ml).

	Grand River @ Churchill Rd. GD-4A			Grand River @ Rives/Eaton Rd. GD-3A			Grand River @ Tompkins Rd. GD-2A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/10/2002	20	113	66	2000	1308	99	1140	1243	96	sunny, 75°
	720			400			1360			
	100			2800			1240			
7/17/2002	200	312	80	20	70	111	100	183	121	sunny, 80°
	400			40			140			
	380			420			440			
7/24/2002	200	68	78	100	99	139	140	100	155	sunny, 65°
	20			60			40			
	80			160			180			
7/31/2002	320	370	140	360	559	271	360	538	300	humid, 85°
	360			640			800			
	440			760			540			
8/7/2002	760	663	226	1000	173	244	280	201	301	sunny, 70°
	480			20			160			
	800			260			180			
8/14/2002	1200	836	338	880	771	220	240	296	226	rain, 75°
	760			100			300			
	640			5200			360			
8/21/2002	280	257	325	220	130	249	280	276	245	sunny, 70°
	380			500			340			
	160			20			220			
8/28/2002	400	365	454	480	473	341	360	339	313	sunny, 70°
	380			480			300			
	320			460			360			

Table 2. continued (*E. coli*/100 ml).

	Grand River @ Churchill Rd. GD-4A			Grand River @ Rives/Eaton Rd. GD-3A			Grand River @ Tompkins Rd. GD-2A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
9/4/2002	460	249	419	440	504	334	380	450	302	sunny, 75°
	560			660			800			
	60			440			300			
9/11/2002	680	711	425	700	733	445	460	391	345	sunny, 70°
	660			740			360			
	800			760			360			
9/18/2002	880	1274	463	920	815	450	320	190	316	cloudy, 75°
	980			840			20			
	2400			700			1080			
9/27/2002	640	145	413	600	593	610	800	425	344	cloudy, 65°
	40			620			120			
	120			560			800			
10/2/2002	760	702	470	600	229	527	620	565	381	sunny, 70°
	760			1000			520			
	600			20			560			

Table 3. MDEQ 2002 *E. coli* monitoring data for tributaries of the Grand River (*E. coli*/100 ml). Shaded areas indicate exceedances of the Water Quality Standard.

	Albrow Creek @ Wood Rd. GD-1A			Portage River @ Hawkins Rd. GD-8A			Portage River @ Cooper/M-106 GD-7A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/15/2002	60	46	---	180	226	---	200	169	---	sunny, 60°
	40			200			240			
	40			320			100			
5/21/2002	40	62	---	20	40	---	80	58	---	sunny, 60°
	100			80			60			
	60			40			40			
5/29/2002	320	306	---	60	84	---	160	180	---	overcast, 65°
	320			100			260			
	280			100			140			
6/5/2002	440	369	---	100	193	---	180	205	---	rain, 70°
	380			360			340			
	300			200			140			
6/12/2002	840	1089	204	80	153	118	20	29	101	overcast, 75°
	1600			160			20			
	960			280			60			
6/19/2002	200	448	321	100	49	87	20	29	71	sunny, 70°
	660			60			60			
	680			20			20			
6/26/2002	20	20	256	60	66	96	20	25	60	overcast, 85°
	20			120			40			
	20			40			20			
7/3/2002	1200	1048	328	200	150	108	320	295	66	sunny, 85°
	800			140			200			
	1200			120			400			

Table 3. continued (*E. coli*/100 ml).

	Albrow Creek @ Wood Rd. GD-1A			Portage River @ Hawkins Rd. GD-8A			Portage River @ Cooper/M-106 GD-7A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/10/2002	280	401	333	20	20	68	20	20	42	sunny, 75°
	320			20			20			
	720			20			20			
7/17/2002	920	916	322	120	175	70	40	58	48	sunny, 80°
	820			160			120			
	1020			280			40			
7/24/2002	840	645	346	20	80	77	160	127	64	sunny, 65°
	800			260			80			
	400			100			160			
7/31/2002	680	564	675	120	182	95	200	306	106	humid, 85°
	440			120			420			
	600			420			340			
8/7/2002	1400	1390	714	420	289	108	320	234	101	sunny, 70°
	1200			220			200			
	1600			260			200			
8/14/2002	2000	1570	939	600	727	222	840	959	219	rain, 75°
	2200			640			1220			
	880			1000			860			
8/21/2002	680	206	696	400	343	254	240	259	296	sunny, 70°
	640			420			280			
	20			240			260			
8/28/2002	560	631	693	480	210	307	420	537	395	sunny, 70°
	700			40			560			
	640			480			660			

Table 3. continued (*E. coli*/100 ml).

	Albrow Creek @ Wood Rd. GD-1A			Portage River @ Hawkins Rd. GD-8A			Portage River @ Cooper/M-106 GD-7A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
9/4/2002	400	682	720	260	211	317	420	173	352	sunny, 75°
	1200			200			620			
	660			180			20			
9/11/2002	6600	1753	754	600	557	361	2400	1133	483	sunny, 70°
	1200			400			740			
	680			720			820			
9/18/2002	20	632	628	3000	974	383	680	733	458	cloudy, 75°
	4200			220			580			
	3000			1400			1000			
9/27/2002	480	377	709	200	96	297	560	335	482	cloudy, 65°
	560			20			840			
	200			220			80			
10/2/2002	560	714	727	400	330	325	320	121	358	sunny, 70°
	740			560			280			
	880			160			20			

Table 4. The Grand River average flows (cfs) at Tompkins Road, Jackson County, Michigan.

May	June	July	August	September	October
440	270	150	120	110	140

Table 5. Distribution of land for each municipality in the TMDL reach.

Municipality	Square miles	Percent
Waterloo Township	47.1	11
Henrietta Township	36.8	9
Rives Township	36.0	9
Leoni Township	35.9	9
Sandstone Township	35.5	8
Bunkerhill Township	32.4	8
Blackman Township	32.0	8
Leslie Township	28.7	7
Tompkins Township	24.1	6
Spring Arbor Township	23.5	5
Summit Township	22.5	5
Grass Lake Township	17.1	4
Stockbridge Township	15.3	4
City of Jackson	10.3	3
Onondaga Township	7.2	1
Ingham Township	5.6	1
Parma Township	4.2	1
Napoleon Township	4.2	1
TOTAL	**418.4**	**100**

Table 6. Permitted outfalls to the Grand River and Portage River Watersheds in the vicinity of Jackson. Source: MDEQ/WD's NPDES Permit Management System (NMS); *MGY = million gallons per year.

Permit Number	Facility	Receiving Waters	Design Flow (MGY*)	Latdd	Longdd
Individual NPDES permits:					
MI0020796	Leslie WWTP	Huntoon Creek	17.20	42.44305	-84.42861
MI0023256	Jackson WWTP	Grand River	6935.00	42.27611	-84.40611
MI0045403	Marathon Ashland Petro-Jackson	Grand River via Tobin Snyder Dr.	39.00	42.31028	-84.42361
MI0046809	Citgo Corp-Jackson	Grand River via Tobin Snyder Dr.	171.00	42.30889	-84.42250
MI0051683	Mechanical Products	Grand River via storm water	33.00	42.27167	-84.39861
MI0054976	MDC-SPSM-GWCU	Grand River	26.00	42.30000	-84.39583
MI0055042	Plastigage Corp	Hurd Marvin Dr. via storm sewer	64.00	42.25417	-84.45000
MI0056006	TRW Inc-Jackson	Grand River	18.30	42.25417	-84.42917
General Permits:					
MIG080265	Wolverine Pipeline Co-Jackson	Tobin Snyder Dr.	10.50	42.30722	-84.42528
MIG250003	Legends Mfg Inc	Sandstone/Blackman Dr.	8.00	42.25389	-84.47583
MIG250042	Industrial Steel Treating Co	Grand River	100.40	42.25583	-84.43194
MIG250355	ADCO Products Inc	Grand River	27.40	42.23417	-84.33389
MIG250359	Elco Prod Welding Inc	Grand River	26.30	42.42472	-84.40833
MIG250360	Lefere Forge & Machine	Grand River	4.40	42.25000	-84.37500
MIG250365	Mid-American Products	Grand River	21.90	42.26250	-84.40833
MIG250396	B & H Machine Inc	Tobin Snyder Dr.	18.30	42.29167	-84.42556
MIG580001	MDC-Waterloo WWSL	unnamed trib. to Portage River	10.95	42.34361	-84.17000
MIG580258	MDC-SPSM-Wing WWSL	Portage River	3.00	42.30972	-84.37778
MIG580259	MDC-SPSM-Dale Foltz TC WWSL	Wildcat Creek	0.50	42.30417	-84.33194
MIG580274	Sherman Oaks MHP WWSL	Grand River	34.00	42.33750	-84.40000
MIG670278	Equilon Enterprises-Jackson	Rives-Blackman Dr.	307.00	42.30861	-84.42444
MIG960019	MDC-Waterloo WWSL			42.34361	-84.17000
Storm Water NPDES Permits:					
MIR011138	Mullins Auto Parts & Towing	Industrial Storm Water Only		42.48194	-84.40167
MIR011220	Wolverine Vinyl Siding	Industrial Storm Water Only		42.24417	-84.39250
MIR011324	Jackson County Airport	Industrial Storm Water Only		42.25972	-84.45917
MIR011327	Thompson-McCully Co-Jackson	Industrial Storm Water Only		42.27722	-84.38833
MIR011332	Legends Mfg Inc	Standard		42.25389	-84.47583
MIR011339	Midbrook Inc	Industrial Storm Water Only		42.22444	-84.39306
MIR011340	Camshaft Machine Co	Industrial Storm Water Only		42.28306	-84.41972

Table 6. continued

Permit Number	Facility	Receiving Waters	Design Flow (MGY*)	Latdd	Longdd
MIR011341	Fourway Machine	Industrial Storm Water Only		42.25528	-84.36028
MIR011342	Hydraulic Systems Inc	Industrial Storm Water Only		42.22611	-84.38917
MIR011343	USF Holland Inc-Jackson	Industrial Storm Water Only		42.25222	-84.47833
MIR011344	C & K Box Company	Industrial Storm Water Only		42.25306	-84.43528
MIR011348	Mich Auto Compressor Inc	Industrial Storm Water Only		42.26722	-84.54167
MIR011350	Blu-Surf Inc.	Industrial Storm Water Only		42.25833	-84.55000
MIR011351	Pioneer Foundry Co Inc	Industrial Storm Water Only		42.24278	-84.39750
MIR011353	Edscha Jackson	Industrial Storm Water Only		42.25306	-84.37611
MIR011418	United Metal Technology Inc	Industrial Storm Water Only		42.26750	-84.28861
MIR011419	Willbee Transit Mix	Industrial Storm Water Only		42.25417	-84.50833
MIR011441	Crankshaft Machine Group	Industrial Storm Water Only		42.24972	-84.40833
MIR011445	Michner Plating-Angling Road	Industrial Storm Water Only		42.22917	-84.38333
MIR011447	Elm Plating Co Plt 2	Industrial Storm Water Only		42.23333	-84.37639
MIR011448	Elm Plating Co-Plt 1	Industrial Storm Water Only		42.22500	-84.39167
MIR011449	H & M Welding & Fab	Industrial Storm Water Only		42.24167	-84.35000
MIR011450	McGill Road Landfill	Industrial Storm Water Only		42.28944	-84.36750
MIR011451	Jackson Co Dalton Road LF	Industrial Storm Water Only		42.29306	-84.38472
MIR011452	Jackson Co RRF	Industrial Storm Water Only		42.29306	-84.38472
MIR011453	Conway Central Express-XJA	Industrial Storm Water Only		42.25000	-84.33333
MIR011455	Mich ARNG Jack Armory OMS12	Industrial Storm Water Only		42.25000	-84.40000
MIR011457	Miller Tool & Die Co	Industrial Storm Water Only		42.23333	-84.39167
MIR011459	Allied Chucker & Engr Co	Industrial Storm Water Only		42.27500	-84.48750
MIR011460	Way Bakery Div	Industrial Storm Water Only		42.23333	-84.37083
MIR011461	Dawn Food Products	Industrial Storm Water Only		42.22500	-84.36667
MIR011462	Advance Packaging Corp-Jac	Industrial Storm Water Only		42.23333	-84.37500
MIR011464	Michner Plating-N Mechanic	Industrial Storm Water Only		42.25417	-84.40417
MIR011465	Worthington Steel	Industrial Storm Water Only		42.24167	-84.38333
MIR011466	TAC Manufacturing	Industrial Storm Water Only		42.27500	-84.47917
MIR011467	Wolverine Metal Specialties	Standard		42.25417	-84.48333
MIR011468	Dawlen Corp	Industrial Storm Water Only		42.22500	-84.36667
MIR011469	John Crowley Inc	Industrial Storm Water Only		42.24167	-84.40000
MIR011470	Mich Extruded Aluminum	Industrial Storm Water Only		42.25417	-84.35417
MIR011471	C & H Stamping Inc	Industrial Storm Water Only		42.41667	-84.23333
MIR011473	Michigan Seat Co	Industrial Storm Water Only		42.22083	-84.38333
MIR011474	Chemical Technologies	Industrial Storm Water Only		42.23333	-84.37917

Table 6. continued

Permit Number	Facility	Receiving Waters	Design Flow (MGY*)	Latdd	Longdd
MIR011476	Jackson Iron & Metal #1	Industrial Storm Water Only		42.24167	-84.37917
MIR011477	Jackson Iron & Metal #2	Industrial Storm Water Only		42.23750	-84.39167
MIR011478	Andys Airport Auto Parts	Industrial Storm Water Only		42.25000	-84.45000
MIR011482	Miller Truck & Storage	Industrial Storm Water Only		42.24167	-84.38333
MIR011483	Boone's Welding & Fab	Industrial Storm Water Only		42.22917	-84.40833
MIR011485	Norfolk Southern Jackson	Industrial Storm Water Only		42.24583	-84.40000
MIR011486	Jackson Auto Salvage	Industrial Storm Water Only		42.25417	-84.50000
MIR011491	International Foam & Trim	Industrial Storm Water Only		42.25000	-84.47917
MIR011512	Riverside Grinding Co	Industrial Storm Water Only		42.22472	-84.37917
MIR011520	Lefere Forge & Machine	Standard		42.25000	-84.37500
MIR011526	B & H Machine Inc	Standard		42.29167	-84.42556
MIR011527	Mid-American Products	Standard		42.26250	-84.40833
MIR011563	Jackson Iron & Metal-Elm Div	Industrial Storm Water Only		42.23556	-84.38417
MIR011609	Orbitform	Industrial Storm Water Only		42.22139	-84.36861
MIR011617	Emmons Service Inc	Industrial Storm Water Only		42.23972	-84.40972
MIR011618	Linear Automatic Systems	Industrial Storm Water Only		42.25389	-84.40639
MIR011619	Industrial Steel Treating Co	Standard		42.25583	-84.43194
MIR011641	Bailey Sand & Gravel Co	Industrial Storm Water Only		42.25000	-84.51278
MIR011659	Sams Iron & Metal Co	Industrial Storm Water Only		42.26583	-84.40833
MIR011673	Kaneka Texas Corp	Industrial Storm Water Only		42.27417	-84.48056
MIR011708	Messners Auto Salvage	Industrial Storm Water Only		42.42639	-84.26556
MIR011710	Eaton Aeroquip Inc	Industrial Storm Water Only		42.24694	-84.39250
MIR011712	Miller Industrial Products	Industrial Storm Water Only		42.24278	-84.39583
MIR011727	D-CO Limestone LLC	Industrial Storm Water Only		42.33292	-84.38182
MIR020005	Equilon Enterprises-Jackson	Standard		42.30861	-84.42444
MIR020014	Koch Materials Co-Jackson	Industrial Storm Water Only		42.24583	-84.40000
MIR020016	ADCO Products Inc	Standard		42.23417	-84.33389
MIR020032	Jackson Power Facility	Industrial Storm Water Only		42.26022	-84.38192
MIS310004	Allied Chucker & Engr Co	Industrial Storm Water Only		42.27500	-84.48750
MIS310007	International Foam & Trim	Industrial Storm Water Only		42.25000	-84.47917
MIS310010	Miller Tool & Die Co	Industrial Storm Water Only		42.23333	-84.39167
MIS310012	Riverside Grinding Co	Industrial Storm Water Only		42.22472	-84.37917
MIS310013	Orbitform	Industrial Storm Water Only		42.22139	-84.36861
MIS310022	Willbee Transit Mix	Industrial Storm Water Only		42.25417	-84.50833
MIS310023	Jackson Auto Salvage	Industrial Storm Water Only		42.25417	-84.50000

Table 6. continued

Permit Number	Facility	Receiving water	Design Flow (MGY*)	Latdd	Longdd
MIS310030	Thompson-McCully Co-Jackson	Industrial Storm Water Only		42.27722	-84.38833
MIS310032	John Crowley Inc	Industrial Storm Water Only		42.24167	-84.40000
MIS310033	Michigan Seat Co	Industrial Storm Water Only		42.22083	-84.38333

Table 7. Active NPDES permit notices of coverage for construction sites in Jackson County, Michigan.

PERMIT NUMBER	FACILITY	LOCATION	TWP.	RANGE	SECTION	DATE RECEIVED	EFFECTIVE DATE
MIR102805	SCHOTT-HICKORY HILLS GOLF CLUB	2540 PAR VIEW DR, JACKSON				01/30/1998	01/30/1998
MIR102912	MDOT-M60-JACKSON COUNTY	SPRING ARBOR, SUMMT, AND BLACKMAN TWPS				03/24/1998	03/24/1998
MIR103006	IPL TOLEDO-HANNAWALD STRG YD	M-52, WATERLOO	T1S	R2E	1	05/11/1998	05/11/1998
MIR103095	WATERLOO GOLF COURSE EXPANSION	11800 TRIST RD, GRASS LAKE	T1S	R2E	33	06/17/1998	06/17/1998
MIR103498	KARVOL-TIMS LAKE PRESERVE	KNIGHT RD - MT HOPE RD, GRASS LAKE	T2S	R2E	21	12/15/1998	12/15/1998
MIR103980	GILLESPIE-GALLERY PLACE	PARNALL RD, NE CORNER OF PARNALL AND LANSING RD	T2S	R1W	15	08/11/1999	08/11/1999
MIR104072	STERLING-ASHTON RIDGE APTS	2905 BLAKE RD, JACKSON BETWEEN N ELM AND DETTMAN RD	T2S	R1W	25	09/28/1999	09/28/1999
MIR104174	JMK-ART MOEHN CHEVROLET/HONDA	SEYMOUR RD N OR I-94				11/29/1999	11/29/1999
MIR104208	NORFOLK-SUMMIT GLEN/RIDGE CNDO	BETWEEN MC CAIN AND MORRELL ST NEAR ROBINSON	T3S	R1E	5	11/17/1999	12/29/1999
MIR104362	JCRC-BOARDMAN ROAD EXTENSION	LONGFELLOW TO MAYNARD TO AIRPORT RD				03/08/2000	03/20/2000
MIR104382	JCRC-WILDWOOD/GANSON RECONST	MICHIGAN AVE TO BROWN	T2S	R1W	32,33	03/24/2000	03/24/2000
MIR104492	SUMMIT GLEN/SUMMIT RIDGE	MCCAIN RD, JACKSON	T3S	R1E	5	04/19/2000	05/15/2000
MIR104558	COLBROOK-COLBROOK MEADOWS	JEFFERSON RD AND TIFFANY RD	T4S	R1E	24	06/05/2000	06/05/2000
MIR104644	MOLTON GROUP-CORONADO	NAPOLEON RD & DORRELL RD	T3S	R1E	14	07/07/2000	07/11/2000
MIR104814	BULLINGER/WANDERING CK CONDO	S JACKSON RD S OF FERGUSON	T3S	R1W	21	09/19/2000	09/19/2000
MIR104943	KIRK MERCER	8049 S JACKSON RD	T4S	R1W	3	11/17/2000	11/29/2000
MIR105057	KINDER MORGAN-ORION PLANT	2219 CHAPIN ST, JACKSON	T3S	R1W	36	01/22/2001	01/22/2001
MIR105198	JACKSON CON ENRGY HEADQUARTER	BETWEEN FRANCIS ST ON AIRLINE DR	T3S	R1W	2	03/28/2001	03/28/2001
MIR105197	PENMARK GOODYR TIRE DEMOLITION	1304 PAGE ST, JACKSON	T2S	R1W	36	03/28/2001	03/28/2001
MIR105238	ECCLESIA RIDGE VIEW ESTATES	MICHIGAN AVE, MT. HOPE ROAD, GRASS LAKE TWP	T2S	R2E	33	04/24/2001	04/24/2001
MIR105297	MDOT CS 38111	JN 55900A				05/17/2001	05/17/2001
MIR105301	SCENIC HILLS	SCENIC HILLS DRIVE	T2S	R1E	29	05/18/2001	05/21/2001
MIR105498	DRS-MYSTIC HILLS-GRANDE GOLF	FLOYD RD NEAR US-127			24, 25	07/30/2001	08/24/2001
MIR105566	GANTON'S-TERRACE HILLS 1A & 1B	ROBINSON & SPRING ARBOR RD, JACKSON	T3S	R1W	7	09/21/2001	09/21/2001
MIR105586	LEFERE-SPEEDWAY-KART TRACK	PAGE AVE, JACKSON	T3S	R1E	6	09/17/2001	10/03/2001
MIR105614	MDOT-US127 RECONSTRUCTION		T3S	R1E		10/17/2001	10/17/2001
MIR105665	SUN COMM-WINDHAM HILLS	COUNTY FARM RD, JACKSON	T2S	R1W	19	11/20/2001	11/20/2001
MIR105695	JACKSON CO-FRANCIS ST RECONST	FRANCIS ST MCDEVITT TO SOUTH ST, JACKSON	T3S	R1W	10,11,14,22,23	11/26/2001	12/04/2001
MIR105704	TAC-MFG PLANT ADDITION	4111 COUNTY FARM RD	T2S	R1W	30	11/30/2001	12/07/2001
MIR105886	MJ FARMS-GREENBRIAR PH 2	KING RD, SPRING ARBOR	T3S	R2W	9	03/25/2002	03/25/2002
MIR105925	MDOT-M50 / US127 BL	NORTH ST TO BOARDMAN RD	T2S	R1W	27,28,33,4	04/05/2002	04/05/2002
MIR105996	VISTA GRANDE VILLA EXPANSION	2251 SPRINGPORT RD	T20S	R1W	28	05/08/2002	05/08/2002
MIR106096	HOME DEPOT-INSTALLMENTS	1400 W MONROE ST	T2N	R1W	28	06/14/2002	06/14/2002
MIR106113	SD-ARBORS @ THE WOODS	DETLMAN & AMOS, JACKSON	T2S	R1W	36	06/19/2002	06/19/2002
MIR106173	HOME DEPOT STORE 2770-JACKSON	NW CORNER OF MONROE & WISNER ST	T2N	R1W	28	07/18/2002	07/18/2002
MIR106172	NORFOLK-SUMMIT GLEN/OAK GROVE	BARRINGTON CIRCLE, JACKSON	T3S	R1E	5	07/18/2002	07/18/2002
MIR106194	SANCTUARY OF BRILLS LK PH 2	3650 WHIPPLE RD, JACKSON	T2S	R1E	22	07/30/2002	07/30/2002
MIR106265	WELLHOFF-BRENDAN ESTATES	M-50, NAPOLEON	T4S	R1E	1	08/21/2002	08/21/2002
MIR106529	MDOT-US127, JACKSON		T4S	R1W	13	01/16/2003	01/16/2003

APPENDIX I

Resolution to Establish Upper Grand Watershed Council

A PETITION TO THE MICHIGAN NATURAL RESOURCES COMMISSION FOR THE FORMATION OF AN UPPER GRAND RIVER WATERSHED COUNCIL PURSUANT TO ACT 451, PUBLIC ACTS OF 1994

WHEREAS, the cooperating local governments signing this petition recognize a common interest in the water and related resources of the Grand River Basin; and

WHEREAS, certain governmental units in the Watershed depend upon the Grand River for water supply and for assimilation of effluent from wastewater treatment plants; and

WHEREAS, private interests such as Grand River Environmental Action Team (GREAT), as well as governmental interests such as the State of Michigan, the County and the City of Jackson, and others have extensive investments in recreational lands and facilities along the Grand River, and

WHEREAS, the natural fluctuation in the flow of the Grand River has in the past caused problems of flooding on the one hand, and low flow on the other; and

WHEREAS, prior studies have indicated benefits to communities will accrue from further coordinated studies, river management, and augmenting the flow of the Grand River; and

WHEREAS, millions of people at present live and work in the Grand River Watershed Area; and

WHEREAS, the government, employment, industry, and economic development of the Grand River Basin and the health, safety, and general welfare of its population are and will continue to be vitally affected by the use, conservation, management, and control of the water and related resources of the Grand River Basin; and

WHEREAS, demands upon the waters and related resources of the Grand River Basin are expected to increase rapidly because the population of the area is projected to increase, together with the trend of wastewater treatment facilities situated in other adjacent watersheds, finding it less expensive to discharge their phosphates into the Grand River Watershed (as opposed to effectively treating and removing the phosphates prior to discharging into their own watershed); and

WHEREAS, the conservation, use, development, management and control of the water related resources of the Grand River Basin require cooperative studies and action by the local units of government in the Basin; and

WHEREAS, the Grand River Intercounty Drainage Board, and a steering committee comprised of all municipalities situated within the Uppper Grand River Watershed, have made investigations, surveys and studies extending over a period of five years, and have concluded that the formation of a Upper Grand River Watershed Council under Act 451, Public Acts of 1994, is advisable and urgently needed;

NOW THEREFORE, the local governments signing this petition, on behalf of several of the communities situated within the Upper Grand River Watershed, respectfully request the Michigan Natural Resources Commission adopt an order establishing the Upper Grand River Watershed Council, said Council to have the following general purposes, functions, area to be served and eligible membership.

DESCRIPTION OF GENERAL PURPOSES AND FUNCTIONS TO BE PERFORMED:

1. Conduct, or cause to be conducted studies of water resources of the Upper Grand River Watershed, including investigations of water use, water quality and the reliability of the water resources, and coordinate the studies which have been undertaken by the Upper, Mid and Lower Grand River Watershed Study groups.

2. Prepare periodic reports concerning among other things, trends in water use and availability, emerging water problems and recommendations for appropriate public policies and programs necessary to maintain adequate water resources for the Grand River Watershed area.

3. If determined necessary by the council, request the Michigan Natural Resources Commission to survey the Grand River Watershed for the purpose of determining minimum levels of stream flow necessary for health, welfare and safety as provided in Act No. 451, Public Acts of 1994.

4. Make plans for development and management of water resources and recommend the creation of a river management district or districts in the Grand River Watershed under the provisions of Act 451 Public Acts of 1994, when the needs warrant such an action.

5. Advise agencies of federal, state and local government as to the council's view of the Grand River Watershed's problems and needs.

6. Cooperate with federal, state and local agencies in providing stream gauges, water quality sampling stations, or other water resources data-gathering facilities or programs that aid the council in its responsibility for studying and reporting on water conditions.

7. Adopt by-laws necessary for its operation.

8. Adopt annual operating budgets and establish apportionment of costs.

9. Hold an annual meeting for the election of Chairman, Vice-Chairman, Secretary-treasurer and such other officers as necessary, submit an annual report to member governments, and hold such other meetings as needed.

10. Employ an executive secretary and such other professional, administrative or clerical staff, including consultants, as may be provided for in an approved budget.

11. Establish such subcommittees or advisory committees as are deemed helpful in the discharge of its functions.

12. Establish special project funds as needed to finance special studies outside its annual budget capacity and for this purpose the council may accept gifts and grants from private individual, corporations and local, state or federal governments.

13. Promote watershed management activities, including: the implementation of the Upper grand River Watershed Plan; the provision of a forum for discussion of watershed issues, and development of recommendations for local land use and ordinance language.

THE GRAND RIVER WATERSHED

The Grand River originates in Somerset Township, Hillsdale County and outlets into Lake Michigan approximately 260 miles downstream at Grand Haven. It drains the second largest watershed in Michigan. The watershed is bounded on the north by the Muskegon River and Saginaw River watersheds, and on the south by the Kalamazoo River, St. Joseph River, and River Rasin watersheds, and to the east by the Huron River Watershed. The watershed has a drainage area of 5,572 square miles and includes all or part of 19 counties.

The drainage area of the Upper Grand River, as defined by the Michigan Water Resources Commission, is approximately 2,840 square miles with a downstream terminus just below the mouth of Prairie Creek at Ionia. As mentioned previously, the planning area for this Watershed Management Plan is defined as starting in northern Hillsdale County and terminating just north (downstream) of the City of Eaton Rapids, an area approximately 700 square miles. This area is referred to as the Upper Grand River Watershed throughout this plan.

This Petition is executed by duly adopted resolutions of the following municipalities: