Appendix 1

- **Table of Field Priority Scores**
    - **Appendix 1 is a .csv document. To request a copy, contact Allegan Conservation District at allegan.admin@macd.org**

Appendix 2

- **2004 Watershed Survey Data Sheets**

Watershed Survey Data Sheet - Gun River Watershed

Site ID# _____

Water Odor	None	Musty	Rotten Eggs	Chemical	Oil	Sewage
Riparian Habitat	Trees	Shrubs	Herbaceous plants		Grass	Bare
Buffer/Filter Strip	Y / N	Width	<1'	1' - 3'	3' - 10'	>10'

Pollutant Source (choose only one, complete section)

SECTION 1. DEBRIS/TRASH/OBSTRUCTIONS

Description				
Amount	Slight	Moderate	Extensive Amount	

SECTION 2. CONSTRUCTION SITE RUNOFF

Location		Left Bank	Right Bank	
Construction type		road	residential	industrial	other
Soil erosion measures		not installed	needs repair	not adequate	
Sedimentation control measures		not installed	needs repair	not adequate	
Extent of erosion/sedimentation		slight	moderate	severe	

SECTION 3. STREAM CROSSING

Type of Crossing	Bridge	Single Culvert	Double Culvert	Other	
Construction material	Concrete	Galvanized	Plastic	Other	
Condition	Good	Fair	Poor		
Flow	Clean	> 1/4 full of Sediment	Obstructed		
Road Surface	Paved	Gravel	Unimproved		
Erosion Location	Streambank	Embankment	Culvert outlet	Shoulder/Ditch	
Extent of Erosion	Minor	Moderate	Severe		

SECTION 4. RILL, GULLY, OR SURFACE DITCH EROSION

Location	Left Bank	Right Bank			
Average Width	_____ feet		(Top width + Bottom width)/2		
Depth	_____ feet				
Length	_____ feet				
Height of streambank	< 3'	3' - 6'	> 6'		
Land use at location	Wooded	Wetland	Agricultural	Residential	Commercial

SECTION 5. LIVESTOCK ACCESS

Location	Left Bank	Right Bank			
Length of erosion	< 10'	10' - 25'	26' - 100'	> 100'	
Height of streambank	< 3'	3' - 6'	> 6'		
Vegetation cover	Bare	Sparse vegetation	Stable vegetation		

SECTION 6. UPLAND NUTRIENT SOURCES

Location	Left Bank	Right Bank			
Cropland Erosion/Runoff		Conventional Tillage	Manure Spreading		Plowing perpendicular to stream
Manure in Stream	None	Some Evident	Extensive Amount		
Manure Storage	Y / N	How far from top of streambank?		_____	feet
Feedlot Area	_____ acres		Paved	_____	%
Animal Operation Type	Dairy	Hog	Beef	Other	

SECTION 7. TILE OUTLETS

Location	Left Bank	Right Bank	Erosion	Y / N	
Pipe diameter	_____	inches			
Pipe Material	Plastic	Clay	Metal	Concrete	Other
Height above Stream Botto	0" - 6"	6" - 12"	12" - 36"	> 36"	
Discharge Color	Clear	Green	Cloudy/Milky	Very Muddy	Black
Discharge Odor	None	Musty	Ammonia/eggs	Chemical/oil	Sewage

SECTION 8. STREAMBANK EROSION

Location	Left Bank		Right Bank		
Length of erosion	< 10'	10' - 25'	26' - 100'	> 100'	
Height of streambank	< 3'	3' - 6'	> 6'		
Severity of Erosion	Some Bare Bank	Mostly Bare Bank	Bare bank w/ Rills	Washout	
Location of Erosion	Toe	High Water Mark	Top of Bank	Entire Bank	

Watershed Survey Data Sheet
Gun River Watershed

Date
Technician
Waterbody Name **Site ID#** _____
Site Reference

Pollutant Source (choose only one, complete section)

1. Debris/Trash 2. Construction Site Runoff 3. Stream Crossing 4. Rill or Gully Erosion

5. Livestock Access 6. Upland Source 7. Tile Outlet 8. Streambank Erosion 9. Other _____

County A / B **Township** **Section #** **1/4** **1/4**
Tract #(s) **Owner**

Current precipitation	None	Light	Moderate	Heavy		
Days since last rain	1 or less	2	3 or more	How much?		inches
Water Color	Clear	Green	Cloudy/Milky	Very Muddy	Black	
Water Odor	None	Musty	Rotten Eggs	Chemical	Oil	Sewage
Stream flow type	Dry	Stagnant	Slow Flow	Rapid Flow		
Average Stream Width	10' or less	11' - 25'	25' - 50'	50' or more		
Average Stream Depth	<1'	1' - 3'	>3'	Don't know		
Riparian Habitat	Trees	Shrubs	Herbaceous plants		Grass	Bare
Buffer/Filter Strip	Y / N	Width	<1'	1' - 3'	3' - 10'	>10'
Land Use (facing u/s)	Left Bank	Woodland	Wetland	Idle	Agricultural	Res/Comm
	Right Bank	Woodland	Wetland	Idle	Agricultural	Res/Comm

SECTION 1. DEBRIS/TRASH/OBSTRUCTIONS

Description

Amount	Slight	Moderate	Extensive Amount	

SECTION 2. CONSTRUCTION SITE RUNOFF

Location	Left Bank	Right Bank		
Construction type	road	residential	industrial	other
Soil erosion measures	not installed	needs repair	not adequate	
Sedimentation control measures	not installed	needs repair	not adequate	
Extent of erosion/sedimentation	slight	moderate	severe	

Watershed Survey Data Sheet

Date: **Time:**
Waterbody Name: **County:** **Station #:**
Location: **Township:** **Sec T R ¼ ¼**
Investigator: **Lat:** **Long:**
Coordinate Determination Method (check the one that applies):
___ GPS ___ GPS w/ DBR ___ Digital mapping software ___ Topographic map ___ Other (describe _____)
Map Scale (if known _____)

PHYSICAL HABITAT

BACKGROUND INFORMATION – pg. 18

Event Conditions noted at site	None	Light	Moderate	Heavy	
Days since Rain	≤ 1	2	≥3	Unknown	
Water Temp./D.O./pH *					
Water Color	Clear	Gray	Brown	Black	Green
Waterbody Type-u/s	Stream	Lake	Impd	Wetland	
Waterbody Type-d/s	Stream	Lake	Impd	Wetland	
Stream Width (ft.)	<10	10-25	25-50	>50	
Avg. Stream Depth (ft.)	<1	1-3	>3	Unknown	
Water Velocity (ft/sec)					
Stream Flow Type	Dry	Stagnant	L	M	H

PHYSICAL APPEARANCE – pg. 20

	U/S (Check all that apply)		D/S (Check all that apply)	
Aquatic Plants	Present	Abundant	Present	Abundant
Floating Algae	Present	Abundant	Present	Abundant
Filamentous Algae	Present	Abundant	Present	Abundant
Bacterial Sheen/Slimes	Present	Abundant	Present	Abundant
Turbidity	Present	Abundant	Present	Abundant
Oil Sheen	Present	Abundant	Present	Abundant
Foam	Present	Abundant	Present	Abundant
Trash	Present	Abundant	Present	Abundant

SUBSTRATE (add to 100%) – pg. 22

	U/S (%)	D/S (%)
Boulder – 10 in. diam.		
Cobble/Gravel –10 to .08 in. diam.		
Sand – coarse grain		
Silt/Detritus/Muck - fine grain/organic matter		
Hardpan/Bedrock – solid clay/rock surface		
Artificial – manmade		
Unknown		

INSTREAM COVER – pg. 23

	U/S (%)	D/S (%)
Undercut Banks		
Overhanging Veg.		
Deep Pools		
Boulders		
Aquatic Plants		
Logs or Woody Debris		

RIVER MORPHOLOGY – pg. 23

	U/S			D/S		
Riffle	Present	Abundant		Present	Abundant	
Pool	Present	Abundant		Present	Abundant	
Channel	Natr	Recv	Maintnd	Natr	Recv	Maintnd
Designated Drain	?	Y	N	?	Y	N

Highest Water Mark (ft.)	?	<1	1-3	3-5	5-10	>10

STREAM CORRIDOR – pg. 26

	U/S				D/S			
Riparian Veg. Width ft.(L)	< 10	10-30	30-100	>100	< 10	10-30	30-100	>100
Riparian Veg. Width ft.(R)	< 10	10-30	30-100	>100	< 10	10-30	30-100	>100
Bank Erosion	0	L	M	H	0	L	M	H
Streamside Land Cover	B	G	S	T	B	G	S	T
Stream Canopy %	<25	25-50	>50		<25	25-50	>50	

Adjacent Land Uses

Wetlands	L	R	L	R
Shrub or Old Field	L	R	L	R
Forest	L	R	L	R
Pasture	L	R	L	R
Crop Land	L	R	L	R
Animal Feeding Operation	L	R	L	R
Maintained Lawns/Parks	L	R	L	R
Impervious Surfaces	L	R	L	R
Disturbed Ground	L	R	L	R
No Vegetation	L	R	L	R

Stream Cross Section

Date: **Watershed Survey Data Sheet (pg. 2)** Station #:

ROAD CROSSING INFORMATION

Crossing Type	Bridge	___ Round Culvert(s)	___ Box Culvert(s)	___ Arch Culvert(s)	Other:			
Road Surface	Paved	Gravel	Sand	Clay	Grass	Other:		
Road Ownership	MDOT	County	USFS	MDNR	Municipal	Priv/Corp	Unknown	Other:
Culvert Problems	Poor Alignment	Inadequate Armoring	Impounding Water	Obstructed	Structural Integrity	Other:		
Perched Culvert	< 3"	3-12"	> 12"	Plunge Pool				
Crossing Erosion	Crossing Embankment	Road Approaches	Road Ditches					

POTENTIAL SOURCES (Severity: S – slight, M – moderate, H – high) pg. 28

	U/S			D/S		
Crop Related Sources	S	M	H	S	M	H
Grazing Related Sources	S	M	H	S	M	H
Intensive Animal Feeding Operations	S	M	H	S	M	H
Highway/Road/Bridge Maintenance and Runoff (Transportation NPS)	S	M	H	S	M	H
Channelization	S	M	H	S	M	H
Dredging	S	M	H	S	M	H
Removal of Riparian Vegetation	S	M	H	S	M	H
Bank and Shoreline Erosion/ Modification/Destruction	S	M	H	S	M	H
Flow Regulation/ Modification (Hydrology)	S	M	H	S	M	H
Upstream Impoundment	S	M	H	S	M	H
Construction: Highway/Road /Bridge/Culvert	S	M	H	S	M	H
Construction: Land Development	S	M	H	S	M	H
Urban Runoff (Residential/ Urban NPS)	S	M	H	S	M	H

	U/S			D/S		
Land Disposal	S	M	H	S	M	H
On-site Wastewater Systems	S	M	H	S	M	H
Silviculture (Forestry NPS)	S	M	H	S	M	H
Resource Extraction (Mining NPS)	S	M	H	S	M	H
Recreational/Tourism Activities (general)	S	M	H	S	M	H
• Golf Courses	S	M	H	S	M	H
• Marinas/Recr. Boating (water releases)	S	M	H	S	M	H
• Marinas/Recr. Boating (bank or shoreline erosion)	S	M	H	S	M	H
Debris in Water	S	M	H	S	M	H
Industrial Pt. Source	S	M	H	S	M	H
Municipal Pt. Source	S	M	H	S	M	H
Natural Sources	S	M	H	S	M	H
Source(s) Unknown	S	M	H	S	M	H

SITE SUMMARY INFORMATION pg. 33

SURVEY DIRECTION	N/A	U/S	D/S
SITE SIMILARITY	?	Y	N
OVERALL SITE RANKING	Good	Fair	Poor
LLOW UP	L	M	H

COMMENTS: _____

Appendix 2A

- **Table 5.1A - 2004 Agriculture BMP Costs by Waterbody**
- **Table 5.2A - 2004 Streambank Erosion BMP Costs by Waterbody**
- **Table 5.3A - 2004 Rill and Gully BMP Costs by Waterbody**
- **Table 5.4A - 2004 Tile Outlet BMP Costs by Waterbody**
- **Table 5.5A - 2004 Road Stream Crossing BMP Costs by Waterbody**
- **Table 5.6A - 2004 Trash and Debris BMP Costs by Waterbody**
- **Table 5.7A - 2004 Other Site BMP Costs by Waterbody**
- **Table 5.8A - 2004 Construction BMP Costs by Waterbody**

Table 5.1A - Agriculture BMP Costs by Waterbody

Site ID	Description	Water Color	Water Odor	Buffer	LU Left Bank	LU Right Bank	Source	Crop Tillage	Manure Usage	Type of Operation	Proposed Improvements	Estimated Unit Cost	Estimated Site Cost[5]	Priority	Comments
Gun River															
RDGUN0101B							Right bank		None		Filter strip[4]	$190/acre filter, $58/ac rental	$1,155	M	
40MAR1201B	122nd Street. crossing	Brown	None	3'-10'	AG	AG	Both	Conventional	None		Conservation tillage[2] BMPs and filter strip[3]	$10/acre till, $190/acre filter, $58/ac rental	$3,110	H	
40MAR3608B	2nd Street bridge north of Hooper	Brown	None				Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[5]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	
40MAR3501	200' upstream from 2nd Street. bridge North of Hooper						Left bank				Conservation tillage[2] BMPs and filter strip[8]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Drop inlet opening stable, but field eroding at inlet
40MAR1301B	120th Avenue crossing	Clear			AG		Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[9]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	M	Left bank downstream road ditch contains field runoff of discolored water
40MAR3502A			None				Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[10]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	
40GUN0210A	Bridge crossing 2nd Street	Brown	None	>10'			Right bank	Conventional	None		Conservation Tillage[2] BMPs and Filter Strip[11]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	
40MAR1402B	2nd Street crossing north of 118th.	Brown	None	3'-10'	AG	AG		Conventional	None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	Possible runoff from field
40MAR2605							Left bank	Conventional			Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	Electric irrigation point
40GUN1001B	110th Avenue bridge	Brown	None	Y			Left bank	Conventional			Conservation tillage BMPs[2]	$10/acre Till	$800	M	Metal retaining wall on right bank, ditch enters from east and irrigation downstream
40MAR2302A			None		AG	Road	Left bank		None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	

Table 5.1A - Agriculture BMP Costs by Waterbody

Site ID	Description	Water Color	Water Odor	Buffer	LU Left Bank	LU Right Bank	Source	Crop Tillage	Manure Usage	Type of Operation	Proposed Improvements	Estimated Unit Cost	Estimated Site Cost[5]	Priority	Comments
40MAR2603A			None		AG	Road	Left bank		None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	
40ORA0601B	Patterson Road crossing	Green	None	3'-10'			Right bank		None		Filter strip[3]	$190/acre filter, $58/ac rental	$1,155	M	
40GUN0103B	200' upstream in ditch adj. to corn						Right bank		None		Filter strip[4]	$190/acre filter, $58/ac rental	$1,155	M	
40GUN0103A	200' upstream in ditch adj. to corn						Right bank		None		Conservation tillage[2] BMPs and filter strip[8]	$10/acre Till, $190/acre filter, $58/ac rental	$1,955	M	Corn field adjacent to ditch
40GUN1801B	107th Street bridge	Clear	None	Y			Left bank				Conservation tillage BMPs[2]	$10/acre Till	$800	L	
Total Cost													**$27,725.00**		
Gregg Brook Drain															
59MAR0301	At 1298	Brown	Rotten eggs	N	AG	AG	Both	Conventional	?	Dairy	Windbreaks and cover crops[1]	$240/acre windbreak, $12/ac cover, and $58/ac rental	$3,432	H	1298 is 3' thick organic muck, brown/gray conglomerate with methane odor, between pastures
59MAR0303	East of long barns, 1,000' d/s from 124th	Cloudy	None	N	AG	AG	Both			Dairy	Filter strip[4]	$190/acre filter, $58/ac rental	$2,310	H	
59MAR0301	At 595 outfall	Cloudy	None	N	AG	AG	Left bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[4]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	595 stagnant, plume into 59, 50' of duckweed up 595
59MAR1005	Next to cornfield up from 593	Brown	None	N	AG	AG	Left bank	Conventional / plow perp			Windbreaks and cover crops[1]	$240/acre windbreak, $12/ac cover, and $58/ac rental	$3,432	H	No buffer at all, some bare to stream, black soils, lots of aquatic vegetation
Total Cost													**$11,129.00**		

Table 5.1A - Agriculture BMP Costs by Waterbody

Site ID	Description	Water Color	Water Odor	Buffer	LU Left Bank	LU Right Bank	Source	Crop Tillage	Manure Usage	Type of Operation	Proposed Improvements	Estimated Unit Cost	Estimated Site Cost[5]	Priority	Comments
Tributary 403															
403GUN1604B	600' upstream from Gun on 7th Street	Brown	None	>10'			Both		None		Filter strip[4]	$190/acre filter, $58/ac rental	$2,310	L	
Total Cost													**$2,310.00**		
Culver Drain															
570MAR2703	Drain inlet east of crossing	Cloudy	None	3'-10'	AG	AG	Right bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[6]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Cloudy/milky water coming from inlet drain.
570MAR2702	Drain inlet at bend in culvert drain	Cloudy	None	3'-10'	AG	AG	Right bank	Conventional	None		Conservation tillage[2] BMPs and filter strip[7]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Evidence of field runoff, picture No.8, water color change, milky water where drain enters
Total Cost													**$3,910.00**		
Tributary 575															
575WAY3502	By dairy on 4th Street	?	None	1'-3'	AG	AG	Right bank	Grazing		Dairy	Agriculture BMPs [2,4]	$18/yd fence	$9,000	H	Utility box falling in
Total Cost													**$9,000.00**		
Tributary 1059															
1059GUN1103		Clear	None	N	AG	AG	Left bank	Conventional			Conservation tillage[2] BMPs and filter strip[8]	$10/acre till, $190/acre filter, $58/ac rental	$1,955	H	Picture available, double culvert coming off field w/ little buffer
1059MAR2508	3rd field u/s from 2nd on left bank	Brown	Musty		AG	AG	Left bank	Conventional			Windbreaks and cover crops[1]	$240/acre windbreak, $12/ac cover,	$3,432	H	Dark soil field, small gullies, substrate very mucky, lots of aquatic

Table 5.1A - Agriculture BMP Costs by Waterbody

Site ID	Description	Water Color	Water Odor	Buffer	LU Left Bank	LU Right Bank	Source	Crop Tillage	Manure Usage	Type of Operation	Proposed Improvements	Estimated Unit Cost	Estimated Site Cost[5]	Priority	Comments
												and $58/ac rental			plants & algae, diverse & prolific pop
Total Cost													$5,387.00		

[1]Windbreak assumes 3.6 acres for a 40 acre square field.
[2]Conservation Tillage: No till or minimum till incorporated with well timed fertilizer and pesticide applications, average 40 acres at $10/acre.
[3]Filter strips: For estimations, a standard 1.5 acres for filter strips was assumed, $190/ac for establishment, $58/ac/year rental for 10 years.
[4]Agricultural BMPs: Use of cattle exclusion fences in waterways, average 500 yards, $18/yd.
[5]Estimated cost for establishment and 10-year rental payments.

High priority	$36,446
Medium priority	$19,905
Low priority	$ 3,110
Total	**$59,461**

Table 5.2A - Streambank Erosion BMP Costs by Waterbody

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
Gun River															
RDWAY3401	Northwest corner 124th and 5th	<1'	AG	Road	Both	26'-100'	3'-6'	Mostly bare bank	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
40GUN0201					Right bank	>100'	>6'	Washout	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
40GUN1801C	107th Street Bridge	Y			Left bank	>100'	3'-6'	Mostly bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
40MAR2308			Utility	Utility	Left bank	26'-100'	>6'	Washout	Entire bank	1,000	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$7,953	H	Erosion under utility pole
40MAR1301C	120th Avenue crossing		AG		Right bank	26'-100'	3'-6'	Mostly bare bank	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
40GUN105					Left bank	26'-100'	>6'	Mostly bare bank	Entire bank	1,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
40MAR2307		Y	AG	Woodland	Left bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Erosion at irrigation point, old diesel-smelling fire engine used for pumping
40MAR2606					Left bank	10'-25'	>6'	Washout	Entire bank	250	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$2,028	H	Erosion threatens utility pole
40ORA0601C	Patterson road crossing	3'-10'			Both	<10'		Washout	Entire bank		Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap		H	
40GUN0208					Right bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
40GUN0204					Right bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
40MAR2303					Left bank	10'-25'	>6'	Washout	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
40MAR3606					Left bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
40MAR2607			AG	Road	Right bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Erosion at top of road grade
40GUN0207		3'-10'			Left bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	LP gas and diesel irrigation upstream

Table 5.2A - Streambank Erosion BMP Costs by Waterbody

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
40GUN0103B	200' upstream in ditch adj. CORN				Right bank	>100'	3'-6'	Some bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	M	
40MAR2302B			AG	Road	Left bank	>100'	>6'	Some Bare BANK	Entire bank	2,000	Bank Shaping and Bioengineering w/riprap	$5.5/$yd^3$ bank $4/foot bio, and $75/yd riprap	$16,240	M	Bank slumping into river, corn up to top of bank
40GUN0104B	Drainage ditch intersection				Left bank	10'-25'	>6'	Some bare bank	Entire bank	250	Bioengineering	$4/foot	$100	M	
40MAR2603B			AG	Road	Left bank	10'-25'	>6'	Some bare bank	Entire bank	250	Bioengineering	$4/foot	$100	M	
40GUN1752C					Left bank	<10'	>6'	Washout	Top of bank	100	Bioengineering	$4/foot	$40	M	
40GUN1001C	110th Ave. Bridge	Y			Left bank	<10'	>6'	Some bare bank	Top of bank	100	Bioengineering	$4/foot	$40	L	Metal retaining wall at ditch enters from east and irrigation. downstream
Total Cost													$110,426.00		
Gregg Brook Drain															
59MAR1003		1'-3'	AG	AG	Left bank	<10'	3'-6'	Mostly bare bank	Top of bank	60	Bioengineering	$4/foot	$40	M	
Total Cost													$40.00		
Tributary 403															
403GUN1602B			Road	Road	Right bank	>100'	3'-6'	Washout		1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
Total Cost													$15,800.00		
Tributary 407															
407GUN0103		N			Both	>100'	>6'	Washout	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	200' of unstable banks on both sides, some road shoulder erosion, light vegetation
407GUN0101	Along roadside 2nd street. across from farmhouse	N	AG	Road	Both	>100'	>6'	Some Bare bank	High water	2,000	Bioengineering	$4/foot	$800	M	
407GUN0102	100 yards south of bridge	Y	AG	Road	Left bank	<10'	>6'	Mostly bare bank	High water	100	Bioengineering	$4/foot	$40	M	
Total Cost													$16,640.00		

Table 5.2A - Streambank Erosion BMP Costs by Waterbody

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
Tributary 408															
408MAR3601B	100 ft. u/s from mouth 408	3'-10'	AG	AG	Right bank	26'-100'	3'-6'	Washout	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	H	
Total Cost													$7,900.00		
Tributary 571															
571MAR2401	300 ft east of 2nd Street many point along bank		AG	Road	Right bank	>100'	>6'	Mostly bare bank	Top of bank	2,000	Bioengineering	$4/foot - bioeng.	$800	H	
571MAR2402	500 ft e of 2nd		AG	Road	Left bank	>100'	>6'	Some bare/mostly bare	Top of bank	2,000	Bioengineering	$4/foot	$800	M	No buff, washes off field, conventional tillage
Total Cost													$1,600.00		
Tributary 572															
572MAR3601	Along farm road	N	AG	Road	Left bank	<10'	3'-6'	Some bare bank	Top of bank	60	Bioengineering	$4/foot	$40	L	Lots of aquatic. plants, another 100 ft. u/s
Total Cost													$40.00		
Tributary 575															
575MAR2601	At west side of 1st field on right	3'-10'	AG	AG	Left bank	10'-25'	>6'	Mostly bare bank	High water	250	Bioengineering	$4/foot	$100	M	Lots of shrubs and woody debris down center of drain
Total Cost													$100.00		
Tributary 1058															
1058GUN1102		N	AG	AG	Both	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
1058GUN1101	At meander	N	AG	AG	Right bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
1058MAR2501	farm drain off 1059 going S, 30 ft. from 114th Avenue		Road	Road	Right bank	10'-25'	>6'	Some bare bank	Toe	250	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$2,028	H	Culvert comes in, making a right turn, erodes far bank which electric pole is on and falling in
Total Cost													$5,978.00		

Table 5.2A - Streambank Erosion BMP Costs by Waterbody

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
Tributary 1059															
1059GUN1101		N	AG	AG	Both	>100'	3'-6'	Mostly bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	Bacterial sheet and lots of aquatic, plants, dark organic soil
1059MAR2514		<1'	AG	AG	Right bank	>100'	>6'	Mostly BARE bank	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	
Total Cost													$31,600.00		
Orangeville Drain															
1060ORA1802	1st trib u/s from Patterson		AG	AG	Both		3'-6'	Washout	Entire bank		Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap		H	
1060ORA1801	East side Patterson road and 120th		AG	RES	Right bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	No buffer nutrients from field wash off. another 30' u/s pic #34
1060ORA1804		>10'	AG	AG	Right bank	<10'	>6'	Mostly bare bank	Entire bank	100	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$790	H	
1060ORA1803			AG	AG	Both	26'-100'	>6'	Some bare/mostly bare	Entire bank	1,000	Bank Shaping and Bioengineering w/riprap	$5.5/$yd^3$ bank $4/foot bio, and $75/yd riprap	$8,813	M	Slumping bank with concrete
Total Cost													$11,578.00		
Tributary 1061															
1061ORA0901	West side next to Mullenhurst golf	N	Golf	Idle	Both	>100'	3'-6'	Mostly bare bank	Entire bank	1,200	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	Might be crossing from agricultural. land, golf course eroded drain
Total Cost													$15,800.00		
Fenner Drain															
1071MAR1410	u/s from storage tank	<1'	AG	AG	Left bank	>100'	>6'	Mostly bare bank	Entire bank	2,000	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$15,800	H	Very long stretch of eroded bank, short area OK, than another long stretch eroded
1071MAR1002	By ag/woods		AG	Woodland	Both	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	
1071MAR1413	500' W of farm crossing, farm access road to N	1'-3'	AG	AG	Left bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	

Table 5.2A - Streambank Erosion BMP Costs by Waterbody

Site ID	Description	Buffer	LU Left	LU Right	Erosion Location	SE length	SE Height	Severity	Erosion*	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
1071MAR1408	Near end of cornfield	<1'	AG	AG	Right bank	10'-25'	>6'	Mostly bare bank	Entire bank	250	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Eroded and slumping, might be recovering but animal path still eroding it
1071MAR1504	500 ft u/s from 4th		AG	AG	Both	10'-25'	>6'	Mostly bare bank	Entire bank	250	Remove obstruction Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap and $325/hour	$2,625	H	Tree fell in (L) pushing water toward bank (R), pic avail
1071MAR1405	d/s from fallen tree	<1'	AG	AG	Left bank	<10'	3'-6'	Mostly bare bank	Entire bank	60	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$790	H	lots of big limbs piled, washing out bank
1071MAR1503	400ft u/s 4th	<1'	AG	AG	Right bank	<10'	>6'	Mostly bare bank	Entire bank	100	Remove obstruction Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap and $325/hour	$1,115	H	Small tree fallen, creates gouging, picture No. 4
1071MAR1415	At end of woods	>10'	AG	Woodland	Left bank	26'-100'	3'-6'	Mostly bare bank	Entire bank	600	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$7,900	M	Looks like it has been slowly eroding for years, might just erode at heaviest rains
1071MAR1407	Next to field, near large willows	<1'	AG	AG	Right bank	26'-100'	>6'	Some bare bank	Toe	1,000	Bank Shaping and Bioengineering w/riprap	$5.5/$yd^3$ bank $4/foot bio, and $75/yd riprap	$8,120	M	Stream is meandering, exposing plastic conduit, which comes from top of bank
1071MAR1409	Rusted tank shell on S. side of drain	<1'	AG	AG	Left bank	10'-25'	>6'	Some bare bank	Entire bank	250	Bioengineering	$4/foot	$100	M	
1071MAR1404	Across from barn	<1'	AG	AG	Left bank	<10'	>6'	Some bare bank	Toe	100	riprap	$75/$yd^2$	$750	M	Looks like they tried to put a piece of plastic in to hold it, but plastic washing out
Total Cost													$43,125.00		
Tributary 1076															
1076MAR2301	Just upstream from trailer	<1'	Road	AG	Left bank	<10'	3'-6'	Some bare bank	Entire bank	60	Backfill and drain w/bioengineering and riprap	$17.5/yd3 - fill, $4/foot bio, and $75/yd riprap	$843	H	Utility box falling in
Total Cost													$843.00		
Tributary 5721															
5721MAR3602	off farm access road	<1'	AG	AG	Right bank	10'-25'	3'-6'	Mostly bare bank	Entire bank	150	Bioengineering or tree revetment w/riprap	$4/foot - bioeng. $75/yd2 - riprap	$1,975	H	Problem persists intermittently 500 ft
Total Cost													$1,975.00		

Table 5.3A - Rill and Gully Erosion BMP Costs by Waterbody

Site ID	Description	Land Use	Buffer	Height	Width	Depth	Length	Volume	Proposed Improvements	Estimated Cost/Site*	Estimated Total Cost**	Priority	Comments
Gun River													
RDGUN0101A		Wood		3-6'	8	3	100	2400	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$5,056	H	
Total Cost											$5,056.00		
Gregg Brook Drain													
59MAR1002	East of woods on west side of stream, field to S&N	AG	3'-10'	3'-6'	6	4	15	360	Berm and Tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,900	H	Gully on L w/trib. draining from field on right
Total Cost											$1,900.00		
Tributary 572													
572MAR3602	100ft. u/s from farm rd.	AG	1'-3'	<3'	2	1	25	50	Grassed waterway	$2,245/acre	$4,490	M	Goes into field 20 ft., rich organic soil, LOTS aq. plants
572MAR3604	Near end of 1st field	AG	<1'	<3'	3	1	25	75	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,833	H	Gully off field, but drops sharply at bank, erodes 4' d/s
572MAR3605	Almost to end of field	AG	<1'	>6'	3	2	8	48	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,607	M	Drains from field w/ sharp drop off
Total Cost											$7,930.00		
Tributary 575													
575MAR0201	100 ft. S of blue house after turn in drain	AG	1'-3'	>6'	1.5	2	15	45	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,600	M	Field slopes toward point
Total Cost											$1,600.00		
Tributary 1058													
1058GUN1103		AG	N	3'-6'	2	1	8	16	Berm and tube with vegetated geogrid	$1500/ berm and $20/yd^2 geogrid	$1,571	L	Picture available
Total Cost											$1,571.00		
Tributary 1059													

Table 5.3A - Rill and Gully Erosion BMP Costs by Waterbody

Site ID	Description	Land Use	Buffer	Height	Width	Depth	Length	Volume	Proposed Improvements	Estimated Cost/Site*	Estimated Total Cost**	Priority	Comments
1059GUN1104		AG	N	3'-6'	3	2	12	72	Grassed waterway	$2,245/acre	$4,490	L	Picture available
1059MAR2501	500ft U/S from 2nd	AG	<1'	>6'	3	2	8	48	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$253	M	
1059MAR2503	At start of corn on right bank	AG	3'-10'	>6'	2	3	20	120	Branch packing	$25/foot	$500	H	Gully at corner of field, goes over so that it's mostly buried
1059MAR2505	2nd field on left 100' in	AG	>10'	>6'	10	5	30	1500	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$2,833	H	Large gully off 30-40 acre soy bean field
1059MAR2506	Halfway through field on left bank	AG	>10'	>6'	5	5	20	500	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$1,056	H	Off 30-40 ac field w/ little slope, plus streambank erosion 100 ft. u/s same bank
1059MAR2509A	150FT U/S from 03	AG	>10'	>6'	2	3	25	150	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,722	M	
1059MAR2511	Toward curve in 1059	AG	<1'	>6'	3	2	15	90	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$475	H	Log fell 20' further d/s backing up water, left bank slumping, gully off corn field red. Flow
1059MAR2513	U/S of curve	RES		3'-6'	6	3	20	360	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$2,033	H	
1059MAR2515		AG	<1'	>6'	1	1	12	12	Grassed waterway	$2,245/acre	$4,490	L	
Total Cost											$17,852.00		
Orangeville Drain													
1060ORA1806	Just up stream from 1st	AG		>6'	4	2	12	96	Grassed waterway	$2245/acre	$4,490	H	Across from each other ground disturbed, cut trees off bank, moved soil on edge u/s 300 ft.
Total Cost											$4,490.00		
Fenner Drain													
1071MAR1001	South side of section 10 at exit of woods and another 100' U/S	AG	<1'	3'-6'	2	1	12	24	Branch packing	$25/foot	$300	M	Gully formed from runoff from field
1071MAR1402	By driveway, behind metal building	AG	N	>6'	2	2	7	28	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$148	M	Attempts were made to fix erosion with cement blocks
1071MAR1501	100 yds. u/s from 4th	AG		3'-6'	2	8	10	160	Rock chute	$9.50/yd^2 and $2/yd^2 Grading	$211	H	Gully off field - conventional corn, picture Nos. 1 and 2.
1071MAR1505	550 U/S from 4th	AG		3'-6'	2	2	10	40	Grassed waterway	$2,245/acre	$4,490	M	Gully forming off field

Table 5.3A - Rill and Gully Erosion BMP Costs by Waterbody

Site ID	Description	Land Use	Buffer	Height	Width	Depth	Length	Volume	Proposed Improvements	Estimated Cost/Site*	Estimated Total Cost**	Priority	Comments
Total Cost											$5,149.00		
Tributary 5721													
5721MAR3601	Just off farm access road	AG	<1'	3'-6'	2	2	2	8	Grassed waterway	$2,245/acre	$4,490	L	Along access road by drain
5721MAR3603	Off farm access rd. 100 ft. south of 114	AG	<1'	3'-6'	1	1	40	40	Berm and tube with vegetated geogrid	$1,500/ berm and $20/yd^2 geogrid	$1,678	M	Gully runs along farm road then turns into drain
Total Cost											$6,168.00		

*Grassed waterway average 2 acres
**Cost are based on 1st year implementation. Future years are $58/year lease on conservation lands

High Priority	$20,387
Medium Priority	$16,288
Low Priority	$15,041
Total	**$51,716**

Table 5.4A - Tile Outlet BMP Costs by Waterbody

Site ID	Description	Buffer Width	Outlet Erosion	Outlet Diameter	Outlet Height	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost*	Estimated Total Cost	Priority	Comments
Gun River											
40MAR3603	pipe outlet from building (Hooper)		Y	6"	0"-6"	10	Check Inlet / stabilize	$75/$yd^2$ and $150/hour Labor	$1,350	H	Possible floor drain from pole barn
40GUN0207		3'-10'	Y	4"	12"-36"	15	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,025	M	LP gas and diesel irrigation upstream
40GUN0203			Y	4-6"	12"-36"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,650	M	Three tile outlets and irrigation point
40MAR3501	200' upstream from 2nd Street bridge north of Hooper		Y		>36"	N/A	Riprap	$75/yd2	$750	M	Drop inlet opening stable, but field eroding at inlet
40GUN0209			N	10"	>36"	N/A	Maintain	$60/yr	$60	L	
40GUN0210B	bridge crossing 2nd Street	>10'	N	8"	>36"	N/A	Maintain	$60/yr	$60	L	
40GUN0102			N	8"	>36"	N/A	Maintain	$60/yr	$60	L	
40GUN0101			N		>36"	N/A	Maintain	$60/yr	$60	L	
40MAR3602A			N		12"-36"	N/A	Maintain	$60/yr	$60	L	Tile outlet appears inactive
40MAR2602			N	12-14"	12"-36"	N/A	Maintain	$60/yr	$60	L	
40MAR2304			N	8"	12"-36"	N/A	Maintain	$60/yr	$60	L	
40MAR3607			N	12"	12"-36"	N/A	Maintain	$60/yr	$60	L	
40MAR3503B			N	12-14"	12"-36"	N/A	Maintain	$60/yr	$60	L	
40MAR3502B			N		0"-6"	N/A	Maintain	$60/yr	$60	L	Drop inlet or side inlet pipe for surface water, no flow
40MAR1201C	122nd Street crossing	3'-10'	Y	8"	0"-6"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,350	L	
40GUN0209			Y	6"	0"-6"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,350	L	Two tile outlets side by side
Total Cost									$9,075.00		

Table 5.4A - Tile Outlet BMP Costs by Waterbody

Site ID	Description	Buffer Width	Outlet Erosion	Outlet Diameter	Outlet Height	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost*	Estimated Total Cost	Priority	Comments
Gregg Brook Drain											
59MAR0305	500 ft d/s from 124th	3'-10'	Y	9"	>36"	20	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,250	H	Digging out stream bottom
59WAY3401	Across from farm house	N	Y	6"	12"-36"	15	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,025	H	Slight erosion, no buffer on fields - lots of aquatic plants - eutrophic
Total Cost									$4,275.00		
Tributary 403											
403GUN1603	Midpoint along ditch at tile outlet	3'-10'	N		6"-12"	N/A	Maintain	$60/yr	$60	L	
Total Cost									$60.00		
Tributary 407											
407GUN0104			Y	6"	6"-12"	15	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,025	M	
407GUN0105B		1'-3'	N	>12"	12"-36"	N/A	Maintain	$60/yr	$60	L	
Total Cost									$2,085.00		
Tributary 408											
408MAR3601A	100 ft. u/s from mouth 408	3'-10'	Y		0"-6"	15	Replace pipe / repair bank	$30/ft - repair $75/yd2 - bank and $150/hour labor	$2,205	H	Tile outlet rusted out, water comes out bottom, below is bac. sheet, iron bacteria, and aq. plants
Total Cost									$2,205.00		
Tributary 572											
572MAR3603	100 yds. u/s from farm rd.	<1'	Y	8"	0"-6"	10	Check Inlet / stabilize	$75/$yd^2$ and $150/hour Labor	$1,350	H	Outlet covered by aq. plants; inside- 3" tan colored algae, muck w/white film on top & dk. brown
572MAR3606	Second field 1/2 way	<1'	Y	12"	12"-36"	15	Replace pipe / repair bank	$30/ft - repair $75/yd2 - bank and $150/hour labor	$2,205	H	Tile outlet rusted through, hanging bent into stream, water comes out hole, eroding bank
Total Cost									$3,555.00		

Table 5.4A - Tile Outlet BMP Costs by Waterbody

Site ID	Description	Buffer Width	Outlet Erosion	Outlet Diameter	Outlet Height	Erosion Area ft^2	Proposed Improvements	Estimated Unit Cost*	Estimated Total Cost	Priority	Comments
Tributary 1059											
1059MAR2502	End of corn field u/s from 2nd	3'-10'	Y	9"	>36"	40	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$3,900	H	End of piece about to fall off bank
1059MAR2509B	150 FT u/s from 03	>10'	N	8"	0"-6"	N/A	Replace pipe / repair bank	$30/ft - repair $75/yd2 - bank and $150/hour labor	$1,530	H	Two rusting through Tile outlet, one flowing - erosion, one not - smells musty & erosion
1059MAR2517		>10'	Y	12"	12"-36"	10	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$1,650	M	
Total Cost									$7,080.00		
Fenner Drain											
1071MAR1406	U/S from fallen tree, just up from barn	<1'	Y	9"	12"-36"	20	Check inlet / stabilize	$75/$yd^2$ and $150/hour Labor	$2,250	M	not presently flowing, but 1/2 full of muck
1071MAR1403	Next to barn	N	N	12"	0"-6"	N/A	Extend outlet	$30/foot - repair and $150/hour labor	$780	M	Tile outlet doesn't extend over stream, depositing lots of dark sediment on bank slope
1071MAR1401	Just upstream from 2nd St. bridge	N	Y	18"	12"-36"	20	Outlet stabilization	$75/$yd^2$ and $150/hour Labor	$2,400	M	
1071MAR1003	At curve in cornfield		N	9"	6"-12"	N/A	Maintain	$60/yr	$60	L	
1071MAR1502	350 ft from 4th u/s		N	8"	12"-36"	N/A	Maintain	$60/yr	$60	L	Erosion on bank around 2 to 6 outlets
Total Cost									$5,550.00		

*Labor cost of $150 hour are added to account for any use of heavy equipment in addition to materials

Table 5.5A - Road Stream Crossing BMP Costs by Waterbody

Site ID	Description	Erosion Location*	Condition	Buffer	Extent of Erosion	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
Gun River										
40ORA0601A	Patterson Road crossing	SB/CO/SD	Good	3'-10'	SEVERE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	H	
40MAR1301A	120th Avenue crossing	SB	Poor		MODERATE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	M	
40GUN1101			Good		MINOR	Bioengineering	$4/foot - tree revetment	$96	L	Upstream side blocked by debris, downstream open
40GUN1801A	107th St. Bridge		Good	Y	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40MAR2601	Crossing at 114th Ave. and 2nd St.		Good		MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40GUN1701	10th st bridge	NONE	Good		MINOR	Bioengineering	$4/foot - tree revetment and $125/hr	$96	L	
40GUN1801	Bridge at Gun River Conservation Club, 11th St.	NONE	Good	>10'	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40GUN1001A	110th Ave. Bridge		Good	Y	MINOR	Bioengineering	$4/foot - tree revetment and $125/hr	$96	L	Metal retaining wall at br. ditch enters from east and irrig. downstream
40MAR2301	116th Ave. bridge at 2nd St.	CI	Good		MINOR	Riprap	$75/yd^2	$450	L	
40GUN1702B		SB	Fair		MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
40MAR2604	Trib. crossing on 2nd St.		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	Rust colored water coming from culverts
40MAR1401	118th St. crossing		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40MAR1402A	2nd st crossing n of 118th		Fair	3'-10'	NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	1920s bridge
40MAR1201A	122nd st crossing		Good	3'-10'	NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	Triple culvert
40MAR3601			Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40OST2401	n farmer st / 106th street bridge		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40ORA0602A	gun river wier		Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	

Table 5.5A - Road Stream Crossing BMP Costs by Waterbody

Site ID	Description	Erosion Location*	Condition	Buffer	Extent of Erosion	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
40GUN1703	9th st bridge	None	Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
40MAR3608A	2nd St. bridge N. of Hooper		Fair		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
Total Cost								$4,515.00		
Gregg Brooks										
59MAR1101	120th Avenue	EB	Poor	1'-3'	SEVERE	Repair Culvert/Bridge	$1125/foot	$28,125	H	
59MAR0304A	Livestock crossing	RB	Poor	N	MODERATE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	M	
Total Cost								$28,917.00		
Tributary 402										
402GUN2101	Crossing 106th	ALL	Good	N	SEVERE	Bioengineering and riprap repair	$4/foot - $75/yd2 - riprap	$792	H	
Total Cost								$792.00		
Tributary 403										
403GUN1604A	600' upstream from Gun on 7th St.		Good	>10'	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	
403GUN1602A			Good		NONE	Clean and Maintain	$8.5/yd^3 cleaning and $150/hour	$201	L	
Total Cost								$297.00		
Tributary 406										
406GUN1102		CO	Fair	1'-3'	SEVERE	Riprap	$75/yard^2	$900	H	
Total Cost								$900.00		
Tributary 407										

Table 5.5A - Road Stream Crossing BMP Costs by Waterbody

Site ID	Description	Erosion Location*	Condition	Buffer	Extent of Erosion	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
407GUN0106		SB/EB/SD	Poor		SEVERE	Replace Culvert	$382/foot	$9,168	H	
407GUN0105A	bridge crossing 2nd Street		Fair	1'-3'	MINOR	Bioengineering	$4/foot - tree revetment	$192	M	
Total Cost								$9,360.00		
Culver Drain										
570MAR2604	Crossing westridge on north cornfield, south of blue and tan house	SB	Poor	1'-3'	MINOR	Replace Culvert	$382/foot	$9,168	M	Vehicle crossing, gravel in stream bed
570MAR2605	crossing at big tan house	SB	Good	1'-3'	MINOR	Bioengineering	$4/foot - tree revetment	$96	L	Single culvert, lg rocks on both banks E of crossing, pics
Total Cost								$9,264.00		
Tributary 571										
571ORA1901	Boysen Road in woods	EB	Fair	>10'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
Total Cost								$192.00		
Tributary 573										
573MAR2601	Crossing 114th and 4th	SB/EB	Good	<1'	SEVERE	Bioengineering	$4/foot - tree revetment	$384	H	
573MAR2701	5th Street 1/3 mi. north of 114th	EB	Fair	<1'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
Total Cost								$576.00		
Tributary 575										
575MAR0202	124th Street west of 4th	CO	Poor	>10'	SEVERE	Replace Culvert	$382/foot	$11,460	H	Concrete casing fell off, culver high, huge pool underneath
575WAY3501	By dairy on 4th Street	EB	Poor	N	MODERATE	Replace Culvert	$382/foot	$9,550	H	
Total Cost								$21,010.00		

Table 5.5A - Road Stream Crossing BMP Costs by Waterbody

Site ID	Description	Erosion Location*	Condition	Buffer	Extent of Erosion	Proposed Improvements	Estimated Unit Cost	Estimated Total Cost	Priority	Comments
Tributary 577										
577MAR0101	At end 577 bend	SB		<1'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
Total Cost								$192.00		
Tributary 1057										
1057GUN1401	West of 3rd on Pierce Road / 106th Avenue		Poor		NONE	Bioengineering	$4/foot - tree revetment	$192	M	
Total Cost								$192.00		
Tributary 1059										
1059MAR2501B	At county line crosses Boysen Road north of 114th	EB	Fair	3'-10'	SEVERE	Bioengineering	$4/foot - tree revetment	$384	H	
1059MAR2516	2nd cross	EB	Fair	<1'	MODERATE	Bioengineering	$4/foot - tree revetment	$192	M	
Total Cost								$576.00		
Orangeville Drain										
1060ORA1701	9 Mile Road crossing	EB	Fair	>10' RT. ONLY	SEVERE	Bioengineering	$4/foot - $75/yd2 - riprap	$792	H	
1060ORA1807	Crossing near farmhouse and corn storage	SB	Fair	<1'	SEVERE	Bioengineering	$4/foot - tree revetment	$384	H	
1060ORA1805			Poor		NONE	Replace Culvert	$382/foot	$9,168	M	Undersized culvert 3/4 full not right after storm. pic #39.
Total Cost								$10,344.00		
Tributary 4061										
4061GUN1101	1/4 mi east from section line 10/11	CO	Good	3'-10'	MODERATE	Riprap	$75/yd^2	$600	M	
Total Cost								$600.00		

Table 5.6A - Trash and Debris BMP Costs by Waterbody

Site ID	Description	BUFFER	Land Use Left	Land Use Right	Amount	Proposed Improvements	Estimated Cost/Site	Estimated Total Cost	Priority	COMMENTS
Gun River										
40GUN1702A					Slight	Volunteer clean-up	$60/day	$60	H	Car battery/toilet
40GUN0104A	Drainage ditch intersection				Moderate	Obstruction removal - mod.	$4/ft	$200	M	Log jam, portage point
40MAR3602B		Y			Moderate	Volunteer clean-up 2 days	$60/day	$120	M	Barrel, steel debris (fencing), etc.
40MAR2305					Moderate	Volunteer clean-up 2 days	$60/day	$120	M	Farm debris
40MAR3605	Tributary intersection	Y	Woodland	Woodland	Slight	Volunteer clean-up	$60/day	$60	M	Two tires, bucket
40MAR3503A					Slight	Volunteer clean-up	$60/day	$60	M	Metal barrel and wooden stairs
Total Cost								$620.00		
Gregg Brook Drain										
59MAR0302	W of barn/north of 595		AG	AG	Extensive	Obstruction removal - ext.	$4/ft	$400	H	Heavy overgrowth and fallen trees for over 100'
59MAR1004	Across from 592, 50' north of 592 and further u/s	1'-3'	Woodland	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Branches/trees in stream causing erosion
59WAY3402	126th Street at dip in road	>10'	Woodland	Woodland	Extensive	Obstruction removal - ext.	$4/ft	$400	M	Lots of fallen trees
59MAR1001	Halfway between 2nd and 121st in fields, plus further up	<1'	AG	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	M	Lots of fallen trees
Total Cost								$1,200.00		
Culver Drain										
570MAR2606	West end of section 26	>10'	AG	AG	Extensive	Obstruction removal - ext.	$4/ft	$1,600	H	Numerous trees and branches, approx. 400'
570MAR2701	Just upstream from 26/27 section line	>10'	Idle	AG	Moderate	Obstruction removal - ext., volunteer clean-up	$4/ft	$460	H	Lots of logs down, brushy shrubs in stream, some barbed wire left bank
570MAR2603	350 upstream of power lines	1'-3'	AG	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Fallen trees created sandbar

Table 5.6A - Trash and Debris BMP Costs by Waterbody

Site ID	Description	BUFFER	Land Use Left	Land Use Right	Amount	Proposed Improvements	Estimated Cost/Site	Estimated Total Cost	Priority	COMMENTS
570MAR2602	At 1st town going u/s from 2nd street	3'-10'	AG	AG	Slight	Obstruction removal - slight	$4/ft	$40	L	Lots of shrubs/small trees and threw in at curve
570MAR2601	At north side of 1st field on right bank	3'-10'	AG	AG	Slight	Volunteer clean-up	$60/day	$60	L	Lots of shrubs and woody debris down culvert
Total Cost								$2,360.00		
Tributary 571										
571MAR2401	300 feet east of 2nd Street		AG	Road	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Road runoff eroding bank, little buffer, opposite bank no buffer, trees dumped on bank
Total Cost								$200.00		
Tributary 574										
574ORA0701	West of intersection Wildwood and Rook		RES	Road	Extensive	Obstruction removal - ext., volunteer clean-up	$4/ft	$460	H	Lumber, tree, u/s fridge, TV, and deer ribcage, clogged driveway culvert
Total Cost								$460.00		
Tributary 1057										
1057GUN1501	Just off Marsh Road	N	AG	AG	Slight	Obstruction removal - slight	$4/ft	$40	M	15 ft. metal pipe, rusted through & laying across stream, little erosion
Total Cost								$40.00		
Tributary 1059										
1059MAR2507	Just upstream from AG crossing				Moderate	Obstruction removal - mod.	$4/ft	$200	H	Lots of trees down, just u/s from crossing
1059MAR2509	At town line drain - Fallen tree		AG	AG	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Tree down, branches caught causing drain to snake around, erosion on both banks
1059MAR2512	Just u/s from large bend	<1'	AG	AG	Slight	Obstruction removal - slight	$4/ft	$40	M	Huge tree lying across bank, threatens to fall in
1059MAR2501A	At county line crosses Boysen Road north of 114th	3'-10'	AG	AG	Slight	Volunteer clean-up	$60/day	$60	M	Air conditioner
1059GUN1102		N	AG	AG	Slight	Volunteer clean-up	$60/day	$60	L	Lots of debris - bricks on bank & irrigation pipe

Table 5.6A - Trash and Debris BMP Costs by Waterbody

Site ID	Description	BUFFER	Land Use Left	Land Use Right	Amount	Proposed Improvements	Estimated Cost/Site	Estimated Total Cost	Priority	COMMENTS
Total Cost								$560.00		
Orangeville Drain										
1060ORA1809	Near end of woods	>10'	Woodland	Woodland	Moderate	Obstruction removal - mod.	$4/ft	$200	H	Bunch of fallen trees - diverting water into bank
1060ORA1808	Border ag/woods		AG	AG	Slight	Obstruction removal - slight, volunteer clean-up	$4/ft - obstruction $60/day - volunteers	$100	M	Barbed wire/electric fence across stream, pallets in water
1060ORA1810	About 100 yds u/s of Saddler Road	>10'	Woodland	Woodland	Slight	Volunteer clean-up	$60/day	$60	M	Some trash - tires, siding, etc. 2 pieces diverting stream
Total Cost								$360.00		
Fenner Drain										
1071MAR1508	Across from white house		Woodland	Woodland	Extensive	Obstruction removal - dam	$150/hr	$1,200	H	Owners built dam with rocks and concrete, probably w/o permit, 15' wide, 3' tall
1071MAR1414	In woods	>10'	Woodland	Woodland	Slight	Obstruction removal - slight	$4/ft	$40	H	Logs down causing stream to divert
1071MAR1507	By white house		RES	Woodland	Extensive	Obstruction removal - ext.	$4/ft	$400	M	Tiles on large bank falling in
1071MAR1506	West side of cornfield by woods		AG	Woodland	Slight	Obstruction removal - slight	$4/ft	$40	M	Log jam
1071MAR1411	By 3rd field going West	<1'	AG	AG	Slight	Obstruction removal - slight, volunteer clean-up	$4/ft - obstruction $60/day - volunteers	$100	M	Palette, Styrofoam, fallen tree
1071MAR1412	15' east of farm crossing	<1'	AG	AG	Slight	Volunteer clean-up	$60/day	$60	L	Rocks/manmade deposits
Total Cost								$1,840.00		
Tributary 5702										
5702MAR2101	Across and u/s from new houses	N	AG	RES	Slight	Volunteer clean-up	$60/day	$60	M	Some concrete in river, lots of trash 20 ft. from bank, tires, car, appliances
Total Cost								$60.00		

Table 5.7A - Other Site BMP Costs by Waterbody

Site ID	Description	Color	Water Odor	Buffer	Land Use Left Site	Land Use Right Side	Proposed Improvements	Estimated Unit Cost*	Estimated Site Cost	Priority	Comments
Gun Lake											
GL03		Clear	None	N			Turf management BMPs	$175/plot	$1,750	H	Lawns mowed to edge, autumn leaves on bank & in lake
GL04		Cloudy	Musty		Road	RES	Check for septic failure, turf management BMPs, roadside filter strips	$78-$2,530/acre	$1,910	H	Unsure of source, but water is cloudy & pungent musty odor
GL02		Clear	None	N			Filter strip	$190/acre and $58/year lease	$628	M	Foamy water, picture available
Total Costs									$4,288.00		
Gun River											
40GUN0205		Cloudy	None	N	AG	AG	Filter strip	$190/acre and $58/year lease	$628	H	Grazing right up to bank, eutrophic
40GUN1704	9th Street bridge	Clear	None	N	Golf	IDLE	Filter strip crossing Improvement	$78/acre $1,200/crossing	$1,770	H	Possible agriculture crossing, golf course, eroded drain, picture 19
Total Costs									$2,398.00		
Gregg Brook Drain											
59MAR0303	East of long barns, 1,000' d/s from 124th	Clear	None	N	Wetland	RES	Wetland restoration	$2,530/acre restoration	$1,265	H	Owners turned wetland into wet lawn
Total Costs									$1,265.00		
Orangeville Drain											
1060ORA1802	1st Trib. U/S from Patterson	No water	None		AG	AG	Filter strip	$190/acre and $58/year lease	$628	H	200 ft, no buffer, sandy soils
Total Costs									$628.00		
Tributary 1061											
1061ORA0901	West side next to Mullenhurst golf	Clear	None	N			Monitor	$60/year	$60	L	Zebra mussels, picture available

Table 5.7A - Other Site BMP Costs by Waterbody

Site ID	Description	Color	Water Odor	Buffer	Land Use Left Site	Land Use Right Side	Proposed Improvements	Estimated Unit Cost*	Estimated Site Cost	Priority	Comments
Total Costs									$60.00		
Tributary 1067											
1067YAN1701	Cobb Lake Road crossing						Maintain site	$60/year	$60	L	Irrigation point, electric on pad
Total Costs									$60.00		
Tributary 4031											
4031GUN1601	On 7th, road ditch to side street, all along roadside						Solar or Electric Irrigation	$3,800/pump and controls	$3,800	M	Diesel irrigation point
Total Costs									$3,800.00		

*Cost are based on 1st year implementation. Future years are $58/year lease on conservation lands.
*Estimates assume 3 acres for filter strips and half acre residential plots

Table 5.8A - Construction BMP Costs by Waterbody

Site ID	Description	County	Township	Section	QTR 1	QTR 2	Color	Buffer	CONSTRUCTION TYPE	Erosion Control Measures	Sediment Control Measures	Extent	Recommended BMP	Estimated Cost/Unit	Estimated Costs	Comments
Gun Lake																
GLORA0901	New development	Barry	Orangeville	9	NW	NW	Clear	N	RES	Not Installed	Not adequate	Slight	Sediment trap / mulching	$500 acre/mulch $1.75 ft/ silt fence	$1,525	Picture avail, large piles of dirt a few feet from lake w/ small silt fence, **4 such sites around Gun Lake**
Total Costs															**$1,525.00**	

Appendix 2B

- **Nonpoint Source Sites by Waterbody**

Gun River (Reach #40) Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Debris and Trash			
40GUN0104A	8/29/2001	DRAINAGE DITCH INTERSECTION	DRAINAGE DITCH RUNS INTO GUN
40GUN1702A	7/31/2001		
40MAR2305	8/28/2001		
40MAR3503A	8/28/2001		
40MAR3605	00000000	tributary intersection	
40MAR3602B	8/29/2001		
Crossings			
40OST2401	8/20/2001	N FARMER ST / 106TH STREET BRIDGE	
40ORA0601A	8/26/2001	PATTERSON RD CROSSING	
40ORA0602A	8/26/2001	GUN RIVER WIER	
40GUN1001A	8/27/2001	110th Ave. Bridge	metal retaining wall at br. ditch enters from east and irrig. downstream
40GUN1703	7/31/2001	9TH ST BRIDGE	
40GUN1701	8/20/2001	10TH ST BRIDGE	
40GUN1801A	8/20/2001	107th St. Bridge	
40MAR1201A	8/26/2001	122ND ST CROSSING	triple culvert
40MAR1301A	8/26/2001	120TH AVE CROSSING	
40MAR1402A	8/26/2001	2ND ST CROSSING N OF 118TH	1920's bridge
40MAR1401	8/26/2001	118th St. crossing	
40MAR2301	8/26/2001	116th Ave. bridge at 2nd St.	
40MAR2604	8/26/2001	Trib. crossing on 2nd St.	rust colored water coming from culverts
40MAR2601	8/26/2001	Crossing at 114th Ave. and 2nd St.	
40MAR3608A	8/27/2001	2nd St. bridge N. of Hooper	
40MAR3601	8/27/2001		
40GUN1801	8/20/2001	Bridge at Gun River Conservation Club, 11th St.	
40GUN1101	8/27/2001		upstream side blocked by debris, downstream open
40GUN1702B	7/31/2001		
Rill and Gully Erosion			
RDGUN0101A	8/29/2001		
Upland Source			
40GUN0103A	8/29/2001	200' UPSTREAM IN DITCH ADJ. CORN	CORN FIELD ADJACENT TO DITCH
40MAR2605	8/26/2001		electric irrigation point
40MAR2302A	8/28/2001		
40MAR2603A	8/28/2001		
40MAR3502A	8/28/2001		
40ORA0602B	8/26/2001	GUN RIVER WIER	
40ORA0601B	8/26/2001	PATTERSON RD CROSSING	
40MAR1301B	8/26/2001	120TH AVE CROSSING	left bank downstream road ditch field runoff discolored water entering river
40MAR1201B	8/26/2001	122ND ST CROSSING	
40MAR3502B	8/28/2001		drop inlet or side inlet pipe for surface water, no flow
40MAR3608B	8/27/2001	2nd St. bridge N. of Hooper	
40GUN0210A	8/27/2001	bridge crossing 2nd St.	
RDGUN0101B	8/29/2001		
40GUN1001B	8/27/2001	110th Ave. Bridge	metal retaining wall at br. ditch enters from east and irrig. downstream
40GUN1801B	8/20/2001	107th St. Bridge	

Gun River (Reach #40) Nonpoint Source Sites

Tile Outlet			
40GUN0102	8/29/2001		
40GUN0101	8/29/2001		
40GUN0209	8/29/2001		
40GUN0203	8/29/2001		3 tile outlets and irrigation point
40MAR2304	8/28/2001		
40MAR2602	8/28/2001		
40MAR3501	8/27/2001	200' upstream from 2nd St. bridge N. of Hooper	drop inlet opening stable, but field eroding at inlet
40MAR3607	8/29/2001		
40MAR3603	8/29/2001	pipe outlet from building (Hooper)	possible floor drain from pole barn
40MAR3602A	8/29/2001		tile outlet appears inactive
40MAR1201C	8/26/2001	122ND ST CROSSING	
40MAR3503B	8/28/2001		
40GUN0210B	8/27/2001	bridge crossing 2nd St.	
Streambank Erosion			
40GUN105	8/29/2001		
40GUN0208	8/29/2001		
40GUN0207	8/29/2001		LP gas and diesel irrigation upstream
40GUN0204	8/29/2001		
40GUN0201	8/29/2001		
40MAR2308	8/28/2001		erosion under utility pole
40MAR2307	8/28/2001		erosion at irrigation point, old diesel-smelling fire engine used for pumping
40MAR2303	8/28/2001		
40MAR2607	8/28/2001		erosion at top of road grade
40MAR2606	8/28/2001		erosion threatens utility pole
40MAR3606	8/29/2001		
40ORA0601C	8/26/2001	PATTERSON RD CROSSING	
40MAR1301C	8/26/2001	120TH AVE CROSSING	
40MAR2302B	8/28/2001		bank slumping into river, corn up to top of bank
40MAR2603B	8/28/2001		
40GUN0104B	8/29/2001	DRAINAGE DITCH INTERSECTION	
40GUN0103B	8/29/2001	200' UPSTREAM IN DITCH ADJ. CORN	
40GUN1001C	8/27/2001	110th Ave. Bridge	metal retaining wall at br. ditch enters from east and irrig. downstream
40GUN1702C	7/31/2001		
40GUN1801C	8/20/2001	107th St. Bridge	
Other - Irrigation			
40GUN0205	8/29/2001		
40GUN1704	8/22/2001	9TH ST BRIDGE	NO VISABLE PROBLEM
Other			
40GUN0206	8/29/2001		
40GUN0301	8/27/2001		possible road runoff
40GUN1601	7/31/2001	7TH ST BRIDGE	
40MAR2306	8/28/2001		stable bank at electric irrigation point
40MAR3604	8/29/2001	tributary intersection	
40MAR1402B	8/26/2001	2ND ST CROSSING N OF 118TH	Poss. runoff from field

Gun Lake (Reach #GL) Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Construction Site			
GLORA0901	11/14/2001	new development	picture avail, large piles of dirt a few feet from lake w/ small silt fence, 4 such sites around lake
Other Sites			
GL02B	11/14/2001		picture available
GL04	11/14/2001		
GL03	11/14/2001		picture available
GL02A	11/14/2001		picture available

Culver Drain (Reach #570) Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Trash and Debris			
570MAR2602	10/29/2001	at 1st town going u/s from 2nd street	old barb wire fence. 100 fott u/s washed d/s
570MAR2606	10/29/2001	west end of section 26	
570MAR2701	10/29/2001	just upstream from 6/27 section line	
Stream Crossings			
570MAR2604	10/29/2001	crossing westridge on north cornfield, southof bue and tan house	
570MAR2605	10/29/2001	crossing at big tan house	
Upland Source			
570MAR2703	10/29/2001	drain inlet east of crossing	cloudy/milky. water coming from inlet drain.
570MAR2702	10/29/2001	drain inlet at bend in culver drain	evidence of field runoff, picture #8. water color change, milkey water where drain enter
Streambank Erosion			
570MAR2601	10/29/2001	at n side of 1st field on right bank	

Fenner Drain (Reach #1071) Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Trash and Debris			
1071MAR1411	10/8/2001	by 3rd field going W.	
1071MAR1412	10/8/2001	15' E of farm crossing	
1071MAR1414	10/8/2001	in woods	
1071MAR1506	10/31/2001	W/SIDE OF CORNFIELD BY WOODS	
1071MAR1507	10/31/2001	BY WHITE HOUSE	
Rill and Gully Erosion			
1071MAR1402	10/8/2001	by driveway, behind metal bldg.	attempts were made to fix erosion with cement blocks
1071MAR1505	10/31/2001	550 U/S FROM 4TH	GULLY FORMING RIGHT OFF FIELD
1071MAR1501	10/31/2001	100 yds. u/s from 4th	gully off field - conventional corn. pic #1 and 2.
1071MAR1001	10/31/2001	S SIDE OF SECTION 10 AT EXIT OF WOODS AND ANTOHER 100FT U/S	GULLY FORMED - RUNOFF FROM FIELD
Tile Outlets			
1071MAR1401	10/8/2001	just upstream from 2nd St. Bridge	
1071MAR1403	10/8/2001	next to barn	TO doesn't extend over stream, depositing lots of dark sed. on bank slope
1071MAR1406	10/8/2001	u/s from fallen tree, just up from barn	not presently flowing, but 1/2 full of muck
1071MAR1502	10/31/2001	350ft from 4th u/s	erosion on bank around 2 to 6 outlets.
1071MAR1003	10/31/2001	AT CURVE IN CORNFIELD	
Streambank Erosion			
1071MAR1404	10/8/2001	across from barn	looks like they tried to put a piece of plastic in to hold it, but plastic washing out
1071MAR1405	10/8/2001	d/s from fallen tree	lots of big limbs piled, washing out bank
1071MAR1407	10/8/2001	next to field, near large willows	stream is meandering, exposing plastic conduit, which comes from top of bank
1071MAR1408	10/8/2001	near end of cornfield	eroded and slumping, might be recovering but animal path still eroding it
1071MAR1409	10/8/2001	rusted tank shell on S. side of drain	
1071MAR1410	10/8/2001	u/s from storage tank	very long stretch of eroded bank, short area OK, than another long stretch eroded
1071MAR1413	10/8/2001	500' W of farm crossing, farm access road to N	
1071MAR1415	10/8/2001	at end of woods	looks like it has been slowly eroding for years, might just erode at heaviest rains
1071MAR1504	10/21/2001	500 ft u/s from 4th	tree fell in (L) pushing water toward bank (R)
1071MAR1002	10/31/2001	BY AG/WOODS	

Gregg Brook Drain (Reach #59) Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Trash and Debris			
59MAR1004	10/17/2001	across from 592, 50' N of 592 & further u/s	
59MAR1001	10/8/2001	halfway between 2nd & 121st in fields, plus further up	
59MAR0302	10/17/2001	W of barn/N of 595	
59WAY3402	10/22/2001	126th St. at dip in road	
Stream Crossin			
59MAR0304A	10/17/2001	livestock crossing	wood restrains soil on top, but falling in, will need to replace
59MAR1101	11/2/2001	120TH AVE	
Rill and Gully Erosion			
59MAR1002	10/8/2001	E of woods on W. side of stream, field to S&N	gully on L w/trib. draining from field on right
Livestock Access			
59MAR0304B	10/17/2001	livestock crossing	electric fence allows access, lots of erosion, aq. plants, & bacterial sheen
Upland Source			
59MAR1005	10/17/2001	next to cornfield up from 593	no buffer at all, some bare to stream, black soils, lots of aq. veg
59MAR0301B	10/17/2001	at 595 outfall	595 stagnant, plume into 59, 50' of duckweed up 595
59MAR0303	10/17/2001	E. of long barns, 1000' d/s from 124th	
59MAR0301A	10/17/2001	at 1298	1298 is 3' thick organic muck, brown/gray conglomerate with methane odor, between pastures
Tile Outlets			
59MAR0305	10/17/2001	500 ft d/s from 124th	digging out stream bottom
59WAY3401	10/22/2001	across from farm house	slight erosion, no buffer on fields - lots of aquatic plants - eutrophic
Streambank Erosion			
59MAR1003	10/8/2001		

Orangeville Drain (Reach #1060) Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Trash and Debris			
1060ORA1810	11/9/2001	abt. 100 yds u/s of Saddler Rd.	
1060ORA1808	11/9/2001	border ag/woods	
1060ORA1809	11/9/2001	near end of woods	
Stream Crossings			
1060ORA1701	10/8/2001	9 Mile Rd. crossing	silt fence on left bank 1/2 in water, car accident crushed upstream culvert
1060ORA1805	10/31/2001		undersized culvert 3/4 full not right after storm. pic #39.
1060ORA1807	10/15/2001	crossing near farmhouse & corn storage	extensive tree removal, corn storage bins on bank, bare roots w/fill, fast flow
Rill and Gully Erosion			
1060ORA1806	10/31/2001	JUST U/S FROM 1ST	ACROSS FROM EACH OTHER THE GROUND DISTURBED. CUT TREES OF BANK, MOVIED SOIL ON EDGE U/S 300FT
Streambank Erosion			
1060ORA1801	10/31/2001	e side patterson road and 120th	no buffer nutrients from field wash off. another 30' u/s pic #34
1060ORA1802	10/31/2001	1ST TRIB U/S FROM PATERSON	
1060ORA1803	10/31/2001		slumping bank with concrete
1060ORA1804	10/31/2001		

Orangeville Drain (Reach #1060) Nonpoint Source Sites

Tributaries 402 - 408 Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Stream Crossing			
402GUN2101	10/15/2001	crossing 106th	recently replaced, no soil eros. control, embankment bare soil & asphalt, R&G eros
403GUN1602A	8/22/2001		
403GUN1604A	8/22/2001	600' upstream from Gun on 7th St.	
406GUN1102	8/27/2001		
4061GUN1101	9/21/2001	1/4 mi E from section line 10/11	
407GUN0106	8/27/2001		
407GUN0105A	8/27/2001	bridge crossing 2nd St.	
Upland Source			
403GUN1604B	8/22/2001	600' upstream from Gun on 7th St.	
Tile Outlets			
403GUN1603	8/22/2001	midpoint along ditch @ tile outlet	
407GUN0104	8/27/2001		
407GUN0105B	8/27/2001		
408MAR3601A	11/9/2001	100 ft. u/s from mouth 408	TO rusted out, water comes out bottom, below is bac. sheet, iron bacteria, and aq. plants
Streambank Erosion			
403GUN1602B	8/22/2001		
407GUN0101	9/21/2001	along roadside 2nd st. across from farmhouse	
407GUN0102	9/21/2001	100 yards south of bridge	
407GUN0103	8/27/2001		200' of unstable banks on both sides. some road shoulder erosion. light veg.
408MAR3601B	11/9/2001	100 ft. u/s from mouth 408	
RDWAY3401	10/22/2001	NW corner 124th & 5th	
Other Site			
4031GUN1601	10/15/2001	on 7th, road ditch to side street, all along roadside	

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Trash and Debris			
5702MAR2101	11/14/2001	across & u/s from new houses	picture available
574ORA0701	10/15/2001	W. of intersection Wildwood & Rook	
Stream Crossings			
571ORA1901	9/28/2001	Boysen Rd. in woods	road runoff top of culvert
573MAR2601	10/22/2001	crossing 114th & 4th	recently constructed, geotextile pieces washed away, severe erosion on banks
573MAR2701	10/22/2001	5th St. 1/3 mi. N of 114th	small clay culvert at bottom of 5 ft. vertical bank
575MAR0202	10/22/2001	124th St. W of 4th	concrete casing fell off, culver high, huge pool underneath
575WAY3501	10/22/2001	by dairy on 4th St.	can't see, completely buried, but a little flow
577MAR0101	11/2/2001	AT END 577 BEND	
Rill and Gully Erosion			
572MAR3602	11/9/2001	100ft. u/s from farm rd.	goes into field 20 ft., rich organic soil, LOTS aq. plants
572MAR3604	11/9/2001	near end of 1st field	gully off field, but drops sharply at bank, erodes 4' d/s
572MAR3605	11/9/2001	almost to end of field	drains from field w/ sharp drop off
575MAR0201	11/9/2001	100 ft. S of blue house after turn in drain	field slopes toward point
Upland Source			
575WAY3502	10/22/2001	by dairy on 4th St.	utility box falling in
Tile Outlets			
572MAR3603	11/9/2001	100 yds. u/s from farm rd.	outlet covered by aq. plants; inside- 3" tan colored algae, muck w/white film on top & dk. brown
572MAR3606	11/9/2001	2nd field 1/2 way	TO rusted through, hanging bent into stream, water comes out hole, eroding bank
Streambank Erosion			
571MAR2401	11/11/2001	300FT E OF 2ND ST, & MANY POINT ALONG BANK	
571MAR2402	11/11/2001	500FT E OF 2ND	NO BUFF ON FIELD WASHES OFF FIELD. CONVENTIONAL TILLAGE.
572MAR3601	11/9/2001	along farm road	lots of aq. plants, another 100 ft. u/s

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Trash and Debris			
1057GUN1501	11/14/2001	just off Marsh Road	picture available
1059MAR2501A	10/15/2001	at Co. line crosses Boysen Rd. N. of 114th	
1059MAR2507	11/2/2001	JUST U/S FROM AG CROSS	
1059MAR2509	11/2/2001	AT TOWN LINE DRAIN - FALLEN TREE	
1059MAR2512	11/2/2001	JUST U/S FROM LARGE CURVE	
1059GUN1102	11/14/2001		picture available
1059MAR2501A	10/15/2001	at Co. line crosses Boysen Rd. N. of 114th	
Stream Crossings			
1057GUN1401	10/15/2001	W of 3rd on Pierce Rd/106th Ave	
1059MAR2501B	10/15/2001	at Co. line crosses Boysen Rd. N. of 114th	severe road erosion above culvert, disposable pic. #3
1059MAR2516	11/2/2001	2ND CROSS	
1059MAR2501B	10/15/2001	at Co. line crosses Boysen Rd. N. of 114th	severe road erosion above culvert, disposable pic. #3
Rill and Gully Erosion			
1058GUN1103	11/14/2001		PICTURE AVAILABLE
1059MAR2501	11/12/2001	500FT U/S FROM 2ND	
1059MAR2503	11/2/2001	AT START OF CORN ON RIGHT BANK	GULLY AT CORNER OF CORN FIELD, GOES OVER TO THAT IS MOSTLY BURIED.
1059MAR2506	11/2/2001	1/2 WAY THROUGH FIELD 2 ON LB	
1059MAR2504A	11/2/2001	150FT U/S FROM 03	
1059MAR2505	11/2/2001	2ND FIELD ON LIFT 100FT IN	GIANT GULLY OFF30-40 ACRE, SOY BEAN FIELD
1059MAR2511	11/1/2001	TOWARD CURCE IN 1059	LOG FELL 20FT FURTHER D/S BACKING UP WATER, LEFT BANK SLUMPING, GULLY OFF CORN FIELD RED. FLOW
1059MAR2513	11/2/2001	U/S OF CURVE	
1059MAR2515	11/2/2001		
1059GUN1104	11/14/2001		picture available
Upland Source			
1059MAR2508	11/2/2001	3RD FIELD U/S FROM 2ND ON LB	dark soil field, lots of sm gullies, substrate mvery mucky, LOTS of aq. plants & algae, diverse & prolific
1059GUN1103	11/14/2001		picture available, double culvert coming off field w/ little buffer
Tile Outlets			
1059MAR2502	11/2/2001	END CORN FIELD GOING U/S FROM 2ND	END OF PIECE TO FALL OFF BANK
1059MAR2517	11/1/2001		
1059MAR2504B	11/2/2001	150FT U/S FROM 03	2 rusting through TO, one flowing - erosion, one not - smells musty & erosion
Streambank Erosion			
1058MAR2501	11/9/2001	farm drain off 1059 going S, 30 ft. from 114th Ave.	culvert comes in, making a right turn, erodes far bank which electric pole is on and falling in
1058GUN1102	11/14/2001		
1058GUN1101	11/14/2001	at meander	
1059MAR2514	11/2/2001		
1059GUN1101	11/14/2001		bacterial sheet and lots of aq. plants, dark organic soil

SITE_ID2	DATE	DESCRIP	COMMENTS
Streambank Erosion			
1061ORA0901	10/15/2001	W side nex	might be crossing from ag. land, golf course eroded drain
Other Sites			
1067YAN1701	10/15/2001	Cobb Lake Road crossing	

Tributaries 1071-1076 Nonpoint Source Sites

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Trash and Debris			
1071MAR1508	10/31/2001	ACROSS FROM WHITE HOUSE	
Steambank Erosion			
1071MAR1503	10/31/2001	400ft u/s 4th	SMALL TREE FALLEN, CREATES GOUGING PIC#4
1076MAR2301	10/26/2001	just upstream from trailer	

SITE_ID2	DATE	DESCRIPTION	COMMENTS
Rill and Gully Erosion			
5721MAR3601	11/9/2001	just off farm acces road	along access road by drain
5721MAR3603	11/9/2001	off farm access rd. 100 ft. S of 114	gully runs along farm road then turns into drain
Streambank Erosion			
5721MAR3602	11/9/2001	off farm access road	problem persists intermittently 500 ft.

Appendix 2C

- **2024 Nonpoint Source Inventory Data**

ObjectID	Culvert source of NPS via	Stream crossing	Road runoff	Gully erosion	Inadequate riparian buffer	Streambank erosion	Livestock access	Agricultural runoff	Tile outlet	Survey date and time	Cropland/pasture manure runoff	Cropland erosion/runoff	Watershed	Longitude	Latitude	Loading (Tons)
2	Improper_width	x	x			x				10/27/22 15:43				-85.56265415	42.55955355	
3				x						10/27/22 16:51			02 Fenner Creek	-85.54327667	42.58736833	1.166
4	Improper_width, Improper_length	x	x							10/27/22 17:06			02 Fenner Creek	-85.5432956	42.58731062	
5						x				11/2/22 15:14			02 Fenner Creek	-85.55206	42.57196333	1.386
6						x							02 Fenner Creek	-85.552185	42.57044333	25.9875
7						x				11/2/22 15:42			02 Fenner Creek	-85.55241	42.570145	5.5
8						x				11/2/22 15:50			02 Fenner Creek	-85.55255667	42.56976167	0.3432
9						x				11/2/22 15:58			02 Fenner Creek	-85.55352333	42.56929833	0.594
10						x				11/2/22 16:05			02 Fenner Creek	0	0	9.45
11						x			x	11/2/22 16:19			02 Fenner Creek	-85.555125	42.568305	0.728
12						x				11/2/22 16:41			02 Fenner Creek	-85.55840667	42.56493833	0.66
13				x						11/2/22 16:47			02 Fenner Creek	0	0	0.594
14				x						11/2/22 17:19				-85.56068333	42.55661833	0.792
15						x				11/2/22 17:44			02 Fenner Creek	-85.56777333	42.54867	7.7
16									x	11/2/22 17:57			02 Fenner Creek	-85.56770333	42.54524333	
17						x				11/4/22 13:45			02 Fenner Creek	-85.56545333	42.55099167	4.5045
18						x				11/4/22 13:53			02 Fenner Creek	-85.56720667	42.550485	0.7722
19						x				11/4/22 14:08			02 Fenner Creek	-85.56766	42.54715167	3.432
20						x				11/4/22 14:16			02 Fenner Creek	-85.56764	42.54517667	4.004
21						x				11/4/22 14:23			02 Fenner Creek	0	0	13.86
22						x				11/4/22 14:36			02 Fenner Creek	-85.56711	42.54406333	1.001
23						x				11/4/22 14:40			02 Fenner Creek	-85.56703	42.543885	9.9
24						x			x	11/4/22 14:46				-85.566755	42.54347333	1.43
25						x				11/4/22 14:53			02 Fenner Creek	-85.56652469	42.54276541	17.82
26						x				11/4/22 15:02			02 Fenner Creek	-85.56601	42.54208833	15.84

ObjectID	Culvert source of NPS via	Stream crossing	Road runoff	Gully erosion	Inadequate riparian buffer	Streambank erosion	Livestock access	Agricultural runoff	Tile outlet	Survey date and time	Cropland/pasture manure runoff	Cropland erosion/runoff	Watershed	Longitude	Latitude	Loading (Tons)
28						x				11/4/22 15:06			02 Fenner Creek	-85.56600225	42.5414953	28.6
29						x			x	11/4/22 15:28			02 Fenner Creek	-85.562975	42.53661667	1.76
30						x				11/4/22 15:33			02 Fenner Creek	-85.56286167	42.53563	1.43
31						x							02 Fenner Creek	-85.56289167	42.53166333	5.5
32						x				11/4/22 15:51			03 Woodside Cemetery	-85.56290667	42.52731667	11
33						x				11/4/22 15:53			03 Woodside Cemetery	-85.56291	42.52697333	3.2175
34						x				11/4/22 15:55			03 Woodside Cemetery	-85.56296833	42.52663333	6.16
35						x				11/4/22 15:58			03 Woodside Cemetery	-85.562935	42.52602667	1.848
36						x				11/4/22 16:03			02 Fenner Creek	-85.56302167	42.523765	2.431
37						x				11/4/22 16:06			03 Woodside Cemetery	-85.56287333	42.522955	7.7
38						x				11/4/22 16:09			03 Woodside Cemetery	-85.56289167	42.522205	5.72
39									x	11/4/22 16:14			03 Woodside Cemetery	-85.56304833	42.52078167	
40									x	11/4/22 16:17			03 Woodside Cemetery	-85.56308	42.52020167	
41						x				11/4/22 16:19			03 Woodside Cemetery	-85.56296	42.519885	4.004
42						x				11/4/22 16:23			03 Woodside Cemetery	-85.56298	42.51938333	1.2012
43						x				11/4/22 16:29			03 Woodside Cemetery	-85.56293333	42.51849667	3.08
44									x	11/4/22 16:31			03 Woodside Cemetery	-85.562985	42.51758	
45									x	11/4/22 16:33			03 Woodside Cemetery	-85.56303067	42.51661177	

ObjectID	Culvert source of NPS via	Stream crossing	Road runoff	Gully erosion	Inadequate riparian buffer	Streambank erosion	Livestock access	Agricultural runoff	Tile outlet	Survey date and time	Cropland/pasture manure runoff	Cropland erosion/runoff	Watershed	Longitude	Latitude	Loading (Tons)
46						x				11/4/22 16:40			03 Woodside Cemetery	-85.561235	42.51449167	7.7
47						x				11/4/22 16:44			03 Woodside Cemetery	-85.56021985	42.51336694	0.324
48						x				11/4/22 16:46			03 Woodside Cemetery	-85.56032333	42.51309167	3.289
49						x				11/4/22 16:49			03 Woodside Cemetery	-85.56023333	42.512785	3.432
50						x				11/4/22 16:51			03 Woodside Cemetery	-85.560155	42.512615	6.875
51						x				11/4/22 16:53			03 Woodside Cemetery	-85.56017333	42.51209333	1.848
52						x				11/4/22 16:57			03 Woodside Cemetery	-85.56016	42.51061667	2.5025
53						x				11/4/22 17:00			03 Woodside Cemetery	-85.560185	42.50983333	1.716
54	deteriorating_culve Improper_width	x	x							11/30/22 17:36			03 Woodside Cemetery	-85.62278833	42.482875	
55	Improper_width	x				x				11/30/22 18:06			03 Woodside Cemetery	-85.60188667	42.49396667	4.8125
56									x	11/30/22 18:53			03 Woodside Cemetery	-85.582475	42.52025333	
57								x			x	x	03 Woodside Cemetery	-85.58212833	42.52342167	
58	Misalignment	x								11/30/22 19:16			02 Fenner Creek	-85.592415	42.53734333	
59	Improper_width, Misalignment	x								11/30/22 19:22			02 Fenner Creek	-85.59402167	42.53790333	
60	deteriorating_culve Improper_length	x											02 Fenner Creek	-85.57252667	42.54155167	
61						x				11/30/22 19:41			02 Fenner Creek	-85.57253667	42.54222833	0.3575
62	Misalignment, Improper_width	x								11/30/22 19:49			02 Fenner Creek	-85.57250333	42.54702	
63	deteriorating_culve Improper_width	x								11/30/22 19:57			02 Fenner Creek	-85.57248333	42.54884667	

ObjectID	Culvert source of NPS via	Stream crossing	Road runoff	Gully erosion	Inadequate riparian buffer	Streambank erosion	Livestock access	Agricultural runoff	Tile outlet	Survey date and time	Cropland/pasture manure runoff	Cropland erosion/runoff	Watershed	Longitude	Latitude	Loading (Tons)
64					x			x		11/30/22 20:16	x	x	02 Fenner Creek	-85.6071	42.54815833	
65	Improper_width	x				x				11/30/22 20:59			01 Gun Lake	-85.61962167	42.58113333	0.0286
67	Perched_culvert	x						x	x	12/1/22 15:19		x	02 Fenner Creek	-85.61694667	42.569805	
68								x		12/1/22 15:36		x	02 Fenner Creek	-85.61692333	42.571775	
69	Improper_width	x	x							12/1/22 15:53			02 Fenner Creek	-85.59525333	42.56356667	
70				x				x				x	02 Fenner Creek	-85.589505	42.56366333	
71									x				02 Fenner Creek	-85.58714556	42.57413229	
72	Improper_width	x						x				x	02 Fenner Creek	-85.58721308	42.57433028	
73	Improper_width	x	x							12/1/22 17:04			02 Fenner Creek	-85.57813333	42.59913333	0.44
74	Improper_width	x				x				12/1/22 17:13			02 Fenner Creek	-85.59845333	42.59438	0.44
75	Perched_culvert, Improper_width	x											02 Fenner Creek	-85.60234833	42.59255833	
76	Improper_width	x								12/1/22 18:56			01 Gun Lake	-85.525955	42.64713667	
77	Improper_width	x								12/1/22 19:07				-85.520545	42.65773	
78	Improper_width	x	x							12/1/22 19:18			01 Gun Lake	-85.50810333	42.65290167	
79				x				x		12/1/22 19:32		x	01 Gun Lake	-85.538125	42.64555	
80								x		2/15/23 19:05	x			-85.54428833	42.64286667	
81								x		2/15/23 19:18	x			-85.56414167	42.646185	

Appendix 3

- **2004 Pollutant Loading and Reduction Calculations**

Project Title: Gun River Watershed Management Plan
Job Number: G01339
Engineer: DF2
Date: 1/21/2004

Template Title: Gun River Watershed - Sediment Reduction (Agricultural Fields)

Sub District	Contributing Area (acres)	Soil Loss Before Treatment (tons/yr)	Area of Conservation Tillage (acres)	Filter Strip Area of Influence (acres)	Soil Loss After Treatment (tons/yr)	Delivery Ratio	Sediment Reduction (tons/yr)
Gregg's Brook	3666	4448	80	280	4234	0.50	107
Orangeville Drain	4444	9295	0	120	9171	0.50	62
Fenner Creek	3097	4920	0	80	4837	0.50	41
Reno Drain	1448	2302	0	0	2302	0.50	0
Culver Drain	2571	9372	400	400	8361	0.50	505
Sutherland Drain	1757	2871	0	240	2492	0.50	190
Monteith Drain	2919	3522	80	0	3510	0.50	6
Along US-131	1110	1011	0	0	1011	0.50	0
Bellingham Drain	1258	2000	0	320	1669	0.50	165
Otsego Plainwell	1882	1576	80	80	1524	0.50	26
Scott Whitcomb	1583	2136	80	80	2092	0.50	22
Gun River Corridor							
Total	25735	43452	720	1600	41204		1124

Notes:

- **Contributing Area** is based upon the amount of Agricultural Land within each Sub District.
- **Soil Loss Before Treatment** was calculated using *Michigan State University's "RUSLE - On Line Soil Assessment Tool"* and assumes an Existing Tillage condition of *"Mulch with 10% Cover"* except along waterways with poorly drained soils, in which case, a *Cover Management "C" Factor* of *0.50* was assumed. **Soil Loss Before Treatment** assumes ***No Filter Strips!***
- **Area of Conservation Tillage** *("Mulch with 30% Cover")* was obtained from *Table 5.1: Agricultural BMP Cost* of the Gun River WMP.
- **Filter Strip Area of Influence** includes all land that drains through a Filter Strip (obtained from *Table 5.1* of the Gun River WMP).
- **Soil Loss After Treatment** accounts for the implementation of BMP's such as Conservation Tillage and Filter Strips.
- **Delivery Ratio** accounts for the amount of eroded soil that actually reaches a water body.
- **Sediment Reduction** was calculated using the method prescribed by the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual.* ***(= ((Soil Loss Before Treatment - Soil Loss After Treatment) * Delivery Ratio))***

Project Title: Gun River Watershed Management Plan
Job Number: G01339
Engineer: DF2
Date: 1/21/2004

Template Title: Gun River Watershed - Nutrient Loading (Agricultural Fields)

Sub District	Sediment Delivery Before Treatment (tons/ac/yr)	Soil Type	Before Phosphorous Content (lbs/ac/yr)	Before Phosphorous Content (lbs/yr)	Before Nitrogen Content (lbs/ac/yr)	Before Nitrogen Content (lbs/yr)
Gregg's Brook	0.61	Peat	1.60	5880	3.22	11797
Orangeville Drain	1.05	Silt	1.65	7351	3.31	14703
Fenner Creek	0.79	Silt	1.33	4125	2.65	8222
Reno Drain	0.79	Peat	2.00	2895	3.99	5776
Culver Drain	1.82	Silt	2.57	6609	5.15	13239
Sutherland Drain	0.82	Peat	2.04	3588	4.08	7165
Monteith Drain	0.60	Silt	1.06	3108	2.13	6215
Along US-131	0.46	Silt	0.85	947	1.71	1894
Bellingham Drain	0.79	Peat	2.00	2515	3.99	5018
Otsego Plainwell	0.42	Silt	0.80	1502	1.60	3003
Scott Whitcomb	0.67	Peat	1.75	2765	3.50	5545
Gun River Corridor						
Total	8.83		17.66	41284	35.32	82579

Notes:

- The terms "**Before**" or "**Before Treatment**" refer to the Existing State of the Sub District, Before any BMP's, such as **Conservation Tillage** or **Filter Strips**, have been implemented.
- **Sediment Delivery Before Treatment** was calculated using the method prescribed by the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. (= ((**Soil Loss Before Treatment / Contributing Area**) * **Delivery Ratio**))*
- **Soil Type** is based upon the Predominate Soil of each Sub District.
- **Phosphorous & Nitrogen Contents** were determined using *figure 5* from the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. Phosphorous & Nitrogen Contents are a function of **Sediment Delivery** and **Soil Type**.

Project Title: Gun River Watershed Management Plan
Job Number: G01339
Engineer: DF2
Date: 1/21/2004

Template Title: Gun River Watershed - Nutrient Reduction (Agricultural Fields)

Sub District	Sediment Delivery After Treatment - P (tons/ac/yr)	Sediment Delivery After Treatment - N (tons/ac/yr)	Soil Type	After Phosphorous Content (lbs/ac/yr)	After Phosphorous Content (lbs/yr)	After Nitrogen Content (lbs/ac/yr)	After Nitrogen Content (lbs/yr)	Phosphorous Reduction (lbs/yr)	Nitrogen Reduction (lbs/yr)
Gregg's Brook	0.57	0.58	Peat	1.53	5622	3.08	11297	258	501
Orangeville Drain	1.03	1.03	Silt	1.64	7266	3.27	14545	84	158
Fenner Creek	0.78	0.78	Silt	1.31	4059	2.62	8101	67	120
Reno Drain	0.79	0.79	Peat	2.00	2895	3.99	5776	0	0
Culver Drain	1.60	1.61	Silt	2.31	5938	4.65	11966	672	1273
Sutherland Drain	0.69	0.70	Peat	1.78	3135	3.61	6349	453	817
Monteith Drain	0.60	0.60	Silt	1.06	3099	2.12	6198	8	17
Along US-131	0.46	0.46	Silt	0.85	947	1.71	1894	0	0
Bellingham Drain	0.64	0.65	Peat	1.68	2114	3.41	4294	401	724
Otsego Plainwell	0.40	0.40	Silt	0.77	1458	1.55	2921	44	83
Scott Whitcomb	0.66	0.66	Peat	1.71	2713	3.44	5448	52	98
Gun River Corridor									
Total	8.23	8.27		16.66	39246	33.46	78790	2039	3790

Notes:

- The terms "**After**" or "**After Treatment**" refer to the State of the Sub District After BMP's, such as **Conservation Tillage** or **Filter Strips**, have been implemented.
- **Sediment Delivery After Treatment** was calculated using the method prescribed by the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. (= (((**Soil Loss After Treatment** (Neglecting Effects of Filter Strips on Soil Loss) / **Contributing Area**) * **Filter Strip Reduction Factor** * **Delivery Ratio**))*
- **Filter Strip Reduction Factor** = 0.25 for *Phosphorous* and 0.30 for *Nitrogen*.
- **Soil Type** is based upon the Predominate Soil of each Sub District.
- **Phosphorous** & **Nitrogen Contents** were determined using *figure 5* from the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. Phosphorous & Nitrogen Contents are a function of **Sediment Delivery** and **Soil Type.**
- **Phosphorous / Nitrogen Reduction** was calculated using the method prescribed by the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. (= (**Before Content - After Content**))*

Project Title: Gun River Watershed Management Plan
Job Number: G01339
Engineer: DF2
Date: 1/21/2004

Template Title: Gun River Watershed - Sediment and Nutrient Loading (NPS Pollution Sites)

	Sediment Loading (tons/yr)								
Sub District	Streambank Erosion	Rill & Gully Erosion	Tile Outlet	Road / Stream Crossing	Livestock Access	Total	Correct Factor	Phosphorous Content (lbs/yr)	Nitrogen Content (lbs/yr)
Gregg's Brook	5.3	1.4	0.3	3.1	0.2	10.2	1.50	15	31
Orangeville Drain	21.0	0.3	0.0	10.7	0.0	32.0	1.00	32	64
Fenner Creek	8.7	1.3	0.1	0.0	0.0	10.1	1.00	10	20
Reno Drain	7.4	3.3	0.1	1.5	0.0	12.2	1.50	18	37
Culver Drain	9.1	0.0	0.0	0.2	0.0	9.3	1.00	9	19
Sutherland Drain	0.7	0.0	0.0	3.6	0.0	4.3	1.50	6	13
Monteith Drain	1.7	0.0	0.0	0.0	0.0	1.7	1.00	2	3
Along US-131	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0	0
Bellingham Drain	26.7	3.4	0.2	2.2	0.0	32.4	1.50	49	97
Otsego Plainwell	1.7	0.0	0.0	0.2	0.0	1.8	1.00	2	4
Scott Whitcomb	6.8	0.2	0.0	1.1	0.0	8.0	1.50	12	24
Gun River Corridor	39.8	2.6	0.2	3.5	0.0	46.1	1.50	69	138
Total	88.9	9.8	0.7	22.5	0.2	122.0		156	311

Notes:

- This Table summarizes the Existing Sediment and Nutrient Loading from NPS Pollution Sites. These values are assumed to be Completely Reduced once site specific BMP's have been implemented.
- **Correction Factor** for Silt = 1, Sand =0.85 and Peat =1.5
- **Phosphorous Content** was calculated using the method prescribed in the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. *(= (**Sediment Loading** (tons/yr) * 0.0005 (lb/lb) * 2000 (lb/ton) * **Correction Factor**))*
- **Nitrogen Content** was calculated using the method prescribed in the *MDEQ - Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. *(= (**Sediment Loading** (tons/yr) * 0.001 (lb/lb) * 2000 (lb/ton) * **Correction Factor**))*
- **Gun River Corridor** = Summation of NPS Pollution Site Data located along the Gun River from various Sub Districts. This Information is for *Reference Purposes Only* and does not contribute to the Overall Totals!

Project Title: Gun River Watershed Management Plan
Job Number: G01339
Engineer: DF2
Date: 1/21/2004

Template Title: Gun River Watershed - Overall Sediment and Nutrient Reduction

Sub District	Before Sediment Delivery (tons/yr)	After Sediment Delivery (tons/yr)	Total Sediment Reduction (tons/yr)	Before Phosphorous Content (lbs/yr)	Before Nitrogen Content (lbs/yr)	After Phosphorous Content (lbs/yr)	After Nitrogen Content (lbs/yr)	Total Phosphorous Reduction (lbs/yr)	Total Nitrogen Reduction (lbs/yr)
Gregg's Brook	2234	2117	117	5896	11828	5622	11297	273	531
Orangeville Drain	4680	4586	94	7383	14767	7266	14545	116	222
Fenner Creek	2470	2419	51	4135	8242	4059	8101	77	140
Reno Drain	1163	1151	12	2913	5813	2895	5776	18	37
Culver Drain	4695	4181	515	6618	13258	5938	11966	681	1292
Sutherland Drain	1440	1246	194	3595	7178	3135	6349	460	830
Monteith Drain	1763	1755	8	3109	6218	3099	6198	10	20
Along US-131	506	506	0	947	1894	947	1894	0	0
Bellingham Drain	1032	834	198	2563	5115	2114	4294	449	821
Otsego Plainwell	790	762	28	1503	3007	1458	2921	46	86
Scott Whitcomb	1076	1046	30	2777	5569	2713	5448	64	122
Gun River Corridor	46	0	46	69	138	0	0	69	138
Total	21848	20602	1246	41440	82891	39246	78790	2194	4101

Notes:

- This Table summarizes the Overall or "**Total**" (Agricultural Fields and NPS Pollution Sites) Sediment and Nutrient Reductions.
- **Before Sediment Delivery** = Existing Sediment Loading, Before any BMP's have been implemented.
- **After Sediment Delivery** = Sediment Loading, After BMP's have been implemented.
- **Total Sediment Reduction** = Reduction in Sediment Loading as a result of BMP Implementation. **Delivery Ratio** was Factored into Agricultural Fields portion of Total Sediment Reduction.
- **Before Phosphorous Content** = Existing Phosphorous Loading, Before any BMP's have been implemented.
- **Before Nitrogen Content** = Existing Nitrogen Loading, Before any BMP's have been implemented.
- **After Phosphorous Content** = Phosphorous Loading, After BMP's have been implemented.
- **After Nitrogen Content** = Nitrogen Loading, After BMP's have been implemented.
- **Total Phosphorous Reduction** = Reduction in Phosphorous Loading as a result of BMP implementation.
- **Total Nitrogen Reduction** = Reduction in Nitrogen Loading as a result of BMP implementation.

Project Title: Gun River Watershed Management Plan
Job Number: G01339
Engineer: DF2
Date: 1/21/2004

Template Title: Gun River Watershed - RUSLE Input Data ("Before Treatment") for Agricultural Fields

Sub-District	Route Number	Area (Acres)	Slope Length (ft)	Soil Type	% of Soil	Slope (%)	Soil Loss	Soil Type	% of Soil	Slope (%)	Soil Loss	Soil Type	% of Soil	Slope (%)	Soil Loss	Weighted Soil Loss (tons/yr)
Gregg's Brook	GR	1833	300	11B	100%	3%	1535									1535
(3666 Acres)	GR Cor	1833	300	39	100%	1%	2914									2914
Orangeville Drain	OR	2222	300	57B	50%	6%	3844	31C	50%	8%	7683					5763
(4444 Acres)	OR Cor	2222	300	74	100%	1%	3532									3532
Fenner Creek	FE	2323	300	12B	65%	3%	4233	11B	20%	3%	1945	75B	15%	3%	3661	3689
(3097 Acres)	FE Cor	774	300	39	100%	1%	1231									1231
Reno Drain	RE Cor	1448	300	39	100%	1%	2302									2302
Culver Drain	CU	2571	300	11C	70%	8%	6927	12C	30%	8%	15076					9372
Sutherland Drain	SU	879	300	11B	100%	3%	735									735
(1757 Acres)	SU Cor	879	300	23	50%	1%	1971	30	50%	1%	2300					2136
Monteith Drain	MO	2919	300	44B	60%	3%	2444	12B	30%	3%	5319	16B	10%	3%	4600	3522
Along US-131	US	1110	300	44B	80%	3%	929	75B	10%	3%	1749	27B	10%	3%	929	1011
Bellingham Drain	BE Cor	1258	300	39	100%	1%	2000									2000
Otsego - Plainwell	OT	1882	300	44B	100%	3%	1576									1576
Scott Whitcomb Drain	SW	475	300	11B	50%	3%	398	10B	50%	3%	351					374
(1583 Acres)	SW Cor	1108	300	39	100%	1%	1761									1761
															Total	43452

Notes:

- **Route Numbers** containing the word ***"Cor"*** account for areas along waterways with poorly drained soils. These areas were evaluated assuming a *Cover Management (C) Factor of 0.50*. All other Route Numbers were evaluated assuming an average *"Before Treatment" C - Factor of 0.0814.*
- **Soil Loss'** were calculated for each Soil Type within a Sub-District using the *RUSLE* equation. A weighted average was then used to determine the Total Soil Loss in each Sub-District.

Project Title: Gun River Watershed Management Plan
Job Number: G01339
Engineer: DF2
Date: 1/21/2004

Template Title: Gun River Watershed - After BMP Implementation ("After Treatment") Input Data for Agricultural Fields

Sub-District	Route Number	Area (Acres)	Area of Only Conservation Tillage (acres)	Filter Strip Only Area of Influence (acres)	Area of Tillage & Filter Strip (acres)	Conservation Tillage Reduction Factor	Soil Loss After Treatment (tons/yr)	Sediment Delivery After Treatment - P (tons/ac/yr)	Sediment Delivery After Treatment - N (tons/ac/yr)
Gregg's Brook	GR	1833		80	80	0.877	1445	0.78	0.78
(3666 Acres)	GR Cor	1833		120			2790	1.51	1.52
Orangeville Drain	OR	2222				0.877	5763	2.59	2.59
(4444 Acres)	OR Cor	2222		120			3408	1.53	1.53
Fenner Creek	FE	2323				0.877	3689	1.59	1.59
(3097 Acres)	FE Cor	774		80			1148	1.47	1.47
Reno Drain	RE Cor	1448					2302	1.59	1.59
Culver Drain	CU	2571			400	0.877	8361	3.20	3.23
Sutherland Drain	SU	879				0.877	735	0.84	0.84
(1757 Acres)	SU Cor	879		240			1756	1.93	1.97
Monteith Drain	MO	2919	80			0.877	3510	1.20	1.20
Along US-131	US	1110				0.877	1011	0.91	0.91
Bellingham Drain	BE Cor	1258		320			1669	1.29	1.31
Otsego - Plainwell	OT	1882	80	80		0.877	1524	0.81	0.81
Scott Whitcomb Drain	SW	475			80	0.877	331	0.68	0.69
(1583 Acres)	SW Cor	1108					1761	1.59	1.59
			160	1040	560		41204		

Notes:

- **Area of Only Conservation Tillage** includes land where Conservation Tillage is the only BMP being Implemented.
- **Filter Strip Only Area of Influence** includes land where Filter Strips are the only BMPs being Implemented. This area includes all land that drains through a Filter Strip!
- **Area of Tillage & Filter Strip** includes land where Conservation Tillage and Filter Strips are being Implemented.
- **Conservation Tillage Reduction Factor** adjusts the *C - Factor* in the RUSLE equation to obtain a Soil Loss value for a Tillage Condition of "Mulch with 30% Cover" *(C-Factor = 0.0714)*. It is a Ratio of the C-Factors for "Mulch with 30% Cover" to that of "Mulch with 10% Cover" *= (0.0714 / 0.0814)*
- **Soil Loss After Treatment** *= (((Area of Conservation Tillage Only / Contributing Area) * (Before Soil Loss * Conservation Tillage Reduction Factor)) + ((Filter Strip Area Only / Contributing Area) * (Before Soil Loss * 0.35)) + ((Area of Tillage & Filter / Contributing Area) * ((Before Soil Loss * Conservation Tillage Reduction Factor) * 0.35)) + (((Contributing Area - Total Area of BMP's) / Contributing Area) * Before Soil Loss))*
- **Sediment Delivery After Treatment** = Same as above except replace the Filter Strip Reduction Value of 0.35 with 0.25 for Phosphorous and 0.30 for Nitrogen; then divide the entire sum by the Contributing Area.

STREAMBANK EROSION

Site ID	Waterbody	Location	Severity of Erosion	Length (ft)	Height (ft)	Lateral Recession Rate (ft/yr)	Soil Weight (tons/ft^3)	Sediment Reduction (tons/yr)
407GUN0103	GUN RIVER	BOTH	WASHOUT	125	10	0.5	0.011	13.750
40GUN0201	GUN RIVER	RIGHT BANK	WASHOUT	125	10	0.5	0.011	6.875
40GUN1801C	GUN RIVER	LEFT BANK	MOSTLY BARE BANK	125	5	0.2	0.011	1.375
1059GUN1101	1059	BOTH	MOSTLY BARE BANK	125	5	0.2	0.011	2.750
1061ORA0901	1061	BOTH	MOSTLY BARE BANK	125	5	0.2	0.055	13.750
1071MAR1410	FENNER DRAIN	LEFT BANK	MOSTLY BARE BANK	125	10	0.2	0.011	2.750
1059MAR2514	1059	RIGHT BANK	MOSTLY BARE BANK	125	10	0.2	0.011	2.750
571MAR2401	571	RIGHT BANK	MOSTLY BARE BANK	125	10	0.2	0.011	2.750
408MAR3601B	408	RIGHT BANK	WASHOUT	75	5	0.5	0.011	2.063
40MAR2308	GUN RIVER	LEFT BANK	WASHOUT	75	10	0.5	0.011	4.125
RDWAY3401	ROAD DITCH	BOTH	MOSTLY BARE BANK	75	5	0.2	0.033	4.950
40MAR1301C	GUN RIVER	RIGHT BANK	MOSTLY BARE BANK	75	5	0.2	0.011	0.825
40GUN105	GUN RIVER	LEFT BANK	MOSTLY BARE BANK	75	10	0.2	0.011	1.650
40MAR2307	GUN RIVER	LEFT BANK	WASHOUT	18	10	0.5	0.011	0.990
40MAR2606	GUN RIVER	LEFT BANK	WASHOUT	18	10	0.5	0.011	0.990
40GUN0208	GUN RIVER	RIGHT BANK	WASHOUT	18	10	0.5	0.011	0.990
40GUN0204	GUN RIVER	RIGHT BANK	WASHOUT	18	10	0.5	0.011	0.990
40MAR2303	GUN RIVER	LEFT BANK	WASHOUT	18	10	0.5	0.011	0.990
1071MAR1002	FENNER DRAIN	BOTH	MOSTLY BARE BANK	18	5	0.2	0.033	1.188
1058GUN1102	1058	BOTH	MOSTLY BARE BANK	18	5	0.2	0.011	0.396
1071MAR1413	FENNER DRAIN	LEFT BANK	MOSTLY BARE BANK	18	5	0.2	0.011	0.198
40MAR3606	GUN RIVER	LEFT BANK	MOSTLY BARE BANK	18	5	0.2	0.011	0.198
5721MAR3602	5721	RIGHT BANK	MOSTLY BARE BANK	18	5	0.2	0.011	0.198
1058GUN1101	1058	RIGHT BANK	MOSTLY BARE BANK	18	5	0.2	0.011	0.198
40MAR2607	GUN RIVER	RIGHT BANK	MOSTLY BARE BANK	18	10	0.2	0.011	0.396
1071MAR1408	FENNER DRAIN	RIGHT BANK	MOSTLY BARE BANK	18	10	0.2	0.011	0.396
1060ORA1801	ORANGEVILLE DRAIN	RIGHT BANK	MOSTLY BARE BANK	18	10	0.2	0.011	0.396
40GUN0207	GUN RIVER	LEFT BANK	MOSTLY BARE BANK	18	10	0.2	0.011	0.396
1071MAR1504	FENNER DRAIN	BOTH	MOSTLY BARE BANK	18	10	0.2	0.033	2.376
1058MAR2501	1058	RIGHT BANK	SOME BARE BANK	18	10	0.05	0.011	0.099
1071MAR1405	FENNER DRAIN	LEFT BANK	MOSTLY BARE BANK	5	5	0.2	0.011	0.055
1060ORA1804	1060	RIGHT BANK	MOSTLY BARE BANK	5	10	0.2	0.011	0.110

STREAMBANK EROSION

Site ID	Waterbody	Location	Severity of Erosion	Length (ft)	Height (ft)	Lateral Recession Rate (ft/yr)	Soil Weight (tons/ft^3)	Sediment Reduction (tons/yr)
1071MAR1503	1071	RIGHT BANK	MOSTLY BARE BANK	5	10	0.2	0.033	0.330
1076MAR2301	1076	LEFT BANK	SOME BARE BANK	5	5	0.05	0.011	0.014
571MAR2402	571	LEFT BANK	SOME BARE/MOSTLY BARE	125	10	0.1	0.011	1.375
40GUN0103B	GUN RIVER	RIGHT BANK	SOME BARE BANK	125	5	0.05	0.011	0.344
407GUN0101	407	BOTH	SOME BARE BANK	125	10	0.05	0.011	1.375
40MAR2302B	GUN RIVER	LEFT BANK	SOME BARE BANK	125	10	0.05	0.011	0.688
1071MAR1415	FENNER DRAIN	LEFT BANK	MOSTLY BARE BANK	75	5	0.2	0.011	0.825
1060ORA1803	1060	BOTH	SOME BARE/MOSTLY BARE	75	10	0.1	0.011	1.650
1071MAR1407	FENNER DRAIN	RIGHT BANK	SOME BARE BANK	75	10	0.05	0.011	0.413
570MAR2601	CULVER DRAIN	LEFT BANK	MOSTLY BARE BANK	18	10	0.2	0.033	1.188
40GUN0104B	GUN RIVER	LEFT BANK	SOME BARE BANK	18	10	0.05	0.011	0.099
40MAR2603B	GUN RIVER	LEFT BANK	SOME BARE BANK	18	10	0.05	0.011	0.099
1071MAR1409	FENNER DRAIN	LEFT BANK	SOME BARE BANK	18	10	0.05	0.011	0.099
40GUN1702C	GUN RIVER	LEFT BANK	WASHOUT	5	10	0.5	0.011	0.275
59MAR1003	GREGG BROOK	LEFT BANK	MOSTLY BARE BANK	5	5	0.2	0.033	0.165
407GUN0102	407	LEFT BANK	MOSTLY BARE BANK	5	10	0.2	0.011	0.110
1071MAR1404	FENNER DRAIN	LEFT BANK	SOME BARE BANK	5	10	0.05	0.011	0.028
572MAR3601	572	LEFT BANK	SOME BARE BANK	5	5	0.05	0.011	0.014
40GUN1001C	GUN RIVER	LEFT BANK	SOME BARE BANK	5	10	0.05	0.011	0.028
403GUN1602B	GUN RIVER	RIGHT BANK	WASHOUT	125	5	0.5	0.011	3.438
40ORA0601C	GUN RIVER	BOTH	WASHOUT	5	5	0.5	0.011	0.275
1060ORA1802	ORANGEVILLE DRAIN	BOTH	WASHOUT	75	5	0.5	0.011	4.125
							Total	88.866

ROAD/STREAM CROSSING EROSION

Site ID	Waterbody	Severity of Erosion	Length (ft)	Height (ft)	Lateral Recession Rate (ft/yr)	Soil Weight (tons/ft^3)	Sediment Reduction (tons/yr)
407GUN0106	GUN RIVER	SEVERE	96	3	0.3	0.011	0.9504
406GUN1102	GUN RIVER	SEVERE	96	3	0.3	0.011	0.9504
575MAR0202	575	SEVERE	96	3	0.3	0.011	0.9504
59MAR1101	GREGG BROOK	SEVERE	96	3	0.3	0.011	0.9504
402GUN2101	402	SEVERE	96	3	0.3	0.011	0.9504
40ORA0601A	GUN RIVER	SEVERE	96	3	0.3	0.011	0.9504
573MAR2601	573	SEVERE	96	3	0.3	0.033	2.8512
1060ORA1701	ORANGEVILLE DRAIN	SEVERE	96	3	0.3	0.055	4.752
1059MAR2501B	1059	SEVERE	96	3	0.3	0.011	0.9504
1060ORA1807	ORANGEVILLE DRAIN	SEVERE	96	3	0.3	0.055	4.752
575WAY3501	575	MODERATE	48	3	0.15	0.011	0.2376
571ORA1901	571	MODERATE	48	3	0.15	0.011	0.2376
40MAR1301A	GUN RIVER	MODERATE	48	3	0.15	0.011	0.2376
573MAR2701	573	MODERATE	48	3	0.15	0.033	0.7128
577MAR0101	577	MODERATE	48	3	0.15	0.011	0.2376
59MAR0304A	GREGG BROOK	MODERATE	48	3	0.15	0.033	0.7128
4061GUN1101	406	MODERATE	48	3	0.15	0.011	0.2376
1059MAR2516	1059	MODERATE	48	3	0.15	0.011	0.2376
40GUN1101	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
407GUN0105A	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
570MAR2604	CULVER DRAIN	MINOR	24	3	0.05	0.033	0.1188
403GUN1604A	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
40GUN1801A	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
40MAR2601	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
40GUN1701	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
40GUN1801	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
40GUN1001A	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
40MAR2301	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
570MAR2605	CULVER DRAIN	MINOR	24	3	0.05	0.033	0.1188
40GUN1702B	GUN RIVER	MINOR	24	3	0.05	0.011	0.0396
						Total	22.4928

TILE OUTLET EROSION

Site ID	Waterbody	Location	Erosion Area (ft^2)	Lateral Recession Rate (ft/yr)	Soil Weight ($tons/ft^3$)	Sediment Reduction (tons/yr)
59MAR0305	GREGG BROOK	RIGHT BANK	20	0.2	0.033	0.132
1059MAR2502	1059	LEFT BANK	40	0.2	0.011	0.088
1071MAR1406	FENNER DRAIN	RIGHT BANK	20	0.2	0.011	0.044
1071MAR1401	FENNER DRAIN	RIGHT BANK	20	0.2	0.011	0.044
59WAY3401	GREGG BROOK	LEFT BANK	15	0.2	0.033	0.099
40GUN0207	GUN RIVER	LEFT BANK	15	0.2	0.011	0.033
572MAR3606	572	RIGHT BANK	15	0.2	0.011	0.033
1059MAR2517	1059	RIGHT BANK	10	0.2	0.011	0.022
40GUN0203	GUN RIVER	RIGHT BANK	10	0.2	0.011	0.022
407GUN0104	GUN RIVER	RIGHT BANK	15	0.2	0.011	0.033
408MAR3601A	408	RIGHT BANK	15	0.2	0.011	0.033
40MAR1201C	GUN RIVER	LEFT BANK	10	0.2	0.011	0.022
40MAR3603	GUN RIVER	RIGHT BANK	10	0.2	0.011	0.022
572MAR3603	572	LEFT BANK	10	0.2	0.011	0.022
40GUN0209	GUN RIVER		10	0.2	0.011	0.022
					Total	0.671

LIVESTOCK ACCESS

Site ID	Waterbody	Location	Cover	Length (ft)	Height (ft)	Lateral Recession Rate (ft/yr)	Soil Weight (tons/ft^3)	Sediment Reduction (tons/yr)
59MAR0304B	GREGG BROOK	RIGHT BANK	BARE	18	2	0.2	0.033	0.2376

Appendix 4

- **Impairments Due to *E. coli***

Appendix 4

Impairments Due to *E. coli*

Starting in 2014, EGLE identified high levels of *E. coli* in the Gun River Watershed, eventually listing impairments for Partial Body Contact Recreation (PBC) and/or Total Body Contact Recreation (TBC) in all three subwatersheds. The impairments and assessed AUIDs are listed below along with the most recent 30 day geometric mean from *E. coli* sampling. Site specific data is included at the end of this appendix.

Name	AUID	Designated Use Impairments	*E. coli* content (CFU/100mL)
Cuddy Drain	040500030701-13	PBC, TBC	1220
Gun River – Gun Lake to Orangeville Creek	040500030702-05	TBC	173
Gun River – Orangeville Creek to Culver Drain	040500030702-06	PBC, TBC	719
Gun River – Culver Drain to Kalamazoo River	040500030703-01	TBC	553

Statewide *E. coli* Total Maximum Daily Load

The remediation of impairments caused by *E. coli* is described under Michigan's Statewide *E. coli* TMDL approved in 2019. TBC recreation is protected during May-October for which the water quality standard is a daily limit of 300 CFU per 100 mL, and 130 CFU per 100 mL as a 30 day geometric mean. PBC recreation is protected year-round with a limit of 1000 CFU per 100 mL based on a geometric mean of 3 samples within a 7 day period. Water bodies that do not attain this standard fall under the TMDL. The TMDL outlines broadly the potential sources of *E. coli* and provides a variety of recommendations for the reduction of nonpoint sources. Legal point sources are directly regulated through State permitting, but illicit discharges may exist and need to be addressed.

Information about the Statewide *E. coli* TMDL can be found at https://www.mi.gov/ecolitmdl.

Recommended Best Management Practices

Agriculture is likely a significant source of *E. coli* in the Gun River Watershed due to widespread use of manure on farmland, 5.5%-8.8% of the watershed's area based on estimations made in the TMDL. The following BMPs identified in the TMDL are recommended for the Gun River Watershed. Further explanation of *E. coli* sources and solutions can be found on the TMDL webpage.

1. Manure management plans that include incorporation or injection of manure
2. Tile line control structures
3. Livestock access control
4. Riparian buffers
5. Grassed waterways
6. Manure storage facilities
7. Cover crops, especially in no till systems

E. coli Sampling Data

The table below contains the monitoring data collected to date by EGLE's monitoring program. Full monitoring reports including collection protocols and other information regarding EGLE's monitoring efforts can be found at https://www.mi.gov/egleecoli. Data from 2014 was collected by the Cuddy Intercounty Drain Drainage Board.

Site Name	AUID	Sample Date	*E. coli* Geometric Mean (CFU/100mL)	
			Daily	30 Day
Cuddy Drain – Chief Noonday	040500030701-13	21-Aug-14	1025.66	
Cuddy Drain – Chief Noonday	040500030701-13	27-Aug-14	558.14	
Cuddy Drain – Chief Noonday	040500030701-13	02-Sep-14	1444.54	
Cuddy Drain – Chief Noonday	040500030701-13	09-Sep-14	334.05	
Cuddy Drain – Chief Noonday	040500030701-13	15-Sep-14	183.13	550.57
Cuddy Drain - Timber Creek Drive	040500030701-13	21-Aug-14	1148.21	
Cuddy Drain - Timber Creek Drive	040500030701-13	27-Aug-14	579.53	
Cuddy Drain - Timber Creek Drive	040500030701-13	02-Sep-14	803.32	
Cuddy Drain - Timber Creek Drive	040500030701-13	09-Sep-14	338.71	
Cuddy Drain - Timber Creek Drive	040500030701-13	15-Sep-14	189.29	509.32
Tawsley and Holbrook Drain	040500030701-13	21-Aug-14	526.77	
Tawsley and Holbrook Drain	040500030701-13	27-Aug-14	772.67	
Tawsley and Holbrook Drain	040500030701-13	02-Sep-14	589.90	
Tawsley and Holbrook Drain	040500030701-13	09-Sep-14	166.27	
Tawsley and Holbrook Drain	040500030701-13	15-Sep-14	176.05	371.00
Cuddy Drain u/s Tawsley and Holbrook Drain	040500030701-13	21-Aug-14	1518.11	
Cuddy Drain u/s Tawsley and Holbrook Drain	040500030701-13	27-Aug-14	1161.43	
Cuddy Drain u/s Tawsley and Holbrook Drain	040500030701-13	02-Sep-14	1463.62	
Cuddy Drain u/s Tawsley and Holbrook Drain	040500030701-13	09-Sep-14	771.17	
Cuddy Drain u/s Tawsley and Holbrook Drain	040500030701-13	15-Sep-14	507.37	1001.94

Site Name	AUID	Sample Date	E. coli Geometric Mean (CFU/100mL)	
			Daily	30 Day
Cuddy Drain - Patterson Rd	040500030701-13	21-Aug-14	1647.49	
Cuddy Drain - Patterson Rd	040500030701-13	27-Aug-14	771.17	
Cuddy Drain - Patterson Rd	040500030701-13	02-Sep-14	1336.94	
Cuddy Drain - Patterson Rd	040500030701-13	09-Sep-14	676.08	
Cuddy Drain - Patterson Rd	040500030701-13	15-Sep-14	1465.15	1109.67
Gardner u/s Timber Creek	040500030701-13	21-Aug-14	1459.03	
Gardner u/s Timber Creek	040500030701-13	27-Aug-14	741.41	
Gardner u/s Timber Creek	040500030701-13	02-Sep-14	953.03	
Gardner u/s Timber Creek	040500030701-13	09-Sep-14	862.45	
Gardner u/s Timber Creek	040500030701-13	15-Sep-14	469.80	839.80
Cuddy Drain - Patterson Rd	040500030701-13	04-Sep-18	519.44	
Cuddy Drain - Patterson Rd	040500030701-13	11-Sep-18	799.62	
Cuddy Drain - Patterson Rd	040500030701-13	17-Sep-18	838.42	
Cuddy Drain - Patterson Rd	040500030701-13	24-Sep-18	492.20	
Cuddy Drain - Patterson Rd	040500030701-13	01-Oct-18	15810.26	1220.65
Gun River - Near Lake Outlet - Patterson Rd	040500030702-05	29-Jul-19	44.81	
Gun River - Near Lake Outlet - Patterson Rd	040500030702-05	05-Aug-19	179.81	
Gun River - Near Lake Outlet - Patterson Rd	040500030702-05	13-Aug-19	171.45	
Gun River - Near Lake Outlet - Patterson Rd	040500030702-05	19-Aug-19	265.52	
Gun River - Near Lake Outlet - Patterson Rd	040500030702-05	26-Aug-19	426.04	173.30
Gun River - 116th Ave	040500030702-06	29-Jul-19	1069.42	
Gun River - 116th Ave	040500030702-06	05-Aug-19	619.05	
Gun River - 116th Ave	040500030702-06	13-Aug-19	907.62	
Gun River - 116th Ave	040500030702-06	19-Aug-19	656.20	
Gun River - 116th Ave	040500030702-06	26-Aug-19	488.60	719.37
Gun River - 10th St	040500030703-01	29-Jul-19	711.62	
Gun River - 10th St	040500030703-01	05-Aug-19	546.52	
Gun River - 10th St	040500030703-01	13-Aug-19	386.12	
Gun River - 10th St	040500030703-01	19-Aug-19	636.03	
Gun River - 10th St	040500030703-01	26-Aug-19	541.09	552.92

Appendix 5

- **Gun River Tillage Survey QAPP**

- **Gun River NPS Inventory QAPP**
    - **Gun River NPS Inventory QAPP Addendum**
    - **Gun River NPS Inventory Data Sheet**
    - **Gun River NPS Inventory Instructions**

- **Kayak-mounted Sensor WWSEM SOP**

Gun River Watershed Tillage Survey
Quality Assurance Project Plan

Gun River Watershed Management Plan Update Project
Tracking Number: #2020-0114
Grantee: Allegan Conservation District

August 24, 2021

Signatures/Approvals:

Prepared By: Brian Talsma Date: 8/27/21
Brian Talsma, Executive Director, Allegan Conservation District

Reviewed By: Alyssa Riley Date: 9/7/21
Alyssa Riley, Ph.D., Monitoring Coordinator, EGLE

For the State: Robert Day Date: 9/7/21
Robert Day, Unit Supervisor, EGLE

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DISTRIBUTION LIST

- Brian Talsma, Executive Director, Allegan Conservation District
- Cheryl Vosburg, Director, Kalamazoo River Watershed Council
- Janelle Hohm, Kalamazoo District Contact, EGLE
- Thad Cleary, Project Administrator, EGLE
- Alyssa Riley, NPS Unit Monitoring Coordinator, EGLE

I. Project Description and Summary

With support from the Michigan Department of Environment, Great Lakes and Energy (EGLE), Allegan Conservation District (ACD) will conduct a tillage survey of the HUC 10 Gun River Watershed (0405000307), a largely agricultural area located in Allegan and Barry Counties, Michigan

ACD will work with the Kalamazoo River Watershed Council (KRWC) to document tillage practices, crops planted, crop residue, and existing best management practices on cropland. All observations will be made from accessible roadways while driving the watershed. All fields and sites visible from roadways will be included in the survey. This inventory will be done as part of the Gun River Watershed Management Plan Update project to identify agriculture-based causes and sources of nonpoint source pollution. Table 1 lists specific personnel and summarizes their responsibilities.

Table 1. Personnel and Responsibilities

Organization	**Personnel**	**General Responsibilities**
ACD	Brian Talsma	Project management and oversight, field work, data entry and analysis, completion of WMP, incorporate tillage survey data and summary into WMP.
	Mike Ludlam	Field work
	Bonne Matheson	Field work and data entry
	Jenna Rasmusson	Field work and data entry
KRWC	Cheryl Vosburg	Field work, WMP comment and review
EGLE	Thad Cleary Pete Vincent Janelle Hohm	Technical Assistance

Contact information for the main personnel is provided below:

Brian Talsma

Allegan Conservation District

1668 Lincoln Rd.

Allegan, MI 49010

Phone: (269) 941-6165

Email: brian.talsma@macd.org

Thad Cleary

EGLE Nonpoint Source Program

525 W. Allegan Street

Lansing, MI 48909

Phone: (517) 512-3970

Email: clearyt@michigan.gov

II. Study Objectives

The purpose of this study is to obtain an understanding of general agricultural management practices used in the watershed, identify potential agricultural based sources and causes of nonpoint source pollution, determine areas where management practices could be altered to better protect water quality, and to prioritize these areas based on their potential to contribute nonpoint source pollutants to surface waters during runoff events.

Results and recommendations stemming from the collected data will be used to assist in the update of the Gun River Watershed Management Plan including:

- Identification of critical areas and prioritization of sites for future outreach and best management practice implementation efforts.
- Recommendations for best management practices to address specific sources of pollutants.
- Loading calculations and targets for future pollutant reductions.

III. Study Design

The basis for this inventory process was originally developed by EGLE's Nonpoint Source Program. Prior to the start of the inventory, EGLE completed several initial steps to prepare ACD for field data collection. ACD will use the tools provided by EGLE to collect information in portions of the Gun River Watershed. A timetable for each work task is included in Table 2, followed by a description of each work task.

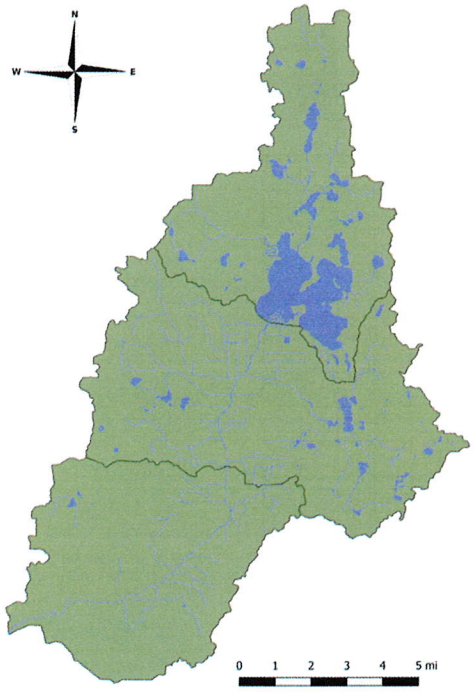

Figure 1: Map of the Gun River watershed.

Table 2. Timetable for Work Tasks

TASK	DESCRIPTION	2021												2022												2023											
		Jan-Mar			Apr-Jun			Jul-Sep			Oct-Dec			Jan-Mar			Apr-Jun			Jul-Sep			Oct-Dec			Jan-Mar			Apr-Jun			Jul-Sep			Oct-Dec		
Task 2	**Agriculture Inventory**																																				
A, B	Digitize fields, GIS analyses																																				
D	Field data collection																																				
	Fall 2021 tillage survey																																				
	Spring 2022 residue survey																																				
	Fall 2022 tillage survey																																				
	Spring 2023 residue survey																																				
	Data analysis																																				
E	Submit data to EGLE																																				

Preparatory Steps: Desktop Analysis and Map Production

EGLE hired contractors to review aerial photographs of the Gun River watershed (HUC 0405000307) and create maps to outline all individual crop fields within the watershed. This work is to be completed by October 2021 in time for the fall tillage survey.

Aerial photos will be overlaid with the HUC 10 watershed boundary to clearly delineate the area included in the inventory. Using best professional judgment, every individual field visible from aerial photographs will be identified within the watershed and field boundaries digitized for use in a geographic information system (GIS). Aerial photographs with high (0.5-1 foot) resolution will be used to get the best level of detail for each site. Fields will be digitized at a maximum scale of 1:4,000.

In addition to field digitization, contractors will hydro-enforce a high resolution digital elevation model of the watershed in order to accurately model surface water flows over the landscape.

ACD staff will also digitize animal feeding operations (AFO) in the watershed based on aerial photos. Aerial photos will be overlaid with the HUC 10 watershed boundary to clearly delineate the area included in the inventory. Using best professional judgment, every individual AFO visible from aerial photography will be identified within the watershed. Each AFO will be stored in a point layer in the project GIS.

Data layers for surface water bodies, areas where concentrated animal feeding operation (CAFO) manure could potentially be applied, and the local road network system will be added to the GIS by ACD staff. These additional data layers provide information that can help further refine what fields are high priorities based on their potential to contribute nonpoint source pollutants to surface waters. Inclusion of the road network will allow for easier navigation during windshield surveys.

These GIS layers will be added to ArcGIS Collector for use during windshield surveys.

Data Collection:

ACD will be responsible for conducting windshield surveys and collecting necessary data. ACD staff have attended a training presentation hosted by EGLE to learn in detail the purpose of the inventory, what data will be collected, and the proper methods and procedures for collecting data. In combination with ACD staff's solid foundation and understanding of agriculture, including knowledge of different crops and practices commonly used in the region, the expertise gained through this training will ensure ACD can successfully complete the inventory, and if needed, train new staff in this process. ACD will be equipped to make all necessary observations and collect all necessary data.

All data will be collected while driving the watershed during windshield surveys and recorded in ArcGIS Collector (see **Appendix A** for example attribute tables used during windshield surveys). Observations will be made from vehicles traveling on accessible roadways. Maps and geospatial datasets created by EGLE will be made available for ACD before inventories begin.

Windshield surveys will be completed by crews of two to four individuals as scheduling permits. A crew of three to four crew members is recommended to capture data in the most efficient and effective manner. One crew member will be responsible for driving during the windshield survey. In order to

collect the most accurate data possible, the driver may need to drive at a slow pace and/or make temporary stops on road shoulders so observations of field conditions can be made. The driver will maintain awareness of their surroundings while driving to maintain the safety of all crew members conducting the windshield survey and all others on the road. Because crew members will at times be driving at slower than typical speeds or may need to pull off onto the road shoulder, being extremely vigilant of the surrounding terrain and traffic is extremely important during the survey. Using hazard lights when driving at slow speeds or when making frequent stops is encouraged.

A second crew member, the field observer, will be responsible for making observations of field conditions and communicating these observations to the data recorder. Because this is the most demanding task, it may be beneficial to have two field observers. Fields on both sides of a two-lane road can be captured this way, making the survey faster and more efficient.

Another crew member, the data recorder, will be responsible for recording observations made by the field observer(s), and using digital or physical maps to navigate and determine which fields are being observed. Observations will be entered directly into the GIS attribute table for the observed field. Physical data sheets will be kept on hand in the case that technical difficulties prevent the use of a tablet or computer.

Four separate windshield surveys will be completed to collect data representative of two agricultural years (fall tillage and spring residue).

A fall tillage survey will be completed to collect information from croplands, specifically: the crop that was last planted, the type of tillage used after harvest of that crop, planting of a winter crop, and the presence or absence of any existing cover crops, filter strips, grassed waterways, or tile risers.

Based on the crop residue remaining on fields, the previous planted crop will be documented in the appropriate column on the data sheet. If a fall crop has been planted, (most typically wheat) this will also be noted. Staff will record any cover crop or over-wintering cash crop (e.g. winter wheat). Any observed tillage practices will also be recorded. Pre-populated categories are shown in Appendix A, but additional categories may be added as necessary. Other observations will be recorded in the "Notes" column of the data sheet.

When conducting windshield surveys, crew members may find that data cannot be collected from every field; some fields may not be visible from roadways or may have been missed during the survey. Several categories exist to document such fields, including fields that are "skipped" (because they were not visible), "pasture", or "not a field". If the crop cannot be identified by the residue remaining on the field at the time of the inventory, it can be labeled as "unknown".

A spring residue survey will also be completed to collect data on the planted crop and the percentage of crop residue remaining on fields after planting.

Based on Natural Resources Conservation Service (NRCS) guidance, at least 30 percent crop residue is needed on cropland fields in order to reduce erosion to tolerable soil loss levels for crop production. This guidance was used to create categories for observed crop residue remaining on fields: zero percent residue, less than 30 percent residue, greater than 30 percent residue, planted with a no-till method, and not planted yet (if the field has not been planted at the time of the inventory). Data collectors will use best professional judgement during windshield surveys to make accurate observations regarding

percent residue on cropland fields. The presence of manure application and field tiles will be noted in the "Notes" column should they be observed. Photographs documenting residue percentage on fields can be found at the following NRCS reference document https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_029000.pdf.
While these photographs were taken while standing on fields, it provides general guidance on the amount of residue that falls under each category included in this inventory.

An AFO survey will be conducted in conjunction with each spring residue survey. The type and number of animals will be recorded along with any manure or runoff concerns. When observers are unable to estimate the number of animals at an AFO (e.g. poultry and swine operations), the barn size will be measured using aerial photography and recorded in the "Notes" column. Additional notes may include details of runoff or manure concerns, details regarding hobby farms, and other observations.

Timing of Windshield Surveys:
The time period that tillage and residue data can be collected via windshield survey is limited and is highly dependent on weather, the amount of precipitation received, and field visibility (snow cover, vegetation cover). Because these factors can vary on a year-to-year basis, so does the precise time frame when windshield surveys should be conducted. A description of the general time frame and conditions required for data collection is listed below for each survey type.

Fall Tillage Survey:
Fall tillage information can be collected at two distinct times; either in late fall or early spring. If collecting information in late fall, the timing of the windshield survey will occur after most fall tillage has been completed, but before snow accumulation obscures visibility of field conditions. In a typical year, the best time to collect this data is late November to early December. However, if the amount of precipitation received in the fall is relatively high, landowners may be forced to wait to conduct fall tillage until field conditions improve, pushing the timing of a tillage survey to later in the year.

If an early spring time frame is selected for the fall tillage data collection, the timing of the windshield survey will occur after the snow cover has melted away, but before any spring tillage has occurred (typically late March to early April). If spring tillage has already occurred, it is not possible to collect information reflecting the tillage practices used the previous fall.

Spring Residue Survey:
Windshield surveys to collect spring residue data will be conducted after that season's crops have been planted, but before crops have grown enough to obstruct the view of crop residue remaining on fields. In a typical year, the general time frame spring residue data can be collected is late May to early June. The timing of crop planting will depend on temperature and precipitation received, which could push this time window earlier or later. If temperatures rise earlier in the year, the timing of planting could also be accelerated. Particularly wet conditions could push the time window for planting back further.

Iterations:
By collecting two fall tillage surveys and two spring residue surveys, a robust data set representative of two full calendar years can be used to analyze and make recommendations providing a more accurate understanding of the management practices used in the watershed.

Data Gaps:

It is possible that data collection will not be possible for all fields and sites. Fields may be too far from roadways to be seen clearly, new development may have altered the land use on sites, or fields could be taken out of production completely. The field data sheet key notes how these fields should be documented. During data analysis, the number of fields skipped or where data could not be collected will be used, so it is important that these fields are correctly categorized.

IV. Field Procedures and Trainings

EGLE provided ACD staff with a virtual training presentation in November of 2020 detailing the inventory process. This presentation included detailed descriptions of what data will be collected during each survey, the appropriate timing of each survey, how to transfer observations made during windshield surveys to the GIS software, and an overview of how the data will be compiled and analyzed to develop recommendations for future implementation efforts. In addition, EGLE staff will accompany ACD staff during the first iteration of the fall tillage and spring residue inventories to ensure observations made by ACD are representative of the parameters detailed in training presentations. If health restrictions do not permit in-person oversight by EGLE staff, ACD will take pictures during a trial observation day, and submit the pictures and data to EGLE staff to insure that field conditions are being accurately recorded.

V. Quality Control Procedures

To ensure that observations made during windshield surveys are both precise and accurate, ACD will take photographs of different field conditions observed during the first fall tillage and spring residue surveys. Photographs will clearly depict crops, tillage practices, and the amount of residue on the fields selected for photo-certification. The field number in each photograph will be noted and the completed data file shared so that observations made by data collectors can be reviewed and confirmed by EGLE. After EGLE review, if recorded observations do not look to be representative of field conditions seen in photographs, EGLE staff will accompany ACD on the next windshield survey and provide in-the-field instruction to provide better guidance for collecting data.

ACD will review the data after completion of each survey to ensure all fields and sites are accounted for during the windshield survey. If any inconsistencies are found, the field number and observation will be noted. Aerial photographs of the fields in question will be reviewed to see if issues can be rectified. Data will be shared with EGLE staff for review as well. EGLE staff will meet with ACD staff to discuss any inconsistencies or other questions as an additional data quality check.

VI. Data Analysis and Interpretations

EGLE will provide ACD with analysis results from the Agricultural Conservation Planning Framework (ACPF). The ACPF is a modeling tool developed for use in ArcGIS to identify opportunities for conservation practices. The tool analyzes hydrology in the watershed to recommend locations where practices may be most impactful. This information will be used to highlight potential priority areas and possible actions that will be identified and assessed in the Gun River Watershed Management Plan.

Analysis of windshield survey data will begin once any written data has been transferred from physical field data sheets to the GIS. After data is transferred, a different crew member will perform quality control by doing a random check of 10% of the entries to ensure data was copied correctly.

Priority areas are those that have a high likelihood of contributing nonpoint source pollutants to surface waters during runoff events based on the field conditions present and its proximity to surface water bodies. Sites will be highlighted as a priority based on several factors, including the tillage practice, percentage of crop residue, lack of buffers, presence of manure, and proximity to surface water bodies. More intensive fall tillage practices reduce the amount of crop residue on field surfaces during the winter and early spring. This reduction in crop residue increases the potential for soil erosion and the delivery of sediment and nutrients to surface waters during storm events and snowmelt events. Plowing is the most intensive tillage practice followed by chisel plowing. Depending on the crop that was planted on a field previously, little to no residue could be left after these tillage practices are implemented, especially if the vegetation of the observed previous crop is not very hearty (e.g. soybeans). Less intensive practices such as mulch till, strip till, planting a winter wheat crop or no tillage at all, result in more crop residue left on the soil surface or include a growing crop such as wheat, reducing the amount of sediment and nutrients reaching surface waters.

Depending on the crop that was planted, even sites where less intensive tillage practices were used, could still have little to no residue left. Fields that were observed to have zero or less than 30 percent residue during spring residue surveys, that are in proximity of a surface water body, and that have no buffer between fields and surface water bodies will be a priority for future best management practice implementation efforts due to the increased likelihood that runoff events could transfer sediment and nutrients unabated to surface waters.

VII. Data Reporting

Data will be collected during windshield surveys by ACD staff with experience and knowledge of agricultural crops and practices. Information will be recorded directly in the attribute table of the fields' GIS layer. A physical data sheet will only be used in the case of technical difficulties, and this data will be transferred to the attribute table when possible.

Statistical data and maps will be produced from the data and published in the Gun River Watershed Management Plan, along with a summary of methods and analysis.

Appendix A:

Field Data Sheets

Fall Tillage and Spring Residue Attribute Table with Possible Entries

ID	Date_21FT	Crop_21FT	Tillage_21FT	WinterCover_21FT	Notes_21FT	Date_22SR	Crop_22SR	Residue_22SR	Notes_22SR
		Corn	Plowed	Winter wheat (crop)			Corn	No residue	
		Corn silage	Chisel plowed	Grass			Corn silage	Less than 30%	
		Soybean	Mulch tilled	Legume			Soybean	More than 30%	
		Wheat	Strip tilled	Brassica			Wheat	Planted no till	
		Hay	No tillage	Mix			Hay	Not planted	
		Pasture					Pasture		
		Unknown					Unknown		
		Not a field					Not a field		
		Skipped					Skipped		

AFO Observations Field Data Sheet with Possible Entries

ID	Animal_Type	Animal_Number	Runoff_Issues	Manure_Issues	Notes1	Notes2
	Dairy	30-60	Yes	Yes		
	Beef	61-100	No	No		
	Poultry	101-150				
	Swine	151-500				
	Hobby	CAFO				
		See Notes				

Gun River Watershed NPS Inventory
Quality Assurance Project Plan

Gun River Watershed Management Plan Update Project
Tracking Number: #2020-0114
Grantee: Allegan Conservation District

October 20, 2021

Signatures/Approvals:

Prepared By: _____ Date:_____
Brian Talsma, Executive Director, Allegan Conservation District

Reviewed By: _____Date:_____
Alyssa Riley, Ph.D., Monitoring Coordinator, EGLE

For the State: _____Date:_____
Robert Day, Unit Supervisor, EGLE

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- Alyssa Riley, NPS Unit Monitoring Coordinator, EGLE

Contact information for the main personnel is provided below:

Brian Talsma

Allegan Conservation District

1668 Lincoln Rd.

Allegan, MI 49010

Phone: (269) 941-6165

Email: brian.talsma@macd.org

Thad Cleary

EGLE Nonpoint Source Program

525 W. Allegan Street

Lansing, MI 48909

Phone: (517) 512-3970

Email: clearyt@michigan.gov

Table 1. Personnel and Responsibilities

Organization	**Personnel**	**General Responsibilities**
ACD	Brian Talsma	Project management and oversight, field work, data entry and analysis
	Bonne Matheson	Field work and data entry
KRWC	Cheryl Vosburg	Field work
EGLE	Thad Cleary Janelle Hohm	Technical Assistance

I. Project Description and Summary

With support from the Michigan Department of Environment, Great Lakes and Energy (EGLE), Allegan Conservation District (ACD) will conduct a nonpoint source (NPS) pollution inventory of the Gun River Watershed (HUC 0405000307), a largely agricultural area located in Allegan and Barry Counties, Michigan. The table below lists documented NPS impairments in the watershed.

Impairment	Cause	Subwatersheds
Total body contact recreation	*E. coli*	040500030701, -02, and -03
Partial body contact recreation	*E. coli*	040500030701, -02, and -03
Other indigenous and aquatic life	Flow regime modification, other anthropogenic substrate alterations	040500030702

An inventory will be completed for the entire Gun River watershed (Figure 1). Meant to be a relatively rapid assessment at the sub-watershed scale, the methodology will employ the use of aerial photography and an in-person survey to determine likely sources of NPS pollution. ACD will review aerial photography to identify concerns throughout the watershed, and further supplement information obtained during the survey. The survey will consist of driving, walking, or kayaking reaches of the Gun River watershed that are identified as a priority by the project steering committee, listed as impaired, or appear to have sites of concern upon inspection of aerial photography. Surveyors will document sites that show signs of contributing NPS pollution such as erosion sites or significant sources of runoff. Information gathered through these methods will be used with the Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL) model to calculate pollutant loads.

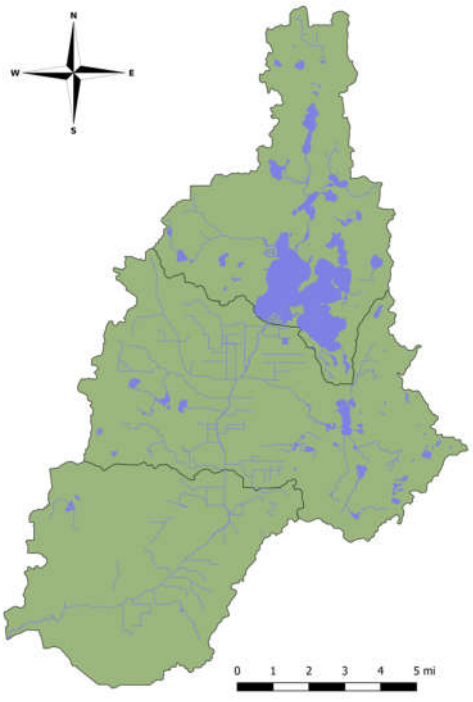


Figure 1: Map of the Gun River watershed.

II. Outline of Inventory Procedure

Aerial Photograph Review

Both this Nonpoint Source Inventory and the Tillage Survey QAPP (signed 9-7-2021) begin with a review of aerial photographs. The watershed will be reviewed using aerial photographs (NRCS, most recent flights) on GIS and web-mapping applications (Bing, Google, etc). When the review of aerials is done, it should include a reconnaissance of all potential NPS sources, covered in both this QAPP and the Tillage Survey QAPP. Any possible pollution sources or other impacts identified on aerial photography (eg. bank erosion, farms, livestock access, dams, golf courses, etc.) will be marked for field inspection. Additionally, historic aerial photography may be reviewed in order to estimate the duration of pollutant contribution at specific sites as needed.

In-Person Survey

Priority reaches of the watershed will be surveyed in-person by walking, driving, or kayaking as access allows. Reaches will be prioritized based on: the existence of designated use impairments, concerns identified during the Tillage Survey and aerial photography review, and recommendations from the project Steering Committee. Surveyors will document details about each site that will be used to estimate pollutant loads for the watershed. In particular, NPS pollution from stream crossings, road runoff, gully erosion, inadequate riparian buffers, stream bank erosion, livestock access, agricultural runoff, and tile outlets will be recorded and used in STEPL to generate pollutant load estimates. Other sites that do not fit into these categories will also be documented, but may not be included in pollutant load calculations.

Details for each observation will be recorded digitally using ArcGIS Collector and Survey123. Physical data sheets will be available as a backup, and will record all of the same information. The field data sheet is attached in Appendix A. In addition to these measurements, photographs will be taken for each site.

III. Project Timetable

Nonpoint Source Pollution (NPS) inventory work, including windshield and walking surveys, will begin in November 2021 and continue until approximately June 2022. Analysis and reporting will be ongoing, with completion set for December 2022.

IV. Field Procedures

Brian Talsma, Bonne Matheson, and Cheryl Vosburg will complete all photo review, surveys, and NPS calculations. Specific instructions for using the field data sheet are attached in Appendix B.

V. Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) guidelines and rules have been established to ensure the reliability and validity of sample collection activities. Compliance with QA/QC is monitored by Brian Talsma. The objectives are to:

- Ensure all procedures are documented, including any changes in administrative and/or technical procedures.
- Ensure all field procedures are conducted according to sound scientific principles and have been validated.

- Monitor performance of the data collection procedures by a systematic inspection program and provide for corrective action if necessary.
- Ensure all data are properly recorded and archived.

A variety of aerial photographs from sources such as Bing and Google maps, and NRCS, have been reviewed and determined to be adequate for their use in this project; aerial photos will be used for general screening purposes.

VI. Field Data Validation

All NPS inventory data will be reviewed at the end of each day prior to leaving the field.

VII. Data Management

Field data will be collected by Brian Talsma, Bonne Matheson, and Cheryl Vosburg. Analysis and interpretation of data will be conducted by Brian Talsma. Quality control/assurance will be conducted by Brian Talsma and will include review of accuracy and completeness for all field data and data entry.

Field Data Quality Objectives will be defined as follows:

- Comparability: Comparability of data will be ensured by using standardized datasheets and established protocols. Similar inventory procedures have also been used in other EGLE-funded projects.
- Completeness: Completeness is ensured by obtaining high-quality data at each NPS site. All data forms will be checked for completeness prior to leaving a site. At least 95% of the data collected during the NPS inventory will be useable.

VIII. Assessments and Response Actions/Reports

Brian Talsma will be responsible for oversight of the inventory work, as well as the review and approval of all deliverables. The information collected during this project will be discussed by the project Steering and Committee, and analyzed and summarized in the Watershed Management Plan by Brian Talsma.

IX. Data Validation and Usability

Review will take place on a quarterly basis during the period of data collection, and once upon entry and analysis of all field data. If errors are suspected or detected, data will be discarded and the site in question will be resurveyed.

Appendix A:

Field Data Sheets

Appendix B:

Survey Instructions

Addendum to
Gun River Watershed NPS Inventory
Quality Assurance Project Plan

Gun River Watershed Management Plan Update Project
Tracking Number: #2020-0114
Grantee: Allegan Conservation District

September 30, 2022

Signatures/Approvals:

Prepared By: _____ Date: 10/11/22
Brian Talsma, Executive Director, Allegan Conservation District

Reviewed By: Alyssa Riley Date: 10/11/2022
Alyssa Riley, Ph.D., Monitoring Coordinator, EGLE

I. Purpose

The purpose of this addendum is to include the addition of water quality monitoring sensors in the Gun River Watershed NPS inventory. Once configured, the sensors will collect data with little additional effort while staff complete the inventory. Upon analysis, irregularities in water quality metrics may indicate a site of concern. The data will either supplement observations and measurements from sites recorded in the initial inventory, or—if overlooked—staff will return to conduct a closer inspection and discern the cause, possibly documenting additional NPS inputs.

II. Sampling Methodology and Locations

Sensors will be attached to a canoe or kayak to record continuous data during portions of the inventory accessed by boat, and at fixed sampling locations at road stream crossings that are accessed by land during the survey. The sensors, collection methods, and analysis methods are the same as described in the Kalamazoo River Watershed Volunteer Water Quality Monitoring Program QAPP (tracking Number: # 2021-0260). The data collected will be dissolved oxygen, temperature, and conductivity.

Continuous Data Collection

Water quality monitoring sensors will collect data throughout the entire mainstem of the Gun River. The float trip will begin at Gun Lake and end 12 miles downstream in Otsego at the Kalamazoo River confluence.

Fixed Point Data Collection

Water quality monitoring sensors will be used at fixed points along Gun River tributaries at road stream crossings that have been prioritized and assessed as part of the inventory.

III. Staffing Revision

Personnel on this project now includes Emily Reichow, a watershed technician hired on to Allegan Conservation District March of 2022, to replace Bonne Matheson. Douglas McLaughlin has replaced Cheryl Vosburg as the staff member at the Kalamazoo River Watershed Council.

Pollutant Source Identification Data Sheet

NOTE: Only document potential pollutant sources - use one data sheet per GPS location.

Revisit:

Site ID #: _____ **Date:** _____

Watershed: _____ **Photo numbers:** _____

Tributary Name: _____ **Investigator(s):** _____

GPS (in decimal degrees): **Lat:** _____ **Long:** _____

Pollutant Source *(choose all appropriate categories, then complete those sections)*

1. Stream crossing **2. Road runoff** **3. Gully erosion**

4. Inadequate riparian buffer **5. Streambank erosion** **6. Livestock access**

7. Agricultural runoff **8. Tile outlet**

SECTION 1. STREAM CROSSING

Type of crossing Bridge Single culvert Double culvert Box culvert Other: _____

Bridge/culvert obstruction None Partial Half Full

Road crossing surface Paved Gravel Unimproved

Approach material Paved Gravel Unimproved

Left approach slope (facing culvert) 0% 1-5% 6-10% >10% **Approach length (ft):** _____

Right approach slope (facing culvert) 0% 1-5% 6-10% >10% **Approach length (ft):** _____

Culvert source of NPS pollution via: 1. Improper length 2. Improper width 3. Deteriorating culvert

(circle all that apply) 4. Misalignment 5. perched culvert (height: _____ft)

Soil texture (circle one): Clay Sand Silt Organic

Years erosion present: _____ years (use best professional judgment, assume that all erosion locations are the same age)

Erosion location (10 possible locations)

UPSTREAM SIDE OF CROSSING (facing crossing)

	Left bank	Right bank	Culvert inlet/face	Approach	Road ditch
Erosion severity (slight/moderate/severe/very severe)					
Top erosion width (ft):					
Bottom erosion width (ft):					
Erosion depth (ft):					
Erosion length (ft):					

DOWNSTREAM SIDE OF CROSSING (facing crossing)

	Left bank	Right bank	Culvert outlet/face	Approach	Road ditch
Erosion severity (slight/moderate/severe/very severe)					
Top erosion width (ft):					
Bottom erosion width (ft):					
Erosion depth (ft):					
Erosion length (ft):					

SECTION 2. ROAD RUNOFF

Road surface (circle one) paved gravel unimproved

Length of road contributing to runoff: _____ feet

Distance of road from water: _____ feet

Years erosion present: _____ years (use best professional judgment)

Soil texture (circle one): Clay Sand Silt Organic

SECTION 3. GULLY EROSION

Location (facing d/s) Left bank Right bank

Apparent cause (fill in blank): _____

Soil texture (circle one): Clay Sand Silt Organic

Top erosion width: _____ feet **Erosion depth:** _____ feet

Bottom erosion width: _____ feet **Erosion length:** _____ feet

Years present: _____ years (use best professional judgment)

SECTION 4. INADEQUATE RIPARIAN BUFFER

Existing buffer/filter strip dimensions (facing d/s)
Left bank: Length: _____ ft Width: _____ ft
Right bank: Length: _____ ft Width: _____ ft

Length of buffer needed (facing d/s)
Left bank: _____ **Right bank:** _____
(estimate linear feet or get upstream and downstream GPS coordinates)

Estimated contributing acreage: (use aerial photos to estimate)
Left bank: _____ acres **Right bank:** _____ acres

Riparian habitat (facing d/s) (circle all that apply)
Left bank Trees Shrubs Native grass Turf/lawn Bare soil
Right bank Trees Shrubs Native grass Turf/lawn Bare soil

Upland land use (facing d/s) (area beyond riparian zone)
Left bank Natural Agricultural Residential Roadway Commercial/Industrial
Right bank Natural Agricultural Residentail Roadway Commercial/Industrial

Pollutant Source Identification Data Sheet **SITE ID #:** _____

Tributary name: _____

SECTION 5. STREAMBANK EROSION

Location (facing d/s) Left bank Right bank

Length of erosion: _____ feet **Height of erosion:** _____ feet

Erosion severity (circle one): Some bare bank (slight) Mostly bare bank (moderate)
Bare bank w/ rills (severe) Undercut/washout (very severe)

Soil texture (circle one): Clay Sand Silt Organic

Apparent cause (circle one): Systemic (ex: unstable hydrology, etc.) Local: _____
Storm water outfall Other: _____

SECTION 6. LIVESTOCK ACCESS

Location (facing d/s) Left bank Right bank

Aquatic vegetation/algal blooms None Slight Moderate Extensive

Soil texture (circle one): Clay Sand Silt Organic

Approxmate # of animals: _____ **Type of animals:** _____

Erosion type:	None	Rill	Streambank		Gully	
(select all that apply)		1. Erosion severity:	1. Erosion height (ft):		1. Top erosion width (ft):	
		slight	2. Erosion length (ft):		2. Bottom erosion width (ft):	
		moderate	3. Erosion severity:	slight	3. Erosion depth (ft):	
		severe		moderate	4. Erosion length (ft):	
		very severe		severe		
Years present:		years (use best professional judgment)		very severe		
Length of access:		feet				

SECTION 7. AGRICULTURAL RUNOFF

Location (facing d/s) Left bank Right bank

Potential pollutant source:	Cropland/pasture manure runoff	Cropland erosion/runoff		Feedlot erosion/runoff	
(select all that apply)	1. Erosion/runoff severity:	1. Tillage:		1. Approx. # animals:	
	slight	no till		2. Type of animals:	
	moderate	conventional		3. Dist. from water (ft):	
	severe	reduced till		4. Erosion/runoff severity:	slight
	very severe	2. Crop type:	Soy		moderate
		Corn	Wheat		severe
		Other:			very severe
		3. Area (acres):		5. Area (acres):	
		4. Erosion/runoff severity:		6. Percent paved:	0-24%
		slight			25-49%
		moderate			50-74%
		severe			75-100%
		very severe			

SECTION 8. TILE OUTLET - EROSION AND DISCHARGE

Location of outlet (facing d/s) Left bank Right bank

Flowing? (circle YES or NO): YES NO

If flowing, discharge color Clear Green Cloudy/milky Very muddy Black

If flowing, discharge odor None Musty Ammonia/eggs Chemical/oil Sewage

Erosion (circle YES or NO) YES NO

Top erosion width: _____ feet **Erosion length:** _____ feet

Bottom erosion width: _____ feet **Erosion height:** _____ feet

Soil texture (circle one): Clay Sand Silt Organic

Years present: _____ years (use best professional judgment)

Additional Comments ***(site sketch, comments about potential pollution source, additional site description, or potential best mangement practice solutions)***

Pollutant Source Identification Data Sheet Instructions

NOTE: This data sheet is set up to collect all necessary parameters to use the Spreadsheet Tool for Estimating Pollutant Loads (STEPL) program to calculate pollutant load estimates. Section 319 and 205(j) grantees should submit this form as part of a Quality Assurance Project Plan (QAPP) document to the Department of Environmental Quality (DEQ) Nonpoint Source (NPS) Program for approval. NPS Program staff is available to help select the appropriate pollutant source sections to include on the field data sheet.

Suggested Equipment checklist

- ☐ Maps with waterways and roads labeled
- ☐ Field data sheets (many copies or electronic data recorder)
- ☐ Clipboard
- ☐ Pens/pencils
- ☐ GPS unit
- ☐ Tape measure (100 ft)
- ☐ Folding ruler (6 ft)
- ☐ Camera with extra batteries
- ☐ Compass
- ☐ Waders, hip boots, or wading shoes
- ☐ Traffic cones
- ☐ Brush clearing tools
- ☐ First aid kit
- ☐ Insect repellant/sunscreen
- ☐ Lunch/snacks/water for long field day

General tips

Follow these guidelines to gather information for documenting nonpoint sources for inclusion in a watershed management plan. This form should be used to document pollutant sources and should not be used as a general watershed characterization form. For example, if you come across a road stream crossing and do not see any pollutant sources to document (e.g. no noticeable erosion), then you do not need to fill out this form for that site. While there is no section for documenting high quality areas for protection it would be beneficial to note those areas in the comment box at the end of the field form.

This form should be used as a walking inventory is conducted but could be used in conjunction with a driving or kayak inventory. It is unrealistic and unnecessary to try to walk an entire watershed to document all potential pollutant sources. Therefore, to be the most efficient with this form, it should be used in areas that have already been prioritized based on other methods (i.e., Total Maximum Daily Load areas and waters on the state's nonattainment list should be a priority as well as other known sources that have already been documented).

In general, face downstream when determining "left bank" or "right bank." The only exception is when you are documenting erosion locations at a road stream crossing, in which case always face the crossing to determine left/right bank.

Revisiting Sites
In some cases it may be necessary to revisit an observation. For example, contacting a landowner for access, or looking at aerial photography back at the office may be necessary to complete the required information. This should be noted at the top of the data sheet with a short description of what needs to be revisited.

Photographic documentation
Taking pictures and documenting where the pictures are taken is a highly useful tool and strongly recommended. Make an effort to get a representative set of photos for each site and take detailed notes.

Site specific information
As field inventories are conducted, site specific Global Positioning System (GPS) information should be recorded in the decimal degrees format using the World Geodetic System (WGS) 1984 geographic coordinate system.

Determining the number of "years present"
The number of years a problem has been present is needed to get an estimate of annual pollutant loads. Use your best professional judgment to estimate the number of years. It may be helpful to speak with nearby landowners or to look at aerial photos.

Determining erosion severity
Erosion severity has been divided into four categories: slight, moderate, severe, or very severe. Technically, the categories are based on the following rates:

Category	Erosion rate (feet/year)
Slight	0.01-0.05
Moderate	0.06-0.2
Severe	0.3-0.5
Very severe	> 0.5

Determining the severity of erosion is somewhat subjective. Use other observations throughout the watershed to determine if the erosion is slight, moderate, severe, or very severe compared to other locations. Gathering information from sites where Best Management Practices (BMP) can be implemented should be a priority activity. Funding BMPs at severe/very severe erosion sites will generally be favored over funding BMPs at slight/moderate erosion sites. Slight/moderate erosion sites should not be the main focus of inventory work.

Determining the "soil texture" type
Determining soil texture can be a difficult task and is a required parameter for calculating pollutant loads for potential nonpoint pollution sources. Therefore, soil texture has been divided into four categories. Choose between the following four general categories:

1. Clay – feels sticky, malleable material
2. Silt – feels smooth, very fine particles
3. Sand – feels gritty
4. Organic – muck, mixture of coarse leaf and wood material

Use the table to match the general soil texture category with the STEPL category.

General soil texture identified in field	**STEPL Category to use for calculations**

Clay	Clay
Silt	Silt loam
Sand	Fine sandy loam
Organic (mixture of detritus, sand, silt, and clay)	Organic

To fill out the data sheet and obtain the most accurate information in an organized manner, it is important to COMPLETELY fill out the data sheet. After field work is complete it may be difficult to determine if a blank field means that the item was not assessed or whether it was not applicable. Instead of leaving a field blank, write NA for items that were not applicable.

All length measurements should be made in feet and recorded to the nearest 0.1 foot. Do not record inches, even for measurements that are less than one foot. For example, record 0.5 feet instead of 6 inches. Measurements longer than 20 feet should be rounded to the nearest foot if you are not confident in the precision of the measurement.

The following instructions for each section are organized in the same order as the field data sheet.

Be sure to fill in the general information at the top of each field sheet including watershed, tributary name, GPS coordinates, site identification, date, photo numbers (so later you can keep track of what photos went with each site), and the names/initials of the people in the field crew. Next, since this field form will only be used to DOCUMENT POTENTIAL POLLUTANT SOURCES, you will circle all of the appropriate source categories that apply to your location. Depending on what source(s) are circled, those are the sections that you will fill out completely. For example, if you are at a location and you observe gully erosion, streambank erosion, and livestock access, you would circle numbers 3, 5, and 6. Then you would fill out sections 3, 5, and 6 completely. You could observe erosion at a stream crossing and an adjacent streambank. Therefore, you would fill out section 1 and 5. If you observe streambank erosion only, then only circle number 5 and fill out the corresponding section.

SECTION 1. STREAM CROSSING

Type of crossing: A stream crossing could include a road stream crossing such as a bridge, culvert, or dam, but it could also include a ford (low-water crossings where vehicles drive across the streambed), an all-terrain vehicle (ATV) crossing, or a logging road.

Bridge/culvert obstruction: Determine if the stream channel is blocked by debris and select either none, partial, half, or full obstruction.

Road crossing surface: Mark if the road surface is paved, gravel or unimproved. Unimproved refers to any two-track or dirt road.

Approach material/slope/length: The approach refers to the section of road that slopes toward the crossing (Figure 1). Record the approach material (it is assumed that the left and right approaches are the same material). Determine the slope for the left and right approach (facing downstream). Measure the length of the left and right approach from the middle of the road stream crossing to the top of the slope leading down towards the structure. This is the distance the water would drain down the road to the structure.

http://www.northernmichiganstreams.org/rsxinfo.asp

Figure 1. Runoff from steep approaches on dirt roads can cause large amounts of sediment to enter watercourses during rain or snow melt.

Contributing to NPS pollution via: Circle all categories that apply.

1. Improper length: If the culvert is too short, there will likely be erosion around the culvert inlet/outlet and could possibly be eroding into the road. If the culvert is too long, the culvert outlet may be perched.
2. Improper width: To determine if the size of the culvert is appropriate or not, the general rule of thumb is that the culvert width should match the width of an upstream riffle. If no upstream riffle is present, then compare the width to a straight stretch upstream.
3. Deteriorating culvert: If the culvert material is severely cracked/rusted/eroded/broken, it could be contributing to NPS pollution.
4. Misalignment: A properly aligned culvert will be positioned to match the alignment of the existing watercourse to the greatest degree practical.
5. Perched culvert: If the crossing is perched (outlet elevated above downstream water surface), measure the vertical distance from the downstream water surface to the bottom of the stream crossing structure to the nearest 0.1 foot interval and write the perch height on the field form.

Soil texture: Determine if the soil is mostly clay, sand, silt, or organic material. See the bottom of page 2 for more guidance.

Years erosion present: Use your best professional judgment to determine the number of years the observed erosion has been present (see page 2). If erosion is observed at different locations around the road stream crossing, it can be assumed that all erosion is the same age. In order to determine the age of a road stream crossing it may be useful to speak with nearby landowners, the road commission or look at aerial photos.

Erosion location (10 possible locations): At one road stream crossing it may be possible to observe erosion at ten different locations (Figure 2). Fill in the column for each location of observed erosion. Write the word (slight/moderate/severe/very severe) that best describes the

overall extent of the erosion. Take width (at the top and bottom of the eroding area), depth, and length measurements for each erosion location.

NOTE: A roadside ditch at a road stream crossing that appears to be a result of the crossing would fall under a STREAM CROSSING and SECTION 1 should be filled out completely. If you observe a roadside ditch that is not the result of a crossing, then it could fall under SECTION 2. GULLY EROSION, or any other appropriate section.

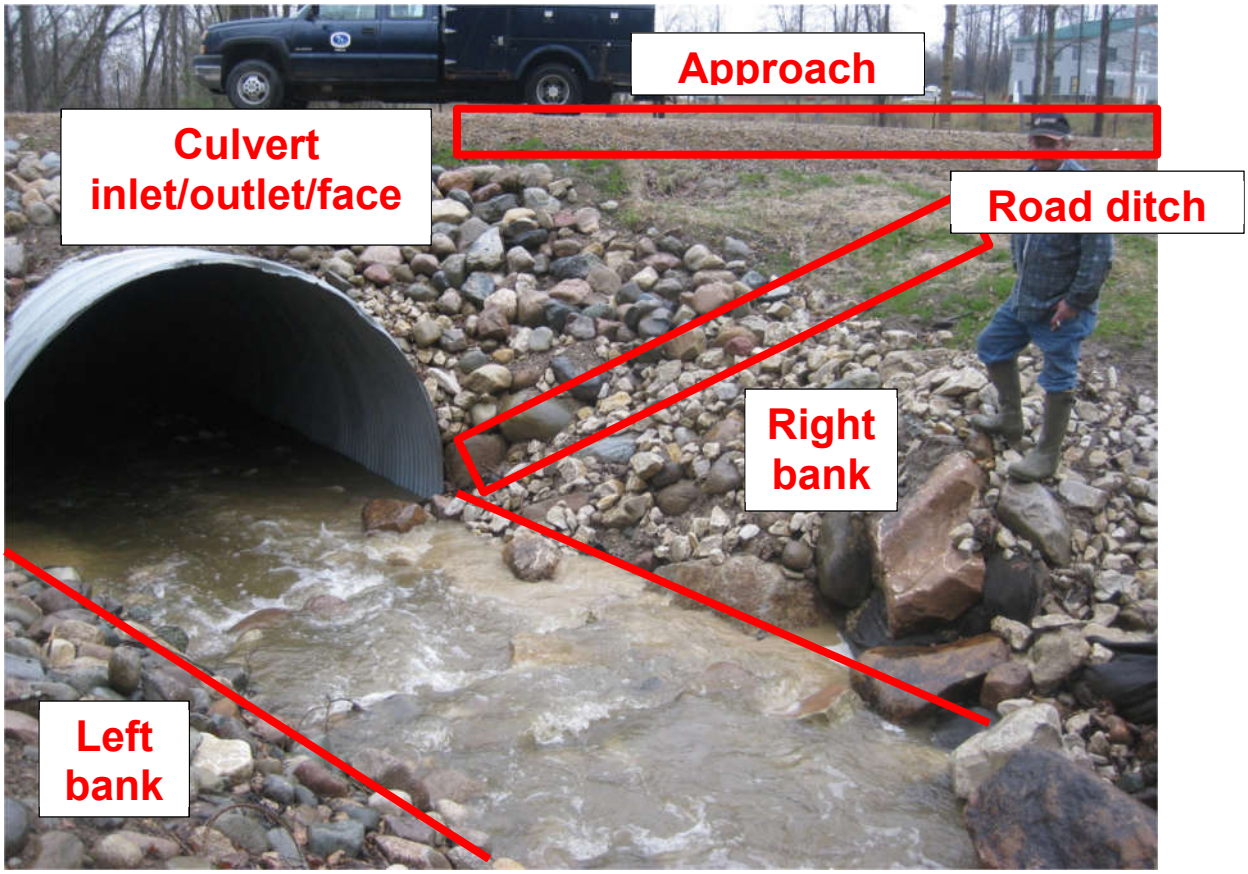


Figure 2. Culvert road stream crossing depicting each possible location of erosion. There are five possible locations of erosion on the upstream side of the road stream crossing, and the same five locations on the downstream side, for a total of ten possible erosion locations.

SECTION 2. ROAD RUNOFF

http://ridgetoriver.com/land_use.html

Figure 3. Road runoff has the potential to increase the amount of nonpoint source pollution that enters water bodies.

A road running parallel to (or close to) a water body would be the first indication that road runoff may be a potential pollutant source. A visual cue that it is a source would be rills (see definition page 8) running from the road surface (Figure 3 and Figure 4a).

Road surface: Circle the type of road surface. Unimproved refers to any two-track or dirt road.

Length contributing to runoff: Estimate the length of road contributing to runoff.

Distance of road from water: Estimate the distance of the road from the water body.

Years erosion present: Use your best professional judgment to determine the number of years the observed erosion has been present (see page 2).

Soil texture: Determine if the soil is mostly clay, sand, silt, or organic material. See the bottom of page 2 for more guidance.

SECTION 3. GULLY EROSION

Location: Face downstream and determine if the observed erosion is on the left bank or right bank.

Apparent cause: There are several possible causes of gully erosion. Some common examples include overland runoff due to poor vegetation cover, overgrazing, human activities, improper land use, or improper irrigation design.

Soil texture: Determine if the soil is mostly clay, sand, silt, or organic material. See the bottom of page 2 for more guidance.

Erosion top/bottom width/depth/length: Measure the top and bottom width of the erosion area along with the depth and length. Measurements should be rounded to the nearest 0.1 foot.

Years erosion present: Use your best professional judgment to determine the number of years the observed erosion has been present (see page 2).

SECTION 4. INADEQUATE RIPARIAN BUFFER

Only fill out this section if there is an inadequate buffer and there is opportunity to restore the riparian area. For example, if the lack of buffer is due to a roadway and runoff is observed, then SECTION 2. ROAD RUNOFF should be filled out, not this section. The adequacy of a buffer will depend on soil type, slope, and upland land use so an adequate buffer width at one site may not be the appropriate width at a different site. For example, the Natural Resources Conservation Service filter strip standard requires a minimum of 20 feet between water bodies and cropland. However, if the riparian area is steeply sloped, the filter strip may need to be wider than 20 feet.

Existing buffer/filter strip dimensions: Facing downstream, estimate the current width and length of the buffer area on the left bank and the right bank. If there are miles of inadequate buffer than estimate current conditions as best as you can. Aerial photos may help get a more accurate estimate.

Length of buffer needed: Estimate the length of buffer needed on the left bank and right bank. If miles of buffer are needed it is suggested to take a GPS reading at the upstream point and at the downstream point and use aerial photos in conjunction with walking the site to get an accurate estimate.

Estimated contributing acreage: Use aerial photos to estimate the amount of acreage contributing nonpoint source pollution for the left and/or right bank.

Riparian habitat: Circle the description of habitat for each bank.

Upland land use: Determine the current upland land use on the left and right bank. This refers to the area beyond the riparian zone.

SECTION 5. STREAMBANK EROSION

Location: Face downstream and determine if the observed erosion is on the left bank or right bank.

Length/height of erosion: Measure the length and height of the eroding streambank in feet.

Erosion severity: Determine the severity of the erosion. “Slight” erosion would be indicated by some visible bare bank. A mostly bare bank would be “moderate” erosion. A bare bank with

rills (see definition at bottom of page 8) present would indicate “severe” erosion. If an undercut bank or washout is observed, that would indicate “very severe” erosion.

Soil texture: Determine if the soil is mostly clay, sand, silt, or organic material. See the description at the bottom of page 2 for more guidance.

Apparent cause: There are several possible causes of streambank erosion. For example, streambank erosion can be the result of a systemic or local action. The erosion could also occur at a storm water outfall, or some other type of structure. A systemic cause could be unstable hydrology. An access point (either human or animal) or a log jam could cause local streambank erosion. If the cause of erosion falls into the “local” or “other” category, be sure to include details on the line provided on the form.

SECTION 6. LIVESTOCK ACCESS

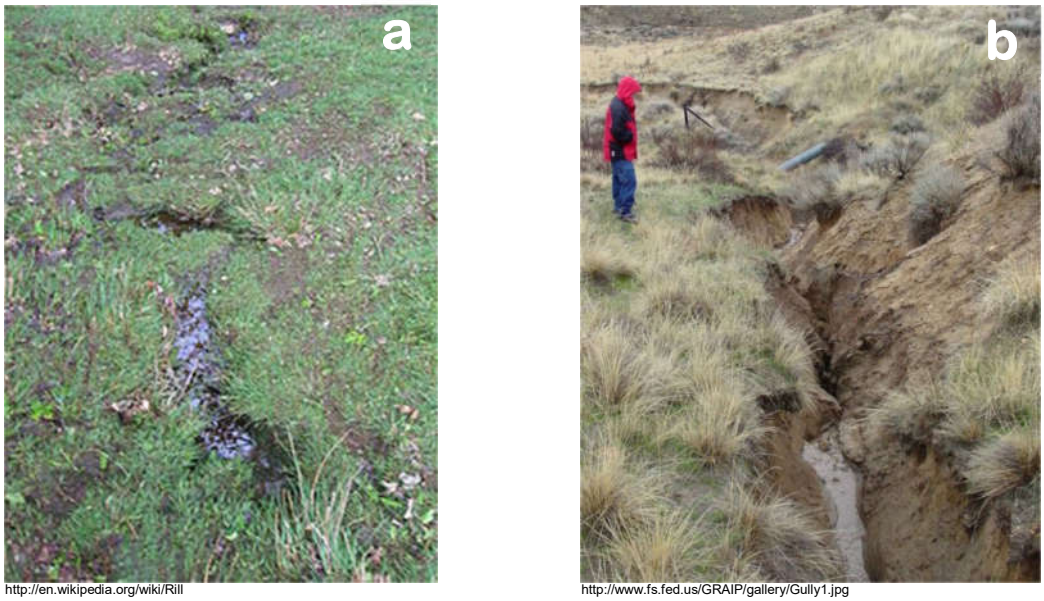
Location: Face downstream and determine if the observed livestock access is on the left bank or right bank.

Aquatic vegetation/algal blooms: Determine if there is: no increased plant/algal growth, slight, moderate, or extensive growth downstream of the livestock access to the water.

Soil texture: Determine if the soil is mostly clay, sand, silt, or organic material. See the description at the bottom of page 2 for more guidance.

Number/type of animal: Determine the approximate number of animals that have access to the watercourse and write down what animals are present. It is important to estimate the number of animals to get an idea of how significantly the livestock access could impact water quality.

Erosion type (select all that apply): If you observe livestock access, but no erosion, then circle “none” for the erosion type. If you observe erosion, determine if the type of erosion is a rill, streambank, or gully (can circle more than one category if applicable). A rill is the initial sign of erosion and is most common on slopes. Rills are much smaller than a gully (Figure 4a). Determine if the rill exhibits minor, moderate, or severe erosion. For streambank erosion that is a direct result of livestock access, measure the height and length of the eroding bank and determine the erosion severity (Remember, if the streambank erosion is not associated with livestock access, then if would fall under SECTION 4. STREAMBANK EROSION, not SECTION 5. LIVESTOCK ACCESS). A gully erodes sharply into the soil and it is often difficult to step across (Figure 4b). Measure the top/bottom erosion width, depth, and length.



http://en.wikipedia.org/wiki/Rill http://www.fs.fed.us/GRAIP/gallery/Gully1.jpg
Figure 4. An example of a rill (a) compared to the size of a gully (b).

Years erosion present: Use your best professional judgment to determine the number of years the observed erosion has been present (see page 2).

Length of access: Estimate the total length of streambank where the livestock have access and round to the nearest 0.1 foot.

SECTION 7. AGRICULTURAL RUNOFF

Location: Face downstream and determine if the observed agricultural runoff is on the left bank or right bank.

Potential pollutant source (circle all that apply): If you observe a potential nonpoint agricultural source of pollution, determine if it is from cropland/pasture manure runoff, cropland erosion/runoff, or feedlot erosion/runoff (circle more than one category if applicable). For cropland/pasture manure runoff, determine if the erosion/runoff severity is slight, moderate, severe, or very severe. For cropland erosion/runoff, the type of tillage needs to be identified. The field form separates tillage practice into three general categories: no-tillage, reduced tillage, and conventional tillage. Descriptive text and pictures for tillage examples that fall into these categories are provided (Figure 5). Also, determine the type of crop, estimate acreage of the source (again, may be more accurate to utilize aerial photos), and erosion/runoff severity (slight, moderate, severe, or very severe). For feedlot erosion/runoff, estimate the number of animals and note the type of animal. Estimate the distance of the source from the water (round to the nearest 0.1 foot). Determine if the severity of the erosion/runoff is slight, moderate, severe, or very severe. Estimate the area of the source in acres. To estimate acreage it may be easier to use aerial photos to obtain accurate size estimates for lots. Estimate the percent of the feedlot that is paved and select the appropriate range.

http://www.ars.usda.gov/images/docs/9372_9566/image003.gif

General photo depicting a side-by-side comparison of a no-till field versus conventional tillage practices.

No-till fields: crops are planted without disturbing the soil through tillage


http://www.extension.iastate.edu/CropNews/2009/0302alkahsi.htm

No-till soybeans planted in corn residue.


http://www.ok.gov/conservation/Conservation_Districts/Garfield_County_No-Till_Conference_2011.html

No-till soybeans growing in wheat residue.

Strip tillage (falls into no-till category): a form of tillage where only narrow strips are tilled


http://www.extension.org/pages/28317/reducing-tillage-to-save-fuel

Strip tillage was used to prepare this field for corn planting.


http://extension.oregonstate.edu/malheur/agriculture/watershed-management

Strip tilled corn planted in wheat residue.

Reduced tillage: method of soil tillage which leaves at least 30% crop residue on the soil surface

http://farmconnection.wordpress.com/

After planting – corn (circled in red) growing after being planted into 30% soybean residue.

http://www.extension.umn.edu/cropenews/2008/08MNCN28.html

Before planting – surface residue coverage after stalk chopping and chisel plowing in a field of corn residue.

Conventional tillage: the traditional method of farming in which the soil is prepared for planting by tillage practices that result in less than 30% residue cover

http://www.tifton.uga.edu/sewrl/radio/gibbover.htm

http://oregonprogress.oregonstate.edu/spr99/images/snapbeans.jpg

http://www.avanzi.unipi.it/ricerca/quadro_gen_ric/solil_tillage/image_soli_tillage/Image15.jpg

Figure 5. Tillage practices vary in the amount of crop residue left on the field.

SECTION 8. TILE OUTLET

Location: Face downstream and determine if the tile outlet is on the left bank or right bank.

Flowing?: Determine if anything is flowing out of the tile outlet and circle YES or NO as appropriate.

Discharge color/odor: If the outlet is flowing, choose from the discharge color and odor categories on the field form to best reflect the properties of the discharge.

Erosion: If erosion is observed, circle YES. If no erosion is evident, circle NO.

Erosion width/length/height: If erosion is observed, measure the top/bottom erosion width, length, and height of the erosion location.

Soil texture: Determine if the soil is mostly clay, sand, silt, or organic material. See the bottom of page 2 for more guidance.

Years erosion present: Use your best professional judgment to determine the number of years the observed erosion has been present (see page 2).

COMMENT BOX

Additional comments: Use this space to sketch a picture of the site, write additional comments about the potential pollution source, write additional site descriptions, or make notes regarding potential best management practice solutions.

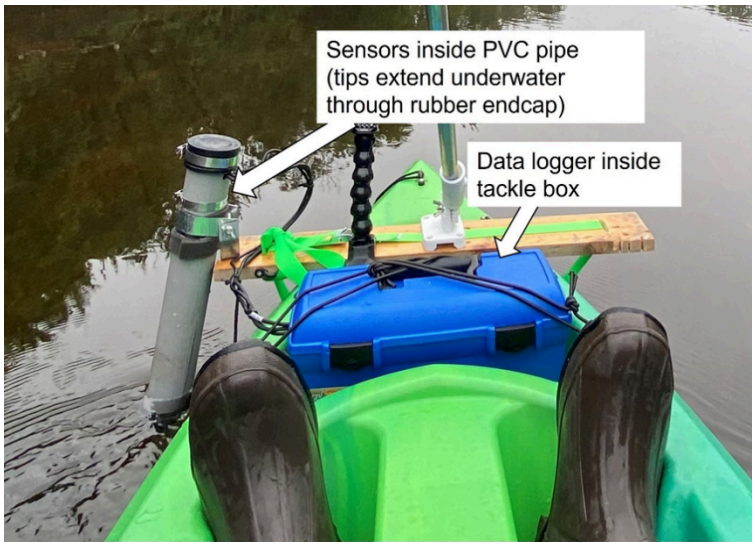
WaterWays|SEM Standard Operating Procedure: Paddling With Vernier LabQuest®3 Data Logger and Wired Temperature, Conductivity, and Optical Dissolved Oxygen Water Quality Sensors

Doug McLaughlin, WaterWays|SEM, L3C
Version 1, 5-3-2022

Summary
This SOP describes how Vernier LabQuest®3 data loggers, with built-in GPS and connected temperature, conductivity, and optical dissolved oxygen (DO) sensors, are assembled, and used to measure water quality while paddling a canoe or kayak during an excursion on a river or lake ("float trip"). To prevent water damage during float trips, the sensors are placed inside a section of PVC pipe ("Sensor Tube") with the sensor tips extending through a rubber end cap, and the data logger is placed inside a plastic tackle box. The Sensor Tube is clamped onto a platform that is attached to the bow area of a canoe or kayak using an adjustable strap. To obtain water quality measurements during a float trip, the end of the Sensor Tube is placed in the water so that the sensor tips are 3-6 inches beneath the water surface. Configured this way, all sensors are either in or out of the water at the same time, providing concurrent, geo-located measurements of all three water quality parameters. The data logger is programed to collect and record frequent measurements during the trip (e.g., every 5 seconds). The high measurement frequency provides the ability to detect water quality changes occurring over short distances (i.e., a few feet at most paddle speeds), which can reveal patterns reflecting important natural and human-caused processes that affect water quality.

Objective
To use a Vernier GPS-enabled data logger (LabQuest®3) with temperature, specific conductivity, and dissolved oxygen sensors to collect information of known quality on small-scale spatial variations in surface water quality while paddling a canoe or kayak on a float trip to obtain insight into factors, activities, and locations in the watershed that influence water quality.

Equipment
Vernier LabQuest®3
Wired Temperature Sensor (TMP-BTA)
Wired Specific Conductivity Sensor (CON-BTA)
Wired Optical Dissolved Oxygen Sensor (ODO-BTA)
PVC pipe with rubber end caps and hose clamps ("Sensor Tube")
Adjustable Sensor Platform with hinged clamp to hold Sensor Tube
Tackle Box for data logger
USB thumb drive
Field Notebook



Equipment Assembly

PVC Sensor Tube

The Sensor Tube consists of a 2” outer diameter PVC pipe 16” to 24” long. Placed over one end of the pipe and secured with a hose clamp, a rubber end cap with holes drilled through it so that the end of each sensor can extend through the cap, keeps a water-tight fit around each sensor. A second rubber end cap is placed over the top of the pipe, and a small hole is drilled in the pipe or the end cap to accommodate the sensor wires going from the Sensor Tube to the data logger.

Adjustable Sensor Platform

Includes a 1”x4” board (treated wood or PVC) placed on top of the canoe or kayak and long enough to extend a few inches beyond the width of the canoe or kayak. Slots are cut into each end of the board to accommodate a tie-strap used to hold the board in place. A hinged conduit clamp is attached to one end of the board to hold the Sensor Tube (with sensors inside). The clamp is designed to allow the end of the Sensor Tube to be placed a few inches beneath the surface of the water while paddling, and easily be removed from the water as needed to avoid damage from debris or the river bottom, or when faster paddling speeds are required.

LabQuest®3 Protection Box

A plastic tackle box large enough to accommodate the LabQuest®3 data logger with sensor wires attached is used to protect the logger from splashing, rain, etc. Even when closed, the box allows for a sufficient GPS signal so that the location coordinate data captured by the data logger remain sufficiently accurate.

Sensor Calibration/Verification

According to manufacturer documentation, all of the sensors used are calibrated before shipment, and need little set up, maintenance, or recalibration. The conductivity sensor can be recalibrated using standards and procedures provided by Vernier (see Vernier conductivity sensor documentation).

Proper calibration of each sensor is verified as follows:

- Temperature: check measured values against known air and water temperatures measured with other reliable thermometers. Agreement within 1 or 2 °F of known values is sufficient for the intended use described in this SOP.
- Conductivity: the conductivity sensor is equipped with a range selector. The “0-2000 uS/cm” range should be selected for most freshwater float trips. Periodic testing of the conductivity sensor is done using distilled water and Vernier conductivity standards. Measured values in air and in distilled water should be near 0. When conductivity in a 150 uS/cm standard differs from the standard value by more than 15 uS/cm (10%), the conductivity probe should be recalibrated using procedures specified by the manufacturer (see Vernier documentation).
- Dissolved Oxygen: proper DO sensor operation is verified using sensor readings of water-saturated air created by placing a water-soaked paper towel in a plastic bag and securing the bag over the DO sensor tip. Measured values should be between 8 mg/L and 10 mg/L.

Initiating Data Collection at the Beginning of a Float Trip

Secure the Sensor Platform and Sensor Tube onto the canoe/kayak in front of the paddler (the bow paddler if two people are in a canoe) to minimize disturbance of the water being measured and to ensure easy access by the paddler during the float trip. When on land, the sensor pipe should be secured on top of the vessel (facilitated by the hinged Sensor Tube clamp) with a bungee cord to minimize the potential for damage to the sensors.

To begin data collection at the start of a float trip:

- Plug all sensors into the appropriate ports on the LabQuest®3.
- Turn on the LabQuest®3; tap File/Open and search for and open the file "riversurveydata2.qmbl".
- Verify that the resulting screen shows the following:
    - Correct time at the top of the screen.
    - Mode: time-based; Rate: 0.20 sample/s; Duration: 15000 sec; Latitude, Longitude Temperature (in °F), Dissolved oxygen (mg/L); Conductivity (uS/cm).
- Tap the "XY" icon at the upper right to change the display to view new measurements being added to the data in real time.
- To start logging measurements, tap the green arrow at the bottom left (observe that measurements are being added to the table shown on the screen at the appropriate frequency).
- Record the time that data recording by the logger was started.

The above steps can be done before the sensors are placed in the water. Once the canoe or kayak is launched with paddler(s) on board, adjust the height of the Sensor Tube using the hinged pipe clamp so that the sensor tips are submerged in the water 3" to 6" during normal paddling. Observe the change in sensor measurements on the LabQuest3 screen reflecting placement of the sensors in water before closing the lid and securing the logger box to the canoe/kayak. Verify that the GPS signal has been established and that the latitude and longitude readings are being recorded along with each sensor reading.

Data Collection During a Float Trip

Data-Logging Duration and Frequency

Using the data collection parameters in the file "riversurveydata2.qmbl", measurements obtained with Vernier temperature, conductivity, DO, and GPS sensors during float trips will be recorded every 5 seconds, yielding 720 measurements of each location point and water quality parameter every hour. The green arrow at the bottom left of the LabQuest®3 display must be tapped as described above, or data from the float trip will not be stored. Measurements are collected for a total of 15,000 seconds (a little over 4 hours) before the logger stops recording values. For float trips longer than 4 hours, data recording can be restarted using the "Append" function (an option presented to the user when saving the original data file), or a second file can be started after saving the data recorded during the first 4 hours.

Canoe/Kayak Route and Conditions for Data Collection

The sensors will provide the most reliable data when turbulence around the submerged sensor tips is minimized. This generally means collecting data while paddling at slower speeds and/or in the direction of any currents. Temperature and conductivity sensors provide relatively steady measurements even in turbulent waters. The DO sensor is more sensitive, and unreliable readings (indicated by wide swings in measured values from 0 to 20 mg/L) can occur more often in turbulent conditions. When it is necessary to paddle upstream or at higher speeds, the hinged Sensor Tube clamp allows the Sensor Tube to easily be removed from the water and secured to the top of the canoe or kayak (e.g., with a bungee cord). The times and locations that the sensors are in and out of the water are recorded by the data logger. They are indicated by rapid, continuous changes in the conductivity data (conductivity approaches 0 when the sensor is in air), and in temperature readings depending on the difference between surface water and air temperature.

To help evaluate the impact of currents and paddling speed on measurement stability and reliability, each float trip should include at least three 1-minute "drift" periods (12 measurements of each parameter at a measurement frequency of 5 seconds) where the paddler drifts without paddling. The time and location of these "drift" periods will be captured in the data logger GPS data. During data analysis, these periods will

provide useful information on variation for all three water quality parameters during times of minimal turbulence around the sensors. Variation in GPS location data can also be assessed.

Where safely feasible, the float trip path should include efforts to get stable readings from points of interest encountered during the trip, such as tributary mouth locations (far enough upstream of the mainstem channel so that readings accurately reflect tributary conditions). Other points of interest may include more stagnant waters near visible sediment deposits or wetlands, locations of point discharges of stormwater or wastewater, inlets from small streams or springs, etc. These points of interest can be noted in a field notebook and/or verbally recorded using a video action camera or smart phone. Record the date, time of day, the point of interest, and a description of the location, along with the name(s) of the person(s) conducting the sampling.

Ending a Float Trip

At the end of the float trip, tap the red button at the bottom left of the logger display screen and record the time in a notebook. Save the data file on the LabQuest®3 with an appropriate filename (e.g., project initials_date). Insert a portable USB thumb drive into the LabQuest®3 and tap File/Export to save a *.txt file to that drive for use in subsequent data processing. Retain the original file on the Vernier LabQuest®3 (do not delete it from the data logger).

Rinse the sensor probes with distilled water and place the plastic sensor cover bag provided with the Sensor Tube over the sensors. In a note book or other device, record any problems or concerns that arose during the float trip that could impact the performance of the sensors. Notify a project coordinator of these concerns to ensure that they are addressed prior to the next float trip. The LabQuest®3 should be charged overnight in preparation for its next use.

Data Processing and Review

Transfer the *.txt file from the USB thumb drive to a computer used for data review and analysis (MS Excel must be installed/available). Open the *.txt file in MS Excel and save as a *.csv file. Open the *.csv file and create a new file in *.xlsx format with data columns that can be filtered. Plot the raw sensor data including latitude and longitude against time to identify highly variable or unusual values. Create maps of all temperature, conductivity, and DO measurements by location to identify "drift" locations (for analysis of sensor variability) and to reveal unusual spatial patterns that warrant additional review for accuracy and representativeness. Preliminary data review will use the following guidelines to flag values that may not be representative that warrant further review:

- The conductivity sensor readings are near 0 (conductivity readings approach 0 when the sensor is not in the water)
- Higher-than-usual variation occurs in a short time series of measurements, indicating the potential effect of turbulent conditions around the sensors
- GPS location data do not reflect known locations at a given time (e.g., at the beginning or end of a float trip)

Allowing for exceptions identified during the preliminary data review described above, data filters in MS Excel will be used to create a "provisional" data set with the following characteristics:

- DO >1 and <18 (unless preliminary review identifies a series of stable measurements outside this range);
- Change between adjacent DO measurements between -1 and 1 mg/L;
- Change between adjacent conductivity measurements between -10 and 10 uS/cm;
- Change between adjacent temperature measurements between -1 and 1 °F.

The provisional data set should be saved in both *.csv and *.xlsx formats for further analysis and mapping.

Additional Guidance

The manufacturer documentation notes that these sensors are “designed for educational use”. Consequently, they likely do not have the long-term durability of more expensive professional grade water quality sensors. Nonetheless, specifications on precision, accuracy, and response time for these temperature, conductivity, and DO sensors, along with demonstrated reliability in the field, indicate that they can be valuable tools for, at a minimum, developing a preliminary assessment of spatially-variable water quality conditions.

The use of a GPS-enabled action camera during a water quality measurement float trip can provide important documentation of the water quality measurement activities described in this SOP. For example, recording a float trip with a 360-degree camera mode (e.g., GoPro Max) will capture times and locations during which the Sensor Tube is in and out of the water, the amount of turbulence around the sensors, the ambient conditions associated with water quality measurements (e.g., near a wastewater outfall, in a tributary), etc. In addition, the camera will provide a backup source of information on the timing and location of the paddle route. This visual record can be a valuable future reference to support interpretations of the water quality data, and to communicate the results to others.

Summary of Sensor Specifications

Table 1. Specifications for Vernier Temperature, Dissolved oxygen, and Conductivity Sensors

Sensor	Range	Accuracy	Response Time
Optical DO (odo-bta)	0 -20 mg/L	±0.2 mg/L below 10 mg/L ±0.4 mg/L above 10 mg/L	90% of final reading in 40 sec
Temperature (tmp-bta)	-40°C -135°C	±0.2 °C at 0°C ±0.4 °C at 100°C	90% change in 10 sec
Conductivity (con-bta)	0 –2000 uS/cm*	±3%*	98% of final reading in 5 sec

* mid-range setting

Documents Referenced in this SOP

LabQuest® 3 User Manual (labq3.pdf)
Stainless Steel Temperature Probe (tmp-bta.pdf)
Conductivity Probe (con-bta.pdf)
Vernier Optical DO Probe(odo-bta.pdf)

Location Map

FIGURE NO. 1

Prepared for the Gun River Watershed Management Plan

ALLEGAN CONSERVATION DISTRICT

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Greggs Brook Drain
Fenner Lake Drain
Orangeville Drain
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed

- Watershed Boundary
- Gun River and Tributaries
- Lakes

N W E S

0 0.5 1 1.5 2 Miles

Prepared for the Gun River Watershed Management Plan

Base Map

FIGURE NO. 2

ALLEGAN CONSERVATION DISTRICT

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Greggs Brook Drain
Fenner Lake Drain
Orangeville Drain
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed Topography

Elevation
- 700 - 750
- 751 - 800
- 801 - 850
- 851 - 900
- 901 - 950
- 951 - 1000
- 1001 - 1050

Watershed Boundary

Gun River and Tributaries

N W E S

0 0.5 1 1.5 2 Miles

Prepared for the Gun River Watershed Management Plan

Topography

FIGURE NO. 3

ALLEGAN CONSERVATION DISTRICT

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Greggs Brook Drain
Fenner Lake Drain
Orangeville Drain
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed Hydrologic Soils

- A-High Infiltration, Low Runoff
- B-Medium Infiltration
- C-Low Infiltration
- D-Very Low Infiltration
- A/D-(Drained/ Natural Condition)
- B/D-(Drained/ Natural Condition)
- C/D-(Drained/ Natural Condition)
- Gun River and Tributaries
- Lakes
- Watershed Boundary

N
W
E
S

0 0.5 1 1.5 2 Miles

Prepared for the Gun River Watershed Management Plan

Hydrologic Soil Groups Map

FIGURE NO. 4

ALLEGAN CONSERVATION DISTRICT

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed Land Use

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock/ Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/ Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands
- Watershed Boundary

N W E S

0 0.5 1 1.5 2 Miles

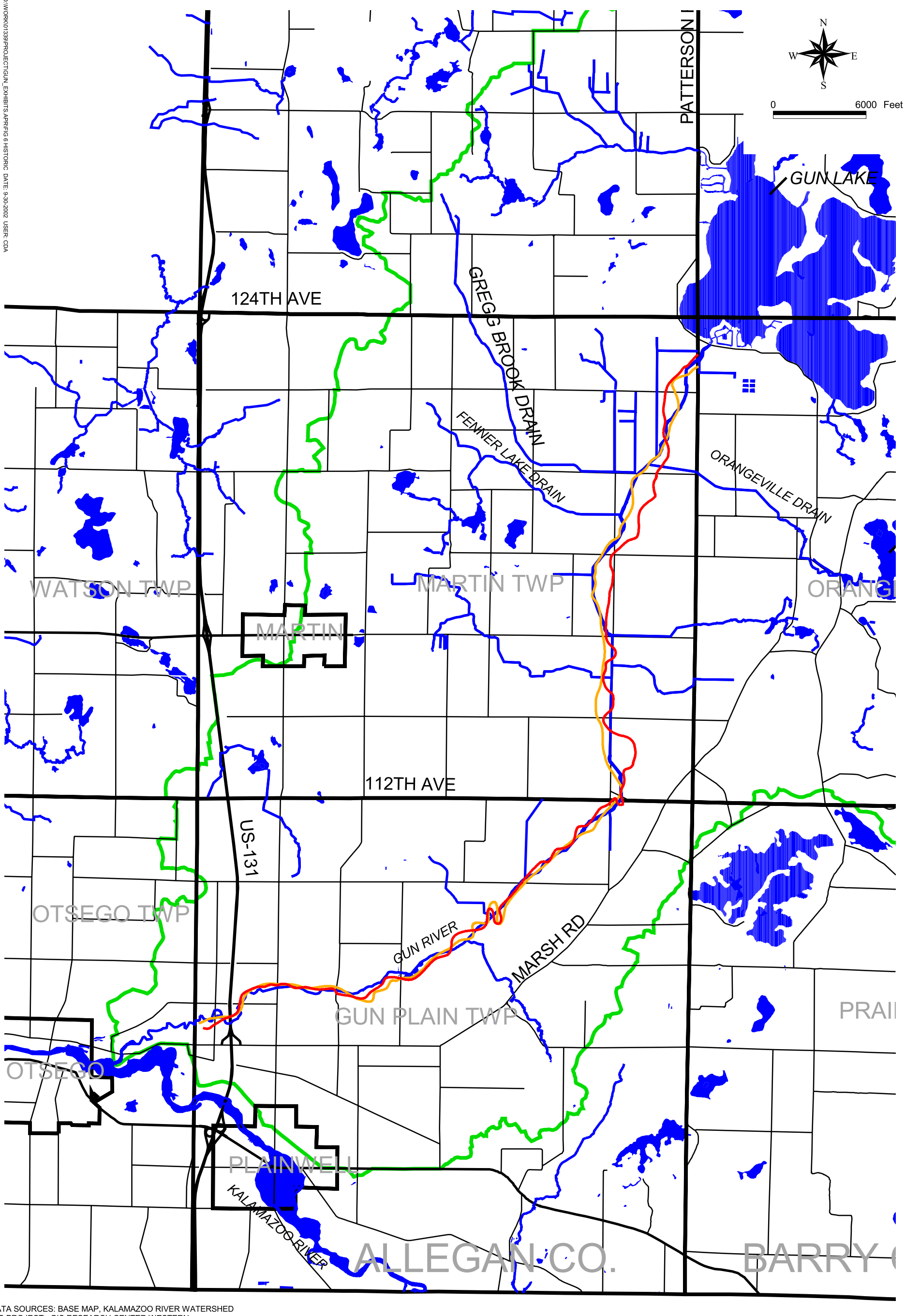
Prepared for the Gun River Watershed Management Plan

Land Use

FIGURE NO. 5

ALLEGAN CONSERVATION DISTRICT

D:\WORK\01339\PROJECT\GUN_EXHIBITS APR\FIG 6 HISTORIC DATE: 9-30-2002 USER: CDA



DATA SOURCES: BASE MAP, KALAMAZOO RIVER WATERSHED GIS PROJECT, GIS RESEARCH CENTER WESTERN MICHIGAN UNIVERSITY 1996.
MICHIGAN DEPARTMENT OF NATURAL RESOURCES MIRIS, 1978, SPCS NAD 27, US FEET.
WATERSHED DELINEATION, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY GIS, DIGITAL SHEDS, 2001.
GUN RIVER HISTORIC LOCATIONS, MARTIN TOWNSHIP PUBLISHED BY C.O.TITUS, PHILADELPHIA, PA, 1873
ALLEGAN COUNTY PLAT BOOK PUBLISHED BY W.W.HIXON, ROCKFORD,IL, 1930.

LEGEND
- GUN RIVER 1873
- GUN RIVER 1930
- GUN RIVER 1978
- GUN RIVER WATERSHED BOUNDARY

HISTORIC LOCATION OF THE GUN RIVER

PROJECT NO. G01339
FIGURE NO. 6

Allegan Conservation District
Allegan County, Michigan

Gun River Watershed Management Plan

Fishbeck, Thompson, Carr & Huber
Engineers • Scientists • Architects
Grand Rapids, Michigan

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Greggs Brook Drain
Fenner Lake Drain
Orangeville Drain
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed Presettlement Vegetation

- Alder/Willow Swamp
- B Oak/W Oak
- Beech/S Maple/B Wood/R Oak
- Black Ash Swamp
- Conifer/Hardwood Swamp
- Emergent Marsh
- Hardwood/Conifer Swamp
- Lake
- Low Conifer Swamp
- Low Hardwood Swamp
- Oak Barrens
- Oak Opening
- Pine Barrens
- River
- Tamarack Swamp
- W Oak/Hickory
- W Pine/W Oak
- Wet Prairie
- Watershed Boundary
- Gun River and Tributaries

N W E S

0 0.5 1 1.5 2 Miles

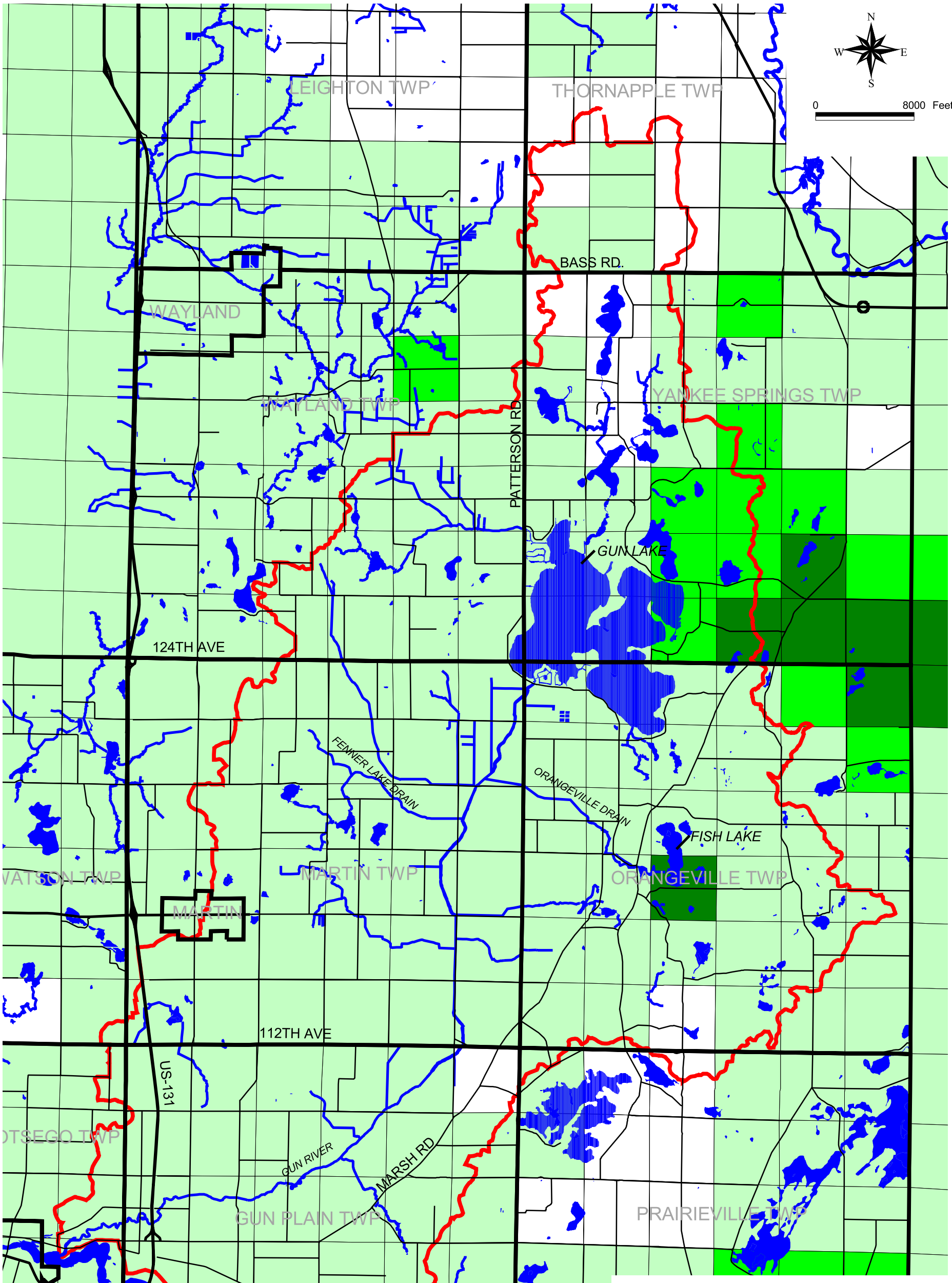
Prepared for the Gun River Watershed Management Plan

Presettlement Vegetation Map

FIGURE NO. 7

ALLEGAN CONSERVATION DISTRICT

D:\WORK\01339\PROJECT\GUN_EXHIBITS.APR\FIG 7.NFI DATE: 9-30-2002 USER: CDA



DATA SOURCES: BASE MAP, KALAMAZOO RIVER WATERSHED GIS PROJECT,
GIS RESEARCH CENTER WESTERN MICHIGAN UNIVERSITY 1996.
MICHIGAN DEPARTMENT OF NATURAL RESOURCES MIRIS, 1978, SPCS NAD 27, US FEET.
WATERSHED DELINEATION, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY GIS, DIGITAL SHEDS, 2001.
MICHIGAN NATURAL FEATURES INVENTORY, MICHIGAN STATE UNIVERSITY EXTENSION,2001.

FREQUENCY OF ELEMENT OCCURANCE NATURAL FEATURES INVENTORY MAP

PROJECT NO. G01339
FIGURE NO. 8

Allegan Conservation District
Allegan County, Michigan

Gun River Watershed Management Plan

Fishbeck, Thompson, Carr & Huber
Engineers • Scientists • Architects
Grand Rapids, Michigan

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Greggs Brook Drain
Fenner Lake Drain
Orangeville Drain
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed Wetlands

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Watershed Boundary

N
W
E
S

0 0.5 1 1.5 2 Miles

Prepared for the Gun River Watershed Management Plan

National Wetlands Inventory Map

FIGURE NO. 9

ALLEGAN CONSERVATION DISTRICT

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Greggs Brook Drain
Fenner Lake Drain
Orangeville Drain
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed Farmland

- Prime Farmland
- Farmland of Local Importance
- Gun River and Tributaries
- Lakes
- Watershed Boundary

N W E S

0 0.5 1 1.5 2 Miles

Prepared for the Gun River Watershed Management Plan

Prime Farmland Map

FIGURE NO. 10

ALLEGAN CONSERVATION DISTRICT

D:\WORK\01339\PROJECT\GUN_EXHIBITS.APR\FIG 11 WATER QUALITY DATE: 9-30-2002 USER: CDA

WAYLAND TWP

PATTERSON RD

GUN LAKE

N
W E
S

0 4000 Feet

124TH AVE

GREGG BROOK DRAIN

FENNER LAKE DRAIN

ORANGEVILLE DRAIN

FISH LA

MARTIN TWP

ORANGEVILLE

GUN RIVER

112TH AVE

DATA SOURCES: BASE MAP, KALAMAZOO RIVER WATERSHED
GIS PROJECT, GIS RESEARCH CENTER WESTERN MICHIGAN UNIVERSITY 1996.
MICHIGAN DEPARTMENT OF NATURAL RESOURCES MIRIS, 1978, SPCS NAD 27, US FEET.
WATERSHED DELINEATION, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY GIS, DIGITAL SHEDS, 2001.

LEGEND

GUN RIVER WATERSHED BOUNDARY
WATER QUAILITY SAMPLE SITES

WATER QUALITY SAMPLING SITES

PROJECT NO. G01339

FIGURE NO. 11

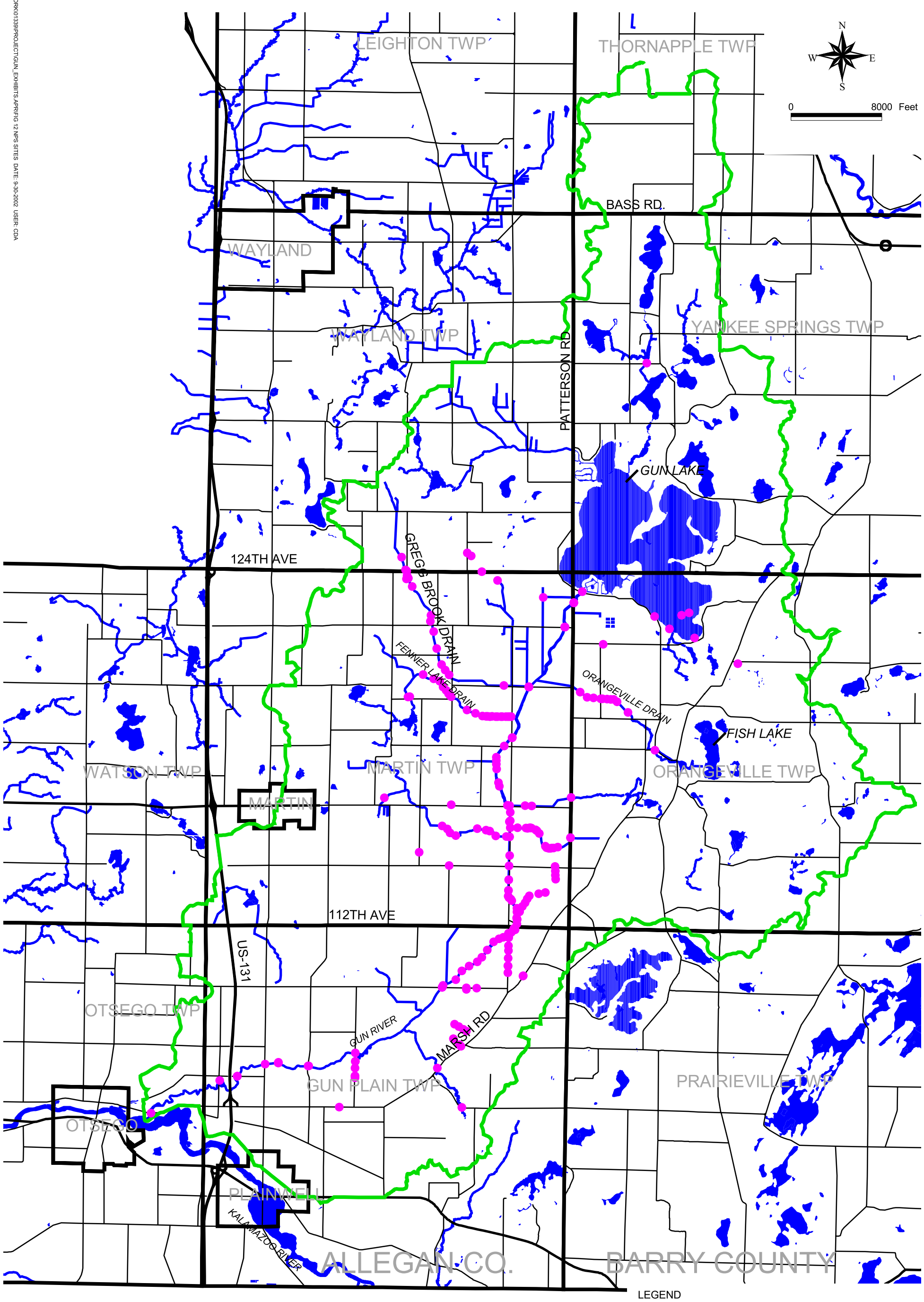
Allegan Conservation District
Allegan County, Michigan

Gun River Watershed Management Plan

fhc&h

Fishbeck, Thompson, Carr & Huber
Engineers • Scientists • Architects
Grand Rapids, Michigan

D:\WORK\01339\PROJECT\GUN_EXHIBITS.APR\FIG 12 NPS SITES DATE: 9-30-2002 USER: CDA



LEGEND

- GUN RIVER WATERSHED BOUNDARY
- IDENTIFIED INVENTORY PROBLEM AREAS

DATA SOURCES: BASE MAP, KALAMAZOO RIVER WATERSHED GIS PROJECT, GIS RESEARCH CENTER WESTERN MICHIGAN UNIVERSITY 1996. MICHIGAN DEPARTMENT OF NATURAL RESOURCES MIRIS, 1978, SPCS NAD 27, US FEET. WATERSHED DELINEATION, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY GIS, DIGITAL SHEDS, 2001.

NONPOINT SOURCE POLLUTION SITES

PROJECT NO. G01339

FIGURE NO. 12

Allegan Conservation District

Allegan County, Michigan

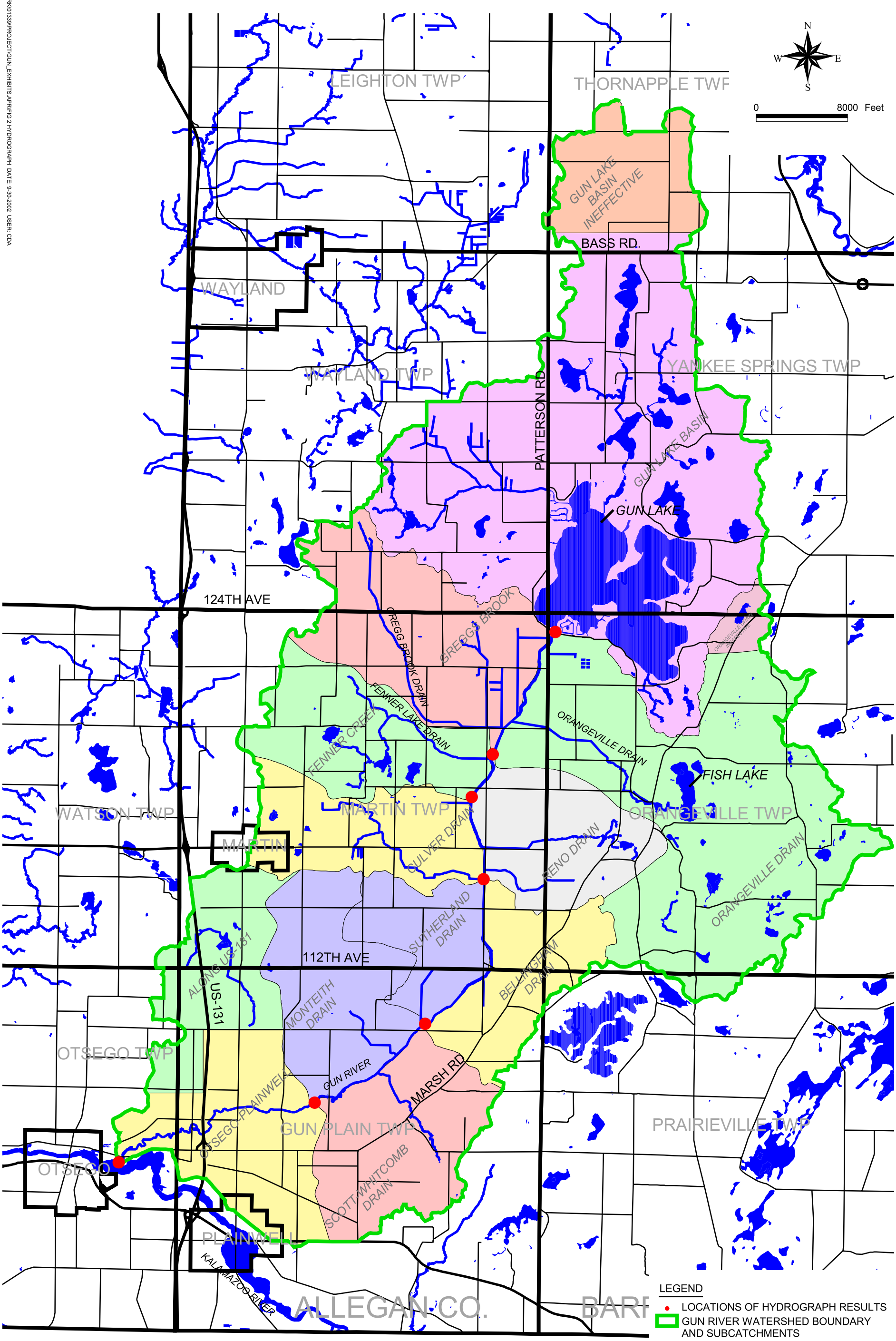
Gun River Watershed Management Plan

Fishbeck, Thompson, Carr & Huber

Engineers • Scientists • Architects

Grand Rapids, Michigan

D:\WORK\01339\PROJECT\GUN_EXHIBITS.APR\FIG 2 HYDROGRAPH DATE: 9-30-2002 USER: CDA



DATA SOURCES: BASE MAP, KALAMAZOO RIVER WATERSHED GIS PROJECT, GIS RESEARCH CENTER WESTERN MICHIGAN UNIVERSITY 1996. MICHIGAN DEPARTMENT OF NATURAL RESOURCES MIRIS, 1978, SPCS NAD 27, US FEET. WATERSHED DELINEATION, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY GIS, DIGITAL SHEDS, 2001.

LOCATIONS OF HYDROGRAPH RESULTS

PROJECT NO. G01339

FIGURE NO. 13

Allegan Conservation District

Allegan County, Michigan

Gun River Watershed Management Plan

Fishbeck, Thompson, Carr & Huber

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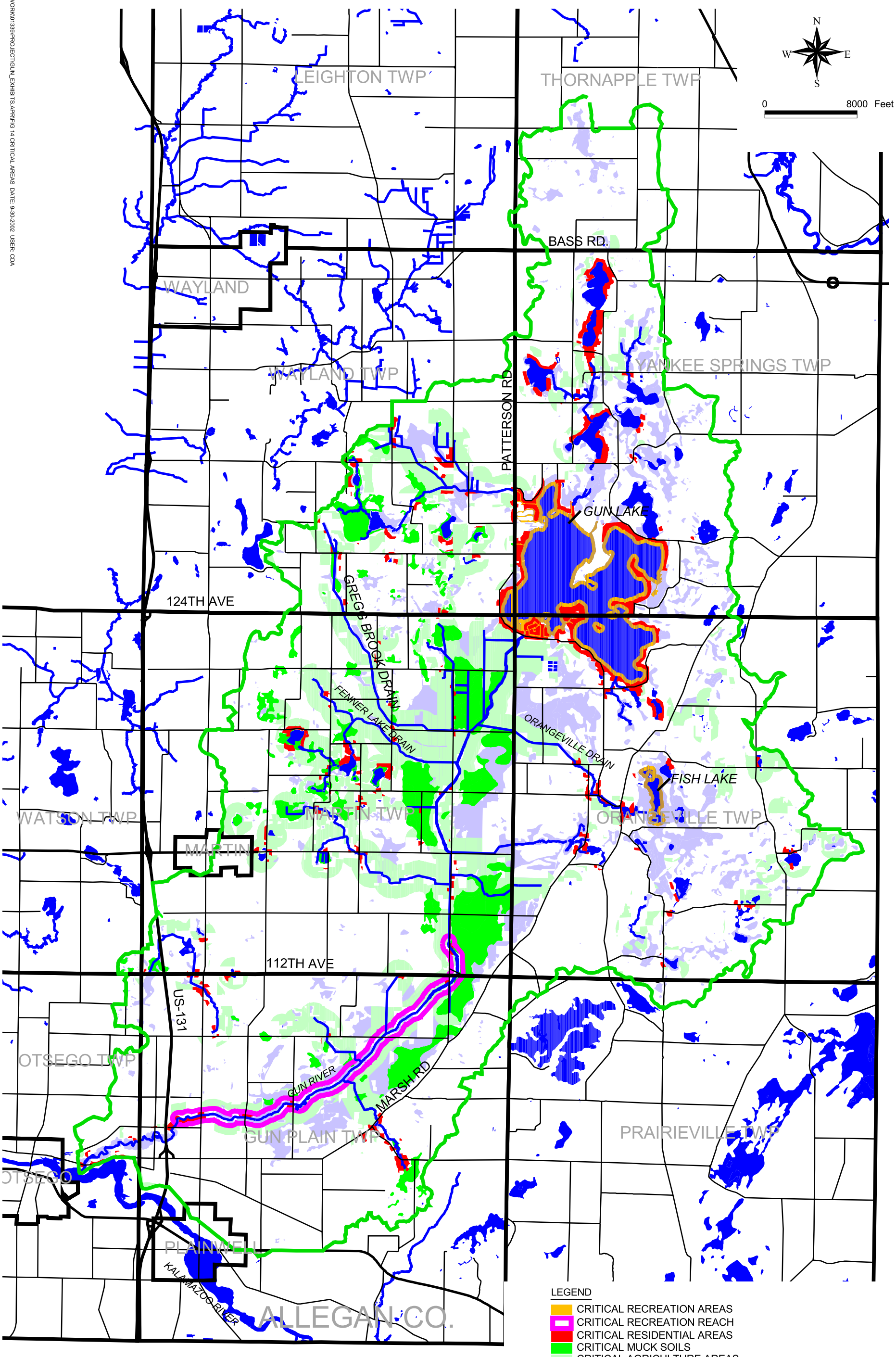
D:\WORK\01339\PROJECT\GUN_EXHIBITS.APR\FIG 14 CRITICAL AREAS DATE: 9-30-2002 USER: CDA



DATA SOURCES: BASE MAP, KALAMAZOO RIVER WATERSHED
GIS PROJECT, GIS RESEARCH CENTER WESTERN MICHIGAN UNIVERSITY 1996.
MICHIGAN DEPARTMENT OF NATURAL RESOURCES MIRIS, 1978, SPCS NAD 27, US FEET.
WATERSHED DELINEATION, MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY GIS, DIGITAL SHEDS, 2001.

CRITICAL AREAS

PROJECT NO. G01339
FIGURE NO. 14

Allegan Conservation District
Allegan County, Michigan

Gun River Watershed Management Plan

Fishbeck, Thompson, Carr & Huber
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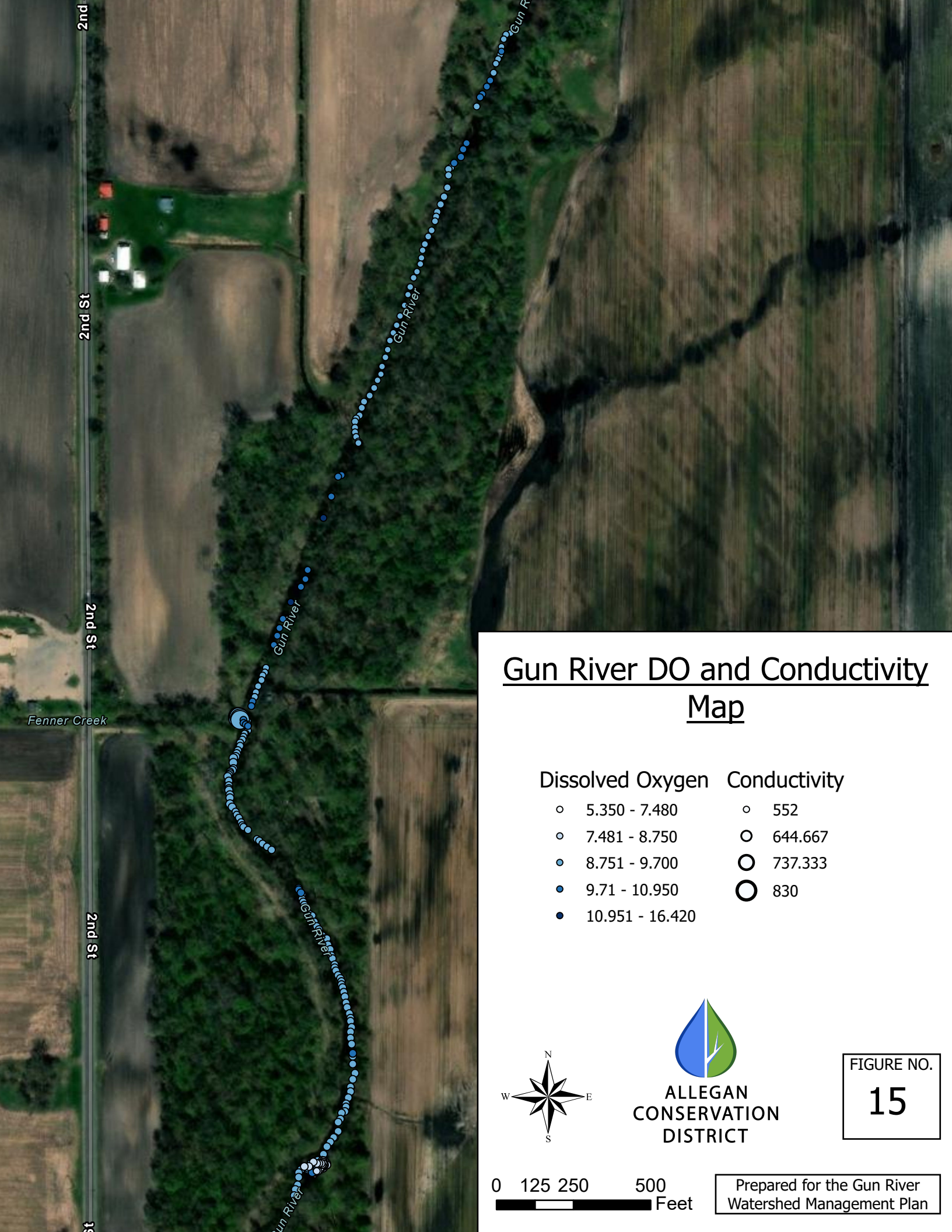

Gun River DO and Conductivity Map

Dissolved Oxygen	Conductivity
5.350 - 7.480	552
7.481 - 8.750	644.667
8.751 - 9.700	737.333
9.71 - 10.950	830
10.951 - 16.420	

N
W E
S

ALLEGAN CONSERVATION DISTRICT

FIGURE NO.
15

0 125 250 500
Feet

Prepared for the Gun River Watershed Management Plan

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Patterson Rd
Yankee Springs
Gun Lake
124th Ave
Greggs Brook Drain
Fenner Lake Drain
Orangeville Drain
Watson
Martin
Fish Lake
Orangeville
112th Ave
Otsego
US-131
Gunplain
Prairieville
Otsego
Plainwell

Field Prioritization for BMPs

Priority
- Low
- Medium
- High

- Gun River and Tributaries
- Lakes
- Watershed Boundary

N
W E
S

0 0.5 1 1.5 2 Miles

Prepared for the Gun River Watershed Management Plan

Field Priority Map

FIGURE NO. 16

ALLEGAN CONSERVATION DISTRICT

Dorr
Leighton
Thornapple
Wayland
Hopkins
Wayland
Yankee Springs
Patterson Rd
Gun Lake
Greggs Brook Drain
124th Ave
Fenner Lake Drain
Orangeville Drain
Fish Lake
Watson
Martin
Orangeville
112th Ave
US-131
Otsego
Gunplain
Prairieville
Otsego
Plainwell

Gun River Watershed Impairments and AFOs

Impaired AUID
Gun River and Tributaries

AFO
- Dairy
- Beef
- Other
- Poultry
- Swine
- Mink
- Hobby

Priority
- 1
- 1.83333
- 2.66667
- 3.5

N W E S

0 0.5 1 1.5 2 Miles

Prepared for the Gun River Watershed Management Plan

Impairments and AFOs Map

FIGURE NO. 17

ALLEGAN CONSERVATION DISTRICT