Manitowoc River Water Quality Evaluation

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Abstract:

A macroinvertebrate investigation of the Manitowoc Drainage Basin indicates overall water quality of the basin is poor. Runoff and other water quality degrading circumstances contribute substantially to the poor quality of the river system. Current agricultural practices allow for excessive runoff of nutrients and sediment.

Introduction

This report identifies general water quality conditions throughout the Manitowoc River Drainage Basin. The primary purpose of the survey was to point out areas in the drainage basin with water quality problems caused by nonpoint sources. The data gathered can be used to direct efforts for future abatement of nonpoint source pollution. In certain instances, the survey may define localized water quality degradation from point sources. This, however, is an indirect product of the survey.

Water quality was determined using macroinvertebrate populations. Hilsenhoff's biotic index system was applied to the macroinvertebrates collected. Results will be used to identify water quality problem areas in the tributaries and streams of the basin.

Forty-seven stations were established and sampled in the Manitowoc River Drainage Basin. The major sampling occurred during the spring of 1979. Additional samples were collected during the fall of 1979 and some stations were sampled twice, spring and fall of 1979. The macroinvertebrate data in this report is a combination of several separate ongoing projects within the drainage basin.

Methods and Materials

Site Selection

The drainage basin was reviewed to determine the number of significant tributaries or branches to the mainstem of the Manitowoc River. Stations were selected at crossroads for ease of access. The number of stations per tributary or branch was determined by the length of the stream. A long tributary may have several stations located along its reach while a short tributary may have only one station near its mouth. The stations were located along the tributary to reflect the water quality of the tributary. Combining the results of the separate tributaries provided an overall water quality evaluation of the entire river system.

Site selection at the station was mostly limited to acceptable riffle areas. If a station did not have good riffle areas, the station was moved upstream or downstream when conditions permitted. When conditions did not permit moving of the station, vegetation and debris were sampled.

Sampling Procedure

Each station was perused to determine the best area to obtain an acceptable sample. Good riffle areas with fast moving water upstream from the road crossing were first choice to eliminate any influence from the crossing. Other areas were selected when good riffle areas could not readily be found.

The sampling procedure utilized a D-Frame aquatic net. The D-Frame aquatic net was held against the substrate. The substrate was disturbed with one's feet directly above the D-Frame net. The dislodged insects were allowed to drift into the net held downstream. Sampling continued until more than 100 insects greater than 3 mm long were caught in the net. The insects and debris collected in the net were then transferred to a jar containing 95% alcohol. Vegetation and debris samples were hand washed in the D-Frame net until adequate numbers were reached. These samples were also placed in alcohol. All samples collected were returned to the lab for later sorting and identification.

Sampling Sorting and Identification

Random picking of the macroinvertebrates from debris was done with a grid system. The sample was first rinsed with clean water and placed in a 7" x 12" glass tray set over a one inch numbered grid system. Sufficient water was added to cover debris, insects, and to facilitate even dispersal of the sample. Grid numbers were selected at random. All insects greater than 3 mm were picked from the consecutive numbered grids until 100 to 125 insects were obtained. Picking ceased at that point and the insects were placed in 70% alcohol for later identification. Standard identification procedures were followed. The Chironomid group were dehydrated through xylene and the heads were mounted on microscope slides with Permount. The macroinvertebrates were then tabulated and Hilsenhoff's Biotic Index applied.

Hilsenhoff's Biotic Index was calculated by using the formula:

$$B.I = \frac{\sum n_j a_j}{N}$$

where n_j is the number of each species, a_j is the value for that species (Appendix I), and N is the total number of arthropods in the sample (usually 100).

Water Quality Determination from Biotic Index Values

Biotic Index	Water Quality	State of the Stream
1.75	Excellent	Clean undisturbed.
1.75-2.25	Good	Some enrichment or disturbance.
2.25-3.00	Fair	Moderate enrichment or disturbance.
3.00-3.75	Poor	Significant enrichment or disturbance.
3.75	Very Poor	Gross enrichment or disturbance.

Results and Discussion

Water quality in the Manitowoc River Basin varies from water course to water course. Some stream reaches were found to have minimal water quality problems while others had severe water quality problems. Major tributaries to the Manitowoc River are Branch River, St. Nazianz tributary, Mud Creek, North Branch of the Manitowoc River, South Branch Manitowoc River, Killsnake and Pine River. Minor tributaries are Schisel Creek, and an unnamed tributary in the Town of Rockland. The Little Manitowoc River, Silver Creek, Calvin Creek, Pine Creek, Point Creek, Fischer Creek and Centerville Creek flow directly into Lake Michigan.

The general water quality of Manitowoc River Basin is fair to poor. The Biotic Index values indicate fair water quality on the mainstem from the mouth upstream to about the Clarks Mills area. Above the Clarks Mills area poorer water quality conditions prevail in the mainstem, major tributaries and both the South and North Branches of the Manitowoc River.

The Branch River has good water quality in the lower half of the stream. Continuing upstream on the Branch River toward the headwaters, water quality decreases to poor conditions. This may be attributed to agricultural practices. Farming in the headwaters is closer to the streams allowing for more rapid runoff. The lower portion of the watershed has more woods and fallow buffering areas along the stream.

Schisel Creek exhibits somewhat different conditions. The central portion of the small watershed has poor water quality while the headwaters and the part of the watershed near the mouth has good to excellent water quality.

Station 23, a small tributary to the Manitowoc River in the Town of Rockland had poor water quality conditions. The sampling location and substrate provided adequate conditions, however, at another time, the stream was noted to have no flow. The poor water quality indicated could be caused by low flow conditions.

The sample at Station 20 was collected below the effluent of the Valders wastewater treatment works. The index value obtained for that station most likely reflects the point source. The St. Nazianz tributary likewise reflects the point source input from the St. Nazianz wastewater treatment works. Hills Creek, a tributary to the St. Nazianz tributary has fair water quality. Fair or good water quality should prevail in St. Nazianz tributary. The lower part of the watershed is unsuitable for sampling due to slow moving water and lack of any suitable riffle areas.

The water quality of Mud Creek is poor to very poor. The lower 1/3 of the watershed is affected by Collins Marsh. The direct water quality effect of the marsh on Mud Creek is unknown. Winter odor problems from the marsh and complete dissolved oxygen depletions have occurred. Water quality conditions on the upper 2/3 of the stream are poor. Station 22 indicates the upper 1/3 is very poor water quality. However, due to noted times of no flow in that area, it is uncertain if the index value accurately reflects the true water quality conditions or maybe reflecting low flow conditions.

The North Branch of the Manitowoc River is a slow sluggish stream originating most of its flow in the Brillion Marsh. Lacking adequate riffle areas, water quality assessment using macroinvertebrates is difficult. The samples that were collected reflect the point source impacts or are affected by low flow conditions or the beginning of the Brillion Marsh.

The South Branch of the Manitowoc River has poor water quality conditions. The upper one half of the Killsnake River has good water quality with poor quality in the lower half. Above Chilton, the water quality is poor. Station 7 has very poor conditions, however, the sampling station did not provide a good riffle area. The very poor water quality conditions related may be due to poor sampling conditions.

The headwaters of the Pine River have fair water quality except for Jordon Creek which has two point sources discharging to it. The index value obtained from Station 14 may reflect low flow conditions since it was noted at various times that the stream had no flow. The lower half of the watershed has poor water quality.

The streams tributary to Lake Michigan were also included in the Manitowoc Basin water quality assessment. Generally, the water quality of these streams is poor. Calvin Creek, Point Creek, and Fischer Creek had index values indicating very poor conditions. Silver Creek had poor water quality while Pine and Centerville Creeks have fair water quality.

Poor water quality generally prevails throughout the Manitowoc River system. In most cases, the headwater receiving streams are degraded by runoff. Problem watershed areas are Mud Creek, upper one half of Branch River, North and South Branch of the Manitowoc River, lower one half of the Pine River and the St. Nazianz tributary. The tributary streams to Lake Michigan basically drain all the area east of State Highway "42". Generally poor water quality caused by nonpoint sources indicate corrective action is needed in this portion of the basin.

Table 1 is the Biotic Index Values for each station. The index values found in parenthesis are samples collected in the fall of 1979. Table 2 provides the macroinvertebrate found at each station and Table 3 contains pertinent sampling station information. Table 4 are maps locating the stations sampled.

It should be noted that as this report is being written, the index values for each macroinvertebrate is being reassessed. Assigned individual numbers by Dr. William Hilsenhoff may be changed, however, it is my opinion that general overall reassignment in water quality interpretations within the Manitowoc drainage basin will not readily change. If the change in index value would cause a change in the Biotic Index Value I believe the change would tend to indicate poorer water quality conditions.

Table 1. Biotic Index Values

Station No.	River	Biotic Ind. Value	Excellent 1.75	Good 1.75-2.25	Fair 2.25-3.00	Poor 3.00-3.75	Very Poor 3.75	Water Qual. Biotic Ind.
1	Manitowoc River	2.33 (3.69)*			X			
2	Manitowoc River	2.19 (2.36)		X				
3	Manitowoc River	3.88 (3.33)					X	
4	Manitowoc River	3.19 (3.67)				X		
5	S. Br. Manitowoc R.	2.89			X			
6	S. Br. Manitowoc R.	3.69				X		
7	S. Br. Manitowoc R.	4.01					X	
15	Killsnake River	3.60				X		
16	Killsnake River	2.09			X			
9	Pine River	3.05				X		
10	Pine River	2.92			X			
11	Pine River	2.79			X			
12	Trib. to Pine R.	2.58			X			
12A	Trib. to Pine R.	3.63				X		
13	Trib. to Pine R.	3.47				X		
14	Trib. to Pine R.	4.65					X	
8	Stoney Brook	2.84			X			
17	Trib. to N. Br. Manitowoc River	2.51			X			
18	Trib. to N. Br. Manitowoc River	4.43					X	
40	Spring Creek	4.00					X	
41	Spring Creek	2.80			X			
32	Little Manitowoc R.	2.60 (2.97)			X			
27	Branch River	1.98		X				
28	Branch River	2.22		X				
29	Branch River	2.66			X			
30	Branch River	2.93			X			
31	Branch River	3.23				X		
24	Schisel Creek	1.62 (2.07)	X					
25	Schisel Creek	3.26 (2.79)				X		
26	Schisel Creek	2.26 (2.54)			X			
23	Unnamed Tributary	3.62 (3.20)				X		
20	Valders Tributary	3.42 (3.64)				X		
19	Hill Creek	2.55 (2.35)			X			
19A	St. Nazianz Trib.	4.91					X	
19B	St. Nazianz Trib.	2.50			X			
21	Mud Creek	3.93 (3.51)					X	
21A	Mud Creek	3.34				X		
21B	Mud Creek	2.50			X			
21C	Mud Creek	3.95					X	
22	Mud Creek	4.47					X	
Tributaries to Lake Michigan								
34	Silver Creek	LOST						
33	Silver Creek	3.71 (4.15)				X		
35	Calvin Creek	3.94 (3.61)					X	
36	Pine Creek	2.80 (3.02)			X			
37	Point Creek	4.00 (3.02)					X	
38	Fischer Creek	4.28 (3.71)					X	
39	Centerville Creek	2.95 (3.24)			X			

* Index values in parenthesis are from samples collected in the fall of 1979.

Table 2. Macroinvertebrate at Each Station

Species	Site No.	1	2	3	4	5	6	7	8	9	10	11	12	12A	13	14	15	16	17	18	19	19A	19B	20
Ephemeroptera																								
Baetidae:																								
Baetis levitans 2			54																					
B. phoebus 2		25		4									1											
B. pygamaeus 3		5																						
Pseudocloeon (all) 2		20																						
Caenidae:																								
Caenis spp. (do not include)				3	27	3	1											3						
Ephemerellidae:																								
Serretta deficiens		2																						
Heptageniidae:																								
Heptagenia hebe 0			2																					
Stenacron interpunctatum 3			1			52	47		45	52	6	55		1			17							
Stenonema bipunctatum 1		1																						
S. terminatum 2		3																						
Leptophlebiidae:																								
Paraleptophlebia spp. 1																							1	
Odonata																								
Calopterygidae:																								
Calopteryx (all) 1														1										
Coenagrionidae:																								
Enallagma spp. 4				1	8																			
Lestidae:																								
Lestes (all) 3				1	8																			
Trichoptera																								
Brachycentridae:																								
Micrasema (all) 0												1												
Helicopsychidae:																								
Helicopsyche borealis 1			1																					
Hydropsychidae																								
Cheumatopsyche spp. (do not include)		2	9			14	1		25	3	26	15	30	9	22		4							
Hydropsyche bifida group (do not include)		5				11			11	3	56	2	44	7										
H. cuanis 3														15										
Hydropsyche															12									
Hydropsyche demora			7																					
Hydroptilidae:																								
Hydroptila spp. 3			1																					
Orthotrichia			2																					

Species	Site No.	1	2	3	4	5	6	7	8	9	10	11	12	12A	13	14	15	16	17	18	19	19A	19B	20
Leptoceridae:																								
Oecetis (all) 2																					1			
Limnephilidae:																								
Neophylax spp. 1												3												
Pycnopsyche spp. 2											1													
Philopotamidae:																								
Chimarra			1																					
Psychomyiidae:																								
Psychomyia flavida 2						1																		
Pyralidae:																								
Nymphula spp. 1					1																			
Dytiscidae:																								
Agabus larvae (all) 1																							3	
Hygrotus																				3				
Laccophilus																				1				
Elmidae:																								
Dubiraphia quadrinotata 3																					1			
Dubiraphia larvae 3																								1
Macronychus glabratus 2						8			1	2	1						11							
Optioservus fastiditus 2			1																					
Optioservus larvae 2			1																		14			
Stenelmis larvae 3		6	12																		1			
Psephenidae:																								
Ectopria spp. 2											1													
Psephenus herricki 2			8																					
Diptera																								
Ceratopogonidae:																								
Palpomyia spp. 3					2										1									
Pupae unidentifiable						4																		
Unkeyable							3																	
Chironomidae:																								
Ablabesmyia spp. 3							1						8		10	9		1						
Cardiocladius spp. 4						1																		
Chironomus spp. 5		1			1														9	4	4	136	3	
Conchapelopia spp. 4					5																3			17
Cricotopus spp. 4			2	2							2			44										
Cryptochironomus spp. 3																							1	
Culicidae																								1
Diamesa spp. 2		2																					1	
Diplocladius									1															
Endochironomus spp. 2		2																						
Eukiefferiella spp. 2						1															34		1	9

Species	Site No.	1	2	3	4	5	6	7	8	9	10	11	12	12A	13	14	15	16	17	18	19	19A	19B	20
Chironomidae Continued:																								
Micropsectra spp. 0																			17	1		1		1
Microtendipes spp. 2		1							1												4			
Orthocladius spp. 4		5	1					1			1					1	1		12		8		3	40
Paratendipes spp. 2							1																	
Paratanytarsus spp. 2		1			9						1									5	1			
Pentaneurini Tribe						1				8														
Phaenopsectra spp. 1									1															
Plecopteracoluthus spp. 1					1																			
Polypedilum spp. 3		5	4																					
Procladius												1								8				
Pseudosmith										2														
Rheocricotopus spp. 1																						2		
Rheotanytarsus spp. 0													4											
Stictochironomus spp. 1																				11				
Tanypus														1										
Zavrelimyia spp. 4																							1	
Zalutschia																			14					
Empididae:																								
(All species) 4						2			1	1					7		1							
Ephydridae:																								
(All species) 4																							4	
Muscidae:																								
Limnophora spp. 0													1		2	2								
Simuliidae:																								
Simulium jenningsi 2		5							3			1						93			11			12
S. tuberosum 2																					8			9
S. venustum 3						11																		
S. vittatum 4				58									6				64				8			23
Stratiomyidae																								
Odontomyia					1																			
Tabanidae:																								
Chrysops spp. 2		1										1			15						1		1	
Tabanus spp. 2													1	1										
Pupa unidentifiable														23										
Tipulidae:																								
Antocha spp. 2									2			1												
Helius													1											
Hexatoma spp. 3		1	1																					
Tipula spp. 2									1			1	1	1	3	1								
Unidentifiable												1												

Species	Site No.	1	2	3	4	5	6	7	8	9	10	11	12	12A	13	14	15	16	17	18	19	19A	19B	20
Hemiptera																								
Corixidae																3								
Amphipoda																								
Gammaridae:																								
Crangonyx gracilis	4						1																	
Gammarus pseudolimneus	2								4			20											25	
Talitridae:																								
Hyallela azteca	4	1			3		14	98	3								1	1			2			
Isopoda																								
Assellidae:																								
Asellus intermedius	5			1			29	1		2		6	1		23	78	1	2	1	92				

Species	Site No.	21	21A	21B	21C	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Plecoptera																									
Perlidae:																									
Neoperla																									
Paragnetina media 1														1	1										
Phasganophora capitata 0						1					1														
Perlodidae:																									
Isoperla (all) 0									1					1									2		
Ephemeroptera																									
Baetidae:																									
Baetis brunneicolor 2					1						1			8	6										
B. frondalis 2											26														
B. levitans 2											1														
B. phoebus 2											2	73		3											
B. pygamaeus 3											3	8	10												
B. vagans 1			1	3	3									8											
Baetis spp. unidentifiable		1											4	3	4									1	
Callibaetis spp. 3																									
Caenidae:																									
Caenis spp. (do not include)												1	45			10	2				1				
Ephemerellidae:																									
Serretta deficiens											13	2													
Ephemeridae:																									
Ephemera simulans 1											2														
Heptageniidae:																									
Stenacron interpunctatum 3		31	3	15			3				5	14	1			1	10				10				3
Stenonema fuscum 1												3											2		
S. rubrum 0											1														
S. tripunctatum 1											5														
Leptophlebiidae:																									
Paraleptophlebia spp. 1						2																			
Siphlonuridae:																									
Isonychia spp. 2											1														
Odonata																									
Aeshnidae:																									
Anax																								2	
Coenagrionidae:																									
Chromagrion conditum 3													3												
Coenagrion														3											
Enallagma spp. 4		4	1		1																				
Ischnura verticalis 4																									

Species	Site No.	21	21A	21B	21C	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Lestidae:																									
Lestes (all) 3		5																							
Trichoptera																									
Brachycentridae:																									
Micrasema (all) 0														11	4										
Helicopsychidae:																									
Helicopsyche borealis 1								1			3														
Hydropsychidae																									
Cheumatopsyche spp. (do not include)				47	19			48	24	21	1			3	2	4	15		34	39	4	1	13		8
Hydropsyche betteni 3									7											1		1			
H. bifida group (do not include)				2							6	2	1												
H. morosa 1												1	8												
Symphitopsyche riola									3																
S. slossonae 2																11			4	7	7		15		
S. sparna 1																			1	2					
Hydroptilidae:																									
Hydroptila spp. 3																2									
Ochrotrichia spp. 2											1														
Leptoceridae:																									
Nectopsyche (all) 2													1												
Limnephilidae:																									
Limnephilus spp. 2										1															
Neophylax spp. 1								10	7	6												4			
Platycentropus spp. 2														1											
Pycnopsyche spp. 2								3					2										1		
Philopotamidae:																									
Chimarra obscura 2											1														
Dryopidae:																									
Helichus (all) 2																			1						
Dytiscidae:																									
Agabus larvae (all) 1															2										
Agabus					1																				
Elmidae:																									
D. vittata 3		1																							
Dubiraphia larvae 3																									2
Macronychus glabratus 2																									1
Optioservus fastiditus 2																21	4		4	12	5	8	7		
Optioservus 2											18	7													
Optioservus larvae 2								4	8							30	1		15	9	1	4	22		
Stemelmis crenata 3									1							2				1					
Stenelmis larvae 3									11												2				

Species	Site No.	21	21A	21B	21C	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Gyrinidae:																									
Gyrinus 2															6										
Hydrophilidae:																									
Tropisternus															1										
Psephenidae:																									
Psephenus herricki 2											7	3													
Diptera																									
Athericidae:																									
Atherix variegata 2											1														
Ceratopogonidae:																									
Palpomyia spp. 3					1										3										
Chironomidae:																									
Ablabesmyia spp. 3			1	4	4							2	11		9										14
Brillia spp. 3								1									1		1	5					
Chaetocladius										2									1						
Chironomus spp. 5			6		23																				15
Conchapelopia spp. 4							2		1							1	1					1			
Cricotopus spp. 4		1				2				22						2	1								
Cryptochironomus spp. 3										1			1							1					
Diamesa spp. 2											2														
Dicrotendipes spp. 3										26															
Endochironomus spp. 2			3																						
Eukiefferiella spp. 2						1	24										11		3	7	1		2		
Glyptotendipes spp. 5					1						1		1	2											
Micropsectra spp. 0								5		12											1				
Microtendipes spp. 2					1								2				7		4	5					
Orthocladius spp. 4		1		6	1	2	21			1		2	1			1	3			6	1				8
Paratanytarsus spp. 2																	1			2	1				
Polypedilum spp. 3												1	1	1											
Procladius								1																	
Rheotanytarsus spp. 0														1	1										7
Stictochironomus spp. 1			10	19																	5	8			14
Trissocladius										10															
Zavrelimyia spp. 4							2									1									
Unidentifiable				2	1																				
Muscidae:												2													
Limnophora spp. 0				1																					2
Simuliidae:																									
Eusimulium latipes 0						5																			
Prosimulium gibsoni (all) 0										3															
Simulium tuberosum 2									3																
S. verecundum						3		1	7							1									
S. vittatum 4				5			63		54				1	59	44		7						1		

Species	Site No.	21	21A	21B	21C	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Stratiomyidae																									
Odontomyia							1																		
Tabanidae:																									
Chrysops spp. 2								1					2	3											
Tabanus spp. 2															31										
Tipulidae:																									
Antocha spp. 2											7														
Hexatoma spp. 3								1																	
Pilaria				1				2							1										
Tipula spp. 2								2														2			10
Amphipoda																									
Gammaridae:																									
Gammarus pseudolimneus 2						1		7	2					1		2									
Talitridae:																									
Hyallela azteca 4		92	8	9	20	1	2							1	9										11
Isopoda																									
Assellidae:																									
Asellus intermedius 5			15	2	9	85	3		1				1			12	35		62	13	61	102	26		

Fall Macroinvertebrate Sampling

Species / Site No.	1	2	3	4	19	20	21	23	24	25	26	32	33	35	36	37	38	39
Ephemeroptera																		
Baetidae:																		
Baetis brunneicolor 2					13								1				1	
B. intercalaris 3				4														
B. phoebus 2		4	3		9								1					
B. pygamaeus 3	1																	
Callibaetis spp. 3							8											
Caenidae:																		
Caenis spp. (do not include)				27		2										11		
Ephemerellidae:																		
Serretta deficiens		7																
Ephemeridae:																		
Hexagenia (all) 1	1																	
Heptageniidae:																		
Stenacron interpunctatum 3	4	5	12						2	5			11	5		20	23	
Stenonema fuscum 1																	2	
S. terminatum 2	2																	
Leptophlebiidae:																		
Leptophlebia spp. 3	4				1													
Potamanthidae:																		
Potamanthus (all) 2	2																	
Siphlonuridae:																		
Isonychia spp. 2		1																
Odonata																		
Coenagrionidae:																		
Argia moesta 2	2																	
Enallagma spp. 4				23														
Ischnura verticalis 4						10	17											
Trichoptera																		
Hydropsychidae																		
Cheumatopsyche spp. (do not include)	1	33	37		26	1			65	26	57	16	21	36	30	1	27	27
Hydropsyche betteni 3					8					4	6	1	3					
H. bifida group (do not include)		6	6					1										
H. dicantha 2									1									
H. Morosa 1		6	4															
H. slossonae 2												60	1	3	18	4		
H. sparna 1													1					
Hydropsyche demora		11	1															

Species	Site No.	1	2	3	4	19	20	21	23	24	25	26	32	33	35	36	37	38	39
Limnephilidae:																			
Pycnopsyche spp. 2								1		1	1	1							
Philopotamidae:																			
C. obscura 2			14																
Phryganeidae:																			
Ptilostomis spp. 2																	1		
Polycentropodidae:																			
Nyctiophylax sp. A 0		1																	
Polycentropus cinereus 0		1																	
Psychomyiidae:																			
Psychomyia flavida 2		1																	
Megaloptera																			
Corydalidae:																			
Sialis Spp.		2																	
Pyralidae:																			
Paragyrachs		1																	
Coleoptera																			
Elmidae:																			
Dubiraphia minima 3								1											
D. quadrinotata 3												1							
D. vittata 3			1					1									1		
Dubiraphia larvae 3					6							7					1		
Optioservus fastiditus 2						7				1					2		1	1	4
Optioservus larvae 2						29				40	5	5	3	9	29	33	1	25	18
Stemelmis crenata 3			1																
Stenelmis larvae 3		3	12							2	40		1				1		
Helophorus A							1												
Diptera																			
Athericidae:																			
Atherix variegata 2																		1	
Ceratopogonidae:																			
Culicoides spp.																	1		
Chironomidae:																			
Brillia spp. 3																7			
Chaetocladius															1	1			
Chironomus spp. 5		28			13									1			1		
Clinotanypus spp. 2												1							
Conchapelopia spp. 4		2	1	1			86	1	4	1		1					4		3
Corynoneura								21											
Cricotopus spp. 4			2	2	1			2											
Cryptochironomus spp. 3		2																	
Dicrotendipes spp. 3					13		2	2											

Species	Site No.	1	2	3	4	19	20	21	23	24	25	26	32	33	35	36	37	38	39
Chironomidae Cont'd:																			
Endochironomus spp. 2								15											
Eukiefferiella spp. 2								1											
Glyptotendipes spp. 5								1											
Micropsectra spp. 0					2		9		40					2		3			3
Microtendipes spp. 2		2	1				1		1					1			9		5
Parametriocnemus spp. 3																		1	
Paratanytarsus spp. 2							3									1	4		
Polypedilum spp. 3			1					2											
Procladius					5														
Stictochironomus spp. 1																	35	1	3
Zavrelimyia spp. 4								1											
Culicidae																			
Chaoborus							2												
Dixidae:																			
Dixella spp. 2								4											
Simuliidae:																			
Simulium vittatum 4		1		23		19										2			
Tipulidae:																			
Antocha spp. 2			1																
Dicranota spp. 0										1					3				1
Pilaria																	1		
Pseudolimnophila spp. 0									1										
Tipula spp. 2																		1	3
Limnophila spp.																		1	
Hemiptera																			
Corixidae																	19		
Amphipoda																			
Gammaridae:																			
Gammarus pseudolimneus 2			1		1					18	13	25	3						13
Talitridae:																			
Hyallela azteca 4			1		2	3		56					13						
Isopoda																			
Assellidae:																			
Asellus intermedius 5					2		3		72		2	4	25	64	45	30	42	52	39

Table 3. Macroinvertebrate Station Data

Sample Number	Stream	Station Location	Date	Substrate	Stream Char. (Ft.) Width - Depth	Current	Sampled Structure
1	Manitowoc	Co. Tr. "JJ"	5/22/79 10/23/79	Rock, Gravel, Sand	75 1-4	Fast	Riffle
2	Manitowoc	Co. Tr. "H"	5/22/79 10/23/79	Rock, Gravel	120 1-2	Fast	Riffle
3	Manitowoc	Clarks Mills Sportsman Club	5/22/79 10/7/79	Bedrock	75 1-3	Fast	Riffle
4	Manitowoc	Quarry Road	5/23/79 10/17/79	Silt	100 5-6	Slow	Vegetation
5	S.Br. Manitowoc	Irish Road	5/7/79	Rock, Sand	30 1-3	Fast	Riffle
6	S.Br. Manitowoc	Harlow Road	5/7/79	Rock, Gravel, Silt	20 3-4	Moderate	Deep Run
7	S.Br. Manitowoc	Co. Tr. "H"	5/7/79	Gravel, Silt	20 3-4	Moderate	Deep Run
8	Stoney Brook	Stoney Brook Rd.	5/7/79	Rock, Sand	10 1-2	Fast	Riffle
9	Pine Creek	Honeymoon Hill Rd.	5/7/79	Rock, Sand	20 2	Moderate	Riffle
10	Trib. to Pine Creek	Megger Road	5/7/79	Rock, Gravel, Sand	8 2	Fast	Riffle
11	Jordan Creek	Tecumseh Road	5/7/79	Rock, Gravel, Sand	6 1	Moderate	Riffle
12	Jordan Creek	Megger Road	10/25/79	Rock, Gravel	3 0.5	Fast	Riffle
12A	Jordan Creek	Megger Road	5/7/79	Rock, Sand	4 1	Fast	Riffle
13	Jordan Creek	Tecumseh Road	10/25/79	Rock, Gravel, Sand, Silt	3 0.5	Fast	Riffle
14	Jordan Creek	Farm Bridge Below STP	10/25/79	Gravel, Silt	2 0.5	Mod.-Fast	Riffle
15	Killsnake	Co. Tr. "Y"	5/7/79	Rock, Sand, Silt	8 2-4	Moderate	Deep Run
16	Killsnake	Killsnake Road	5/7/79	Rock, Sand, Silt	10 2	Fast-Mod.	Riffle
17	Trib. to N. Br. Manitowoc	Below Hilbert Lagoons	6/4/79	Sludge	2 0.5	Slow	Run
18	Trib. to N. Br. Manitowoc	Above Hilbert STP	6/4/79	Rock, Gravel, Silt	2-3 0.5	Very Slow	Pool
19	Hills Creek	Co. Tr. "A"	4/24/79 10/17/79	Rock, Gravel	6 2	Fast	Deep Run
19A	St. Nazianz Tributary	Baer Road	6/4/79	Rock, Silt, Sludge	2-3 0.5-2	Fast	Run
19B	St. Nazianz Tributary	Above St. Nazianz STP	6/4/79	Gravel, Silt	2-3 0.5	Slow	Run
20	Valders Creek	Washington St.	5/1/79 10/17/79	Rock, Gravel, Sand	4 1	Fast	Riffle
21	Mud Creek	Hilltop Road	5/22/79 10/17/79	Silt, Mud	25 2+	Slow	Vegetation
21A	Mud Creek	W. Goodwin Road	10/25/79	Rock, Gravel, Silt	10 1-2	Slow	Run
21B	Mud Creek	Below Reedsville STP	10/25/79	Rock, Gravel, Sand, Silt	5 1	Moderate	Riffle
21C	Mud Creek	Above Reedsville STP	10/25/79	Rock, Gravel, Sand, Silt	5 1	Moderate	Riffle
22	Mud Creek	Reif's Mill Road	5/22/79	Gravel, Silt	5 2	Moderate	Riffle
23	Trib. to Manitowoc	Clarks Mills Road	5/1/79 10/17/79	Rock, Gravel	7 1	Fast	Riffle
24	Schisel Creek	Near Mouth	5/2/79 10/23/79	Rock, Gravel, Sand	7 1	Moderate	Riffle
25	Schisel Creek	Morgan Road	5/2/79 10/25/79	Rock, Gravel, Sand	6 1	Fast	Riffle
26	Schisel Creek	Co. Tr. "S"	5/2/79 10/23/79	Gravel, Sand	5 1	Moderate	Riffle
27	Branch	Union Road	5/22/79	Rock, Gravel	20 1-2	Fast	Riffle
28	Branch	Co. Tr. "H"	5/23/79	Rock, Gravel, Sand	25 1-2	Fast to Mod.	Riffle
29	Branch	Co. Tr. "A"	5/23/79	Rock, Pea Grav., Sand, Silt	25 1-3	Moderate	Riffle
30	Branch	Grimms Road	5/22/79	Sand, Silt	6 2-3	Moderate	Sand & Veg. Wash
31	Branch	County Line Road	5/22/79	Silt	15 1-3	Slow	Debris & Veg
32	Little Manitowoc	Co. Tr. "B"	5/22/79 10/23/79	Rock, Sand, Silt	15 0.5-2	Fast	Riffle

33	Silver Creek	Silver Cr. Road	4/24/79 11/14/79	Rock, Grav.,Sand	14	0.5-2	Fast	Riffle
34	Silver Creek	U.S. "151"	4/24/79	S A M P L E L O S T				
35	Calvin Creek	Co. Tr. "LS"	4/24/79 11/14/79	Rock, Gravel, Sand, Clay	8	0.5-1	Fast	Riffle
36	Pine Creek	Co. Tr. "LS"	4/24/79 11/14/79	Rock, Sand, Silt, Clay	10	1-3	Fast	Riffle
37	Point Creek	Co. Tr. "LS"	4/24/79 11/14/79	Rock, Sand, Gravel, Clay	10	1-3	Fast	Riffle
38	Fischer Creek	Centerville Rd.	4/24/79 11/14/79	Rock, Grav.,Sand	8	1-2	Fast	Riffle
39	Centerville Creek	North Av. Rd.	4/24/79 11/14/79	Rock, Gravel, Sand, Silt	12	0.5-2	Mod.-Fast	Riffle
40	Spring Creek	Sunset Road	10/24/79	Muck	20	5	None	Vegetation
41	Spring Creek	Co. Tr. "PP"	10/25/79	Gravel, Sand, Silt	4	0.5-1	Mod.-Fast	Riffle

Table 4. Station Locations

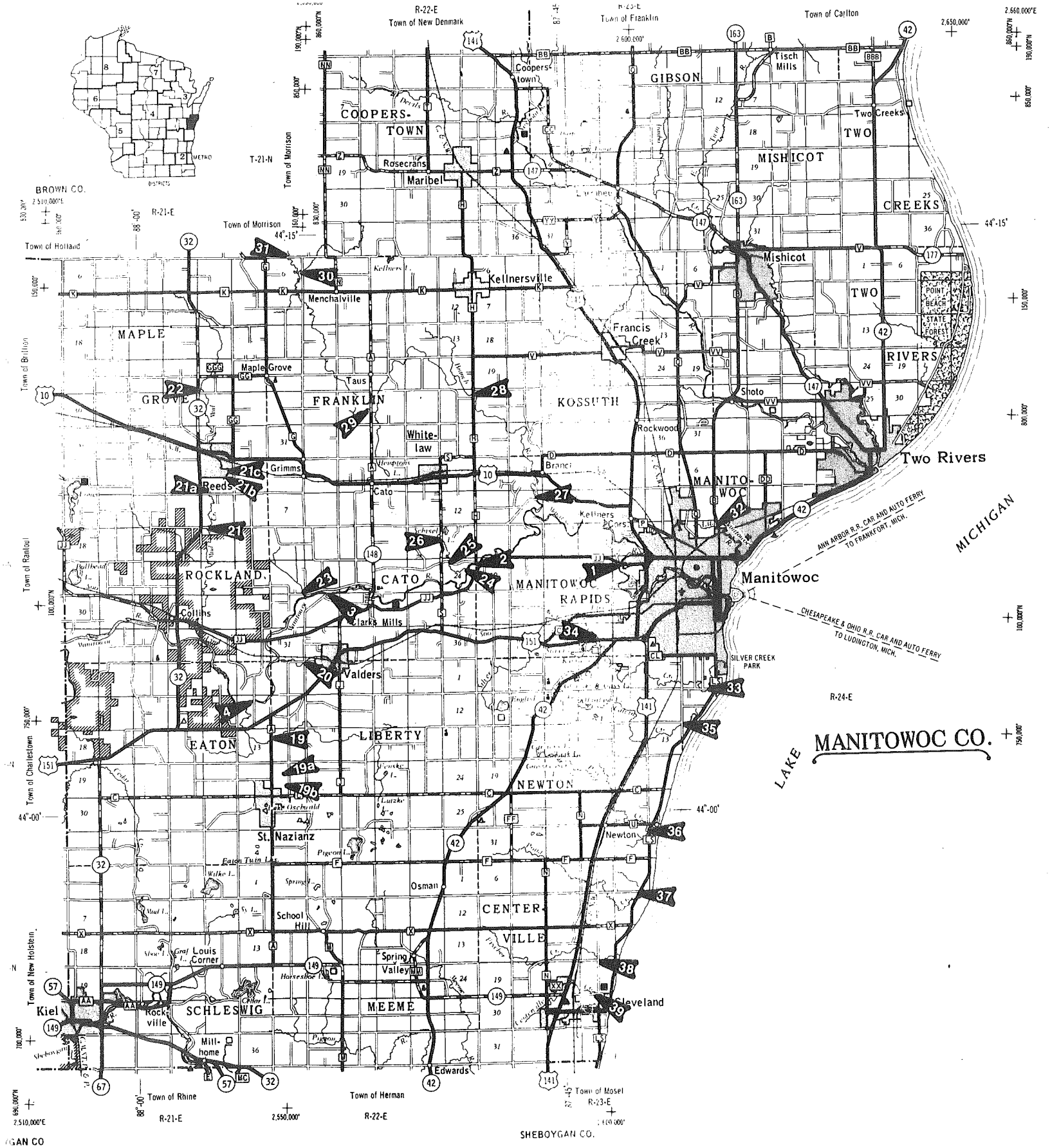
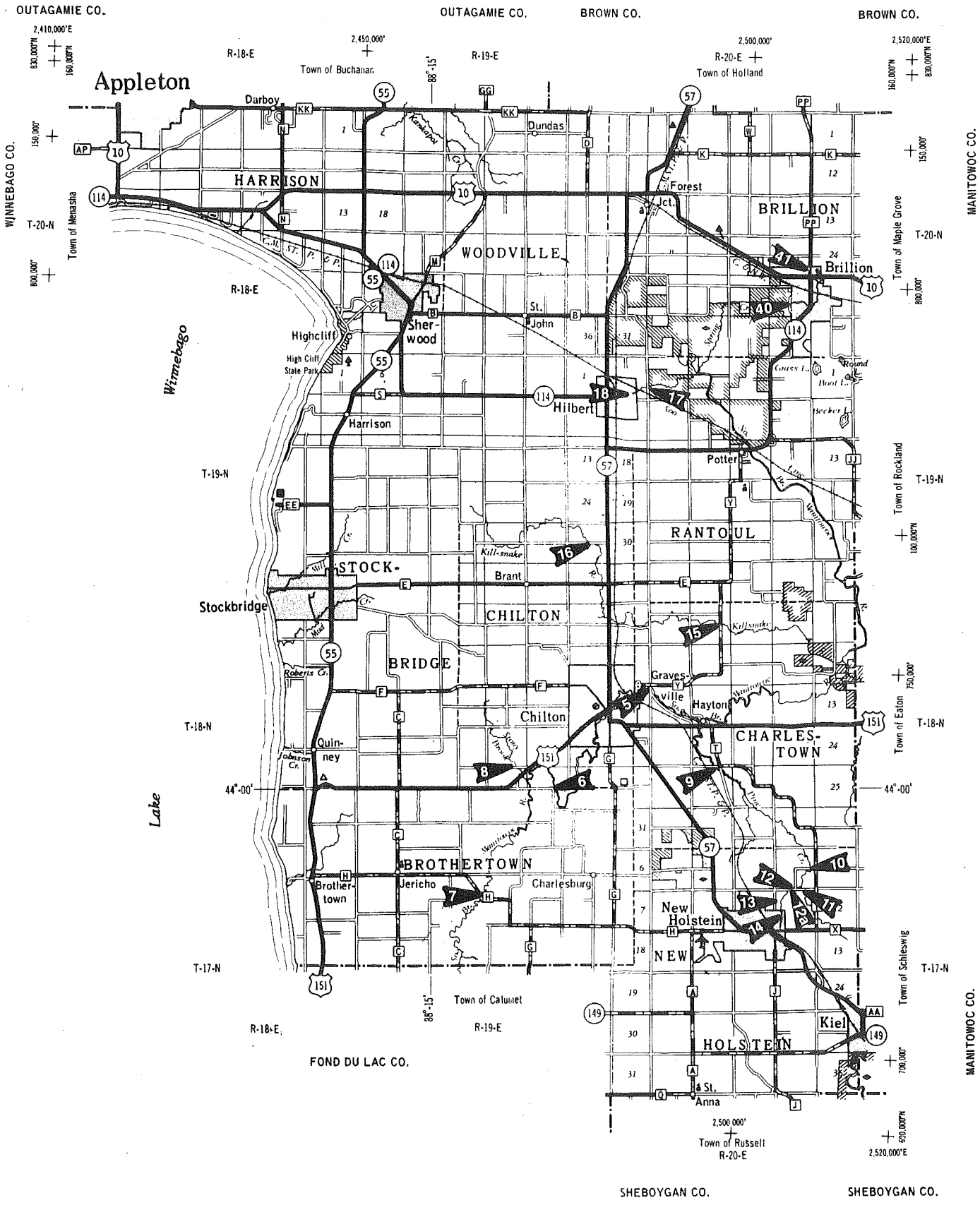


Table 4. Station Locations



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