

PRE-POST OPERATIONAL POINT SOURCE IMPACT STUDY OF THE PIGEON RIVER
RELATED TO THE MARION PUBLICLY OWNED TREATMENT WORKS

Performed as Part of the Lake Michigan
District Basin Assessment Study Program.

October 1982

GENERAL INFORMATION

Drainage Basin: Wolf River - 112

Location: Pigeon River in and below the Village
of Marion, Waupaca County, Wisconsin

Investigation Dates: Summer and fall of 1978 and summer
and fall of 1981.

Personnel: Michael D. Reif, Dennis Weisensel,
Tim Rasman and Laura Herman

Author: Michael D. Reif

TABLE OF CONTENTS

	Page
LIST OF TABLES	i
LIST OF FIGURES	iii
SUMMARY AND CONCLUSIONS	1
OBJECTIVES	2
INTRODUCTION	2
PHYSICAL SETTING OF STUDY AREA	2
MATERIAL AND METHODS	2
RESULTS AND DISCUSSION	5
Summary of the 1978 and 1981 Discharge Monitoring Reports	5
Chemical and Bacteriological Survey	5
Macroinvertebrate Survey Results	6
LITERATURE CITED	17
PHOTOGRAPHS	18-22

LIST OF TABLES

	Page
Table 1. Marion POTW WPDES interim limits, May 31, 1978 to December 31, 1979.	4
Table 2. Marion POTW WPDES final effluent limits (January 1, 1980 to September 30, 1984).	4
Table 3. Chemical (1) and macroinvertebrate (M1) site descriptions.	4
Table 4. Water quality determinations from biotic index values.	5
Table 5. Summary of the City of Marion 1978 discharge monitoring reports.	7
Table 6. Summary of the City of Marion 1981 discharge monitoring reports.	8
Table 7. August 10, 1981, chemical survey results.	9
Table 8. Load data from the August 10, 1981, chemical survey	9
Table 9. August 7, 1978, chemical survey results.	10
Table 10. Taxonomic list of macroinvertebrates from macroinvertebrate site 1.	11
Table 11. Taxonomic list of macroinvertebrates from macroinvertebrate site 2.	12
Table 12. Taxonomic list of macroinvertebrates from macroinvertebrate site 3.	13
Table 13. Taxonomic list of macroinvertebrates from macroinvertebrate site 4.	14
Table 14. Taxonomic list of macroinvertebrates from macroinvertebrate site 5 (site not sampled in 1978)	15
Table 15. Physical characteristics of the macroinvertebrate sites.	15
Table 16. 1978 and 1981 biotic index values from the macroinvertebrate sites.	15

LIST OF FIGURES

	Page
Figure 1. Map of study area	3
Figure 2. Graph comparing the biotic index values of the Pigeon River before and after upgrading of the Marion POTW.	16

SUMMARY AND CONCLUSIONS

1. According to the City of Marion Publicly Owned Treatment Works (POTW) discharge monitoring reports (1978 compared to 1981) the upgrading of the POTW resulted in an average yearly reduction in BOD₅ concentration and load of 62% and 71% respectively and an average yearly reduction in SS concentration and load of 85% and 90%.
2. The upgrading of the POTW also resulted in an improvement of the water quality of the Pigeon River from fair at the mixed point and poor 1.5 miles downstream to good at the mixed point and very good 1.5 miles downstream according to biotic index values derived from the macroinvertebrate populations.

2
OBJECTIVES

The objective of this study was to document water quality conditions (biological, chemical, and physical) in the Pigeon River before and after the upgrading of the City of Marion Publicly Owned Treatment Works (POTW).

INTRODUCTION

The Pigeon River receives effluent from the City of Marion (1980 population 1348) POTW near the east edge of the village. The old POTW was a primary plant. The new POTW has three rotating biological contactors. The old effluent limits are in Table 1 while the final effluent limits for the new POTW are in Table 2.

PHYSICAL SETTING OF STUDY AREA

The study reach stretches from the 100 feet above the City of Marion POTW outfall downstream to Magolski Road (Figure 1). The Pigeon River is classified trout stream within the study reach. However warming effects from Marion Pond (located approximately 1/4 miles above the POTW) may result in marginal conditions for trout within the study reach.

The Pigeon River is a small clear hardwater stream within the study reach. The reach is characterized by many (90%) riffles and flats with approximately 10% pools. Land use is primarily (approximately 90%) wooded and 10% agricultural or open. Agricultural use was observed at the tributary at site 6 along the banks (see photographs).

MATERIALS AND METHODS

Chemical surveys were conducted on August 7, 1978 and August 10, 1981. The sample sites are illustrated in Figure 1 and described in Table 3 (chemical and macroinvertebrate sites). Water samples were collected from the sites (1, 2, 4, 5, 6 and 7 on August 7, 1978; and 1-6 on August 10, 1981) iced, and sent to the State Laboratory of Hygiene. In 1978 samples were analyzed for biochemical oxygen demand, 5-day (BOD₅), suspended solids (SS), dissolved ammonia nitrogen (NH₃-N), and lab pH. In 1981 samples were analyzed for biochemical oxygen demand, 6-day (BOD₆), SS, total solids (TS), total phosphorus (TP), dissolved ortho-phosphorus (OP), NH₃-N, dissolved nitrite plus nitrate nitrogen (NO₂+NO₃-N), and total kjeldahl nitrogen (TKN). Dissolved oxygen (D.O.) and temperature were measured on-site.

Macroinvertebrate surveys were conducted on August 7, 1978, and November 13, 1981. Samples were collected from sites M1-M4 in 1978, and M1-M5 in 1981.

Macroinvertebrate sites were selected that were similar in physical characteristics whenever possible so the only variable between sites would be water quality.

A D-frame net was used to collect bottom material (12-inch opening with 1mm² mesh openings). Macroinvertebrates were collected by placing the net downstream and disturbing the bottom with one's feet, while the current carried the dislodged material into the net. Macroinvertebrates

FIGURE 1. Map of study area.

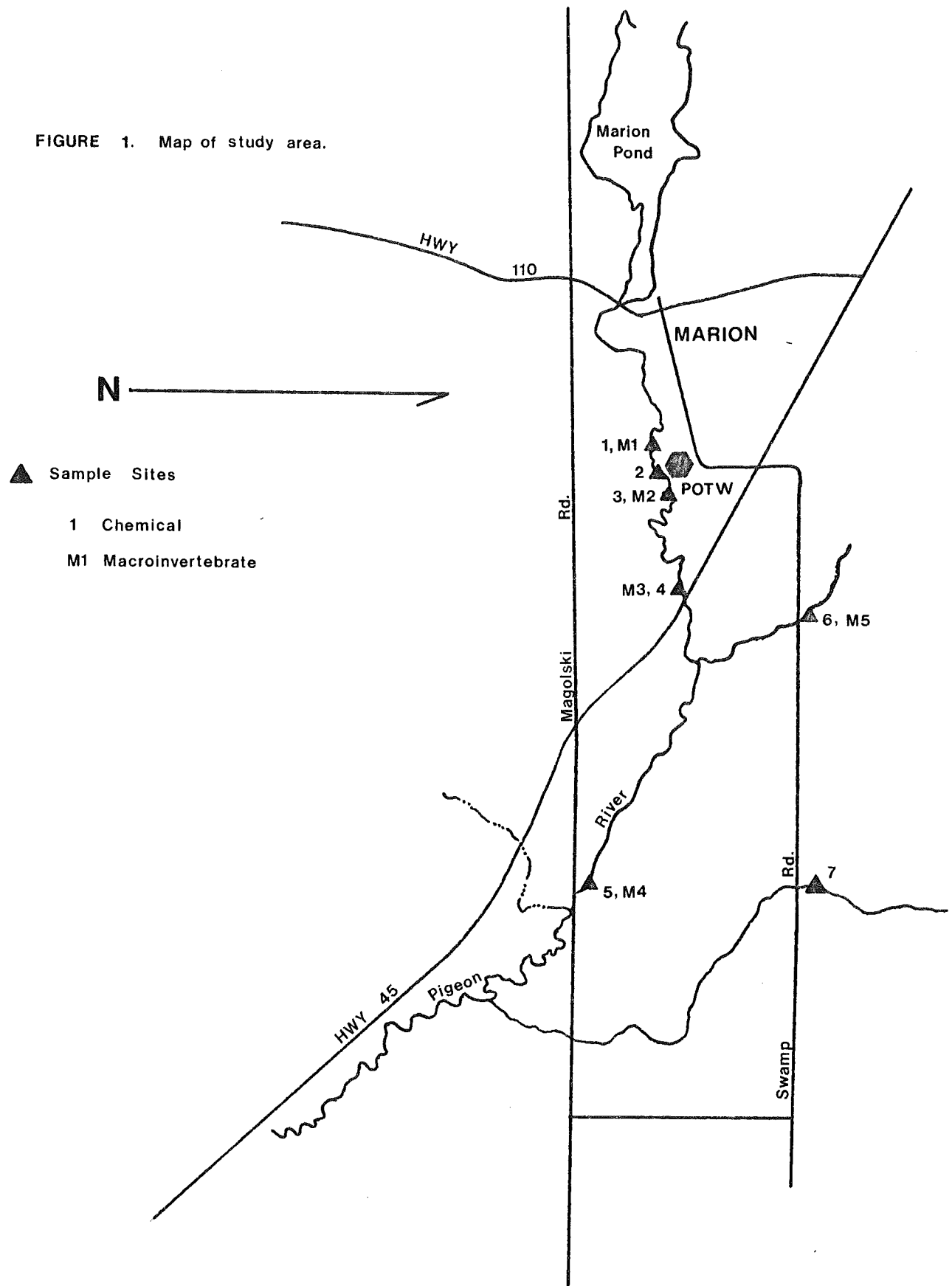


Table 1. Marion POTW WPDES interim effluent limits (May 31, 1978 to December 31, 1979).

Parameter	Average lbs./day	Average mg/l	Minimum s.u.	Maximum s.u.
BOD ₅ (monthly)	54.6	30	-	-
BOD ₅ (weekly)	82	45	-	-
SS (monthly)	54.6	30	-	-
SS (weekly)	82	45	-	-
pH	-	-	6.0	9.0

Table 2. Marion POTW-WPDES final effluent limits (January 1, 1980 to September 30, 1984).

Parameter	Average lbs./day	Average mg/l	Minimum	Maximum
BOD ₅ (weekly, May-Oct)	40	20	-	-
BOD ₅ (weekly, Nov-April)	60	30	-	-
SS (weekly, May-Oct)	40	20	-	-
SS (weekly, Nov-April)	60	30	-	-
pH (daily, May-Oct)	-	-	6.0	7.2
pH (daily, Nov-April)	-	-	6.0	7.6
NH ₃ -N (weekly, May-Oct)	-	2.5	-	-
NH ₃ -N (weekly, Nov-April)	-	3.5	-	-
D.O. (daily)	-	-	7.0 mg/l	

Table 3. Chemical (1) and macroinvertebrate (M1) site descriptions.

1, M1	Pigeon River - 100-200 feet above the Marion POTW outfall
2	Marion POTW outfall
3, M2	Pigeon River - Mixed point below the Marion POTW outfall
4, M3	Pigeon River - 0-200 feet above Hwy 45
5, M4	Pigeon River - 50-100 feet above Magolski Road
6, M5	Tributary - 0-200 feet above Swamp Road
7	Hydes Creek - Swamp Road

were also collected manually from sticks, rocks and leaves collected from the stream. Collection continued until at least 100 organisms were obtained. All material was placed into pint mason jars containing 95% ethanol.

In the laboratory macroinvertebrates were initially separated into easily discernable taxa. They were picked from a white enamel pan and put into vials containing 95 percent alcohol. Picking of each sample continued until at least 100 organisms were picked. Macroinvertebrates were then identified to the lowest possible taxonomic level.

A taxonomic list was prepared for each site with numbers of each taxa. Biotic index values were assigned for each appropriate taxa and a biotic index calculated for each site according to Wisconsin Department of Natural Resources Technical Bulletin 100 (1981 updated edition) by William Hilsenhoff. Biotic index values range from 0-5 with 0 being indicative of streams with no organic pollution and 5 of streams that have severe pollution. Water quality determinations from biotic index values by Hilsenhoff are below (Table 4).

Table 4. Water quality determinations from biotic index values.

Biotic Index	Water Quality	State of the Stream
0 - 1.75	Excellent	No organic pollution
1.75 - 2.25	Very Good	Possible slight pollution
2.26 - 2.75	Good	Some pollution
2.76 - 3.50	Fair	Significant pollution
3.51 - 4.25	Poor	Very significant pollution
4.26 - 5.00	Very Poor	Severe pollution

RESULTS AND DISCUSSION

Summary of the 1978 and 1981 Discharge Monitoring Reports

A summary of the City of Marion POTW discharge monitoring reports are in Tables 5 and 6 for 1978 and 1981 respectively. There was a 62% reduction average in BOD₅ effluent concentrations and a 71% reduction in the average BOD₅ effluent load between 1978 and 1981. There was an 85% reduction in average SS effluent concentrations and 90% reduction in average SS loads between 1978 and 1981. These are significant reductions and are due to the upgrading of the POTW.

Chemical and Bacteriological Survey

The chemical and bacteriological results for this study are in Tables 7 and 9 for 1981 and 1978 respectively. The loads were calculated for the 1981 data and are in Table 8.

Differences in parameter concentrations were small between the 1978 and 1981 chemical surveys. Streamflow was very similar. There was a small depression in D.O. (1.4 mg/l) at the mixed point in 1978 whereas in 1981 the D.O. rose 0.5 mg/l from above the POTW to the mixed point.

Nitrite + Nitrate Nitrogen levels were at least 3 times higher in the tributary at site 6 than at any point on the Pigeon River during the 1981 chemical survey. This is assumed by the author to be the result of non-point source input substantiated by the fact that the tributary flows through pastureland and the FC level was fairly high at 3,300. However the load of $\text{NO}_2 + \text{NO}_3\text{-N}$ was 3 times less in the tributary than the Pigeon River because of the smaller flow of the tributary.

Macroinvertebrate Survey Results

A list of Macroinvertebrates are in Tables 10-14 for sites 1-5 respectively for 1978 and 1981. The physical characteristics for these sites are in Table 15. The biotic index values for these sites are in Table 16 and illustrated in Figure 2.

The worst condition existed at site M4 in 1978 which had a biotic index of 3.80 indicating poor water quality. In 1978 the water quality as indicated by the biotic index (Hillsenhoff, 1977 with 1981 update) dropped from very good above the POTW to fair at the mixed point and to poor at site M4. This situation changed considerably by the 1981 survey where the water quality was good above the POTW and at the mixed point and increased to very good at site M4.

There was a large change in macroinvertebrate community structure between 1978 and 1981. This is particularly exemplified by the addition of a large population of the mayfly Stenonema fuscum (biotic index value of 1) at sites M2, M3, and M4 and a large population of the mayfly leptophlebia spp (biotic index value of 2) at site M3. The elimination of the Amphipod Hyallolella Azteca and the addition of a large number of Gammarus pseudolimneaus at site M4 also contributed to the difference as did the elimination of the black fly Simulium vittatum at site M4. These changes are assumed by this author to be primarily due to the upgrading of the POTW.

Table 5. Summary of the City of Marion 1978 discharge monitoring reports.

Month	Average Flow MGD	BOD ₅				SS			pH			
		Average mg/l	Minimum mg/l	Maximum mg/l	Average lbs/day	Average mg/l	Minimum mg/l	Maximum mg/l	Average lbs/day	Average s.u.	Minimum s.u.	Maximum s.u.
January	.182	34	10	118	33	35	9	82	34	7.4	7.4	7.4
February	.172	9	1	16	8	30	5	59	28	7.4	7.4	7.4
March	.184	20	3	72	20	38	13	74	38	7.2	7.2	7.2
April	.239	19	3	47	24	28	9	48	36	7.3	7.2	7.4
May	.224	18	6	27	22	21	3	42	25	7.4	7.4	7.4
June	.182	25	7	70	25	20	10	37	20	7.3	7.2	7.4
July	.207	19	4	74	21	30	11	56	33	7.3	7.2	7.4
August	.237	27	13	55	35	20	7	35	26	7.3	7.2	7.4
September	.228	14	1	30	17	22	5	53	27	7.3	7.2	7.4
October	.254	14	3	36	19	20	7	34	27	7.4	7.2	7.4
November	.241	15	3	35	19	23	11	39	30	7.4	7.4	7.4
December	.207	38	7	89	42	35	11	71	39	7.3	7.2	7.4
Yearly	.213	21	1	118	24	27	3	82	30	7.3	7.2	7.4

Table 6. Summary of the City of Marion 1981 discharge monitoring report.

Month	Avg. Flow MGD	BOD ₅			SS			pH			NH ₃ -N				
		Avg. mg/l	Min. mg/l	Max. mg/l	Avg. lbs/ day	Avg. mg/l	Min. mg/l	Max. mg/l	Avg. s.u.	Min. s.u.	Max. s.u.	Avg. mg/l	Min. mg/l	Max. mg/l	Avg. lbs/ day
January	.165	17	3	32	15	7	2	26	7.0	7.0	7.5	0.77	.14	1.68	.69
February	.185	4	2	9	4	5	0	10	7.2	7.0	7.5	1.42	.19	7.09	1.42
March	.210	2	1	3	2	4	1	9	7.7	7.3	7.8	1.92	.20	5.97	2.17
April	.261	3	1	8	4	3	1	7	7.6	7.3	8.1	1.77	.30	3.92	2.49
May	.198	19	2	53	20	2	2	4	7.8	7.4	8.1	1.07	.28	3.74	1.14
June	.162	3	2	5	3	10	<1	19	7.5	7.1	8.0	1.20	.46	1.79	1.07
July	.130	8	6	10	6	5	<1	11	7.8	7.6	7.9	.40	.00	.75	0.28
August	.168	8	8	12	7	<1	<1	<1	7.8	7.5	7.7	.75	.09	2.50	.68
September	.139	6	3	12	4	<1	<1	<1	8.0	7.8	8.2	.14	.00	.37	0.10
October	.185	7	0	10	7	<1	<1	<1	7.7	7.1	8.0	.35	.00	.84	.35
November	.161	8	0	12	7	<1	<1	<1	8.3	7.1	8.4	.37	.09	.75	.32
December	.145	6	0	13	5	3	1	8	7.6	7.1	8.3	1.27	.28	2.71	0.99
Yearly	.176	8	0	53	7	4	0	26	7.7	7.0	8.4	0.95	.00	7.09	0.98

Table 7. August 10, 1981, chemical survey results.

Parameter	Station					
	1	2	3	4	5	6
Time	10:05	10:15	10:30	10:40	10:55	11:15
Water Temp. (°C)	21	15	21	21	20	18
D.O (mg/l)	6.4	8.3	6.9	7.0	8.2	9.5
Lab pH (s.u.)	8.9	7.9	8.8	8.7	8.6	8.5
BOD ₆ (mg/l)	2.0	7.4	3.7	2.1	2.0	2.7
Total Residue (mg/l)	235	535	240	250	275	380
Total Nonfilt. Residue (mg/l)	4	10	5	3	2	22
Total -P (mg/l)	0.04	1.43	0.12	0.11	0.10	0.05
Dis. O-P (mg/l)	0.012	1.08	0.082	0.074	0.070	0.010
NH ₃ -N (mg/l)	0.05	3.3	0.22	0.18	0.08	<0.02
NO ₂ +NO ₃ -N (mg/l)	0.13	5.1	0.40	0.43	0.82	3.3
Total Kjehl.-N (mg/l)	0.6	4.7	1.0	0.8	0.7	0.7
Fecal. Coliform M-FCAGAR/100ml	460	-	<10	<10	210	3,300

Table 8. Load data from the August 10, 1981, chemical survey.

Parameter	Station					
	1	2	3	4	5	6
BOD ₆ (lbs/day)	68	11	131	74	81	8
SS (lbs/day)	137	15	176	106	81	62
T-P (lbs/day)	1.37	2.08	4.23	3.88	4.07	0.14
O-P (lbs/day)	0.41	1.57	2.89	2.61	2.85	0.03
NH ₃ -N (lbs/day)	1.71	4.8	7.76	6.34	3.26	<0.06
NO ₂ +NO ₃ -N (lbs/day)	4.45	7.4	14.11	15.17	33.39	9.3
TKN (lbs/day)	20.5	6.8	35.3	28.2	28.5	2.0
Flow (CFT ³ /Sec)	6.35	0.27	6.54	8.87*	7.55	0.52

* This stream flow measurement is assumed to be in error so the flow from site 3 was used to calculate the loads since little or no inputs occur between the sites.

Table 9. August 7, 1978 Chemical survey results.

Parameter	Station					
	1	2	4	5	6	7
Water Temp. (°C)	20	20	21	22	21	21
D.O. (mg/l)	5.8	5.8	4.4	9.8	8.8	11.1
Lab pH (s.u.)	7.8	7.6	7.6	8.1	8.3	8.4
BOD ₅ (mg/l)	3.3	12.0	6.0	4.1	2.9	2.9
SS (mg/l)	4	13	5	2	23	3
Dis. NH ₃ -N (mg/l)	0.11	0.64	0.88	<0.02	<0.02	<0.02
Flow (Ft ³ /sec)	6.29	6.94	7.97	8.02	0.73	3.5

Table 10. Taxonomic list of macroinvertebrates from macroinvertebrate site 1.

Taxa	No. Collected in 1978	No. Collected in 1981
Amphipoda		
<u>Gammarus pseudolimneaus</u>	4	7
Diptera		
<u>Simulium vittatum</u>	2	2
<u>Strictochironamus</u> spp	-	3
Ephemeroptera		
<u>Baetis phoebus</u>	6	10
<u>Leptophlebia</u> spp	-	2
<u>Stenonema exiguum</u>	19	-
<u>Stenonema fuscum</u>	-	14
<u>Stenonema tripunctatum</u>	-	3
Lepidoptera		
<u>Sisyra vicaria</u>	1	-
Tricoptera		
<u>Ceraclea</u> spp	1	-
<u>Cheumatopsyche</u> spp	49	65
<u>Hydropsyche</u> spp	2	-
<u>Hydropsyche betteni</u>	-	3
<u>Macronema</u> spp	19	-
Totals	103	109

Table 11. Taxonomic list of macroinvertebrates from macroinvertebrate site 2.

Taxa	No. Collected in 1978	No. Collected in 1981
Amphipoda		
<u>Gammarus pseudolimneaus</u>	-	4
<u>Hyallela azteca</u>	1	-
Coleoptera		
<u>Optioservus spp</u>	-	2
Diptera		
<u>Ablabesmyia spp</u>	14	-
<u>Brillia spp</u>	-	3
<u>Chironomus spp</u>	-	1
<u>Cricotopus spp</u>	2	-
<u>Cryptochironomus spp</u>	1	-
<u>Microtendipes spp</u>	-	2
<u>Polypedilum spp</u>	1	-
<u>Psectrocladius spp</u>	1	-
<u>Simulium vittatum</u>	2	17
<u>Stenochironomus spp</u>	1	-
<u>Strictochironomus spp</u>	-	3
<u>Tribelos spp</u>		
Ephemeroptera		
<u>Baetis phoebus</u>	6	-
<u>Stenonema fuscum</u>	-	33
<u>Stenonema tripunctatum</u>	-	6
Isopoda		
<u>Asellus intermedius</u>	-	1
Tricoptera		
<u>Cheumatopsyche spp</u>	28	27
<u>Diplectrona spp</u>	1	-
<u>Pycnopsyche spp</u>	1	1
Total	59	100

Table 12. Taxonomic list of macroinvertebrates from macroinvertebrate site 3.

Taxa	No. Collected in 1978	No. Collected in 1981
Amphipoda		
<u>Gammarus pseudolimneaus</u>	2	28
<u>Hyallela azteca</u>	2	-
Coleoptera		
<u>Dubiraphia spp</u>	1	-
<u>Gyrinus spp</u>	3	-
<u>Optioservus spp</u>	-	2
Diptera		
<u>Ablabesmyia spp</u>	40	-
<u>Crictopus spp</u>	1	-
<u>Glyptotendipes spp</u>	2	-
<u>Microtendipes spp</u>	-	2
<u>Simulium vittatum</u>	-	1
Ephemeroptera		
<u>Baetis brunneicolor</u>	1	-
<u>Baetis vagans</u>	1	-
<u>Caenis spp</u>	1	-
<u>Leptophlebia spp</u>	-	17
<u>Stenonema fuscum</u>	-	14
Isopoda		
<u>Asellus intermedius</u>	6	-
Odonata		
<u>Calopteryx spp</u>	1	-
<u>Enallagma spp</u>	-	2
Tricoptera		
<u>Cheumatopsyche spp</u>	16	26
<u>Hydropsyche betteni</u>	-	3
Total	71	95

Table 13. Taxonomic list of macroinvertebrates from macroinvertebrate site 4.

Taxa	No. Collected in 1978	No. Collected in 1981
Amphipoda		
<u>Gammarus pseudolimneaus</u>	2	34
<u>Hyaloleia azteca</u>	24	-
Coleoptera		
<u>Optioservus spp</u>	-	2
<u>Gyrinus spp</u>	1	-
<u>Stenelmis spp</u>	-	1
Diptera		
<u>Ablabesmyia spp</u>	2	-
<u>Chrysops spp</u>	1	-
<u>Microtendipes spp</u>	-	4
<u>Simulium vittatum</u>	119	-
<u>Stictochironomus spp</u>	2	-
Ephemeroptera		
<u>Baetis brunneicolor</u>	7	-
<u>Baetis phoebus</u>	1	2
<u>Baetis pygmaeus</u>	1	-
<u>Baetis vagans</u>	1	-
<u>Leptophlebia spp</u>	-	11
<u>Pseudocloeon spp</u>	4	-
<u>Stenonema fuscum</u>	-	10
<u>Stenonema mediopunctatum</u>	-	1
Isopoda		
<u>Asellus intermedius</u>	5	-
Odonata		
<u>Enallagma spp</u>	-	1
Plecoptera		
<u>Taeniopteryx spp</u>	-	10
Tricoptera		
<u>Cheumatopsyche spp</u>	8	18
<u>Nemotaulius hostilis</u>	-	1
<u>Symphitopsyche sloossonae</u>	-	1
Total	178	95

Table 14. Taxonomic list of macroinvertebrates from macroinvertebrate site 5 (site not sampled in 1978)

Taxa	No. Collected
Amphipoda	
<u>Gammarus pseudolimneaus</u>	52
Tricoptera	
<u>Glossosoma spp</u>	49
<u>Limnephilus spp</u>	3
Total	104

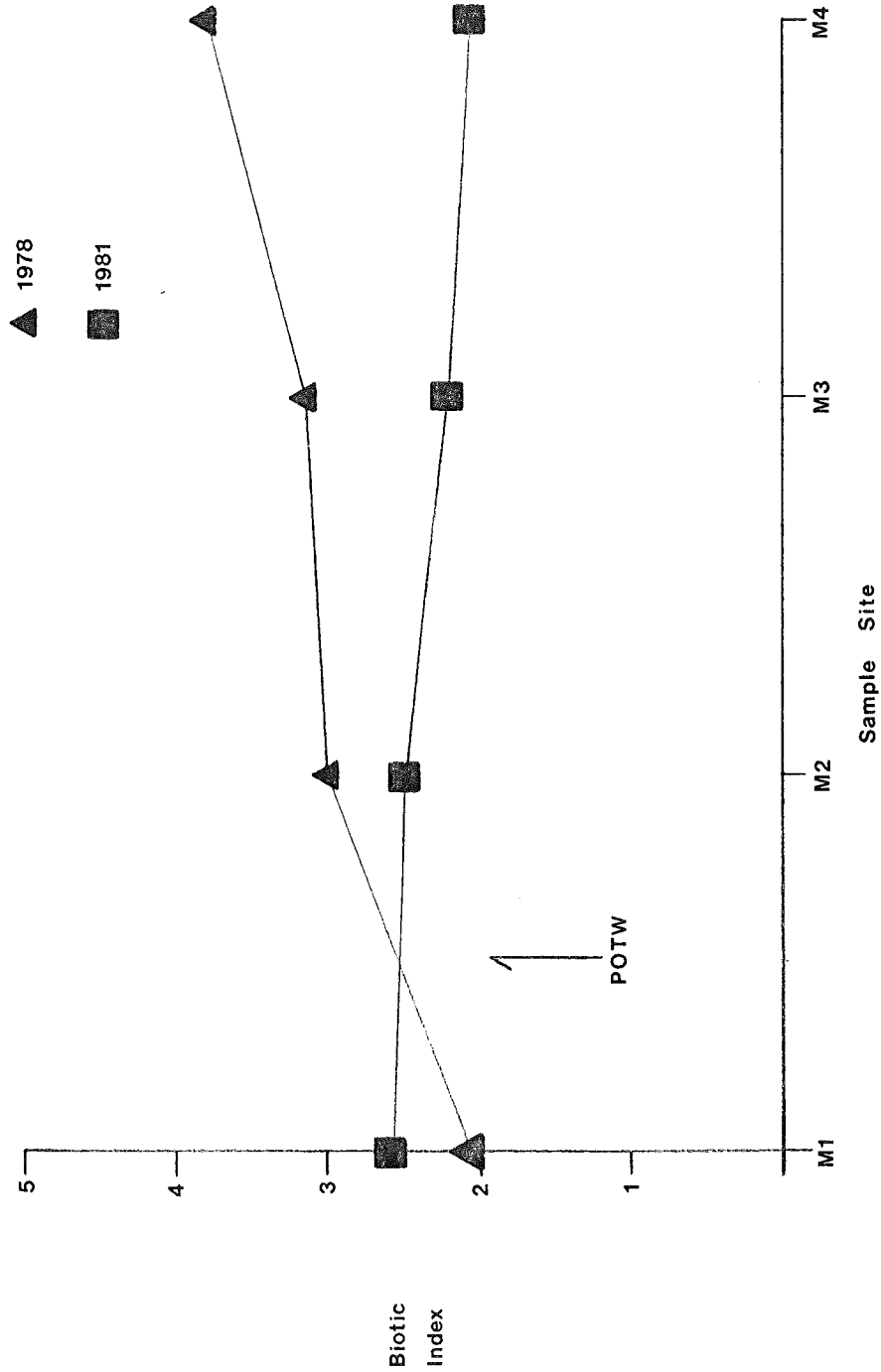
Table 15. Physical Characteristics of the Macroinvertebrates Sites.

	Site				
	1	2	3	4	5
Substrate Composition					
% Boulders	0	0	5	0	0
% Rubble	25	10	10	25	5
% Gravel	50	40	40	50	5
% Sand	5	30	30	5	80
% Silt	0	5	0	0	5
% Clay	0	0	0	0	0
% Debris	10	10	5	10	5
% Muck	0	0	0	0	0
% Vegetation	5	5	10	5	0
Current	Riffle	Riffle	Riffle	Riffle	Riffle
Current Characteristic	Fast	Moderate	Fast	Fast	Fast
Average Width (A)	15	20	20	20	5
Average Depth (ft)	0.5	0.5	0.5	0.5	0.3
Streambank	Wooded	Wooded	Wooded	Wooded	Pasture

Table 16. 1978 and 1981 biotic index values from the macroinvertebrate sites.

Site	1978 B.I.	1981 B.I.
M1	2.08	2.59
M2	3.00	2.48
M3	3.15	2.22
M4	3.80	2.06
M5	-	1.53

Figure 2. Graph comparing the biotic index values of the Pigeon River before and after upgrading of the Marion POTW.



LITERATURE CITED

- Hilsenhoff, W. L. 1981. Use of arthropods to evaluate water quality of streams. Tech. Bul. No. 100. Wis. Dept. Nat. Res. 17 p.



Marion Pond
looking west from outlet
bridge.
(November 13, 1981)



Outfall of Marion Pond.
(November 13, 1981).



Looking downstream (east)
from outfall of Marion Pond
(November 13, 1981).



Marion POTW
looking NNW.
(November 13, 1981).



Pigeon River at site 1
looking upstream (west)
from the snowmobile bridge.
The POTW outfall is to the
right immediately out of the
photographs.
(November 13, 1981).



Pigeon River looking down-
stream (east) from the snow-
mobile bridge. (Site 3 -
Mix point below POTW).
(November 13, 1981).



Pigeon River looking
upstream from HWY 45
(site 4). (November 13, 1981)



Pigeon River looking
downstream from HWY 45.
(November 13, 1981).



Tributary looking north from
Swamp Road (site 6).
(November 13, 1981).