

Lower Pine River  
Diurnal Dissolved Oxygen Survey  
Tim Doelger - 3/90

On July 18, 1989, continuous recording D.O. meters were put into operation at three sites on the Lower Pine River near Wild Rose in Waushara County. They were allowed to run until July 20. This was done to augment other survey work performed in 1987 to further document conditions prior to a discharge planned by the village.

The Lower Pine is a highly productive Class I trout stream which originates at the Wild Rose Millpond dam and flows about 23 miles through mostly wooded and light agricultural land before entering Lake Poygan. In the study area, approximately the first 1.5 miles below the millpond, the stream is shaded and relatively free of aquatic vegetation. Starting above the 19th Road, the tree canopy gives way to meadows, and in-stream macrophytes become profuse.

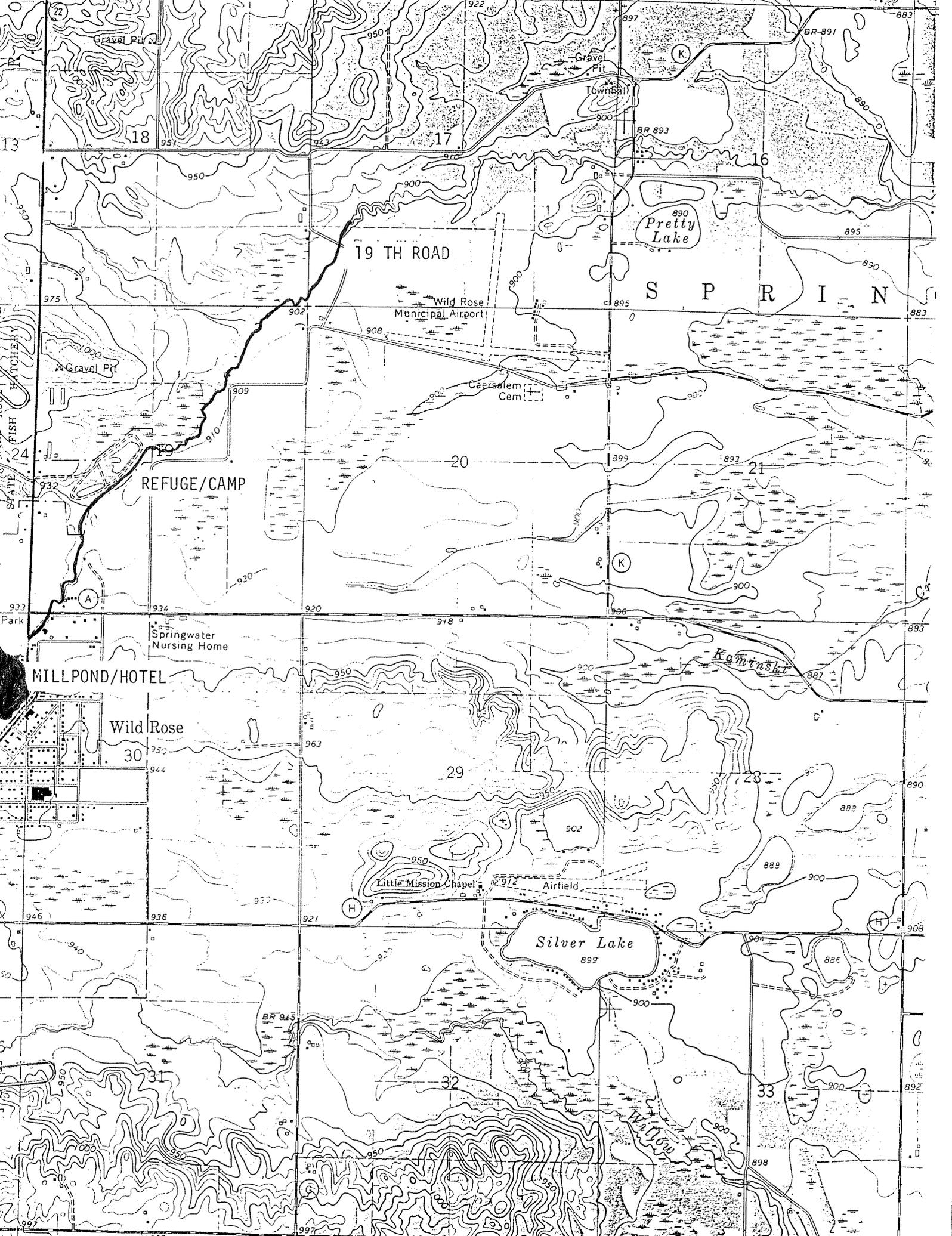
These conditions were documented in the 1987 report by Steve Mace (DNR-SED) which is attached. The report also used a model generated by the PHARTS study to predict what increase in plant biomass could be expected after Wild Rose begins discharging.

Dissolved oxygen meters were placed in the millpond (behind the hotel), at a DNR fish refuge 1/2 - 3/4 mile below STH 22, and at the crossing of 19th Road.

The millpond site was used to determine ambient conditions and to see if the pond has any effect on the stream. The fish refuge site is below the DNR hatchery and was selected to assess any impacts it might have on D.O. The station at 19th Road is in the area where macrophyte abundance begins increasing and was thought to be a likely area to see diurnal fluctuations.

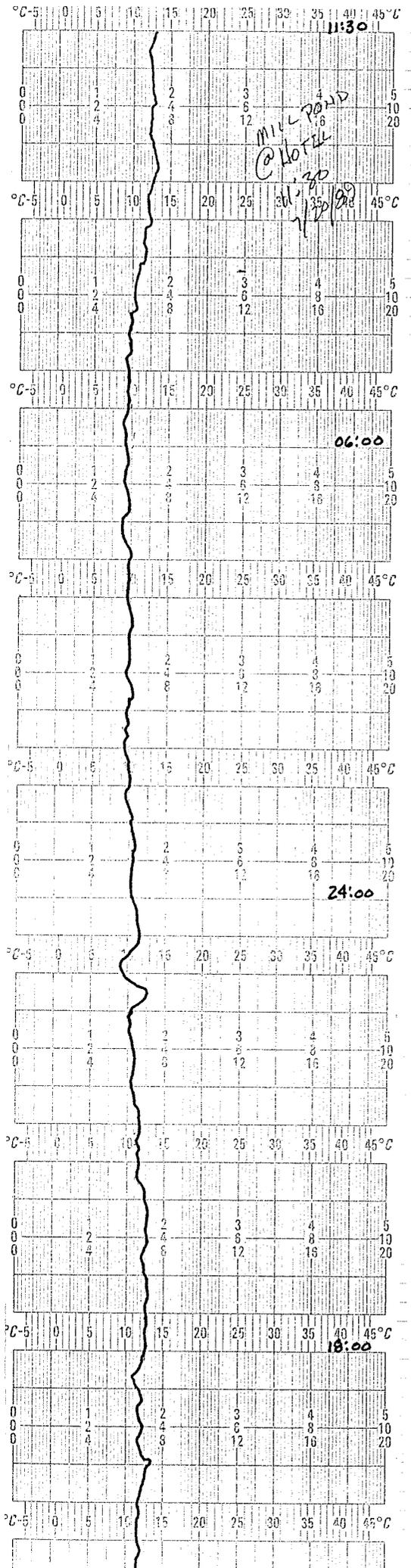
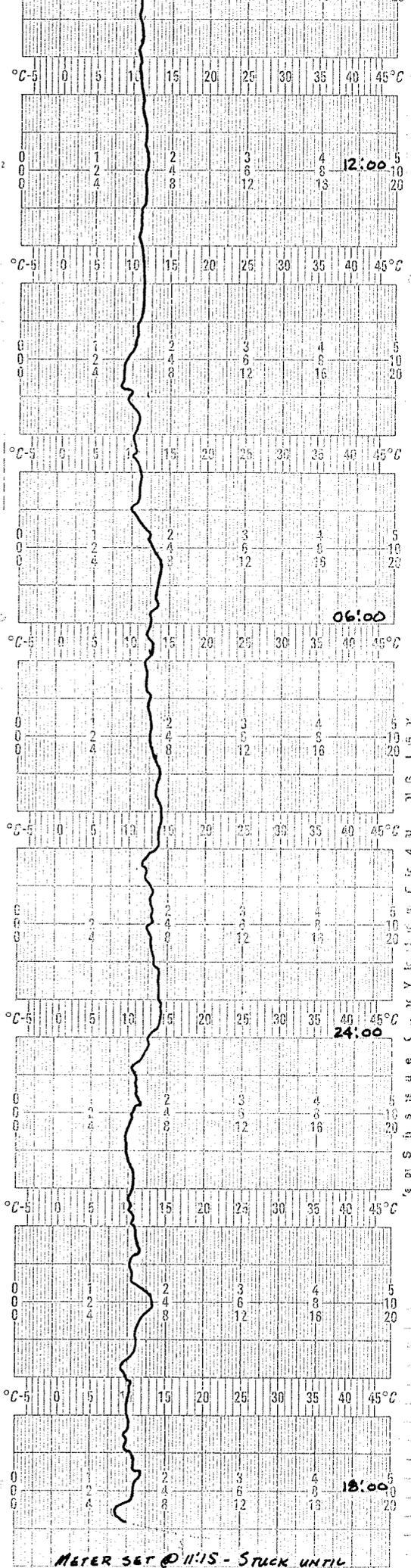
The results are in the form of strip charts which have been duplicated and are attached. At first glance, the record from the 19th Road location looks too low. The meter was originally set at 11 mg/l, and within an hour apparently lost calibration and dropped 4-5 mg/l. With this taken into account, D.O.s are very good as is the case at the other two sites. There were only slight diurnal swings, indicating that even though aquatic vegetation is profuse, the respiration associated with it is not adversely affecting D.O. levels.

In conclusion, it would appear that the river is capable of assimilating the discharge from the DNR hatchery in terms of oxygen demanding wastes, but the nutrients, particularly phosphorus, are causing an overabundance of macrophytes. The additional loading from the new WWTP will quite likely exacerbate this condition, but to what extent is not completely known. Follow-up monitoring should be performed to document any changes. This situation makes a strong point for the need to develop water quality based phosphorus limits.



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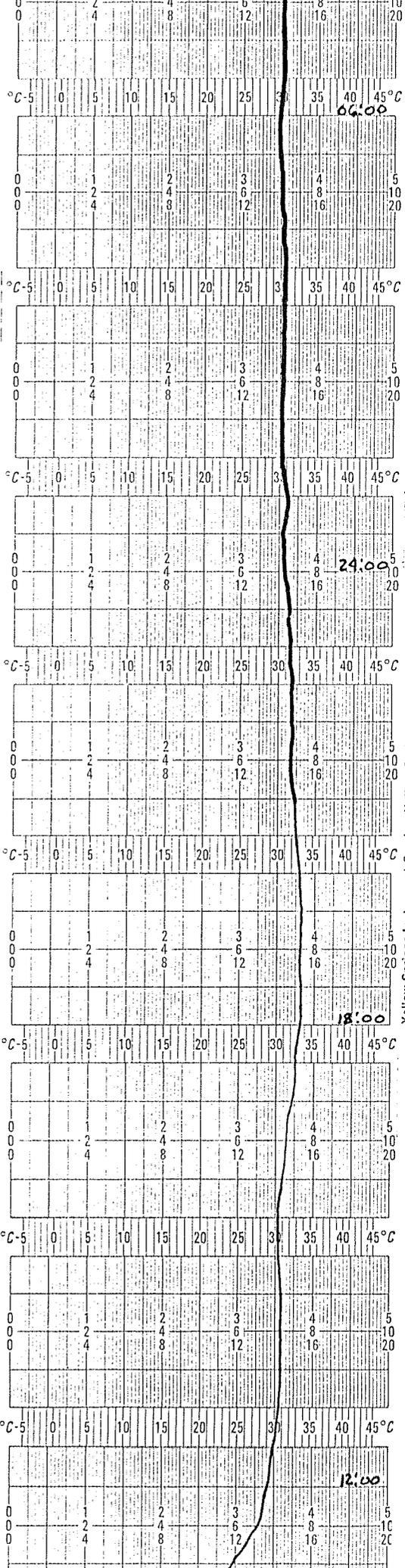
MILK POND  
@ HOTEL

WILDROSE MILL POND  
2cm/HR, 0-20 PPT  
7/18-20/1989

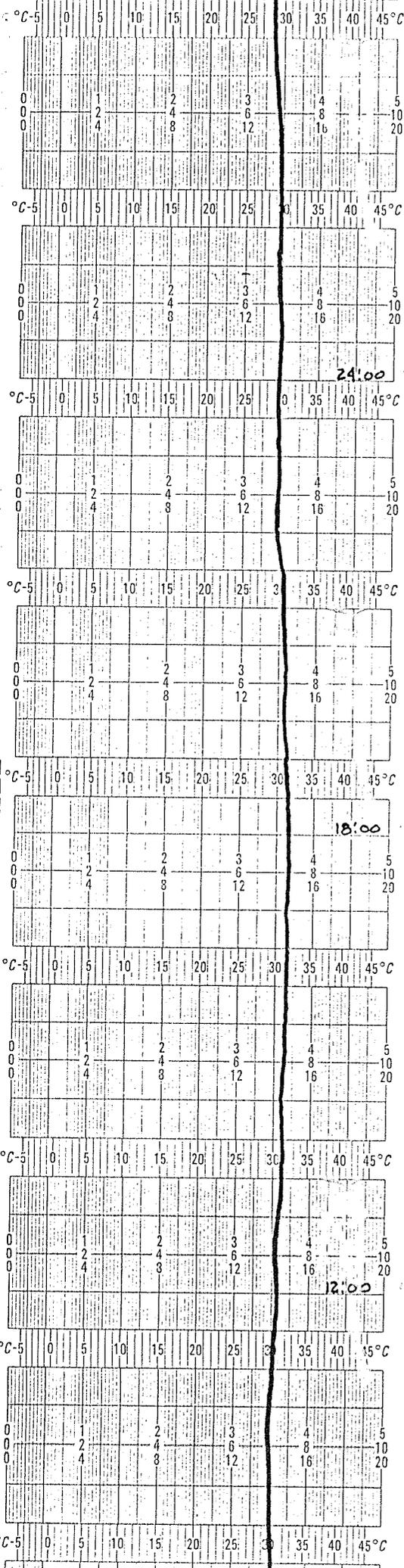
METER SET @ 11:15 - STUCK UNTIL

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Instrument Co., Inc. Yellow Springs, Ohio 45387 DWG # B05602A



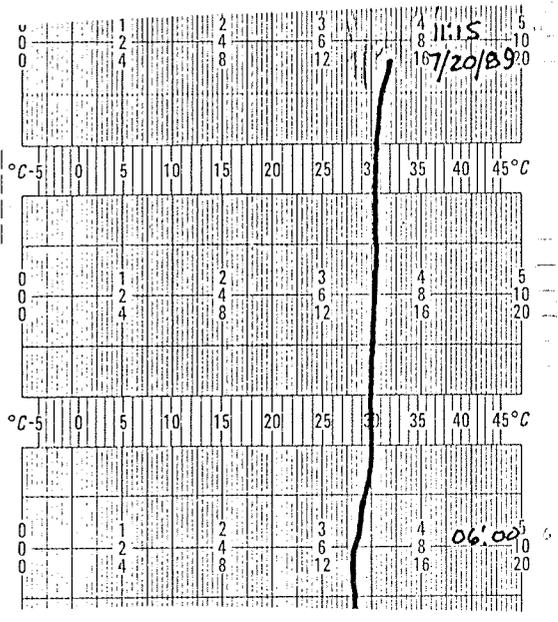
Yellow Springs Instrument Co., Inc. Yellow Springs, Ohio 45387 DWG # B05602A



LOWER PINE R.  
REFUGE/CAMP

Yellow Springs Instrument Co., Inc. Yellow Springs, Ohio 4

REFUGE (CONT'D)

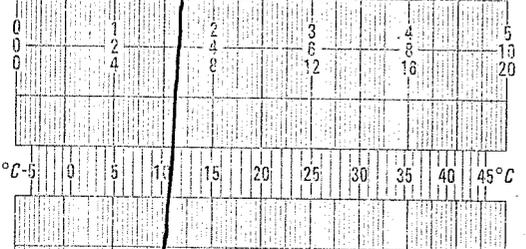
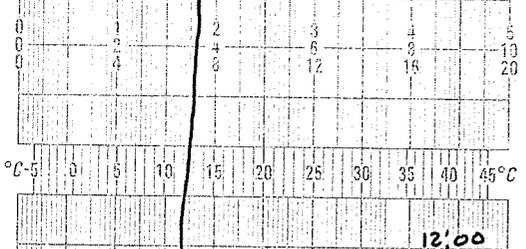
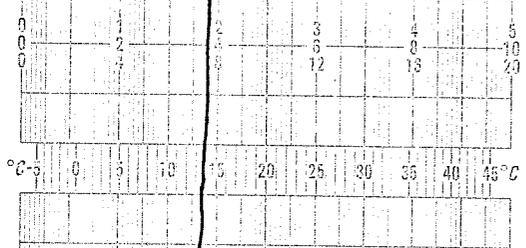
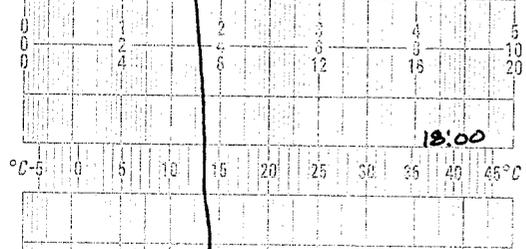
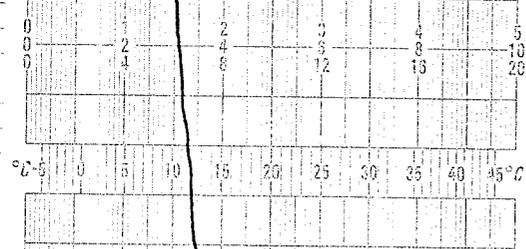
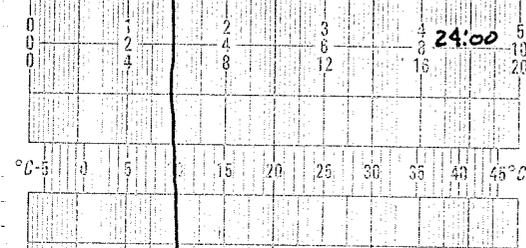
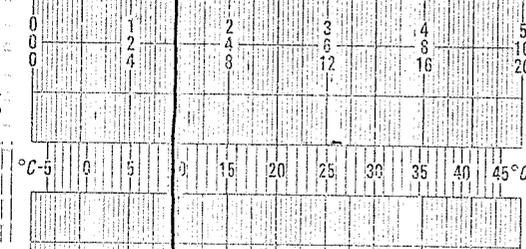
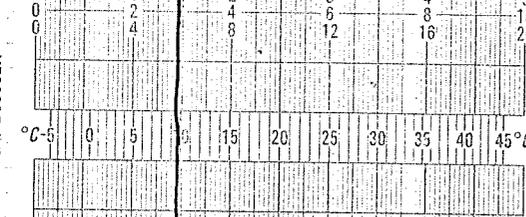
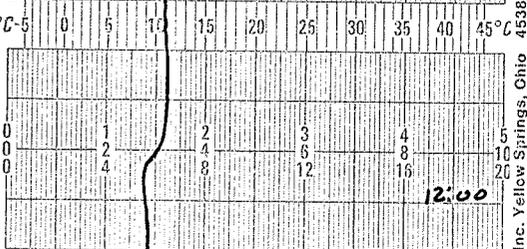
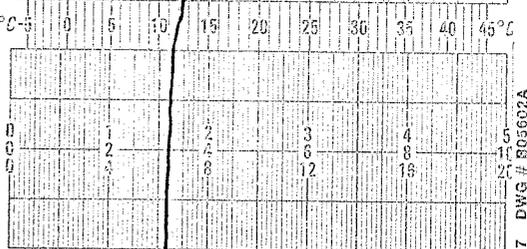
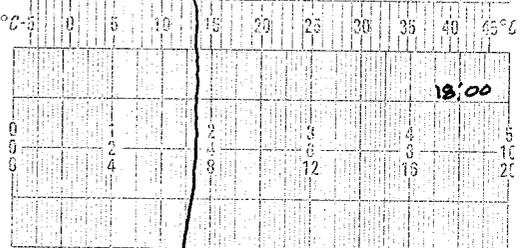
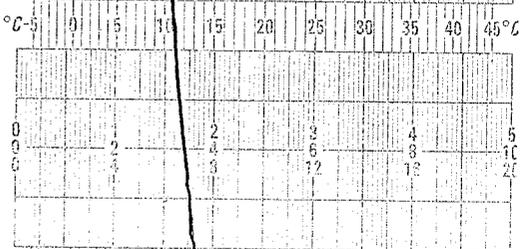
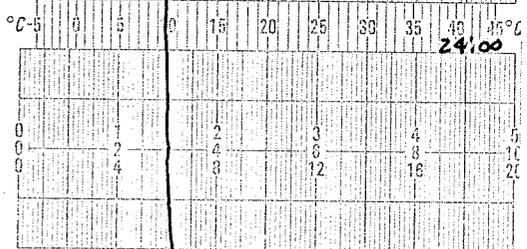
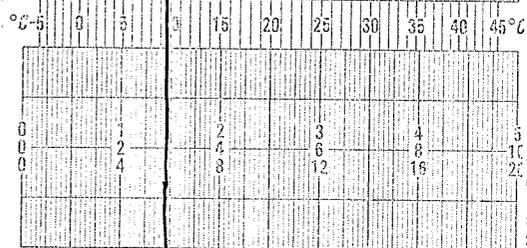
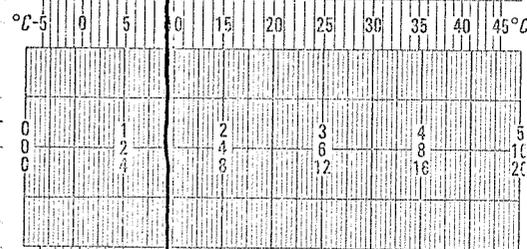
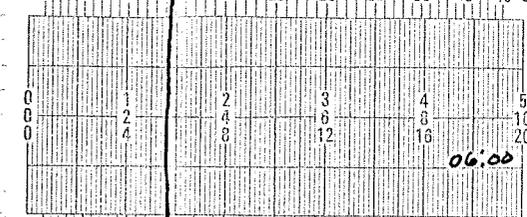


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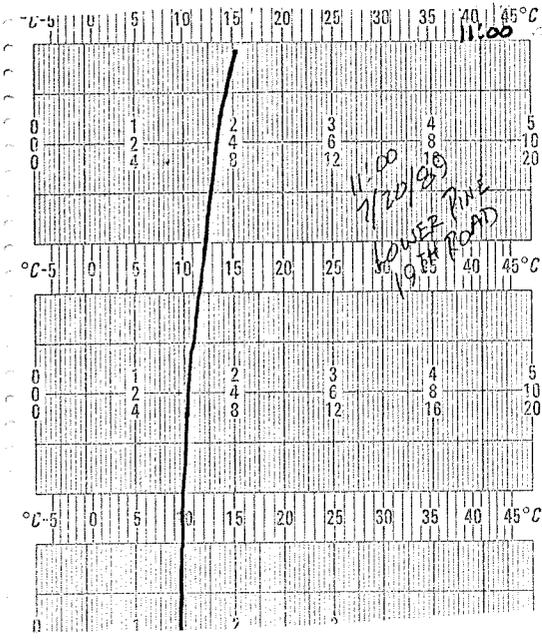
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Yellow Springs Instrument Co., Inc. Yellow Springs, Ohio 45387 DWG # B05602A

LOWER PINE R  
19TH ROAD



19TH ROAD (CONT'D)



## CORRESPONDENCE/MEMORANDUM

STATE OF WISCONSIN

Date: 9 Oct '87

File Ref: 3200

To: → Tom Bennwitz WR/2

From: Steve Mace *SM*

OCT 11 1987

Subject: Recommendations for P limits in the Pine River, Waushara County

SUMMARY

Elevated nutrient concentrations in the portion of the Pine R. near Wild Rose, particularly phosphorus are attributed to discharge of the hatchery effluent(s). Macrophyte populations in the surveyed portions of the Pine R. approach nuisance conditions. Current impairments include restricted access to the stream, flooding of riparian areas, inundation of habitat improvement structures, and silt deposition. Subsequent silt wash-out in the spring may smother trout fry near time of emergence. Impacts of plant abundance on diel dissolved oxygen is unknown; daytime DO supplies appear adequate.

Macrophyte models project a 2.5 times increase in plant biomass in the Pine River from effluent added by the proposed Wild Rose POTW without nutrient removal. Expected impacts include increased ponding of the free-flowing portions of the river and flooding of the lower banks. In addition to the recreational impairments, water quality changes would include lowered reaeration and decreased nighttime DO. Another important consideration not addressed in this assessment are the impacts on the Pine River farther downstream of this survey area, particularly any impounded reaches.

My recommendation is to re-assess ground water discharge of the Wild Rose POTW effluent or, failing that, consider phosphorus removal for both the POTW and the effluent from the hatchery. There is some reason to believe that removal to less than 1 mg/l PTOT may be advisable.

The following is my analysis.

SURVEY AREA

The Pine R. (erroneously designated as Humphrey Cr. on the USGS 7.5' topo) was surveyed August 20 and September 9, 1987. Observations included temperature, dissolved oxygen (DO), pH, instantaneous discharge and collection of water chemistry samples. Direct observations of stream bottom type, bank and

channel configuration, submerged macrophyte and algae abundance were made from the wayside near CTH "A" to to the discharge(s) of the Wild Rose Hatchery, immediately up- and downstream of the site designated as the campsite (~RM 30.25), the habitat management site upstream to 19th Rd., and about 500 yds. downstream of CTH "K" and the millpond.

In general, dense overhead canopy limits plant growth in the wooded sections from CTH "A" to about RM 30. Macrophytes are moderately abundant where the canopy opens up. Species present are Anacharis, watercress and water buttercup. Measured nutrient concentrations are low in this portion of stream above the hatchery discharge(s).

Up- and downstream of 19th Rd. the the canopy opens up and the surrounding floodplain vegetation is wet meadow. Macrophytes are abundant through the habitat management area; chiefly dense growth of Anacharis and filamentous algae.

Bottom substrate is primarily sand and gravel. Extensive beds of Anacharis result in formation of large lateral and point sand bars and concomitant silt deposition. The dense stands of macrophytes results in ponding of water which extends far into the floodplain. Observations on both survey dates showed water depths greater than 1 foot on the streambanks. Habitat structures were completely inundated. Fishability in this area is difficult. Flooding restricts access and instream vegetation makes fishing difficult.

Observations of the Pine downstream of CTH "K" were made adjacent to the state-owned land at about RM 26.7. At this point forest canopy begins to restrict the abundance of plants in some areas.

### STREAM NUTRIENTS AND PLANT GROWTH

#### Current Conditions

Elevated nutrient concentrations at the campsite station are attributed to the hatchery effluent. Based on measured phosphorus concentrations in the hatchery mix-zone, Model I calculates existing biomass to be about 110 gm/m<sup>2</sup>. Based on my work in the SED this is a moderate, acceptable biomass. PHARTS study sites expressing the same range of biomass are the Ashippun R. and Sugar Creek. In these systems this amount of plant material is not considered a severe problem.

Observations in the Pine R., however, suggest current levels of plant growth to be higher than the model predicts. Several factors may be responsible for this. Plant biomass is expressed on an areal basis. When plant growth begins to pond water, this, in effect, increases the available water for support and growth. My experience with Mt. Vernon, Black Earth and Scuppernong creeks (all coldwater streams) suggest that plants in these relatively uniform environments (temperature and baseflow) may in fact have a

longer growing season, allowing them to more effectively exploit nutrients and the increased water volume caused by ponding.

For example, in the southeast, plant biomass begins to rapidly increase in early to mid June, reaching maximum standing crop in late July/early August when flowering occurs. This is followed by a fairly rapid die-back, those plants remaining in mid-August are moribund. My observations on the Pine showed the plants to be in excellent physiological condition in mid-August and September. Discussion with Ed Avery (Coldwater Research) and Mike Primising confirmed that this is common. Ponding in the Pine reportedly begins in mid-June and growth decline begins in the fall. This provides a much longer growth period than warmwater streams. In other words, I may be understating the current biomass and, more importantly, projected increases in plant biomass resulting from additional phosphorus loading.

### Projected Conditions With Additional Nutrient Inputs

In my judgement, additions of phosphorus can be expected to significantly increase instream plant biomass, making the current situation worse. I don't believe the additional hydraulic loading (0.2 cfs) will be a problem in and of itself. Increased biomass, however, will result in increased ponding, flooding and recreational impairments.

Mass balance calculations indicate the addition of wastewater from the Town of Wild Rose would result in a mix-zone concentration of 0.195 mg/l. Using Model I of the PHARTS Study, this additional discharge would result in a 2.5 times increase in plant biomass. The model calculates existing biomass to be about 110 gm/m<sup>2</sup>. The model projects that addition of secondary effluent combined with hatchery discharge(s) would increase biomass to about 280 gm/m<sup>2</sup>.

If the POTW and hatchery were to treat to 1 mg/l effluent P with the resulting mix-zone concentration of 0.07 mg/l the model projects biomass will increase to about 180 gm/m<sup>2</sup>, roughly half again the existing biomass. [Treatment to 0.5 mg/l (0.04 mix) would increase to 136 gm/m<sup>2</sup>]

Increased biomass may also have other direct and indirect impacts on the Pine River. An increase of 170 gm/m<sup>2</sup> would have an increased respiratory demand of about 12 mg O<sub>2</sub>/l·day<sup>-1</sup> or an equivalent BOD<sub>5</sub> of about 110 (if we assume an average depth of 1 ft). Put another way, this additional biomass would consume over 6 gm O<sub>2</sub>/day per meter<sup>2</sup> colonized - in addition to existing respiratory demand.

Ponding of water would also be expected to decrease K<sub>2</sub>. While the rate a portion of the deficit [K<sub>2</sub>(C<sub>S</sub> - C<sub>O</sub>)] is satisfied may be high due to a high C<sub>S</sub>, K<sub>2</sub> itself should decrease. If the K<sub>2</sub> is large enough, the maximum deficit (C<sub>S</sub> - C<sub>O</sub>)<sub>max</sub> may be specified as R/K<sub>2</sub>.

As an example:

Assume: avg. depth = .26m = 260 l/m<sup>2</sup>  
respiration = 1.5 mg O<sub>2</sub>/gm DW · hr<sup>-1</sup>  
                  = 36 mg O<sub>2</sub>/gm DW · day<sup>-1</sup>  
C<sub>S</sub> @ 16°C = 9.8 mg/l  
K<sub>2</sub> = 10 · day<sup>-1</sup>

1) Existing condition; Biomass = 110 gm DW/m<sup>2</sup>

$$R = 110\text{gm}/260\text{l} \times 36\text{mg}/\text{gm}\cdot\text{day}^{-1} = 3960\text{mg}/260\text{l}\cdot\text{day}^{-1}$$
$$= 15.2 \text{ mg}/\text{l}\cdot\text{day}^{-1}$$
$$R/K_2 = 15.2/10 = 1.52$$

$$R/K_2 = (C_S - C_O)$$
$$1.52 = (9.8 - C_O)$$
$$C_O = 9.8 - 1.52 = \underline{8.2 \text{ mg}/\text{l} \text{ minimum nighttime DO}}$$

2) Potential Condition; Biomass = 270 gm DW/m<sup>2</sup>

$$R = 270\text{gm}/260\text{l} \times 36\text{mg}/\text{gm}\cdot\text{day}^{-1} = 9720\text{mg}/260\text{l}\cdot\text{day}^{-1}$$
$$= 37.38\text{mg}/\text{l}\cdot\text{day}^{-1}$$
$$R/K_2 = 37.38/10 = 3.74$$

$$R/K_2 = (C_S - C_O)$$
$$3.74 = (9.8 - C_O)$$
$$C_O = 9.8 - 3.74 = \underline{6.06 \text{ mg}/\text{l} \text{ minimum nighttime DO}}$$

3) Condition; if K<sub>2</sub> were halved due to ponding (K = 5)

$$R/K_2 = 37.38/5 = 7.48$$
$$7.48 = (9.8 - C_O)$$
$$C_O = 9.8 - 7.48 = \underline{2.32 \text{ mg}/\text{l} \text{ minimum nighttime DO}}$$

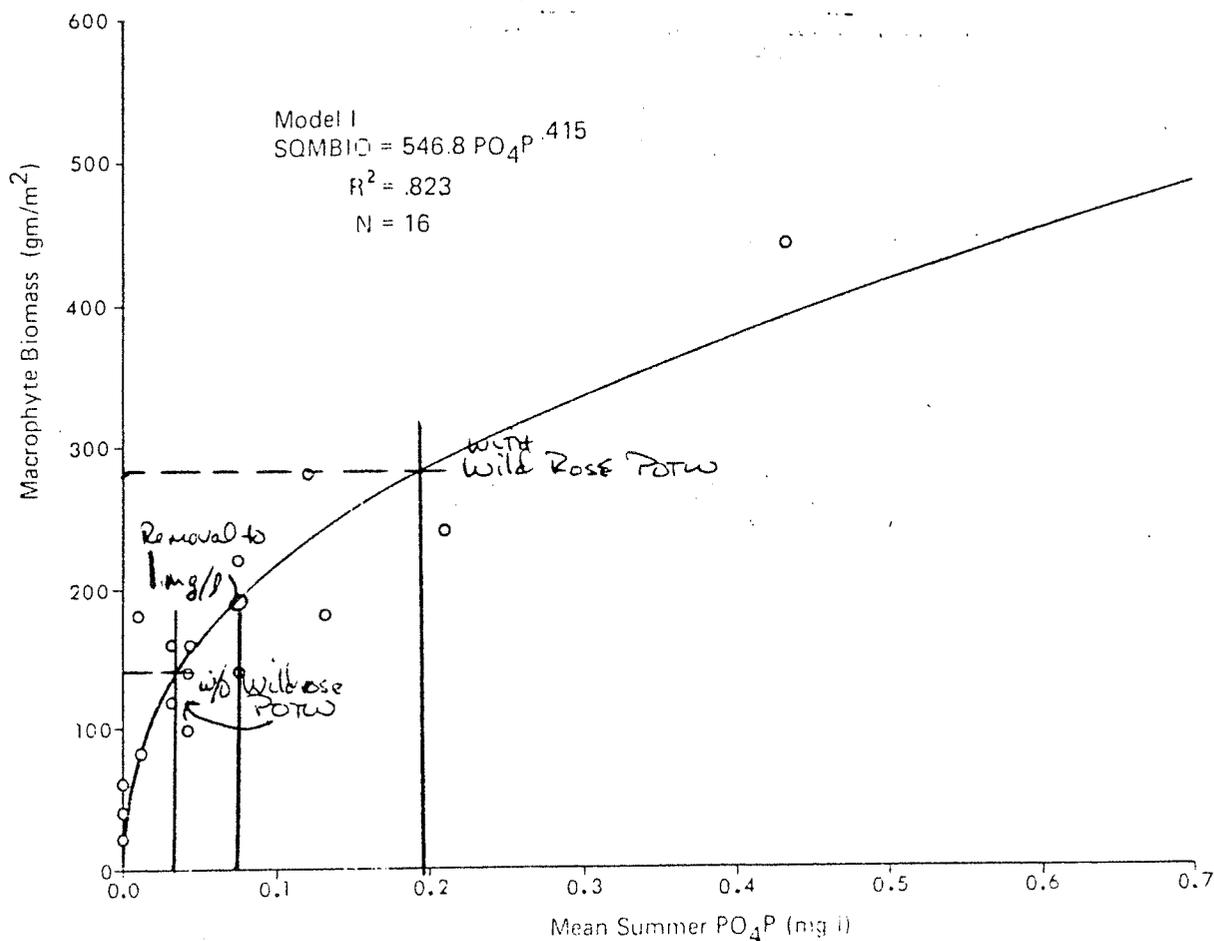
It's important to note that for the purposes of this discussion and ease of calculations I have arbitrarily selected a K<sub>2</sub> of 10. In all likelihood this is quite a bit larger than that in the macrophyte-impacted portions of the Pine. This means that minimum nighttime DO will be substantially less than that calculated. If we wish to pursue this further we should assign some realistic K<sub>2</sub> values or ranges for more vigorous treatment.

attach.

cc Tim Doelger LMD  
\* Mike Primising Wautoma

Figure 3

Regression line of late summer biomass (gm/m<sup>2</sup>) on mean summer phosphate-phosphorus concentration (PO<sub>4</sub> in mg/l) for Type I streams



nitrogen concentrations in Type I streams. The highest correlations occurred between the logarithmic transformations of tissue phosphorus and PO<sub>4</sub>P ( $r=.959$ ,  $p=.0001$ ) and TOTP ( $r=.930$ ,  $p=.0001$ ). The correlation of the natural logarithmic transformations of tissue-nitrogen with inorganic nitrogen was  $.826$  ( $p=.0001$ ) and tissue nitrogen with total kjeldahl nitrogen was  $.397$  ( $p=.17$ ).

The relationships between macrophyte tissue nutrients and in-stream nutrients led to the development of a predictive equation. This model resulted from the least squares regression of the natural log of the macrophyte tissue phosphorus concentration on

the natural log of the mean summer phosphate-phosphorus concentration in Type I stream reaches (Tables II and I2). The equation describing the relationship is:

Model II

$$PHOS = 9.469 (PO_4P)^{.310}$$

where: PHOS = Macrophyte tissue phosphorus concentration (grams per kilogram)

PO<sub>4</sub>P = Instream phosphate-phosphorus concentration (milligrams per liter)

*Schwarz* <sup>Balger-LND</sup>  
Green Bay

HATCHERY EFFLUENT EFFECTS UPON HUMPHREY CREEK

*Lower Pine actually  
(see map p. 13)*

Richard Greene  
Water 480,482

Peter Segerson  
Water 482

*From:* Kurt Welke  
Water 482

## HATCHERY EFFLUENT EFFECTS UPON HUMPHREY CREEK

### ABSTRACT

A study to determine the impact of the Wild Rose Hatchery upon water quality and Arthropod communities was conducted during early 1978. A Biotic Index using Hilsenhoff's model suggested a significant decline in water quality. Concentrations of the major nutrients of hatchery effluent, nitrogen and phosphorous, were found to increase immediately below the hatchery. Two settling ponds, between sampling sites, significantly reduced the nutrient load entering Humphrey Creek. This reduction was supported by evidence from both the chemical parameters and the biological index.

## INTRODUCTION

The Wild Rose State Fish Hatchery is the largest cold water fish hatchery in the state of Wisconsin. It is located on Highway 22, north of Wild Rose, in Waushara county. The hatchery grounds are in the Spring Water township, T20N, section 24.

The predominant geologic features present in the study area are a pre-Cambrian sandstone substrate covered by alluvial sand. Rolling hills and level uplands are covered by a sandy loam soil, which supports hardwoods, conifers, and mixed agriculture. These geologic conditions lead to an almost continual recharging of the ground water reserves and account for the large number of natural springs and artesian wells in the area. The Wild Rose Hatchery takes advantage of these conditions, its 2500-gallon-per-minute-inflow is supplied by the natural springs and artesian wells on the hatchery grounds. After use within the hatchery, this water flows into Humphrey Creek. (See map on page 13)

Between 140,000 and 150,000 pounds of trout and salmon are produced annually by the hatchery. The excrement and waste products from these fish represents a sizeable nutrient contribution to the natural fertility of Humphrey Creek. We reviewed previous work on the problems posed by Hatchery effluent. Primmer and Clugston (1975) evaluated three southeastern United States trout hatcheries for their effect on benthos and fish in streams. Numbers and kinds of fish and benthos increased below the hatchery outfall. They found pollution intolerant benthos remaining below fish hatcheries.

Bodien (1971) found low summer flows create nuisance algae conditions in receiving waters. He recommended pollution control measures for any new and existing facilities.

Szluha (1972) on a study of Michigan's Jordan River concluded that hatchery effluent was responsible for exponential periphyton production and a seven fold increase in mean productivity below the hatchery outfall.

Liao (1970) sent a questionnaire to 65 agencies responsible for hatchery operations. Results were as follows; thirteen indicated the existence of pollution problems, nine had made pertinent research studies, eight had instituted special pollution control measures, and eighteen felt that there was a potential problem with fish hatchery wastes. Liao's review concluded that pollution control should be through in-hatchery improvements and treatment of effluents:

Our objective of this study was to determine the effect of hatchery effluent upon water quality in Humphrey Creek.

#### MATERIALS AND METHODS

Three test sites were sampled to compare chemical parameters. Two stations served as sites for an arthropod biotic index evaluation of water quality.

Site One was comprised of the natural springs and artesian wells that serve as the water supply for the hatchery. This site demonstrated the water quality before being affected by hatchery effluent.

Site Two was located directly below the hatchery outfall. This site represents the chemical parameters and biotic index measurements before entering settling ponds. The site was characterized by .5-.75 meters of accumulated organic matter and the presence of sewage fungi and filamentous bacterium.

Site Three was in the natural channel of Humphrey Creek below the settling ponds. The stream bottom is predominantly shifting sand with large deposits

of organic matter where the current slows. The streambank vegetation consists of mixed hardwoods. See maps for location of the above 3 sites.

The water samples for the analysis of the chemical parameters were taken in clean, one gallon plastic milk jugs. Oxygen determinations were taken using a standard 300 ml. D.O. bottle at each site. Chemical analyses followed procedures found in the 14th edition of Standard Method for Examination of Water and Wastewater. (See Table 6)

Arthropods for the biotic index were sampled using a dip net, a Surber sampler and a general examination of fallen tree limbs and various debris. We tried to randomly sample approximately 100 specimens greater than 3 mm. without concentrating on number while sampling. This method follows Hilsenhoff's (1977) outline for using arthropods in a biotic index to evaluate water quality of streams. The biotic index was calculated using the following formula:

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

where  $n_j$  = number in each taxa  
 $a_j$  = assigned value for that species  
 $N$  = total number of arthropods in that sample

Assigned values ( $a_j$ ) range from 0 to 5. Value 0 is assigned to pollution intolerant taxa and values 1,2,3,4,5 are assigned to taxa increasing in tolerance to pollution.

RESULTS

Table 1 \*

Water Quality Determination From Biotic Index Values

<u>B.I. Value</u>	<u>Water Quality</u>	<u>State of Stream</u>
less than 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
greater than 3.75	Very poor	gross enrichment or disturbance

\* from Hilsenhoff (1977)

Table 2

Sample Site Two  
(below hatchery and above settling ponds)

<u>Taxa</u>	<u>Assigned Value (a<sub>i</sub>)</u>	<u>Number in each Taxa</u>		
		<u>Feb. 18</u>	<u>March 16</u>	<u>Mar. 13</u>
<u>Gammarus psuedolimneus</u>	2	29	21	13
<u>Asellus intermedius</u>	5	8	10	21
<u>Chironomous</u>	5	98	57	75
Total <u>N</u>		135	88	109
Biotic Index Value		4.36	4.28	4.64

Table 3

Sample Site Three  
(below settling ponds)

Taxa	Assigned Value (a <sub>j</sub> )	Number in each taxa		
		Feb. 18	Mar. 16	Mar. 31
scud → <u>Gammarus psuedolimneus</u> <i>C. crustacea</i> <i>O. amphipoda</i>	2	146 73	42	79
slow bug → <u>Asellus intermedius</u> <i>C. crustacea</i> <i>O. isopoda</i>	5	100 20	10	23
Pink Fly → <u>Simulium venustum</u> <i>C. insecta</i> <i>O. Diptera</i> <i>f. Simuliidae</i>	3	246 63 309 21	9	13
Caddis fly → <u>Hydropsyche</u> <i>C. insecta</i> <i>O. trichoptera</i>	3	63 309 21	13	19
midge → <u>Chironomus</u> <i>C. insecta</i> <i>O. Diptera</i> <i>f. Chironomidae</i>	5	10 2	0	4
caddis fly → <u>Ceraclea</u> <i>C. insecta</i> <i>O. trichoptera</i> <i>f. Ceracleidae</i>	2	4 2	0	0
may fly → <u>Baetisca</u> <i>C. insecta</i> <i>f. Baetiscidae</i> <i>O. ephemeroptera</i>	2	1 1	0	2
may fly → <u>Argia moesta</u> <i>C. insecta</i> <i>O. odanota</i>	2	1 1	0	0
may fly → <u>Antocha</u> <i>C. insecta</i> <i>O. Diptera</i>	2	0	3	6
may fly → <u>Chauliodes rasticornis</u> <i>C. insecta</i> <i>O. Megaloptera</i>	2	0	1	2
may fly → <u>Callibaetis</u> <i>C. insecta</i> <i>f. Baetiscidae</i> <i>O. ephemeroptera</i>	3	0	7	3
Black fly → <u>Atherix variegata</u>	2	0	0	1
Caddis fly → <u>Hesperophylax</u> <i>C. insecta</i> <i>O. trichoptera</i> <i>f. Limnephilidae</i>	1	0	0	2
Total N		141	85	154
B.I. Value		2:76-	2:69	2:66

390  
1  
2,41  
2,76  
1,846  
1,957 0  
2,200  
3,991 6

Table 4

Summary Table For Biotic Index

	<u>February 18</u>	<u>March 16</u>	<u>March 31</u>	<u>Mean</u>
Site Two	4.36	4.28	4.64	4.42
Site Three	2.76	2.69	2.66	2.70

Table 5

Comparison Of Biotic Indices Of Other Wisconsin Streams

<u>Stream</u>	<u>County</u>	<u>Biotic Index</u>	<u>Disturbance</u>
*Sidney Creek	Marinette	1.29	None
*Lawrence Creek	Marquette	1.39	None
*Big Roche a Cri	Adams	1.69	None
*Pine River	Vernon	2.67	Cheese factory, cattle pasturing upstream
Humphrey Creek (site 3)	Waushara	2.70	primary treated trout hatchery effluent
*Badfish Creek	Rock	4.29	urban effluent
Humphrey Creek (site 2)	Waushara	4.47	untreated trout hatchery effluent

\* from Hilsenhoff (1977)

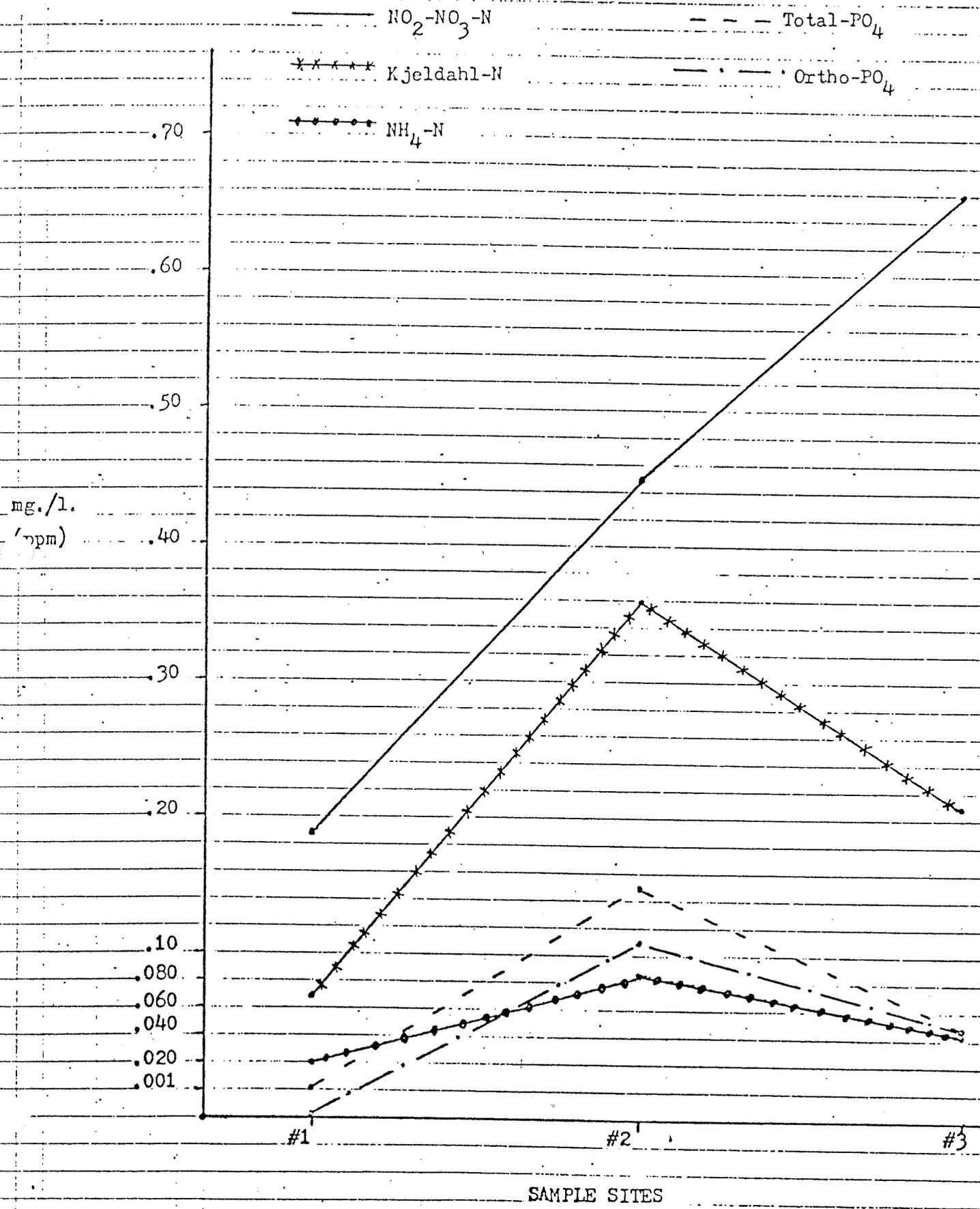
TABLE 6. Methods Used for Analysis of Chemical Parameters

Chemical Parameter	Basic idea of method used	Reference in 14th. St'd Metho
Conductivity	Electrical flow across a cell of a self-contained conductance instrument	pp. 71-75.
pH	Electronic pH meter; glass and reference electrodes	pp. 460-465.
Alkalinity	Titration with $H_2SO_4$ meq $H_2SO_4$ = meq alkalinity	pp. 278-282.
Hardness (Ca <sup>++</sup> & Total)	Titration with EDTA mmole EDTA = mmole hardness	pp. 200-206.
Nitrogen (NO <sub>2</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , NH <sub>4</sub> <sup>+</sup> , Kjeldahl)	Conc. $H_2SO_4$ digestion for Kjeldahl Distillation apparatus, Titration with $H_2SO_4$	pp. 406-440.
Phosphorus (Total & Ortho)	Persulfate digestion for Total; Color development with Stannous Chloride. Spectrophotometer reading at 690nm compare to standard curve	pp. 479-480.
Dissolved Oxygen	Azide modification of Winkler method	pp. 443-447.
Biochemical Oxygen Demand, 5 day - 20 C	Aeration, Initial D.O. measurement, Incubation for 5 days at 20 C, remeasure D.O.	pp. 543-549.
Chemical Oxygen Demand	Potassium dichromate, Reflux, Back titrate with ferrous ammonium sulfate	pp. 550-554.
Residual Chlorine	Titration with sodium thiosulfate	pp. 316-318.
Iron	Color development with phenanthroline, Spectrophotometer reading at 508nm, compare to standard curve	pp. 208-213.
Sulfate	Turbidimetric method, form barium sulfate turbidity, Spectrophotometer reading at 420nm, compare to standard curve	pp. 496-498.
Silica	Color development with ammonium molybdate, Spectrophotometer reading at 650nm, compare to standard curve	pp. 487-490.
Potassium Sodium	Flame Photometry	pp. 234, 250-25
Fluoride	Electronic meter; solid-state and reference electrodes	Handout Weber, Stephen

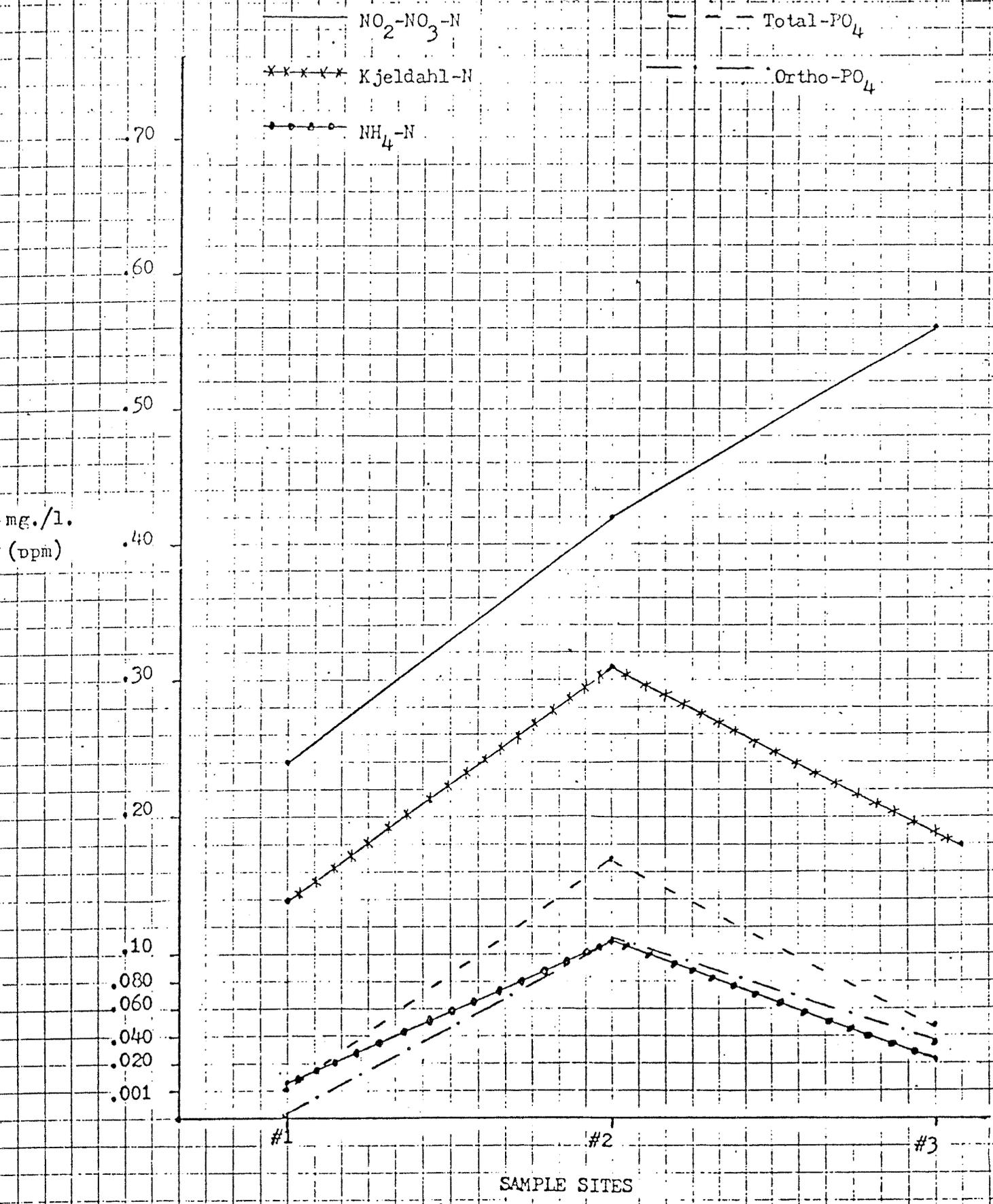
RESULTS: TABLE 7 - Chemical Parameters

Site	1	2	3	1	2	3
	<del>2/18/78</del>	<del>2/18/78</del>	<del>2/18/78</del>	3/10/78	3/10/78	3/10/78
Temp. °C	4, clear	4, clear	4, clear	6.5, cloudy	6.5, cloudy	6.5, cloudy
Temp. °C	7.0	7.5	4.0	8.5	9.0	6.5
	8.5	6.5	11.3	9.3	6.6	11.8
Humidity	69.7%	53.3%	86.3%	78.2%	56.9%	94.5%
Temp. °C	4.8	6.9	5.5	5.0	7.0	5.3
	2.5	10.1	3.8	3.4	8.8	4.0
	7.9	7.8	8.1	8.1	7.8	8.2
Conductivity /cm	329	363	391	349	375	390
Hardness	158	186	200	156	184	196
Hardness	208	186	206	178	192	206
Hardness	98	112	116	100	112	124
	.02	.084	.042	.014	.11	.042
NO <sub>3</sub> -N	.19	.45	.66	.24	.42	.56
Ammonia-N	.07	.36	.21	.14	.31	.18
Ortho-PO <sub>4</sub>	.0017	.15	.045	.0012	.17	.049
Para-PO <sub>4</sub>	BDL*	.11	.045	BDL	.11	.028
Total Cl	BDL	BDL	BDL	BDL	BDL	BDL
	.022	.08	.036	.019	.071	.025
Alkalinity	7.6	13.2	5.6	8.7	11.5	7.4
Chloride	4.2	3.3	4.1	3.8	3.1	3.5
Sulfate	2.4	1.4	3.4	3.1	1.6	3.5
Sodium	1.9	2.5	2.3	1.4	1.3	1.3
Ammonium	4.4	4.6	4.3	2.9	2.8	2.8
Ammonium	.0055	.0050	.0057	-	-	-
	.025	.0125	.020			

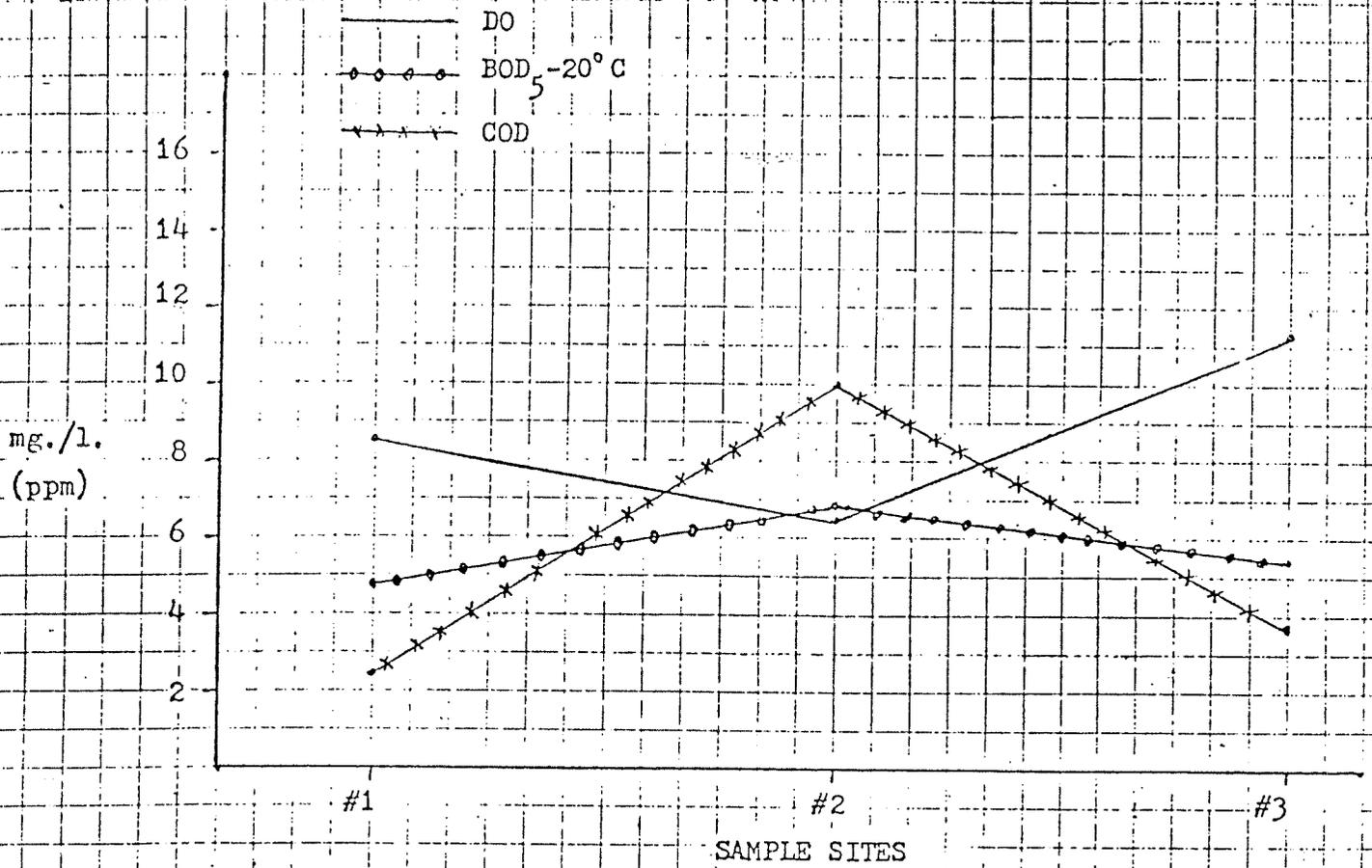
GRAPH 1 - Comparing  $\text{NH}_4\text{-N}$ ,  $\text{NO}_2\text{-NO}_3\text{-N}$ , Kjeldahl-N, Total- $\text{PO}_4$ , and Ortho- $\text{PO}_4$  on the first sample date 2/18/78.



GRAPH 2 - Comparing  $\text{NH}_4\text{-N}$ ,  $\text{NO}_2\text{-NO}_3\text{-N}$ , Kjeldahl-N, Total- $\text{PO}_4$ , and Ortho- $\text{PO}_4$  on the second sample date 3/10/78.



GRAPH 3 - Comparing DO, BOD<sub>5</sub>-20°C, COD on first sample date 2/18/78.



GRAPH 4 - Comparing DO, BOD<sub>5</sub>-20°C, COD on second sample date 3/10/78.

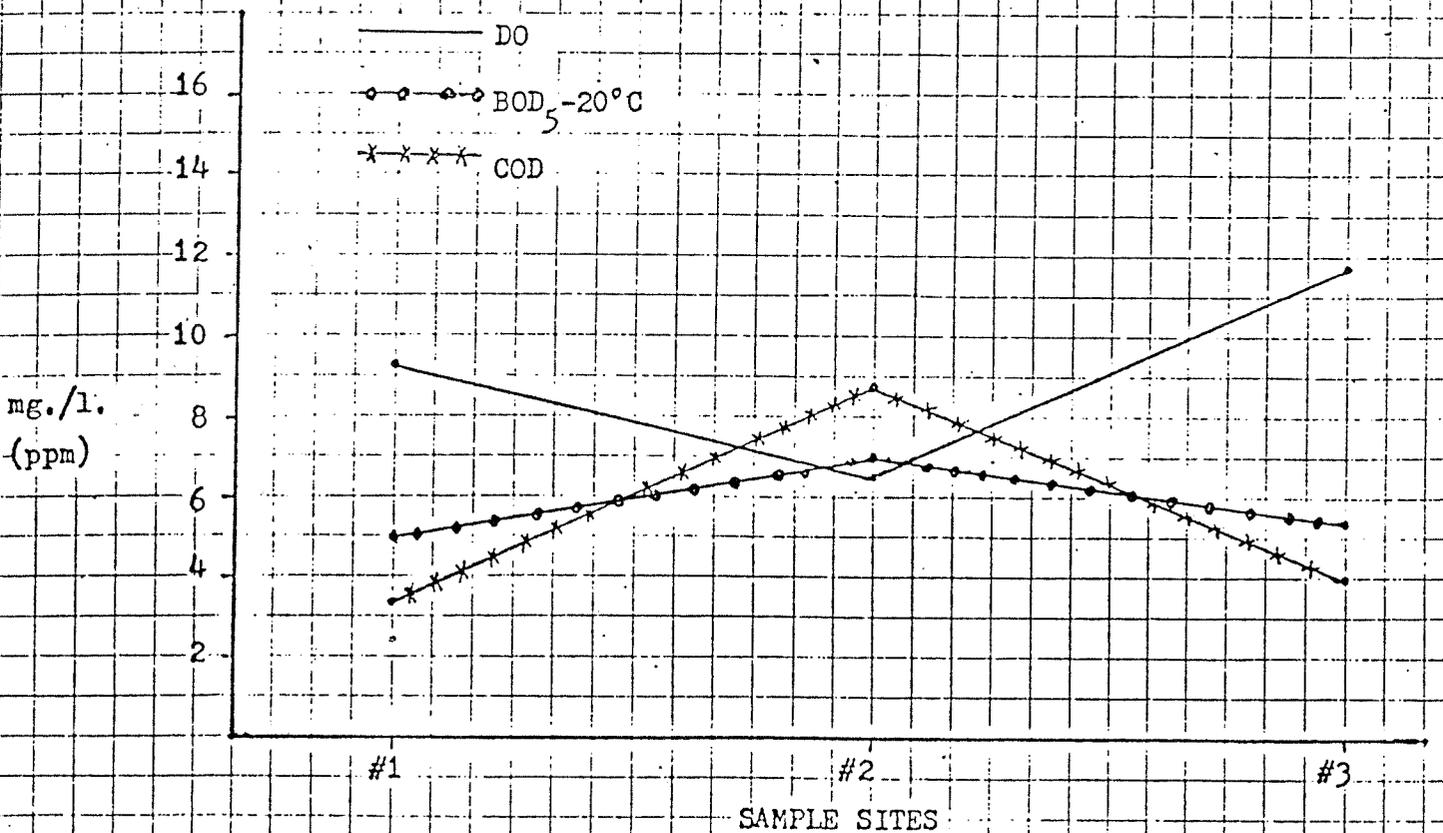


Table 8 - Computer Printout Data

Carbonate Program

Sample Site	Date	pH	pHs	CO <sub>2</sub> ppm excess or deficit
1	2/18/78	7.9	7.745	-2.28
2	2/18/78	7.8	7.623	-3.95
3	2/18/78	8.1	7.584	-9.59
1	3/10/78	8.1	7.620	-5.89
2	3/10/78	7.8	7.502	-6.79
3	3/10/78	8.2	7.565	-10.84

Charge Balance Program

Sample Site	Date	Meq. Positive Charge	Meq. Negative Charge	Difference	%
1	2/18/78	4.0981	3.6474	Pos. exceeds Neg. by .450701	12.36% of Neg.
2	2/18/78	3.9853	4.1206	Neg. exceeds Pos. by .135370	3.40% of Pos.
3	2/18/78	4.3645	4.2773	Pos. exceeds Neg. by .087216	2.04% of Neg.
1	3/10/78	3.7201	3.4227	Pos. exceeds Neg. by .297438	8.69% of Neg.
2	3/10/78	3.9978	4.0375	Neg. exceeds Pos. by .039628	.99% of Pos.
3	3/10/78	4.2210	4.0700	Pos. exceeds	1.46% of

Spring Pond and Artesian Wells \*

\* SAMPLE SITE ONE

Hatchery Runways

Hatchery Grounds and Buildings

Highway 22

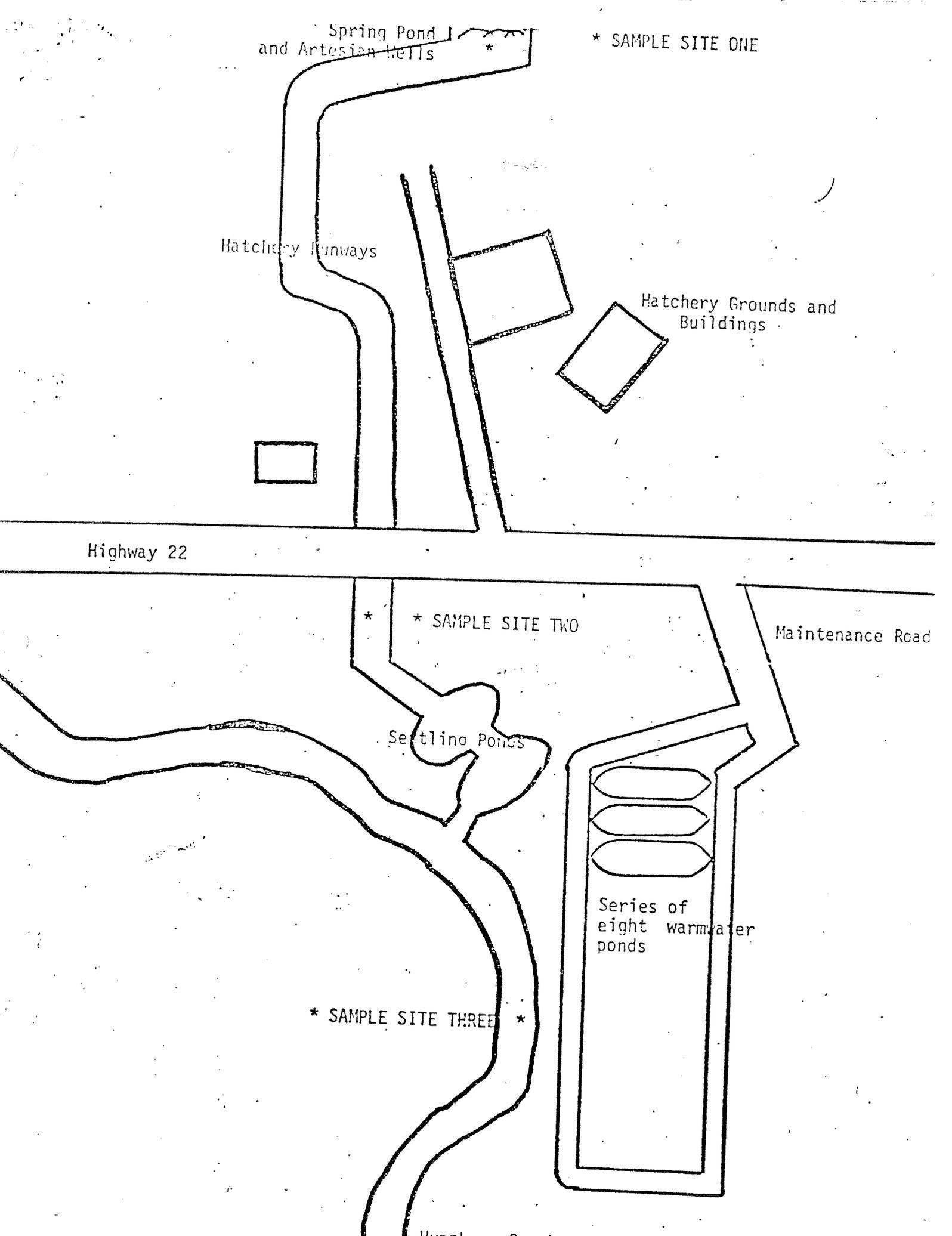
\* SAMPLE SITE TWO

Maintenance Road

Settling Ponds

Series of eight warm water ponds

\* SAMPLE SITE THREE \*



## DISCUSSION - Biotic Index

The biotic index gave remarkably consistent values on 3 different dates at both sample sites.

At Site Two the values ranged from 4.28 to 4.64 with a mean of 4.42. These values indicate gross enrichment and disturbance at this site. This sample consisted of three taxa; Gammarus psuedolimneus, Asellus intermedius, Chironomus sp. The genus Chironomus, a good pollution indicator, comprised 75% of the sample. This lack of diversity may be due to the absence of favorable substrate sites, because of the .5 to .75 meter organic deposits and abundant growths of sewage fungi and filamentous bacterium. The lack of substrate sites may have caused an artificially higher value. The conditions that may have caused this value, are in themselves indicative of organic pollution.

At Site Three the values ranged from 2.66 to 2.76 with a mean of 2.70. These values indicate moderate enrichment or disturbance. At this site Gammarus psuedolimneus (approximately 50%) was the dominant organism with Asellus intermedius, Simulium venustum and Hydropsyche sp. contributing approximately 15% each. Two relatively pollution intolerant caddis flies of the genus Hesperophylax were sampled. Primmer and Clugston (1975) had found pollution intolerant benthos remaining below fish hatcheries.

Small woodland streams like Humphrey Creek are generally low in diversity and biomass. (Hilsenhoff 1977) Organic enrichment from fish excrement is probably increasing Arthropod production in Humphrey Creek. Again, Primmer and Clugston (1975) showed this in 3 southeastern United States streams below fish hatcheries.

When comparing our biotic index value to some of Hilsenhoff's (1977) it shows the hatchery effluent as a significant pollutant. The value at Site Two was

greater than that found in Badfish Creek, which carries the treated urban effluent from the city of Madison. The value at Site Three, after the settling ponds, is similar to that calculated for the Pine River in Vernon County. The Pine is polluted by pasturing cattle and a cheese factory.

The biotic index indicates an improvement in water quality after the settling ponds, though there is still sufficient reason to consider Humphrey Creek polluted.

#### DISCUSSION - Chemical

The two most important nutrients in aquatic ecosystems are nitrogen (Kjeldahl-N,  $\text{NO}_2\text{-NO}_3\text{-N}$ ,  $\text{NH}_4\text{-N}$ ) and phosphorous (Total- $\text{PO}_4$  and ortho- $\text{PO}_4$ ). The trend in nutrient concentrations was a general increase from Site One to Site Two followed by a decrease from Site Two to Site Three for all nutrients except  $\text{NO}_2\text{-NO}_3\text{-N}$ . This trend can be observed on both sampling dates. (See graphs 1 and 2). The individual nutrient forms varied between the sites for a combination of reasons.

The analysis of ammonium at Site One revealed low concentrations (.02 ppm, .014 ppm). This level of ammonium would seem to indicate two possibilities. First, nitrification is taking place and the ammonium is changing forms. The second possibility for these levels is that no appreciable source of  $\text{NH}_4$  exists at Site One. In our estimation the ammonium source is present in the form of decaying leaves (the BOD indicates this), but nitrification is taking place simultaneously. At Site Two ammonium levels increased sharply (.084 ppm, .11 ppm). This would seem to be a direct result of the hatchery effluent. At Site Three, after the water has passed through the settling ponds, ammonium levels decreased somewhat to .042 ppm on both sample dates. This decrease in  $\text{NH}_4$  concentrations

may be due to the utilization of this nutrient by bacteria and algae within the ponds, as well as the occurrence of nitrification.

The nitrite-nitrate levels at Site One were determined to be .19 ppm and .24 ppm. These amounts could be attributed to nitrate leeching through ground water, dry fallout, or also through nitrification of the ammonium present at the site. Fixation by algae could be a source of nitrate, however, steep banks prevent the necessary sunlight to augment the production of this nutrient. The  $\text{NO}_2\text{-NO}_3$  levels at Site Two were found to increase (.45 ppm, .42 ppm), which again could be due primarily to the large volumes of fish waste reaching the site. This was the only primary nutrient found to increase between sample sites Two and Three. (Concentrations at Site Three were .66 ppm and .56 ppm). The most possible reason for these levels would be the fixation of atmospheric nitrogen by blue-green algae present in the settling ponds. Some nitrification of  $\text{NH}_4$  could also be taking place. We feel fixation by blue-green algae is the main source; a .1 ppm increase in  $\text{NO}_2\text{-NO}_3$  was ascertained on the first sample date when sunshine prevailed, over that of sample date two when appreciable <sup>cloud</sup> cover was present.

Kjeldahl nitrogen amounts at Site One were .07 ppm, .14 ppm. Slightly increased temperature resulting in altered bacterial activity may account for the differences in Kjeldahl values on the two sample dates. At Site Two the Kjeldahl-N increased to .36 ppm and .31 ppm. Once again this could be due to the excretion of the hatchery trout. Levels showed a decrease at sample Site Three. Particulate settling within the ponds would seem to be the main reason for lower Kjeldahl-N levels. Algal and bacterial utilization in the settling ponds could also be responsible for the decreased amounts.

Ortho-phosphate levels on both sample dates were below detectable limits at Site One. The usual absence of ortho- $\text{PO}_4$  in groundwater is illustrated in these

springs and artesian wells. The amounts increased greatly at Site Two. (.11 ppm, .11 ppm) The increase of dissolved inorganic phosphate would seem to be caused by the trout rearing between Sites One and Two. At Site Three the Ortho- $\text{PO}_4$  concentrations decreased to .045 ppm both sample dates. Algal use of this nutrient, along with settling in the ponds, may be the cause for these lowered levels. Particulate precipitation could also be a minor factor.

Total phosphates at Site One were also quite low (.0017 ppm, .0012 ppm). The breakdown of organic leaf matter may explain these quantities. At Site Two the total  $\text{PO}_4$  raised to .15 ppm and .17 ppm. Once more this indicates the possible effect of trout waste products. Also any residual uneaten trout food may dissolve and contribute to this amount. At Site Three, amounts of total  $\text{PO}_4$  decreased (.045 ppm, .049 ppm). Algal and bacterial activity, along with settling within the ponds may have reduced concentrations of total phosphate at Site Three.

There was a variation in oxygen relationships between sample sites. (See graphs 3 and 4). However,  $\text{O}_2$ , BOD, COD levels on the separate sample dates were so close as to be nearly equal, therefore only one value for each (for the first sample date) is presented in this discussion.

The D.O. level at sample Site One was 8.5 ppm. This represents a 69.7% saturation at a water temperature of 7° C. Although groundwater is normally low in oxygen, the absence of ice at Site One made possible  $\text{O}_2$  exchange between the air and water surface. The BOD (4.8 ppm) from the breakdown of organic matter (leaves) was probably the reason for the determined level of saturation. The COD was 2.56 ppm, this being lower than the BOD, may indicate nitrogenous oxygen demand.

On sample date one, the Site Two oxygen level was 6.5 ppm. Similarly a 7.5° C.

temperature yielded a 53.3% saturation. Between Sites One and Two, continuous aeration took place to keep O<sub>2</sub> levels optimum for fish propagation. Site Two was beyond the aeration zone, and the decreased concentration was noted. The comparatively low O<sub>2</sub> level is reflective of the high BOD (6.9 ppm) and COD of 10.0 ppm. These high BOD and COD levels are most likely due to the hatchery wastes reaching the site. The partial nonutilization of the fish food contributes organic matter, thus influencing BOD and COD levels.

Site Three had a dissolved oxygen determination of 11.3 ppm. This is an 86.3% saturation at a 4° C water temperature. Turbulence at Site Three allowed ample opportunity for O<sub>2</sub> exchange. BOD levels at Site Three were still a relatively high 5.5 ppm. Due to bacterial action and settling, the ponds removed 1.4 ppm BOD and 6.2 ppm COD. The primary reason for this saturation is the inefficiency of the removal of organic matter within the ponds. The settling ponds removed some organic matter, but it would seem that a significant amount did reach Humphrey Creek, due to a insufficient retention time in the ponds.

High conductivity, alkalinity, and hardness throughout the test sites seem to be indicative of the water source itself. Slow moving groundwater, the major source of water supply, allows for sufficient contact time between the minerals present in the substrate and the groundwater itself. This contact time presents an opportunity for many ions to be taken into solution. A CO<sub>2</sub> deficiency at all sample sites could allow for precipitation of CaCO<sub>3</sub>.

The alkalinity was observed to increase steadily from Sites One to Three. One possible reason for this increase could be the fact that concrete raceways form the channels within the hatchery. Concrete, being a very alkaline material, could contribute to the increase.

## CONCLUSION

In our sampling of Humphrey Creek, both the biological index and the measured chemical parameters indicated gross organic pollution before the settling ponds. Humphrey Creek remains a Class I trout stream below the Wild Rose Hatchery. In part, this quality is ensured by the removal of nutrients and organic matter in the two settling ponds. Brynildson and Mason (1975), showed that enrichment of Black Earth Creek, by effluent from the municipality of Cross Plains, increased trout production. Similarly, hatchery effluent may lead to increased biological productivity in Humphrey Creek.

Overall, water use at the hatchery is efficient in our estimation. Warmwater rearing ponds for the propagation of Northern pike (Esox lucius), Muskellunge (Esox masquinongy), and Walleye (Stizostedion vitreum) make use of the water supply from the trout operation. (Czeskleba, 1975). These warmwater ponds are only in operation during summer months. Therefore summer conditions in Humphrey Creek may differ from our data.

We feel that the information we collected has implications for any new or existing hatcheries in Wisconsin. For the future, fish hatchery pollution control should be through in-hatchery improvements, efficient use of water and effluent treatment.

## CORRESPONDENCE/MEMORANDUM

STATE OF WISCONSIN

cc Jim Moore

Date: September 22, 1987

File Ref: 3200

To: Tom Bennwitz - WR/2

RECEIVED DNK

From: Mike Primising/Wautoma *mmf*

SEP 24 1987

Lake Mich. Dist.

Subject: Lower Pine River near Wild Rose

The Pine River downstream from the Wild Rose dam for a distance of approximately 9.8 miles is Class I trout water with the predominant species being brown trout. (Some native brook trout plus rainbow escapees from the state fish hatchery). There is a fish management concern over the growth of instream aquatics in that portion of river lying between the Wild Rose Dam, Section 19 and the Idlewild Millpond in Section 17, T20N, R11E. Growth of rooted aquatics (Anacharis, Ranunculas, Veronica) plus thread and filamentous algae vary from year to year with periods when stream flow is impeded by very lush growth. This results in water back ups and flooding of lowland areas adjacent to the stream channel. At times, man-installed habitat improvement structures (bank covers, wings and bank rip-rap, has been overtopped by the impounding effects of vegetation. This condition intensifies the further downstream and closer to the inlet of the stream into the Idlewild pond above County Highway "K".

On at least 3 occasions in the 1980's, Mecan River Youth Camp crews have mechanically removed nuisance growth of aquatic in the vicinity of 19th Drive Road crossing in Section 17 to alleviate water back up problems.

Public comments in 1984-85 at informational meetings on our Departments Pine River Master Plan addressed the concern by fishermen and local riparians over excessive weed growth and potential causes. General consensus being that outfalls from Wild Rose sewage plant, plus waters from the state fish hatchery, may be significant factors to nutrient loading and subsequent weed growth.

Of added concern is the fact that there have been documented instances of groundwater pollution resulting from irrigation practices in Central Wisconsin which indicates how existing human activities can degrade this fragile resource. Of concern is the wide spread use of fertilizer and pesticides on agricultural lands in the watershed and long-term effect on surface flows and groundwater tables that are the lifeblood of the stream system.

In my opinion, this section of the Pine River below Wild Rose should not be the receiving waters for increased nutrient loading from expansion of existing sewage facilities at Wild Rose. I believe the state has to take a long, hard look at water quality running from our hatchery facilities and the effects of this nutrient source as a contributor to the weed growth problem in the Pine River.

MJP:jcl

NOTED: \_\_\_\_\_ Date

cc: Tim Doelger/Green Bay  
Steve Mace - SED/Milwaukee