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DEPARTMENT OF ECOLOGY
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MEMORANDUM
April 5, 1983

To: Carl Nuechterlein

From: Bill Yake

Subject: Colfax Class II and Receiving Water Survey

INTRODUCTION

Colfax (population 2,780) is served by a wastewater treatment plant (WTP) located along the Palouse River just downstream of its confluence with the South Fork of the Palouse River (SFPR). During the late 1970s, the Colfax WTP was upgraded to comply with secondary treatment standards for biochemical oxygen demand (BOD) and suspended solids (SS). Originally, the plant consisted of a single aeration basin followed by a secondary clarifier. The post-upgrade design includes a second aeration basin followed by a new chlorine contact structure and a series of infiltration cells (Figure 1). The plant upgrade, including new laboratory facilities was completed in the spring of 1979.

A Class II (source compliance) inspection and receiving water study were conducted August 30 - September 1, 1982, at the request of the Eastern Regional Office (ERO) of the Washington State Department of Ecology (WDOE). The purposes for this study were several:

1. Determine if the upgraded plant is complying with NPDES permit limits and assess the efficiency of infiltration beds in providing improved effluent quality;

2. Review and evaluate laboratory procedures at the Colfax WTP's laboratory. This was considered particularly important because this facility serves as a regional laboratory, processing wastewater samples from a number of nearby communities; and

3. Assess the impact of Colfax WTP effluent on water quality in the Palouse River. Information from this work is to be used in drafting the new NPDES permit for the Colfax plant.

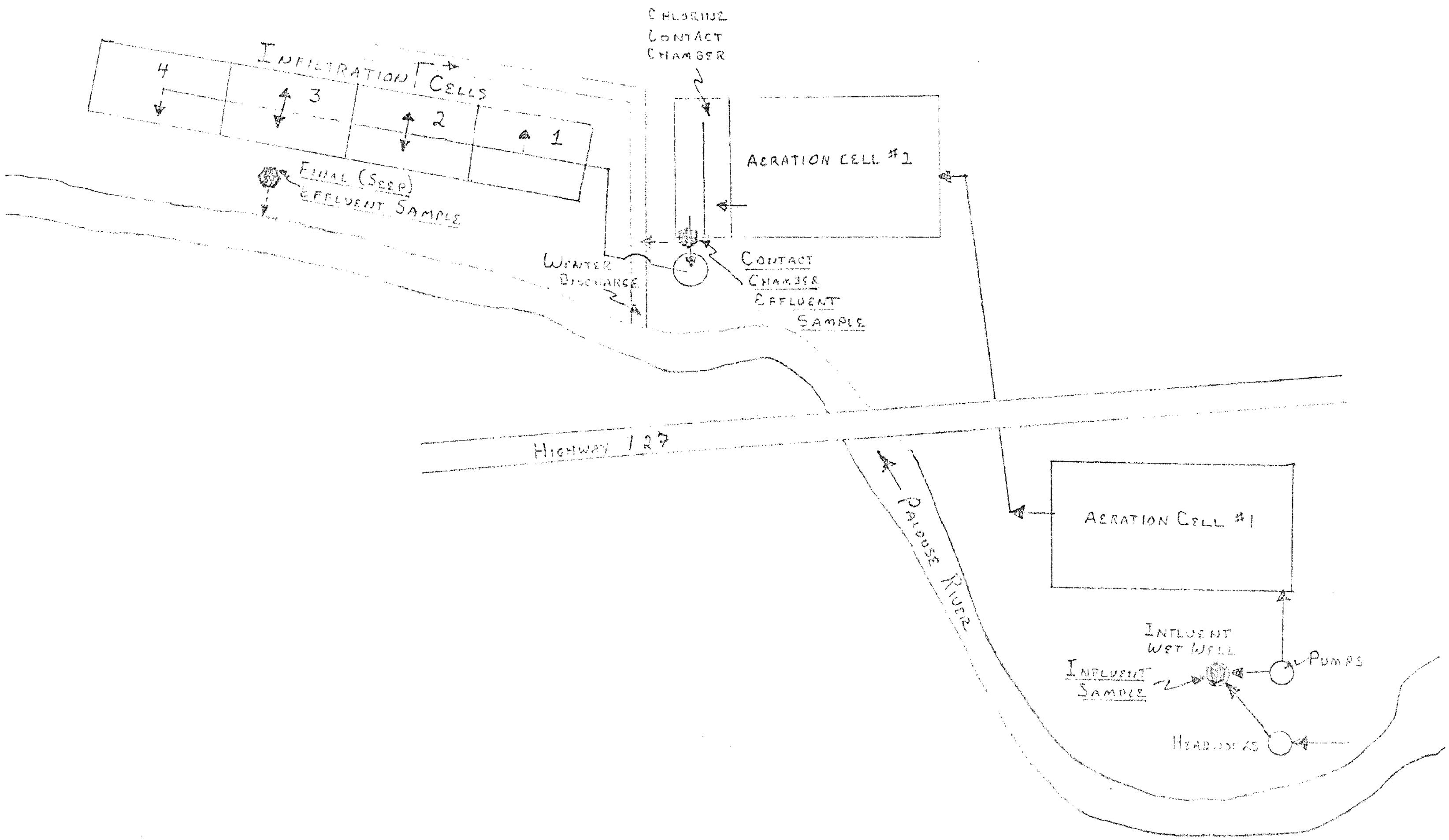

Figure 1. Colfax sewage treatment plant and sample locations.

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Participating in the survey were Marc Heffner and Bill Yake (WDOE, Water Quality Investigations Section). Substantial and valuable assistance was provided by Carl Nuechterlein and Larry Peterson (WDOE, ERO). Special thanks are also due to the Environmental Engineering Department of the Washington State University (Gary Bailey in particular) for the loan of a "pygmy" flow meter when our original meter failed to operate.

The aid and cooperation of Lem Long (chief operator, Colfax WTP) is much appreciated, as was the attendance of the following operators during laboratory review: Bill Kavanaugh (Colfax); Wayne Bly (St. John); and Mark Hegg (Palouse).

The results of this study are reported in two sections: Part I - Colfax WTP Class II Survey; and Part II - Colfax Receiving Water Survey.

Part I. Colfax WTP Class II Survey

Introduction

The flow diagram of the Colfax WTP is illustrated in Figure 1. Incoming sewage is comminuted at the headworks and then pumped from the influent wet well to aeration basin #1. Influent samples are obtained from the wet well. Wastewater then flows to aeration basin #2. The total detention time in basins #1 and #2 is about 25 days. Chlorine is added at the discharge of basin #2. Plant flow is measured at a 90° V-notch weir located at the end of the contact chamber. After passing through the contact chamber, effluent is usually pumped to a series of infiltration beds. During the winter, effluent has been discharged directly to the Palouse River. There are four filtration beds. These are flat-bottomed cells built in, and bermed by, native soils. During the survey, only cells 2 and 3 were being used. Cell 4 was not being used due to inadequate permeability. Cell 1 is excessively permeable and was not being used.

During winter high flow (December to March), use of infiltration cells has been suspended and effluent is discharged directly from the contact chamber. This is done for two reasons: (1) the final (seep) effluent sampling location is often inundated by the Palouse River; and (2) the pipes between the pump station and the infiltration cells are not insulated and can freeze. Eastern Regional Office personnel have recommended insulation of the pipes and year-around use of the infiltration cells.

Obtaining representative effluent samples at the Colfax plant has posed some problems. Plant personnel have developed a seep down-gradient from cell #3. Drainage from this seep is routed to a bucket and the effluent sample is obtained from this bucket using a portable Manning composite sampler. This method appears to be satisfactory. Comparison of conservative tracers (dissolved solids, conductivity) revealed little or no dilution of effluent by groundwater.

During the inspection, aeration basin #2 contained large populations of a rooted macrophyte (probably Eurasian milfoil) which formed floating mats. These macrophytes appear to hinder aeration and mixing, and operators have had to remove several truck loads of the plants from the cell. Chief operator Lem Long is currently discussing possible solutions with the WSU Environmental Engineering Department and the ERO.

Sampling Methodology

Twenty-four-hour composite samples were obtained at the influent, contact chamber effluent, and a seep below infiltration cell #3 (see Figure 1). In addition, fecal coliform grab samples were obtained at both effluent sampling sites and field tests for three parameters (temperature, pH, and specific conductivity) were conducted twice at each of the three sample sites. Total chlorine residual was measured concurrently with fecal coliform sampling. Table 1 contains specific information regarding times, dates, locations, and analyses pertinent to each of these samples.

In addition to the samples noted above, Colfax WTP personnel collected their weekly influent and effluent composite samples during approximately the same time period. Colfax WTP and WDOE composite samples were split, allowing analysis of all composite samples by both the Colfax laboratory and the WDOE Tumwater laboratory. Table 2 summarizes the WDOE analytical results, while Table 3 summarizes Colfax WTP laboratory results.

Table 3. Colfax WTP laboratory results.

	Influent		Contact Chamber Effluent	Final Effluent (seep)	
	WTP Comp.	WDOE Comp.	WDOE Comp.	WTP Comp.	WDOE Comp.
BOD_5 (mg/L)	166	139	10.2	15	6
TSS (mg/L)	122	155	5.2	8	13

The plant's original Sparling flow meter, located in the pipe between aeration cell #2 and the contact chamber, was out of order. A Leopold-Stevens recorder had been placed behind a 90° V-notch weir located at

Table 1. Composite and grab sample information.

24-hour Composite Sampler Information

Sampler	Date & Time Installed	Location
1. Influent sample aliquot: 230 ml/30 min.	8/31 - 0840	Influent wet well
2. Contact Chamber Effluent sample aliquot: 230 ml/30 min	8/31 - 0900	Immediately upstream of V-notch weir
3. Final (seep) Effluent sample aliquot: 230 ml/30 min.	8/31 - 1015	Seep below infiltration Cell #3

Grab Sample Information

Sample Location	Date & Time	Laboratory Analyses
Contact Chamber Effluent	9/01 - 0910	Fecal coliform
Final (seep) Effluent	8/31 - 1015	Fecal coliform
Final (seep) Effluent	9/01 - 0945	Fecal coliform

Field Data

Sample Location	Date & Time	Field Analyses
Influent	8/31 - 0840	Temp., pH, conductivity
Influent	9/01 - 0840	Temp., pH, conductivity
Influent	Composite	Temp., pH, conductivity
Contact Chamber Effluent	8/31 - 0900	Temp., pH, conductivity
Contact Chamber Effluent	9/01 - 0905	Temp., pH, cond., TCR
Contact Chamber Effluent	Composite	Temp., pH, conductivity
Final (seep) Effluent	8/31 - 1015	Tempt, pH, cond., TCR
Final (seep) Effluent	9/01 - 0940	Temp., pH, cond., TCR
Final (seep) Effluent	Composite	Temp,, pH, conductivity

Table 2. Colfax WTP: composite wastewater samples (WDOE laboratory results).

Parameter	Influent WTP Composite	Influent WDOE Composite	Contact Chamber Effluent WDOE Composite	Final (seep) Effluent WTP Composite	Final (seep) Effluent WDOE Composite
Flow (MGD)	(.295)	(.294)	.294	.295	(.294)
COD (mg/L)		300	53		12
BOD_5 (mg/L)	140	110	6	10	4
Carbonaceous BOD (mg/L)			<2		<2
Turbidity (JTU)	68	72	8	7	10
Total Solids (mg/L)		510	400		390
Tot. Non-Vol. Solids (mg/L)		310	260		280
Tot. Susp. Solids (mg/L)	160	140	6	10	26
TNVSS (mg/L)		73	4		16
NH_3-N (mg/L)		16	3.3		0.30
NO_2-N (mg/L)		<0.10	0.30		0.05
NO_3-N (mg/L)		0.60	6.4		5.7
O-PO_4-P (mg/L)		4.1	5.7		4.4
T-PO_4-P (mg/L)		5.7	5.7		4.4
pH (Standard Units)	7.4	7.6 7.65† 7.8* 7.7*	8.1 7.7† 7.25* 7.3*	8.1	7.8 7.3† 7.1* 7.0*
Spec. Cond. (μmhos/cm)	529	537 535† 525* 560*	519 550† 545* 540*	551	506 530† 540* 530*
Temperature (°C)		18.4* 19.2*	19.0* 18.7*		19.3* 19.3* 19.1*
Fecal Coli. (#/100 mL)			<1**		5 est** 6 est**
Total Chlorine Resid. (mg/L)			2.1*		.06* .065*

() = Estimated

† = Field analysis of composite sample

* = Field analysis of grab sample

** = Grab sample, laboratory analysis

the contact chamber outfall. This was being used to determine plant flows. A Manning "Dipper" flow recorder was also installed behind the weir to record flows during the 24-hour sampling period. The flow trace for the sampling period is shown in Figure 2.

Findings

In general, the Colfax plant was meeting all limitations specified in their NPDES permit (WA-002061-3). Table 4 compares data obtained during the survey with current permit limitations. Although not listed in Table 4, flow and pH were also within permit limits.

Table 4. Permit compliance.

	WDOE Results				
	Contact Chamber Effluent	Final (seep) Eff. Colfax Sample	Final (seep) Eff. WDOE Sample	Weekly Permit Limits	Monthly Permit Limits
BOD_5 (mg/L)	6	10	4	45	30
(lbs/day)	15	25	10	225	150
(percent removal)	94.5%	92.9%	96.4%		85%
TSS (mg/L)	6	10	26	45	30
(lbs/day)	15	25	64	225	150
(percent removal)	95.7%	93.8%	81.4%		85%
Fecal coliform (col/100 ml)	<1		5 est. 6 est.	400	200

The only constituent approaching permit limits was the suspended solids value (26 mg/L) for the WDOE final (seep) effluent sample. This was responsible for the low (81 percent) removal rate calculated based on this result. It is probable that the relatively high suspended solids concentration in this sample was an artifact. The seep was developed by digging a hole in the grade between the river bank and the infiltration cell. Although the seepage is routed through a plastic pipe to a bucket, any disturbance of the seep can suspend mud which can subsequently be picked up in the sample. This is apparently what happened with this sample. (Note that the suspended solids concentration in the contact chamber effluent sample [6 mg/L] is much lower than that collected from the seep [26 mg/L].)

Total flow recorded by the plant's Leopold-Stevens meter and WDOE's Manning "Dipper" flow meter were very similar (.295 vs. .294 MGD, respectively). This indicates that the plant's meter is well calibrated and that flows are reported accurately on the discharge monitoring reports (DMRs).

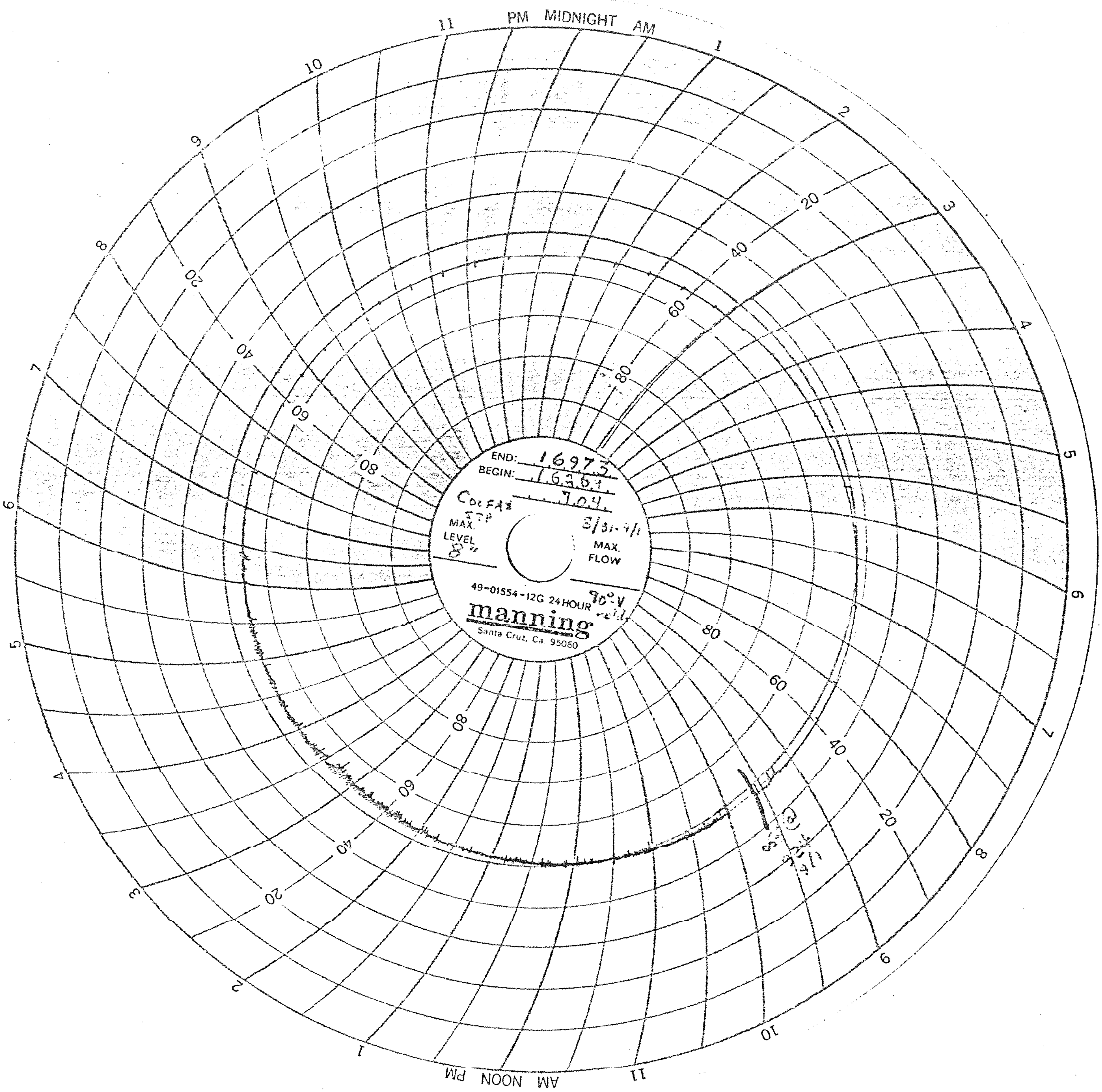

Figure 2. 24-hour flow chart.

Based on the results reported in Table 2, it appears that the Colfax facility was producing a very high-quality effluent. Carbonaceous BOD_5 in both WDOE effluent samples was below the 2 mg/L detection limit. Ammonia was partially nitrified through the lagoon system, and almost completely nitrified after passing through the infiltration cell. Percolation through the infiltration cell also appeared to substantially dechlorinate the effluent. Total chlorine residual decreased from 2 mg/L to approximately .065 mg/L.

It is interesting to note the very low suspended solids (SS) concentration (6 mg/L) in the contact chamber effluent. Typically, lagoon effluent SS concentrations are substantially higher due to algae, particularly during the summer. The reason for the low SS concentration is unknown.

In reviewing DMRs for October 1981 through March 1982, no violations of current permit limits were noted. Only during December and January were the 85 percent removal limits for BOD and SS approached. Operating the infiltration basins on a year-around basis would provide a margin of safety in assuring continual compliance with all permit conditions. In addition, any potential problems with possible chlorine toxicity in the receiving water would be minimized by continued infiltration basin operation. Operation of the filtration basins may, of course, have to be suspended if frozen soils limit seepage during the winter.

<u>Review of Analytical Procedures and Split Sample Results</u>

The results of split sample results are summarized in Table 5.

Table 5. Split sample results.

Sample Location:	Influent				Contact Chamber		Final (seep) Effluent			
Sample by:	Colfax WTP		WDOE		WDOE		Colfax WTP		WDOE	
Analysis by:	Colfax	WDOE	Colfax	WDOE	Colfax	WDOE	Colfax	WDOE	Colfax	WDOE
BOD_5 (mg/L)	166	140	139	110	10.2	6	15	10	6	5
TSS (mg/L)	122	160	155	140	5.2	6	8	10	13	26

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In general, comparability of split sample results were acceptable. It is particularly difficult to get close agreement on samples with very low BOD and SS concentrations.

Sampling and analytical methods were reviewed in some detail with laboratory personnel and the attached "Laboratory Procedural Survey" details current practices at the Colfax facility with regard to sampling, BOD analysis, and SS analysis. Testing methods at the Colfax laboratory appeared to be, in general, very good. In some cases, changes were recommended which conform to good laboratory practice and should improve the reliability and accuracy of data generated. Observations and recommendations for sampling and analysis are:

Sampling - Methodology is generally adequate; however, composite samples are neither iced nor refrigerated. In addition, sampling equipment is not regularly cleaned.

Recommendations

1. Ice should be used to cool composite sample bottles during sampling.

2. Sampling equipment (sampling lines, interior sampler parts) should be cleaned weekly. This may be accomplished by running three to four cycles of hot, clean water through the samplers and wiping accumulated grease from the interior of the sampling bowl with a paper towel.

pH - Methods are generally adequate; however, only pH buffers of 4 and 7 are used to calibrate the instrument. A pH 10 buffer should be used in conjunction with a pH 7 buffer when sample pH values are greater than 7.

BOD - Methods are generally adequate; however, several modifications are suggested to improve precision and repeatability of test:

1. Dechlorination should be performed more precisely. An easy way to do this is to first measure the total chlorine residual of the sample; then, use the following formula to determine the amount of .025 normal sodium thiosulfate to add to a 2-liter sample:

$$V = 2.25\ (TCR)$$

where: TRC = The total chlorine residual concentration of the sample in mg/L

V = The volume of .025 N sodium thiosulfate adequate to dechlorinate a 2-liter sample (V is in mls)

This amount of thiosulfate should precisely dechlorinate the chlorine residual and leave no excess thio to interfere with the BOD test.

2. Review and use WDOE methods for reporting "greater than" or "less than" values when dissolved oxygen depletions in test bottles are either too small or too large.

3. Maintain a running log of incubator settings, dial thermometer and internal (water bath) thermometer readings to track performance of incubator.

Suspended Solids - Methodology good - no recommendations.

Conclusions and Recommendations

1. The Colfax WTP was operating efficiently and producing a high-quality effluent during the study period. The use of infiltration cells appears to be a good concept and, at least in this situation, appeared to promote nitrification, nitrogen removal, and dechlorination.

2. The Colfax WTP was meeting all permit limits at the time of this study. Review of DMRs indicates that the plant is capable of meeting permit limits on a year-around basis and that compliance would be best assured by operating the infiltration cells throughout the year.

3. Sampling and analytical methods at the plant were generally adequate. Specific recommendations are made in the body of this report which should improve the precision and accuracy of the reported data. These recommendations should be addressed.

Part II. Receiving Water Survey: Water Quality Assessment of the Palouse and South Fork of the Palouse Rivers near Colfax, Washington

Introduction

This study was conducted primarily to assess the impact of treated wastewaters discharged from the Colfax WTP on water quality in the Palouse River. In addition, sampling sites on the SFPR and Palouse River were chosen to provide information on other possible impacts on surface water quality near Colfax. The study area is shown in Figure 3.

Study Methodology

Seven sites on the SFPR and Palouse River were sampled. Station numbers, names, and river mile locations are given in Table 6A; Figure 3 displays the locations of the sampling sites. Stations SP-1 and P-1 correspond to historical ambient monitoring stations 34B090 and 35A110, respectively.

In addition to river stations, composite and grab samples were collected at three points in the Colfax WTP. These are described in Part I. Only the data from the final (seep) effluent sample are included in Tables 6A and 6A (continued). A final sample site was located at the "grange drain", a discharge pipe located immediately upstream of the Highway 295 bridge across the Palouse River.

At each station, field tests were conducted for temperature, specific conductivity, pH, and dissolved oxygen (Winkler method, azide modification). Grab samples were obtained for laboratory water quality analyses. Laboratory analyses included tests for ammonia, nitrite, nitrate, total- and orthophosphate, fecal coliforms, chemical oxygen demand (COD), suspended solids, turbidity, and, at several selected stations, carbonaceous biochemical oxygen demand (CBOD). Percent dissolved oxygen saturation and un-ionized ammonia concentrations were calculated based on field and laboratory results for relevant parameters.

Flow was calculated at stations SP-1 and SP-2 using cross-sectional velocity and depth measurements obtained using a Marsh-McBurney magnetic flow meter and top-setting rod. After obtaining these two sets of measurements, this meter failed and a "pygmy" meter was borrowed from the Environmental Engineering Department at WSU. This was used to determine flows at stations P-3 and P-4. Treatment plant flow was obtained using a Manning "Dipper" meter located behind a 90° V-notch weir as described in Part I. Estimated flows were obtained for remaining stations by difference. An attempt was made to compare flow

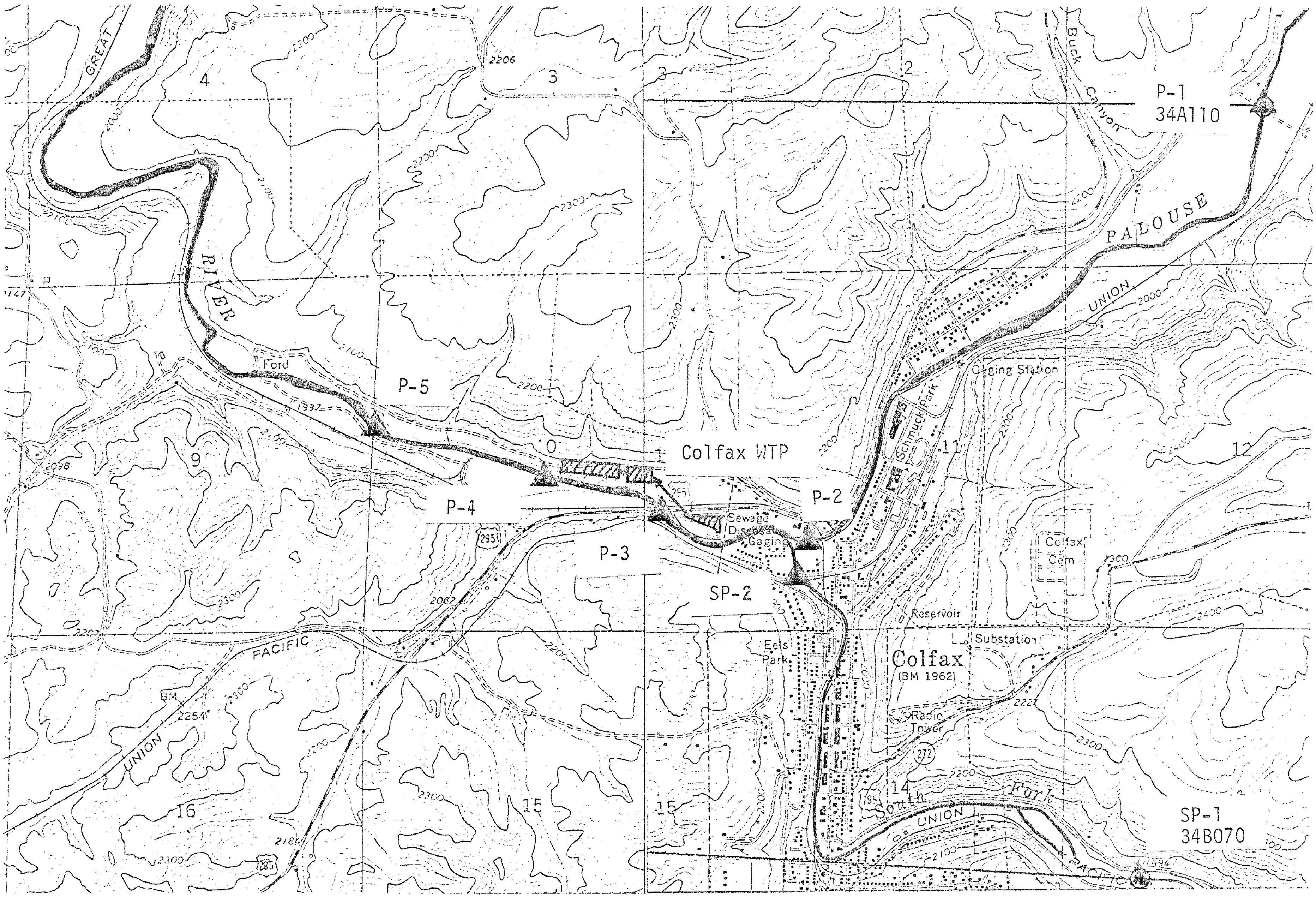

Figure 3. Study area and station locations.

measurements with the USGS flow monitoring station located just below the confluence of the SFPR and Palouse River. Unfortunately, a newly constructed beaver dam just downstream of this monitor had rendered flows recorded by USGS during this survey inaccurate.

Aquatic macroinvertebrates were collected at each river station using a method described by Bernhardt and Yake (1979). Briefly, this method involved sampling three stones per site. Stones are removed from the substrate and placed immediately in the fine-mesh net. After being removed from the stream, all attached benthic organisms are removed from the stone and placed in 70 percent ethyl alcohol. The largest two right-angle dimensions of each stone are measured and multiplied to obtain an estimate of surface area sampled at each location. Collected organisms were later keyed to genus and species, if possible, and the Shannon diversity index computed (Lloyd, *et al.*, 1973).

Results

Water Quality

This survey was conducted during the summer low-flow period because the impact of Colfax WTP effluent was expected to be most pronounced at this time. During the study period, Palouse River flow above the treatment plant was about 17.3 cfs, while Colfax WTP flow averaged 0.46 cfs. These flows result in a dilution ratio of approximately 38 to 1. Flow data from the USGS gaging station below the SFPR confluence (13349210) yield a 7-day, 10-year low flow of 2.8 cfs; a 7-day, 5-year low flow of 4.1 cfs; and a 1-day, 2-year low flow of 7.1 cfs. Dilution ratios for these flows would be 6:1, 9:1, and 15:1, respectively.

As noted in Part I, the Colfax WTP was operating efficiently and discharging a high-quality effluent. Under these conditions (adequate dilution, high-quality effluent), one would expect little impact on receiving water quality. In general, analyses of receiving water quality confirmed this expectation.

Results of field and laboratory analyses are summarized in Tables 6A and 6A (continued). The data demonstrated clearly some substantial differences between water quality in the SFPR and water quality in the upper Palouse River. While certain parameters were similar -- high temperatures (17.5 to 22.5°C); high pH values (8.8 to 9.2); and generally similar COD, turbidity, and ammonia concentrations -- conductivity, bacteria, and most nutrient results were quite different. The SFPR had much higher concentrations of nitrate, total inorganic nitrogen, orthophosphate, and total phosphate than the upper Palouse River. Specific conductivity was also much higher in the SFPR while fecal coliform concentations were lower.

Table 6A: (continued) Summ... ...tem near Colfax.

Station	Description	Date	Time	Flow (MGD)	Flow (cfs)	Temp. (°C)	Sp. Cond. (μmhos/cm)	D.O. (mg/L)	D.O. Sat. (%)	pH (S.U.)	Fecal Coli. (col/100 mL)
SP-1	S.F. Palouse R. (34B070)		1120	4.7	7.3	17.9	525	10.6	119%	8.8	4 est.
SP-2	S.F. Palouse R.		1215	4.7	7.3	17.6	537	12.5	140%	8.9	8 est.
P-1	Palouse River (34A110)		1330	(6.5)	(10.0)	21.7	148	11.8	142%	9.1	108
P-2	Palouse R. abv.		1500	(6.5)	(10.0)	19.4	160	10.6	123%	9.2	80
Drain	Grange Drain		1620	(.006)	(.01)	17.4	655	8.0	89%	--	--
			1050	(.006)	(.01)	17.3	830	6.7	75%	7.1	4000
P-3	Palouse R. at		1700	(11.2)	(17.3)	19.7	332	12.5	146%	--	--
			1530	(11.2)	(17.3)	20.6	345	13.5	160%	9.1	80
			1640	11.2	17.3	--	372	--	--	9.4	--
Effluent	Colfax WTP Eff.		1620	(.29)	(.46)	19.3	540	7.4	86%	--	--
			1015	(.29)	(.46)	19.3	530	--	--	7.1	5 est.
		/01	Comp.	.29	.46	--	530	--	--	7.3	--
			0940	(.29)	(.46)	19.1	515	--	--	7.0	6 est.
P-4	Palouse R. 100		1540	(11.5)	(17.8)	20.2	345	14.5	170%	9.1	--
			1615	(11.5)	(17.8)	21.5	345	14.4	173%	9.4	32
			1730	11.5	17.8	--	382	--	--	--	--
P-5	Palouse R. 1 M.		1700	(11.5)	(17.8)	18.2	355	10.0	113%	8.6	148
			1830	(11.5)	(17.8)	--	366	--	--	9.3	--

( ) = Estimated
-- = Not tested

y of water quality data; Palouse River system near Colfax.

	Date	Time	COD (mg/L)	Carb. BOD (mg/L)	Turb. (NTU)	TSS (mg/L)	Un-ionized NH_3-N (mg/L)	NH_3-N (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	T-In-N (mg/L)	O-PO_4-P (mg/L)	T-PO_4-P (mg/L)
ov. Colfax	8/31	1120	24	--	4	<0.1	.008	.05	.01	.62	.68	2.2	2.3
r. Mouth	8/31	1215	20	--	6	4	.007	.04	.01	.59	.64	2.0	2.0
ve Colfax	8/31	1330	20	--	31	24	.014	.04	.01	.02	.07	.07	.08
.F. Palouse R.	8/31	1500	16	--	4	6	.009	.03	<.01	.02	.05	.03	.05
	8/31	1050	20	--	7	--	.041	10	.30	8.8	19.1	2.1	2.1
Bridge	8/31	1530	20	3	4	5	.010	.03	.01	.26	.30	.90	.90
	9/01	1640	--	--	--	--	(.062)	.13	.01	.27	.41	1.0	1.0
nt	8/31-9/1	Comp.	12	<2	10	26	(.002)	.30	.05	5.7	6.0	4.4	4.4
s. below STP	8/31	1615	32	(1.8)	7	7	.025	.07	.01	.75	.83	1.2	1.2
	9/01	1730	--	--	--	--	(.054)	.11	.02	.75	.88	1.3	1.3
below STP	8/31	1700	24	--	5	6	.007	.06	.01	.51	.58	1.0	1.0
	9/01	1830	--	--	--	--	(.041)	.10	.01	.46	.57	1.2	1.2

All of these differences are attributable primarily to the effects of two relatively large municipal treatment plants (Pullman, Washington, and Moscow, Idaho) which discharge to the SFPR system (Bernhardt and Yake, 1979). The reasons for high nutrient levels and elevated conductivities are relatively straightforward. The fact that fecal coliform counts in the SFPR were lower (4 to 8/100 mls) than in the upper Palouse River (80 to 108/100 mls) may be more obscure. Bernhardt and Yake (1979) noted a steep drop in fecal coliform counts in the SFPR below the Pullman STP and attributed this to high residual chlorine concentrations caused by the plant discharge at low SFPR flows. It is likely that the same mechanism was functioning during the present survey, although no upriver stations were sampled to verify this.

It is also somewhat unusual that the total inorganic nitrogen to total phosphorus ratio in the SFPR was about 0.3:1 while the ratio in municipal wastewaters is typically greater than 3:1. It may be that rapid algae and macrophyte growth in the SFPR serves to "polish" nitrogen from the stream because nitrogen is incorporated into cell mass at a much higher rate (usually about 12:1) than phosphorus.

Water quality in the Palouse River below its confluence with the SFPR is intermediate between the two streams. Temperatures, pH values, and dissolved oxygen concentrations all remained high. The fact that dissolved oxygen concentrations (and percent saturation values) were very high at all stations suggests high algal productivity in all stream segments. Dissolved oxygen concentrations peaked (14.5 mg/L, 170 percent saturation) in samples taken from the Palouse River in a still stretch immediately downstream from the WTP. These samples were taken in the middle of the afternoon when one would expect peak dissolved oxygen concentrations from photosynthesis. This suggests that there may be substantial diurnal variations in dissolved oxygen concentrations during the peak growing season and that primary production in the waters of the study area can be very high.

The Colfax WTP effluent increased nutrient concentrations in the Palouse River. Nitrate-N concentrations approximately tripled (0.26 to 0.75 mg/L), while total phosphate-P concentrations increased by about 30 percent (1.0 to 1.3 mg/L). Other than slight increases in specific conductivity, these were the only impacts attributable to the Colfax WTP effluent.

As noted in Part I, during the survey the Colfax plant was reducing wastewater concentrations of total inorganic nitrogen by about 65 percent and total phosphate by about 25 percent. The nitrogen removal rate is excellent for a facility which was not specifically designed to reduce nutrient concentrations. Thus, although the Colfax effluent does enrich nutrient concentrations in the Palouse River, this increase is as low as one could reasonably expect from a treatment facility providing secondary treatment.

It should probably be noted here that the most likely explanation for the excellent removal rate for inorganic nitrogen is the heavy macrophyte (Eurasian milfoil) growth in the #2 lagoon. It is likely that when the milfoil is eliminated, nitrogen removal rates will drop.

Because temperatures and pH values measured during this study were very high, these streams are very susceptible to un-ionized ammonia problems. Despite the fact that total ammonia-N concentrations were low to moderate (.03 to .13 mg/L), un-ionized ammonia-N concentrations above the EPA criterion of .017 mg NH_3-N/L were noted in the Palouse River both above and below the Colfax WTP. The highest un-ionized ammonia concentration noted was .062 mg NH_3^o-N/L immediately upstream from the WTP.

As noted in Part I, the Colfax WTP was achieving a high degree of ammonia nitrification during this survey. The influent ammonia concentration of 16 mg NH_3-N/L was reduced to effluent concentration of 0.30 mg/L, a 98 percent reduction. At this effluent concentration and at plant and river flows recorded during the survey, Colfax effluent could be expected to raise total ammonia-N concentrations in the river by only about .01 mg NH_3-N/L.

<u>Biological (Benthic Invertebrates)</u>

The makeup of benthic invertebrate communities provides a good indication of long-term water quality in a study area. Certain "clean water" organisms are eliminated by adverse conditions including low dissolved oxygen concentrations, pH extremes, unacceptable concentrations of toxic substances including un-ionized ammonia and chlorine and so on. In addition, measures of community diversity provide a measure of the environmental quality as high diversities are generally associated with stable, healthy communities in a hospitable habitat.

Table 7 summarizes the benthic invertebrate data. All stations had a wide range of invertebrates and diversity indices ranged from 2.35 to 3.48, indicating good to excellent water quality. The stonefly nymph, *Acroneuria*, was found only in the Palouse River upstream of the confluence with the SFPR. Stoneflies are among the most sensitive of "clean-water forms". Otherwise, there appeared to be no clear pattern to the distribution of various taxonomic groups. This probably indicates that the SFPR and lower Palouse River stations were essentially equivalent, while the Palouse River above the confluence may provide a slightly better habitat for "clean-water" invertebrates.

Figure 4 presents diversity data from benthic invertebrate studies conducted on the SFPR and Palouse River between 1970 and present. Although there were some differences in collection techniques, a

Table 7. Benthic invertebrate data.

Taxonomy	S.F. Palouse River SP-1	S.F. Palouse River SP-2	Palouse River P-1	Palouse River P-2	Palouse River P-3	Palouse River P-4	Palouse River P-5
Turbellaria							
Planariidae							
unidentified genus	--	2	--	--	1	--	--
Annelida (segmented worms)							
Oligochaeta (aquatic worms)							
unidentified genus	--	6	--	--	--	--	--
Hirudinea (leeches)							
unidentified genus	--	--	--	--	1	--	--
Mullusca							
Gastropoda (snails)							
Physa sp.	5	--	--	--	--	--	--
Planorbis sp.	2	1	--	--	2	--	2
Ferrissia sp.	--	2	--	3	2	1	--
Insecta							
Ephemeroptera (mayflies)							
Heptageniidae							
Heptagenia sp.	1	--	14	20	2	9	18
Stenonema sp.	--	22	--	22	10	18	--
Ironodes sp.	2	--	--	--	--	--	--
Baetidae							
Baetis spp.	153	--	--	2	9	2	61
Ameletus sp.	--	1	4	6	8	4	--
Tricorythodes sp.	--	52	5	11	46	31	1
Odonata (dragon flies)							
Coenagronidae							
Argia sp.	--	5	--	1	7	4	8
Plecoptera (stone flies)							
Perlidae							
Agroneuria sp.	--	--	6	1	--	--	--
Hemiptern (true bugs)							
Gerridae (water striders)							
Metrobates sp.	--	--	--	--	2	--	--
Rhagovelia distincta	1	--	--	--	--	--	--
Coleoptera (beetles)							
Elmidae (riffle beetles)							
Narpus sp.	48	85	11	19	57	11	41
Ampumixis sp.	2	--	--	--	--	--	--

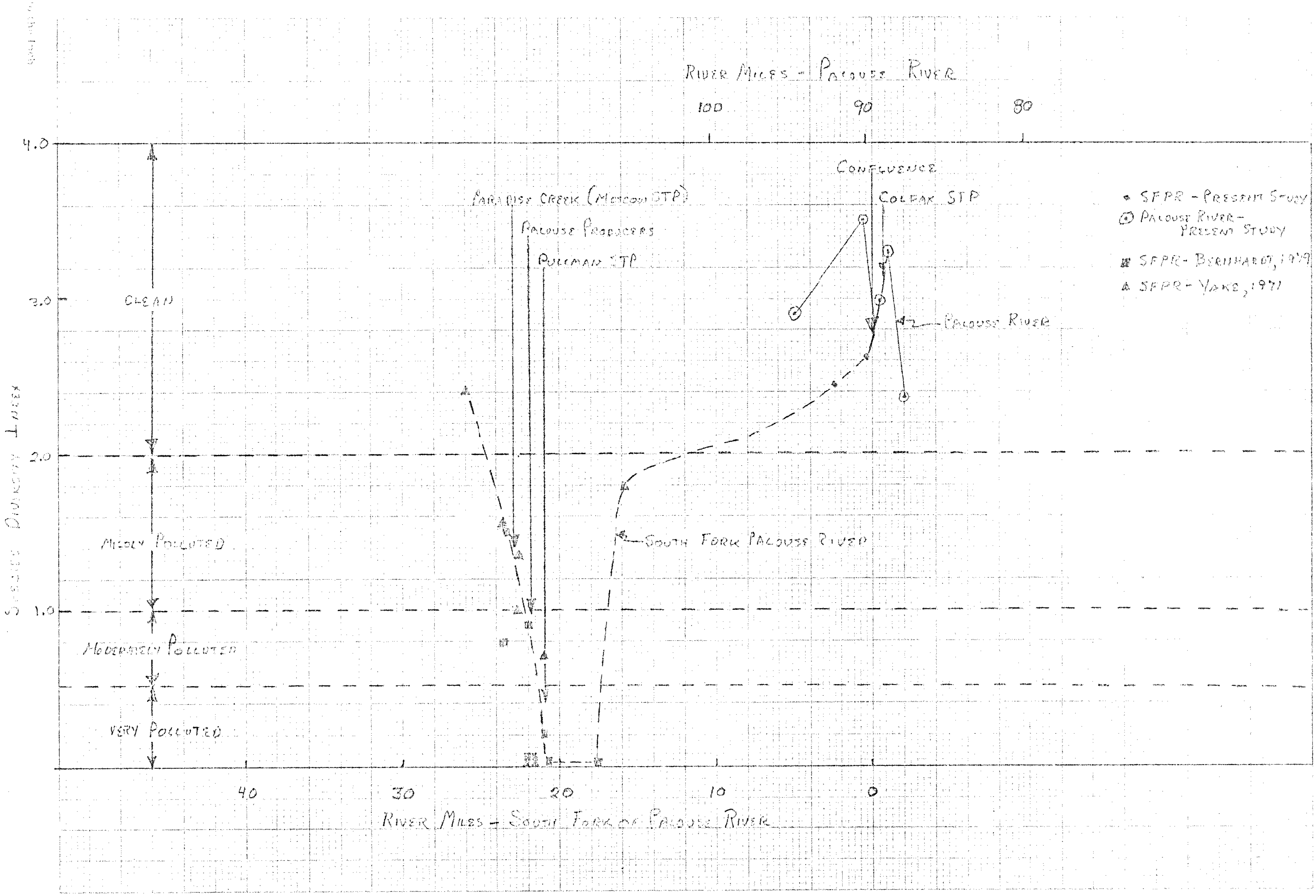

Figure 4. Species diversity: South Fork Palouse and Palouse Rivers.

clear pattern emerges. Diversities measured in the lower SFPR and Palouse River near Colfax are substantially higher than those in the upper SFPR. The worst conditions have been measured in the SFPR between downtown Pullman and Albion with Palouse Producers and the Pullman WTP being the most likely major causes. The SFPR appears to have recovered by the time it reaches Colfax and diversities in the Palouse River above and below its confluence with the SFPR and the Colfax WTP indicate generally good water quality.

Conclusions

The Colfax WTP was providing very good-quality effluent during this survey. Table 8 summarizes the percent reduction and effluent quality recorded for important constituents.

Table 8. Colfax WTP: Treatment efficiency and effluent quality.

Constituent	Effluent Concentration (mg/L)	Percent Reduction (%)
BOD_5	4	96.4
TSS	10	92.9
NH_3-N	0.3	98.1
Total inorganic-N	6.0	63.9
T-PO_4-P	4.4	22.8
Chlorine residual	.06	--

Measurable impacts on the Palouse River were limited to increases in nitrate, total phosphate, and orthophosphate concentrations below the plant. These nutrient loadings probably serve to feed the high rates of primary productivity indicated at all sampling sites. However, Colfax WTP nutrient loads are only 5 percent (for total inorganic nitrogen) and 15 percent (for total phosphate) of the equivalent Pullman WTP loads (Bernhardt and Yake, 1979). This and the fact that the dilution ratio at Colfax (approximately 40:1 during this survey or 6:1 during 7-day, 10-year flow flow) is substantially greater than that at Pullman (less than 1:1 at low flow) place the impact of the Colfax effluent in some perspective.

Measures of diversity in the benthic invertebrate community above and below the Colfax discharge revealed no apparent impact.

Memo to Carl Nuechterlein
Colfax Class II and Receiving Water Survey
April 5, 1983

High temperatures and pH values in the Palouse drainage indicate that the streams in the study area would be very vulnerable to un-ionized ammonia toxicity. Ammonia discharge from the Colfax WTP was very low, indicating no significant problem with this facility. However, the high vulnerability of these streams should be considered when proposals for new discharges are considered.

BY:cp