Publication No. 84-e46

WA-57-1010

JOHN SPELLMAN
Governor

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

MEMORANDUM

February 7, 1984

To: Roger Ray

From: Bill Yake BY

Subject: Spokane Industrial Park Class II Inspection; August 29-30, 1983

INTRODUCTION

The Spokane Industrial Park (SIP) is a light industrial complex located in Spokane Valley. The SIP is owned by the Washington Water Power Company. A list of Park tenants is given in Appendix I. Process and sanitary wastewaters from a wide range of operations are routed to a wastewater treatment plant (WTP) located near the Spokane River. The plant consists of an oxidation ditch with secondary clarification. Its effluent is discharged to the Spokane River at river mile 87.0, approximately 0.6 mile downstream from the Sullivan Road bridge.

A Class II (source compliance) inspection and receiving water study were conducted August 29-30, 1983 at the request of the Eastern Regional Office of the Washington State Department of Ecology (WDOE). The receiving water study was conducted by Gary Bailey and Lynn Singleton (WDOE, Water Quality Investigations Section [WQIS]) and will be reported separately. The compliance inspection was conducted by Marc Heffner and Bill Yake, (WQIS). Regional representatives were Roger Ray and Jim Prudente. The Spokane Industrial Park was represented by Clayton Repp (Assistant Manager). Washington Water Power was represented by Rhonda Purvis.

The purposes for the source sampling and receiving water study were several:

1. Determine if the WTP is complying with NPDES permit limits, and characterize SIP wastewaters with respect to both conventional and priority pollutants.

2. Assess the efficiency of the current plant configuration and operation with respect to removal of conventional and priority pollutants.

3. Assess the impacts of SIP effluent on the chemical and biological characteristics of the Spokane River. Information from these surveys is to be used in modifying the NPDES permit for the SIP facility.

The flow diagram for the SIP WTP is illustrated in Figure 1. The headworks consist of a comminutor and rectangular weir for flow measurement. Wastewater is then routed to an oxidation ditch. The ditch has two brush aerators which are operated only intermittently. The flow from the oxidation ditch is routed to a clarifier. Underflow solids are pumped back to the ditch, while the clarified wastewaters are chlorinated and discharged to two side-by-side contact chambers. The effluent is then discharged to the Spokane River.

To place the problems experienced at the SIP WTP into perspective, it is important to note that:

1. Oxidation ditches are generally used to treat domestic, sanitary wastewaters. Although they can be used to treat organic wasteloads (for instance, from food-processing industries), they are not intended to handle heavy metals or treat discharges containing organic priority pollutants.

2. Characterization of SIP wastewaters indicates they are weak with respect to conventional organic parameters (COD, BOD, and TSS) and strong with respect to certain priority (toxic) pollutants--especially heavy metals. Thus the current treatment scheme is inappropriate for the wastewaters now generated by the SIP.

3. There are design and operational deficiencies in the present facility which would severely limit its efficiency, even if it were treating wastewaters with the appropriate characteristics (for instance, conventional domestic sewage).

SAMPLING AND STUDY DESIGN

SIP plant influent and effluent were sampled over a 24-hour time period using automatic composite samplers. The influent composite sample was obtained using a specially designed and cleaned toxics sampler, allowing the wastewater sample to contact only glass or teflon surfaces. Organic priority pollutant, heavy metal, and conventional pollutant sample aliquots were all obtained from this influent automated composite sample. A second toxics sampler malfunctioned, thus a conventional automated composite sampler was used to collect the effluent sample. For this reason, the organic priority pollutant sample of plant effluent was collected directly into the sample container as a grab composite sample.

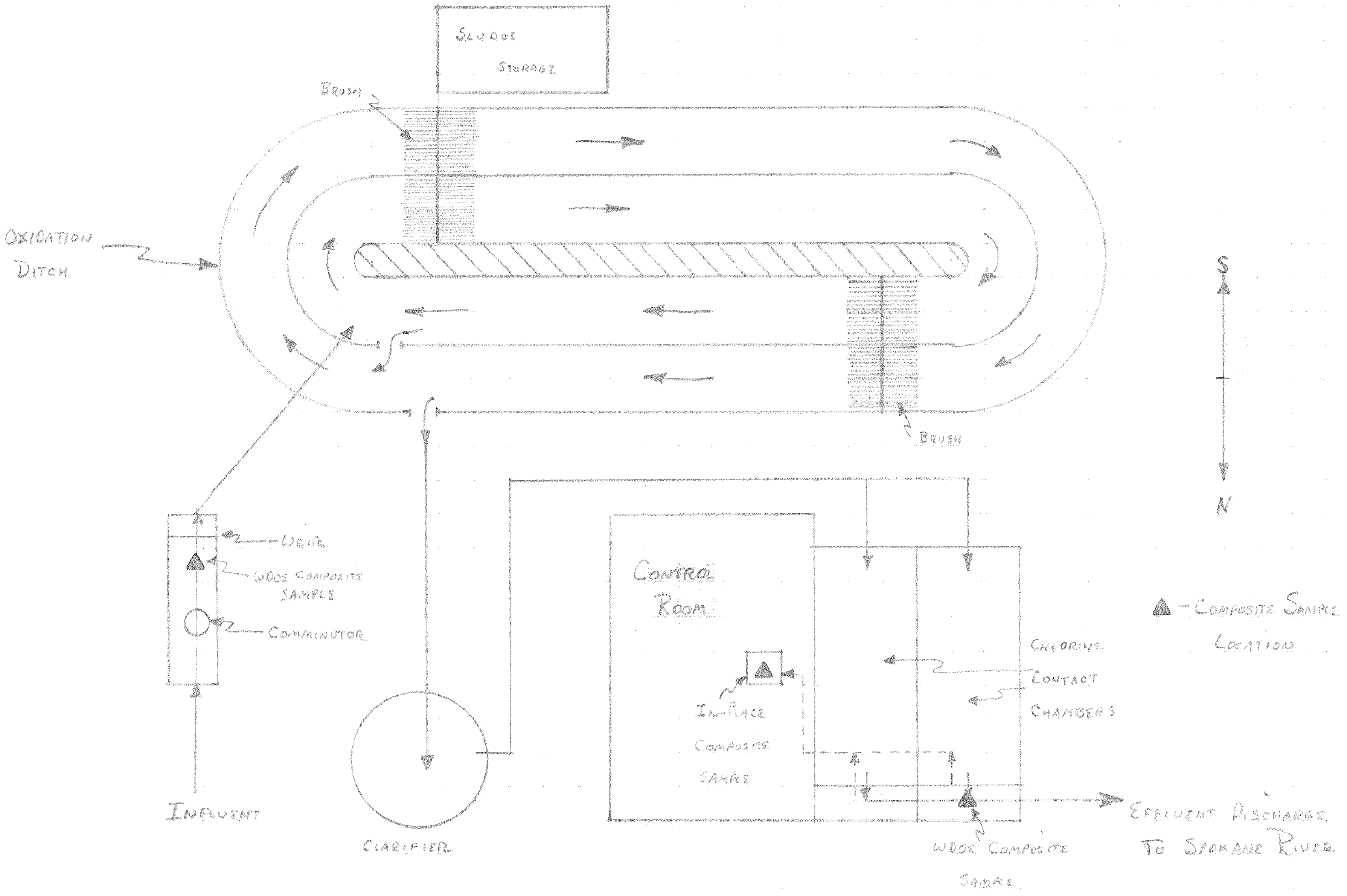

Figure 1. Spokane Industrial Park - Wastewater Treatment Plant

The SIP WTP has an automated sampler which collects composite effluent samples. This compositor operated during the 24-hour inspection period. Samples from WDOE influent compositor, WDOE effluent compositor, and SIP effluent compositor were split between the WDOE laboratory and Clayton Repp (SIP). Mr. Repp routed their subsamples to ABC Laboratories for the analysis required by the NPDES permit. Unfortunately, ABC Laboratories generated only a single set of effluent results. When contacted for clarification, neither ABC Laboratories nor Mr. Repp could determine whether the samples analyzed came from the WDOE sampler or the SIP sampler.

In addition to composite samples collected for most analyses, grab samples were obtained for oil and grease, fecal coliform, cyanide, and volatile organic analyses. Temperature, pH, specific conductivity, dissolved oxygen, and chlorine residual were measured in the field. A sample of sludge from the sludge drying beds was also obtained for heavy metals analysis, organic priority pollutant analyses, and bioassay determination of dangerous or extremely hazardous waste status. Table 1 summarizes specific sampling information including times, dates, locations, and analyses.

A rectangular weir at the headworks serves as the primary flow-measuring device. Head heights behind the weir are converted to instantaneous and totalized flows with readouts in the control room. The accuracy of the flow-measuring system was assessed by comparing readouts to the flow calculated based on head height measurements behind the weir. These values are summarized in Table 2.

Table 2. Accuracy determination; flow-measuring system (August 29, 1983 -- 0913 to 0953).

Type of Flow Determination	Flow (MGD)	Error
Actual Flow/Based on Head Measurement	.83	--
Instantaneous Arrow	.85	+2.4%
Script Chart	.80	-3.6%
Flow Totalizer	.86	+3.6%

Accuracy of the flow-measuring system was good; thus flows recorded by the in-place flow-monitoring system are used in this report.

Table 1. Composite and grab sample information.

24-hour Composite Sample Information

Sample Name/Aliquot	Date and Time Installed	Location
1. Influent Aliquot - 230 mL/30 min.	8/29 - 0950	Between comminutor and influent weir
2. Chlorinated Effluent Aliquot - 230 mL/30 min.	8/29 - 1025	Immediately upstream of discharge weir on chlorine contact chamber

Grab Composite Information

Sample Name	Dates and Times	Location
Chlorinated Effluent (priority pollutant sample)	Equal Aliquots 8/29 - 1130, 1200, 1420, 1525, 1600 8/30 - 0840, 1200	Immediately below the discharge weir on the chlorine contact chamber

Grab Sample Information

Sample Location	Dates and Times	Laboratory Analyses
Influent	8/29 - 1100	VOA, CN
	8/30 - 1215	VOA
Chlorinated Effluent	8/29 - 1130	VOA, CN, fecal coliform
	8/29 - 1525	Fecal coliform
	8/30 - 1145	Oils & grease, fecal coli.
	8/30 - 1215	VOA
Sludge Drying Bed	8/29 - 1300	Priority pollutants, bioassay, metals
Mixed Liquor	8/29 - 1520	Solids

Field Data

Sample Location	Dates and Times	Field Analysis
Influent	8/29 - 0950	Temp., cond., pH, D.O.
	8/29 - 1110	Cr^{+6}
	8/29 - 1425	Temp., cond., pH
	8/30 - 1600	Temp., cond., pH
Oxidation Ditch	8/29 - 0850	D.O.
	8/29 - 1425	D.O.
Unchlorinated Effluent	8/29 - 1025	D.O.
Chlorinated Effluent	8/29 - 1025	Temp., cond., pH
	8/29 - 1130	TCR
	8/29 - 1525	TCR
	8/30 - 1145	TCR, temp., cond., pH

FINDINGS

The results of the conventional pollutant analyses are summarized in Table 3. Metals results from wastewater samples are located in Table 4, while organic priority pollutant results for wastewater, sludge, and a Spokane River sample are summarized in Table 5. The Spokane River sample was collected from the SIP discharge plume by Gary Bailey and Lynn Singleton and is discussed in more detail in the receiving water report.

In reviewing the wastewater quality data summarized in Tables 3, 4, and 5, it is apparent that SIP wastewaters are not typical municipal sewage. Table 6, which summarizes effluent data from five WDOE sampling efforts at the SIP plant (1979 to 1983), further supports this observation. SIP wastewaters vary from typical sewage in the following ways:

1. SIP wastewaters are generally very weak with respect to conventional measures of organic matter. Influent BOD and COD concentrations during WDOE inspections have been low--only about 10 percent of concentrations in municipal sewage. Likewise, nutrient concentrations are low--generally about 30 to 50 percent of concentrations typical of domestic wastewater. Discharge monitoring reports (DMRs) occasionally report much higher organic loads (for instance, maxima of 339 mg/L of BOD and 1086 mg/L of TSS for influent samples during May 1983). Mr. Repp was able to provide no explanation for the source or reason for these apparent wide swings in influent strength. Incorrect sampling procedures (discussed later) may be partially responsible; however, it is unlikely that poor sampling is entirely responsible for these data.

2. Concentrations of certain potentially toxic compounds are high. Particularly notable are high concentrations of 1,1,1-trichloroethane and several heavy metals. Table 7 compares concentrations of metals in SIP sludge to metals concentrations in sludges from municipal activated sludge plants. Sludge concentrations for nickel (25X), lead (10X), zinc (10X), copper (6X), and cadmium (3X) were elevated substantially above mean values for sludges from municipal plants.

3. There are indications that the toxic characteristics of the wastewater are adversely affecting testing and treatment at the plant as well as biota in the receiving water. Despite apparently inefficient disinfection, fecal coliform counts in the effluent are generally very low. During this inspection, even prior to chlorination, the counts were low (<7 col/100 mLs). BOD-to-COD ratios are quite low, indicating either a refractory organic load or toxic effects in the BOD test. The sludge was almost odorless, indicating that decomposition was not proceeding normally. Trout bioassay tests on the effluent and sludge (discussed later) clearly indicated that both are toxic to rainbow trout.

Table 3. Conventional Pollutant Results; WDOE analyses.

	Influent		Oxidation Ditch Effluent†	Unchlorinated Effluent	Chlorinated Effluent		
Parameter	WDOE Composite	Grab Sample	Grab Sample	Grab Sample	SIP Composite	WDOE Composite	Grab Sample
Flow (MGD)	.715				(.715)		
BOD (mg/L)	16				6	4	
COD (mg/L)	48				36	28	
TS (mg/L)	290		950		300	320	
TNVS (mg/L)	140		390		230	230	
TSS (mg/L)	29		570		34	25	
NVSS (mg/L)	10		140		18	12	
Turbidity (NTU)	30				54	38	
NH_3-N (mg/L)	5.0				6.0	6.1	
NO_2-N (mg/L)	<.05				<.05	<.05	
NO_3-N (mg/L)	1.6				1.4	1.5	
O-PO_4-P (mg/L)	2.0				1.3	1.3	
T-PO_4-P (mg/L)	2.1				1.9	1.6	
Phenolics (mg/L)	.055					.037	
pH (S.U.)	7.4 7.2*	7.1* 7.1* 7.7*			7.8	7.8	7.0* 7.4*
Spec. Cond. (µmhos/cm)	397 420*	500* 395* 550*			439	453	495* 395*
Temp. (°C)		16.7* 17.7* 17.8*	16.8*				17.2* 17.5*
D.O. (mg/L)		7.9*	8.6* 5.4*	9.1*			
TCR (mg/L)							0.3* 0.2* 0.4*
FC (#/100 mL)				<7			<7 10 est
Total Oils & Grease (mg/L)							2
Hex-chromium (mg/L)		<0.1					

*Field Measurement

†Sample obtained while brush aerators operating

Table 4. Metals results; Spokane Industrial Park (all units µg/L).

	Influent		Effluent	
	WDOE Composite		WDOE Composite	
Metal	Dissolved	Total	Dissolved	Total
Arsenic	<1	<1	<1	<1
Cadmium	2	14	2	8
Copper	950	7300	860	7300
Chromium	2	2	1	<1
Iron	<20	200	<20	320
Lead	1	300	2	100
Mercury		0.3		0.3
Molybdenum	5	7	13	12
Nickel	1100	1100	900	1000
Zinc	41	204	89	310

Table 5. Organic pollutants results; Spokane Industrial Park.

Constituent/Location	Influent (μg/L)		Effluent (μg/L)	Sludge (μg/Kg d.w.)	Spokane River (μg/L)
Sample Type	Grab	Grab	Grab	Grab	Grab
Date	8/29	8/30	8/30	8/30	8/30
Volatiles					
methylene chloride	16	--	--	--	--
1,1-dichloroethane	--	--	--	17	--
1,2-dichloroethane	3.2	--	--	--	--
1,1-dichloroethylene	20	--	--	--	--
1,1,1-trichloroethane	5,800	35,000	5,300	47	22
trichloroethylene	16	T^1	T^2	T^3	--
tetrachloroethylene	2	--	--	T^3	--
ethylbenzene	22	--	--	8.7	--
toluene	3	--	--	9.8	--
Sample Type	Composite		Composite	Grab	Grab
Date	8/29-30		8/29-30	8/30	8/30
Base/Neutral Extractables					
1,4-dichlorobenzene	0.4		--	--	--
naphthalene	0.09		--	T^4	--
phenanthrene	--		--	380	--
dimethyl phthalate	--		--	420	--
butylbenzyl phthalate	--		--	1,100	--
bis(2-ethylhexyl) phthalate	*		*	*	*
di-n-butyl phthalate	*		*	--	*
di-n-octyl phthalate	--		--	*	*
Acid Extractables					
phenol	0.13		0.12	--	--
Non-Priority Pollutant Organics					
ethanol	--		--	(130)	--
xylene (total)	(40)		--	(20)	--
1,2-dimethylbenzene	(23)		--	--	--
1,3-dimethylbenzene	(61)		--	--	--
benzoic acid	(2.7)		--	--	--
4-phenyl-2-butanone	(4.7)		--	--	--

-- = None detected.
T = Trace
* = Detected, but also detected in blank.
( ) = Estimated concentrations.
T^1 = <100
T^2 = <20
T^3 = <8
T^4 = <150

Table 6. Compilation of selected Spokane Industrial Park effluent data collected and analyzed by WDOE (1979-1983). Concentrations in mg/L; loads in lbs/day unless otherwise stated.

Reference	1		2		2		2		3	
Date Collected	2/6-7/79		3/31-4/1/80		6/10-11/80		2/10-11/81		8/29-30/83	
Parameter	Conc.	Load	Conc.	Load	Conc.	Load	Conc.	Load	Conc.	Load
Flow (MGD)	.645		.61		.69		.78		.715	
BOD_5	4 est	22 est	9	46	6	35	14	91	4	24
COD	58	312	52	265	43	247	61	397	28	167
TSS	29	156	22	112	29	167	81	527	25	149
O-PO_4-P	1.6	8.6	1.2	6.1	1.5	8.6	3.7	24.1	1.3	7.8
T-PO_4-P	2.3	12.4	1.6	8.1	2.9	16.7	3.7	24.1	1.6	9.5
Cadmium	<.01	<.05	<.01	<.05	<.01	<.06	<.01	<.07	.008	.048
Chromium	<.02	<.11	<.01	<.05	<.02	<.12	<.02	<.13	<.001	<.006
Copper	2.9	15.6	2.2	11.2	3.1	17.8	2.7	17.6	7.3	44
Iron	.22	1.18	0.15	0.76	0.98	5.6	0.46	3.0	.32	1.9
Mercury			.00033	.002			.00072	.005	.0003	.002
Molybdenum									.012	.072
Nickel	.30	1.61	<.05	<.25	0.42	2.4	0.31	2.0	1.0	6.0
Lead	.19	1.02	0.20	1.02	0.17	0.98	1.0	6.5	.10	0.60
Zinc	.15	.81	0.14	0.71	0.20	1.15	0.82	5.3	.305	1.8
Cyanide	.007	.038			.02	.11			.002	.012
Phenolics	.002	.011	.011*	0.05	.010*	0.06			.037	.22

*Mean of two grab samples.

References:
1. Yake, 1979
2. Singleton & Joy, 1982
3. Present study

Table 7. Sludge metals; Spokane Industrial Park compared to Washington State municipal sludges (all units mg/Kg dry weight).

	SIP	Municipal Activated Sludge[1]	
Metal	Sludge	Geometric Mean	Geo. Mean ± 1 SD
Arsenic	3.9		
Cadmium	21	6.9	1.7 - 28.2
Copper	1800†	326	173 - 612
Chromium	79	81	42 - 155
Lead	2400†	238	109 - 519
Mercury	1.6		
Nickel	460†	17.5	2.7 - 115
Zinc	12,000†	1200	615 - 2330

[1] Summary of sludge data from previous Class II surveys at municipal activated sludge plants as reported in memorandum.

† = Concentrations greater than the geometric mean plus one standard deviation for municipal sludges.

It appears that both the plant design and the NPDES permit limits are predicated on the assumption that SIP wastewater characteristics approximate those of municipal sewage. This assumption now seems unwarranted. Nonetheless, Table 8 compares effluent quality during the inspection with current NPDES permit limits. The only current limits which were not met during the sampling period were the 85 percent removal requirements for BOD and TSS. Based on results from this inspection, the plant was achieving removal efficiencies of only 75 percent and 14 percent for BOD and TSS, respectively. Plant flow (.715 MGD) was approaching the monthly average permit limit of .75 MGD.

Table 8. Comparison of effluent quality and NPDES permit limits.

Parameter	Effluent Values WDOE Samples/WDOE Lab	NPDES Permit Limits Monthly Average	NPDES Permit Limits Weekly Average
Flow (MGD)	.715	.75	--
BOD (mg/L)	4	30	45
(lbs/day)	24	188	281
(% removal)	75%	>85%	--
TSS (mg/L)	25	30	45
(lbs/day)	149	188	281
(% removal)	14%	>85%	--
Fecal Coliform (#/100 mL)	<7* 10 est*	200	400
pH (S.U.)	7.0† 7.4† 7.8	6.5 to 8.5	

*Grab sample; laboratory analysis.

†Grab sample; field analysis.

There were several design and/or operational deficiencies at the plant which would decrease its efficiency in treating conventional wastewaters:

1. The sludge return pump from the secondary clarifier to the oxidation ditch pumps at a 500 gpm rate for 27 minutes every hour. When this pump is operating, its output is equivalent to a flow of .72 MGD. This has the effect of cutting effluent flow to nearly zero when the pump is on and doubling the effluent flow when the pump is off. The net effect creates hydraulic surges in both the secondary clarifier and chlorine contact chamber. Surges to the secondary clarifier may, in part, be responsible for the poor TSS removal. This problem could be minimized by down-sizing the sludge pump and/or decreasing substantially its operating time.

2. Rotating brushes in the oxidation ditch provide aeration and impart circulatory motion to wastewaters in the oxidation ditch. Because of the low organic strength of the wastewater, relatively little oxygen is needed; therefore, the brushes are operated only five hours/day. This creates another potential problem. Without the circulating motion provided by the brushes, there appears to be a significant probability of short-circuiting from the ditch influent to the ditch effluent when the brushes are off. As noted in Figure 1, the influent to the ditch, the passageway from the inner raceway to the outer raceway, and the ditch effluent weir are quite near each other and without the motion imparted by the rotors, actual wastewater detention time in the ditch may be very low. Dye-testing would confirm this. When organic loads to the system are low, the present mode of brush opration is probably adequate. However, if DMR data indicating occasionally high organic loads are correct (see earlier discussion), an operational mode which responds to these fluctuations is necessary. Under these circumstances, increased rotor operation is needed to: (a) maintain adequate oxygen levels, (b) prevent short-circuiting, and (c) keep the activated sludge suspended and in contact with the wastewater.

3. The disinfection system appears to be poorly designed. As noted previously, hydraulic surges are created by the sludge pump. However, the system has a constant (rather than flow-paced) chlorine feed. This leads to fluctuations in chlorine residuals. In addition, the contact chambers appear to short-circuit very badly. When a small stick was floated on the contact chamber, it took only about 2-1/2 minutes to travel the length of the chamber. A dye test indicated that effluent took another 4 minutes to reach the river. Thus the total effective detention time was about 7 minutes compared to the WDOE criteria of 1 hour at average design flow and 20 minutes at peak design flow (WDOE, 1979). Over/under baffles in the contact chambers would probably correct this design deficiency.

Even if these design deficiencies were remedied, it is hard to image that the current plant could reliably achieve 85 percent removal of BOD and TSS. The influent BOD load was so low that it appears impossible to simultaneously carry on adequate sludge inventory (say, MLSS > 2000 mg/L) and maintain a reasonable food:microorganism ratio (approximately 0.1). Attempts to increase mixed liquor solids (they were only 590 mg/L during the inspection) invariably led to a very long sludge age. Rough calculations yield a sludge age of greater than 20 days with most of the solids being wasted in the effluent. A fiberous material was visible in the effluent. It is not possible, based on the information now available, to determine why the plant is so inefficient in terms of solids removal. It is probably due to several of the factors mentioned above. One of the few viable solutions appears to be segregation of industrial and domestic waste flows. Each waste could then be treated in an appropriate manner.

As noted previously, SIP wastewaters contain high concentrations of various heavy metals. Table 9 compares concentrations of metals found by WDOE in SIP wastewaters to concentrations which inhibit secondary treatment.

Based on Table 9, copper and lead (and possibly nickel and zinc) are present in concentrations high enough to inhibit carbonaceous BOD removal. All four of these metals are present in concentrations high enough to inhibit nitrification.

Bioassays were performed on both the final effluent and the sludge using rainbow trout. The sludge was tested to determine whether it classified as a "dangerous waste" (DW) or "extremely hazardous waste" (EHW) under state law Chapter 70.105 RCW (Hazardous Waste Disposal) and state regulations WAC 173-303 (Dangerous Waste Regulations). Table 10 summarizes the results which characterized the sludge as an EHW.

Table 10. SIP sludge bioassay results.

	Sludge Concentration		Mortality	
Test	mg/L Wet Weight	mg/L Dry Weight	Deaths/ Total Fish	Percent Mortality
Control	0	0	0/30	0%
EHW	100	12.8	24/30	80%
DW	1000	128	30/30	100%

The final effluent was tested using upstream Spokane River water as a control and as the dilution water. The results of this bioassay will be discussed in more detail in the receiving water study. Briefly, two effluent dilutions were used: 0.6 percent and 4.2 percent effluent. These correspond to in-stream dilutions during a 7-day, 10-year low flow of 170 cfs. The SIP discharge was assumed to be 0.7 MGD. The 0.6 percent dilution assumes complete mixing with 100 percent river flow; the 4.2 percent dilution represents an estimated concentration at the edge of a dilution zone comprising 15 percent of the river flow (Table 11).

Table 11. SIP effluent bioassay.

	Effluent Concentration	Mortality	
Test	(Percent)	Deaths/ Total Fish	Percent Mortality
Control	0%	0/30	0%
Full Mix	0.6%	1/30	3%
Dilution Zone Mix	4.2%	30/30	100%

Table 9. Heavy metal concentrations in SIP wastewaters compared to concentrations toxic to biological treatment (all concentrations in mg/L).

Metal	Range of Influent Concentrations	Range of Effluent Concentrations	Threshold Concentrations Inhibitory to the Activated Sludge Process[1]	
			Carbonaceous Removal	Nitrification
Cadmium	<.01 to .014	.008	10 to 100	
Chromium	2	<.001	50	
Copper	3.2 to 7.3	2.2 to 7.3	1.0	.005 to 0.5
Lead	0.16 to 0.30	0.17 to 1.0	0.1	0.5
Nickel	0.30 to 1.0	<.05 to 1.0	1.0 to 2.5	0.25
Zinc	0.15 to 0.20	0.14 to 0.82	0.08 to 10	0.08 to 0.5

[1] WPCF, 1977.

It is apparent that the SIP effluent substantially raises the toxicity of Spokane River water. Table 12 summarizes concentrations of five metals in the river water and SIP effluent as well as calculated concentrations in the test dilutions. These concentrations are then compared to 96-hour LC_{50} values reported by Bailey and Saltes (1982). Hardness values for both current study and the Bailey-Saltes bioassays were in the range of 21 to 29 mg/L as $CaCO_3$.

It is generally accepted that metals in the dissolved form are much more toxic to fish than metals associated with particulate matter. Therefore, based on the metals concentrations in Table 12, the dissolved copper in the SIP effluent appears to be largely responsible for the increase in toxicity seen in the 4.2 percent effluent sample. It should also be noted that toxic materials are generally responsible for deleterious chronic effects at concentations well below those at which mortality occurs (e.g., 96-hour LC_{50}). This will be discussed in more detail in the receiving water report.

REVIEW OF SAMPLING AND ANALYTICAL PROCEDURES

Sampling and analytical procedures were not reviewed in detail with SIP personnel or with ABC Laboratories which conducts SIP's wastewater analyses. Nonetheless, samples were split for analysis by WDOE and ABC Laboratories, and during the course of the inspection some aspects of sampling and analysis were discussed with SIP personnel. This section discusses the split-sample results as well as several aspects of sampling at the SIP treatment plant.

As mentioned in the "Sampling and Study Design" section of this report, three composite samples were split with SIP for laboratory analyses: samples from the WDOE influent and effluent composite samplers, as well as a sample from the SIP effluent composite sampler. Only two sets of data were reported by ABC Laboratories; one set for influent, one for effluent. Subsequent checks with Clayton Repp (SIP) and Bill Burkhardt (ABC Laboratories) failed to clarify what happened to the third sample or which of the effluent samples was analyzed. This may be an indication of inadequate communication between SIP and ABC Laboratories. A further indication of inadequate communication was the lack of appropriate sample containers when the time came to split samples with SIP personnel. Although our intention to split samples had been discussed in some detail with Mr. Repp several weeks before the inspection, evidentally no contact had been made with ABC Laboratories to provide the appropriate sample containers with appropriate preservatives. Table 13 presents the split-sample results.

The results noted in Table 13 raise several concerns:

1. Although the ABC Laboratories' report transmitting data to SIP does not specify which samples were grabs and which were

Table 12. Bioassay metals concentrations (all concentrations in μg/L).

Metal	River Water* Control & Dilutant		SIP Effluent 100%		Control 0% Effluent		Test Solutions 0.6% Effluent		Test Solutions 4.2% Effluent		96-hour LC_{50}[1]
	Total Rec.	Diss.	Total Rec.	Diss.	Total Rec.	Diss.	Total Rec.	Diss.	Total Rec.	Diss.	
Cadmium	<2	0.5	8	2	(0.5)	0.5	(0.5)	0.5	(0.8)	0.6	1.8
Copper	<10	2	7300	860	(2)	2	(45)	7.1	(308)	38	29
Nickel	<50	<50	1000	900	(<1)	(<1)	(6)	(5)	(42)	(38)	7700
Lead	<50	1	100	2	(1)	1	(2)	1	(5)	1	150
Zinc	51	43	305	89	51	48	52	48	62	50	100

*River Water and Control are the same water. Detection limits were too high in some cases. Therefore, actual concentrations were estimated ( ) based on comparison with other upstream river samples collected during the survey and best judgment.

( ) = Estimated concentrations; see above. Also calculated concentrations in the test solutions based, in part, on these estimated concentrations.

[1] Bailey and Saltes, 1982. The concentration at which 50 percent of hatchery rainbow trout die when exposed for 96 hours.

Table 13. Comparison of laboratory results.

Sample Location	Influent			Effluent				
Sample Type	Composite-WDOE		Grab	Composite-WDOE	Composite-SIP	?	Grab	Grab
Parameter (units) Laboratory	WDOE	ABC	WDOE	WDOE	WDOE	ABC	WDOE	ABC
BOD (mg/L)	16	23		4	6	10		
TSS (mg/L)	29	25/14†		25	34	30/30†		
Cyanide (mg/L)		<.01	.001				.002	
Recoverable Phenolics (mg/L)	.055	.0046		.03				
O-PO_4-P (mg/L)	2.0			1.3	1.3	0.57		
Hex-chromium (mg/L)		<.01	<0.1*					
Total Chromium (mg/L)	.002	<.01		<.001				
Total Copper (mg/L)	7.3	6.96		7.3		6.05		
Total Iron (mg/L)	0.25	0.30		.32				
Total Molybdenum (mg/L)	.007	<.03		.012				
Total Zinc (mg/L)	.204			.305		7.0		
Fecal Coliform (#/100 mL)							10	4

? = See text, page 4 & 16
* = Field analysis.
† = Two analyses were performed.

composites, it appears that the influent cyanide sample was run from the same composite sample split as the influent metals. This sample was not preserved with 2 mL of 10 N sodium hydroxide per liter of sample (pH > 12) at time of collected as specified by EPA methods (USEPA, 1979). Later contact with Bill Burkhardt (ABC Laboratories) revealed that ABC Laboratories routinely provides a sample container with the appropriate preservative, but this was not requested by SIP.

2. There is a substantial discrepancy between the total recoverable phenolics results reported for the influent sample. The WDOE laboratory reported .055 mg/L while ABC Laboratories reported .0046 mg/L. Detailed discussions between WDOE and ABC Laboratories' chemists revealed no apparent reason for this difference; however, SIP/ABC were not preserving the sample with phosphoric acid and copper sulfate as specified by USEPA (1979). Correct preservation has subsequently been implemented.

3. There is a substantial discrepancy in dissolved orthophosphate results with WDOE detecting 1.3 mg/L and ABC 0.57 mg/L in the effluent sample. For the first six months of 1983, ABC Laboratories reported $O\text{-}PO_4\text{-}P$ values of 1.0 to 1.5 mg/L while previous WDOE analyses have yielded values of 1.2 to 3.7 mg/L. ABC Laboratories uses the stannous chloride method (Standard Methods 424E) whereas WDOE uses the acetic acid method (EPA method 365.1). The stannous chloride method is not referenced in EPA's latest methods manual (EPA, 1979) and Standard Methods 15th Edition notes a greater relative error for this method. As noted later, we recommend changing the SIP permit to require analysis for total phosphorus-P analyses rather than dissolved orthophosphate-P. At the time of this change, we recommend that quality assurance samples be sent to ABC Laboratories to assure their ability to correctly analyze wastewater samples for total phosphate.

4. A third discrepancy was noted in the effluent zinc results. WDOE reported .310 mg/L while ABC reported 7.0 mg/L. The methods used by each laboratory were essentially equivalent. The major notable difference was in the type of sample containers used. Again, due to lack of communication, an inappropriate container was used by SIP. The bottle provided by SIP had not been acid-cleaned and may have been contaminated. Presently, ABC provides the SIP with new quart cubitainers for metals sampling and that HNO_3 is added to the sample after it is returned to ABC. We recommend that the cubitainers be acid-rinsed prior to use.

The other analytical results reported in Table 13 appear to be reasonable.

Another parameter required by the present permit and reported by ABC Laboratories is "loading index". The permit does not define this term. ABC Laboratories provided a value of .074, but specified no units. Bill Burkhardt of ABC Laboratories subsequently explained that this value was intended to represent food-to-microorganism ratio. The form of the equation being used to deterine F:M was, however, incorrect. The equation now being used to calculate F:M is given below:

$$F/M = {}^{(L_i - L_o)(Q)}/(MLVSS)(V)$$

where: F/M = food-to-microorganism ratio in lbs of BOD/day/lb MLVSS
L_i = influent BOD_5 (mg/L)
L_o = effluent BOD_5 (mg/L)
Q = plant flow (gallons per day)
V = aeration basin volume (gallons)
$MLVSS$ = mixed liquor volatiles suspended solids (mg/L)

Substituting in the values obtained by WDOE during this inspection:

$$F/M = (16-4)(715{,}000)/(430)(750{,}000) = .027$$

This is a very low loading rate (F/M). Typically, extended aeration facilities (like SIP's oxidation ditch) should operate at an F/M of about 0.1. This is another indication of the incompatibility between the type of wastewater and the type of treatment system employed at the SIP.

In discussing sampling technique with SIP personnel, a major problem was discovered. Influent grab samples (for BOD and suspended solids) were being taken daily (about 3:30 p.m.) and composited for a week prior to sending them to ABC Laboratories. Effluent composite samples were collected daily and an aliquot of each daily sample was composited over the course of a week. This sample was then submitted for analysis. This practice casts into serious doubt all previous BOD data for two reasons: (1) the maximum recommended holding period for BOD samples is 24 hours, and (2) the influent samples did not, in any way, represent 24-hour composites as required by the permit.

To remedy these problems, we recommend:

1. The SIP should obtain a composite sampler for collecting 24-hour influent composite samples. Composite influent samples for BOD and suspended solids are currently required by the permit. As noted later in this report, we recommend modifying the permit to require 24-hour composite samples for metals in both the influent and effluent. Prior to obtaining this influent sampler, we recommend that SIP collect an influent

grab composite sample for BOD and suspended solids during the same time period that the effluent composite sample is being taken.

2. A single 24-hour effluent composite should be taken weekly for BOD and suspended solids analysis. SIP personnel are now doing this. The sample is composited between 10:00 a.m. Tuesday and 10:00 a.m. Wednesday. It is then transmitted directly to ABC Laboratories for analysis.

PERMIT MODIFICATION

Based on the results of this inspection and subsequent discussions with Eastern Regional Office personnel, it appears that certain changes should be made in the current NPDES permit. The most important of these involve placing numerical concentration and/or loading limits on several of the metals detected in SIP wastewaters. These metals include copper, lead, nickel, and zinc. A related issue involves the advisability of placing an effluent bioassay requirement in the permit. These issues will be addressed in a subsequent document.

In addition to the above-mentioned issues, we would also recommend:

1. Require analysis of influent and effluent composite samples for metals (at least Cu, Pb, Zn, and Ni) on at least a monthly basis.

2. Because all Spokane River wasteload analyses are based on total phosphorus measurements, change the current requirement for dissolved orthophosphate-P to total phosphate-P. This analysis should be conducted on a composite rather than grab sample. Considerations should be given to requiring both influent and effluent measurements to assess removal efficiencies.

3. The efficacy of current requirements for Cr, Cr^{+6}, Mo, phenol, and cyanide monitoring should be reassessed in light of the fact that these constituents have rarely, if ever, been detected at significant concentrations in SIP wastewaters.

4. Because a number of volatile organics were detected in both the wastewaters and sludge at SIP, we recommend requiring influent and effuent volatile organics analysis at SIP on at least a quarterly basis. This is particularly important in light of the high concentations of 1,1,1-trichloroethane detected in the wastewaters. The ultimate aim of this monitoring should be minimizing or eliminating these priority pollutant discharges.

CONCLUSIONS

Based on the findings during this and previous surveys, the following conclusions appear warranted:

1. The present characteristics of SIP wastewaters and the SIP treatment plant are not compatible. This, in conjunction with design and operational deficiencies at the treatment plant, as well as the potentially toxic nature of the waste stream, result in relatively poor removal efficiency for pollutants in SIP wastewaters. Segregation of process wastewaters, non-contact waters, and sanitary wastewaters (each with appropriate treatment and discharge) is a possible solution. Pretreatment of selected process wastewaters may solve some of the problems (for instance, decrease metals loading to the present system).

2. The current SIP discharge contains unacceptable concentrations of several heavy metals (Cu, Pb, Ni, Zn). This effluent is toxic to trout at relatively high dilutions (25:1) with Spokane River water. These problems should be addressed and remedied. Elevated volatile organics concentrations (especially 1,1,1-trichloroethane) are an additional concern.

3. The current NPDES permit should be modified to address the toxicity issues noted above as well as several other issues detailed in the "Permit Modification" section of this report.

4. Although SIP sampling practices and ABC Laboratories analytical procedures were not reviewed in detail, several sampling deficiencies and analytical discrepancies were noted. Recommendations in the body of this report should be addressed.

BY:cp

Attachments

BIBLIOGRAPHY

Bailey, G.C. and J. Saltes, 1982. *The Development of Some Metal Criteria for the Protection of Spokane River Rainbow Trout.* WDOE Project Report. 80 pp.

Singleton, L.R. and J. Joy, 1982. *Spokane River Data.* Memorandum to files. 23 pp.

USEPA, 1979. *Methods for Chemical Analysis of Water and Wastes.* EPA-600/4-79-020

WDOE, 1979. *Criteria for Sewage Works Design.* 357 pp.

WPCF, 1977. *Wastewater Treatment Plant Design; Manual of Practice #8.* 560 pp.

APPENDIX I

SPOKANE INDUSTRIAL PARK TENANTS

PILGRIM'S FINE FOODS, INC. Building #5 Thomas Hamilton, President Mfg. & distribution of food products	924-7781
PROGRESS TOOL & DIE Building #5 Arthur Barnes & Arnold Gull, Owners Tool design & engineering	922-4490
QUARRY TILE CO. Building #12 Richard Balter, Jr., President Mfg. quarry tile & glazed tile	924-1466
ROSAUER'S ICE CREAM PLANT Building #13 Pat Young, Manager Mfg. ice cream	924-2135
SENTEL CORPORATION Building #102 David Lentes, Vice President Marketing company	928-1675
SERAC Building #5 Mark Kubiak, Manager Mfg. ski apparel & outer garments	922-1900
SNE CORPORATION Building #13 Keith Harris, Manager Wood products warehousing & mfg.	924-0300
SPOKANE CRUSHER MFG. CO. Building #4 Greg Tenold, Manager Mfg. rock crushing machines	928-0750
SPOKANE METAL PRODUCTS Building #4 Tyrus Tenold, Manager Mfg. mild & stainless steel fabrication	928-0720
SPOKANE-PACIFIC Building #24 James Evans, Manager Public warehousing	922-8967
SPOKANE PRES-TO-LOG CO., INC. Building #8 Robert Cook, Vice President Mfg. plastic bottles, jugs, etc.	924-7900
SPOKANE STEEL FOUNDRY Building #1 John Tenold, Pres. & Gen. Mgr. Steel foundry	924-0440
SUN WEST PRODUCTIONS Building #101 Bob Asbury, Manager Recording studio	924-7573
TELECT, INC. Building #12 Bill Williams, President Electronics & Electrical assembly	926-6000
TENOLD, JOHN Building #N2 Attorney at Law	928-1023
TRAVIS PATTERN & FOUNDRY Building #4 Travis Garske, Owner Aluminum foundry	924-6464
TRI-STATE METAL FAB, INC. Building #8 Hugh Kridler, President Sheet metal operation	926-7165
TRI STATE WOOD PRODUCTS, INC. Building #32 Chuck McConnell, President Millwork mfg.	928-6515
UNITED CAR SERVICE Building #N14 Rich Fitzgerald, Manager GM car repair	928-6618
VALLEY CARBURETION Building #S-4 John Lubbers, Owner Carburetion repair	922-4832
VALLEY DISTRIBUTING CO. Building #16 Ralph Boyd, Wrehouse Manager Storage & distribution	928-2324
VALLEY ENTERPRISES Building S-6 Mitchell King, Vice President Machinery sales & parts	926-7338
VARI-TRONICS CO., INC. Building #5 Theodore C. Brown, Manager Electronics & electrical assembly	924-0083
W.S.I., INC. Building #N-5 Gary Floan, President Resaw operation & millwork	924-1375
WAREHOUSE STOVE DISTRIBUTION Building #S-6 J. Don Firestone, Manager Retail sales of wood stoves	922-0102
WESTERN HEAT SERVICE, INC. Building #103 Furnace cleaning & installation	
WILDERNESS ENTERPRISES, INC. Building #16 Div. of Lippincott Ind., Inc. Jim Lippincott, Manager Refurbishing used telephone equipment	926-5298

TENANTS OF THE SPOKANE INDUSTRIAL PARK, INC.

a subsidiary of
The Washington Water Power Company
Spokane, Washington 99216
509/924-1720

S.I.P.

JUNE 1, 1983

Richard Vollmer
Vice President
and General Manager