A Department of Ecology Report

Spokane River Basin Class II Inspection at the City of Spokane Wastewater Treatment Plant

Abstract

Announced Basin Class II inspections were conducted at three industrial wastewater treatment plants (WWTPs) and two municipal WWTPs including the City of Spokane in the Spokane River Basin during March 22-24, 1993. A separate inspection report was written for each discharger in the basin. This report is based on the inspection conducted at the City of Spokane WWTP. The plant was operating well at the time of inspection and met permit requirements for five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), fecal coliform, pH, ammonia, mercury, and silver. According to the permittee's discharge monitoring report (DMR), effluent exceeded the daily maximum loadings for total residual chlorine -- violations of the permit. Removal efficiencies for BOD_5 and TSS were higher than the 85% requirement. Ammonia, lead, and mercury concentrations exceeded chronic water quality criteria, while copper and zinc concentrations exceeded both acute and chronic water quality criteria. A concurrent metals study progressing in the Spokane River Basin should provide insight concerning the potential for effluent metals toxicity at acute and chronic mixing zone boundaries. Due to heavy rains during the inspection, the monthly average design flow was exceeded by approximately 29%; influent BOD_5 and TSS loads also exceeded design criteria.

Introduction

Announced Basin Class II inspections were conducted at two municipal WWTPs and three industrial WWTPs in the Spokane River Basin on March 22-24, 1993. Entities operating the plants are as follows: City of Spokane, Liberty Lake Sewer District, Inland Empire Paper Company, Spokane Industrial Park, and Kaiser Aluminum and Chemical Corporation. These Basin Class II inspections are done in support of an emerging concept within the Department of Ecology to conduct activities on a coordinated geographic basis. This concept is referred to as the Basin (Watershed) Approach to environmental management. Figure 1 is a map showing the locations of the five WWTPs.

Conducting the inspections were Rebecca Inman and Tapas Das of the Environmental Investigations and Laboratory Services Program's Watershed Assessments Section. Patrick Hallinan and Kenneth Merrill of Ecology's Eastern Regional Office were present to observe a portion of the inspections. The data obtained from these Basin Class II inspections will subsequently support the Spokane River total maximum daily load (TMDL) study. A concurrent metals study is also progressing in the basin (Pelletier, in prep.).

A separate Class II inspection report was written for each discharger. This report is based on the Class II inspection conducted at the City of Spokane WWTP. Michael Coster, laboratory supervisor, provided assistance during the inspection.

by Tapas Das

May 1994

Waterbody No. WA-54-1020

Ecology Report #94-89

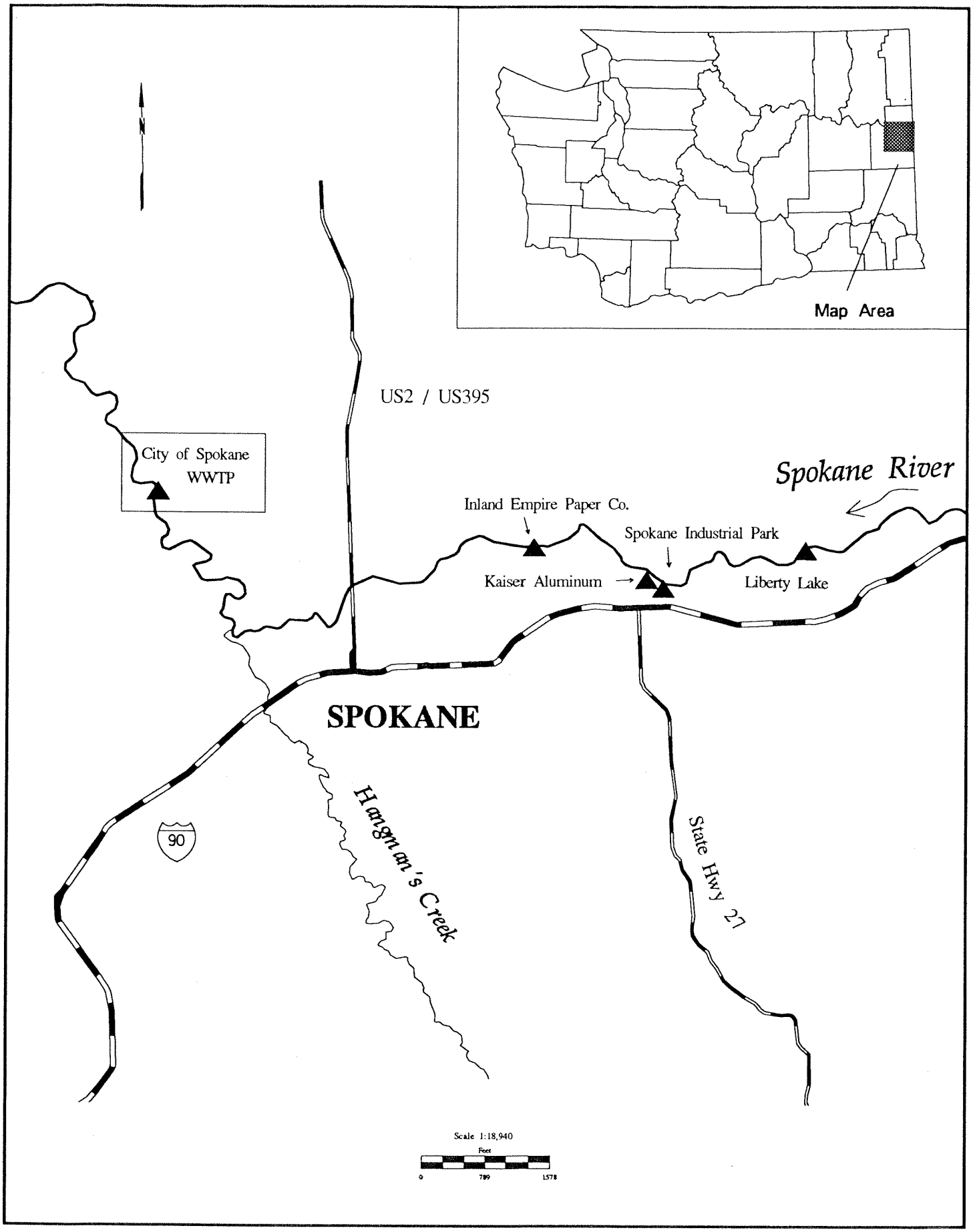

Figure 1. Location of City of Spokane WWTP – Spokane River Basin, 3/93

Objectives

1. verify compliance with NPDES permit limits;
2. provide effluent data (including metals) to support the Spokane River TMDL assessment; and
3. evaluate permittee's sampling and testing procedures by conducting sample splits.

The City of Spokane is authorized to discharge treated wastewater to the Spokane River under NPDES Permit No. WA-002447-3, which will expire on April 30, 1997. The permit contains additional limits on effluent ammonia, total residual chlorine, mercury, and silver (Ecology, 1992a).

The WWTP headworks consists of three channels (Figure 2). Flow from the three channels is combined in a wet well. Flow from the wet well is then fed to two aerated grit chambers via three lines each of which is fitted with a six-foot Parshall flume. Any overflow is routed from the grit chambers to the two storm water clarifiers. The WWTP's secondary system consists of two pre-aeration basins, four primary clarifiers, four aeration basins, and four secondary clarifiers. Effluent from the secondary clarifiers is chlorinated in two chlorine contact chambers, followed by dechlorination with sulfur dioxide before discharge down a steep embankment to the Spokane River. Effluent flow is measured by a Parshall flume. Both primary and secondary sludge are anaerobically digested. Digested sludge is dewatered by filter press and applied on land.

Procedures

Sampling locations are shown in Figure 2. A summary of the analytical methods and laboratories conducting the analyses is given in Table 1. Standard operating procedures (SOPs) which are routinely employed when conducting Basin Class II inspections and when preserving and analyzing the samples are contained in the Ecology document Quality Assurance Project Plan for Basin Class II Inspections (Glenn, in prep.). The following procedures were exceptions to these SOPs (asterisks denote QAPP changes made at the request of the client):

1) Composite samples of influent wastewater were obtained from the permittee's sampler;
*2) several standard influent and effluent parameters were not analyzed for;
*3) duplicates were not collected for all effluent parameters;
4) orthophosphate samples were filtered in the field rather than by the Manchester Lab; and
5) instantaneous flow verification could not be done because the flow measuring devices weren't accessible.

Results and Discussion

General chemistry results are summarized in Table 2. Effluent composite results should be interpreted with caution since composite sample temperatures exceeded 4°C. BOD_5, TSS, and NH_3 data indicate that the plant was receiving a weak influent (Metcalf & Eddy, 1991). Due to continuing heavy rains before and during the inspection, the WWTP was experiencing about 29% higher flows (56.55 MGD) than normal (Coster, 1993). However, BOD_5 and TSS results indicated a well-treated effluent. The ammonia concentration in effluent was roughly 33% of influent, indicating that some nitrification was taking place. Ammonia in effluent was 3.76 mg/L, somewhat above the chronic water quality criterion of 1.85 mg/L, which is based on salmonid presence at pH = 7.6 S.U. and temp. = 4.5°C (EPA, 1986). Concern over chronic toxicity would be minimized by a dilution factor of 2:1 at the edge of the chronic mixing zone.

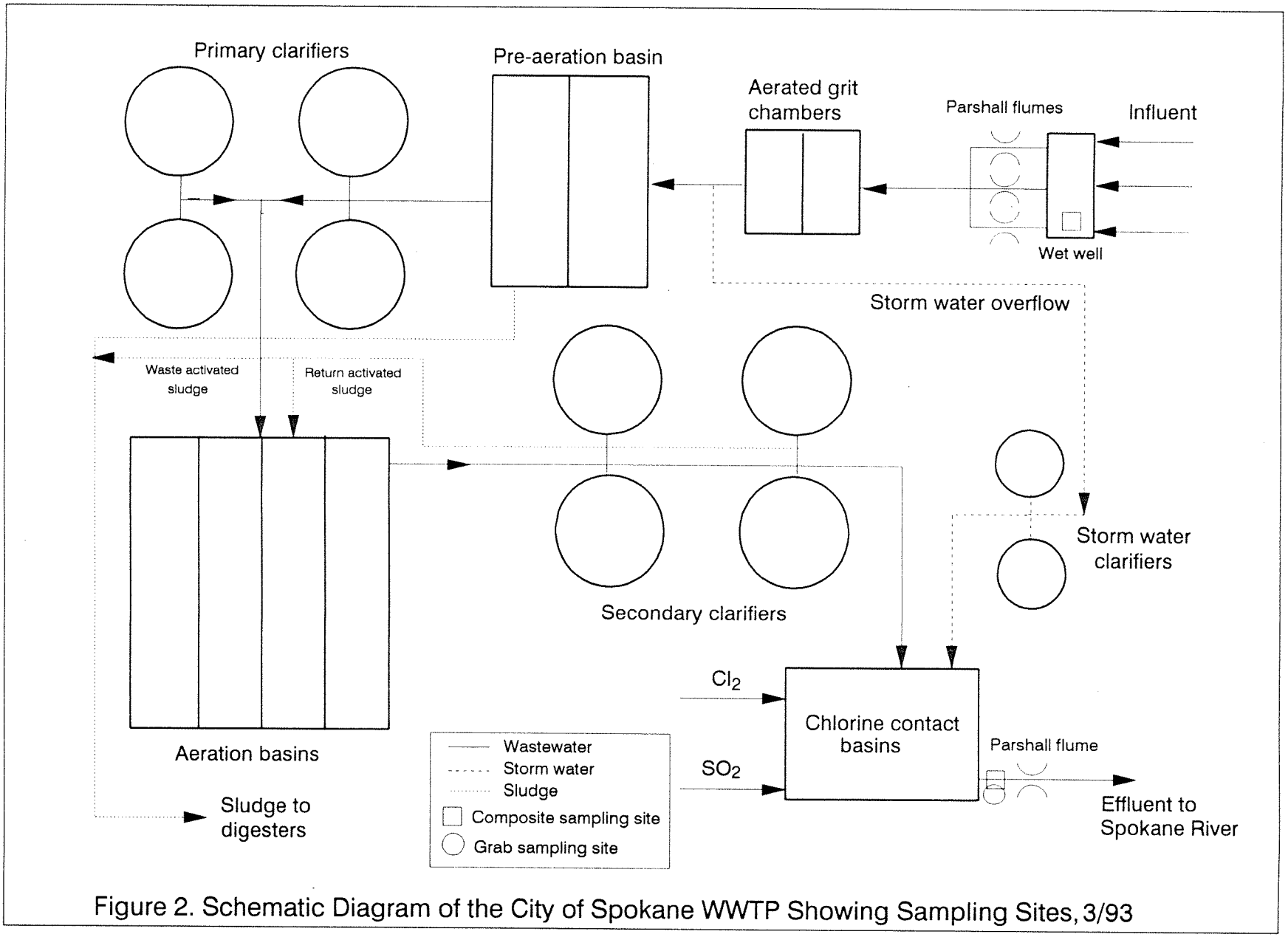

Figure 2. Schematic Diagram of the City of Spokane WWTP Showing Sampling Sites, 3/93

Table 1. Analytical Methods and Laboratories, City of Spokane WWTP - Spokane River Basin Class II Inspections, 3/93

Parameter	Method	Lab used
Turbidity	EPA, 1983: 180.1	Ecology; Manchester, WA
Conductivity	EPA, 1983: 120.1	Ecology; Manchester, WA
Alkalinity	EPA, 1983: 310.1	Ecology; Manchester, WA
Hardness	EPA, 1983: 130.2	Ecology; Manchester, WA
SOLIDS4		
TS	EPA, 1983: 160.3	Ecology; Manchester, WA
TNVS	EPA, 1983: 106.4	Ecology; Manchester, WA
TSS	EPA, 1983: 160.2	Ecology; Manchester, WA
TNVSS	EPA, 1983: 106.4	Ecology; Manchester, WA
BOD5	EPA, 1983: 405.1	Ecology; Manchester, WA
TOC	EPA, 1983: 415.2	Ecology; Manchester, WA
NUTRIENTS		
NH3-N	EPA, 1983: 350.1	Ecology; Manchester, WA
NO2+NO3-N	EPA, 1983: 353.2	Ecology; Manchester, WA
T-phosphorus	EPA, 1983: 365.1	Ecology; Manchester, WA
O-phosphate	EPA, 1983: 365.3	Ecology; Manchester, WA
Total Kjeldahl nitrogen	EPA, 1983: 351.4	Analytical Resources Inc.; Seattle, WA
Fecal coliform (MF)	APHA, 1989:9222D	Ecology; Manchester, WA
Oil and grease	EPA, 1983: 413.1	Ecology; Manchester, WA
METALS		
Cr;Cu;Ni;Zn	EPA, 1983: 200.7	Ecology; Manchester, WA
Hg	Bloom & Fitzgerald, 1988	Battelle; Sequim, WA
Hg	EPA, 1983: 245.5	Ecology; Manchester, WA
Ag	EPA, 1983: EP1-272.2	Ecology; Manchester, WA
Cd	EPA, 1983: EP1-213.2	Ecology; Manchester, WA
Pb	EPA, 1983: EP1-239.2	Ecology; Manchester, WA

Table 2. General Chemistry Results, City of Spokane WWTP - Spokane River Basin Class II Inspections, 3/93
(Effluent Composite Results Should be Interpreted with Caution since Composite Sample Temperatures Exceeded 4°C)

	Station:	Eff-1	Eff-T	Inf-CS	Eff-E	Eff-CS	Eff-2	Blank
	Type:	grab	grab	comp	comp	comp	grab	rinsate
	Date:	3/22	3/22	3/22-23	3/22-23	3/22-23	3/24	3/24
	Time:	0930	0930	0800-0800	0830-0830	0800-0800	0835	1830
Parameter	Lab ID#1382	-30	-31	-32	-33	-34	-35	-36
Turbidity (NTU)					4.4	4.9		
Conductivity (µmhos/cm)					674	642		
Alkalinity (mg/L)					166	169		
Hardness (mg/L CaCO3)					175	176		
TS (mg/L)					397			
TNVS (mg/L)					293			
TSS (mg/L)				157	11	10		
TNVSS (mg/L)					4			
BOD5 (mg/L)				134	12	14		
TOC (mg/L)					9.8	11.1		
NH3-N (mg/L)		1.93	1.94	12.20+	3.76	3.87		
NO2+NO3-N (mg/L)					3.66	4.04		
Total Phosphate (mg/L)				4.18	1.83	1.95		
Ortho-Phosphate (mg/L)					1.38	1.66		<0.01
TKN (mg/L)					5.99	6.74		
Oil & Grease (mg/L)		2	2				4	
F-Coliform MF (#/100 mL)		36	33				210	
FIELD OBSERVATIONS								
Flow (MGD)					56.55**			
Temperature (°C)		11.3	11.0	9.4*	4.5*	10.0*	10.3	
pH (S.U.)		6.6	7.0				7.7	
Conductivity (µmhos/cm)		465	510	710	650	660	580	
Chlorine								
Free (mg/L)		0.08	0.08				0.08	
Total (mg/L)		0.20	0.22				0.15	

Eff - Effluent, Inf - Influent, E - Ecology sample, CS - City of Spokane WWTP sample, T - Ecology replicate sample

\+ Influent NH3-N result was obtained from the WWTP laboratory.

* Iced composite sample.

** Flow was obtained from plant's totalizer for a 24-hour time period (3/22-23).

Effluent had high residual chlorine levels despite the fact that measurements were taken post-dechlorination. Total residual chlorine was measured by Ecology using the colorimetric method, while the City used the low-level amperometric titration method in accordance with their permit. The WWTP's influent and effluent total phosphorus concentrations indicated that there was some phosphorus removal (53%) by the treatment process. It should be noted that according to the discharger's current NPDES permit, phosphorus removal is not mandatory during the high flow season (November-June).

A listing of priority pollutant metal results is presented in Table 3. The water quality criteria for these metals were calculated using a receiving water hardness of 28.5 mg/L as $CaCO_3$ (Pelletier, in prep.). Cadmium, copper, mercury, silver, and zinc were detected in effluent. The acute criterion for silver is "an instantaneous concentration not to be exceeded at any time" (Ecology, 1992b). Effluent concentrations were twice this criterion. Lead and mercury concentrations exceeded chronic water quality criteria, while copper and zinc concentrations exceeded both acute and chronic criteria (EPA, 1986). It should be noted that copper was found in the equipment blank at 5.8 μg/L. The potential impact of these metals on the receiving water will be evaluated by Pelletier (in prep.).

A comparison of effluent parameters to NPDES permit limits is presented in Table 4. The plant's totalizer reading for a 24-hour time period (March 22-23) indicated a flow of 56.55 MGD; this flow was used to calculate effluent mass loadings for comparison to permit limits. Effluent met permit requirements for BOD_5, TSS, pH, fecal coliform, ammonia, mercury, and silver. Removal efficiencies for BOD_5 and TSS were higher than 85% requirement.

Total residual chlorine concentrations measured on March 22 and 24 were 0.20 and 0.15 mg/L according to Ecology's field test kit. Total residual chlorine loading exceeded the daily maximum permit limit by 8-10 folds. The facility permit specifies use of the low-level amperometric titration method (Standard Method 4500). However, total residual chlorine concentrations reported on their discharge monitoring report for the period March 22-24 were 0.07, 0.08, and 0.07 mg/L, respectively (Coster, 1994). The resultant loadings also exceeded the daily maximum limit. These are permit violations. Plant flow and influent BOD_5 and TSS loads during the inspection exceeded 85% of design criteria, a threshold beyond which planning must begin for an upgrade to the plant (Ecology, 1992a). It should be noted that the planning for an upgrade to the plant has already started (Coster, 1994).

Table 5 compares results of analyses performed by Spokane and Ecology labs on splits of the same samples. Among all influent split results, the permittee's BOD_5 result (78 mg/L) was considerably lower than Ecology's result (134 mg/L). An incomplete mixing of the sample before pouring into individual bottles might have caused this difference. It also may be due to the type of "seed" (activated sludge) used by each lab. The influent mercury result obtained by the permittee's lab (0.77 μg/L) was much higher than Ecology's result (0.15 μg/L). However, Ecology's value carries a "J" qualifier, indicating an estimated value.

Among effluent split results, both labs detected the presence of copper. The results (9 versus 17 μg/L) were considerably different, but again Ecology's result was flagged with the qualifier "P" indicating a value near the detection limit. However, BOD_5, TSS, NH_3, total phosphorus, silver, mercury, lead, and zinc showed good agreements. Overall, these results did not indicate any obvious problem in the areas of sample representativeness and lab performance. Temperatures of samples composited by both Ecology and plant personnel were above the recommended 4°C (APHA, 1989).

Table 3. Results of Metals Analyses, City of Spokane WWTP - Spokane River Basin Class II Inspections, 3/93.

Station:	Blank	Inf-CS	Eff-E	Eff-CS	Water Quality Criteria (μg/L)	
Type:	rinsate	comp	comp	comp	Freshwater	
Date:	3/22	3/22-23	3/22-23	3/22-23		
Time:	0830	0800-0800	0830-083	0800-0800		
Lab ID#:	138264	138232	138233	138234	Acute	Chronic
Metals tot rec (μg/L)						
Cadmium	<0.10 J	0.67 J	0.14 J	0.13 J	1*	0.4*
Chromium	<5	<5	<5	<5	16	11
Copper	5.6 P	54.3	17 P	17 P	5*	4*
Lead	<1	15.2	2.50 P	2.50 P	17*	0.6*
Mercury	<0.0015***	0.15 J	0.023***	0.023	2.4	0.012
Nickel	<10	<10	<10	<10	490*	55*
Silver	<3	5.98	0.97 P	1 P	0.5**	0.12
Zinc	<4 J	117 B	45.6 B	43.9 B	40*	37*

Eff - Effluent, Inf - Influent, E - Ecology sample, CS - City of Spokane sample

B - Analyte was also found in the analytical method blank indicating the sample may have been contaminated.

J - Indicates an estimated value when result is less than specified detection limit.

P - The analyte was detected above the instrument detection limit but below the established minimum quantitation limit.

* Criteria are river water hardness dependent (based on 28.5 mg/L as CaCO3) (EPA, 1986)

** An instantaneous concentration not to be exceeded at any time (Ecology, 1992b).

*** Analyzed by Battelle of Sequim lab (Bloom and Fitzerald, 1988).

Shaded area denotes metal detected.

Table 4. Comparison of Results to NPDES Permit Limits, City of Spokane WWTP – Spokane River Basin Class II Inspections, 3/93

	NPDES Permit Limits		Inspection Data		Loading and Performance			
Parameter	Monthly Average	Weekly Average	Ecology/WWTP Composite	Grab Samples	Design Criteria	Derived Results	Plant Loading (% of DC***)	Planning to begin (% of DC)
Influent BOD5								
(mg/L)			134*	– – –				
(lbs/day)					70,000	63,200	90	85
Effluent BOD5**								
(mg/L)	30	45	12	– – –				
(lbs/day)	10,500	15,750				5,660		
(% removal)	85					91		
Influent TSS								
(mg/L)			157*	– – –				
(lbs/d)					58,500	74,100	126	85
Effluent TSS**								
(mg/L)	30	45	11	– – –				
(lbs/day)	8,775	13,162				5,190		
(% removal)	85					93		
Fecal Coliform++	200	400		87				
(#/100 mL)			– – –	(36;210)				
pH (S.U.)		6.0 ≤ pH ≤ 9.0	– – –	6.6;7.7				
Flow (MGD)					44	56.55+	129	85
	Monthly Average (November – June)	Daily Maximum						
Ammonia (as N), mg/L			3.76					
(lbs/day)	870	2,191				1,773		
T–Residual Chlorine, mg/L				0.20;0.15				
(lbs/day)	3.7	9.2				94;71		
Mercury (total), µg/L			0.023					
(lbs/day)	0.04	0.09				0.01		
Silver (tot rec), µg/L			0.97					
(lbs/day)	0.36	0.92				0.46		

\+ Flow obtained from WWTP's totalizer for a 24–hour time period.

++ The average for fecal coliform bacteria is based on the geometric mean of the samples taken.

* Data obtained by analyzing sample from the WWTP's compositor.

** The monthly and weekly averages for BOD5 and TSS are based on the arithmetic mean of the samples taken.

*** Design criterion is based on a monthly average flow (Ecology, 1992a).

Table 5. Comparison of Laboratory Results of Sample Splits, City of Spokane WWTP - Spokane River Basin Class II Inspections, 3/93

Station:	Inf-CS		Eff-E		Eff-CS	
Lab ID#:	138232		138233		138234	
Date:	3/22-23		3/22-23		3/22-23	
Sampler:	Spokane		Ecology		Spokane	
Laboratory: / Parameter	Ecology	WWTP	Ecology	WWTP	Ecology	WWTP
BOD5 (mg/L)	134	78	12	12	14	10
TSS (mg/L)	157	172	11	12	10	13
NH3-N (mg/L)	---	12.20	3.76	4.15	3.87	4.26
T.Phos (mg/L)	4.18	3.69	1.83	2.08	1.95	2.05
Ag (µg/L)	5.98	5.0	0.97 P	1.0	1.0 P	0.80
Cu (µg/L)	54.3	43	17 P	9	17 P	9
Hg (µg/L)	0.15 J	0.77	0.05 UJ	<0.06	0.05 UJ	0.06
Pb (µg/L)	15.2	10	2.50 P	2	2.50 P	2
Zn (µg/L)	117 B	110	45.6 B	50	43.9 B	50

Inf - Influent, Eff - Effluent, E - Ecology sample, CS - City of Spokane sample
B - Analyte was also found in the analytical method blank indicating the sample may have been contaminated.
J - Indicates an estimated value when result is less than specified detection limit.
P - The analyte was detected above the instrument detection limit but below the established minimum quantitation limit.
U - The analyte was not detected at or above the reported result.

Conclusions and Recommendations

1. Due to heavy rains during the inspection (March 22-24), the plant was receiving approximately 29% higher flow and consequently, the monthly average design flow was exceeded. Also, influent BOD_5 and TSS loads exceeded 85% of design criteria for maximum month. Facility planning for an upgrade to the plant to meet future demands is currently underway (Coster, 1994).
2. The plant was operating well during the inspection and met applicable effluent limitations except for total residual chlorine loads. It is recommended that the Spokane chlorination/dechlorination system be checked and corrected as necessary.
3. The effluent total ammonia concentration exceeded the chronic freshwater quality criterion. Concern over this toxicity would be minimized by a dilution factor of 2:1 at the edge of the chronic mixing zone.
4. Cadmium, lead, zinc, copper, mercury, and silver were detected in effluent. Among them, lead and mercury concentrations were higher than chronic water quality criteria, while copper and zinc concentrations exceeded both acute and chronic water quality criteria. It is recommended that Pelletier's (in prep.) Spokane River metals study be consulted to address concern about metal toxicity in the receiving water.
5. The discharger's influent and effluent composite sample temperatures were higher than the recommended 4°C. The plant's sample cooler should be inspected and repaired as necessary to provide better sample cooling.

References

APHA-AWWA-WPCF, 1989. Standard Methods for the Examination of Water and Wastewater. 17th edition. American Public Health Association, Washington DC.

Bloom, N. and W. Fitzgerald, 1988. Determination of Volatile Mercury Species at the Picogram Level by Gas Chromatography with Cold Vapor Atomic Fluorescence Detection. *Anal. Chim. Acta*, vol. 209, pp. 151-161.

Coster, M., 1993. Personal Communication. Laboratory Supervisor, Spokane WWTP, Spokane WA. November 2.

------, 1994. Personal Communication. Laboratory Supervisor, Spokane WWTP, Spokane WA. April 20.

Ecology, 1992a. National Pollutant Discharge Elimination System Waste Discharge Permit for the City of Spokane. Washington State Department of Ecology, Olympia WA. Section - S1.A.1, pp. 5-6 & S4.B, pp. 12.

------, 1992b. Water Quality Standards for Surface Waters of the State of Washington. Washington State Department of Ecology, Olympia WA, November 25.

EPA, 1983. Methods for Chemical Analyses of Water and Waste. EPA-600/4-79-020 (Rev. March 1983), Washington DC.

------, 1986. Quality Criteria for Water. EPA 440/5-86-001.

Glenn, N., in prep. Quality Assurance Project Plan for Basin Class II Inspections. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia WA.

Metcalf & Eddy, Inc., 1991. Wastewater Engineering: Collection, Treatment, & Disposal. 3rd edition, New York, NY. pp. 109.

Pelletier, G., in prep. Spokane River Metals Project. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia WA.

Contacts

Tapas Das — Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
(206) 407-6684

Will Kendra — Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
(206) 407-6698

If you have special accommodation needs, please contact Barbara Tovrea at (206) 407-6696 (voice). Ecology's telecommunications device for the deaf (TDD) number at Ecology Headquarters is (206) 407-6006.

For additional copies of this publication, please contact Ecology's Publications Distribution Office at (206) 407-7472, and refer to publication number 94-89.