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SALMON CREEK WTP
CLASS II INSPECTION

by
Tapas Das

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Watershed Assessments Section
Olympia, Washington 98504-7710

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ABSTRACT

A Class II Inspection was conducted at the Salmon Creek Wastewater Treatment Plant in Burien, on June 4-6, 1991. The effluent met NPDES permit requirements except for fecal coliform. Lead was found in effluent at a concentration slightly above the chronic marine water quality criterion. Several organic priority pollutants were also detected in the effluent. No whole effluent toxicity was indicated by rainbow trout, *Daphnia magna*, and *Ceriodaphnia dubia* bioassays. Seven volatile organic compounds, 10 base neutral acids, and 10 priority pollutant metals were detected in the sludge sample. Split sample analyses indicated a problem with fecal coliform measurement. Several recommendations were made, foremost of which was that the disinfection system be inspected and repaired as necessary.

INTRODUCTION

A Class II Inspection was conducted at the Salmon Creek (SC) Wastewater Treatment Plant (WTP) on June 4-6, 1991. Conducting the inspection were Tapas Das, Norm Glenn, and Rebecca Inman from the Washington State Department of Ecology's (Ecology) Environmental Investigations and Laboratory Services Program (EILS). Dale Van Donsel and Perry Brake of EILS' Quality Assurance Section conducted an on-site laboratory inspection on June 4. The inspection was requested by Laura Fricke of the Ecology Northwest Regional Office (NWRO). Phil Baga, SC Operations Supervisor, provided assistance during the inspection.

Salmon Creek WTP is located in Burien (Figure 1) and is operated by the Southwest Suburban Sewer District. The collection system serves approximately 30,000 residential users, but no industrial wastes are contributed. The SC discharge into Puget Sound is regulated by NPDES Permit No. WA-002277-2, which expired on July 25, 1991.

The original treatment plant was built in 1955 to provide primary treatment. The plant was upgraded in 1973-74, and underwent extensive modifications to achieve secondary treatment capability in 1988, including the addition of Rotating Biological Contactors (RBCs). The existing wastewater treatment system consists of a mechanically cleaned bar screen, grit chamber, primary clarifier, RBC units, secondary clarifier, and chlorine contact chamber (Figure 2).

Sludge process units include primary and secondary anaerobic digesters, a filter press, and odor scrubbers. Sludge handling includes an option to compost at the neighboring Miller Creek (MC) WTP and market the sludge. Currently, SC is hauling its entire sludge to the MC composting site.

Objectives of the inspection were:

- Verify flowmeter accuracy;
- Assess SC effluent compliance with NPDES permit limits;
- Chemically characterize WTP influent, effluent, and sludge;
- Determine effluent toxicity using rainbow trout, *Daphnia magna*, and *Ceriodaphnia dubia* bioassays; and
- Split samples with the permittee to determine comparability of both sampling methods and laboratory analyses.

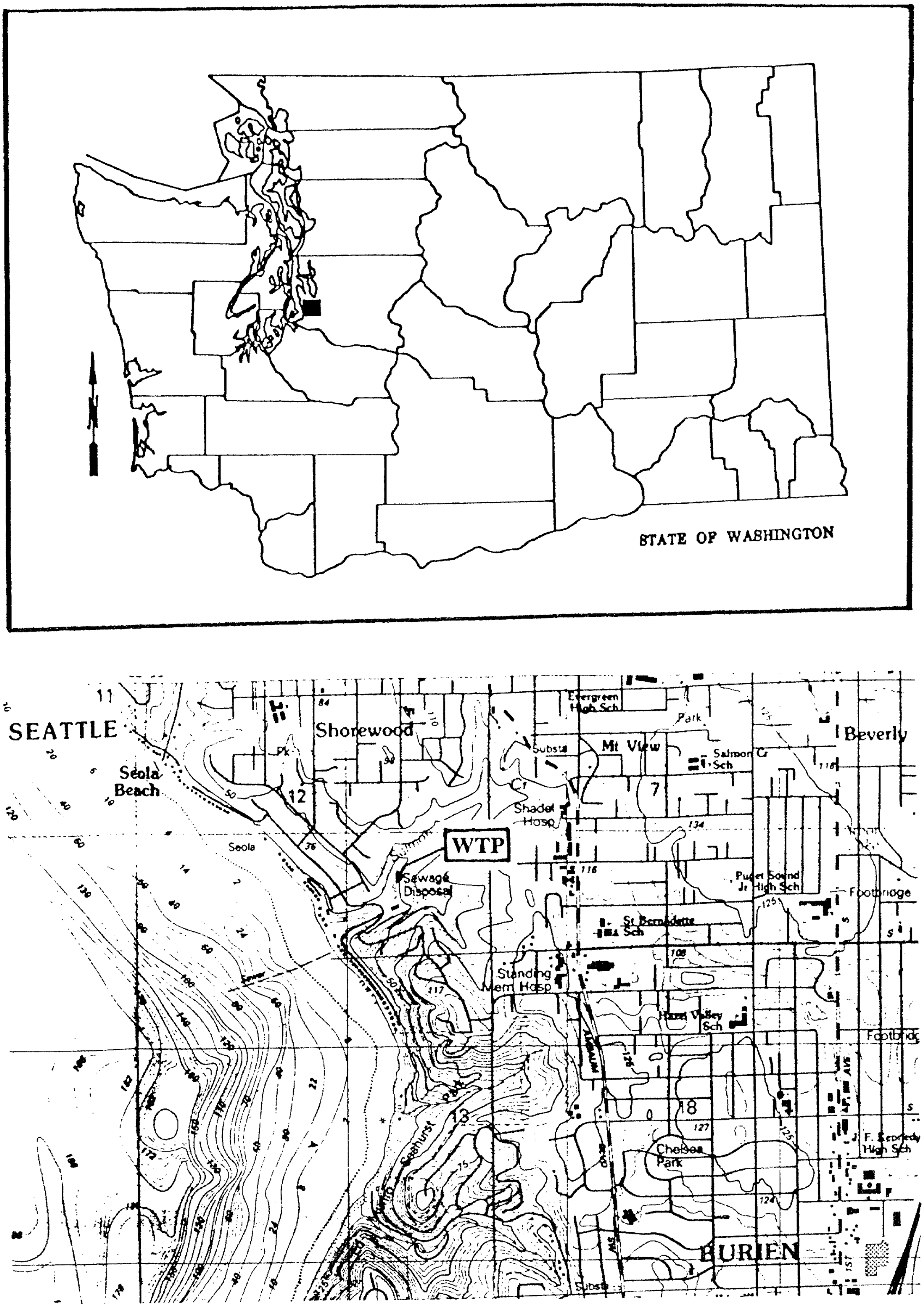

Figure 1 - Location Map - Salmon Creek WTP, 6/91.

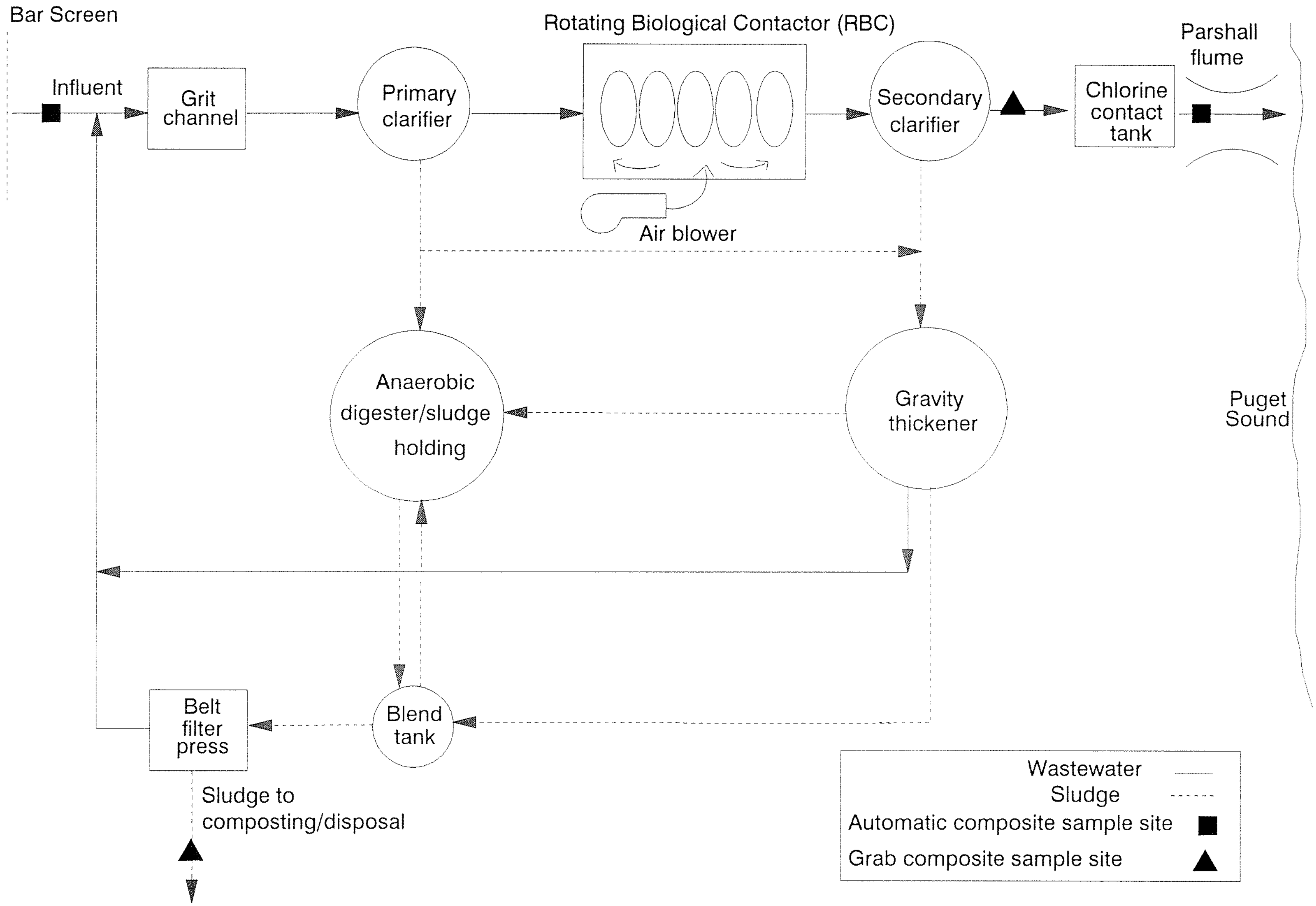

Figure 2 - Schematic and Sample Sites - Salmon Creek Wastewater Treatment Plant, 6/91

PROCEDURES

Grab samples and 24 hour composite samples of wastewater were taken at two locations: (1) influent at a point between the bar screen and comminutor; and (2) effluent at the end of the chlorine contact chamber upstream of the Parshall flume (Figure 2). An additional composite sampler was set up to collect replicate samples of effluent to determine representativeness of the samples and variability of lab results. ISCO compositors were set for time proportional collection of 320 mL of sample every 30 minutes. Salmon Creek's influent and effluent composite samplers were installed at approximately the same locations as Ecology's samplers. They were set for flow proportional collection and took about 400 mL of sample every 60,000 gallons.

The composite samplers were cleaned for priority pollutant sampling prior to the inspection (Table 1). Transfer blank samples were taken for total organic carbon (TOC), volatile organic compounds (VOCs), and metals analyses.

Effluent grab samples for fecal coliform, VOCs, and oil and grease were collected at the end of the chlorine contact chamber. Hand composites, consisting of three equal volumes, time separated grab samples of unchlorinated effluent, were taken for bioassay tests. They were collected at a wet well between the secondary clarifier and the chlorine contact chamber (Figure 2).

Primary and secondary sludges are combined and thickened, then dewatered in a sludge filter press. Grab composites of dewatered sludge were collected at the end of the belt press as cake dropped into a hauler truck.

Sampling times, parameters analyzed, and sample splits between Ecology and SC are included in Table 2. All samples were held on ice until delivery to the Manchester Laboratory. A summary of the analytical methods and laboratories conducting the analyses are given in Appendix A.

QUALITY ASSURANCE/QUALITY CONTROL

Laboratory quality assurance and quality control (QA/QC) methods, which were followed during analyses of general chemistry parameters and priority pollutants, are described by Huntamer and Hyre (1991) and Kirchmer (1988). Analyses for all parameters were performed within holding time limits.

No target analytes were detected in method blanks. For VOC analyses, the gas chromatograph/mass spectrometer (GC/MS) met contract laboratory protocol (CLP) requirements (EPA, 1990b). Matrix spike recoveries and precision data for VOCs were acceptable and within recommended limits. All spike recoveries for metals in water and sludge were within the acceptable limit of $\pm 25\%$. For organics analyses, matrix spike/spike duplicate recovery and precision data were acceptable and within recommended limits (Perez, 1991; Smith, 1991).

Table 1. Priority Pollutant Cleaning and Field Transfer Blank Procedures - Salmon Creek WTP, 6/91.

Priority Pollutant Sampling Equipment Cleaning Procedure

1. Wash with laboratory detergent (phosphate free).
2. Rinse several times with tap water.
3. Rinse with 10% nitric acid solution.
4. Rinse three times with distilled/deionized water.
5. Rinse with high purity methylene chloride.
6. Rinse with high purity acetone.
7. Allow to dry and seal with aluminum foil.

Field Transfer Blank Procedure

1. Pour organic free water directly into appropriate bottles for parameters to be analyzed from grab samples, namely VOCs.

2. Run approximately 1 liter of organic free water through a compositor and discard.

3. Run approximately 6 liters of organic free water through the same compositor and put the water into appropriate bottles for parameters to be analyzed from composite samples, namely priority pollutant metals, TOC, and VOCs.

Table 2 - Sampling Schedule and Parameters Analyzed - Salmon Creek WTP, 6/91.

Location:	Blank	Inf-E	Inf-SC	Inf-1	Inf-2	Eff-E	Eff-ER	Eff-SC	Eff-1	Eff-2	Effluent	Sludge
Type:	trans	comp	comp	grab	grab	comp	comp	comp	grab	grab	grab-comp	grab-comp
Date:	6/4	6/5-6	6/5-6	6/5	6/6	6/5-6	6/5-6	6/5-6	6/5	6/6	6/6	6/5
Time:	1345	0800-0800	0800-0800	0925	1140	0815-0815	0815-0815	0815-0815	1440	1010	1000-1130	0800-1100
Parameters Lab ID#2381:	-05	-06	-07	-08	-09	-10	-11	-12	-13	-14	-15	-16
GENERAL CHEMISTRY												
Conductivity		E	E	E	E	E	E	E	E	E	E	
Alkalinity		E	E			E	E	E			E	
Hardness		E	E			E	E	E			E	
SOLIDS 4		E,SC	E,SC			E,SC	E	E,SC			E	
% Solids												E
% Volatile Solids												E
BOD5		E,SC	E,SC			E,SC	E	E,SC				
BOD5 Soluble		E	E			E	E	E				
TOC (water)	E	E	E			E	E	E				
TOC (soil)												E
NH3-N		E	E			E	E	E				
NO2+NO3-N		E	E			E	E	E				
NO2-N		E	E			E	E	E				
NO3-N		E	E			E	E	E				
Phosphorus - Total		E	E			E	E	E				
Oil and Grease				E	E				E	E		
F-Coliform MPN/MF									E	EE*		E
ORGANICS and METALS												
VOCs (water)	E			E					E			
VOCs (sludge)												E
BNAs (water)		E				E						
BNAs (sludge)												E
Pesticides/PCBs (water)						E						
PP Metals	E	E				E		E				E
BIOASSAYS												
Rainbow trout (acute)											E	
Daphnia magna (acute)											E	
Ceriodaphnia dubia (acute & chronic)											E	
FIELD OBSERVATIONS												
Temp		E	E	E	E	E	E	E	E	E	E	
pH		E	E	E	E	E	E	E	E	E	E	
Conductivity		E	E	E	E	E	E	E	E	E	E	
Chlorine Free									E	E		
Total									E	E		

Inf - Influent, E - Ecology sample, Eff - Effluent, ER - Replicate of E, SC - Salmon Creek sample, * - Replicate Analysis (by MF method)

Ecology collected replicate samples at the effluent station (Eff-ER) to quantify variability of results. A selected number of parameters were analyzed for these samples and the results were in good agreement except for ammonia, nitrate, and nitrate-nitrite (Table 4). Approximately two times the NH_3-N and NO_2+NO_3-N concentrations were found in Eff-ER than Eff-E.

RESULTS AND DISCUSSION

Flow

Physical measurements taken of the 24" Parshall flume showed it was correctly installed and calibrated. Verification of the accuracy of instantaneous flow readings was accomplished by having one inspector take the depth measurement at the flume while another recorded the plant flowmeter reading. Flow for a given flume depth was obtained from ISCO (1985). Flow measurement data are summarized in Table 3. SC totalizer readings for a 24-hour time period beginning at 0815 on June 5, 1991, indicated 2.89 MGD; this flow was used to calculate mass loadings for permit parameters.

Table 3. Instantaneous Flow Measurements at Effluent Flume - Salmon Creek WTP, 6/91. Size of Parshall flume = 24 inches.

Date	Time	Ecology Measurement		SC Meter Reading, MGD
		Depth (Ft)	Flow (MGD)	
6/5	1035	0.69	2.92	2.81
6/5	1040	0.66	2.75	2.55
6/5	1510	0.59	2.31	2.34
6/5	1515	0.57	2.15	2.11

General Chemistry and NPDES Permit Compliance

Conventional pollutant data collected during the inspection are tabulated in Table 4. The plant performed well during the inspection. BOD_5 and TSS results indicated a well-treated effluent. However, the effluent fecal coliform bacteria count was very high (24,000 #/100 mL) and grossly exceeded the NPDES permit limit. The count was still high when resampled by Ecology four months later.

A comparison of effluent parameters to NPDES permit limits is presented in Table 5. The effluent met permit limits for BOD_5, TSS, and pH at the time of the inspection. However, fecal coliform counts exceeded both monthly average and weekly average limits. As a quality assurance check, another effluent sample was collected on October 22, 1991, for a fecal coliform

Table 4 - Summary of General Chemistry - Salmon Creek WTP, 6/91.

Parameters	Blank	Inf-E	Inf-SC	Inf-1	Inf-2	Eff-E	Eff-ER	Eff-SC	Eff-1	Eff-2	Effluent	Sludge
Station:	Blank	Inf-E	Inf-SC	Inf-1	Inf-2	Eff-E	Eff-ER	Eff-SC	Eff-1	Eff-2	Effluent	Sludge
Type:	trans	comp	comp	grab	grab	comp	comp	comp	grab	grab	grab-comp	grab-comp
Date:	6/4	6/5-6	6/5-6	6/5	6/6	6/5-6	6/5-6	6/5-6	6/5	6/6	6/6	6/5
Time:	1345	0800-0800	0800-0800	0925	1140	0815-0815	0815-0815	0815-0815	1440	1010	1000-1130	0800-1100
Lab ID#2381:	-05	-06	-07	-08	-09	-10	-11	-12	-13	-14	-15	-16
GENERAL CHEMISTRY												
Conductivity, µmhos/cm		669	669	634	588	517	515	516	485	516	513	
Alkalinity, mg/L CaCO3		195	202			88.1	86.4	84.7			80.7	
Hardness, mg/L CaCO3		59.2	58.7			57.2	54.2	56.7			54.7	
TS, mg/L		558	562			351	357	335			408	
TNVSS, mg/L		25	15			1 U	1 U	1 U			1 U	
TSS, mg/L		168	170			11	9	6			6	
TNVS, mg/L		225	228			176	123	125			88	
% Solids												20
% Volatile Solids												80
BOD5, mg/L		190	190			12	10	14				
BOD5 Soluble, mg/L		130	69			10	10	< 10				
TOC (water), mg/L	2.78	113	86			28.4	21.9	19.8				
TOC (soil)												11*
NH3-N, mg/L		36.7	33.7			12.8	26	9.2				
NO2+NO3-N, mg/L		< 0.01	0.026			5.5	11.8	22.3				
NO2-N, mg/L		0.01	0.001			1.0	0.99	1.14				
NO3-N, mg/L		< 0.01	0.025			4.5	10.81	21.2				
Phosphorus-T, mg/L		7.8	7.1			5.7	5.5	5.7				
Oil & Grease, mg/L				30	34				34	< 1		
F-Coliform, #/100 mL									24,000	24,000(13,000+)		
F-Coliform, #/100 mg												30,000,000
FIELD OBSERVATIONS												
Temperature, °C		3.8^	16.4^^	16.1	15.9	3.6^	4.2^	9.2^^	172	170	8.2	
pH, S.U.		6.8	7.3	8.1	8.2	7.4	7.3	7.4	6.9	7.1	7.3	
Conductivity, µmhos/cm		630	620	520	520	450	470	460	430	470	480	
Chlorine Residual, mg/L												
Free									<0.1	<0.1		
Total									0.2	0.2		

U - The analyte was not detected at or above the reported result.

J - The analyte was positively identified. The associated numerical result is an estimate.

* - % dry weight.

^ - Iced composite sample. ^^ - Refrigerated samples.

+ - Resampled on 10/22 at 1120, and analyzed by Membrane Filter (MF) method.

Table 5 – Comparison of Inspection Results to NPDES Permit Limits – Salmon Creek WTP, 6/91.

	NPDES Permit Limits		Inspection Data	Plant Loading			
Parameter	Monthly Average	Weekly Average	Ecology Composite	Design Criteria	85% of DC	Inspection Results	% of DC
Influent BOD5							
(mg/L)			190				
(lbs/day)				7,200	6,120	4,558	63
Effluent BOD5							
(mg/L)	30*	45	12				
(lbs/day)	1,080	1,620				288	
(% removal)	85		94				
Influent TSS							
(mg/L)			168				
(lbs/day)				7,200	6,120	4,050	56
Effluent TSS							
(mg/L)	30*	45	11				
(lbs/day)	1,080	1,620				264	
(% removal)	85		93				
Fecal Coliform							
(#/100 mL)	200^	400	24,000;24,000^^				
pH (S.U.)	6.0≤pH≤9.0		6.9-7.1^^				
Flow (MGD)				6.4+	5.44	2.89	45

DC Design criteria.

* or 15% of the respective influent concentrations, whichever is more stringent.

^ The average for fecal coliform bacteria are based on the geometric mean of the sample taken.

^^ Results from Ecology grab samples.

\+ Maximum monthly flow.

test (analyzed by Membrane Filter (MF) method). The result was 13,000 #/100 mL, which also exceeded NPDES permit limits (Table 4).

The permit also specifies that when the actual flow or waste load reaches 85% of design capacity, the permittee shall submit to the department a plan and schedule for continuing to maintain adequate capacity. Table 5 indicates that BOD_5, TSS, and flow loadings were well within 85% of design criteria.

Effluent Priority Pollutant Scan

A listing of priority pollutants detected in effluent samples is presented in Table 6. A complete listing of effluent priority pollutant scan results is included in Appendix B. Two metals were detected, but only lead exceeded the chronic water quality criterion. Among pesticides/PCBs, three compounds were positively identified.

Acetone, a volatile organic compound (VOC), was detected at 50 μg/L. Among base neutral acids (BNAs), bis(2-ethylhexyl)phthalate and benzoic acid were reported at 4 μg/L and 5 μg/L, respectively (Appendix B).

Effluent Bioassays

Bioassays determine the relative toxicity of WTP effluent by measuring the response of organisms to solutions containing various percentages of effluent and dilution water. For this inspection, rainbow trout, *Daphnia magna*, and *Ceridaphnia dubia* were used as test organisms. Results are given in Table 7. No effluent toxicity was indicated by any of the three.

Sludge Analyses

General chemistry data for the sludge sample collected during the inspection are listed in Table 4. Percent volatile solids (VS) reduction was determined through an approximate mass balance on VS across the anaerobic digester using the final sludge product per day. The calculation[1] estimated a 66% volatile solids reduction in the digester. According to the proposed EPA regulations, 40 CFR part 503, a sludge is considered to have adequately reduced vector attraction if its volatile solids are reduced by 38% (EPA, 1989).

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[1]Volatile solids reduction = $[(QY)_{raw}-(QY)_{digested}]/(QY)_{raw}$; Where: Q = average sludge flow rate in MGD, Y = percent volatile solids, Volatile solids reduction = [(0.011^*0.075^*0.085^)-(0.0099^*0.037^*0.65^)]/(0.011*0.075*0.85) = 66%
^ Note: data obtained from the SC plant operator (Mutton, 1992).

Table 6 - Comparison of Effluent Priority Pollutants to Water Quality Criteria, Salmon Creek WTP, 6/91.

Location:	Effluent	Effluent	Water Quality Criteria* (μg/L)	
Field Station:	Ecology	Salmon Creek	Saltwater	
Parameter Sample #:	238110	238112	Acute	Chronic
Metals (μg/L)				
Lead	-	7	140	5.6
Zinc	40	40	95	86
Pesticides/PCBs (μg/L)				
alpha-BHC	0.03 J	-	0.34	-
gamma-BHC	0.02 J	-	0.34	-
beta-BHC	0.02 J	-	0.34	-

* - EPA, 1986a.

J - The analyte was positively identified. The associated numerical result is an estimate.

Table 7 - Effluent Bioassay Results - Salmon Creek WTP, 6/91.

Rainbow trout - 96 hour survival test		
Lab ID# 238115		
Concentration (% vol/vol)	Number Tested^	Percent Survival
Control	30	100
100	30	100

^ - Three replicates of ten organisms.
LC50 - >100%.

Daphnia Magna	- 48 hour acute screening test	
Lab ID# 238115		
Concentration (% vol/vol)	Number Tested*	Percent Survival
100	20	100
Control	20	100

* - Four replicates of five organisms.
LC50 - >100%.

Ceriodaphnia dubia	- 7 day survival and reproduction test		
Concentration (% vol/vol)	Number Tested*	Percent Survival	Average Number of Young/Adult
Control	10	94	29.1
6.25	10	99	54.1
12.5	10	92	72.7
25	10	87	66.6
50	10	100	55.3
100	10	91	21.6

NOEC - 100% effluent.

* - Ten replicates of one organism.
LC50 - 100%.

A complete listing of sludge priority pollutant scan results is included in Appendix C. Priority pollutant metals, VOCs, and BNAs detected in the sludge sample are listed in Table 8. A national survey has been conducted to determine the constituents of a typical municipal sludge (EPA, 1990a). Compared to these survey results, none of the metals exceeded the typical concentration. A number of organic compounds were also detected.

Laboratory Review

Table 9 shows a comparison of data resulting from the four-way split of composite samples during the inspection. Results from samples collected (e.g., influent) by two different compositors (Ecology and SC) but analyzed at the same lab (e.g., SC) address the issue of sample representativeness. For the example presented, BOD_5 data were 232 vs 195 mg/L; TSS data were 192 vs 215 mg/L. The results in Table 9 indicate that samples appear to be representative.

Results from samples collected (e.g., influent) by the same compositor (e.g., SC) but analyzed at two different labs (Ecology and SC) address the issue of laboratory performance. For the example presented, BOD_5 data were 190 vs 195 mg/L; TSS data were 170 vs 215 mg/L. The BOD_5 data show good agreement. On the other hand, TSS data reveal a slight disparity. No definite conclusions on lab performance can be drawn from these limited lab data. Therefore, in addition to four-way splits, a performance evaluation (PE) sample should be analyzed in the future to help compare lab performance.

Fecal coliform results of chlorinated effluent reported by Ecology were 24,000 #/100 mL, compared to 26 #/100 mL reported by SC. Salmon Creek's fecal coliform results were much lower than Ecology's results. This situation warrants further investigation.

Dale Van Donsel and Perry Brake of Ecology's Quality Assurance Section conducted an on-site laboratory evaluation on June 4, 1991. Their report indicates that SC's laboratory is providing reliable analytical data to the Department. Their complete audit report is included in Appendix D.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Field observation data indicated that SC influent and effluent sample temperatures were much higher than the recommended 4°C.

2. Salmon Creek's Parshall flume was properly installed and calibrated. Comparison of Ecology's instantaneous flow measurement to the WTP effluent flowmeter reading was good.

Table 8 – Results of Sludge Priority Pollutant Metals and Organics Analyses – Salmon Creek WTP, 6/91.

	Field Station:	Sludge	National Sewage Sludge Survey+		
	Type:	grab–comp			
	Date:	6/5			
	Time:	0800–1100	Number of	Percent	Geometric
Parameters	Lab Sample#:	238116	Samples	Detected++	Mean
Metals (mg/kg)					
Chromium		23	70	99	160.57
Copper		350	70	100	670.68
Lead		71	70	87	156.99
Mercury		3.6	70	79	3.96
Nickel		21	70	81	48.36
Silver		24	--	--	--
Zinc		1,100	70	100	1,708
VOCs (μg/kg)					
Acetone		8,800 E			
Carbon Disulfide		42			
2–Butanone (MEK)		1,400 E			
Toluene		92			
Chlorobenzene		10 J			
Ethylbenxene		7 J			
Total Xylenes		31			
BNAs (μg/kg)					
Naphthalene		610 J			
4–Chloroaniline		1,300 J			
2–Methylnaphthalene		940 J			
Fluorene		580 J			
Phenanthrene		1200 J			
Fluoranthene		760 J			
Pyrene		930 J			
Bis(2–Ethylhexyl)phthalate		79,000 E			
Chrysene		590 J			
Di–n–Octylphthalate		9,200			
Phenol		880 J			

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

E – Reported result is an estimate because of the presence of interference.

\+ – EPA, 1990a. Values presented are for WTPs with flows between 1 and 10 MGD.

++ – Percent of samples in which the compound was detected above the quantification limit.

Table 9 - Comparison of Laboratory Results of Sample Splits - Salmon Creek WTP, 6/91.

Sample	Sampler	Laboratory	BOD5 (mg/L)	BOD5 sol (mg/L)	TSS (mg/L)	F-Coliform #/100 mL
Inf-E	Ecology	Ecology	190	130	168	
(238106)		Salmon Creek	232	-	192	
Inf-SC	Salmon Creek	Ecology	190	69	170	
(238107)		Salmon Creek	195	-	215	
Eff-E	Ecology	Ecology	12	10	11	24,000/24,000
(238110)		Salmon Creek	22	9	9	
Eff-SC	Salmon Creek	Ecology	14	<10	6	
(238112)		Salmon Creek	17	8	10	26

3. The SC wastewater treatment plant performed well during the inspection. Conventional parameters indicated a well-treated effluent. Permit limits for BOD_5, TSS, and pH were being met during the inspection. However, fecal coliform counts were very high and did not meet the permit limit. Trace amounts of free chlorine (<0.1 mg/L) and total residual chlorine (0.2 mg/L) were found in the treated effluent during field observations. Still, it is not clear whether inadequate chlorine dosing, length of contact time, or other factors may have contributed to the high fecal coliform counts.

4. On the day of inspection, BOD_5 loading (4,558 lbs), TSS loading (4,030 lbs), and flow (2.89 MGD) to the plant were well within design criteria.

5. Among pesticides/PCBs, three compounds were detected in the effluent stream. Among VOCs, acetone was found. Two BNAs bis(2-ethylhexyl)phthalate and benzoic acid were detected. Among priority pollutant metals, lead was found at 7 μg/L, slightly above the chronic marine water quality criterion. Zinc was detected at 40 μg/L, below acute and chronic marine water quality criteria.

6. No effluent toxicity was indicated by using rainbow trout, *Daphnia magna*, or *Ceriodaphnia dubia* bioassays.

7. Seven volatile organic compounds and 10 base neutral acids were detected in the sludge sample. Ten priority pollutant metals were also detected. Under proposed EPA 503 regulations, SC's processed sludge did meet the requirement of 38% volatile solids reduction for land application.

8. Ecology and SC lab results of split samples for permit parameters compared fairly well, except that fecal coliform results reported by Ecology were three orders of magnitude higher than the value reported by SC. There was no obvious reason found why fecal coliform results reported by both labs varied so widely.

Recommendations

1. Salmon Creek's influent and effluent sample coolers should be inspected and repaired as necessary to provide sample cooling to 4°C.

2. Salmon Creek's chlorination system should be inspected and repaired as necessary. More frequent fecal coliform testing should be implemented after the chlorination process is fixed. SC's laboratory method for fecal coliform should be reviewed in detail and corrected if necessary.

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APPENDICES

Appendix A. Chemical Analytical Methods Used - Salmon Creek WTP, 6/91.

Parameters	Method	Lab Used
GENERAL CHEMISTRY		
Conductivity	EPA, 1983: 120.1	Ecology; Manchester, WA
Alkalinity	EPA, 1983: 310.1	Ecology; Manchester, WA
Hardness	EPA, 1983: 130.2	Ecology; Manchester, WA
SOLIDS 4		
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
% Solids	APHA, 1989: 2540G	AMTest Inc.; Redmond, WA
% Volatile Solids	EPA, 1983: 160.4	AMTest Inc.; Redmond, WA
BOD5	EPA, 1983: 405.1	AMTest Inc.; Redmond, WA
Soluble BOD5	EPA, 1983: 405.1	AMTest Inc.; Redmond, WA
TOC (water)	EPA, 1983: 415.2	Ecology; Manchester, WA
TOC (sludge)	APHA, 1989: 5310	AMTest Inc.; Redmond, WA
NUTRIENTS		
NH3-N	EPA, 1983: 350.1	AMTest Inc.; Redmond, WA
NO2+NO3-N	EPA, 1983: 353.2	AMTest Inc.; Redmond, WA
NO2-N	EPA, 1983: 353.2	AMTest Inc.; Redmond, WA
NO3-N	EPA, 1983: 352.2	AMTest Inc.; Redmond, WA
Phosphorus - Total	EPA, 1983: 365.1	AMTest Inc.; Redmond, Wa
Oil and Grease	EPA, 1983: 413.1	AMTest Inc.; Redmond, WA
F-Coliform MF	APHA, 1989: 9222D	Ecology; Manchester, WA
F-Coliform MPN	APHA, 1989: 908C	Ecology; Manchester, WA
ORGANICS		
VOCs (water)	EPA, 1984: 624	National Express Laboratories Inc.; Redmond, WA
VOCs (sludge)	EPA, 1986b: 8240	National Express Laboratories Inc.; Redmond, WA
BNAs (water)	EPA, 1984: 625	National Express Laboratories Inc.; Redmond, WA
BNAs (sludge)	EPA, 1986b: 8270	National Express Laboratories Inc.; Redmond, WA
Pesticides/PCBs (water)	EPA, 1984: 608	North Creek Analytical; Bothell, WA
METALS		
PP Metals	EPA, 1983: 200	
Total (water)	EPA, 1983: 200	Sound Analytical Services Inc.; Tacoma, WA
Total (sludge)	EPA, 1983: 200	Sound Analytical Services Inc.; Tacoma, WA
BIOASSAYS		
Rainbow trout (acute)	Ecology, 1981	Ecology; Manchester, WA
Daphnia magna (acute)	EPA, 1985	Ecology; Manchester, WA
Ceriodaphnia dubia (chronic)	EPA, 1989b	Ecology; Manchester, WA

Appendix B. Results of Influent & Effluent Pesticide/PCB and Priority Pollutant Metal Analyses - Salmon Creek WTP, 6/91.

	Field Station:	Eff-E
	Type:	comp
	Date:	6/5-6
	Time:	0815-0815
Parameter (μg/L)	Lab sample#:	238110
alpha-BHC		0.03 J
gamma-BHC (Lindane)		0.02 J
beta-BHC		0.02 J
Heptachlor		0.01 U
delta-BHC		0.01 U
Aldrin		0.01 U
Heptachlor Epoxide		0.01 U
Endosulfan I		0.01 U
4,4'-DDE		0.01 U
Dieldrin		0.01 U
Endrin		0.01 U
4,4'-DDD		0.01 U
Endosulfan II		0.01 U
4,4'-DDT		0.01 U
Endrin Aldehyde		0.05 U
Endosulfan Sulfate		0.15 U
Methoxychlor		1.0 U
Toxaphene		0.05 U
alpha-Chlordane		0.01 U
gamma-Chlordane		0.01 U
PCB-1016		1.0 U
PCB-1221		1.0 U
PCB-1232		1.0 U
PCB-1242		1.0 U
PCB-1248		1.0 U
PCB-1254		1.0 U
PCB-1260		1.0 U

	Field Station:	Blank	Inf-E	Eff-E	Eff-SC
	Type:	trans	comp	comp	comp
	Date:	6/4	6/5-6	6/5-6	6/5-6
	Time:	1345	0800-0800	0815-0815	0815-0815
	Lab sample#2381:	-05	-06	-10	-12
Metals (μg/L)					
Antimony		60 U	60 U	60 U	60 U
Arsenic		10 U	10 U	10 U	10 U
Beryllium		50 U	5 U	5 U	5 U
Cadmium		50 U	5 U	5 U	5 U
Chromium		10 U	10 U	10 U	10 U
Copper		25 U	55	25 U	25 U
Lead		5 U	25	5 U	7
Mercury		0.2 U	0.2 U	0.2 U	0.2 U
Nickel		40 U	40 U	40 U	40 U
Selenium		5 U	5 U	5 U	5 U
Silver		10 U	10 U	10 U	10 U
Thallium		10 U	10 U	10 U	10 U
Zinc		20 U	170	40	40

U - Indicates compound was analyzed for but not detected at the given detection limit.

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

Appendix B - Cont. - Results of Influent and Effluent BNA Analyses - Salmon Creek WTP, 6/91.

	Field Station:	Inf-E	Eff-E
	Type:	comp	comp
	Date:	6/5-6	6/5-6
	Time:	0800-0800	0815-0815
Parameter (µg/L)	Lab sample#2381:	-06	-10
N-Nitrosodiphenylamine		10 U	10 U
Bis(2-Chloroethyl)Ether		10 U	10 U
1,3-Dichlorobenzene		10 U	10 U
1,4-Dichlorobenzene		10 U	10 U
1,2-Dichlorobenzene		10 U	10 U
Bis(2-chloroisopropyl)ether		10 U	10 U
N-Nitroso-Di-n-Propylamine		10 U	10 U
Hexachloroethane		10 U	10 U
Nitrobenzene		10 U	10 U
Isophorone		10 U	10 U
Bis(2-Chloroethoxy)Methane		10 U	10 U
1,2,4-Trichlorobenzene		10 U	10 U
Naphthalene		10 U	10 U
4-Chloroaniline		10 U	10 U
Hexachlorobutadiene		10 U	10 U
4-Chloro-3-methylphenol		10 U	10 U
2-Methylnaphthalene		10 U	10 U
Hexachlorocyclopentadiene		10 U	10 U
2-Chloronaphthalene		10 U	10 U
2-Nitroaniline		50 U	50 U
Dimethyl Phthalate		10 U	10 U
Acenaphthylene		10 U	10 U
3-Nitroaniline		50 U	50 U
Acenaphthene		10 U	10 U
Dibenzofuran		10 U	10 U
2,4-Dinitrotoluene		10 U	10 U
2,6-Dinitrotoluene		10 U	10 U
Diethyl Phthalate		4 J	10 U
4-Chlorophenyl-Phenylether		10 U	10 U
Fluorene		10 U	10 U
4-Nitroaniline		50 U	50 U
4-Bromophenyl-Phenylether		10 U	10 U
Hexachlorobenzene		10 U	10 U
Phenanthrene		10 U	10 U
Anthracene		10 U	10 U
Dibutylphthalate		10 U	10 U
Fluoranthene		10 U	10 U
Pyrene		10 U	10 U
Butylbenzylpthalate		10 U	10 U
3,3'-Dichlorobenzidine		20 U	20 U
Benzo(a)Anthracene		10 U	10 U
Bis(2-Ethylhexyl)phthalate		19	4 J
Chrysene		10 U	10 U
Di-n-Octyl Phthalate		10 U	10 U
Benzo(b)Fluoranthene		10 U	10 U
Benzo(k)Fluoranthene		10 U	10 U
Benzo(a)Pyrene		10 U	10 U
Indeno(1,2,3-cd)Pyrene		10 U	10 U
Dibenzo(a,h)Anthracene		10 U	10 U
Benzo(g,h,i)Perylene		10 U	10 U
Phenol		16	10 U
2-Chlorophenol		10 U	10 U
Benzyl Alcohol		290	10 U
2-Methylphenol		10 U	10 U
4-Methylphenol		42	10 U
2-Nitrophenol		10 U	10 U
2,4-Dimethylphenol		10 U	10 U
Benzoic Acid		360 E	5 J
2,4-Dichlorophenol		10 U	10 U
2,4,6-Trichlorophenol		10 U	10 U
2,4,5-Trichlorophenol		50 U	50 U
2,4-Dinitrophenol		50 U	50 U
4-Nitrophenol		50 U	50 U
4,6-Dinitro-2-Methylphenol		50 U	50 U
Pentachlorophenol		50 U	50 U

U - None detected at or above the method reporting limit.
J - Indicates an estimated value when result is less than specified detection limit.
E - Reported result is an estimate because of the presence of interference.

Appendix B Cont. - Results of Influent and Effluent VOC Analysis - Salmon Creek WTP, 6/91.

	Field Station:	Blank	Inf-1	Eff-1
	Type:	trans	grab	grab
	Date:	6/4	6/5	6/5
	Time:	1345	0925	1440
Parameters (μg/L)	Lab sample#2381:	-05	-08	-13
Chloromethane		10 U	10 U	10 U
Vinyl Chloride		10 U	10 U	10 U
Bromomethane		10 U	10 U	10 U
Chloroethane		10 U	10 U	10 U
1,2-Dichloroethene (total)		5 U	5 U	5 U
1,1-Dichloroethene		5 U	5 U	5 U
Acetone		10 U	50	50
Carbon Disulfide		5 U	5 U	5 U
Methylene Chloride		5 J	5 U	5 U
2-Butanone		10 U	10 U	10 U
Acrolein		100 U	100 U	100 U
Chloroform		5 U	3 J	5 U
1,1,1-Trichloroethane		5 U	5 U	5 U
Carbon Tetrachloride		5 U	5 U	5 U
Benzene		5 U	5 U	5 U
1,2-Dichloroethane		5 U	5 U	5 U
Vinyl Acetate		10 U	10 U	10 U
Trichloroethene		5 U	5 U	5 U
1,2-Dichloropropane		5 U	5 U	5 U
Bromodichloromethane		5 U	5 U	5 U
Trans-1,3-Dichloropropene		5 U	5 U	5 U
2-Hexanone		10 U	10 U	10 U
4-Methyl-2-Pentanone		10 U	10 U	10 U
Toluene		5 U	2 J	5 U
cis-1,3-Dichloropropene		5 U	5 U	5 U
1,1,2-Trichloroethane		5 U	5 U	5 U
Tetrachloroethene (PCE)		5 U	5 U	5 U
Dibromochloromethane		5 U	5 U	5 U
Chlorobenzene		5 U	5 U	5 U
Ethylbenzene		5 U	5 U	5 U
Styrene		5 U	5 U	5 U
Total Xylenes		5 U	5 U	5 U
Bromoform		5 U	5 U	5 U
Acrylonitrile		100 U	100 U	100 U
1,1,2,2-Tetrachloroethane		5 U	5 U	5 U
1,3-Dichlorobenzene		5 U	5 U	5 U
1,4-Dichlorobenzene		5 U	5 U	5 U
1,2-Dichlorobenzene		5 U	5 U	5 U

U - None detected at or above the method reporting limit.

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

Appendix C. Results of Sludge Priority Pollutant Metals Analyses - Salmon Creek WTP, 6/91.

	Field Station:	Sludge
	Type:	grab-comp
	Date:	6/5
	Time:	0800-1100
Metals (μg/kg-dry)	Lab sample#:	238116
Antimony		13 U
Arsenic		4.2 U
Beryllium		1.1 U
Cadmium		1.1 U
Chromium		23
Copper		350
Lead		71
Mercury		3.6
Nickel		21
Selenium		2.1 U
Silver		24
Thallium		25 U
Zinc		1,100

U - Indicates compound was analyzed for but not detected at the given detection limit.

Appendix C - Cont. - Results of Sludge BNA Analyses - Salmon Creek WTP, 6/91.

	Field Station:	Sludge
	Type:	grab-comp
	Date:	6/5
	Time:	0800-1100
Parameter (µg/kg-dry)	Lab sample#:	238116
N-Nitrosodiphenylamine		3700 U
Bis(2-Chloroethyl)Ether		3700 U
1,3-Dichlorobenzene		3700 U
1,4-Dichlorobenzene		3700 U
1,2-Dichlorobenzene		3700 U
Bis(2-chloroisopropyl)ether		3700 U
N-Nitroso-Di-n-Propylamine		3700 U
Hexachloroethane		3700 U
Nitrobenzene		3700 U
Isophorone		3700 U
Bis(2-Chloroethoxy)Methane		3700 U
1,2,4-Trichlorobenzene		3700 U
Naphthalene		610 J
4-Chloroaniline		1300 J
Hexachlorobutadiene		3700 U
4-Chloro-3-methylphenol		3700 U
2-Methylnaphthalene		940 J
Hexachlorocyclopentadiene		3700 U
2-Chloronaphthalene		3700 U
2-Nitroaniline		18000 U
Dimethyl Phthalate		3700 U
Acenaphthylene		3700 U
3-Nitroaniline		18000 U
Acenaphthene		3700 U
Dibenzofuran		3700 U
2,4-Dinitrotoluene		3700 U
2,6-Dinitrotoluene		3700 U
Diethyl Phthalate		3700 U
4-Chlorophenyl-Phenylether		3700 U
Fluorene		580 J
4-Nitroaniline		18000 U
4-Bromophenyl-Phenylether		3700 U
Hexachlorobenzene		3700 U
Phenanthrene		1200 J
Anthracene		3700 U
Dibutylphthalate		3700 U
Fluoranthene		760 J
Pyrene		930 J
Butylbenzylpthalate		3700 U
3,3'-Dichlorobenzidine		7300 U
Benzo(a)Anthracene		3700 U
Bis(2-Ethylhexyl)phthalate		79000 E
Chrysene		590 J
Di-n-Octyl Phthalate		9200
Benzo(b)Fluoranthene		3700 U
Benzo(k)Fluoranthene		3700 U
Benzo(a)Pyrene		3700 U
Indeno(1,2,3-cd)Pyrene		3700 U
Dibenzo(a,h)Anthracene		3700 U
Benzo(g,h,i)Perylene		3700 U
Phenol		880 J
2-Chlorophenol		3700 U
Benzyl Alcohol		3700 U
2-Methylphenol		3700 U
4-Methylphenol		3700 U
2-Nitrophenol		3700 U
2,4-Dimethylphenol		3700 U
Benzoic Acid		18000 U
2,4-Dichlorophenol		3700 U
2,4,6-Trichlorophenol		3700 U
2,4,5-Trichlorophenol		18000 U
2,4-Dinitrophenol		18000 U
4-Nitrophenol		18000 U
4,6-Dinitro-2-Methylphenol		18000 U
Pentachlorophenol		18000 U

U - None detected at or above the method reporting limit.

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

E - Reported result is an estimate because of the presence of interference.

Appendix C. Cont. - Results of Sludge VOC Analysis - Salmon Creek WTP, 6/91.

	Field Station:	Sludge
	Type:	grab-comp
	Date:	6/5
	Time:	0800-1100
Parameter (μg/kg-dry)	Lab sample #:	238116
Chloromethane		56 U
Vinyl Chloride		56 U
Bromomethane		56 U
Chloroethane		56 U
1,2-Dichloroethene (total)		28 U
1,1-Dichloroethene		28 U
Acetone		8,800 E
Carbon Disulfide		42
Methylene Chloride		28 U
2-Butanone (MEK)		1,400 E
Acrolein		560 U
Chloroform		28 U
1,1,1-Trichloroethane		28 U
Carbon Tetrachloride		28 U
Benzene		28 U
1,2-Dichloroethane		28 U
Vinyl Acetate		56 U
Trichloroethene		28 U
1,2-Dichloropropane		28 U
Bromodichloromethane		28 U
Trans-1,3-Dichloropropene		28 U
2-Hexanone		56 U
4-Methyl-2-Pentanone		56 U
Toluene		92
cis-1,3-Dichloropropene		28 U
1,1,2-Trichloroethane		28 U
Tetrachloroethene (PCE)		28 U
Dibromochloromethane		28 U
Chlorobenzene		10 J
Ethylbenzene		7 J
Styrene		28 U
Total Xylenes		31
Bromoform		28 U
2-Chloroethylvinyl ether		280 U
Acrylonitrile		560 U
1,1,2,2-Tetrachloroethane		28 U
1,3-Dichlorobenzene		28 U
1,4-Dichlorobenzene		28 U
1,2-Dichlorobenzene		28 U

U - None detected at or above the method reporting limit.

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

E - Reported result is an estimate because of the presence of interference.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Post Office Box 488 • Manchester, Washington 98353-0488 • (206) 895-4649

June 6, 1991

TO: Tapas Das

FROM: Cliff Kirchmer

SUBJECT: Class II Inspection of Salmon Creek WWTP Lab

Dale Van Donsel and Perry Brake of this office completed their inspection of the Salmon Creek Wastewater Treatment Plant laboratory on June 4, 1991. Their report, which contains no indication that the lab is not providing reliable analytical data to the Department, is attached. A copy of the report has been furnished to the operations supervisor at the plant (Phil Baga) to assist him in preparing for accreditation of the laboratory as required by WAC 173-220.

We have informed Mr. Baga that if his application for accreditation is submitted in a timely manner, we will be able to use the results of this Class II Inspection as the on-site audit for accreditation of the lab, although a follow-up visit will probably be necessary to verify a formal quality assurance program has been implemented as recommended in the attached report.

WASHINGTON STATE DEPARTMENT OF ECOLOGY
ENVIRONMENTAL INVESTIGATIONS AND LABORATORY SERVICES
QUALITY ASSURANCE SECTION

SYSTEM AUDIT REPORT

LABORATORY:	Salmon Creek Wastewater Treatment Plant Laboratory	
ADDRESS:	12550 Shorewood Drive, SW Seattle, WA 98146	
DATE OF AUDIT:	June 4, 1991	
AUDITORS:	Dale Van Donsel	Microbiology
	Perry Brake	General Chemistry
PERSONNEL INTERVIEWED:	Phil Baga	Operations Supervisor
	Keith Lundin	Operator/Lab Analyst

AUTHENTICATION:

Dale J. Van Donsel

Perry F. Brake

GENERAL FINDINGS AND RECOMMENDATIONS

General

1. A system audit was conducted at the Salmon Creek Wastewater Treatment Plant laboratory on June 4, 1991, in conjunction with the Class II Inspection of the treatment plant. The purpose of the audit was to verify laboratory capabilities pertaining to analyses required in the treatment plant discharge permit (WA0022772) and to review analytical and quality control data. General audit findings and recommendations are documented below. Significant recommendations for improvement of laboratory operations are highlighted by use of *italics*.

2. A very significant deficiency in the overall lab operation at the Salmon Creek plant lab was the lack of a formal (i.e., documented) quality assurance (QA) program designed to assure reliability of analytical data generated in the lab. *A recommendation was made to the operations supervisor that establishment of such a program and preparation of a QA manual be made a high priority.* A model QA manual for a wastewater treatment plant lab had previously been given to the operations supervisor at the Miller Creek Wastewater Treatment Plan (a sister plant in the SW Suburban Sewer District) who will coordinate with Mr. Baga to develop a joint QA program and manual. A commitment was made by the visiting team to assist both plants lab in development of the joint QA program and manual.

Personnel

3. Mr. Baga is responsible for all analytical procedures used in the lab and is the immediate supervisor of laboratory operations. Plant operators rotate between lab and other plant duties on a weekly basis, spending a full week in the laboratory each rotation. Mr. Lundin was assigned to lab duties during the lab visit. Mr. Lundin has several years experience in analytical procedures and appeared very knowledgeable in methods and techniques for which the laboratory is responsible. Reportedly, other operator/analysts are equally as well qualified.

Facility

4. The lab facility consists of one small, conveniently arranged room which is also used for some most administrative functions (i.e., as office space). Other administrative functions are conducted in Mr. Baga's office which is in close proximity to the lab. Current floor and bench space is crowded, even for only one analyst, and is marginally adequate to support current lab operations and efficient administrative functions. Significant expansion of lab operations to include any significant new analytical capability would require additional lab space for efficient operations.

5. There were no records available to indicate the fume hood used in the lab had ever been check for adequacy of air flow. A check was made by the visiting team during the visit and the flow found to be in excess of 200

cubic feet per minute which is better then the ASTM-recommended flow of 125 CFM. *A recommendation was made to have the flow checked periodically (e.g., every year) or whenever there is suspicion that flow may have been reduced for some reason.* (NOTE: Air velocity measuring devices are available from several suppliers, but the Salmon Creek plant should consider borrowing a device periodically from another lab or perhaps a fire department.)

Equipment and Supplies

6. A log of checks on lab equipment and supplies (e.g., temperature checks on refrigerators and incubators, calibration tests on balances, conductivity tests on distilled water) was not available in the lab. *A recommendation as made that a schedule of such checks be set up and that a log be maintained as a record that the checks were being conducted.* There was no record to indicate the (approximately) 2-year old Mettler analytical balance had ever been checked by a service representative. *A recommendation was made to have such checks made annually.*

7. *A recommendation was made for the lab to purchase a spill cleanup kit (as a safety matter and not a matter affecting quality of the analytical work done in the lab).* Information on "Kolor-safe" liquid neutralizers available from Aldrich was provided to the lab. Those and other kits would be sufficient for the Salmon Creek lab.

8. A nonindicating desiccant was being used in desiccators which provided no means of determining if the desiccant was still effective. *A recommendation was made to replace the desiccant with a product such as Drierite Indicating Desiccant, available from various suppliers.*

Sample Management

9. Formal chain-of-custody procedures had not been established (as might be expected, given the absence of a documented QA program in the lab) to assure samples were being properly secured and accounted for from time of receipt in the lab to disposal. *A recommendation was made to establish and implement such procedures without delay to preclude potential problems should future analytical results be involved in litigation.* With minor modifications and proper documentation, sample handling procedures currently used in the lab will suffice for chain-of-custody purposes. The lab's QA manual should document the fact that those procedures, which include identification of all plant personnel involved in analyzing a specific sample, constitute the chain-of-custody procedures for the lab. A copy of ASTM Standard D 4840-88, "Sampling Chain of Custody Procedures," was provided to Mr. Baga subsequent to the visit.

Data Management

10. Some past data (particularly on bench sheets) had been recorded in pencil but recent changes had resulted in all data being recorded in ink at the time of the audit. *A recommendation was made to continue recording all*

data and observations in ink and correcting any errors by crossing out with a single line, entering the correct data, and signing or initialling the change.

11. Initials were being used on lab worksheets and elsewhere for data entry and corrections. *A permanent record should be retained in the plant matching initials with each employee to assure employee identification should lab data be involved in future legal proceedings.*

PE Samples

12. Performance evaluation (PE) samples were not provided to the lab prior to the visit because they were not required by the Quality Assurance Project Plan (QAPjP) associated with the Class II Inspection. However, inspection of results for EPA DMR-QA studies for the past ten years revealed that the lab had missed only one pH analysis during that period and all other results were acceptable, a very respectable track record.

Quality Assurance/Quality Control

13. The most significant deficiency in the quality assurance area is the lack of a formal QA program, already mentioned in paragraph 2 above. Within the QA program, the most significant deficiency is the lack of any protocol to establish data quality objectives (in terms of bias and precision, or, together, accuracy) and track the lab's capability to meet those objectives. As implied above, blind performance evaluation samples are being analyzed annually as part of the EPA DMR-QA study program but this alone is not sufficient to determine whether or not the lab is "in control" on a continuing basis. The following recommendations were made to assist the lab in setting up a protocol to establish and track data quality objectives:

a. *The lab should establish a schedule for routinely analyzing quality control (QC) samples along with other analyses.*

(1) *First priority should go to analyzing standard solutions (solutions of known concentration) for those parameters where it is appropriate to do so.* The objective in doing this QC test is to discover any <u>bias</u> in the test by comparing the observed value to the known or expected value, and to track <u>precision</u> as the tests are done repetitively. For the plant performance parameters reported by the Salmon Creek lab, appropriate standard solution tests would be BOD (the glucose-glutamic acid solution described in the method) and TSS (using a suspension of a suitable material such as Sigma Cell 20, information on which was provided to the lab by the visiting team).

(2) *Second priority should go to analyzing duplicate samples, preferably from the effluent stream since duplicates taken elsewhere in the plant are likely to vary widely in concentration.* The objective here is to

track precision of analysis on real samples (as opposed to the relatively clean standard solutions). For the plant performance parameters reported by the Salmon Creek lab, appropriate duplicate tests (on effluent samples) would be BOD, TSS, and pH. Duplicate tests can also be done on fecal coliforms if time and manpower resources allow.

b. *After running sufficient QC tests to provide statistically significant data (ten tests of a given type are enough but 20 are better), control charts should be constructed and used as a means to check precision as a routine procedure.* Information on how to construct and use control charts for both standard solutions and duplicate analyses can be found in the Procedural Manual for the Environmental Laboratory Accreditation Program. Consistent use of control charts will provide evidence to interested parties, inside and outside the lab, concerning capability of the lab to accurately analyze environmental samples.

14. Most reagent containers were not annotated to indicate when they were received and opened and when they should be discarded although this practice had just been initiated in the lab. *A recommendation was made to continue marking each reagent container with date received, date opened, and (where known) expiration date.*

15. The lab should be using thermometers for both the fecal coliform and BOD incubators which are NBS (NIST) certified or traceable to NBS certified thermometers. The BOD incubator (an expensive Precision Low Temperature Incubator Model 185) has an integral digital thermometer which was being relied upon to monitor and control incubator temperature. *A recommendation was made to either calibrate the digital thermometer against a NIST certified thermometer, or to place a NIST-traceable thermometer in a water heat-sink in the incubator.* The fecal coliforms thermometer is discussed below.

16. When calibrating the pH meter, the expected pH of the sample was not always being bracketed in accordance with the written method (e.g., no buffer solution above 7.0 pH units was ever used in calibrating the meter. (NOTE: Not surprisingly, the one pH sample missed on ten year's worth of DMR-QA results was a high-pH sample.) A recommendation was made to purchase a pH 10.0 buffer and use it (along with the pH 7.0 buffer) to calibrate the meter whenever the sample pH is suspected or found to be greater than 7.0.

17. Aluminum evaporating dishes were being used for the TSS test rather than porcelain, glass, or platinum as required by the written method. Aluminum dishes are preferred for the test, especially when TSS values are low, as the precision of the test is improved. The lab should document this procedure as a modification of the written method. An acceptable place to do this is in the QA manual.

18. Microbiology

a. It is important that the lab establish its own credibility with the fecal coliform test. EPA Guidelines Establishing Test Procedures for the

Analysis of Pollutants Under the Clean Water Act (corrections to 40 CFR Part 136 dated January 4, 1985) state, "Since the membrane filter technique usually yields low and variable recovery from chlorinated wastewaters, the MPN method will be required to resolve any controversies." There are no equivalents of PE samples or other objective measurements for this parameter. The simplest approach for this lab is to do periodic sample splitting. Comparison of fecal coliform MPN results with this lab's membrane filter results is the verification method of choice. MPNs may be done by a laboratory accredited for this procedure by the Department of Ecology or certified by the Department of Health. The object of these comparisons is not to seek an exact comparison of numbers between the two methods, but to watch for MPN results significantly and consistently higher than the MF which would indicate failure to recover some organisms.

b. There are several steps the lab can take to improve recovery of organisms that are damaged by chlorine or "stressed". A slight modification of the M-FC medium and a change to a specialized type of membrane can help. Several other items that will improve laboratory operation are also noted.

(1) Sample Bottles. Sodium thiosulfate for neutralization of chlorine should be added to sample bottles before sterilization. One mL of a 1% or 0.1 mL of a 10% solution can be used.

(2) Temperature Control. The 44.5°C water bath was not being used at the time of the visit, so its temperature could not be verified. The thermometer in the bath was not suitable for monitoring its temperature; it was calibrated in 1° intervals. The temperature of the fecal coliform test is one of most critical elements; only a 0.2°C tolerance is allowed. *It is recommended that the laboratory acquire several thermometers calibrated in 0.1 or 0.2° increments and that these be checked against a reference thermometer for accuracy.*

(3) Membrane Filters. The 0.45μ membranes used for the fecal coliform test are acceptable. However, when new membranes are purchased, *it is recommended that the laboratory obtain a type of filter developed for testing chlorinated effluents.* The Millipore Corporation type HC filter (or equivalent if available) helps prevent heat damage to chlorine-injured coliforms during the critical first few hours at the very high temperature of the fecal coliform test. Because they have a larger pore size, they are less subject to clogging. Despite quantity discounts, it is good practice to order no more than a year's supply at a time.

(4) M-FC Medium. The lab prepares its own M-FC from dehydrated medium, so it has the option of deleting rosolic acid. This is normally added to suppress "background" organisms that can interfere with the test, but it can also inhibit growth of "stressed" fecal coliforms. *It is recommended that the lab do a comparison of the medium with and without rosolic acid with the same samples to see whether it can be eliminated.* If there is no overgrowth of nuisance organisms, use of rosolic acid should be discontinued, but it should be kept available in the event background organism numbers increase. The pH of the medium should also be regularly checked, because eliminating rosolic acid also eliminates addition of the 0.2N NaOH.

(5) Phosphate Buffered Dilution Water. The rinse water used for the membrane filter test is not being sterilize as is required. The only way to do this is by autoclaving; Mr. Baga said that an autoclave is available in the area and can be moved into the laboratory. Ample amounts should be prepared so that filters can be rinsed properly; the purpose of this step is not only to wash down the funnel wall, but to wash filters free of interfering materials. Three rinses of 20-30 ml each are necessary for this. The lab was using an older formulation for this that contained $MgSO_4$ instead of $MgCl_2$. *It is recommended that when this is used up the lab change to the newer recommended version.* Information on this was provided to the lab subsequent to the visit.

(6) Distilled Water. The lab has a glass still that should produce an excellent quality water. However, water is stored in glass carboys that are not regularly cleaned. The best practice is to use freshly drawn water for preparation of media and buffered rinse water. *If water must be stored, it is recommended that carboys be cleaned periodically. Monthly intervals would be adequate for this. Old tubing should be discarded.* This is to reduce the bacterial growth that can occur on surfaces and serve as an inoculum for the next batch of water. Common organisms such as *Pseudomonas* are notorious for growing in stored water. Sufficient nutrients can be absorbed from the air in the form of ammonia and carbon dioxide to result in bacterial growth which produces toxic compounds that can interfere with test results.

Methods

19. The copy of Standard Methods being used by the lab was Edition 14. For NPDES monitoring, 40 CFR 136 requires that Edition 15 or later be used. The lab has a copy of Edition 17 on order.

20. Coordination with Laura Fricke, Department of Ecology Northwest Regional Office, revealed that a requirement to report residual chlorine to Ecology could be included in an update of the Salmon Creek discharge permit. In anticipation of this requirement, which in turn would require the Salmon Creek to be accredited (under WAC 173-50), or to use an accredited lab, for residual chlorine analyses, the lab's capability to do the test was evaluated during the visit. The lab has on hand all the required equipment (Hach 100 and Hach 3000 spectrophotometers) and supplies and has been doing the test as a process control check for several years. Accreditation of the lab for residual chlorine would be warranted if substantiated by results of blind sample analysis (i.e., PE results).

21. For the BOD determination, the DO determination obtained with a DO meter was checked during every batch with a Winkler titration. An alternative procedure which would require less effort from lab personnel while still providing an adequate degree of assurance that DO determinations were being accurately performed would be to check the calibration of the DO meter, cross checking with a Winkler titration on a periodic basis (once per month should suffice unless there is an indication of problems with the meter).