89-e41

Segment No.: 01-01-04

WA-01-1010

FERNDALE WASTEWATER TREATMENT PLANT CLASS II INSPECTION

by
Carlos E. Ruiz

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Compliance Monitoring Section
Olympia, Washington 98504

February 1989

ABSTRACT

A Class II inspection was conducted at the Ferndale Wastewater Treatment Plant on February 22-24, 1988. The effluent was within permit limitations during the inspection. Laboratory samples, except for influent total suspended solids (TSS), correlated very well. A composite sampler needs to be installed to obtain a more representative influent sample. Bioassay test results indicated the effluent was toxic. Chlorine and ammonia are the suspected major toxicants. Leachate sources need to be monitored for heavy metals.

INTRODUCTION

A Class II inspection was conducted at the Ferndale Wastewater Treatment Plant (WTP) on February 22-24, 1988. The inspection was requested by David Nunnallee of Ecology's Northwest Region. Conducting the survey were Carlos E. Ruiz and Don Reif of the Compliance Monitoring Section (CMS) of Environmental Investigations and Laboratory Services. Assisting from the WTP was Jerry Leuenberger, water and wastewater plants operator.

The survey objectives were to:

1. Collect samples and measure flows at WTP to determine loadings and efficiencies.

2. Perform a laboratory evaluation, including sample splits, for accuracy and adherence to accepted analytical protocol.

3. Determine compliance with NPDES permit.

4. Perform a series of effluent bioassays and bioassay on sediments from vicinity of outfall.

5. Characterize both influent leachate sources for metals and priority pollutants.

LOCATION AND DESCRIPTION

The city of Ferndale is a community of 4,600 located in the northwest corner of the state of Washington northwest of Bellingham (Figure 1). The Ferndale WTP is located southwest of downtown on Ferndale Road (Figure 2). The Ferndale lagoon wastewater treatment system was upgraded in the summer of 1986. An additional aerated cell increased treatment capacity and ability to treat landfill leachate on October 1987. Ferndale receives leachate from two sources: an incinerator ash landfill owned and operated by Thermal Reduction Company (delivered via sewer line) and Cedarville landfill (delivered by truck). An inspection by Ecology's CMS unit was last performed on April 7, 1981.

A schematic diagram of the plant is shown in Figure 3. Treatment consists of a communitor located in a pump station near the plant; an aerated lagoon with three 25 horsepower (hp) high speed surface aerators; two aerated lagoons, each with a 7 hp and a 10 hp aerator; a polishing pond; and a chlorine contact chamber. In addition, an aerated lagoon is used for pretreatment

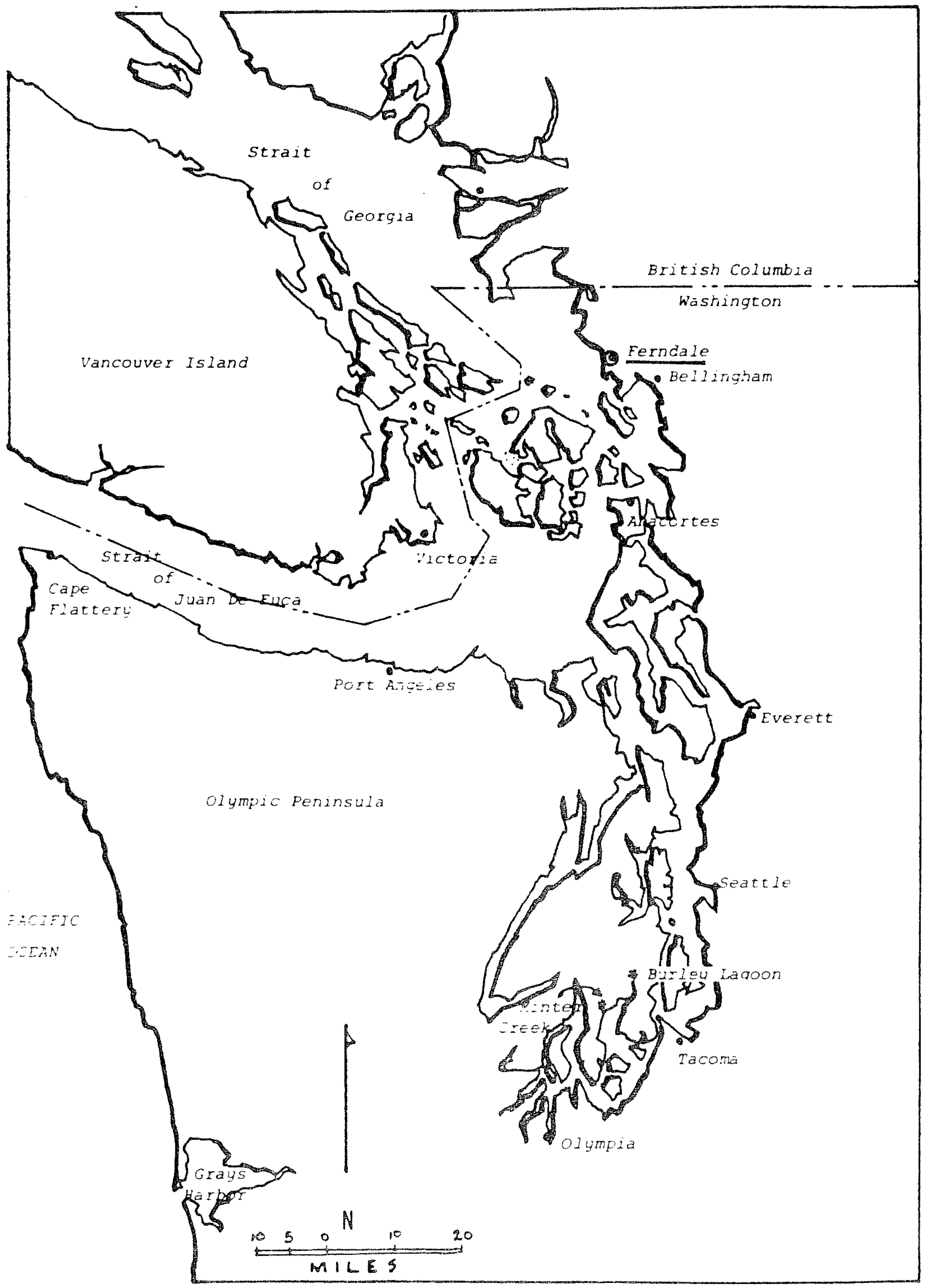

Figure 1. Site Location

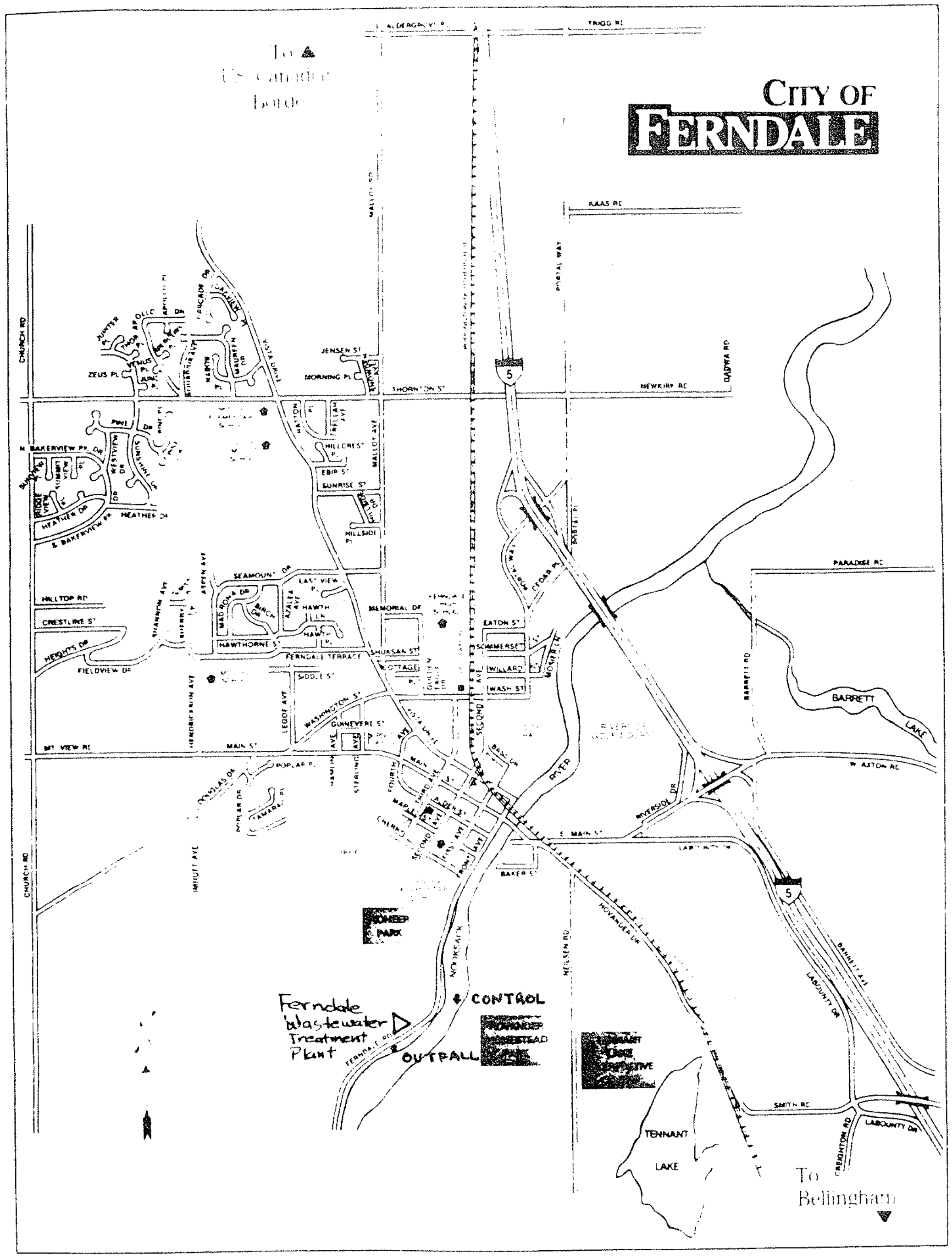

Figure 2. City of Ferndale

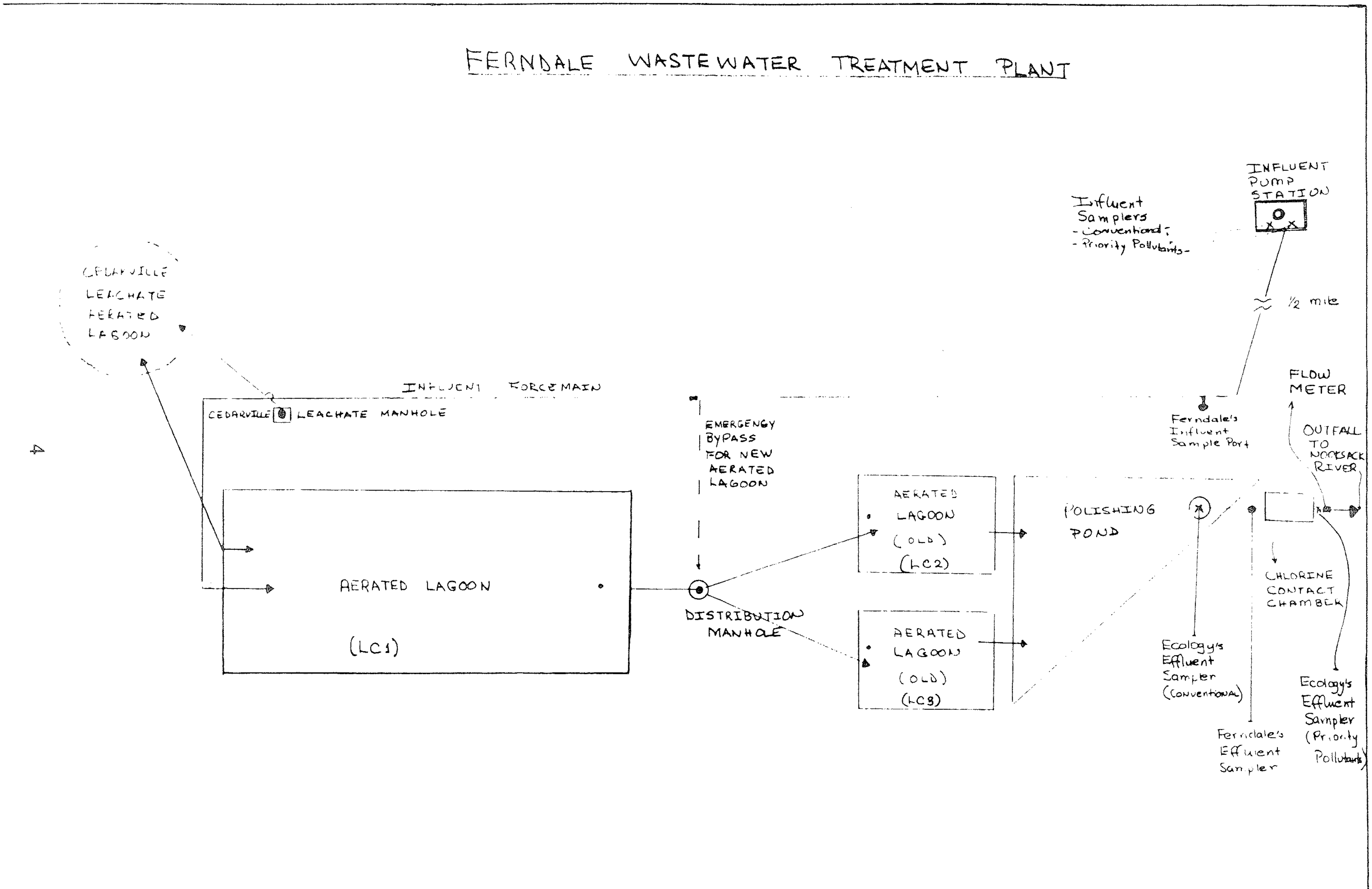

Figure 3. Flow Schematic - Ferndale Wastewater Treatment Plant, February 1988

and bleeding of Cedarville landfill leachate. Flow is measured with an ultrasonic sensor in the effluent channel above a two-foot Cipolletti weir. Chlorinated effluent is discharged to the Nooksack River in accordance with NPDES permit No. WA-002245-4.

METHODS

Twenty-four hour composite samples were collected at the effluent of the polishing pond and at the effluent Cipolletti weir (chlorinated). Each compositor collected approximately 200 mL of sample every 30 minutes. Conventional and field parameters were run on the polishing pond effluent, priority pollutants, bioassays and field parameters on the chlorinated effluent (station EFF-ECO). Two influent composite samplers were set up at the Ferndale pump station downstream from the communitor (station INF-ECO). About 200 mL of sample was collected every 30 minutes for twenty-four hours. One sampler was set up for conventional pollutants, the other for priority pollutants.

Sediment samples were collected from the Nooksack River (see Figure 2). The sediment field control was collected upstream of the WTP outfall. The station (CONTROL) was located 50 feet from the east bank, across from the water treat plant intake. The outfall station (OUTFALL) was located 10 to 15 feet from the outfall (bank outfall). The downstream sediment station (BELWZON) was located 100 yards downstream from the outfall.

A grab sample was collected from the sewer line serving Thermal Reduction Company (TRC). Conventional pollutants and priority pollutant metals were requested from this sample (Aleach). Grab composite samples were collected from the truck delivering the Cedarville leachate. Conventional pollutants, field parameters, and priority pollutants were run on the samples from this station (Mnleach).

Grab samples were collected from the new aerated lagoon (Lcell1), and the two existing aerated lagoons (Lcell2 and Lcell3). Conventional and field parameters were run on the lagoon samples from these stations (see Figure 3).

A series of effluent bioassays were collected at the Ferndale WTP. Two acute tests: Rainbow trout (Salmo gairdneri) and Microtox; and a chronic Ceriodaphnia (Ceriodaphnia dubia) were used as the bio-indicators. Sediment bioassays (Hyallela azteca) were performed on all sediment samples collected.

Sampling times, stations, and parameters are listed on Table 1.

RESULTS AND DISCUSSION

General Results

Ecology's analytical results are summarized in Table 2. The plant was providing good BOD_5 and TSS removal, but very little ammonia removal. The effluent grab samples and the effluent composite samples (EFF-ECO) show remarkable agreement. However, there were significant differences between the results of the influent composite sample (INF-ECO) and

Table 1: Ecology Sampling Schedule: Ferndale Class II Inspection, February 22-24, 1988.

Station	Date	Time	Field Analysis: Temperature (°C)	pH	Cond.	Chlorine Residual (mg/L): Free	Total	Dissolved Oxygen	Fecal Coliform	Laboratory Analysis: BOD_5	COD	Solids (mg/L): TS	TNVS	TSS	TNVSS	Nutrients (mg/L): NH_3-N	NO_2+NO_3-N	Total-P	Cond.	pH	Alkalinity	Turbidity	Hardness	Grease & Oils	Priority Pollutants: Phenols	Cyanide	Acid Base Neutrals	Pesticides/PCB's	VOA's	Metals Water	Metals Sediment	TOC	Grain Size	% Solids	Bioassays: Rainbow Trout	Microtox	Ceriodaphnia	Hyallela Azteca
Composite																																						
INF-ECO	23-24	comp	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X								
Inffern	23-24	comp								X	X	X	X	X	X	X	X	X	X	X	X	X																
EFF-ECO	23-24	comp	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X					X	X	X	
Eflfern	23-24	comp								X	X	X	X	X	X	X	X	X	X	X	X	X																
Grab																																						
Influent	23	16:12	X	X	X						X			X	X	X	X	X	X	X	X	X																
	24	8:45	X	X	X						X			X	X	X	X	X	X	X	X	X																
	24	15:15	X	X	X						X			X	X	X	X	X	X	X	X	X																
Effluent	23	15:58	X	X	X	X	X		X		X			X	X	X	X	X	X	X	X	X		X														
	24	9:17	X	X	X	X	X		X		X			X	X	X	X	X	X	X	X	X		X														
	24	14:45	X	X	X			X	X		X			X	X	X	X	X	X	X	X	X		X														
Lcell1	23	16:40	X	X	X						X			X	X	X	X	X	X	X	X	X																
	24	9:37	X	X	X			X			X			X	X	X	X	X	X	X	X	X																
Lcell2	23	16:26	X	X	X						X			X	X	X	X	X	X	X	X	X																
	24	10:05	X	X	X			X			X			X	X	X	X	X	X	X	X	X																
Lcell3	23	16:29	X	X	X				X		X			X	X	X	X	X	X	X	X	X																
	24	9:55	X	X	X			X	X		X			X	X	X	X	X	X	X	X	X																
Mnleach	23-24	comp	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X								
			X	X	X																																	
Aleach	24	14:00	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X	X							X								
Blank	23	8:00																							X	X	X	X	X	X								
Sediment																																						
CONTROL	22	15:12																							X	X	X	X	X		X	X	X	X				X
OUTFALL	22	16:15																							X	X	X	X	X		X	X	X	X				X
BELWZON	22	15:45																							X	X	X	X	X		X	X	X	X				X

Table 2 Parameters analyzed, Ferndale Class II Inspection, February 22-24, 1988

					Field Analysis						Laboratory Analysis																				
								Chlorine Residual (mg/L)						Solids (mg/L)						Nutrients (mg/L)											
Station	Date	Time	Sampler	Laboratory	Temperature (°C)	pH (S.U.)	Cond. (umhos/cm)	Free	Total	Dissolved Oxygen	Fecal Coliform (#/100mL)	BOD_5 (mg/L)	COD (mg/L)	TS	TNVS	TSS	TNVSS	NH_3-N	NO_2-N	NO_2+ NO_3-N	O-PO_4-P	Total-P	Cond. (umhos/cm)	pH (S.U.)	Alkalinity (mg/L as $CaCO_3$)	Turb. (NTU)	Hardness (mg/L as $CaCO_3$)	Grease & Oils (mg/L)	Phenols (ug/L)*	Cyanide (mg/L)*	TOC (%)
Composite																															
INF-ECO	23- 24	13:15 13:15	Ecol	WE	4.6	7.69	X **					170	1100	2100	730	460	24	13.0	0.08	0.60	2.3	4.6	1550	7.60	210	70	120		17.5	0.005	
Infl.	23-	13:30	Fern	WE	11.7	7.69						160	420	570	240	86	12	11.0	0.08	0.54	3.1	6.6	586	7.80	170	30					
EFF-ECO	23- 24	13:30 13:30	Ecol	WE	3.4	7.54	X					21	79	890	750	18	8	17.0	0.12	0.45	3.0	3.7	1670	7.20	220	9	140		5U	0.014	
Eff.	23-	13:30	Fern	WE	6.8	7.59						24	83	880	760	16	8	17.0	0.12	0.44	2.9	3.7	1670	7.70	230	8					
Grab			Ecol																												
Inf	23 24 24	16:12 8:45 15:15			9.2 9.3 12.0	7.66 7.83 7.48	X X X						320 460 520			230 150 230	26 20 56	15 13 19		0.52 0.51 0.65		4.9 6.3 5.7	675 972 638	7.90 7.60 8.20	230 200 220	42 39 34					
Eff	23 24 24	15:58 9:17 14:45			6.9 6.1 7.6	7.34 7.21 7.33	X X X	<0.1 <0.1	2.0 2.5	 3.2	3U 1U 1U		78 71 84			15 12 13	1 8 8	17 16 16		0.55 0.53 0.51		3.8 3.5 3.5	1570 1620 1600	7.50 7.50 7.40	210 220 210	9 8 9		3 1 5			
Lcell1	23 24	16:40 9:37			7.8 7.2	7.68 7.56	X X			 8.3			110 110			45 29	9 6	16 16		0.64 0.55		2.9 3.6	1730 1740	7.70 7.70	240 240	12 12					
Lcell2	23 24	16:26 10:05			7.5 6.7	7.49 7.34	X X			 1.2			90 89			20 19	1 9	17 16		0.58 0.47		3.2 3.6	1690 1710	7.60 7.50	230 230	9 8					
Lcell3	23 24	16:29 9:55			7.4 6.7	7.60 7.38	X X			 2.3			79 87			22 19	1 13	17 17		0.60 0.51		3.0 3.6	1690 1710	7.60 7.50	230 230	8 9					
Mnleach	23- 24	comp			12.6 13.4	6.85 6.81	X X					320	970	2500	1500	230	84	84	0.0	0.15	0.1	0.5	3580	6.90	1440	60	1100		170.0	0.007	
Aleach	24	14:00											87	2600	2300	4	13	10		0.83		0.3	4230	8.10	700	7	330				
Blank	23	8:00																											0.005U	0.005U	
Sediment			Ecol																												
CONTROL	22	15:12																											0.005U	0.005U	0.4 7
OUTFALL	22	16:15																											0.005U	0.005U	0.2 8
BELWZON	22	15:45																											0.005U	0.005U	0.2 7

* Sediment Units (mg/kg-dr)

** >1000

U - compound was analyzed for, but not detected. Number is estimated minimum detection limit.

the influent grab samples. This shows that significant loads of TSS, and COD are not accounted for by the grab samples. The influent sample (Inffern) collected by plant personnel, being a grab sample, represented loads comparable to Ecology's grabs rather than the Ecology composite. Generally this will tend to underestimate the load to the treatment plant; therefore, the WTP should install an influent composite sampler.

The composite influent BOD_5 concentration is of medium strength as compared to typical domestic sewage (Metcalf & Eddy, 1972). The BOD_5 load (920 lbs/day) was near the expected 0.2 lbs./day/capita. However, TS, TSS, and COD are all above typical strong domestic waste. The COD/BOD_5 ratio (6.5) is higher than typical domestic sewage (2-4). Since the TRC (Aleach, Table 2) was very low in COD and TSS, other industrial dischargers are presumed responsible for the loads.

The high TSS load in combination with high inorganic sludge (iron precipitation) from the leachate could result in substantial sludge accumulation in the lagoons. The increase in sludge accumulation could result in premature dredging of the lagoons and/or decrease of treatment efficiency.

The fecal coliform count was far below the effluent limitations, but the chlorine residual was greater than the recommended 0.5 mg/L (Table 2). Based on DMR data, the 1981 Class II inspection (Chase, 1981), and this inspection, it is recommended that the WTP reduce its total chlorine residual (TCR) and allow the fecal counts to increase. The lower the chlorine residual, the better the receiving water quality, as long as the fecal coliform count remains within the effluent limitations specified in the permit.

Field conductivity readings were collected, but resulted in erroneous values due to equipment failure (probe out of scale).

Flow

There was good agreement between the plant's total flow and Ecology's measurement during the inspection (Table 3). Figure 4 and 5 show the WTP's script chart and Sigma Bubbler chart respectively. The plant uses a 2 ft. wide Cipolletti weir, while Ecology's Bubbler results are for 1 ft. wide weir (factor of 2). In addition, initial instantaneous measure-ments agreed very closely with the WTP's instantaneous flow rate.

NPDES Permit Compliance

Comparison of plant effluent parameters to NPDES effluent limitations is shown in Table 4. BOD_5, TSS, fecal coliform counts, and pH were well under permitted limits. BOD_5 removal efficiency was over 85 percent and TSS reduction was in excess of 95 percent. Plant flow was above the design flow of 0.5 MGD, a temporary limitation that should be upgraded, since the WTP was expanded in late 1986. The flow was well within the new design criteria (Nunnallee, 1988) of 0.9 MGD (average annual flow), and 1.15 MGD (January flow). BOD_5 loading was below the new design criteria of 1400 lbs/day BOD_5 (Nunnallee, 1988).

Table 3. Flow Measurements: Ferndale Class II Inspections, February 22-24, 1988.

Ferndale Treatment Plant

Date	Time	Totalizer Reading	Total Flow (MGD)
2/23/88	13:15	5822626	
2/24/88	13:39	5833268	.642

Ecology's Sigma Bubbler Flow Meter Results

Date	Time	Totalizer Reading	Total Flow (MGD)
2/23/88	13:15	11914	
2/24/88	13:39	12260	.692

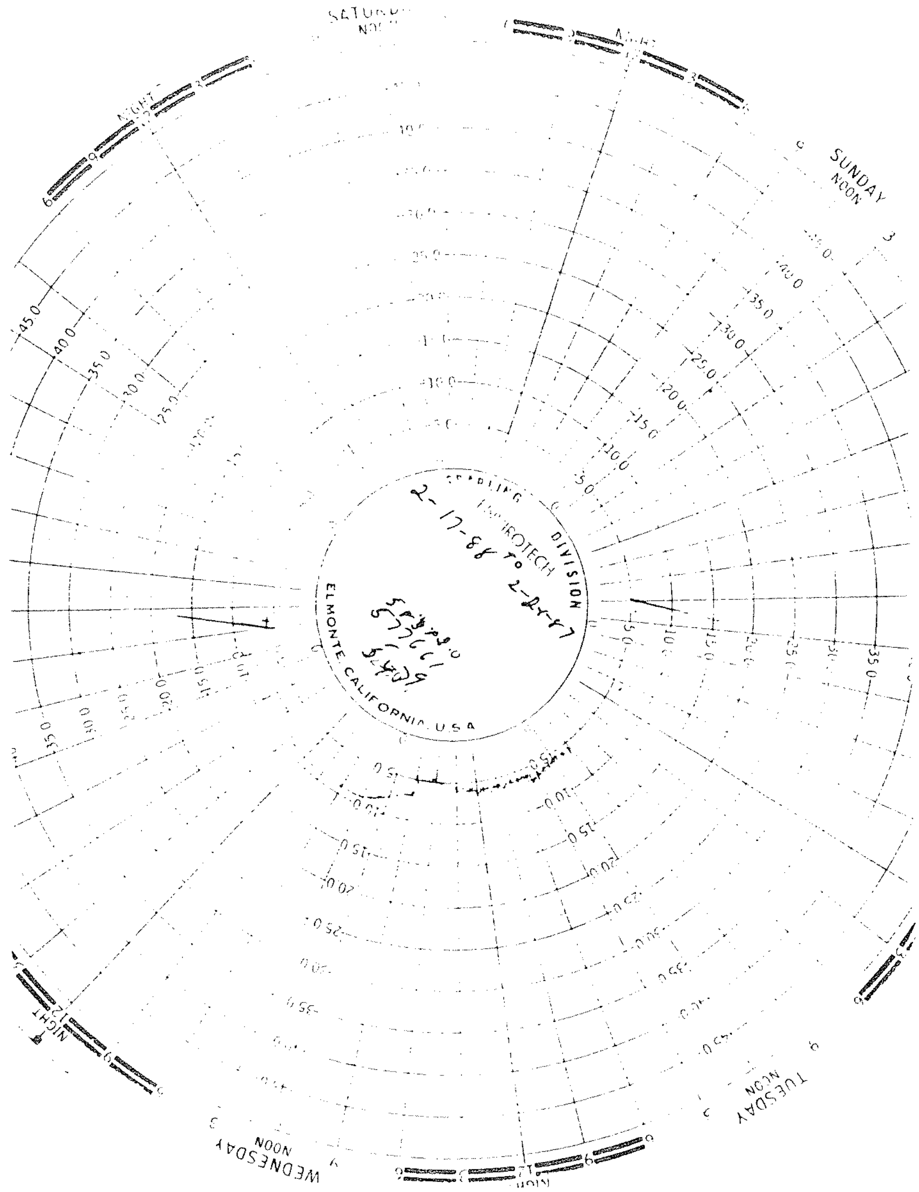

Figure 4. Ferndale's Wastewater Treatment Plant Flow Meter Recorder.

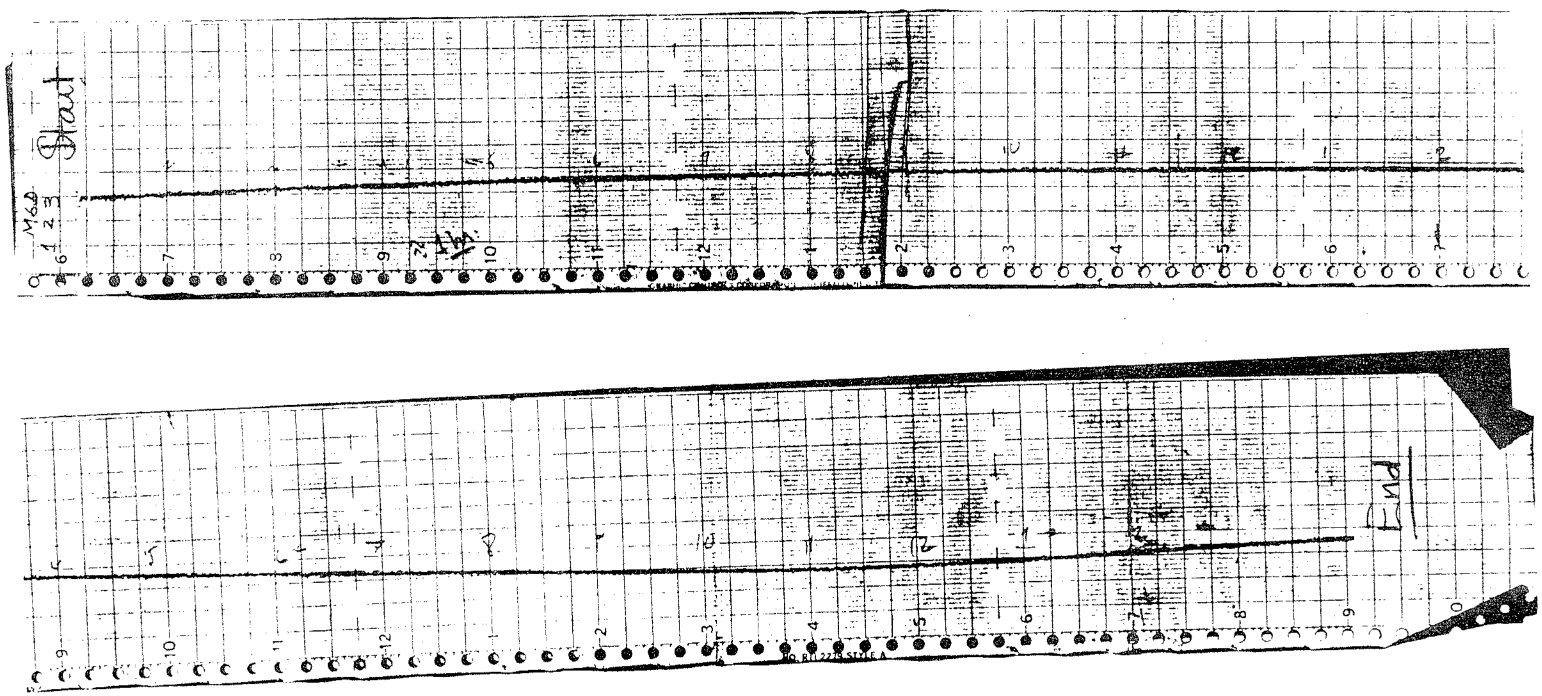

Figure 5. Ecology's Sigma Flow Meter Recorder (Factor = 2)

Table 4. Comparison of Inspection Results to NPDES Permit Effluent Limitations: Ferndale Class II Inspection, February 22-24, 1988.

	NPDES Permit Limits			Inspection Data		
Parameter	Monthly Average	Weekly Average	Design Criteria	Ecology Composite	Grab Samples	WTP Totalizer
Flow (MGD)	0.5*		0.5*			0.642
Influent BOD5						
(mg/L)				170.00		
(lbs/D)				910.2		
BOD5						
(mg/L)	30	45		21.0		
(lbs/D)	125	190		112.4		
(% removal)				87.6		
Influent TSS						
(mg/L)				460.0		
(lbs/D)				2,463.0		
TSS						
(mg/L)	75	110		18.0		
(lbs/D)	313	460		96.4		
(% removal)				96.1		
Fecal coliform (#/100 mL)	200	400			1 U	
pH (S.U.)			6 - 9		7.21 - 7.34	

* Prior to facility upgrade

Laboratory Review

The Ferndale WTP laboratory was clean and organized. The operator's techniques appear sound, although two recommendations for improvements from the 1981 Class II Inspection (Chase, 1981) have not been implemented and again were found deficient in this inspection:

1. The pH meter should be calibrated daily.

2. Distilled water was used instead of the phosphate buffer in the fecal coliform test.

In addition to the above, the following is recommended to keep laboratory procedures in conformance with standard methods:

- The temperature in the composite sampler should be maintained at approximately 4 degrees C.

BOD

- The initial D.O. of each dilution should be measured. It should approximate saturation.

- The incubator temperature should be checked daily during the test. A log or recording on the BOD sheet is recommended.

- The minimum acceptable D.O. depletion after 5 days should be at least 2.0 mg/L and at least 1.0 mg/L should remain after incubation (APHA, 1985). Tests that do not follow this criteria are not valid.

TSS

- The rough side of the filter paper should be up (APHA, 1985).

FECAL COLIFORM

- Sodium thiosulfate rather than PAO (phenylarsine oxide) should be added to the collection bottle prior to sterilization, for dechlorination purposes (APHA, 1985).

A comparison of Ecology and Ferndale WTP Laboratory results is given in Table 5. There is close agreement in the BOD test, chlorine residual, fecal coliform, and TSS of the effluent samples (lower range - 15 mg/L). However, a significant difference was observed between TSS of both influent samples: >20 percent difference for Ferndale's influent (station Inffern); 300 percent difference for Ecology's influent (INF-ECO). Typical deviations for TSS samples in the 200-500 mg/L range should be in the order of 10 percent.

Ecology's influent sample was significantly different from all the other influent grabs (see Table 2). Three major points could be addressed from this: either the sample was not properly

Table 5. Comparison of laboratory results: Ferndale Class II Inspection, February 22-24, 1988.

Station	Date	Time	Sampler	Laboratory	Chlorine Residual (mg/L) Free	Chlorine Residual (mg/L) Total	Fecal Coliform (#/100mL)	BOD5 (mg/L)	TSS (mg/L)
Composite									
INF-ECO	2/23 -	13:00	Ecology	Ecology				170	460
	2/24	13:00		Ferndale				155	153
Inffern	grab	13:30	Ferndale	Ecology				160	86
				Ferndale				150	109
EFF-ECO	2/23 -	13:30	Ecology	Ecology				21	18
	2/24	13:30		Ferndale				14	17
Eflfern	2/23 -	13:20	Ferndale	Ecology				24	16
	2/24	13:20		Ferndale				18	28
Grab									
Effluent	2/23	15:58	Ecology	Ecology	<0.1	2.0	3U		
			Ferndale	Ferndale		1.8	<10		
Effluent	2/24	14:45	Ecology	Ecology	<0.1	2.5	1U		
			Ferndale	Ferndale		2.0	<10		

analyzed, it was mislabeled, or significant loads occur in the evening or early morning. The analysis for all the parameters are reasonable with respect to each other (all in the high end), so proper analysis should not be questioned. Mislabeling is not probable since the only sample with high values (concentration) is the Mnleach (see Table 2), but several parameters differ substantially (conductivity, ammonia and phosphates). The difference is probably due to substantial loadings occurring between the evening of the 23rd and the next morning.

The variability and significant difference between the grab samples and the composite sample reaffirms the need for an influent composite sampler at the Ferndale WTP. A composite influent sampler was recommended in the 1981 Class II inspection and is strongly recommended from the results of this inspection.

Bioassays

Effluent bioassays results are given in Table 6. Rainbow trout bioassay was run at 100 percent whole chlorinated effluent. Mortality for the chlorinated sample (0.6 mg/L total chlorine as measured at the laboratory) was 100 percent within 24 hours. A follow-up test was conducted where the chlorine in the effluent was neutralized with sodium thiosulfate; mortality for the dechlorinated effluent was 96.7 percent after 96 hours.

Table 7 compares the ammonia water quality criteria with the estimated ammonia concentration in the trout bioassay (100% WTP effluent (EFF-ECO), see Table 2). The actual concentration, after 24 hours, was twice the 1 hour criteria and over 12 times the 4 day criteria. More than 80 percent of the mortality occurred after this period (24 hrs). Total cyanide concentration (Table 2) was close to the water quality criteria for acute (22 ug/L), and exceeded the chronic (5.2 ug/L) freshwater criteria (EPA, 1985b). The mixture of ammonia and cyanide is more toxic, for rainbow trout, than either substance alone (NRC, 1979).

The Microtox test results indicate that the chlorinated effluent (0.9 mg/L total chlorine as measured at the laboratory) was considerably more toxic than the dechlorinated effluent (see Table 6). The Ceriodaphnia bioassay showed significant acute and chronic toxicity, both chlorine and ammonia are the suspected acute toxicants. Cyanide, lead, mercury, and zinc are over the chronic freshwater quality criteria (Table 2 and 8) and could have partially contributed to the toxicity in the bioassay test.

Only slight toxicity, as compared to the control, was indicated by the Hyallela azteca sediment bioassay (Table 9). The only station to exhibit higher mortalities, than the laboratory test control, was the station upstream of the outfall (CONTROL). Survival was greater in stations OUTFALL and BELWZON (downstream of the mixing zone) than in the test control. These sediments consisted of mostly sand with very little fine material on which toxicants might adsorb. The CONTROL station was sandy with a larger percentage of silts and clays. Table 10 shows the priority pollutant metals scan for both water and sediment stations. Only nickel and chromium are above the marine sediments apparent effects threshold level (Tetra Tech, 1986 for Puget Sound).

Table 6. Effluent Bioassay Results: Ferndale Class II Inspection, February 22-24, 1988.

Ceriodaphnia

Effluent Concentration	Survival %	Total Reproduction
Control	100	162
1.5 %	100	158
3.0 %	100	146
6.0 %	100	137
13.0 %	100	126
25.0 %	40	21
50.0 %	0	0
100.0 %	0	0

NOEC = 13.0 %
LOEC = 25.0 %

Microtox	EC50 (5 minutes)	EC50 (15 min.)	EC50 (30 min.)
Effluent with chlorine residual (0.9 mg/L Cl)	21.8 % ± 4.3	11.7 % ± 3.6	
Effluent with chlorine neutralized	57.0 % ± 23.5	38.6 % ± 11.8	33.4 % ± 4.9

Rainbow Trout	Number of Live Test Organisms Initial	After 96 hours	Percent Mortality
Control	30	29	3.3 %
Effluent with chlorine residual (0.6 mg/L Cl)	30	0 *	100.0 %
Control	30	29	3.3 %
Effluent with chlorine neutralized	30	1	96.7 %

* All of the fish died within 24 hours

Table 7. Ammonia Toxicity: Ferndale Class II Inspection, February 22-24, 1988.

Table 7. Ammonia Toxicity: Ferndale Class II Inspection, February 22-24, 1988.

Bioassay Conditions (Rainbow Trout)						Criteria calculations **				
						1 hour			4 day	
time (hours)	temp (C)	pH (SU)	NH3-N (mg/L)	% NH3 unionized	Actual* unionized NH3-N (mg/L)	Criteria unionized NH3-N (mg/L)	Criteria unionized NH3-NH3 (mg/L)	Ratio Actual/Criteria	Criteria unionized NH3-N (mg/L)	Ratio Actual/Criteria
0	12.3	7.63	17.0	0.927	0.158	0.099	0.120	1.596	0.017	9.204
0	12.3	7.55	17.0	0.772	0.131	0.092	0.112	1.429	0.014	9.218
0	12.3	7.63	17.0	0.927	0.158	0.099	0.120	1.596	0.017	9.204
24	12.4	7.88	17.0	1.650	0.280	0.119	0.144	2.362	0.023	12.282
24	12.4	7.93	17.0	1.847	0.314	0.122	0.148	2.573	0.023	13.381
24	12.4	7.91	17.0	1.765	0.300	0.121	0.147	2.486	0.023	12.927
48	12.5	7.93	17.0	1.861	0.316	0.123	0.149	2.575	0.024	13.390
48	12.5	8.08	17.0	2.609	0.444	0.127	0.155	3.484	0.024	18.116
48	12.5	7.99	17.0	2.131	0.362	0.127	0.154	2.862	0.024	14.881
72	12.4	8.04	17.0	2.367	0.402	0.126	0.154	3.183	0.024	16.549
72	12.4	8.04	17.0	2.367	0.402	0.126	0.154	3.183	0.024	16.549
72	12.4	8.04	17.0	2.367	0.402	0.126	0.154	3.183	0.024	16.549
96	12.4	8.16	17.0	3.097	0.526	0.126	0.154	4.164	0.024	21.653
96	12.4	8.01	17.0	2.212	0.376	0.126	0.154	2.975	0.024	15.469
96	12.4	7.91	17.0	1.765	0.300	0.121	0.147	2.486	0.023	12.927

* Yake and James, 1983.
** EPA, 1985.

Table 8. Effluent metals compared with EPA water quality criteria: Ferndale Class II inspection, February 22-24, 1988.

Metal	Effluent (EFLECO) (ug/L)	Criteria *			
		FW Acute	FW Chronic	SW Acute	SW Chronic
Antimony	1 U	9000	1600	-	-
Beryllium	1 U	130	5.3	-	-
Cadmium	5 U	41	1.48	43	9.3
Chromium+3	10 U	2287	273	10300	-
Copper	12	24	16	2.9	2.9
Lead	**12**	125	5	140	5.6
Mercury	**0.06**	2.4	0.012	2.1	0.025
Nickel	19	2382	123	75	8.3
Selenium	1 U	260	35	410	54
Silver	0.2 U	7	0.12	2.3	-
Thallium	1 U	1400	40	2130	-
Zinc	**50**	425	47	95	86
Hardness	140				

* EPA, 1986.

Table 9. Sediment Parameters and Bioassay Results: Ferndale Class II Inspection, February 22-24, 1988.

Station	Solids (%)	TOC (% dry basis)	Grain Size Analysis: Gravel (>2mm)	Sand (2mm-62um)	Silt (62um-4um)	Clay (4um)	*Hyallela azteca* bioassay: Number of Survivors, Replicate Numbers 1	2	3	Percent Survival
CONTROL	71.76	0.4	10.51	61.63	23.47	4.42	7	10	6	77
CONTROL *	71.86		12.13	60.43	23.02	4.20				
OUTFALL	80.67	0.2	10.39	86.69	2.66	0.47	10	10	10	100
BELWZON	75.41	0.2	6.47	93.09	0.22	0.39	10	10	7	90
Test Control**	-	-	-	-	-	-	9	10	7	87

* Indicates replicate analysis (grain size and % solids).
** Control for the bioassay test.

Table 10. Priority Pollutant Metals

	EFLECO Total (µg/L)	INFECO Total (µg/L)	MLEACH Total (µg/L)	ALEACH Total (µg/L)	Sediments CONTROL (mg/kg-dr)	Sediments OUTFALL (mg/kg-dr)	Sediments BELWZON (mg/kg-dr)	Sediment Criteria* (mg/kg-dr)**
Arsenic	1 U	1 U	5	1 U	5.2	1.3	2.1	85
Lead	12	41	20	1 U	2.4	2.3	1.4	300
Thallium	1 U	1 U	1 U	1 U	0.1 U	0.1 U	0.1 U	-
Silver	0.2 U	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U	5.2
Antimony	1 U	1 U	1 U	1 U	1 U	1 U	1 U	3.2
Selenium	1 U	1 U	1 U	1 U	0.2 U	0.2 U	0.2 U	-
Mercury	0.06	0.17	0.68	0.11	0.016	0.006U	0.006U	0.41
Beryllium	1 U	1 U	2.	1 U	0.6	0.6	0.5	-
Cadmium	5 U	5 U	5 U	5 U	0.5 U	0.5 U	0.5 U	5.8
Chromium	10 U	10 U	26	56	**37.8**	**39.3**	**35.6**	27
Copper	12	65	150	41	26.0	15.3	14.6	310
Nickel	19	12	197	52	**109.4**	**196.7**	**123.0**	28
Zinc	50	124	366	79	62.3	57.2	51.5	260

* Lowest apparent effects threshold (AET), Tetra Tech, 1986.
**dr - per dry weight of sediment

Leachate Characterization

Results for the conventional pollutants of the Cedarville leachate are shown on Table 2 (Mnleach). During the inspection period this leachate comprised 3 percent of the plant flow and COD load; 6 percent of the BOD_5 load; 1.5 percent of the TSS load; 24 percent of the phenol load; and 17 percent of the ammonia load. Elevated values of mercury, chromium, copper, nickel, and zinc characterize the leachate (Table 10, Mnleach station).

The Thermal Reduction Company leachate (at the sewer) results for conventional pollutants are shown in Table 2 (Aleach). The leachate combines with water from TRC as it flows into the sewer to the WTP. The sample can be characterized by low COD, TSS, nutrients and high dissolved solids.

Priority Pollutants Metals

Priority pollutant metals scans are shown in Table 10 for water and sediment stations. Only nickel is above both the AET's and background levels, upstream station (CONTROL), pointing to the WTP effluent as the probable source of metal contamination. Chromium below the outfall is not significantly different from the background concentration (upstream station CONTROL).

A reduction between influent and effluent metal concentration occurred for every detected metal except nickel (Table 10). The reason for the apparent increase in nickel is probably due to the municipal (Cedarville) leachate nickel load. The metal load from the leachate (Mnleach) was between 10 percent for zinc and mercury, and 33 percent for nickel, as compared to the influent.

Levels of heavy metals from the TRC sewer line station (Aleach) are much lower than those reported by Kittle (Chase, 1981). Dilution with process water from Thermal Reduction is the probable reason for the difference in concentration.

Priority Pollutant Organics

Tables 11, 12, and 13 show the priority pollutant scan of acid, base, neutral organics, pesticides and polychlorinated biphenyls (PCB), and volatile organics. Both sediment stations and whole water stations are presented. Phthalates are present in both sediment and all water samples; phthalates are used in plastics and are common in wastewaters. The municipal leachate sample shows detectable levels of phenol, 2-methylphenol, 4-methylphenol, and naphthalene, all below the water quality criteria (USDC, 1979; EPA, 1986). There were no pesticides and or PCB's detected in the water and sediment samples (Table 12).

The VOA scan identified several organics in the water and sediment samples (Table 13). Methylene chloride, acetone, 2-butanone, and toluene were found in the field blank and in all water stations, indicating a contamination in the blank and sampling equipment. Toluene was found below the outfall, in the effluent, influent and in the municipal leachate, at levels below the water quality criteria. Chloroform in the effluent is likely a result of the chlorination

Table 11. Results of BNA priority pollutant scan: Ferndale Class II Inspection, February 22-24, 1988.

Priority Pollutant	Stations			Sediments		
BNA Compound	INF-ECO (µg/L)	EFF-ECO (µg/L)	Mnleach (µg/L)	CONTROL (ug/kg)	OUTFALL (ug/kg)	BELWZON (ug/kg)
Phenol	1 U	1 U	**48**	75 U	64 U	76 U
bis(2-Chloroethyl)Ether	1 U	1 U	1 U	75 U	64 U	76 U
2-Chlorophenol	1 U	1 U	1 U	75 U	64 U	76 U
1,3-Dichlorobenzene	1 U	1 U	1 U	75 U	64 U	76 U
1,4-Dichlorobenzene	1 U	1 U	1 U	75 U	64 U	76 U
Benzyl Alcohol	5 U	5 U	2 J	3 U	320 U	380 U
1,2-Dichlorobenzene	1 U	1 U	1 U	75 U	64 U	76 U
2-Methylphenol	**2**	1 U	**6**	75 U	64 U	76 U
bis(2-chloroisopropyl)ether	1 U	1 U	1 U	75 U	64 U	76 U
4-Methylphenol	**1**	1 U	**160**	75 U	64 U	76 U
N-Nitroso-Di-n-Propylamine	1 U	1 U	1 U	75 U	64 U	76 U
Hexachloroethane	2 U	2 U	2 U	150 U	130 U	150 U
Nitrobenzene	1 U	1 U	1 U	75 U	64 U	76 U
Isophorone	1 U	1 U	1 U	75 U	64 U	76 U
2-Nitrophenol	5 U	5 U	5 U	380 U	320 U	380 U
2,4-Dimethylphenol	2 U	2 U	2 J	150 U	130 U	150 U
Benzoic Acid	**7 J**	10 U	**44**	750 U	640 U	760 U
bis(2-Chloroethoxy)Methane	1 U	1 U	1 U	75 U	64 U	76 U
2,4-Dichlorophenol	3 U	3 U	3 U	230 U	190 U	230 U
1,2,4-Trichlorobenzene	1 U	1 U	1 U	75 U	64 U	76 U
Naphthalene	**1**	1 U	**8**	75 U	64 U	76 U
4-Chloroaniline	3 U	3 U	3 U	230 U	190 U	230 U
Hexachlorobutadiene	2 U	2 U	2 U	150 U	130 U	150 U
4-Chloro-3-Methylphenol	2 U	2 U	2 U	150 U	130 U	150 U
2-Methylnaphthalene	1 M	1 U	1 U	75 U	64 U	76 U
Hexachlorocyclopentadiene	5 U	5 U	5 U	380 U	320 U	380 U
2,4,6-Trichlorophenol	5 U	5 U	5 U	380 U	320 U	380 U
2,4,5-Trichlorophenol	5 U	5 U	5 U	380 U	320 U	380 U
2-Chloronaphthalene	1 U	1 U	1 U	75 U	64 U	76 U
2-Nitroaniline	5 U	5 U	5 U	380 U	320 U	380 U
Dimethyl Phthalate	1 U	1 U	1 U	75 U	64 U	76 U
Acenaphthylene	1 U	1 U	1 U	75 U	64 U	76 U
3-Nitroaniline	5 U	5 U	5 U	380 U	320 U	380 U
Acenaphthene	1 U	1 U	1 U	75 U	64 U	76 U
2,4-Dinitrophenol	10 U	10 U	10 U	750 U	640 U	760 U
4-Nitrophenol	5 U	5 U	5 U	380 U	320 U	380 U
Dibenzofuran	1 U	1 U	1 U	75 U	64 U	76 U
2,4-Dinitrotoluene	5 U	5 U	5 U	380 U	320 U	380 U
2,6-Dinitrotoluene	5 U	5 U	5 U	380 U	320 U	380 U
Diethylphthalate	**6**	1 U	**4**	75 U	64 U	76 U
4-Chlorophenyl-phenylether	1 U	1 U	1 U	75 U	64 U	76 U
Fluorene	1 U	1 U	1 U	75 U	64 U	76 U
4-Nitroaniline	5 U	5 U	5 U	380 U	320 U	380 U
4,6-Dinitro-2-Methylphenol	10 U	10 U	10 U	750 U	640 U	760 U
N-Nitrosodiphenylamine	1 U	1 U	1 U	75 U	64 U	76 U
4-Bromophenyl-phenylether	1 U	1 U	1 U	75 U	64 U	76 U
Hexachlorobenzene	1 U	1 U	1 U	75 U	64 U	76 U
Pentachlorophenol	5 U	5 U	5 U	380 U	320 U	380 U
Phenanthrene	1 U	1 U	1 U	75 U	64 U	76 U
Anthracene	1 U	1 U	1 U	75 U	64 U	76 U
Di-n-Butylphthalate	2	1 U	1 U	75 U	64 U	76 U
Fluoranthene	1 U	1 U	1 U	75 U	64 U	76 U
Pyrene	1 U	1 U	1 U	75 U	64 U	76 U
Butylbenxylphthalate	3	1 U	1 U	75 U	64 U	76 U
3,3'-Dichlorobenzidine	5 U	5 U	5 U	380 U	320 U	380 U
Benzo(a)Anthracene	1 U	1 U	1 U	75 U	64 U	76 U
bis(2-Ethylhexyl)Phthalate	**15**	**2**	**6**	**34 JB**	**140**	76 U
Chrysene	1 U	1 U	1 U	75 U	64 U	76 U
Di-n-Octyl Phthalate	2	1 U	1 U	75 U	64 U	76 U
Benzo(b)Fluoranthene	1 U	1 U	1 U	75 U	64 U	76 U
Benzo(k)Fluoranthene	1 U	1 U	1 U	75 U	64 U	76 U
Benzo(a)Pyrene	1 U	1 U	1 U	75 U	64 U	76 U
Indeno(1,2,3-cd)Pyrene	1 U	1 U	1 U	75 U	64 U	76 U
Dibenz(a,h)Anthracene	1 U	1 U	1 U	75 U	64 U	76 U
Benzo(ghi)Perylene	1 U	1 U	1 U	75 U	64 U	76 U

U Indicates compound was analyzed for but not detected at the given detection limit.
J Indicates an estimated value when result is less than the specified detection limit.
B Indicates the analyte is found in the blank as well as the sample, indicates possible/probable blank contamination.
M Indicates an estimated value of analyte found and confirmed by analyst, but with low spectral match parameters.
K Indicates that quantitative value falls above the limit of the calibration curve, and dilution should be run.

Table 12. Results of Pesticide/PCB priority pollutant scan: Ferndale Class II Inspection, February 22-24, 1988.

Priority Pollutant	Stations			Sediments		
Pesticide/PCB Compound	INF-ECO (µg/L)	EFF-ECO (µg/L)	Mnleach (µg/L)	CONTROL (mg/kg)	OUTFALL (mg/kg)	BELWZON (mg/kg)
Alpha-BHC	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Beta-BHC	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Delta-BHC	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Gamma-BHC (Lindane)	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Heptachlor	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Aldrin	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Heptachlor Epoxide	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Endosulfan I	0.1 U	0.1 U	0.1 U	0.01 U	0.01 U	0.01 U
Dieldrin	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
4,4'-DDE	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
Endrin	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
Endosulfan II	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
4,4'-DDD	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
Endosulfan Sulfate	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
4,4'-DDT	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
Methoxychlor	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
Endrin Ketone	0.2 U	0.2 U	0.2 U	0.02 U	0.02 U	0.02 U
Chlordane	0.4 U	0.4 U	0.4 U	0.04 U	0.04 U	0.04 U
Toxaphene	20 U	20 U	20 U	2 U	2 U	2 U
Aroclor-1016	2 U	2 U	2 U	0.2 U	0.2 U	0.2 U
Aroclor-1242	2 U	2 U	2 U	0.2 U	0.2 U	0.2 U
Aroclor-1248	2 U	2 U	2 U	0.2 U	0.2 U	0.2 U
Aroclor-1254	2 U	2 U	2 U	0.2 U	0.2 U	0.2 U
Aroclor-1260	2 U	2 U	2 U	0.2 U	0.2 U	0.2 U

Table 13. Results of VOA priority pollutant scan: Ferndale Class II Inspection, February 22-24, 1988.

Priority Pollutant	Stations			Field Blank	Sediments		
VOA Compound	INF-ECO (μg/L)	EFF-ECO (μg/L)	Mnleach (μg/L)	(μg/L)	CONTROL (μg/kg)	OUTFALL (μg/kg)	BELWZON (μg/kg)
Chloromethane	2.9 U	2.9 U	2.9 U	2.9 U	2.5 U	2.7 U	2.2 U
Bromomethane	0.9 U	0.9 U	0.9 U	0.9 U	2.1 U	2.2 U	1.8 U
Vinyl Chloride	1.1 U	1.1 U	1.1 U	1.1 U	1.3 U	1.4 U	1.2 U
Chloroethane	0.9 U	0.9 U	0.9 U	0.9 U	2.2 U	2.3 U	2.0 U
Methylene Chloride	**370 KB**	**55 B**	**60 B**	**49 B**	**3.5 B**	**6.8 B**	**1.4 JB**
Acetone	**2000 KB**	**2300 KB**	**850 KB**	**860 KB**	4.6 U	**3.2 M**	4.1 U
Carbon Disulfide	2.0 U	2.0 U	2.0 U	2.0 U	0.8 U	0.9 U	0.7 U
1,1-Dichloroethene	1.3 U	1.3 U	1.3 U	1.3 U	0.5 U	0.5 U	0.4 U
1,1-Dichloroethane	1.1 U	1.1 U	10	1.1 U	0.4 U	0.4 U	0.4 U
1,2-Dichloroethene (total)	1.2 U	1.2 U	3.1	1.2 U	0.5 U	0.6 U	0.5 U
Chloroform	**3.6**	**1.6**	0.9 U	0.9 U	0.7 U	0.8 U	0.7 U
1,2-Dichloroethane	0.6 U	0.6 U	0.6 U	0.6 U	0.3 U	0.4 U	0.3 U
2-Butanone	**13 B**	**3.4 B**	**620 KB**	**1.8 B**	4.1 U	4.4 U	3.7 U
1,1,1-Trichloroethane	1.0 U	1.0 U	**20**	1.0 U	0.4 U	0.4 U	0.4 U
Carbon Tetrachloride	0.5 U	0.5 U	0.5 U	0.5 U	0.6 U	0.6 U	0.5 U
Vinyl Acetate	1.7 U	1.7 U	1.7 U	1.7 U	2.1 U	2.2 U	1.8 U
Bromodichloromethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-Dichloropropane	0.6 U	0.6 U	0.6 U	0.6 U	0.5 U	0.5 U	0.4 U
Trans-1,3-Dichloropropene	0.5 U	0.5 U	0.5 U	0.5 U	1.2 U	1.3 U	1.1 U
Trichloroethene	0.8 U	0.8 U	**1.3**	0.8 U	0.4 U	0.4 U	0.4 U
Dibromochloromethane	0.9 U	0.9 U	0.9 U	0.9 U	0.5 U	0.5 U	0.4 U
1,1,2-Trichloroethane	0.3 U	0.3 U	0.3 U	0.3 U	0.5 U	0.5 U	0.4 U
Benzene	**2.1**	0.4 U	**6.2**	0.4 U	0.7 U	0.7 U	0.6 U
cis-1,3-Dichloropropene	0.6 U	0.6 U	0.6 U	0.6 U	1.3 U	1.4 U	1.1 U
2-Chloroethylvinylether	1.5 U	1.5 U	1.5 U	1.5 U	1.8 U	1.9 U	1.6 U
Bromoform	0.3 U	0.3 U	0.3 U	0.3 U	1.7 U	1.8 U	1.5 U
4-Methyl-2-Pentanone	1.8 U	1.8 U	**38**	1.8 U	2.3 U	2.5 U	2.1 U
2-Hexanone	1.3 U	1.3 U	**250 K**	1.3 U	2.1 U	2.3 U	1.9 U
Tetrachloroethene	**1.0 M**	0.6 U	0.6 U	0.6 U	0.3 U	0.4 U	0.3 U
1,1,2,2-Tetrachloroethane	0.6 U	0.6 U	0.6 U	0.6 U	1.8 U	1.9 U	1.6 U
Toluene	**37**	**21**	**47**	**11**	0.5 U	**1.1**	0.5 U
Chlorobenzene	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.5 U
Ethylbenzene	0.9 J	1.0 U	**38**	1.0 U	0.5 U	0.6 U	0.5 U
Styrene	0.5 U	0.5 U	0.5 U	0.5 U	0.7 U	0.8 U	0.7 U
Total Xylenes	**7.3**	1.5 U	**61**	1.5 U	1.2 U	1.3 U	1.1 U

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

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

B Indicates the analyte is found in the blank as well as the sample, indicates possible/probable blank contamination.

M Indicates an estimated value of analyte found and confirmed by analyst, but with low spectral match parameters.

K Indicates that quantitative value falls above the limit of the calibration curve, and dilution should be run.

process. Levels from the municipal leachate are within the range of priority pollutants detected in solid waste leachate (Robinson, 1986).

CONCLUSIONS AND RECOMMENDATIONS

The Ferndale WTP discharge was within the NPDES permit effluent limitations during the inspection. A composite influent sampler needs to be installed to obtain a more representative influent sample/load. The chlorine residual in the effluent should be reduced; it is too high and proved lethal on a rainbow trout bioassay. Lower levels of total chlorine residual would achieve the required fecal coliform control without causing adverse effects on the receiving water. The WTP should improve its nitrification process, although effluent dilution is above Ecology's requirement (100:1).

Monitoring and metering the sewer line from Thermal Reduction Company is recommended. Heavy metals loadings to the WTP needs to be addressed, both from TRC and the Cedarville leachate.

TSS loading to the WTP from both the influent and the municipal leachate needs to be addressed. Inorganic sludge produced by leachate treatment should be quantified. Lagoon sludge should be tested periodically to assess its impact when disposed off-site.

Effluent bioassays showed high levels of toxicity; chlorine and ammonia are the suspected major toxicants. Other heavy metals are close to the chronic water quality level. Cyanide concentration in the effluent was close to the chronic water quality criteria. Dilution of the WTP discharge by the receiving water reduces the overall impact of the effluent.

Lower chlorine residuals, effluent bioassay (Microtox or rainbow trout), heavy metals monitoring, and lagoon sludge monitoring are strongly recommended. Recommendations on laboratory procedures are included in the laboratory review section.

REFERENCES

APHA, 1985. Standard Methods for the Examination of Water and Wastewater, 16th Edition, American Public Health Association, Washington, D.C., 1986.

Chase, 1981."Ferndale Sewage Treatment Plant Class II Inspection," Ecology Memo to John Glynn, June 23, 1981.

EPA, 1985. Ambient Water Quality Criteria for Ammonia - 1984, EPA 440/5-85-001, January 1985.

EPA, 1985b. Ambient Water Quality Criteria for Cyanide - 1984, EPA 440/5-84-028, January, 1985.

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

Metcalf & Eddy, 1972. Wastewater Engineering: Collection, Treatment, Disposal, McGraw Hill Book Company, New York, 1972.

NRC, 1979. Ammonia, Subcommittee on Ammonia, National Research Council, University Park Press, Baltimore, 1979.

Nunnallee, 1988. Personal communication, DMR Analysis, and Plant Schematics, January, 1988.

Robinson, 1986. The Solid Waste Handbook. John Wiley & Sons, New York, 1986.

Tetra Tech, 1986. User's Manual for the Pollutant of Concern Matrix, Puget Sound Estuary Program. Prepared for U.S. EPA, August 1986.

U.S.D.C., 1979. Chemical Pollutants of the New York Bight; Priorities for Research. U.S. Department of Commerce, Boulder, Colorado, June, 1979.

Yake and James, 1983. "Setting effluent ammonia limits to meet in-stream toxicity criteria." Journal Water Pollution Control Federation, March 1983.