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Segment No. 25-00-01

WA-PS-0230

KINGSTON WASTEWATER TREATMENT PLANT
CLASS II INSPECTION

by
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ABSTRACT

A Class II inspection was conducted at the Kingston wastewater treatment plant on March 22 and 23, 1988. The WTP is an activated sludge package plant operated by Kitsap County serving the community of Kingston. The effluent was within permit limitations during the inspection. However, the plant has a history of occasional upsets. The cause of these upsets was suspected to be a very high sludge age causing poor sludge settleability. A more aggressive sludge-wasting strategy is recommended to help avoid poor plant performance.

INTRODUCTION

A Class II inspection was conducted on March 22 and 23, 1988, at the Kingston wastewater treatment plant (WTP). Conducting the inspection were Pat Hallinan and Marc Heffner from the Ecology Compliance Inspection Section and Mike Dawda from the Ecology Northwest Regional Office (NWRO). Ralph DeClements, Wastewater Operations Supervisor for Kitsap County, and Kathy Cahall, laboratory supervisor at the Central Kitsap treatment plant, provided assistance.

Kingston is a small community (population approximately 2000) located on Puget Sound across from the North Seattle area (see Figure 1). Main businesses of Kingston include a ferry terminal, restaurants, and taverns. The WTP is an activated sludge package plant with a history of occasional upsets involving solids losses from the final clarifier. The plant is operated along with three others by Kitsap County. Treated effluent is discharged into Appletree Cove in Puget Sound in accordance with NPDES permit #WA-002326-4. Sludge from the process is aerobically digested then trucked to the Central Kitsap WTP for dewatering and disposal. The Central Kitsap WTP laboratory conducts most permit parameter testing for the Kingston WTP.

Objectives of this survey included:

1. Verify effluent compliance with NPDES permit limits.

2. Analyze the WTP performance by determining plant loading and efficiency, and verifying flows.

3. Verify that laboratory procedures at the Central Kitsap WTP are in conformance with standard techniques. This included splitting samples with the WTP to determine the accuracy of laboratory results.

PROCEDURES

Kingston WTP influent, effluent, and unchlorinated effluent composite samples were collected by Ecology. ISCO automatic samplers were set to sample approximately 200

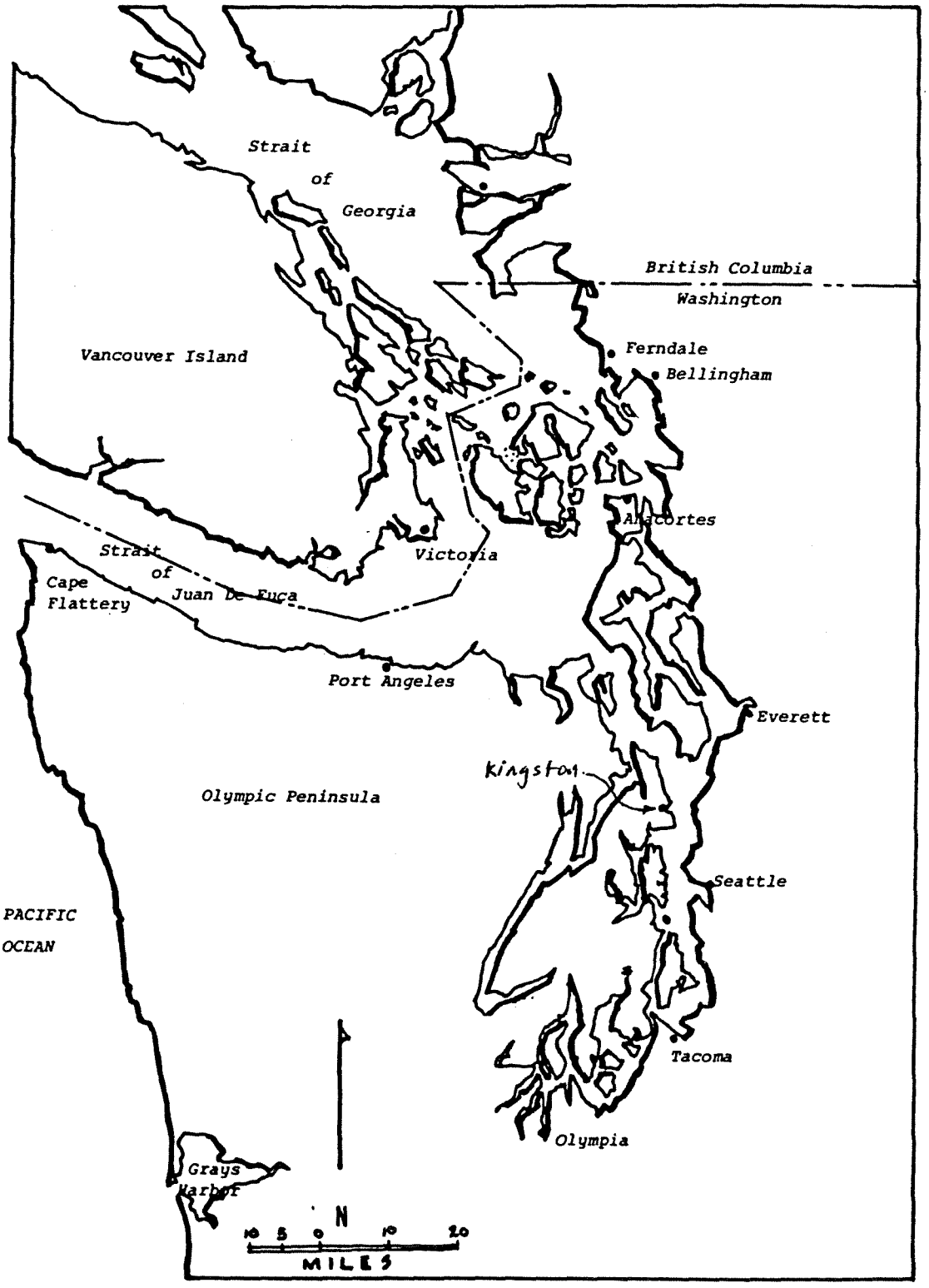


Figure 1. Site Location

mLs every 30 minutes for 24 hours at these locations. The WTP personnel also collected influent and effluent composite samples using automatic samplers. The WTP influent compositor was time-paced, collecting 200 mLs of sample every 30 minutes for 24 hours. The effluent WTP sampler was flow-paced, collecting 200 mLs after every 1800 gallons of effluent flow. Composite samples were split by Ecology and the WTP laboratory for analysis. Grab samples were also collected by Ecology for field and lab analysis. Sampling times and parameters analyzed are listed in Table 1.

A Sigma bubbler flow meter was used by Ecology to check the accuracy of the effluent plant flow meter. Instantaneous measurements were also made.

RESULTS AND DISCUSSION

Data collected during the inspection are summarized in Table 2 (flow measurements) and Table 3 (data analysis).

Instantaneous flow measurements at the effluent 60 degree v-notch weir revealed that the instantaneous plant flow recording was not accurate (Table 2). Further checking of the plant meter showed there was no agreement between the instantaneous recording and the totalizer. The WTP uses only totalizer readings from their meter to determine daily plant flows. A Sigma flow meter was set up by Ecology at the weir to check the accuracy of the plant totalizer. The Sigma meter functioned properly during the afternoon on March 22, but failed during the night. The Ecology and the plant totalizers agreed closely, indicating the plant meter was accurate.

A schematic diagram of plant flow is shown in Figure 2. The package plant is presently set up in the contact stabilization mode of operation. Raw sewage flows through a comminutor and bar screen into an aeration basin where it is mixed with re-aerated sludge. Mixed liquor is withdrawn from one end of the aeration basin and fed to the clarifier. Settled sludge from the clarifier is fed to the opposite end of the aeration basin and re-aerated. Clarifier effluent is chlorinated, held in the chlorine contact chamber, then discharged over the 60 degree v-notch weir. A discharge line carries the effluent to Appletree Cove. Waste sludge is pumped from the aeration basin to the aerobic digestion compartment.

During the afternoon on March 22 and 23, floc was observed rising in the clarifier and going over the clarifier weir. The floc consisted of small lumps (1/4 to 1/2 inch in diameter) and had a greasy appearance.

Activated sludge process parameters were calculated for the WTP using plant design data. Table 4 compares these values to typical activated sludge design parameters (Ecology, 1985). The sludge age of 45 days was approximately three times as high as recommended for a contact stabilization or completely mixed system. Also, the food-to-microorganism ratio of 0.05 was low compared to the recommended range of 0.2 to 0.6. Other parameters (mixed liquor suspended solids, aerator loading, and

Table 1. Sampling Times and Parameters Analyzed - Kingston, March 1988.

Station	Date	Time	Sampler	Laboratory	Field Analyses: Temp. (°C)	pH (S.U.)	Conductivity (umhos/cm)	Chlorine Residual (mg/L): Free	Chlorine Residual (mg/L): Total	D.O. (mg/L)	Sludge Depth	Fecal Coliform (#/100 mL)	Laboratory Analyses: Oil & Grease (mg/L)	BOD_5 (mg/L)	Inhib. BOD_5 (mg/L)	COD (mg/L)	Solids (mg/L): TS	TNVS	TSS	TNVSS	Turbidity (NTU)	Nutrients (mg/L): NH_3-N	NO_2+NO_3-N	Total-P	Conductivity (umhos/cm)	Alkalinity (mg/L as $CaCO_3$)	% Solids	Sludge Metals
Influent	3/22	10:00			X	X	X																					
		16:30			X	X	X																					
	3/23	9:20			X	X	X																					
		11:30											X															
		Comp	Ecology	Ecology										X	X	X	X	X	X	X	X	X	X	X	X	X		
		(10:30-		Kingston										X					X									
		10:30)	Kingston	Ecology										X	X	X	X	X	X	X	X	X	X	X	X	X		
				Kingston										X					X									
Unchlorinated Effluent	3/22	10:00			X	X	X									X			X									
		16:30			X	X	X									X			X									
	3/23	9:20			X	X	X					X				X			X									
		11:30										X	X			X			X									
		Comp	Ecology	Ecology										X	X	X	X	X	X	X	X	X	X	X	X	X		
		(10:30-		Kingston										X					X									
		10:30)	Kingston	Ecology										X	X	X	X	X	X	X	X	X	X	X	X	X		
				Kingston										X					X									
Chlorinated Effluent	3/22	10:00			X	X	X	X	X																			
		16:30			X	X	X																					
	3/23	9:20			X	X	X	X	X																			
		11:30																										
		Comp	Ecology	Ecology										X	X	X	X	X	X	X	X	X	X	X	X	X		
		(10:30-																										
		10:30)																										
Mixed Liquor	3/23	9:20																	X	X								
		11:30																	X	X								
		11:30											X						X	X								
Return Sludge	3/23	9:20																	X	X								
		11:30																	X	X								
Clarifier	3/22	10:30								X	X																	
		16:10								X	X																	
	3/23	9:40									X																	
		11:30											X															
Aerobic Sludge	3/23	11:30																									X	X
Aeration Basin	3/22	10:30								X																		
Aerobic Digester	3/22	10:30								X																		
Chlorine Contact Chamber	3/22	10:30									X																	

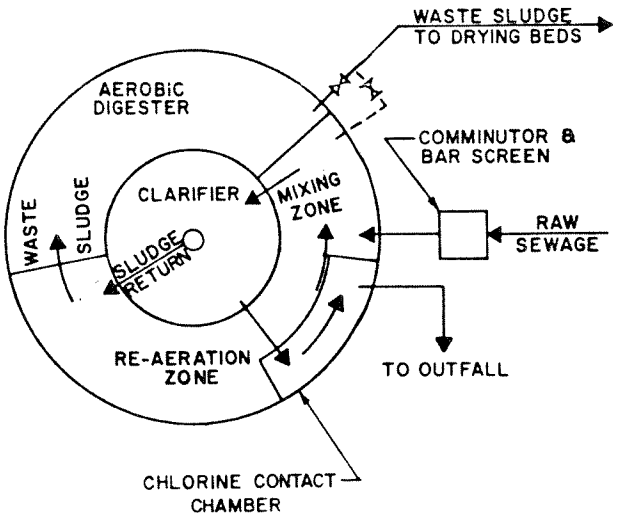
Table 2. Flow Measurements - Kingston, March 1988.

		Plant Meter			Ecology Sigma Meter		
Date	Time	Instantaneous Flow* (MGD)	Totalizer Reading	Flow for Time Increment (MGD)	Instantaneous Flow (MGD)	Totalizer Reading	Flow for Time Increment (MGD)
3/22	856	0.080	26289821				
				0.093			
3/22	1013	0.067	26290320				
				0.091			
3/22	1309	0.063	26291428		0.095	13227	
				0.074			0.071
3/22	1608	0.025	26292346		0.044	13317	
				0.066			
3/23	844	0.092	26296939				
				0.086			
3/23	1016	0.044	26297487				
			Average flow during inspection = 0.073				

* Ecology check showed that plant instantaneous readings were inaccurate.

Table 3. Ecology Analytical Results - Kingston, March 1988.

Station	Date	Time	Sampler	Field Analyses: Temp. (°C)	pH (S.U.)	Conductivity (umhos/cm)	Chlorine Residual (mg/L): Free	Chlorine Residual (mg/L): Total	Fecal Coliform (#/100 mL)	Laboratory Analyses: Oil & Grease (mg/L)	BOD_5 (mg/L)	Inhib. BOD_5 (mg/L)	COD (mg/L)	Solids (mg/L): TS	Solids (mg/L): TNVS	Solids (mg/L): TSS	Solids (mg/L): TNVSS	Turbidity (NTU)	Nutrients (mg/L): NH_3-N	Nutrients (mg/L): NO_2+NO_3-N	Nutrients (mg/L): Total-P	Conductivity (umhos/cm)	Alkalinity (mg/L as $CaCO_3$)
Influent	3/22	10:00		15.2	8.0	420																	
		16:30		15.0	7.8	550																	
	3/23	9:20		14.6	7.6	725																	
		11:30								36													
		Comp (10:30-10:30)	Ecology								230	210	780	690	300	190	15	45	18	0.53	1.6	616	220
			Kingston								210	170	480	590	290	170	10	45	25	0.29	2.0	646	210
Unchlorinated Effluent	3/22	10:00		15.6	6.9	550							47			9							
		16:30		15.4	7.0	550							97			56							
	3/23	9:20		15.0	6.2	550			4				45			25							
		11:30							2	4			50			18							
		Comp (10:30-10:30)	Ecology								18	5	53	430	310	22	<1	2	0.99	1.1	0.90	599	160
			Kingston								28	9	67	450	310	67	<1	5	1.00	1.3	0.86	596	150
Chlorinated Effluent	3/22	10:00		15.4	6.8	590	0.2	2.0															
		16:30		15.4	6.8	625																	
	3/23	9:20		14.8	6.2	500	0.3	1.0															
		Comp (10:30-10:30)	Ecology								<8	4	65	440	310	25	<1	4	0.92	1.2	0.9	610	150
Mixed Liquor	3/23	9:20														3900	440						
		11:30														4000	450						
		11:30								140						3600	300						
Return Sludge	3/23	9:20														6500	530						
		11:30														6400	680						
Clarifier	3/23	11:30								9													



DESIGN DATA

Smith & Loveless Sewage Treatment Plant

Capacity	150,000 gallons per day, contact stabilization 100,000 gallons per day, extended aeration
Population	1,500
Aeration Basin	18,700 gallons
Re-Aeration Basin	48,100 gallons
Aerobic Digester	33,700 gallons
Settling Basin	19 feet 3 inches in diameter
Chlorine Contact Tank	6,300 gallons
Outfall	1,700 lineal feet of 12 inch pipe
Sludge Drying Beds	2 each, 20 feet by 40 feet
Pumping Station	240 gallons per minute
Auxiliary Power	115 KW
Collection System	17,000 lineal feet of 8" to 12" sewer pipe

Figure 2. Flow scheme, Kingston 3/88 (URS, 1974)

Table 4. Comparison of Plant Data with Design Criteria - Kingston, March 1988.

		Typical design parameters (Ecology, 1985)	
	Kingston	Complete Mix	Contact Stabilization
AERATION BASIN			
Food to microorganism ratio (lb BOD/MLVSS/day)	0.05	0.2-0.6	0.2-0.6
Sludge age (days)	45	5-15	5-15
MLSS (mg/L)	3600* 4000+	2000-5000	1000-4000* 4000-10000+
Aerator loading (lb BOD/ 1000 cu ft tank volume	15	20-120	30-75
Activated sludge return ratio	1	0.25-1.0	0.25-1.0
Detention time (hr)	3.1* 15.8+	3-5	0.5-1.5* 3-6+
CLARIFIER			
Surface overflow rate** (gpd/sq ft)	250	400-600	300-500
Solids loading rate** (lb/day/sq ft)	16	25	25

* Contact tank
+ Stabilization tank
** At average design flow

activated sludge return ratio) were near or within suggested ranges. The solids loading and surface overflow rate of the clarifier were below state design criteria, indicating the clarifier should have the capacity to handle the present hydraulic and solids loading.

Total suspended solids data from the aeration basin showed that the plant is not in a true contact stabilization mode of operation, but rather approximating a completely mixed system. There was little difference in suspended solid concentrations in the contact and stabilization zones of the aeration basin, suggesting back mixing of influent is occurring. Sludge is returned to the stabilization zone at a concentration of about 6000 mg/L. TSS concentrations varied from 3600 to 4000 mg/L throughout the aeration basin.

Sludge depth measurements were taken in the clarifier and chlorine contact chamber using a Sludge Judge tube sampler. Sludge depths in the 15-feet-deep clarifier were extremely high, ranging from twelve to thirteen feet. Data from Discharge Monitoring Reports (DMRs) show the sludge does not settle well; the 30-minute settled sludge volume is usually 900 mL. The operator also reported that solids accumulate rapidly in the chlorine contact chamber, requiring frequent clean-out. A one-foot sludge depth was measured in the chamber.

The plant was nitrifying and denitrifying during the inspection; about 20 mg/L of influent nitrogen (NH_3-N and NO_2+NO_3-N) was reduced to 2 mg/L of effluent nitrogen. Denitrification was not considered to be the cause of the rising solids in the clarifier because 0.25 to 0.5 mg/L of dissolved oxygen was measured in the clarifier during the plant upsets (denitrification can only occur when anoxic conditions exist). Higher daytime flows are most likely causing a hydraulic washout of the upper portion of the sludge blanket.

Dissolved oxygen measurements were made in the aeration basin and aerobic digestion compartment using a portable YSI D.O. meter. Dissolved oxygen ranged from 1.1 to 1.2 mg/L at the outside edge of the aeration basin. Typical D.O.s for activated sludge aeration basins run from 1.0 to 2.0 mg/L. D.O.s at the outer edge of the aerobic digestion compartment were 0.5 to 0.6 mg/L.

Samples of influent, unchlorinated effluent, aeration basin liquor, and clarifier overflow were taken for oil and grease analysis to determine whether excessive amounts of grease were contributing to the poor plant performance. Results from the analysis are listed in Table 3. The influent oil and grease concentration of 36 mg/L is low compared to typical concentrations in domestic wastewater (Metcalf and Eddy, 1972).

Comparison of plant effluent parameters to NPDES permit limits is given in Table 5. The effluent was within permit limits for BOD_5, TSS, pH, and fecal coliform. The plant was providing BOD_5 and TSS removals in excess of 85 percent. Average plant flow during the inspection was 73,000 gallons/day which is about half of the design capacity of 150,000 gallons/day.

Table 5. Comparison of Effluent Parameters to NPDES Permit Limitations - Kingston, March 1988.

Parameter	NPDES Permit Limits Monthly Average	NPDES Permit Limits Weekly Average	Inspection Data Ecology Composite	Inspection Data Grab Samples
Influent BOD5 (mg/L)			230	
BOD5 (mg/L)	30	45	18	
BOD5 (lbs/D)	38	57	10.9	
BOD5 (% removal)			92.2	
Influent TSS (mg/L)			190	
TSS (mg/L)	30	45	22	
TSS (lbs/D)	38	57	13.3	
TSS (% removal)			88.4	
Fecal coliform (#/100 mL)	200	400		2,4
pH (S.U.)	6.0-9.0			6.2,6.9,7.0
Flow (MGD)			0.073	

Results of metal analysis on digested sludge from the plant are given in Table 6. Metals found in the sludge were within ranges found at other activated sludge plants during previous Class II inspections in Washington State (Hallinan, 1988).

Laboratory Review

BOD_5, TSS, and fecal coliform tests for the Kingston WTP are run at the Central Kitsap WTP, while pH tests are performed at the Kingston WTP. Both labs were clean and well-organized. A laboratory review sheet is included in the appendix of this report. Comments to keep lab procedures in conformance with standard methods include:

> BOD_5 dilution water should not be aged without nitrification inhibitor. Dilution water with nitrification inhibitor can be aged for a week before use (APHA, 1985, p. 528, #5b).

A comparison of Ecology and WTP laboratory results is given in Table 7. There was some disagreement between the laboratory results. Influent BOD_5 measured by the Central Kitsap WTP was 70 to 80 mg/L higher than the result obtained by Ecology. The cause of the BOD_5 differences will be further examined at the Class II inspection of the Central Kitsap WTP scheduled for later this year. Ecology's effluent TSS result of 67 mg/L appeared to be too high. Laboratory TSS results of other composite samples ranged from 8 to 22 mg/L. Influent TSS and effluent BOD_5 results for both labs agreed closely.

RECOMMENDATIONS AND CONCLUSIONS

The upsets experienced by the Kingston WTP are likely the result of the high sludge age causing poor sludge settleablility. Reducing the sludge age of the plant is recommended. Since the inspection, the operations supervisor has started a program of wasting more sludge from the plant. The WTP has the design capacity to handle the present organic and solids loading. Other conclusions from the inspection include:

1. Plant effluent parameters (BOD_5, TSS, fecal coliform, and pH) were within permit limits.

2. The plant performed adequately during the inspection, except for periods of upsets. BOD_5 and TSS removal efficiencies were greater than 85 percent.

3. Laboratory procedures were generally good. Minor recommendations are included on the laboratory review sheet in the appendix of this report.

REFERENCES

APHA-AWWA-WPCF, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed.

Ecology, 1985. Criteria for Sewage Works Design, DOE 78-5, Revised October 1985.

Hallinan, P., "Metals Concentrations Found During Ecology Inspections of Municipal Wastewater Treatment Plants," Ecology Memo to J. Bernhardt, April 11, 1988.

Metcalf and Eddy, Inc., Wastewater Engineering: Collection, Treatment, Disposal, McGraw-Hill, Inc., 1972.

URS, Ingman, Chase and Co. Engineers, Kingston Wastewater Treatment System Brochure, 1974.

Table 6. Sludge Metals Data - Kingston, March 1988.

Metal	STP** sample (mg/Kg dry wt)	Data from Previous Inspections*		
		Range (mg/Kg dry wt)	Geometric mean (mg/Kg dry wt)	Number of samples
Cadmium	2.8	<0.1-25	7.6	34
Chromium	23.7	15-300	61.8	34
Copper	389	75-1700	398	34
Lead	26.6	34-600	207	34
Nickle	29.1	<0.1-62	25.5	29
Zinc	555	165-3370	1200	33
Mercury	0.8	-	-	-

* data collected during previous Class II inspections at activated sludge plants (Hallinan, 1988).

** percent solids = .65 estimated from sludge TSS of 6500 mg/L (assuming 1000 mg/l is equivalent to 0.1 % solids).

Table 7 - Comparison of Laboratory Results - Kingston, March 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)	NH3-N (mg/L)
Influent	3/22-23	Comp (10:30-10:30)	Ecology	Ecology				230	190	18
			Kingston	Kingston				307	161	22.3
			Kingston	Ecology				210	170	
			Kingston	Kingston				289	170	
Chlorinated Effluent	3/22	10:00	Ecology	Ecology	0.2	2.0				
			Kingston	Kingston		1.8				
	3/23	9:20	Ecology	Ecology	0.3	1.0	4			
			Kingston	Kingston		1.1	68			
Unchlorinated Effluent	3/22-23	Comp (10:30-10:30)	Ecology	Ecology				18	22	0.99
			Ecology	Kingston				14	8	1.11
			Kingston	Ecology				28	67	
			Ecology	Kingston				21	22	

Laboratory Procedure Review Sheet

Discharger: Kingston WTP

Date: 3/22/88

Discharger representative: Kathy Cuhall

Ecology reviewer: P. Hallinan

Instructions

Questionnaire for use reviewing laboratory procedures. Circled numbers indicate work is needed in that area to bring procedures into compliance with approved techniques. References are sited to help give guidance for making improvements. References sited include:

Ecology = Department of Ecology Laboratory User's Manual, December 8, 1986.

SM = APHA-AWWA-WPCF, Standard Methods for the Examination of Water and Wastewater, 16th ed., 1985.

SSM = WPCF, Simplified Laboratory Procedures for Wastewater Examination, 3rd ed., 1985.

Sample Collection Review

1. Are grab, hand composite, or automatic composite samples collected for influent and effluent BOD and TSS analysis? ✓

2. If automatic compositor, what type of compositor is used? ✓
The compositor should have pre and post purge cycles unless it is a flow through type. Check if you are unfamiliar with the type being used.

3. Are composite samples collected based on time or flow?

4. What is the usual day(s) of sample collection? Tuesday

5. What time does sample collection usually begin? Morning

6. How long does sample collection last? 24 hrs

7. How often are subsamples that make up the composite collected? inf time - 30 min eff flow - after every 1800 gals

8. What volume is each subsample? 200 mls

9. What is the final volume of sample collected? ✓

10. Is the composite cooled during collection? yes

11. To what temperature? checked once a week
The sample should be maintained at approximately 4 degrees C (SM p41, #5b: SSM p2).

12. How is the sample cooled?
Mechanical refrigeration or ice are acceptable. Blue ice or similar products are often inadequate.

13. How often is the temperature measured?
The temperature should be checked at least monthly to assure adequate cooling. weekly

14. Are the sampling locations representative? yes

15. Are any return lines located upstream of the influent sampling location? no
This should be avoided whenever possible.

16. How is the sample mixed prior to withdrawal of a subsample for analysis? good
The sample should be thoroughly mixed.

17. How is the subsample stored prior to analysis? right away
The sample should be refrigerated (4 degrees C) until about 1 hour before analysis, at which time it is allowed to warm to room temperature.

18. What is the cleaning frequency of the collection jugs? every sample
The jugs should be thoroughly rinsed after each sample is complete and occasionally be washed with a non-phospate detergent.

19. How often are the sampler lines cleaned? once a month
Rinsing lines with a chlorine solution every three months or more often where necessary is suggested.

pH Test Review ✓

1. How is the pH measured?
A meter should be used. Use of paper or a colorimetric test is inadequate and those procedures are not listed in Standard Methods (SM p429).

2. How often is the meter calibrated?
The meter should be calibrated every day it is used.

3. What buffers are used for calibration?
Two buffers bracketing the pH of the sample being tested should be used.

If the meter can only be calibrated with one buffer, the buffer closest in pH to the sample should be used. A second buffer, which brackets the pH of the sample should be used as a check. If the meter cannot accurately determine the pH of the second buffer, the meter should be repaired.

BOD Test Review

1. What reference is used for the BOD test?
   Standard Methods or the Ecology handout should be used.

2. How often are BODs run? *once a week*
   The minimum frequency is specified in the permit.

3. How long after sample collection is the test begun? *right away*
   The test should begin within 24 hours of composite sample completion (Ecology Lab Users Manual p42). Starting the test as soon after samples are complete is desirable.

4. Is distilled or deionized water used for preparing dilution water?

5. Is the distilled water made with a copper free still? *yes*
   Copper stills can leave a copper residual in the water which can be toxic to the test (SSM p36).

6. Are any nitrification inhibitors used in the test? *NO* What?
   2-chloro-6(trichloro methyl) pyridine or Hach Nitrification Inhibitor 2533 may be used only if carbonaceous BODs are being determined (SM p 527, #4g: SSM p 37).

7. Are the 4 nutrient buffers of powder pillows used to make dilution water? *yes*
   If the nutrients are used, how much buffer per liter of dilution water are added?
   1 mL per liter should be added (SM p527, #5a: SSM p37).

8. How often is the dilution water prepared? *once a week*
   Dilution water should be made for each set of BODs run.

9. Is the dilution water aged prior to use? *5-6 days*
   Dilution water with nitrification inhibitor can be aged for a week before use (SM p528, #5b).
   Dilution water without inhibitor should not be aged.

10. Have any of the samples been frozen? *No*
    If yes, are they seeded?
    Samples that have been frozen should be seeded (SSM p38).

11. Is the pH of all samples between 6.5 and 7.5? *checked*
    If no, is the sample pH adjusted?
    The sample pH should be adjusted to between 6.5 and 7.5 with 1N NaOH or 1N H_2SO_4 if 6.5 > pH >7.5 if caustic alkalinity or acidity is present (SM p529, #5e1: SSM p37).
    High pH from lagoons is usually not caustic. Place the sample in the dark to warm up, then check the pH to see if adjustment is necessary.

    If the sample pH is adjusted, is the sample seeded?
    The sample should be seeded to assure adequate microbial activity if the pH is adjusted (SM p528, #5d).

12. Have any of the samples been chlorinated or ozonated? Kingston – No
If chlorinated are they checked for chlorine residual and dechlorinated as necesssary?
How are they dechlorinated?
Samples should be dechlorinated with sodium sulfite (SM p529, #5e2: SSM p38), but dechlorination with sodium thiosulfate is common practice. Sodium thiosufate dechlorination is probably acceptable if the chlorine residual is < 1-2 mg/L.
If chlorinated or ozonated, is the sample seeded?
The sample should be seeded if it was disinfected (SM p528, #5d&5e2: SSM p38).

13. Do any samples have a toxic effect on the BOD test? No
Specific modifications are probably necessary (SM p528, #5d: SSM p37).

14. How are DO concentrations measured? YSI Probe
If with a meter, how is the meter calibrated?
Air calibration is adequate. Use of a barometer to determine saturation is desirable, although not manditory. Checks using the Winkler method of samples found to have a low DO are desirable to assure that the meter is accurate over the range of measurements being made.

How frequently is the meter calibrated? twice daily
The meter should be calibrated before use.

15. Is a dilution water blank run? yes
A dilution water blank should always be run for quality assurance (SM p527, #5b: SSM p40, #3).

What is the usual initial DO of the blank?
The DO should be near saturation; 7.8 mg/L @ 4000 ft, 9.0 mg/L @ sea level (SM p528, #5b). The distilled or deionized water used to make the dilution water may be aged in the dark at ~20 degrees C for a week with a cotton plug in the opening prior to use if low DO or excess blank depletion is a problem .

What is the usual 5 day blank depletion? ✓
The depletion should be 0.2 mg/L or less. If the depletion is greater, the cause should be found (SM p527-8, #5b: SSM p41, #6).

16. How many dilutions are made for each sample? 2
At least two dilutions are recommended. The dilutions should be far enough apart to provide a good extended range (SM p530, #5f: SSM p41).

17. Are dilutions made by the liter method or in the bottle?
Either method is acceptable (SM p530, #5f).

18. How many bottles are made at each dilution? 1 each
How many bottles are incubated at each dilution? same
When determining the DO using a meter only one bottle is necessary. The DO is measured, then the bottle is sealed and incubated (SM p530, #5f2).
When determining the DO using the Winkler method two bottles are necessary. The initial DO is found of one bottle and the other bottle is sealed and incubated (Ibid.).

19. Is the initial DO of each dilution measured? yes
What is the typical initial DO?
The initial DO of each dilution should be measured. It should approximate saturation (see #14).

20. What is considered the minimum acceptable DO depletion after 5 days? ✓
What is the minimum DO that should be remaining after 5 days? ✓
The depletion should be at least 2.0 mg/L and at least 1.0 mg/L should be left after 5 days (SM p531, #6: SSM p41).

21. Are any samples seeded? Kingston - no
Which?
What is the seed source?
Primary effluent or settled raw wastewater is the preferred seed. Secondary treated sources can be used for inhibited tests (SM p528, #5d: SSM p41).

How much seed is added to each sample? —
Adequate seed should be used to cause a BOD uptake of 0.6 to 1.0 mg/L due to seed in the sample (SM p529, #5d).

How is the BOD of the seed determined? —
Dilutions should be set up to allow the BOD of the seed to be determined just as the BOD of a sample is determined. This is called the seed control (SM p529, #5d: SSM p41).

(22.) What is the incubator temperature? ✓
The incubator should be kept at 20 +/- 1 degree C (SM p531, #5i: SSM p40, #3).

How is incubator temperature monitored? in air
A thermometer in a water bath should be kept in the incubator on the same shelf as the BODs are incubated.

How frequently is the temperature checked? every day
The temperature should be checked daily during the test. A temperature log on the incubator door is recommended.

How often must the incubator temperature be adjusted? not often
Adjustment should be infrequent. If frequent adjustments (every 2 weeks or more often) are required the incubator should be repaired.

Is the incubator dark during the test period? yes
Assure the switch that turns off the interior light is functioning.

23. Are water seals maintained on the bottles during incubation? ✓
Water seals should be maintained to prevent leakage of air during the incubation period (SM p531, #5i: SSM p40, #4).

24. Is the method of calculation correct? ✓
Check to assure that no correction is made for any DO depletion in the blank and that the seed correction is made using seed control data.

Standard Method calculations are (SM p531, #6):

for unseeded samples;

$$BOD\ (mg/L) = \frac{D1 - D2}{P}$$

for seeded samples;

$$BOD\ (mg/L) = \frac{(D1 - D2) - (B1 - B2)f}{P}$$

Where: D1 = DO of the diluted sample before incubation (mg/L)
D2 = DO of diluted sample after incubation period (mg/L)
P = decimal volumetric fraction of sample used
B1 = DO of seed control before incubation (mg/L)
B2 = DO of seed control after incubation (mg/L)

$$f = \frac{\text{amount of seed in bottle D1 (mL)}}{\text{amount of seed in bottle B1 (mL)}}$$

Total Suspended Solids Test Review

Preparation

1. What reference is used for the TSS test? Standard Methods

2. What type of filter paper is used?
   Std. Mthds. approved papers are: Whatman 934AH (Reeve Angel), Gelman A/E, and Millipore AP-40 (SM p95,footnote: SSM p23)

3. What is the drying oven temperature? ✓
   The temperature should be 103-105 degrees C (SM p96, #3a: SSM p23).

4. Are any volatile suspended solids tests run? yes
   If yes--What is the muffle furnance temperature?
   The temperature should be 550+/- 50 degrees C (SM p98, #3: SSM p23).

5. What type of filtering apparatus is used?
   Gooch crucibles or a membrane filter apparatus should be used (SM p95, #2b: SSM p23).

(6.) How are the filters pre-washed prior to use? once
   The filters should be rinsed 3 times with distilled water (SM p23, #2: SSM p23, #2).

   Are the rough or smooth sides of the filters up? ✓
   The rough side should be up (SM p96, #3a: SSM p23, #1)

   How long are the filters dried? ✓
   The filters should be dried for at least one hour in the oven. An additional 20 minutes of drying in the furnance is required if volatile solids are to be tested (Ibid).

   How are the filters stored prior to use?
   The filters should be stored in a dessicator (Ibid).

7. How is the effectiveness of the dessicant checked? ✓
   All or a portion of the dessicant should have an indicator to assure effectiveness.

Test Procedure

8. In what is the test volume of sample measured? ~~graduated~~ ✓ ✓
   The sample should be measured with a wide tipped pipette or a graduated cylinder.

9. Is the filter seated with distilled water? ✓
   The filter should be seated with distilled water prior to the test to avoid leakage along the filter sides (SM p97, #3c).

10. Is the entire measured volume always filtered? ✓
The entire volume should always be filtered to allow the measuring vessel to be properly rinsed (SM p97, #3c: SSM p24, #4).

11. What are the average and minimum volumes filtered?

	Volume	
	Minimum	Average
Influent		~ 50 mls
Effluent		

12. How long does it take to filter the samples?

	Time
Influent	
Effluent	right away

13. How long is filtering attempted before deciding that a filter is clogged? —
Prolonged filtering can cause high results due to dissolved solids being caught in the filter (SM p96, #1b). We usually advise a five minute filtering maximum.

14. What do you do when a filter becomes clogged? —
The filter should be discarded and a smaller volume of sample should be used with a new filter.

15. How are the filter funnel and measuring device rinsed onto the filter following sample addition? ✓
Rinse 3x's with approximately 10 mLs of distilled water each time (? ?).

16. How long is the sample dried?
The sample should be dried at least one hour for the TSS test and 20 minutes for the volatile test (SM p97, #3c; p98, #3: SSM p24, #4). Excessive drying times (such as overnight) should be avoided.

17. ✓Is the filter thoroughly cooled in a dessicator prior to weighing?
The filter must be cooled to avoid drafts due to thermal differences when weighing (SM p97, #3c: SSM p97 #3c).

18. How frequently is the drying cycle repeated to assure constant filter weight has ben reached (weight loss <0.5 mg or 4%, whichever is less: SM p97, #3c)?
We recommend that this be done at least once every 2 months. once a week

19. Do calculations appear reasonable? ✓
Standard Methods calculation (SM p97, #3c).

$$\text{mg/L TSS} = \frac{(A - B) \times 1000}{\text{sample volume (mL)}}$$

where: A= weight of filter + dried residue (mg)
B= weight of filter (mg)

Fecal Coliform Test Review

1. Is the Membrane Filtration (MF) or Most Probable Number (MPN) technique used?
   This review is for the MF technique.

2. Are sterile techniques used? ✓

3. How is equipment sterilizated?
   Items should be either purchased sterilized or be sterilized. Steam sterilization, 121 degrees C for 15 to 30 minutes (15 psi); dry heat, 1-2 hours at 170 degrees C; or ultraviolet light for 2-3 minutes can be used. See Standard Methods for instruclions for specific items (SSM p67-68).

4. How is sterilization preserved prior to item use? ✓
   Wrapping the items in kraft paper or foil before they are sterilized protects them from contamination (Ibid.).

5. How are the following items sterilized?

	Purchased Sterile	Sterilized at Plant
Collection bottles	✓	
Phosphate buffer	✓	
Media	✓	
Media pads	✓	
Petri dishes	✓	
Filter apparatus		
Filters		
Pipettes		
Measuring cylinder		
Used petri dishes		

6. How are samples dechlorinated at the time of collection? ✓
   Sodium thiosulfate (1 mL of 1% solution per 120 mLs (4 ounces) of sample to be collected) should be added to the collection bottle prior to sterilization (SM p856, #2: SSM p68, sampling).

7. Is phosphate buffer made specifically for this test? ✓
   Use phosphate buffer made specifically for this test. The phosphate buffer for the BOD test should not be used for the coliform test (SM p855, #12: SSM p66).

8. What kind of media is used? ✓
   M-FC media should be used (SM p896, SSM p66).

9. Is the media mixed or purchased in ampoules?
   Ampoules are less expensive and more convient for under 50 tests per day (SSM p65, bottom).

10. How is the media stored? ✓
    The media should be refrigerated (SM p897, #1a: SSM p66, #5).

11. How long is the media stored? ✓
Mixed media should be stored no longer than 96 hours (SM p897, #1a: SSM p66, #5). Ampoules will usually keep from 3-6 months -- read ampoule directions for specific instructions.

12. Is the work bench disinfected before and after testing? ✓
This is a necessary sanitazation procedure (SM p831, #1f).

13. Are forceps dipped in alcohol and flamed prior to use? ✓
Dipping in alcohol and flaming are necessary to sterilize the forceps (SM p889, #1: SSM p73, #4).

14. Is sample bottle thoroughly shaken before the test volume ✓ is removed? The sample should be mixed thoroughly (SSM p73, #5).

15. Are special procedures followed when less than 20 mLs of sample is to be filtered? —
10-30 mLs of sterile phosphate buffer should be put on the filter. The sample should be put into the buffer water and swirled, then the vacuum should be turned on. More even organism distribution is attained using this technique (SM p890, #5a: SSM P73, #5).

16. Are special procedures followed when less than 1 mL of sample is to be filtered? —
Sample dilution is necessary prior to filtration when <1 mL is to be tested (SM p864, #2c: SSM p69).

17. Is the filter apparatus rinsed with phosphate buffer after sample filtration? ✓
Three 20-30 mL rinses of the filter apparatus are recommended (SM p891, #5b: SSM p75, #7).

18. How soon after sample filtration is incubation begun? right away
Incubation should begin within 20-30 minutes (SM p897, #2d: SSM p77, #10 note).

19. What is the incubation temperature? ✓
44.5 +/- 0.2 degrees C (SM p897, #2d: SSM p75, #9).

20. How long are the filters incubated? ✓
24 +/- 2 hours (Ibid.).

21. How soon after incubation is complete are the plate counts made? ✓
The counts should be made within 20 minutes after incubation is complete to avoid colony color fading (SSM p77, FC).

22. What color colonies are counted?
The fecal coliform colonies vary from light to ✓ dark blue (SM p897, #2e: SSM p78).

23. What magnification is used for counting? ✓
10-15 power magnification is recommended (SM p898, #2e: SSM p78).

24. How many colonies blue colonies are usually counted on a plate?
Valid plate counts are between 20 and 60 colonies (SM p897, #2a: SSM p78).

25. How many total colonies are usually on a plate? < 50
The plate should have <200 total colonies to avoid inhabition due to crowding (SM p893, #6a: SSM p63, top).

26. When calculating results, how are plates with <20 or >60 colonies considered when plates exist with between 20 and 60 colonies?
In this case the plates with <20 or >60 colonies should not be used for calculations (SM p898, #3: SSM p78, C&R).

27. When calculating results how are results expressed if all plates have < 20 or > 60 colonies?
Results should be identified as estimated.
The exception is when water quality is good and <20 colonies grow. In this case the lower limit can be ignored (SM p893, #6a: SSM p78, C&R).

28. How are results calculated?
Standard Methods procedure is (SM p893, #6a: SSM p79):

$$\text{Fecal coliforms/100 mL} = \frac{\text{\# of fecal coliform colonies counted}}{\text{sample size (mL)}} \times 100$$