STATE OF WASHINGTON
Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, Olympia, Washington 98504

MEMORANDUM
April 16, 1980

Publication No. 80-e18

WA-07-1160

To: Dave Wright

From: Bill Yake

Subject: Monroe Class II Inspection

Introduction

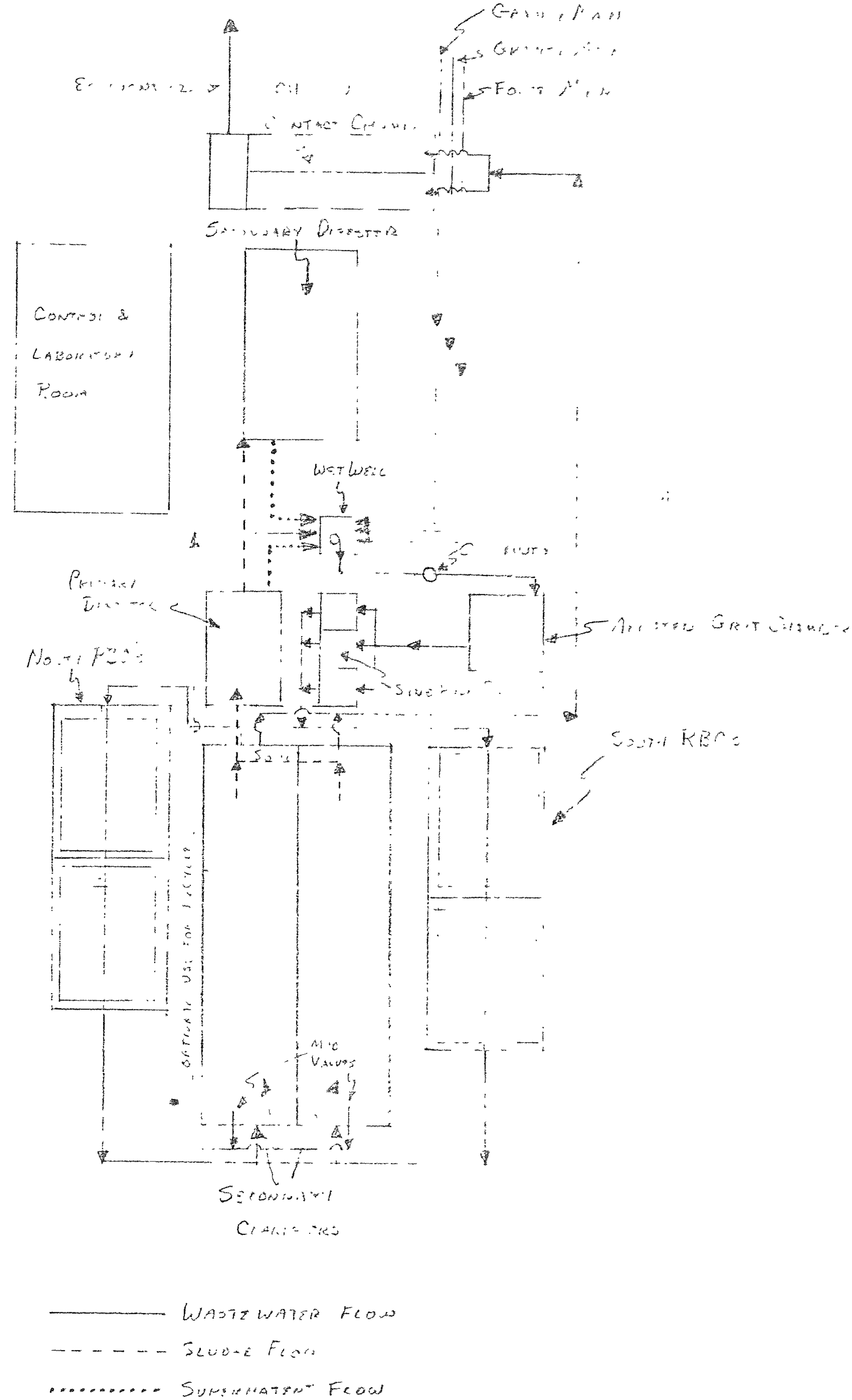
A Class II compliance monitoring inspection was conducted at the Monroe Wastewater Treatment Plant (STP) on February 26-27, 1980. Representatives of the Department of Ecology (DOE) included Dave Wright (Northwest Regional Office), Skip Harlan (Municipal Section), and Bill Yake and Dale Clark (Water and Wastewater Monitoring Section). The town was represented by Mel Morse (operator) and Rick Esvelt (consultant, KCM).

The Monroe treatment plant was upgraded to secondary treatment and began operation in February of 1977. The flow scheme is outlined in Figure 1. Briefly, two gravity and one force main drain to a wet well with level-controlled, constant feed pumps. The waste stream is comminuted and fed to an aerated grit chamber, then to side hill screens. Effluent from the screens is split to two parallel sets of rotating biological contactors (RBC's), each set consisting of two identical in-series shafts. Each shaft bears two stages. RBC effluent is routed to two rectangular secondary clarifiers. Under typical low flow conditions, only one clarifier is used. Clarified flow is chlorinated and routed to two contact chambers. Head measuring devices coupled with contracted weirs at the effluent end of the contact chambers, calculate and record plant flow.

The plant discharges to the Skykomish River (waterway setment 03-07-11). The Five-Year Strategy defines this segment as one not meeting the state water quality goals for fecal coliforms and turbidity due primarily to non-point sources and it is unknown if the goals can be met with the application of BMP. The Monroe discharge probably bears little responsibility for the failure of the segment to attain water quality goals.

The Monroe plant has generally failed to meet its permit requirements for organic (BOD) removal. This failure, coupled with the proposed expansion of the Monroe Reformatory which discharges to the Monroe plant, were the primary reasons for conducting a Class II inspection at this plant.

Fig. 1. [illegible] Wastewater Treatment Plant



The failure of the plant to perform as anticipated has been investigated by the consultants (KCM) and the RBC vendor (Autotrol). Based on this information and discussions with the operator, regional personnel and the consultant, it appears that the most likely reasons for failure fall into two general categories: (1) inadequate design; and (2) unusual and unanticipated characteristics of wastewater flow from the Monroe Reformatory. Specific problems or suspected problems are:

1. Inadequate Design

   A. Wet well pumps are fixed-speed, level-controlled, rather than variable-speed. This, coupled with lower than anticipated plant flows, results in alternate periods of surge and quiesence through the plant.

   B. Based on currently acceptable design criteria, the first stage of the RBC's may be organically overloaded. RBC vendors have used "soluble BOD_5" loading in developing their design and performance curves. This is a confusing convention because "soluble BOD_5" data are rarely available and plant effluents must meet total BOD_5 criteria. Nonetheless, as noted in Table 7, the present total BOD_5 loading to the first stage is about 10 lbs. total BOD_5/1000 ft^2 of surface area. The currently recommended BOD loading is 4 lbs. soluble BOD_5/1000 ft^2 or 5 lbs/1000 ft^2 if air is added. Autotrol generally assumes that about 40 percent of influent BOD is soluble, which puts the Monroe plant right at the limit for RBC's without added air. Slugs of high BOD_5 wastes from the reformatory probably result in short-term excessive organic loads.

   C. Inadequate settlable solids removed by side-hill screens which, together with non-ideal flow patterns in the RBC tanks, leads to solids deposition in the RBC's tanks.

   D. The inappropriate use of rectangular, chain-drag secondary clarifiers which do not adequately clarify the final effluent.

   E. The sizing and flow regime in the chlorine contact chambers which, together with the lack of an adequate means of removing settled solids from the chambers, lead to substantial solids deposition.

2. Unusual Reformatory Wastewater Characteristics

   A. Highly concentrated strength wastewater (24-hr. BOD's up to 800 mg/l), which often reaches the Monroe plant in slugs, temporarily overloading and shocking the treatment plant's biomass.

B. The discharge of large amounts (40 garbage cans daily) of garbage sent through reformatory garbage grinders which aggravates the situation described above.

C. The discharge of large quantities of grease which leads to digester upset and foaming and may also impede oxygen transfer to the biomass.

D. The possible slug discharge of caustic or toxic materials which may shock the system. No such materials have yet been isolated, but the operator reports that occasionally BOD tests on reformatory effluent will yield unusually low values, suggesting the possible presence of a toxic material.

Efforts are underway to solve both sets of problems. Solids are being removed from the RBC tanks and a small quantity of diffused air added to keep settlable solids in suspension. Plans are being formulated to remove grease and garbage from the reformatory waste stream and send the remaining wastewater to aerated holding ponds. Pond discharge will be bled to the Monroe plant during acceptable times at acceptable flows.

The removal of the concrete retaining walls between the first and second stages has been considered. This would allow the present first and second stages to be combined into a single first stage and decrease the first stage loading. This option has tentatively been rejected as too costly. It may, however, be necessary to ultimately increase the first stage surface area if the plant is to operate adequately.

Findings

During the sampling period, the plant was exceeding monthly average limitations for BOD_5; compliance with suspended solids limitations was marginal (see Table 1).

Table 1. BOD and Suspended Solids Compliance

	DOE Samples		Monroe Samples		Monthly Avg. NPDES
	DOE Lab.	Monroe Lab.	DOE Lab.	Monroe Lab.	Limitations
BOD_5 (mg/l)	34	36	34	40	30
(lbs/day)	>270	>290	>280	>330	250
(% Removal)	66%	46%	66%	67%	(85%)
TSS (mg/l)	29	25	33	31	30
(lbs/day)	>230	>200	>270	>250	250
(% Removal)	84%	81%	82%	79%	(85%)

High storm flows may have made this sampling period somewhat atypical. Flow through the plant was in excess of 950,000 gpd, while average dry weather flow is about 400,000 gpd. However, the operator put the second secondary clarifier into operation at the beginning of the sampling period, so it's unlikely that any of the unit processes were operating above design flows (i.e., the plant should not have been hydraulically overloaded). Accurate effluent flows could not be determined because the contracted weirs used for flow measuring were submerged during a portion of the sampling period. The present flow measuring capacity of the weir configuration is 1.5 MGD; this is clearly inadequate. Figure 2 is the strip chart for the sampling period and illustrates this. It is suggested that the contracted weirs now in place be replaced with another size or type of weir. Because the plant experiences such a wide range of flows, V-notch weirs might be a good choice.

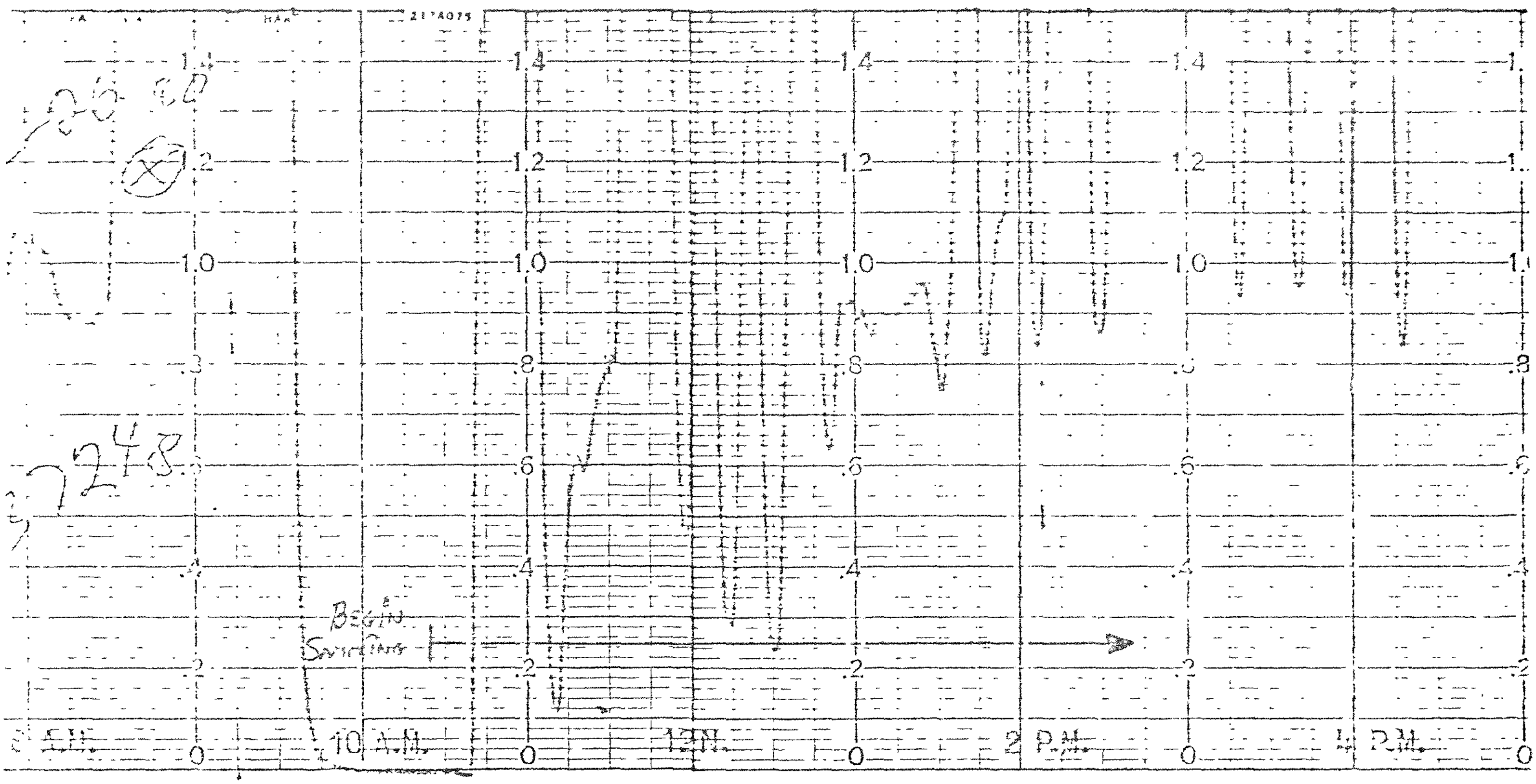
The plant was meeting limitations for pH and fecal coliforms.

A series of tests were conducted to address some of the suspected causes for the plant's failure to achieve adequate treatment (see discussion). These are addressed briefly below:

1. Dissolved oxygen concentrations were obtained at various points in the treatment flow. The results are given in Table 2. There is a slight apparent increase in dissolved oxygen concentrations through the north bank of RBC's, probably due to the addition of air to this side and the recent removal of settled organic solids. As noted in the introduction, air was added primarily to prevent solids from settling in the RBC tanks. Dissolved oxygen concentrations on both sides were more than adequate during the inspection, but this was primarily due to the large storm flows entering the plant.

2. Influent, effluent, and sludge samples were analyzed for six trace metals. The results are given in Table 3. An earlier report by Autotrol referred to "extraordinary amounts of chromium and nickel" present in the biomass. The concentrations found during this inspection were generally on the low side of normal and there is no indication of trace metal toxicity.

3. Plant influent, RBC influent, and final effluent grabs were made for grease. The results are given in Table 4. The plant has experienced digester foaming problems due to excessive grease and it is assumed that this grease originates at the reformatory which has not historically done a good job of removing grease from its waste stream. Although three grab samples are certainly not adequate to define grease problems at the plant, it appears that influent values are substantial


212A075
1.4
1.2
1.0
.8
.6
.4
.2
0
10 A.M.
12N.
2 P.M.
4 P.M.
BEGIN SWITCHING

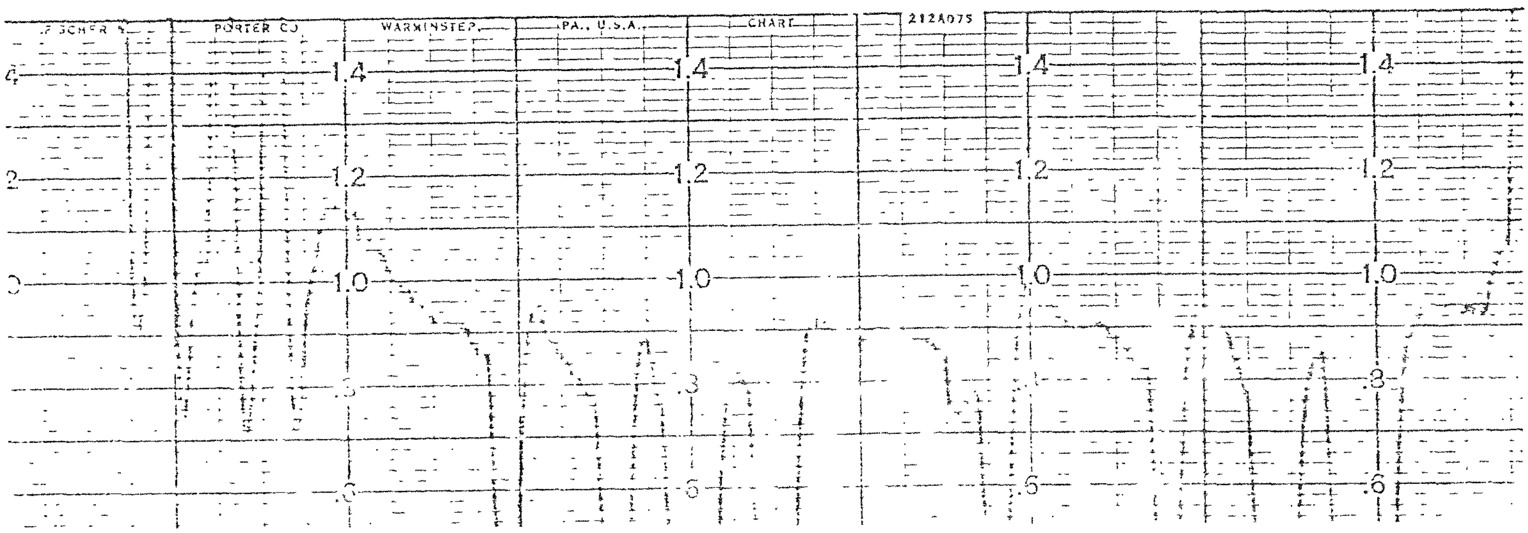

FISCHER & PORTER CO
WARMINSTER
PA., U.S.A.
CHART
212A075
1.4
1.2
1.0
.8
.6

Table 2. Dissolved Oxygen Concentrations in Plant

Location	2/26/80[1] Dissolved Oxygen Concentration (mg/l)		2/27/80[2] Dissolved Oxygen Concentration (mg/l)	
Influent	6.8		7.9	
	North Bank*	South Bank	North Bank*	South Bank
RBC Influent	7.8	7.3	8.4	7.9
Between Stages	6.2	5.0	8.0	6.4
RBC Effluent	4.8	3.8	5.2	3.4
Final Effluent	6.7		5.1	

*North Bank has added air to first stage.

[1] Samples taken between 1105 and 1220.

[2] Samples taken between 0910 and 1010.

Table 3. Metals Results

	Influent* (mg/l)	Effluent* (mg/l)	Sludge mg/kg dry wt.
Cadmium	.01	<.01	6.8
Chromium	<.01	<.01	33.8
Copper	.07	.03	557
Nickel	<.05	<.05	32
Lead	<.1	<.1	459
Zinc	.104	.060	1135

*Composite samples.

Table 4. Grease Results (Grab)

	Influent	North RBC Influent	Chlorinated Effluent
Grease (mg/l)	20	89	7

and that much of the grease is removed by the process. Although we are not aware of supporting literature, it seems feasible that excessive grease may be coating the biomass and inhibiting the flux of oxygen and/or soluble BOD to the microorganisms, thus reducing plant efficiency.

4. Samples of the biomass were observed on-site, under a microscope. Scrapings were also returned to DOE laboratories for possible identification. On-site observation revealed rotifers and nematodes, as well as flocced particles in a filimentous matrix. The filimentous organisms dominated. A report detailing the laboratory's identification of the filimentous growth is attached. Although certain identification of the organisms was not possible, it appears that some of the organisms could have been *Beggiatoa*, a sulfur bacteria. The community represented in the biomass is an unusual one. The presence of rotifers indicates a well aerated, relatively stable growth, while the presence of filimentous growth is usually indicative of organic overload. It is possible that the radical changes in influent concentrations allow the growth of both types of organisms.

5. The results of all analyses performed on the composite samples are presented in Tables 5 and 6. From Table 5 it is apparent that the side-hill screens are not very effective in removing either BOD or suspended solids, which places additional strain on the RBC's. The results of sample splits on reformatory effluent (Table 6) also give some idea of the strength of this waste.

6. Table 7 summarizes design and present loading figures for the plant. Based on average daily loads, the plant seems to be near presently accepted design limits for organic loading.

Summary/Conclusions and Recommendations

There are numerous factors which appear to be contributing to the inefficiency of the Monroe treatment plant. These problems fall primarily into two categories: inadequate plant design and unusual wastewater characteristics which are associated with the reformatory.

Effluent quality should improve as efforts to resolve the current problems are completed. These steps include removal of solids from the RBC tanks followed by application of diffused air; removal of grease and garbage from the reformatory discharge; pretreatment of reformatory wastewaters in stabilization ponds, and controlled feed of the pretreated effluent to the Monroe STP. The effect of these efforts on

Table 5. Results from DOE Composite Samplers

The following table is a comparison of laboratory results from 24-hour composite(s) together with NPDES permit effluent limitations. Additional results pertinent to this inspection have also been included.

	DOE Results				Monroe Results		NPDES Permit (Monthly average)
	Influent	Primary Effluent	RBC Effluent	Final Effluent	Influent	Primary Effluent	
BOD_5 mg/l lbs/day	100 >800	120 >960	73 >580	34 >270	67 >530	36 >290	30 250
Carb. BOD_5 (mg/l) lbs/day				27 >215			
TSS mg/l lbs/day	180 >1400	150 >1200	140 >1100	29 >230	150 >1200	25 >200	30 250
Total Plant Flow MGD				>.956		>.956	1.4
COD (mg/l)	170	140	170	80			
pH (S.U.)	6.9	7.2	7.0	6.4			6.5-8.5
Fecal Coliform (#/100 ml)				7 15			200
Tot. Chl. Res. (mg/l)				0.4* 0.9*			
Temp. (°C)	12*	12*	12*	12*			
Total Solids (mg/l)	290	280	250	160			
Tot. Non-Vol S. (mg/l)	96	130	120	97			
TSS (mg/l)	180	150	140	29			
TNVSS (mg/l)	33	49	32	8			
NH_3-N (mg/l)	9.0	9.2	7.1	6.9			
NO_2-N (mg/l)	<.2	<.2	.1	<.1			
NO_3-N (mg/l)	.6	.8	.6	.5			
O-PO_4-P (mg/l)	1.2	2.0	1.5	1.5			
T-PO_4-P (mg/l)	2.5	3.8	3.2	2.5			
Conductivity (µmhos/cm)	162* 220** 205	169* 220** 218	145* 220** 194	143* 160** 214			
Turb (NTU)	44	62	46	32			

*Field Analysis - grab "<" is "less than" and ">" is "greater than"
**Field Analysis - Composite

Table 6. Results from Monroe Samples

	DOE Laboratory Results			Monroe Laboratory Results			NPDES Permit (Monthly average)
	Monroe Reformatory	Influent	Final Effluent	Monroe Reformatory	Influent	Final Effluent	
BOD_5 (mg/l)	410	100	34	338	122	40	30
lbs/day		>810	>280		>944	>330	250
TSS (mg/l)	380	180	33	260	150	31	30
lbs/day		>1470	>270		>1200	>250	250
Flow (MGD)			>.977			>.977	1.4
Carb. BOD_5 (mg/l)			26				
(lbs/day)							
COD (mg/l)	710	240	80				6.5 - 8.5
pH (S.U.)	7.0	6.7	7.0				
Total Solids (mg/l)	760	300	150				
TNVS (mg/l)	210	120	83				
TSS (mg/l)	380	180	33				
TNVSS (mg/l)	63	24	9				
NH_3-N (mg/l)	---	11.4	7.8				
NO_2-N (mg/l)	---	<.2	<.1				
NO_3-N (mg/l)	---	<.2	.5				
T-PO_4-P (mg/l)	---	1.4	1.7				
O-PO_4-P (mg/l)	---	3.5	2.6				
Conductivity (μmhos/cm)	413	211	190				
Turbidity (NTU)	260	50	44				

Table 7. Design and Operating Parameters

	Design Winter	Design Summer	Present Ave. Dry Weather	During Inspection	Recommended Design
Average flow (MGD)	1.40	0.90	0.40	1.1	
BOD loading (lbs/day)	1,580	1,811	950	1,000	
BOD conc (mg/l)	133	220	285	110	
RBC surface (ft^2)	384,000		384,000	384,000	
1st stage RBC surface (ft^2)	96,000		96,000	96,000	
1st stage hydraulic loading (gal/day/ft^2)	14.6	9.38	4.17	11.5	
1st stage organic loading (lbs BOD_5/day/1000 ft^2)	16.5*	18.9*	9.9*	10.4*	<5.0†
Overall hydraulic loading (gal/day/ft^2)	3.65	2.34	1.04	2.86	
Overall organic loading (lb BOD/day/1000 ft^2)	4.1*	4.7*	2.5*	2.6*	2.5 - 3.5
Tank volume (ft^3)	7,725		7,725	7,725	
Design detention time (minutes)	59	92	208	76	
Estimated volume of settled solids (ft^3)	450		450	340	
Estimated volume of shaft and growth (ft^3)	1,340		1,340	1,340	
Operating volume (ft^3)	5,935		5,935	6,045	
Operating detention time (minutes)	46	71	160	59	>55 minutes

*Lbs <u>total</u> BOD_5/day/1000 ft^2

†Lbs <u>soluble</u> BOD_5/day/1000 ft^2

plant performance should be tracked closely. At present, the removal of grease from the effluent is considered to be a temporary measure, taken prior to pre-treatment of the reformatory wastewater. If grease removal appears to have a beneficial effect on treatment efficiency at the Monroe facility, permanent grease removal should be strongly considered.

Operational flexibility at the plant is limited; however, it is possible that recirculation around the RBC's may improve effluent quality during the interim period prior to full implementation of the pre-treatment and flow equalization at the reformatory. Recirculation could have two positive effects: (1) the increased hydraulic load to the influent wet well would keep the pumps operating and minimize the settling associated with the stilling of flow in the RBC tanks when the pumps are off; and (2) the recirculation of effluent should serve to even out some of the influent BOD peaks, moving these organic slugs past the media more quickly so that absorbtion and metabolism of the waste is spread more evenly over all stages. This recirculation can be carried out by manual adjustment of the mud valves at the secondary clarifiers. As a first cut, one might aim for a retention time of 55 minutes in the RBC tanks. This would require a total flow to the wet well of 1.1 to 1.2 MGD which could be obtained by adjusting the mud valves and monitoring the timing on the pumps.

As mentioned previously, the contracted effluent weirs should be replaced with weirs (possibly V-notch) capable of monitoring the full range of flows experienced at the plant.

The plant is understaffed. A single operator cannot maintain and operate this plant adequately. Serious maintenance problems are developing, primarily due to corrosion. The enclosed nature of the plant makes corrosion a serious problem.

Additional recommendations are included in the Laboratory Procedures and Techniques section of this memorandum.

Review of Laboratory Procedures and Techniques

Laboratory procedures were reviewed with Mel Morse. Although TSS and BOD_5 results compared well for the lower values, there were discrepancies with the more concentrated samples. Ways in which sampling and analytical methods should be improved are noted below:

Sampling

(1) The influent sampling location (wet well) is subjected to both supernatant return and recycle (if in operation). These streams can be shut off during sampling, but this may upset

plant operation. It is suggested that influent values be flagged if affected by either of these streams and explained on the bottom of the DMR's.

(2) The effluent sample location is six feet below the water surface in a dead portion of the contact chambers. It is suggested that when the water level is drawn down for cleaning, this sample hose be moved closer to the effluent weirs.

(3) Fecal coliform samples are taken in an unsterilized bucket. This should be changed and is addressed under fecal coliform procedures;

<u>BOD_5</u>

(1) An old (1974) procedures manual is being used. Mel was given a current DOE BOD manual. This should be used in the future.

(2) BOD samples should be tested for pH. If pH is outside the 6.5 to 8.5 range, samples should be adjusted to neutrality.

(3) Five-day BOD's should be performed on the dilution water blanks. If five-day drops are >0.3 mg/l, the BOD results should be flagged and steps taken to correct dilution water contamination.

(4) Zero-day dissolved oxygen concentrations above the saturation value (9.2 mg/l) have been reported. This may be due to inaccuracies in analyzing for D.O. (See #5). If these sample dilutions are actually supersaturated, this can lead to overestimates of BOD concentrations. To avoid this, samples should be brought to room temperature prior to making sample dilutions. Dilution water should also be allowed to equilibrate after aerating.

(5) D.O. titrant (thio) should be standardized weekly using the method specified in the manual.

(6) A thermometer set in a water bath and placed in the incubator on the same shelf as the sample dilutions should be used to control incubator setting and temperature. A log of settings and temperatures should be maintained.

(7) The BOD of the seed material should be obtained (run sample dilution of seed) and incorporated into the calculations as per the manual.

Suspended Solids

(1) Update procedures by using 14th edition of *Standard Methods*.

(2) After present supply of Whatman 40 filters is exhausted, reorder and use approved filters (Reeve Angel 934AH or Gelman A/E).

(3) Pre-wash filters prior to drying, dessicating, and pre-weighing. Store in dessicator prior to use.

Fecal Coliform

(1) Samples should be collected in a sterile bottle. Sodium thiosulfate should be added to the bottle prior to sterilization to dechlorinate the sample when it is collected.

(2) Temperature control in the open incubator was erratic. Mel has since covered the incubator and has better control; however, a more accurate thermometer is needed to measure the required 44.5± 0.2°C.

BY:cp

Attachments

Class II Field Review and Sample Collection

24-hour Composite Sampler Installations

Sampler	Date and Time Installed	Location
1. Influent	2/28/80 - 1015	Influent to grit chamber
sample aliquot: 250 ml/30 min		
2. Primary Effluent	2/26/80 - 1025	Through wall port to side hill screen effluent
sample aliquot: 250 ml/30 min		
3. RBC Effluent	2/26/80 - 1110	In drain from north RBC bank
sample aliquot: 250 ml/30 min		
4. Final Effluent	2/26/80 - 1130	In collection channel below contact chamber weirs
sample aliquot: 250 ml/30 min		
5.		
sample aliquot:		

Field Data

Parameter(s)	Date and Time	Sample Location
Cond., Temp.	2/26/80 - 1015	Influent
Cond., Temp.	2/26/80 - 1045	Primary Effluent
Cond., Temp.	2/26/80 - 1110	RBC Effluent
Cond., Temp.	2/26/80 - 1130	Final Effluent
D.O.	See Table No.	See Table No.
Cond.	Composite	Influent
Cond.	Composite	Primary Effluent
Cond.	Composite	RBC Effluent
Cond.	Composite	Final Effluent
Total Chlorine Residual	same as fecal coliform	Final Effluent

Grab Samples

Lab Analysis	Date and Time	Sample Location
Oils and Grease	2/26/80 - 1445	Influent
Oils and Grease	2/26/80 - 1150	RBC Effluent
Oils and Grease	2/26/80 - 1150	Final Effluent
Metals (sludge)	2/26/80 - 1230	Loading spout to truck
Fecal Coliform	2/27/80 - 0840	Final Effluent

STATE OF WASHINGTON

Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY

7272 Cleanwater Lane, Olympia, Washington 98504 206/753-2353

MEMORANDUM

TO: Bill Yake, Water and Wastewater Monitoring Section

FROM: Nancy Jensen, Microbiologist, Olympia Environmental Laboratory

SUBJECT: Presumptive identification of *Beggiatoa sp.* in white slime from Monroe STP.

DATE: March 13, 1980

Beggiatoa is a colorless filamentous sulfur bacteria containing internal sulfur granules.[1] Bergy's Manual describes *Beggiatoa* as colorless cells in unattached filaments, 1-30 by 4-20 um. Motile by gliding. Gram negative. Cells contain granules of sulfur when grown in the presence of hydrogen sulfide. Marine and fresh water forms known.

On a wet mount preparation, long filaments were seen. Upon gram staining long filamentous gram negative bacteria were seen under oil immersion. These filaments had cell segments and appeared sheathed.

According to the descriptions in Bergy's Manual, in Standard Methods, and those given by Jay Vasconcellos, EPA microbiologist, these filamentous bacteria could be *Beggiatoa*. Cultures of the organisms would be of great value, especially for demonstration of the characteristic gliding motion, but we do not have the facilities for this.

Visual identification is also difficult even for those with experience with *Beggiatoa*. For more definitive identification I would recommend that Jay Vasconcellos the EPA microbiologist look at the Monroe STP white slime since he has had some experience with *Beggiatoa*.

1. *Standard Methods For The Examination of Water and Wastewater*, 14th Edition pp. 998-999 and 1001-1002.

Attachment:1