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DEPARTMENT OF ECOLOGY
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MEMORANDUM
February 25, 1981

To: Harold Porath

From: Will Abercrombie and Mike Blum

Subject: Cashmere Sewage Treatment Plant Class II Inspection

Introduction

A Class II compliance inspection was conducted at the Cashmere sewage treatment plant (STP) on October 14-15, 1980. Department of Ecology (DOE) representatives present during the inspection were Will Abercrombie (Water and Wastewater Monitoring Section) and Mike Blum (Municipal Division). The STP representative present for the inspection was Charles Cruickshank (operator). Personnel assisting in various aspects of the inspection were Sharon Chase (Water and Wastewater Monitoring, DOE), Wes Maier (Roving Operator, DOE), and Jeff Davis (Consulting Engineer, Tree Top, Inc.).

A receiving water study was conducted in conjunction with this inspection by Art Johnson and Shirley Prescott (Water and Wastewater Monitoring Section, DOE). Receiving water study results have been compiled in a separate memorandum to Harold Porath (Central Regional Office, DOE).

Setting

The Cashmere STP is a secondary treatment facility consisting of two aerated and one polishing lagoon operated in series (Figure 1). Two influent pipes enter the first cell, one from the City of Cashmere and one from Tree Top, Inc.

City influent enters a lift station situated approximately one-quarter mile from the three lagoons. A "modified" Parshall flume is located in a manhole just prior to the lift station (Figure 2). The city influent passes through the flume and is then pumped to the first lagoon (Cell I).

Tree Top, Inc. processes fruit into concentrate and is the major industrial contributor to the Cashmere STP. At the time of this inspection, Tree Top was processing 700 tons of fruit per day. Tree Top effluent leaves the processing plant and flows through a manhole containing an unusual flow monitoring device. The flume consists of a pipe

Figure 1

Cashmere S.T.P.

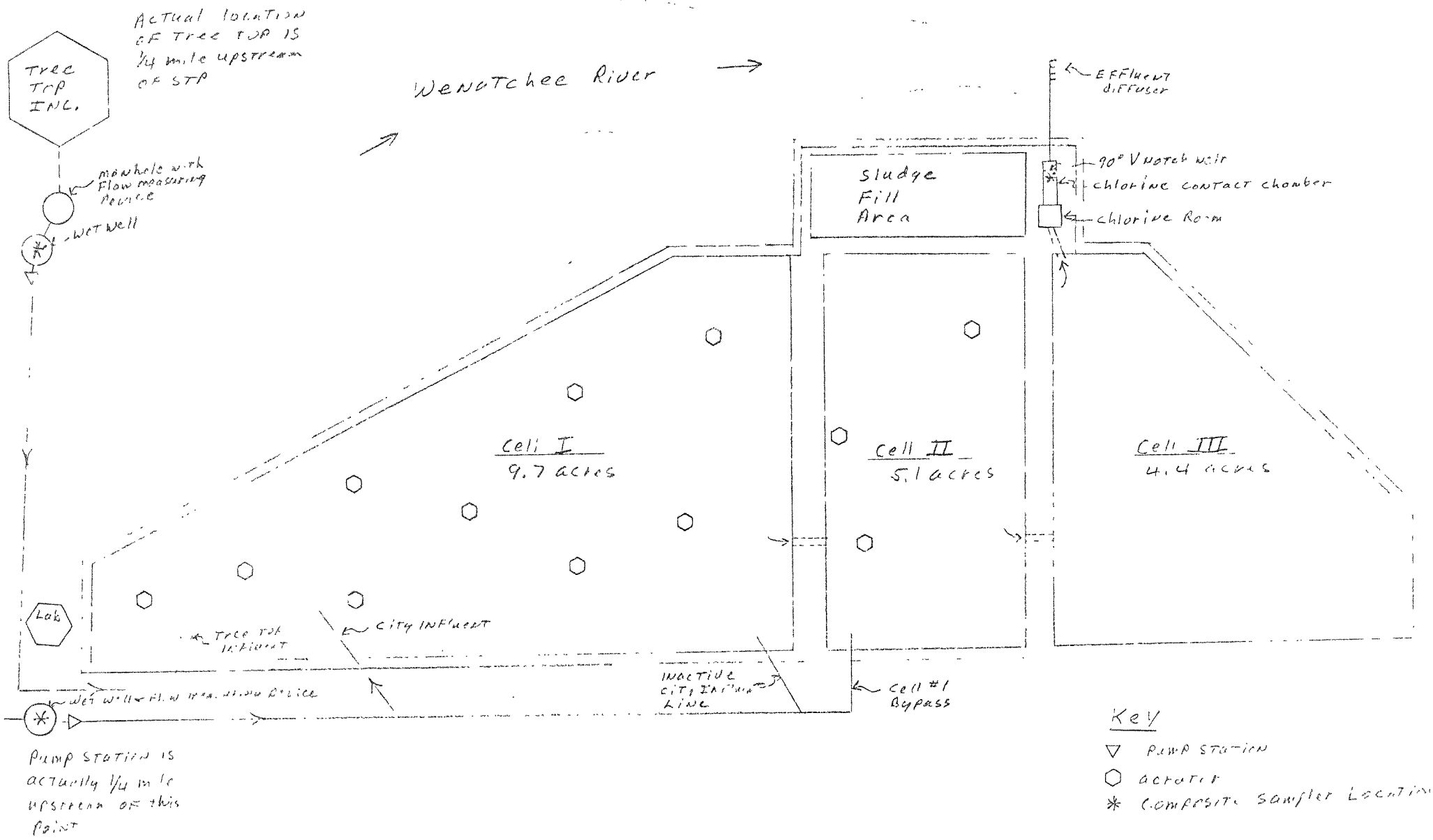
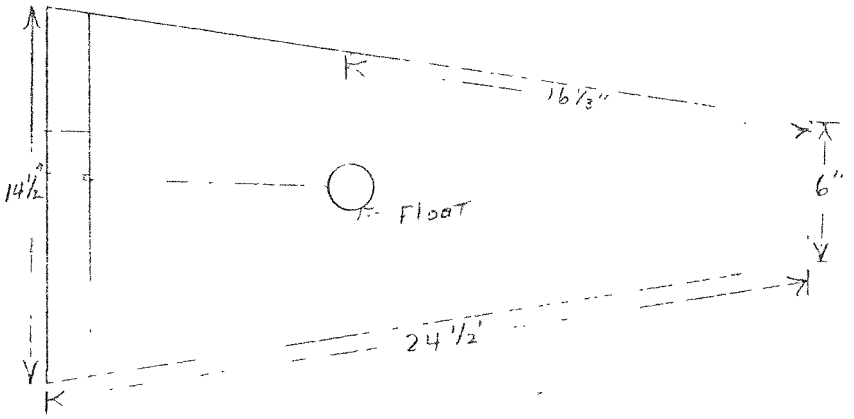
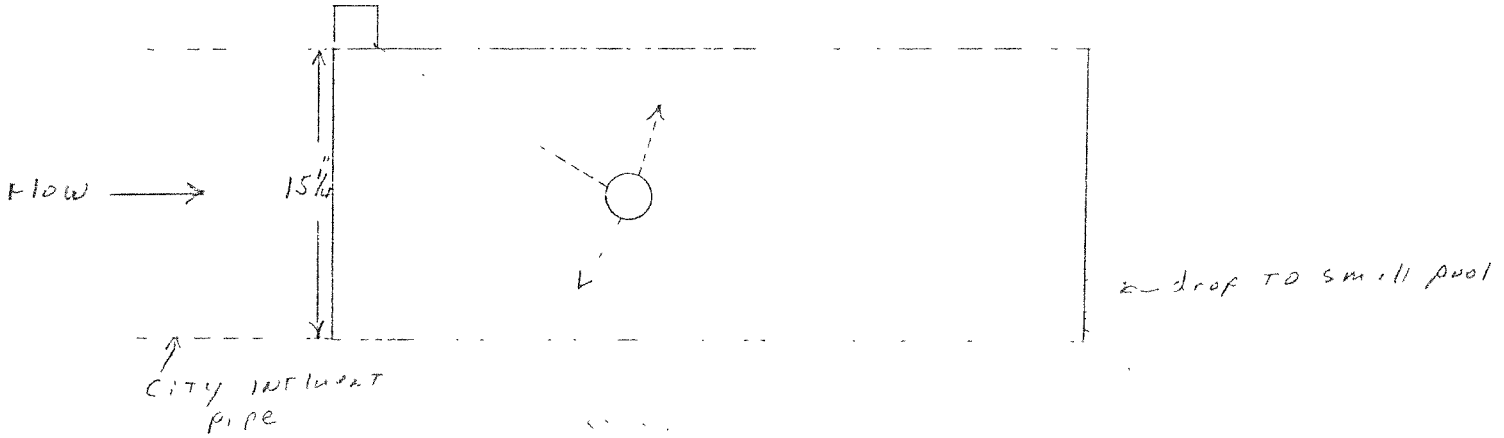


Figure 2

Cashmere S.T.P Flume Design





with the top half removed. The head is measured via a float which rests on the liquid surface. A wet well and a pump station are situated just downstream of the flume. From this point the Tree Top effluent is pumped across the Wenatchee River and into Cell I at the Cashmere STP.

Cell I is the largest of the three cells with 424,277 square feet (9.7 acres) of surface area. Nine 25-horsepower mechanical aerators are somewhat evenly spaced throughout Cell I. Effluent from Cell I flows through a weir to Cell II which has 219,960 square feet (5.1 acres) of surface area. Cell II contains three 25-horsepower mechanical aerators. The effluent from Cell II flows through a weir into Cell III, the smallest of the three cells with 192,414 square feet (4.4 acres) of surface area. This final cell contains no aerators and acts as a polishing pond prior to effluent discharge. The effluent from Cell III flows into a chlorine contact chamber. A 90° V-notch weir is located at the downstream end of the chlorine contact chamber. The final effluent pipe is 210 feet long and has a 10-inch inside diameter and a diffuser at its terminus. The Cashmere STP discharges into the Wenatchee River (Segment No. 21-45-01) at mid-stream.

Inspection Procedures

Table 1 shows the composite and grab sampling scheme used during the Class II inspection. Grab samples were collected and analyzed for field parameters on October 14, 1980.

A 24-hour composite sampler was installed in the city headworks manhole just prior to the lift station. In addition to normal household wastes, the city influent line contains wash water from four apple packing plants.

Tree Top's influent to the Cashmere STP was sampled from a wet well just prior to the pump station located on Tree Top property. The Manning sampler originally installed at this site malfunctioned after taking a few samples. The malfunction was discovered at 1715 hours on October 14, 1980. A new sampler was installed at that time resulting in a 19-1/4 hour composite sample at this site.

A 24-hour composite sampler was installed on the final effluent just prior to the 90° V-notch weir located at the end of the chlorine contact chamber.

The city influent flume was measured and found to be very similar to the dimensions one would expect to find on the approach side of a Parshall flume with a six-inch throat width. The level in the flume is measured with a float which swings in an arc as the flow fluctuates. This type of flow monitoring device creates an unknown amount of error because the float distance from the downstream end of the flume varies as the head fluctuates.

Table 1. Cashmere Class II 24-hour Composite Sampler and Grab Sample Schedule.

Composite Sampler	Sample Interval	Sampling Period	Location	Field Parameters Tested
City Influent	250 ml/30 min.	10-14-80 (1030) to 10-15-80 (1055)	Headworks manhole	pH, Cond., Temp.
Tree Top Influent	250 ml/30 min.	10-14-80* (1715) to 10-15-80 (1230)	Wet well at Tree Top, Inc.	pH, Cond., Temp.
Final Chlorinated Effluent	250 ml/30 min.	10-14-80 (1145) to 10-15-80 (1115)	End of chlorine contact chamber	pH, Cond., Temp.

Grab Sample	Date and Time	Location	Field Parameters Tested
City Influent	10-14-80 (1030)	Headworks manhole	pH, Cond., Temp.
Tree Top Influent	10-14-80 (1110)	Wet well at Tree Top Inc.	pH, Cond., Temp., Settleable solids
	10-15-80 (0830)	Same	Same
Final chlorinated Effluent	10-14-80 (1155)	End of chlorine contact chamber	pH, Cond., Temp., TCR
	10-14-80 (1205)	Same	TCR
	10-15-80 (0850)	Same	TCR
	10-15-80 (1145)	Same	TCR
	10-15-80 (0945)	Same	Fecal coliform grab
	10-15-80 (1145)	Same	Fecal coliform grab/split
Cell III Effluent	10-15-80 (0900)	Prior to chlorination	D.O.

*Initial sampler malfunctioned. Restarted at 1715.

Memo to Harold Porath
Cashmere Sewage Treatment Plant Class II Inspection
February 25, 1981

A Manning dipper was installed on the city influent flume on October 14, 1980 in order to determine the accuracy of the STP flow monitoring device. Both the STP and dipper totalizers were on for a total of 24 hours and 40 minutes necessitating the subtraction of 40 minutes' flow in order to acquire a 24-hour totalizer flow.

No flow was determined for the Tree Top influent. The flume design was not standard and could not be monitored with the equipment at hand. The STP operator stated that the Tree Top influent flow monitoring device was unreliable. Since this Class II inspection, Tree Top has installed an in-line flow meter which now may be providing accurate flows.

The 90° V-notch weir located at the end of the chlorine contact chamber was measured for accuracy. The V-notch was found to be within acceptable limits with a 91.6° V. Our measuring accuracy could be partially responsible for this minor discrepancy.

The STP effluent flow monitoring device was inoperative at the time of the inspection. In order to estimate a 24-hour effluent flow, instantaneous flow readings were taken on four separate occasions. Little change in effluent flow was noted during the inspection period.

A dissolved oxygen (D.O.) profile was conducted in Cell I in order to determine aerator adequacy. D.O. readings were taken at random intervals from a small boat with a calibrated IBC D.O. meter.

Rhodamine WT dye was added to the final effluent on October 15, 1980. Detention time in the outfall pipe was measured and the effectiveness of the diffuser was determined via observation of the dye pattern on the receiving water surface.

Results and Discussion

Table 2 shows the results of DOE laboratory and field analysis for specific parameters. In general, the Cashmere STP was well within permit limits at the time of this inspection. A minor permit violation was observed in the pH level of the final effluent.

The National Pollution Discharge Elimination System (NPDES) waste discharge permit issued for the Cashmere STP dictates that the pH of the final effluent should be between 6.5 and 8.5. The pH of the final effluent was 8.7.

High pH values are not uncommon during the summer months in lagoon systems. It appears that algal blooms are at least partially responsible for the high pH values observed at the Cashmere STP. During the daylight hours, algae use free carbon dioxide (CO_2) for their photosynthetic activities. CO_2 plays an important role in buffering water systems. As algae use free CO_2, the equilibrium of the carbonate buffering system (equation 1) is shifted to the left resulting in higher pH values. This pH increase changes the alkalinity of the water which

Table 2. DOE Laboratory Results.

Parameters	DOE Sample			STP Sample			Design and/or Permit Limits	
	City Influent 24-hr. Comp.	Tree Top Influent 24-hr. Comp.	Chlorinated Effluent 24-hr. Comp.	City Influent 8-hr. Comp.	Tree Top Influent 8-hr. Comp.	Chlorinated Effluent 8-hr. Comp.	Monthly Average	Weekly Average
Flow (MGD)	.361[5]	[7]	.207[1]	.241[4]	[7]	.207[1]	<.313	
BOD_5 (mg/l)	120	4,000	36	*	2,800	*	105	158
lbs/day	361		62				274	412
TSS (mg/l)	90	1,800	63	130	830	81	133	200
lbs/day	271		109	391		140	347	522
Fecal Coliform (org./100 ml)			220[2] 280[2]				200	400
TCR (mg/l)			0.4[1]					
D.O. (mg/l)			3.1[1,8]					
pH (S.U.)	7.8[3]	9.2[3]	8.7[3]				6.5 to 8.5	
Sp. Cond. (µmhos/cm)	1,030	765[3]	1,160	1,240	584	1,700		
COD (mg/l)	220	6,200	200	250	3,800	420		
Turbidity (NTU)	31	390	30	38	260	25		
NH_3-N (mg/l)	0.40	1.8	<0.10	0.25	1.9	<0.20		
NO_2-N (mg/l)	<0.20	0.10	<0.10	<0.25	0.10	<0.20		
NO_3-N (mg/l)	14	0.8	2.2	21	0.90	1.2		
Total Inorganic-N (mg/l)	~14.6	2.7	~2.4	~21.5	2.9	~1.6		
O-PO_4-P (mg/l)	3.6	4.1	5.5	3.5	6.5	5.6		
T-PO_4-P (mg/l)	6.3	[6]	7.4	6.0	[6]	7.3		
Total Solids (mg/l)	690	6,000	850	780	3,600	1,300		
TNVS (mg/l)	460	850	580	530	570	980		
TSS (mg/l)	90	1,800	63	130	830	81		
TNVSS (mg/l)	16	740	10	24	320	14		
Settleable Solids (mg/l)		3.5[1]						
Temperature (°C)	17.5[1]	29.2[1]	10.5[1]					

1/Grab Sample - field analysis
2/Grab Sample - Lab analysis
3/Composite Sample - Field analysis
4/STP Totalizer
5/Manning dipper totalizer
6/Interference
7/Undetermined
8/Taken prior to chlorination
*Sample volume too low for analysis

allows the algae to extract CO_2 from both bicarbonates (equation 2) and carbonates (equation 3) resulting in even higher pH values (Sawyer, C.N. and P.L. McCarty, 1967).

Equation 1

$$CO_2 + H_2O \rightleftarrows H_2CO_3 \rightleftarrows 1H^+ + HCO_3^- \rightleftarrows 2H^+ + CO_3^=$$

Equation 2

$$2HCO_3^- \rightleftarrows CO_3^= + H_2O + CO_2$$

Equation 3

$$CO_3^= + H_2O \rightleftarrows 2OH^- + CO_2$$

During an algal bloom, the pH will continue to increase until a pH is reached (pH 10-11) at which the algae can no longer survive. As the algae die, the buffering system will drive equation 1 to the right, lowering the pH. Cell III at the Cashmere STP had a very active algal bloom in progress during the inspection period. Review of Cashmere's DMRs indicates that meeting the pH permit limit is a chronic problem during the summer months.

Cashmere's NPDES permit does not stipulate total chlorine residual (TCR) effluent limits. Final effluent chlorine concentrations were, we feel, more than sufficient to produce adequate disinfection. On October 14, 1980 the TCR of the final effluent was 1.3 mg/L while using eight pounds of chlorine per day. On our recommendation, the STP operator reduced chlorine use to four pounds per day which resulted in a TCR of 0.4 mg/L. A fecal coliform grab sample was taken on October 15, 1980 with a TCR of 0.2 mg/L. The resultant fecal coliform concentration was calculated to be 280 colonies per 100 ml of sample. We recommended that the operator fluctuate the chlorine usage in order to keep the TCR as low as possible yet remain in compliance with fecal coliform permit limits. Mr. Cruickshank appeared very receptive to this recommendation.

Table 3 compares DOE and STP split sample results. As can be seen, there are quite a few result discrepancies. The DOE laboratory was unable to analyze for BOD_5 on the 8-hour city influent and 8-hour chlorinated effluent samples due to low sample volumes. The STP operator missed the correct dilution on both Tree Top influent BOD_5 samples. This error resulted in "greater than" values for both analyses. Of the BOD_5 split samples that are comparable, the STP result for the chlorinated effluent, 8-hour grab composite sample, appears to be a little high.

Table 3. DOE/STP Comparison of Laboratory Results

	City Influent 24-hour Composite		Tree Top Influent 24-hour Composite		Chlorinated Eff. 24-hour Composite		City Influent 8-hour Grab Comp.		Tree Top Influent 8-hour Grab Comp.		Chlorinated Eff. 8-hour Grab Comp.	
	DOE Results	STP Results	DOE Results	STP Results	DOE Results	STP Results	DOE Results	STP Results	DOE Results	STP Results	DOE Results	STP Results
BOD_5 (mg/l)	120	104	4,000	>1,281	36	73	2/	130	2,800	>1,286	2/	215
lbs/day	361	313	1/	1/	52	126		391	1/	1/		371
% DOE/STP Diff.		15% low		N/A		51% high		N/A		N/A		N/A
TSS (mg/l)	90	97	1,800	928	63	73	130	60	830	710	81	57
lbs/day	271	292	1/	1/	109	126	391	181	1/	1/	140	98
% DOE/STP Diff.		7% high		54% low		14% high		116% low		17% low		42% low
Fecal Coliform 3/ (org/100 ml)					280	116						
% DOE/STP Diff.						141% low						

1/ No flow from Tree Top, Inc.

2/ Volume too low for analysis.

3/ Chlorinated effluent grab.

Memo to Harold Porath
Cashmere Sewage Treatment Plant Class II Inspection
February 25, 1981

A total of six total suspended solids (TSS) split samples was analyzed by DOE and STP laboratories. Three of the samples, Tree Top influent 24-hour composite, city influent 8-hour grab composite, and chlorinated effluent 8-hour grab composite, do not compare within acceptable limits. Diatomateous earth may be responsible for the Tree Top influent split sample result discrepancy. It is very difficult to keep the relatively heavy diatomateous earth in suspension while splitting samples.

Fecal coliform split sample results are not in agreement. Both DOE and STP plate counts are valid (between 20 to 60 colonies per plate).

In summary, BOD_5, TSS, and fecal coliform split sample results contain some conspicuous discrepancies.

When conducting the laboratory procedural survey, found at the end of this report, it was obvious the STP operator was familiar with correct sampling and analytical procedures. Very few deviations from standard analytical methods were noted. Mr. Cruickshank appeared to be a very conscientious operator.

Comparison of split sample results remains inconclusive. We suggest that another split sample comparison be conducted in the near future to determine if the above-mentioned discrepancies are due to isolated aberrations or improper analytical techniques.

The Class II inspection conducted at the Cashmere STP in April of 1979 recommended using settled city influent as a seed material for BOD_5 analysis (Egbers, 1979). After discussion with Mr. Cruickshank and Wes Maier, it was decided that settled Cell I effluent would be a more desirable seed source. The primary advantages of this would be the acquisition of a more diverse microorganism population and a decreased chance of microorganism mortality due to shock loads.

Flow Monitoring

The Cashmere STP has three continuous flow monitoring locations; city influent, Tree Top influent, and final chlorinated effluent. The Tree Top flow monitoring device is known to be inaccurate. The exact reason for the equipment malfunction is not known. Undoubtedly, age and the lack of calibration are contributing factors.

The final chlorinated effluent flow monitoring device has been inoperative for months due to extreme corrosion. Most of the flow monitoring equipment at this location is situated within the chlorine room. The operator informed me that he has trouble with a small chlorine leak. He suspects the corroded flow recording equipment is due to oxidation by chlorine gas. Of even greater concern is the possible public health hazard resulting from this periodic chlorine leak. We recommended that the chlorine leak problem be solved immediately.

At the time of this inspection, it was thought that the city influent flow monitoring device was fairly accurate. The Manning dipper installed on the city influent flume proved this assumption to be incorrect. The city influent 24-hour totalizer flow was .248 million gallons per day (MGD) while the Manning dipper recorded a flow of .361 MGD. The STP totalizer recorded a flow 31 percent below the flow recorded by the Manning dipper.

Figure 3 compares the flume rating curve to an instantaneous flow curve taken manually from the city influent flume. The instantaneous flows were acquired by manually measuring the depth in the flume and immediately reading the corresponding flow value from the flow strip chart. It is apparent that the city influent flow monitoring device is underestimating flows.

Equations 4 and 5 are regression formulas calculated using the power curve fit technique where Q is the flow (MGD) for any given head (h) in inches. The R^2 value is the coefficient of determination which indicates how well the data pairs fit the equation. The closer the R^2 value is to 1.0, the better the data pairs fit the curve. Equation 4 has a better curve fit (R^2 = .99982) than equation 5 (R^2 = .98840). This also can be seen when observing the instantaneuos STP flow values in Figure 3. These values should produce a smooth curve much like the flume rating curve. It is apparent that problems exist with the STP city influent flow monitoring device other than just the underestimation of flows. These problems, which result in the lowered R^2 value, could be due to a number of items. The flume may not be installed correctly. More probably, the lack of consistency with the instantaneous STP flow values is due to the lack of calibration and/or maintenance of the mechanical apparatus connected to the flume or the strip chart recorder.

An explanation of why the chlorinated effluent flow is approximately half the city influent flow is warranted (Table 2). The ponds at the Cashmere STP are lined with asphalt to reduce infiltration of ground water and to minimize contamination of ground water. At present, this asphalt barrier is in disrepair resulting in an unknown amount of fluid exchange between the ponds and the surrounding water table.

Evaporation plays an important role in loss of water from the ponds. Throughout most of the summer, the Cashmere STP has no discharge. This is understandable if one is aware that the total surface area of the three cells is 836,651 cubic feet (19.2 acres).

One must keep in mind that the detention time is approximately 30 days at the Cashmere STP. As a result, influent flow fluctuations are not immediately reflected in the effluent flow.

Cell I Dissolved Oxygen Profile

Figure 4 shows the results of the dissolved oxygen profile conducted in Cell I. Dissolved oxygen levels below 2 mg/l make aerobic decomposition

Figure 3

Cashmere STP City INFLUENT Flume Rating Curve / INSTANTANEOUS Flow Comparison

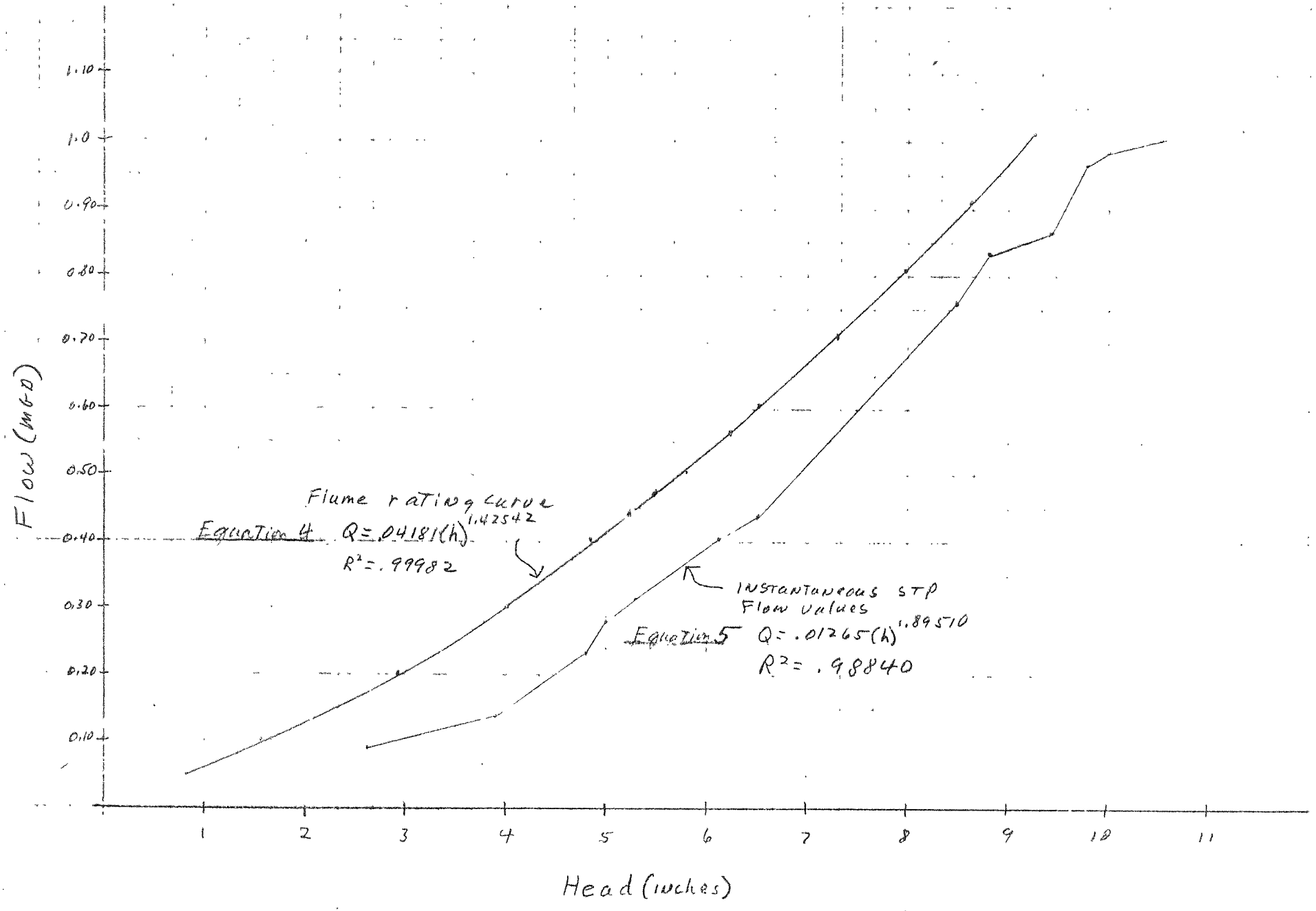
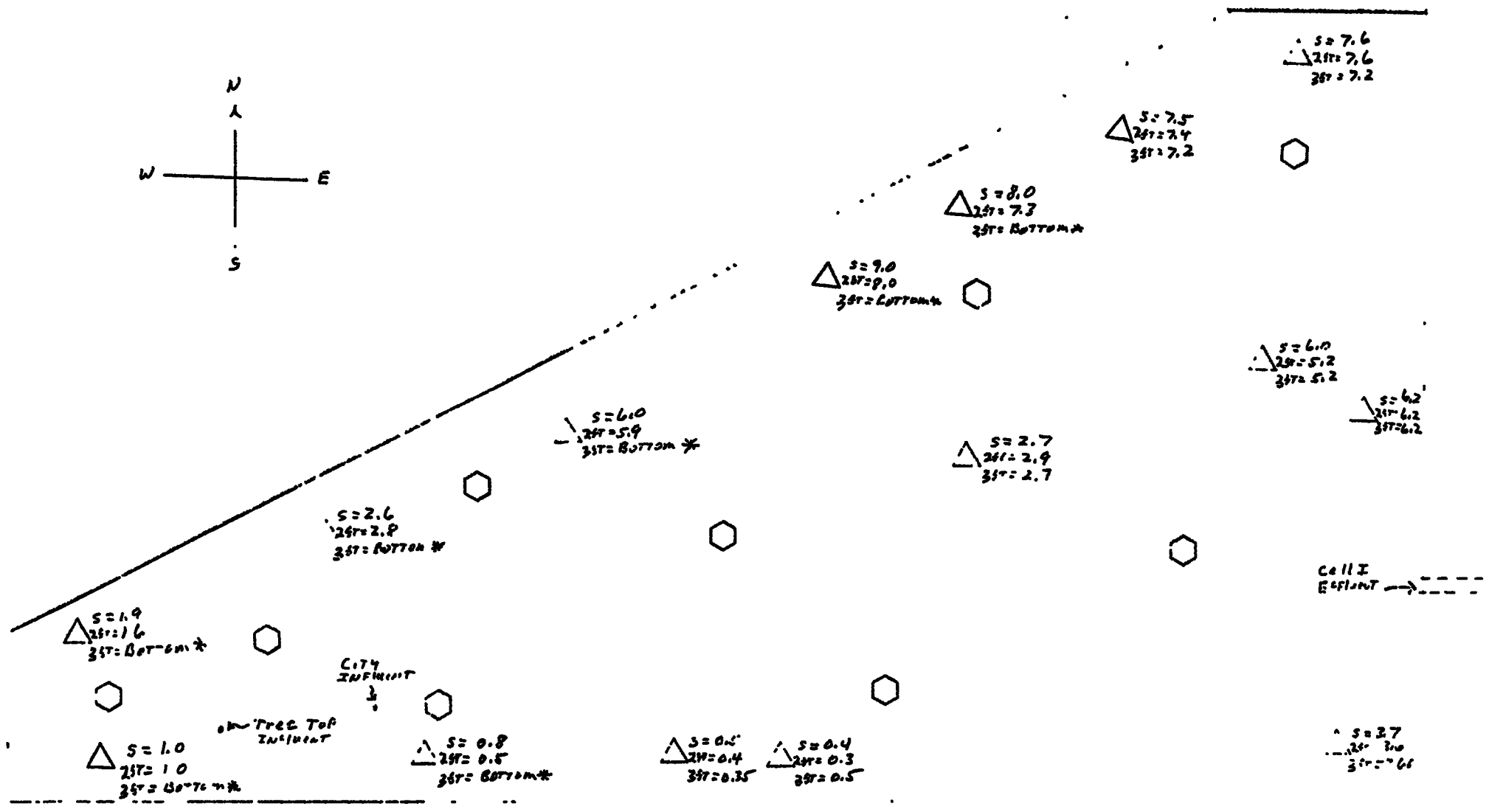


Figure 4

Cashmere S.T.P. – Cell #1

Dissolved Oxygen Profile



* D.O. NOT taken due to possible H_2S contamination of probe

All locations are approximate
All D.O. values are in mg/l

⬡ = Aerator

△ = Sampling location

S = Surface

of wastes difficult. Low D.O. concentrations were found in the southwest portion of Cell I. Two factors account, at least in part, for the low D.O. values in this area:

1. Both City and Tree Top influents enter Cell I in this area, resulting in rapid D.O. depletion due to heavy organic loading.

2. At times, Tree Top discharges diatomateous earth into Cell I. This results in a loss of cell depth which creates a barrier to aerator mixing.

It is apparent that the area of Cell I with the highest BOD loading is not receiving adequate aeration. The installation of additional aerators or the relocation of existing aerators should increase D.O. levels in the southwest corner of Cell I. This action should result in an increase in biological treatment in Cell I and, one would expect, an increase in overall treatment plant efficiency. An added advantage of increased aeration would be a reduction in obnoxious odors resulting from septic conditions in the area of Tree Top's influent.

The fact that Tree Top occasionally discharges large quantities of diatomaceous earth into Cell I presents an immediate problem which we feel should be dealt with. Tree Top uses diatomaceous earth as a filtering medium. There exists a filtering system on Tree Top's effluent designed to remove all diatomaceous earth from the waste liquid before it leaves the processing plant. Evidentally some of the earth is bypassing the filtering system. The major concern here is the deposition of diatomaceous earth around the Tree Top influent pipe in Cell I. The cell depth in the vicinity of the Tree Top influent pipe is approximately one foot less than the depth found in the remainder of the cell (Figure 4). At times, a small island of diatomaceous earth and organic matter is formed around Tree Top's influent pipe. Organic matter in this island produces obnoxious odors as it decays. The island is periodically knocked down with a water hose.

The design depth of Cell I is four feet. Design depth criterion for aerated lagoons is at least seven feet in order to allow adequate aeration and mixing (DOE, 1978). Any additional decrease in cell depth will further compound the mixing and aeration problem evident in Cell I.

BOD_5 Loading

At 0.2 lbs/day/capita, one would expect an organic loading of 400 lbs/day which approximates the actual value of 361 lbs/day (Table 2). City influent BOD_5 is more dilute (120 mg/L) than one would expect for raw municipal influent (about 200 mg/L). The dilution of the city influent probably is due to the contribution of washwater from four apple packing plants. This possible explanation for a dilute city influent is further substantiated by the fact that the expected flow of .200 MGD (100 gal/day/capita) is about half the actual flow of .361 MGD.

Memo to Harold Porath
Cashmere Sewage Treatment Plant Class II Inspection
February 25, 1981

The high BOD_5 concentration of Tree Top's influent undoubtedly has an adverse effect on the STP treatment efficiency, especially during the winter months. Permit limits for BOD_5 and TSS are exceeded quite often during the winter. Low cell temperatures and icing problems slow organic breakdown and reduce the already marginal aerator capacity.

Although the addition or relocation of aerators should increase overall treatment plant efficiency, it is doubtful that year-round permit compliance will be realized under existing conditions, especially with Tree Top's planned production increase.

The problem of diatomaceous earth deposition in Cell I needs to be addressed by the City of Cashmere. One obvious solution to this problem would be a substantial reduction in the amount of diatomaceous earth discharged by Tree Top.

Water Quality Index (WQI) - Segment 21-45-01

The Cashmere STP discharges into the Wenatchee River at Cashmere (segment 21-45-01). According to the "1980 Analysis of Receiving Water Segments" (Singleton, 1980), this segment has an overall WQI of 6.2 (Table 4).

Table 4. Water Quality Index for Segment 21-45-01.

	Water Quality Index Categories								
Station	Temp.	Oxygen	pH	Bact.	Trophic	Aesth.	Susp. Solids	NH_3-N	Overall Index Rating
45A110 (Wenatchee at Leavenworth)	5.5	7.8	8.3	5.5	3.7	5.9	(7.9)	0.0	3.3
45A070 (Wenatchee at Wenatchee)	12.0	7.4	6.3	9.1	5.1	5.9	(10.9)	0.7	7.7
$\bar{X}$	9.8	7.5	7.0	7.9	4.6	5.9	(9.9)	0.5	6.2

( ) = Not used in the calculation of the Overall Index Rating.

A WQI falling between 0 to 20 meets the goals of the Federal Water Pollution Control Act. An increasing trend can be seen when comparing the upstream station (45A110) to the downstream station (45A070).

Nonetheless it is difficult to say from ambient data what effects the Cashmere STP has on the water quality of the Wenatchee River. Cashmere is located approximately half-way between the two ambient monitoring stations. There are many probable point and nonpoint sources of pollution which enter the Wenatchee River between the two stations.

Outfall Detention Time and Diffuser Efficiency

On October 15, 1980, Rhodamine WT dye was added to the final effluent. Dye appeared on the receiving water surface after 5.5 minutes at a flow of .185 MGD. Three diffuser holes were observed to be working. The dye appeared to diffuse rapidly and could not be seen after a very short time.

We do not feel that it is necessary to take outfall pipe detention time into account when dechlorinating fecal coliform samples. The detention time in the outfall pipe is very short. Any additional microorganism mortality occurring in the outfall line is probably minimal.

Recommendations

The following is a list of recommendations which, we feel, should be implemented by the City of Cashmere with respect to the existing treatment facility.

1. Use settled Cell I effluent as a seed source for BOD_5 determination.

2. The chlorine leak in the chlorine room deserves immediate attention. This leak presents a serious public health hazard. If it has not already been done, chlorine detectors should be installed in the chlorine room.

3. Data presented in this report indicate that the Cashmere STP has serious organic overloading and diatomaceous earth deposition problems resulting from Tree Top's contribution to the treatment facility. It is recommended that the City of Cashmere, Tree Top, Inc., and DOE agree upon a valid solution to the problem.

4. Due to the inconclusive split sample data, we would like to split samples again with the STP operator.

5. The few minor recommendations found in the Laboratory Procedural Survey attached to this report should be implemented as soon as possible.

WA:cp

Attachments

REFERENCES

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