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M E M O R A N D U M
October 5, 1983

To: Skip Harlan, Municipal Grants Division

From: Kevin Kiernan, Water Quality Investigations Section KK

Subject: Granite Falls Class II Inspection - August 2-3, 1983

INTRODUCTION

A Class II inspection and receiving water study were conducted at the Granite Falls sewage treatment plant (STP) on August 2-3, 1983. The Class II inspection was conducted by Kevin Kiernan (Department of Ecology [WDOE], Water Quality Investigations Section [WQIS]). Dave Wright represented the Northwest Regional Office of WDOE and Skip Harlan represented the Municipal Grants Division. Granite Falls was represented by Don Davis (the STP operator) and his assistant, Bruce Caley. John Bernhardt (WDOE, WQIS) conducted the receiving water study. His results will be presented in a separate memorandum.

This inspection was requested by the Northwest Regional office. A previous Class II inspection (Yake, 1980) had indicated that the Granite Falls STP was causing degradation of the receiving water. The primary cause of this problem was an inadequate collection system which allowed substantial infiltration and exfiltration. Additionally, during periods of peak flow, some wastewater inflow bypassed the plant entirely and was discharged into the sludge drying beds. Effluent from these beds flowed into the Pilchuck River without receiving any treatment. Finally, the existing primary treatment plant was beginning to deteriorate (Yake, 1980) and could no longer provide adequate waste treatment.

As a result of the 1980 investigation report and others, the collection system and treatment plant were replaced and the new system came on line November 1982. This inspection was conducted before the end of the customary one-year break-in period because of high interest to measure receiving water quality improvement as a result of the new facility. Figures 1a and b show the locations of Granite Falls' new and old STPs.

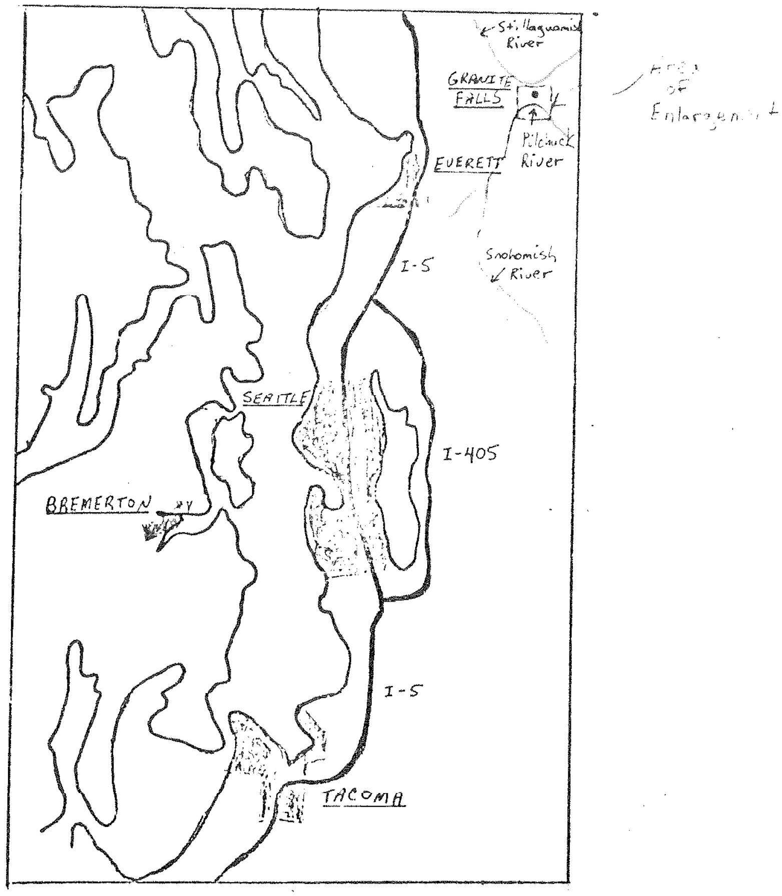


Figure 1a. Granite Falls vicinity map.

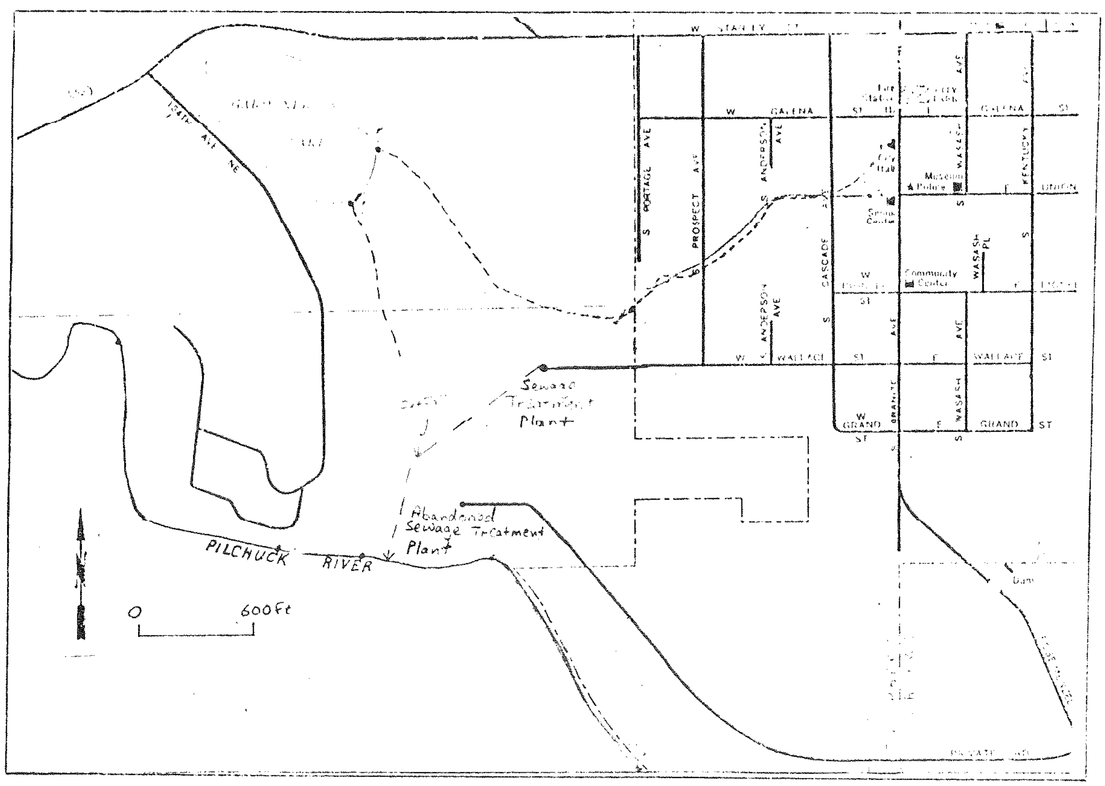


Figure 1b. Location of Granite Falls STP.

PLANT LAYOUT AND OPERATION

The Granite Falls STP is an oxidation ditch secondary treatment facility. Figure 2 schematically illustrates the flow pattern through the plant. Plant influent passes through a grit channel, Parshall flume, and a comminutor prior to entering the oxidation ditch. The ditch is a conventional race track design with two rotating brushes providing aeration and ditch flow. Ditch effluent flows to a circular clarifier and then to chlorination facilities. Flow is measured with a Foxboro in-line flow meter located between the clarifier and the contact chamber. The flow meter also controls chlorine addition and influent and effluent compositor sampling times (sampling points are indicated on Figure 2). Effluent is discharged via a submerged pipe with diffusion ports into the Pilchuck River (segment 03-07-10) in accordance with NPDES permit WA-002113-0(M).

Table 1 compares Granite Falls design data with conditions at the time of this inspection. These data show that the plant is currently underloaded. Because the plant is in the first year of a 20-year design period, this is to be expected. This phenomenon has not caused any operational problems (Table 1).

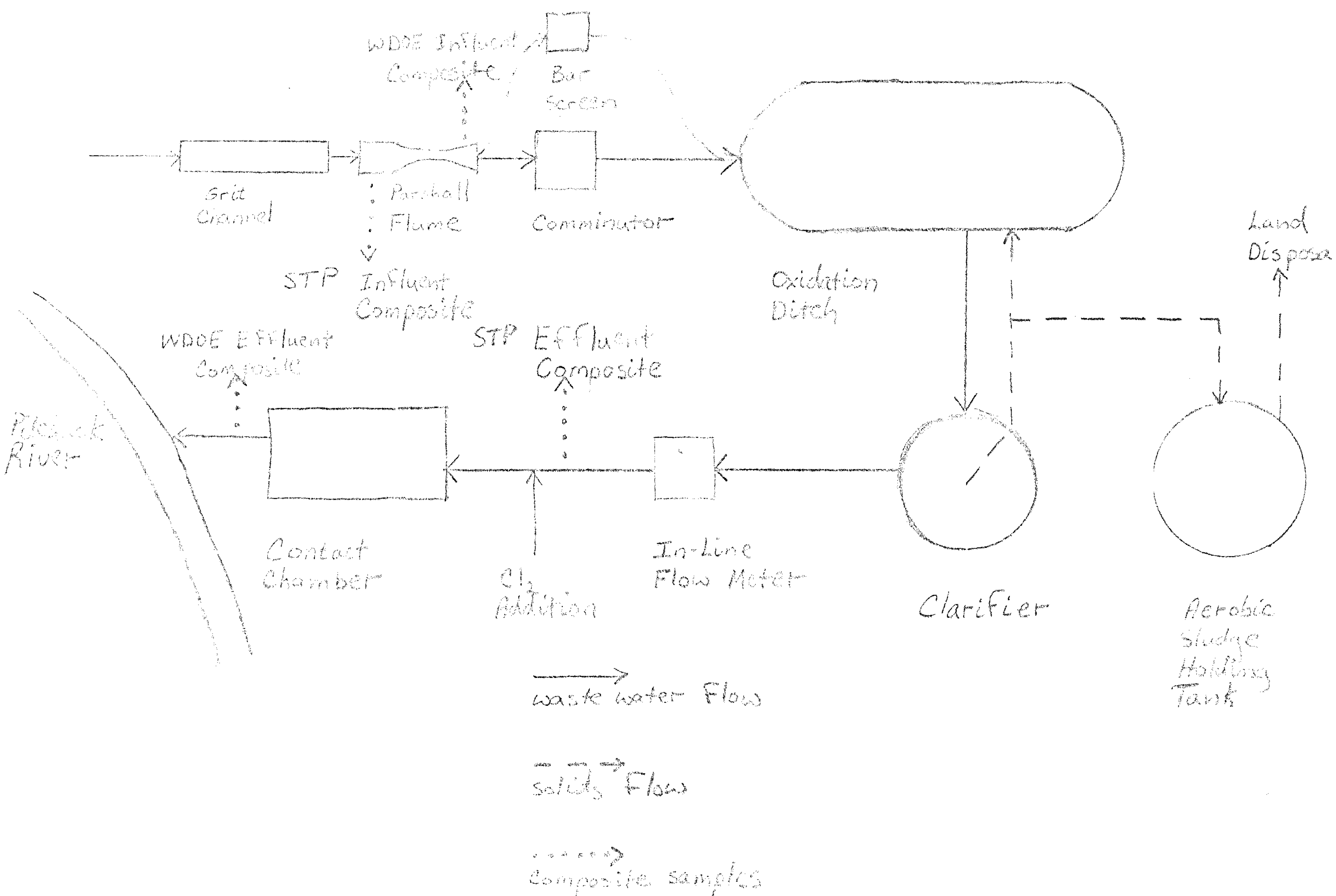
Table 1. Comparison of design loading to actual operating conditions.

	Flow (MGD)	BOD (lbs/day)	SS (lbs/day)	Detention Time (days)
Design	0.185	312	359	24
Actual	0.121	182	152	37

The STP has two grit channels, clarifiers, and contact chambers. Flow can be directed in parallel through each pair, although at present only one unit of each set is normally used. The operator periodically alternates the units being used to allow cleaning and inspection of the idle units. Both clarifiers have been used during wet weather to provide improved solids removal during high flows.

Excess solids are digested in an aerobic holding tank and eventually disposed of via land application with an Ag-Gator truck (manufactured by the Ag-Chem Equipment Co., Inc.) which injects the sludge into a narrow furrow. The operator reports that this works quite well, and he has a number of local landowners who are willing to accept the sludge.

Figure 2: Schematic Diagram of Flow through Granite Falls STP



INSPECTION PROCEDURE

After a tour of the treatment plant, WDOE compositors were set up below the Parshall flume and at the outlet from the contact chamber (Figure 2). Compositor failure prevented the collection of a WDOE composite of the clarifier effluent, so the STP composite was used. WDOE compositors collected 220 mL of sample each 30 minutes while the plant compositors collected 250 mL for each 5,000 gallons of plant flow. Compositors were removed after 24 hours and the STP and WDOE composite samples were split and returned to the WDOE and Granite Falls laboratories for analysis. The results of the WDOE analyses are presented in Table 2.

Table 2. Summary of WDOE laboratory analyses; Granite Falls STP composite samples.

	Influent		Clarifier Effluent	Final Effluent
Parameter	WDOE Composite	STP Composite	STP Composite	WDOE Composite
$O\text{-}PO_4\text{-}P$ (mg/L)	4.2	--	5.6	5.3
$T\text{-}PO_4\text{-}P$ (mg/L)	7.1	--	5.8	5.6
$NH_3\text{-}N$ (mg/L)	15	--	0.20	0.40
$NO_2\text{-}N$ (mg/L)	<0.10	--	0.05	0.05
$NO_3\text{-}N$ (mg/L)	0.10	--	9.8	12
COD (mg/L)	320	--	55	32
BOD_5 (mg/L)	180	180	10	4.8*
BOD_5 (inhibited) (mg/L)	--	--	7	4.0
pH (S.U.)	7.6		7.1	6.9
Conductivity (µmhos/cm)	437		341	337
Turbidity (NTU)	130	--	6	8
Total Solids (mg/L)	420	520	300	290
TNVS (mg/L)	220	230	200	200
TSS (mg/L)	150	280[1/]	14	7
TNVSS (mg/L)	18	35	3	2

*Estimated

[1/] Suspended solids value from STP compositor is inconsistent with other data and was not used in analysis of results.

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Grab samples for field measurement were taken at the compositor locations at the beginning and end of the sample period. Field measurements included pH, conductivity, temperature, and, dissolved oxygen (D.O.). D.O. measurements were discontinued after the first day due to erratic meter behavior. Also, a final effluent grab sample was collected for total chlorine residual (TCR) field analysis and WDOE laboratory fecal coliform analysis. An additional influent grab sample was taken at 1630 hours on August 2 when the flow turned milky white. Along with the standard field parameters, nutrient analyses were conducted on this sample. These results are presented in Table 3.

Table 3. Summary of analyses; Granite Falls STP grab samples.

	Influent			Clarifier Effluent		Final Effluent	
Date	8/02/83	8/02/83	8/03/83	8/02/83	8/03/83	8/02/83	8/03/83
Time	1330	1630	1130	1340	1140	1350	1150
pH (S.U.)	7.5	7.6	6.9	6.5	6.7	6.6	6.4
Conductivity (μmhos/cm)	490	342	320	358	380	350	390
Temperature (°C)	17.5	17.5	15.6	18.3	18.1	18.1	18.1
Dissolved Oxygen (mg/L)	5.2	--	--	3.1	--	3.4	--
Total Chlorine Residual (mg/L)	--	--	--	--	--	1.5	0.9
Fecal Coliform* (#/100 mL)	--	--	--	--	--	1 Est.	2 Est.
NH_3-N (mg/L)*	--	10.6	--	--	--	--	--
NO_2-N (mg/L)*	--	0.10	--	--	--	--	--
NO_3-N (mg/L)*	--	<0.10	--	--	--	--	--
O-PO_4-P (mg/L)*	--	4.3	--	--	--	--	--
T-PO_4-P (mg/L)*	--	8.2	--	--	--	--	--

*Laboratory analyses.

A Manning dipper was placed at the Parshall flume stilling well to measure plant flow. Problems with the dipper clock mechanism prevented the unit from providing a continuous flow record; however, the totalizer did provide a record of total daily flow.

RESULTS AND DISCUSSION

Table 4 illustrates how the influent at Granite Falls compares to a "normal" influent, based upon loading factors recommended by Metcalf & Eddy (1979). The recorded flow is one third higher than would be expected, based upon the town's population. The most likely cause for this would be infiltration and/or inflow of water into the collection system. A review of the plant's Discharge Monitoring Reports (DMRs) shows that during wet periods the plant flow increases, and the operator confirms that plant flow can double during heavy storms. The plant and WDOE flow measures match almost exactly.

Table 4. Comparison of measured to predicted plant loading.

	WDOE Samples	Granite Falls Samples	Predicted[1/]	
			Average	Range
Flow (MGD)	0.121	0.122	0.091	--
BOD (mg/L)	180	190	220	110-400
(lbs/day)	182	192	170	85-300
TSS (mg/L)	150	188	220	100-350
(lbs/day)	152	190	170	85-270

[1/] Calculated based on population of 910 and Metcalf & Eddy (1979) loading factors.

Biochemical oxygen demand (BOD) and suspended solids loadings fall within the range of typical values for domestic wastewater (Metcalf & Eddy, 1979). The DMRs indicate that the values in Table 4 are representative of the plant loading. The ratio of BOD:nitrogen:phosphorus (100:8.4:6.3) approximates the 100:5:1 ratio required for balanced growth.

At 1630 hours, August 2, the influent appeared milky white rather than its usual grey color. Field and nutrient analyses (Table 3) of this influent showed no significant differences from the other samples run. The operator indicated he had noticed this phenomenon before and it did not cause any operational problems, so it was not pursued any further.

The plant itself appeared to be functioning quite well. Because this is a new facility, the operator is still experimenting with various control parameters in an effort to achieve maximum treatment efficiency. He has varied sludge recycle to determine the effect of differing concentrations of mixed liquor suspended solids, and is currently gradually decreasing chlorine dosage to determine the minimum effective dose. He has also varied the detention time of the sludge in the digestor. The plant's physical condition is excellent, and the operator and his assistant have a regular and thorough maintenance program.

Table 5 compares effluent characteristics to permitted concentrations. The plant is well within the permit limits in all cases. DMRs indicate that, with the exception of a plant upset in March when the sludge blanket was lost, the plant consistently meets permit limits. Table 1 also shows nitrification is occurring, with nearly all NH_3-N converted to NO_3-N. This is most likely occurring due to the plant's long (37 hours) hydraulic detention time. Nitrification is probably the cause of the drop in pH which occurs during treatment (Tables 2 and 3). This should be self-limiting since a lowered pH will inhibit nitrification.

Table 5. Comparison of effluent characteristics to NPDES limits.

	WDOE Results	Percent Reduction of Influent Concentration	NPDES Permit Limits Monthly Average
BOD (mg/L)	10		30[1/]
(lbs/day)	10		46
(percent removal)		94%	85%
Susp. Solids (mg/L)	14		30[1/]
(lbs/day)	14		46
(percent removal)		94%	85%
Flow (MGD)	0.121	--	0.185[2/]
pH (S.U.)	6.9	--	6.0-9.0
Fecal Coliform (col/100 mL)	1*	--	200

[1/] Or 15 percent of the influent concentration.

[2/] Average dry-weather flow.

* = Estimated.

Dye added to the contact chamber outflow showed the effluent took 13 minutes to reach the Pilchuck River and also revealed the only significant problem at this plant. The previous winter's high flows had apparently broken off several of the PVC discharge ports from the outfall line. Sand then covered the line and only a few of the ports were operational. Since this inspection, the broken ports have been replaced. However, the problem may arise again this coming winter if high river flows recur. The operator has indicated that he may replace the ports with flexible automobile radiator hose. This may solve the breakage problem, but they will be more likely to bend and restrict flow. Regardless of the type of port, the outfall line should be examined after high river flows.

Table 6 compares the metals content of Granite Falls sludge to data collected in previous Class II inspections. With the exception of chromium, these data fall within the range of previously reported values. The chromium concentration is slightly lower than that found in other inspections.

Table 6. Sludge metals results - comparison of Granite Falls to previous Class II data (mg/Kg dry weight unless otherwise noted).

Metal	Granite Falls Sludge[2/]	Previous Class II Data[1/] Geometric Mean	Geometric Range	Number of Samples
Cd	8.6	6.90	1.69 - 28.2	16
Cr	36	80.7	42.1 - 154.7	16
Cu	500	325.6	173.3 - 611.6	16
Pb	230	237.7	109.0 - 518.6	16
Ni	43	17.5	2.7 - 114.9	12
Zn	960	1198	615 -2334	16

[1/] Summary of data collected during Class II inspections at activated sludge plants.

[2/] Grab sample of sludge from aerobic digestor; 1.3 percent solids.

LABORATORY PROCEDURES - DISCUSSION

Sampling Procedure

Composite Samples

Flow-weighted influent and clarifier effluent composite samples are taken with a Century 2000 automatic compositor. Sample locations are indicated on Figure 2 and should yield representative samples. The compositor draws 250 mLs of sample per 5,000 gallons of plant flow and holds the sample in a refrigerator. During this inspection, the refrigerator kept the samples at 11°C.

Compositor lines are purged with air before and after each sample withdrawal. Because the lines are permanently installed, they are not cleaned. This may present a problem in the future if bacterial growth causes clogs.

Grab Samples

Grab samples are taken of the influent for pH measurement and of the final effluent for pH and fecal coliform analysis. Samples are taken at a point where flow is well mixed and analytical results should be representative of the flow. Oxidation ditch grab samples are taken weekly for solids analyses. Both brushes are turned on prior to sampling to assure a representative sample.

Recommendations

- Refrigerator holding composite samples should be adjusted to maintain sample temperature of 2 to 6°C.
- Compositor lines should be flushed periodically with hot water and/or a dilute chlorine solution to clean out accumulated bacterial growth. If chlorine is used, lines should be rinsed thoroughly to prevent interferences with BOD analyses.

Instrumental Analyses

Dissolved Oxygen (D.O)

Daily D.O. measurements are taken at the grab sample points with a Y.S.I. meter. The meter is air calibrated daily and the probe membrane is changed whenever readings drift excessively.

Total Chlorine Residual (TCR)

TCR is determined daily with an amperometric titrator. WDOE results are comparable with those reported in DMRs.

pH

pH measurements are made daily on grab samples. The operator uses a Corning pH meter which he standardizes daily with pH 7 buffer. At the time of this inspection, he had a great deal of trouble with getting a stable reading. He has since replaced his electrode with a newer one with a replaceable junction. This junction is removed periodically and soaked in weak acid to clean it and readings seem much more stable.

Recommendations

- D.O. meter calibration should occasionally be checked with a Winkler titration.
- Two buffers should be used to calibrate the pH meter - either 4 and 7 or 7 and 10 -- to bracket the given sample. If necessary, the temperature knob can be used to adjust the meter to either 4 or 10 after calibrating at 7. If this is done, sample and buffers should be the same temperature.

Biochemical Oxygen Demand (BOD)

Weekly BOD analyses are done on influent and unchlorinated effluent samples. Composite samples are shaken well and set up immediately after collection. The operator carefully follows WDOE procedures (WDOE, 1977a) and runs two replicates at two dilutions for each sample. Table 7 compares WDOE Environmental Laboratory and Granite Falls analytical results. These data fall within the expected precision of the test and agree favorably with DMR data.

Recommendations

- Incubator thermostat should be checked by placing a thermometer in a water bath inside the incubator.
- A daily log should be kept of incubator temperature during BOD tests.
- Samples should be allowed to reach room temperature before starting BOD tests.
- While reagent water is aging, bottle cover should be removed and replaced with a cotton plug to allow water to become saturated with oxygen.

Table 7. Comparison of WDOE environmental laboratory analyses and Granite Falls laboratory analyses.

	Influent Composite		Oxidation Ditch	Clarifier Effluent	Final Effluent
	WDOE Sampler	G.F. Sampler			
BOD (WDOE)	180 mg/L	180	--	10	4.8 Est.
(G.F.)	170	190	--	13	--
TSS (WDOE)	150 mg/L	280[1/]	3100	14	7
(G.F.)	90	188	3246[2/] 3209[3/]	10	--
Fecal Coliform					
(WDOE)	--	--	--	--	1 est./100 mL
(G.F.)	--	--	--	--	<10/100 mL

[1/] Suspended solids value from STP compositor is inconsistent with other data and was not used in analysis of results.

[2/] Run August 1

[3/] Run August 4

Est. = Estimated.

Total Suspended Solids (TSS)

Weekly TSS samples are run on influent and effluent composites and on a mixed liquor sample from the oxidation ditch. The operator follows WDOE procedures and runs three replicates per sample. Table 7 compares WDOE and Granite Falls analytical results. Oxidation ditch and clarifier effluent samples agree, but influent sample results are quite inconsistent. The WDOE analysis of the Granite Falls composite is uncharacteristically high and is not consistent with either the other TSS results or the BOD. It is assumed that this is due to either a sampling or analytical error. Other influent TSS analyses show an uncomfortably wide range. This may be due to using insufficiently mixed sample splits. Operator techniques were quite good and his replicates showed very little variability.

Fecal Coliform (F.C.)

Fecal coliform grab samples are taken three times weekly from the effluent end of the contact chamber. Sampling techniques are good, and the operator follows the WDOE recommended analytical method (WDOE, 1977b). He is currently reducing the chlorine dose and monitoring the effect on effluent fecal coliform levels.

Recommendations

- Phosphate buffer should be sterilized before use.
- Thermometer used to monitor the incubator is only accurate to ±1°C. It should be replaced with one accurate to ±0.2°C.
- Petri dishes should be sterilized after use.

CONCLUSIONS

The Granite Falls STP is currently operating well within its permit limits. The operator is very conscientious about both plant operations and analytical procedures. Most of the recommendations made in this report are minor, and many of them have already been acted upon. The effect of this system upgrade on the receiving water will be addressed in a future memorandum (Bernhardt, in progress).

KK:cp

Attachment

cc: Dave Wright
Stew Messman
John Bernhardt
Bill Yake
Unit Files
Section Files
Central Files

REFERENCES

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