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MEMORANDUM
August 18, 1983

To: John Glynn

From: Marc Heffner

Subject: Friday Harbor Sewage Treatment Plant (STP) Class II Inspection, May 17-18, 1983

## Introduction

On May 17 and 18, 1983, a Class II inspection was conducted at the Friday Harbor STP. Personnel involved included Marc Heffner (Washington State Department of Ecology (WDOE), Water Quality Investigations Section (WQIS); John Glynn and Dave Nunnallee (WDOE, Northwest Regional Office); and Kevin Kirk (Friday Harbor STP operator). As the Class II was being conducted, a receiving water study was being conducted in Friday Harbor by Lynn Singleton and Joe Joy (WDOE, WQIS). Results of the receiving water study are reported in a separate memorandum (Singleton and Joy, 1983).

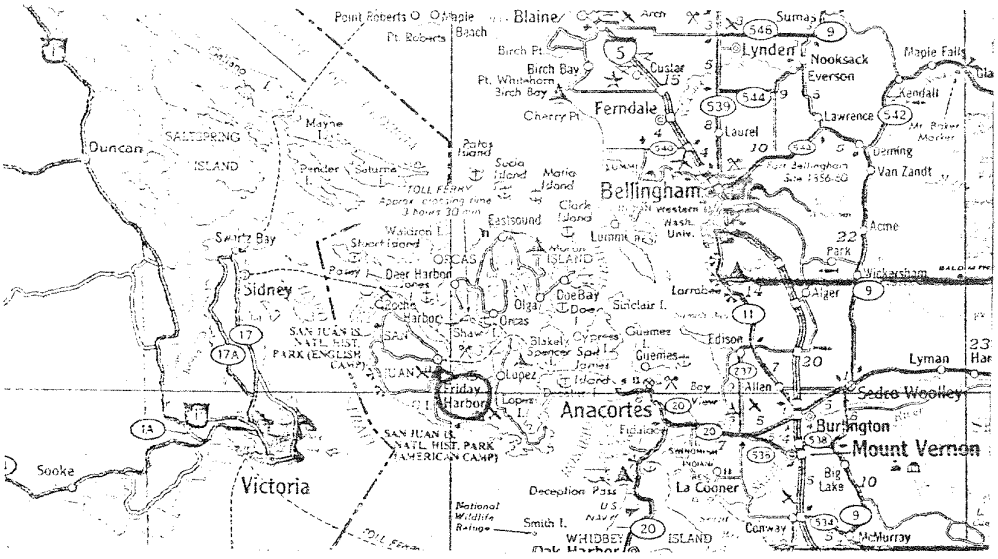
The Friday Harbor STP is a primary plant including bar screen, spiragester (a round Imhoff tank), and chlorine addition facilities (Figures 1 and 2). Discharge is via a 10-inch outfall line into Friday Harbor. Sludge from the plant is dried in drying beds, then land-filled. The facility is limited by National Pollutant Discharge Elimination System (NPDES) permit number WA-002358-2(M).

Improvements at the STP are planned for the near future. A variation of the extended aeration process will be used to provide secondary treatment. A project to extend the sewage outfall line is also being considered. The Class II inspection will provide some measure of pre-upgrade conditions at the plant.

## Sampling Procedure

Automatic compositors were set up by WDOE to collect 24-hour influent and effluent composite samples. The samples were run from ≈ 1000 on May 17 to ≈ 1000 on May 18 with ≈ 200 mls of sample collected every 30 minutes. Flow to the treatment plant was entirely from a pump station and occurred in surges. Assuring that a sample was collected during each sampling cycle became a concern when choosing sampling locations,

Figure 1. Location of Friday Harbor STP - May 1983 Friday Harbor Class II inspection.



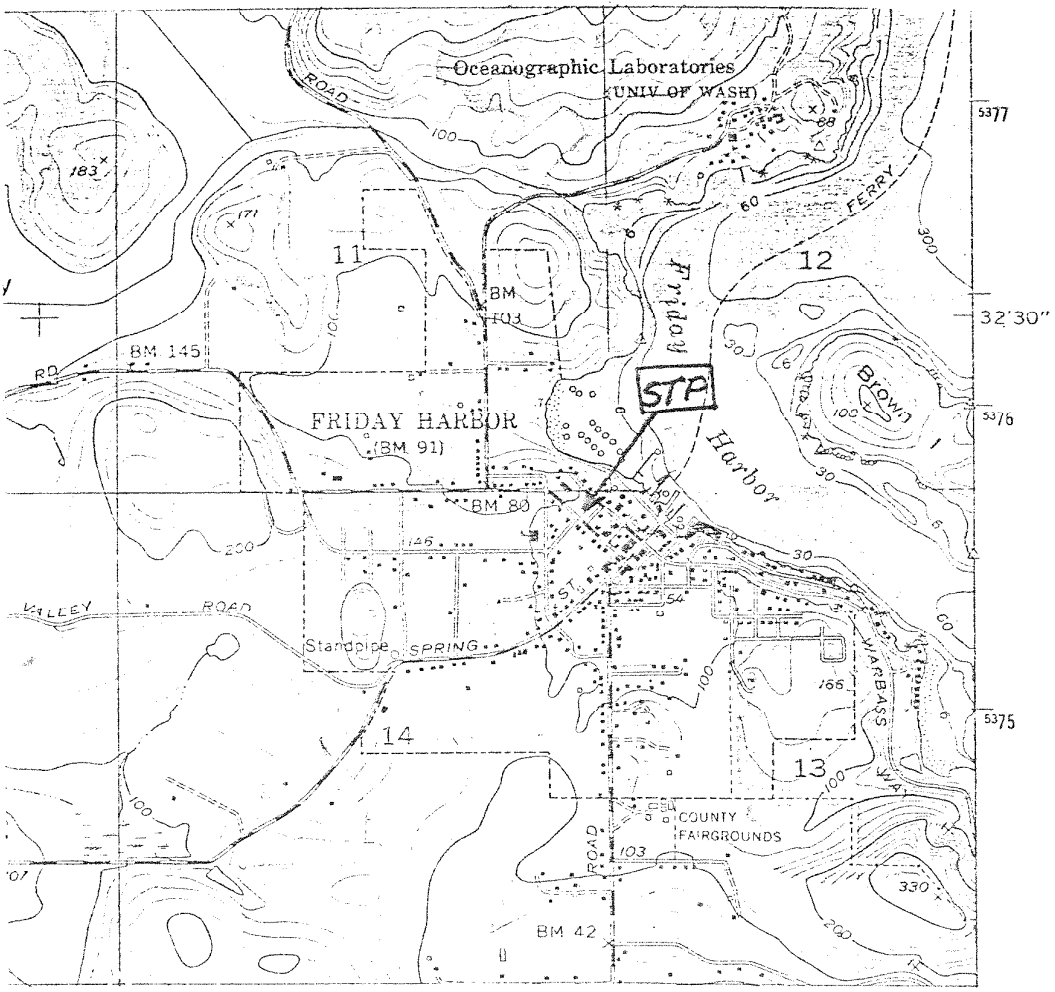
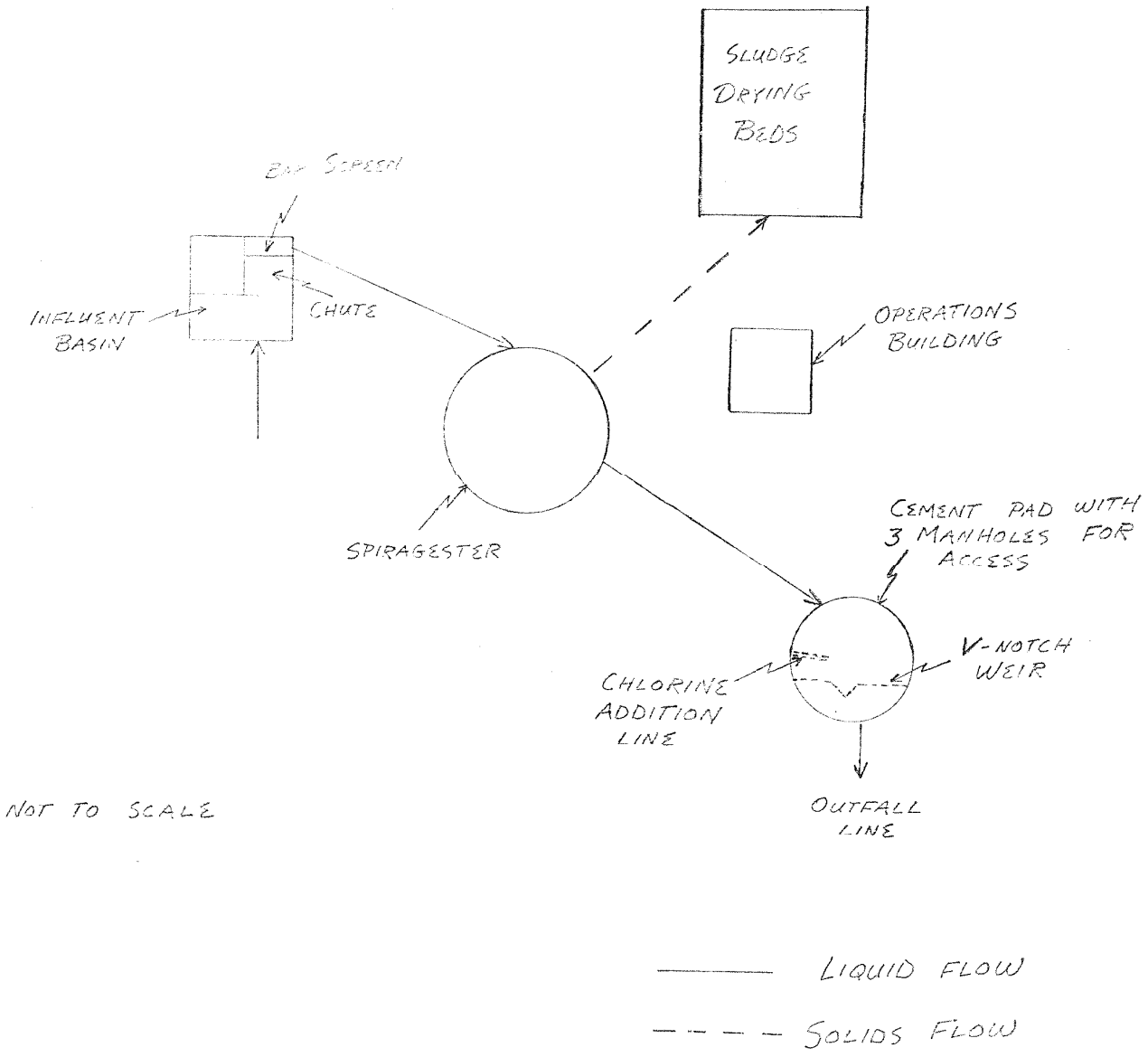



Figure 2. Friday Harbor STP flow scheme - May 1983 Friday Harbor Class II inspection.



as some channels were dry between influent surges. The inlet structure included a small basin (approximately 4 feet square and 3 feet deep) from which wastewater flowed down a chute then through a bar screen. Wastewater pooled in the basin between pumping cycles. This basin was chosen as the influent sampling site. The effluent sample was taken from a manhole just behind (approximately 3 feet) a V-notch weir over which the chlorinated effluent entered the outfall line. Water pooled sufficiently behind the weir to allow effluent samples to be taken. The sites selected were thought to be the most representative sites that were practical. Hand composite samples were taken by the Friday Harbor operator on May 18. Three samples of equal volume taken at intervals between 0700 and 1100 were combined to form a composite sample. Both the WDOE and STP composites were split for analysis by both laboratories. Results of the WDOE analysis are presented in Table 1.

Table 1. WDOE laboratory results of composite samples - May 1983 Friday Harbor Class II inspection.

| | | | | Solids (mg/L) | | | | | | | | Nutrients (mg/l) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | Compositor | $BOD_5$ (mg/L) | COD (mg/L) | Total | Total Non-volatile | Total Suspended | Total Non-volatile Suspended | Turbidity (NTU) | Conductivity (µmhos/cm) | Salinity (pst) | pH | $NO_3$-N | $NO_2$-N | $NH_3$-N | O-$PO_4$-P | Tot.-P |
| Influent | WDOE | 240 | 600 | 2500 | 1900 | 320 | 62 | 300 | 3500 | 2.1 | 7.4 | .20 | <.10 | 18 | 4.0 | 5.2 |
| | FH | 240 | | 1900 | 1500 | 140 | 23 | | 2950 | | | .20 | <.10 | 14 | 3.2 | 5.0 |
| Effluent | WDOE | 200 | 340 | 2100 | 1700 | 160 | 24 | 140 | 3110 | 1.9 | 7.4 | .15 | <.05 | 15 | 3.4 | 4.6 |
| | FH | 210 | | 2700 | 2200 | 70 | 11 | | 4050 | | | .15 | <.05 | 11 | 2.7 | 3.5 |

Grab samples were taken for field analysis and fecal coliform analysis (Tables 2 and 3). Also, a grab sample of sludge was taken for metals and solids analysis. The sludge sample, representative of that put on the drying bed, was a mixture of sludge taken from mid-depth and the bottom of the spiragester tank. Addition of the mid-depth sludge to the bottom sludge was necessary as the operator indicated that the bottom sludge was too thick to be pumped by itself with the available pump.

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Table 2. Field data - May 1983 Friday Harbor Class II inspection.

| Sample | Date | Time | Temperature (°C) | pH (S.U.) | Conductivity (μmhos/cm) |
|---|---|---|---|---|---|
| Influent | 5/17/83 | 1015 | 14.3 | 7.6 | 1800 |
| | 5/17/83 | 1445 | 14.5 | 7.6 | 540 |
| | 5/18/83 | 1005 | 14.3 | 7.9 | 3100 |
| | 5/17-18/83 | Comp. | 3.0 | 7.7 | 3500 |
| Effluent | 5/17/83 | 1025 | 14.0 | 7.1 | 2150 |
| | 5/17/83 | 1455 | 14.5 | 7.2 | 900 |
| | 5/18/83 | 1020 | 14.0 | 7.3 | 3200 |
| | 5/17-18/83 | Comp. | 3.3 | 7.5 | 3250 |

Table 3. Fecal coliform and chlorine residual data.
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| Sample | Date | Time | Fecal Coliform (#/100 mL) | Chlorine Residual (mg/L) |
|---|---|---|---|---|
| Effluent | 5/17 | 1350 | 530,000 | 0 |
| | 5/17 | 1530 | 3,900 | |
| | 5/18 | 1005 | 11,000 | 3.5* |
| | 5/18 | 1035 | | .2** |
| | 5/18 | 1050 | 60,000† | |

*Effluent flowing freely over weir.
**Effluent backing up behind weir.
†Analysis by the Friday Harbor STP lab of a sample collected at the same time found 5,000 colonies/100 mL.

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Flow measurement at the plant was difficult. The plant flow meter had not been operational for some time and was not in operation during the inspection. The effluent V-notch weir became submerged during part of the influent pumping cycle and could not be used. The operator determined flow by checking the hours of operation for the influent pumps and multiplying by the pump capacity (500 gpm). A WDOE flow estimate was made using the pump time and multiplying by an estimated pump output. The pump output estimate was based on measurements taken in the chute between the influent basin and the bar screen with a Marsh-McBernie magnetic flow meter (Table 4).

Table 4. Flow data and calculations - May 1983 Friday Harbor Class II inspection.

| | Plant Pump Records | | Marsh-McBernie Meter Flows (GPM) Measurement Number | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Clock Hours* | Pump Hours | 1 | 2 | 3 | 4 | Pump Rating (gpm)† | Flow (GPD) |
| Pump #1 | 26 | 6.1 | | | | | ≈300 | ≈101,000 |
| Pump #2 | 26 | 4.4 | | | | | ≈400 | ≈ 97,000 |
| Total | | 10.5 | 281 | 320 | 370 | 424 | | ≈200,000 |

*0915 on May 17 to 1115 on May 18.

†Pump rating estimates were made by averaging the two highest and two lowest Marsh-McBernie meter flows. This appeared reasonable because:

1. Based on visual observations of flow depth at the measuring station, it appeard that the flow rate was not constant.
2. Pumps at the pump station operated on an alternating basis yet the pump hours were not equal as one would expect.
3. The operator noted that pump #2 had recently been rebuilt, so one would expect it to be more efficient.
4. The averages estimate similar volumes pumped by each pump.

## Results and Discussion

Results of WDOE laboratory analysis of the composite samples are presented in Table 1. Composite sample conductivity results (range 2950-4050 µmhos/cm) were higher than generally expected for domestic wastes, indicating a portion of the plant flow may be saltwater. Field conductivities (Table 2) suggest that the amount of saltwater in the waste stream may be tide-related. On May 17, low low tide was at approximately 1410. At 1015 the plant influent conductivity was 1800 µmhos/cm while at 1445 the plant influent conductivity was 540 µmhos/cm. Using the following data;

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seawater conductivity = 32,500 µmhos/cm, based on receiving water data (Singleton & Joy, 1983)

influent conductivity at low low tide = 540 µmhos/cm (5/17 @ 1445 WDOE field measurement)

and, the WDOE influent composite conductivity of 3500 µmhos/cm,

it appears that approximately 10 percent of the plant flow during the Class II may have been seawater.

The other parameters measured from the WDOE composite sample seem indicative of a fairly typical sewage. It was noted by city personnel that during the inspection two pumper tanks of septic tank septage were dumped into the system, but the effect was not determined.

Flow to the plant was estimated to be 200,000 gpd (Table 4). As noted on the table, several assumptions were made in rating the influent pumps to make the estimation. The estimate was based on the entire flow entering the plant from the lift station. The instantaneous flow rate into the plant was either the capacity of the pump being used at the lift station or zero. This created an alternating series of surges and rest periods for the plant. Since surges of this nature are generally disruptive to treatment plant efficiency, allowance for or prevention of surging should be included as part of the treatment plant upgrade.

Loads to the plant based on the flow of .2 MGD and WDOE influent data are 400 lbs/D $BOD_5$ and 534 lbs/D TSS. Based on the NPDES permit monitoring reports listing a population of 1,220, one might expect 207 lbs/D $BOD_5$ (.17 lbs/cap.-D) and 244 lbs/D TSS (.2 lbs/cap.-D) and a flow of 122,000 gpd (100 gal/cap.-D). The heavier-than-expected loadings may be due in part to the tourist contribution to flow.

Fecal coliform counts at the plant were high and variable (Table 3, range 3900/100 mL to 530,000/100 mL). High counts were anticipated after inspecting the plant chlorination facilities. Chlorine was added to the surface of the flow about four feet upstream of the V-notch weir. Mixing was minimal and detention time variable as the surging effect of the influent pumps was realized at the weir. The variation in chlorine residual concentrations on May 18 (1005 chlorine residual 3.5 mg/L, 1035 chlorine residual .2 mg/L) illustrates the problem.

Table 5 compares WDOE Class II data to NPDES permit limits. The percent removal for TSS (50 percent) was reasonable for a primary system, while the $BOD_5$ percent removal (17 percent) was lower than might be expected. Percent removals for both fell far short of the secondary treatment requirements upon which the permit is based. Fecal coliform limits were also exceeded. Limits of the previous permit (based on primary treatment) are also included in Table 5. The old $BOD_5$, TSS, and fecal coliform limits were also exceeded.

Table 5. Comparison of Class II results to NPDES permit limits - May 1983 Friday Harbor Class II inspection.

| Parameter | NPDES Permit Limits | | Class II Results† | | Expired NPDES Permit Limits | |
|---|---|---|---|---|---|---|
| | Monthly Average | Weekly Average | Concentration and Load | Percent Removal | Monthly Average | Weekly Average |
| $BOD_5$ (mg/L) | 30* | 45 | 200 | | 165 | 180 |
| (lbs/day) | 75 | 113 | 334 | 17 | 275 | 300 |
| TSS (mg/L) | 30* | 45 | 160 | | 115 | 140 |
| (lbs/day) | 75 | 113 | 267 | 50 | 190 | 230 |
| Fecal Coliform (#/100 mL) | 200 | 600 | 3,900-530,000 | | 700 | 1500 |
| pH | $6.0 \leq pH \leq 9.0$ | | $7.1 \leq pH \leq 7.5$ | | $6.0 \leq pH \leq 9.0$ | |

†Results of WDOE analysis of the WDOE effluent composite.
*30 mg/L or 15 percent of the influent load, whichever is more stringent.

Table 6 reports the metals and solids analytical results for the sludge sample taken during the survey. Sludge metals concentrations are also compared to concentrations found in sludges from previously inspected primary plants throughout Washington State. Pb and Ni concentrations were found at lower concentrations than had been found previously. The other metals were found at concentrations within the range of concentrations found at other primary plants. The results of this sludge solids analysis indicate a watery sludge with a comparatively high percentage of volatile solids.

Table 6. Sludge metals and solids data - May 1983 Friday Harbor Class II inspection.

| | Friday Harbor Sludge | Previous Class II Data* | | |
|---|---|---|---|---|
| | | Geometric Mean | Range | Number of Samples |
| Metals (mg/Kg dry weight) | | | | |
| Cd | 4.2 | 6.9 | 1.8 - 17 | 19 |
| Cr | 14 | 57 | 11 - 540 | 19 |
| Cu | 400 | 434 | 137 - 1190 | 19 |
| Pb | 64 | 325 | 73 - 1090 | 19 |
| Ni | 14 | 49 | 18 - 120 | 13 |
| Zn | 690 | 1284 | 180 - 2680 | 19 |
| Solids (mg/L) | | | | |
| Total | 26,000 | | | |
| Volatile | 19,500 | | | |
| Non-Volatile | 6,500 | | | |

*Summary of data collected during Class II inspections at selected primary plants.

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Table 7 compares the Friday Harbor sludge solids content to "typical" sludge solids makeup (Metcalf and Eddy, 1972). The Friday Harbor "digested" sludge compares more closely to the "typical" raw primary sludge than "typical" digested sludge. Similarly, the percent volatile fraction of the Friday Harbor "digested" sludge was quite similar to the percent volatiles in the solids settled out by clarification during the Class II (Table 7). The data indicate that stabilization in the spiragester was minimal. Because of minimal stabilization and location in a residential area, limiting access to the drying beds might be considered.

Table 7. Comparison of Friday Harbor sludge solids concentrations to "typical values"* - May 1983 Friday Harbor Class II inspection.

| | Raw Primary Sludge* | | Digested Sludge* | | Friday Harbor Sludge |
|---|---|---|---|---|---|
| | Range | Typical | Range | Typical | |
| % TS | 2 - 7 | 4 | 6 - 12 | 10 | 2.6 |
| % of TS that are Vol. | 60 - 80 | 65 | 30 - 60 | 40 | 75 |

| | Friday Harbor** | | |
|---|---|---|---|
| | TSS (mg/L) | VSS (mg/L) | % Volatile |
| Influent | 320 | 258 | 81 |
| Effluent | 160 | 136 | 85 |
| Settled | 160 | 122 | 76 |

*Typical values from Metcalf and Eddy (1972).
**WDOE sampler WDOE analysis (Table 1).

General plant housekeeping could be improved. Equipment (hoses, rakes, shovels, etc.) laying around in the plant yard posed a safety hazard.

## Laboratory Analysis

Composite samples were split for analysis by both WDOE and Friday Harbor labs and laboratory procedures were reviewed with the Friday Harbor operator (the operator does his own laboratory analysis). Laboratory facilities at Friday Harbor were not adequate. The facility was small and served as both the laboratory and office area. Sufficient equipment to run the $BOD_5$ test was available in the lab, but neither an autoclave nor a functional balance were available at the plant. Autoclaving and weighing were done at the nearby University of Washington Oceanographic Laboratories.

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A comparison of results from the split sample analysis is presented in Table 8. The Friday Harbor lab ran only the $BOD_5$ test on the split composite samples and a fecal coliform test on grabs taken at the same time. Results from the two laboratories compare well for the WDOE influent composite, compare marginally for the WDOE effluent composite, and compare poorly for the Friday Harbor composite samples. It is unclear which BOD analyses for the Friday Harbor composite samples are more accurate. The WDOE TSS results indicated that the Friday Harbor composites may be weaker than the WDOE composites, but the WDOE $BOD_5$ results did not indicate that. Insufficient sample was requested from Friday Harbor and this prevented rerunning the TSS test or running a COD test which would have helped determine which results were more accurate.

Table 8. Comparison of WDOE and Friday Harbor laboratory results - May 1983 Friday Harbor Class II inspection.

| | | $BOD_5$ (mg/L) | | TSS (mg/L) | | F. Coli. (#/100 mL) | |
|---|---|---|---|---|---|---|---|
| Sample | Compositor | WDOE Analysis | Friday Harbor Analysis | WDOE Analysis | Friday Harbor Analysis | WDOE Analysis | Friday Harbor Analysis |
| Influent | WDOE | 240 | 251 | 320 | * | | |
| | Friday Hbr. | 240 | 146 | 140 | * | | |
| Effluent | WDOE | 200 | 152 | 160 | * | | |
| | Friday Hbr. | 210 | 111 | 70 | * | | |
| | Grab** | | | | | 60,000 | 5,000 |

*Analysis not performed.
**Grab samples taken at the same time by Friday Harbor and WDOE.

Grab samples were taken in succession for WDOE and Friday Harbor fecal coliform analysis. Results were not identical (WDOE 60,000/100 mL; Friday Harbor 5,000/100 mL), but because of the variation in chlorine residuals and fecal coliform counts noted in Table 3, the difference was not surprising. In this case, filling a vessel with sample and splitting that was probably the most advisable method of collecting coliform samples for lab comparison.

Review of the laboratory procedures with the operator showed that laboratory procedures were generally acceptable. Items warranting comment include:

1. pH meter calibration should be more frequent than monthly. Calibration with pH 7 buffer before use and two buffers weekly was suggested.

2. Use of a regular laboratory soap, such as "Alconox" for cleaning glassware was suggested. Use of an antibacterial hand soap as was done at Friday Harbor may inhibit BOD test activity if rinsing is inadequate.

3. Use of a Standard Methods approved filter paper for TSS analysis was suggested (APHA, 1980).

4. Limiting filtering time during the TSS test to less than five minutes was suggested. This minimizes the impact of dissolved solids on the test.

5. It was suggested that duplicate samples be run for TSS analysis when <50 mls of sample can be filtered. This allows more sample to be tested, thus helping minimize erroneous data due to small sample size.

6. As a quality assurance measure for the TSS test, it was suggested that occasionally the drying and weighing cycle for a sample be repeated to assure that a constant weight is attained and thus the sample is being completely dried.

## Conclusions

Based on WDOE analysis of the WDOE composite sample, the Friday Harbor STP removed about 17 percent of the $BOD_5$ and 50 percent of the TSS coming into the plant. The Friday Harbor STP is a primary plant and, as was expected, removals fell far short of the secondary treatment limits required by their NPDES permit. Observations relative to plant operation include:

1. The plant lacked an operable flow meter.

2. The entire flow to the plant came as surges from a pump station. As noted in the text, surging often limits treatment process efficiency. Allowance for, or prevention of, surging should be included as part of the treatment plant upgrade.

3. Some saltwater was entering the plant during the inspection (approximately 10 percent of the flow).

4. High fecal coliform levels were detected in the effluent. The high levels were thought to be the result of inadequate chlorine injection, mixing, and contact facilities.

5. Lab facilities were small and inadequate to conduct necessary tests without borrowing equipment.

6. The volatile solids content of the digested sludge (75 percent) indicated that stabilization during the digestion process was minimal. Restricting access to the drying beds might be advisable.

7. STP yard housekeeping posed safety risks.

8. Operator knowledge of laboratory testing procedures was generally good. Several suggestions are made in the text that may help improve reliability of results. As noted in the text, comparison of results from samples split for analysis by both the Friday Harbor and WDOE laboratories gave little insight into lab testing accuracy.

MH:cp

Attachments

# REFERENCES

APHA, AWWA, WPCF, Standard Methods for the Examination of Water and Wastewaters, 15th ed., 1980.

Singleton L. and J. Joy. Friday Harbor Receiving Water Survey. Memorandum to Dave Nunnallee, 1983.