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**WA-34-1020**

STATE OF WASHINGTON

Dixy Lee Ray
*Governor*

DEPARTMENT OF ECOLOGY
Olympia, Washington 98504 206/753-2800

MEMORANDUM

October 24, 1978

To: Claude Sappington

From: Bill Yake

Re: Pullman STP
Class II Inspection

Introduction:

A Class II inspection was conducted at the Pullman Sewage Treatment Plant on September 12-13, 1978. Present were Norm Glenn (DOE, Water Quality Management), Claude Sappington (DOE, Eastern Regional Office), Bill Yake and John Bernhardt (DOE, Water and Wastewater Monitoring), Ken Mosebaugh (U.S. EPA) and George Valentine (plant operator). A receiving water study was conducted in conjunction with this Class II by John Bernhardt and Bill Yake. The results of the receiving water study will be appended to this memorandum.

The Pullman treatment plant is an activated sludge plant with a design flow of 4.0 MGD. It consists of a single primary and single secondary clarifier, two aeration basins (only one operates during summer flow, both basins operate in parallel when Washington State University is in session), and anaerobic sludge digestion. The plant has been modified to allow step feeding of return activated sludge (RAS) at three locations along the length of each aeration basin. Control of the treatment process is maintained by a method using respiration rates. Respiration rates are determined for aeration basin influent and effluent mixtures and used to determine RAS rates and the point at which RAS is returned.

Historical difficulties with the plant include difficulty in adjusting to the dramatic loading changes associated with the transient university population and poor chlorine contact chamber design. Poor contact chamber design results in either high residual chlorine concentrations or the discharge of high fecal coliform concentrations. This inspection was conducted under stable operating conditions just prior to the fall influx of students.

Findings and Conclusions:

At the time of the inspection the plant was operating very efficiently with respect to $BOD_5$ and suspended solids removal. The results reported here and in recent DMR's indicate that under stable loading conditions this is one of the best operated medium-sized secondary

treatment plants in the state. Much of this success can be credited to the head operator, George Valentine. The modifications (stepped RAS feeding) and control scheme might well serve as an interim solution for other secondary treatment plants experiencing difficulty in meeting permit limitations.

Based on the results of the receiving water study the treatment plant's adverse effects on the biota of the South Fork of the Palouse River (SFPR) were primarily due to ammonia and chlorine residual. The impact of these two substances is aggravated by low flow conditions which regularly result in effluent dilution ratios as low as 2:1 to 3:1. Chlorine residuals of approximately 1.5 mg/l are required to achieve necessary disinfection. Poor chlorine contact tank design is largely responsible for poor disinfection efficiency. Chlorine residuals of 0.2 mg/l were detected more than a mile downstream of the discharge. Improved design in the upgrade should allow adequate disinfection with chlorine residuals of approximately 0.5 mg/l. Because of low dilution ratios, dechlorination will be necessary to achieve receiving water concentrations of less than the criteria level of 0.02 mg/l.

Effluent ammonia-nitrogen concentrations were approximately 15 mg/l during the inspection. If one assumes that no ammonia were present in the SFPR above the plant, this effluent concentration would have resulted in an undisassociated ammonia-nitrogen concentration of 0.06 mg/l under the existing conditions (i.e. SFPR upstream flow: 3.41 MGD, plant flow: 2.66 MGD, SFPR downstream pH 7.4, SFPR downstream temperature 18.5°C). This compares to the criteria level of 0.017 mg $NH_3$-N/l (0.02 mg $NH_3$/l). This situation will be discussed more fully in the recommendations section of the receiving water study; however, it should be noted that relatively minor increases in receiving water pH would dramatically raise the concentration of undisassociated ammonia. The inclusion of a nitrification mode in the plant upgrade would assure compliance with the 0.02 mg $NH_3$/l criteria level in all but the worst case conditions (concurrently high receiving water pH and temperature, coupled with low receiving water flow).

The Pullman facility discharges to waterway Segment 16-34-02 (SFPR and tributaries) which is identified in the five-year strategy as not meeting state and federal goals for pH, dissolved oxygen, and fecal coliform concentrations primarily due to non-point sources. This segment is, based on frequency and severity of violations, the third worst of 36 segments in the category. These violations are probably largely due to the following factors:

1) Under summer low flow conditions most of the flow in the SFPR above the Pullman STP is treated effluent from Moscow, Idaho.

2) Nutrient concentrations are high in this drainage's waters due to both agricultural runoff and urban effluents (Moscow, Pullman, and Albion). The extremely eutrophic condition of these waters is probably, at least in part, responsible for high pH's and low dissolved oxygen concentrations.

3) High fecal coliform concentrations are probably due to a combination of sources including a dairy upstream of Pullman, streamside watering of livestock, storm sewer overflows, summer regrowth in slow sections of the stream, and possible septic tank drainfield failures.

Laboratory procedures are discussed in detail in the "Review of Laboratory Procedures" section of this report, as well as in the attached "Laboratory Procedures Survey." Procedures were, in general, excellent. As in earlier $BOD_5$ sample splits the Pullman laboratory results are approximately 20-25% lower than other laboratories. Although this is within an acceptable error range for this test a complete review of dissolved oxygen measurement techniques by the laboratory might reveal the source of the apparent error.

Under the above-mentioned conditions, the Pullman STP has little direct adverse effect on the stream with respect to pH, dissolved oxygen and fecal coliforms. Addition of nutrients may accelerate indirect (eutrophic) effects, and excess chlorine residual and high ammonia concentrations are probably responsible for toxicity to certain aquatic organisms.

WY:ee

cc: Dick Cunningham
Central Files
Files (2)

24 Hour Composite Sampler Installations

| Sampler | Date and Time Installed | Location |
|---|---|---|
| 1. Influent aliquot - 250 ml/30 min. | 9/12/78 - 0915 | Between comminutor and Parshall flume, same location used by STP. |
| 2. Unchlorinated effluent aliquot - 250 ml/30 min. | 9/12/78 - 0940 | Outfall of secondary outfall, same location used by STP. |
| 3. Chlorinated effluent aliquot - 250 ml/30 min. | 9/12/78 - 1000 | Outfall of chlorine contact chamber. |

Grab Samples

| | Date and Time | Analysis | Sample Location |
|---|---|---|---|
| 1. | 9/12/78 - 1030 | Fecal Coliform & Fecal Strep | Outfall to S.F. Palouse River |
| 2. | 9/13/78 - 1030 | Fecal Coliform | Outfall to S.F. Palouse River |
| 3. | 9/13/78 - 1000 | Trace metals | Sludge from secondary digester |
| 4. | | | |
| 5. | | | |
| 6. | | | |

Flow Measuring Device

1. Type - Parshall flume
2. Dimensions

a. Meets standard criteria [XX] Yes
[ ] No Explain:

b. Accuracy check

| | Actual Instan. Flow | Recorder Reading | Recorder Accuracy (% of inst. flow) |
|---|---|---|---|
| 1. | 3.88 MGD | 4.0 MGD | 103.1% |
| 2. | 3.70 MGD | 4.0 MGD | 108.1% |
| 3. | | | |

[X] is within accepted 15% error limitations
[ ] is in need of calibration

Field Data

| Parameter | Date and Time | Sample Location | Result |
|---|---|---|---|
| pH, Temp., Cond. | 9/12/78 - 0915 | Influent | See Results |
| pH, Temp., Cond. | 9/12/78 - 0940 | Unchlorinated effluent | " |
| pH, Temp., Cond. | 9/12/78 - 1000 | Chlorinated effluent | " |

Review of Laboratory Procedures and Techniques

Laboratory procedures were reviewed with George Valentine. The attached "Laboratory Procedure Survey" details $BOD_5$ and suspended solids analytical procedures. In general, laboratory procedures appear to be excellent:

$BOD_5$

1) Incubator apparently has temperature gradient. However, the present procedure includes determination of test temperature using water bath located on same shelf as BOD bottles. Because the thermostat is adjusted to provide 20°C temperature on the incubation shelf, this problem is probably minimized.

2) A small amount of water is displaced by the D.O. probe when initial D.O.'s are determined. Presently distilled water is added to replace displaced water. It was suggested that specially made rings available from standard scientific supply sources can be attached to the necks of the bottles to prevent loss of dilution water.

3) Sample water is not brought to 20°C prior to making dilutions. Conceivably this could result in false D.O. depletions in effluent dilutions where substantial volumes of sample would lower the initial temperature of the dilution. However, tests previously run by the STP lab indicate this has little, if any, effect on results. The problem is minimized possibly because of tight BOD bottle caps and low sample D.O. concentrations.

4) The STP laboratory $BOD_5$ results are generally 20-25% lower than sample splits with other laboratories. This kind of consistent error is often caused by an error in D.O. determination. Although the lab's calibration and standardization techniques were apparently correct, a detailed review of D.O. meter accuracy and sodium thiosulfate standardization by the lab could reveal the source of the apparent error.

TSS

1) At least 50 ml of sample should be filtered for analysis. For influent samples this may require duplicate, 25-35 ml aliquots.

Fecal Coliform

1) Lab uses membrane filter technique, analyses correct.

$Cl_2$ Residual

1) Lab uses LaMotte DPD #4 tables, analyses correct.

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 Samplers DOE Laboratory | | | DOE Samplers Pullman STP Laboratory | | | NPDES (Monthly average) |
|---|---|---|---|---|---|---|---|
| | Influent | Unchlor. Effluent | Chlor. Effluent | Influent | Unchlor. Effluent | Chlor. Effluent | |
| $BOD_5$ mg/l | 136 | 12 | < 4 | 112 | 7.4 | | 70** |
| lbs/day | 3020 | 265 | <89 | 2480 | 165 | | 3500** |
| TSS mg/l | 190 | 4 | 5 | 171 | 9.1 | | 90** |
| lbs/day | 4220 | 89 | 110 | 3790 | 202 | | 4500** |
| Total Plant Flow MGD | 2.66 | | | 2.66 | | | |
| COD (mg/l) | 329 | 67 | 67 | | | | |
| pH | 7.9* | 7.4* | 7.4* | | | | 6.5 - 8.5 |
| | 7.7† | 7.5† | 7.5† | | | | |
| Spec. Cond. (µmhos/cm) | 610* | 680* | 660* | | | | |
| | 612† | 575† | 593† | | | | |
| Organic-N (mg/l) | 4.6 | - - | - - | | | | |
| $NH_3$-N (mg/l) | 14.4 | 14.6 | 13.1 | | | | |
| $NO_2$-N (mg/l) | < 0.02 | < 0.02 | < 0.02 | | | | |
| $NO_3$-N (mg/l) | < 0.02 | < 0.02 | < 0.02 | | | | |
| O-$PO_4$-P (mg/l) | 3.2 | 3.0 | 3.0 | | | | |
| T-$PO_4$-P (mg/l) | 5.9 | 3.7 | 3.3 | | | | |
| Fecal Coliform (#/100 ml) | - - | - - | 10 est.[1] | | | | 200 |
| | | | 10 est.[2] | | | | |
| Chlorine Residual (mg/l) | - - | - - | 1.5[1]* | | | | 0.1-0.5** |
| | | | 1.6[2]* | | | | |
| Total Solids (mg/l) | 635 | 366 | 368 | | | | |
| TNVS (mg/l) | 341 | 284 | 289 | | | | |
| Total Sus. Solids (mg/l) | 190 | 4 | 5 | | | | |
| TNVSS (mg/l) | 54 | 1 | 2 | | | | |
| Turbidity | 72 | 4 | 4 | | | | |
| Temp. °C | 20.2 | 19.3 | 19.0 | | | | |

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

† Laboratory analysis of composite

** Order (DE 77-284) Amending NPDES Permit

[1] Grab - 9/12/78, 1030

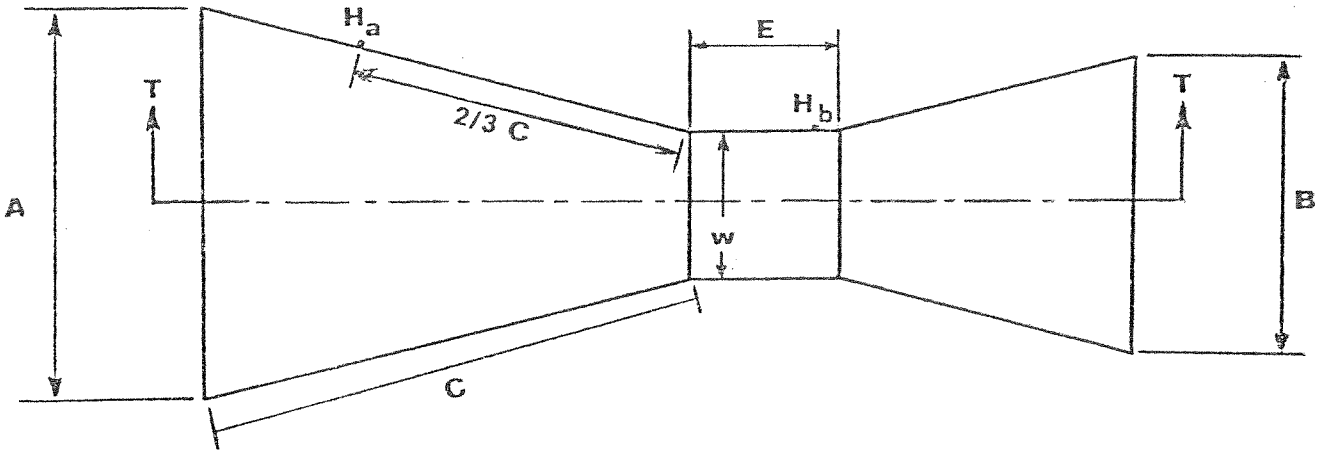
[2] Grab - 9/13/78, 1030

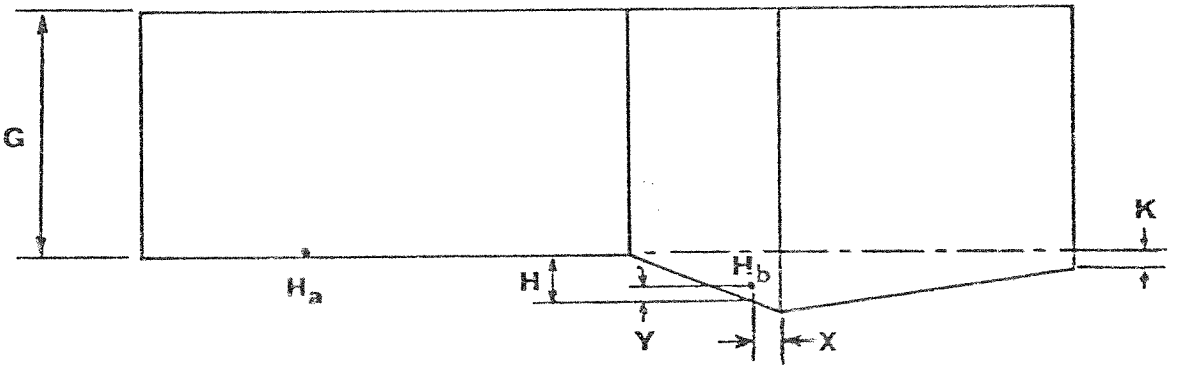
| | Pullman STP Samples DOE Laboratory | | Pullman STP Samples Pullman STP Laboratory | | NPDES (Monthly Average) |
|---|---|---|---|---|---|
| | Influent | Unchlor. Effluent | Influent | Unchlor. Effluent | |
| BOD (mg/l) | 160 | 9 | 132 | 7.9 | 70** |
| lbs/day | 3440 | 194 | 2840 | 170 | 3500** |
| TSS (mg/l) | 122 | 5 | 151 | 9.5 | 90** |
| lbs/day | 2630 | 108 | 3250 | 205 | 4500** |
| Total Plant Flow MGD | 2.58 | | 2.58 | | |
| COD (mg/l) | 329 | 67 | | | |
| pH | 7.5 | 7.8 | | | 6.5 - 8.5 |
| Spec. Cond. (µmhos/cm) | 643 | 641 | | | |
| Total Solids (mg/l) | 559 | 380 | | | |
| TNVS (mg/l) | 319 | 308 | | | |
| Total Suspended Solids (mg/l) | 122 | 5 | | | |
| TNVSS | 36 | 1 | | | |

* Field Analysis "<" is "less than" and ">" is "greater than"
** Order (DE 77-284) Amending NPDES Permit

# PARSHALL FLUME: Pullman

## Dimensions & Flow




| Code | Spec's | Measured |
|---|---|---|
| A | 40 3/8" | 40" |
| B | 30" | 30¼" |
| C | 57" | 58¼" |
| 2/3 C | 38" | ? |
| E | 24" | 20 1/8" |
| G | 36" | 54" |
| H | | |
| K | | |
| W | | 18" |
| X | | |
| Y | | |

| Time | $H_a$ | $H_b$ | Theoretical Flow | Recorded Flow |
|---|---|---|---|---|
| 0850 | 12" | | 3.88 | 4.2 (outside) |
| 0855 | 11 5/8" | | 3.70 | 4.0 script chart |
| | | | | 4.09 outside |
| | | | | 4.00 script chart |

LABORATORY PROCEDURAL SURVEY

Discharger: PULLMAN SEWAGE TREATMENT PLANT

NPDES Permit Number: WA-004465

Date: 9/12/78

Industry Representatives present: GEORGE VALENTINE

Agency Representatives present: BILL YAKE

I.) BIOCHEMICAL OXYGEN DEMAND CHECKLIST

What analysis technique is utilized in determining biochemical oxygen demand?

1. Standard Methods X
2. EPA
3. NCASI
4. Other

A.) SAMPLE COLLECTION AND PREPARATION

1. Are samples collected at a point where homogeneous conditions exist? YES
2. Are samples collected via composite or grab? GRAB COMPOSITE
3. What is compositing period? hourly from 0700-2100 How often does compositor draw a sample? hourly, night flow represented by morning grab.
4. Is composite sample flow proportional? YES
5. Are composites refrigerated during collection? YES
6. Are BOD samples frozen prior to analysis? NO

   If Yes: a.) For how long? N.A.

   b.) Are samples reseeded before set-up? N.A.

7. How long are samples held prior to analysis? 2-3 hr.
8. Under what condition are samples held prior to analysis?

   REFRIGERATED AT 36°F.

9. What is the approximate sample water temperature at time of set-up? 36°F, this may affect test when 100-200 ml sample diluted. SAYS tight tops & lack of air space prevents false D.O. depletion. Have run tests.

10. Are compositor bottles and sampling lines cleaned periodically? BOTTLES YES, SAMPLING LINES N.A.

11. Does compositor go through a flush cycle before drawing sample? N.A.

12. Are composite container contents mixed thoroughly before sample is withdrawn? YES.

B.) SEED MATERIAL

1. Is seed material used in determining BOD? NO

2. Where is seed material obtained? N.A.

3. Is seed from an unchlorinated effluent? N.A.

4. How long is a batch of seed kept? N.A.

5. Under what conditions is seed kept? (temperature, dark)

N.A.

C.) DILUTION WATER

1. Reagent water utilized in preparing dilution water is:

distilled, deionized, tap, other STOKES STILL

If tap, is it chlorinated or unchlorinated? N.A.

2. Is reagent water aged prior to use? NO, DILUTION WAS IS.

3. How long is it aged, and under what conditions? DILUTION WATER AGED UP TO 4 WEEKS.

4. When is the phosphate buffer added (in relation to sample set-up)? UP TO 2 WEEKS PRIOR TO USE.

5. Are the four (4) nutrient buffers added to the reagent water in prescribed volumes? YES

6. How often is dilution water made up? (Maximum age of dilution water at time of set-up.) 4 WKS.

7. How often are BOD's being set up? 2 to 3 per week

8. Under what conditions is reagent water kept? N.A.

9. Under what conditions is dilution water kept? 20°C in incubator

10. What is dilution water temperature at time of set-up? 20°C

D.) TEST PROCEDURE

1. Does sample to be tested contain residual chlorine? No

   If yes, is sample dechlorinated and reseeded? N.A.

2. Is sample pH 6.5-8.5? Not checked, probably not a problem

   If no, is sample pH adjusted and reseeded? No

3. How is pH measured? Photovolt 115A

   Probe calibration frequency: When questionable reading noted. Suggested keeping buffers on hand.

4. Is effluent sample toxic? Probably not

5. Is BOD of dilution water determined? Yes. (usually < 0.2 mg/l)

6. Is seed BOD determined? N.A.

7. Is BOD of seeded blank determined? N.A.

   If yes, is 5-day dissolved oxygen depletion of seeded blank near 0.5 mg/l beyond that of dilution water blank? N.A.

8. Is zero day D.O. obtained from sample dilution or from dilution water prior to sample addition?

   From sample dilution (slight water displacement - distilled water added to bring water back over cap, i.e. water seal)

9. What is the range of zero day D.O. in dilution water blank?

   7.5 - 8.2 mg/l

10. How much seed is used in preparing seeded dilution water?

    N.A.

11. Is liter dilution method or bottle dilution method utilized in the preparation of:

a.) Seeded dilution water: N.A.

b.) Sample dilutions: BOTTLE DILUTION METHOD

12. Are samples and controls incubated for 5 days at 20°C? YES

13. How is incubator temperature range regulated and kept track of? THERMOMETER IN WATER BATH, RECORDED WITH EACH BATCH OF RESULTS.

THERMAL GRADIENT NOTED IN INCUBATOR, THERM. ON SAME SHELF AS SAMPLES

14. By what method are dissolved oxygen concentrations determined?

Probe USUALLY Winkler OCCASIONALLY Other _____

If by probe: What method of calibration is in use? THIO.

What is frequency of calibration: WHENEVER USED.

If by Winkler: Is sodium thiosulfate or PAO used as titrant? USUALLY THIO, HAVE TRIED PAO

How is standardization of titrant accomplished? AGAINST BI-IODATE

What is the frequency of standardization?

WITH EACH NEW BATCH.

15. What is the observed dissolved oxygen depletion in the dilution water blank? 0.2 mg/l

## BIOCHEMICAL OXYGEN DEMAND
## METHODS FOR CALCULATING FINAL VALUES

1.) WASHINGTON STATE DEPARTMENT OF ECOLOGY

A.) CORRECTION FACTORS

1. Dilution factor:

$$= \frac{\text{total dilution volume (ml)}}{\text{volume of sample diluted (ml)}}$$

2. Seed correction:

$$= \frac{(\text{BOD of Seed})(\text{ml of seed in 1 liter dilution water})}{1000}$$

3. F factor ~ a minor correction for the amount of seed in the seeded reagent versus the amount of seed in the sample dilution:

$$F = \frac{[\text{total dilution volume (ml)}] - [\text{volume of sample diluted, ml}]}{\text{Total dilution volume, ml}}$$

B.) FINAL BOD CALCULATIONS:

For seed reagent:

(seed reagent depletion-dilution water blank deoletion) x D.F.

For seeded sample:

(sample dilution depletion-dilution water blank depletion-scf) x DF

For unseeded sample:

(sample dilution depletion-dilution water blank depletion) x D.F.

2.) INDUSTRY

$BOD_5 = f(D.O._0 - D.O._5)$

DO NOT CORRECT FOR BLANK

REQUIRE 30-80% D.O. DROP

RUN GLUCOSE-GLUTAMIC ACID ~~Blanks~~ STANDARD MONTHLY, USUALLY WITH IN RANGE.

WHEN SPLITS ARE RUN, THE STP LAB USUALLY COMES ABOUT 25% LOW.

II.) TOTAL SUSPENDED SOLIDS CHECKLIST

What analysis technique is utilized in determining total suspended solids?

(a. Standard Methods)

b. EPA

c. NCASI

d. Industry

A.) Sample Collection

1. Are TSS samples representative of the discharge in question, i.e., taken from a homogeneous segment of the effluent? Yes

2. How long are samples held prior to analysis? 2 HRS.

3. Is composite container well mixed when sample is withdrawn? Yes

4. Under what conditions are samples held prior to analysis? ____

REFRIGERATED AT 36°F

B.) Test Procedure

1. What type of filter is utilized:

(Reeve Angel 934 AH)
Gelman Type A/E
Other _____ Size _____

2. What type of filter support is used?

   Gooch crucible X, Millipore filter suction base ____, Other ____

3. Are filters washed prior to adding sample? YES

   a. If yes: are filters then dried for a minimum of one hour ____ at 103-105°C ____. FIRED AT 550°C

   b. Are filters allowed to cool in a dessicator prior to weighing? YES

4. How are filters stored prior to use? IN DESSICATOR

5. What is the average and minimum volume filtered?

   35 ml. INFLUENT 200-300 ml effluent.

6. How is sample volume selected?

   a. ease of filtration ____

   b. ease of calculation ____

   c. grams per unit surface area ____

   d. other TIME OF FILTRATION 5-10 MIN.

7. What is the average filtering time (assume sample is from final effluent)? 5-10 MINUTES

8. How does analyst proceed with the test when the filter clogs at partial filtration? SAYS IF DOESN'T HAPPEN, DUE TO CORRECT VOLUME CHOICE

9. If less than 50 milliliters can be filtered at a time, are duplicate or triplicate filtrations performed? NO, HOWEVER THIS WAS SUGGESTED

10. Is filter funnel washed following sample filtration? YES

11. Following filtration, is filter dryed for 1 hour, cooled in a dessicator and then reweighed?

    YES

12. Is a filter aid such as cellite used? NO

TOTAL SUSPENDED SOLIDS
METHODS OF CALCULATION

1.) WASHINGTON STATE DEPARTMENT OF ECOLOGY

$$mg/l\ TSS = \frac{A-B}{C} \times 10^6$$

Where: A = final weight of filter & residue (grams)
B = initial weight of filter (grams)
C = milliliters of sample filtered

2.) INDUSTRY

$$\left(\frac{1000}{\text{mls of sample}}\right)\left(\text{weight change in mg.}\right) = \frac{\text{mg solids}}{l}$$

SPLIT SAMPLE RESULTS:

Origin of Sample Automatic & grab composites
Collection Date 9/12-13/78

| BOD | | TSS | | EPA BOD Standard | |
|---|---|---|---|---|---|
| DOE | IND. | DOE | IND. | DOE | IND. |
| 136 | 112 | 190 | 171 | ___ | ___ |
| 12 | 7.4 | 4 | 9.1 | | |
| 160 | 132 | 122 | 151 | | |
| 9 | 7.9 | 5 | 9.5 | | |