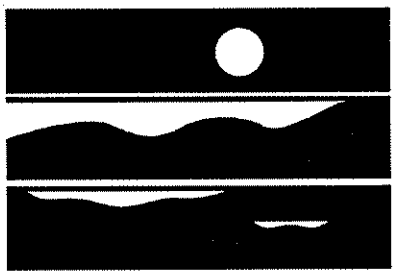

CITY OF PORT ORCHARD
SEWAGE TREATMENT PLANT
CLASS II INSPECTION

January 1995

Water Body No. 15-00-40
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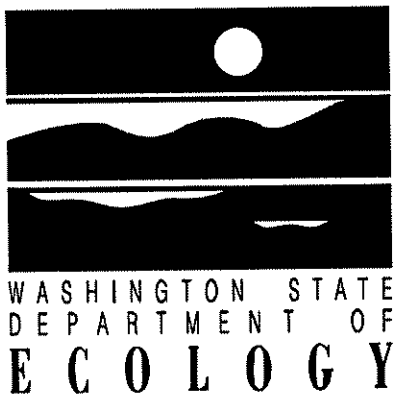

City of Port Orchard Sewage Treatment Plant Class II Inspection

by
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Environmental Investigations and Laboratory Services Program
Olympia, Washington 98504-7710

January 1995

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Abstract

An announced Class II Inspection was conducted March 14-16, 1994 at the Port Orchard Sewage Treatment Plant in Kitsap County, Washington. The facility operates a conventional activated sludge treatment system, with chlorine disinfection and anaerobic digestion of sludge. **Most effluent results were within the NPDES permit limits**. Reduction of BOD_5 and TSS across the plant was excellent. **NH_3-N removal did not occur in the system, and the effluent concentration exceeded Washington State acute and chronic marine water quality standards for ammonia**. Tentative dilution zone modeling suggests that dilution at the edge of the chronic mixing zone is insufficient to meet the ammonia standard, but a mixing zone study is recommended to confirm this conclusion. **It is recommended that the mixing zone study be used to determine if a mixing zone can be included in the Port Orchard permit**. The Port Orchard sample results produced an effluent BOD_5 concentration that exceeded the percent-of-influent concentration allowed by permit. **One effluent fecal coliform count exceeded the monthly average permit limit. Contact time in the chlorine contact chamber should be evaluated**. Split comparisons between samples were divergent, and Port Orchard should review sampling protocol to identify improvements in sampling technique.

Priority pollutant organics and metals were detected in the effluent, but only **bis(2-ethylhexyl)-Phthalate and copper exceeded the state water quality standards for marine receiving waters. A tentative dilution zone model analysis suggests that dilution was adequate to meet both standards. Wastewater bioassays exhibited significant acute and chronic toxicity. It is recommended that further bioassays be conducted to characterize effluent toxicity and determine effluent impact on marine organisms. The need for a pretreatment program to reduce influent metals should also be evaluated**. Digested sludge contained a slightly higher percent of volatile solids and a higher concentration of Kjeldahl nitrogen than typical treatment systems.

Sediment bioassays exhibited acute and chronic toxicity. It is recommended that the impact of outfall deposition on sediment toxicity be evaluated.

Summary

Flow Measurements

The accuracy of Port Orchard's effluent flow measurement device was not independently corroborated by Ecology. Documents showed that the Port Orchard flow meter had been calibrated by a factory representative three days prior to the inspection. An average effluent flow of 1.19 MGD was calculated from totalizer records over the three day period of the inspection. Influent flows were not measured by Port Orchard.

Wastewater General Chemistry

The influent BOD_5 concentration was within a typical medium range. TOC concentration fell into the weak range of typical influent concentrations. The BOD_5/TOC ratio was higher than typical and may indicate a deficiency of biologically inactive organic carbon. TS concentration fell into a medium range for typical influents and when interpreted with the BOD_5/TOC ratio results suggests a higher than typical concentration of non-organic constituents in the influent. The primary clarifier reduced BOD_5 by 39% and TSS by 55%, removal efficiencies that compare well with similar designs. Across the plant BOD_5 removal approached 95% and TSS removal 94%, both excellent efficiencies compared to other treatment plants. Ammonia nitrogen removal efficiency was 2%, nitrate+nitrite-nitrogen concentration remained unchanged, and alkalinity concentration was stable, all indicating a lack of nitrification. A complete lack of nitrification is unusual for conventional secondary treatment processes. Effluent ammonia concentrations exceeded both acute and chronic Washington marine water quality standards for ammonia (WAC 173-201A). Tentative dilution zone modeling suggests that dilution is insufficient at the edge of the chronic dilution zone to meet water quality standards.

NPDES Comparisons

Effluent BOD_5 and TSS concentrations and the corresponding calculated loads were all within the NPDES permit monthly and weekly average limits. The Ecology 24-hour composite sample result for effluent BOD_5 was within the NPDES monthly limit, which restricts the effluent concentration to no more than 15% of the influent concentration. The Port Orchard 24-hour composite BOD_5 sample result exceeded this limit.

Plant flow rate and chlorine residual concentrations were within NPDES permit limits. The fecal coliform density for one grab sample exceeded the permit limit, despite a relatively high chlorine residual concentration. This may indicate inadequate retention time in the chlorine contact chamber.

Split Samples

Comparison of Ecology lab results showed some divergence between Ecology and Port Orchard effluent samples for TSS and BOD_5. Port Orchard was producing a higher value and this may be a systematic problem. Influent BOD_5 results and primary clarifier effluent TSS results also differed between samples. Port Orchard lab results for these sample splits closely mirrored Ecology's results. These findings indicate differences in sampling techniques.

Comparisons between laboratories showed close agreement for BOD_5, TSS results, and field pH results. Comparison of Port Orchard lab results for fecal coliform to Ecology results produced a relative percent difference of more than 100%.

Wastewater Organic and Metal Scan Results

Three VOAs were detected in the effluent, but none exceeded the State or EPA water quality criteria for marine receiving waters. One BNA, bis(2-ethylhexyl)phthalate, exceeded the EPA chronic water quality criteria for marine receiving waters. Copper was detected in the effluent at a concentration exceeding the State acute water quality criteria for marine receiving waters (WAC 173-201A). Preliminary dilution zone modeling indicates that these concentrations would be reduced below the Washington State marine water quality criteria in both the acute and chronic zone. Arsenic, cadmium, silver, and zinc were also detected in the effluent samples (*Table 5*), but none exceeded either the EPA or state marine water quality standards.

Wastewater Bioassays

Significant acute toxicity in the effluent was demonstrated by the *Daphnia magna* 48-hour survival test and the fathead minnow 96-hour larval survival test. Toxicity for these acute tests exceeded the performance standards cited in Washington State's Whole Effluent Toxicity Testing and Limits (WAC 173-205). The *Ceriodaphnia dubia* 7-day survival and reproduction test and the fathead minnow 7-day larval survival and growth test revealed severe chronic toxicity. One possible cause of this toxicity could be the high concentration of ammonia in the effluent. Copper and mercury concentrations may also be a cause of the toxicity.

Sludge

Volatile solids as a percent of total percent solids was above the range for typical anaerobically digested primary and waste activated sludge. The Kjeldahl nitrogen concentration was also higher than that found in typical digested sludge. Several VOAs and one BNA were detected in appreciable concentrations. A number of metals were also detected, but none were found in concentrations affecting landfill disposal or inhibited anaerobic digestion.

Sediments

Average grain sizes predominated, followed by a moderate percentage of silt. Most general chemistry constituents fell into typical ranges for marine sediments. Metals concentrations were well below the Marine Sediment Quality Standards. The *Rhepoxynius abornius* 10-day emergence and survival test showed some chronic toxicity in the sediment sample taken from Sinclair Inlet at the middle of the Port Orchard diffuser length. The Microtox test revealed acute toxicity at all sample locations. The cause of the toxicity is inconclusive, although it may be associated with outfall deposition.

Recommendations

General Chemistry

- Port Orchard should investigate methods for reducing ammonia nitrogen concentrations in the effluent.
- Ammonia nitrogen limits should be included in the NPDES permit if a mixing zone study shows a reasonable potential for exceedences of water quality standards..

NPDES Comparisons

- Port Orchard should review DMRs and scrutinize ongoing monitoring to determine how frequently effluent BOD_5 concentrations in the effluent exceeds 15% of the concurrent influent BOD_5 concentration, as restricted by the NPDES permit.
- Port Orchard should investigate whether retention times in the chlorine contact chambers are sufficient to adequately control fecal coliform counts.

Split Samples

- Port Orchard should review composite sampling protocols to identify potential improvements in sampling techniques.
- Port Orchard should review their laboratory's fecal coliform analysis protocol to identify potential problems with accuracy.

Wastewater Organic and Metal Scans

- An effluent and receiving water mixing study should be completed to confirm whether dilution reduces bis(2-ethylhexyl)phthalate and copper concentrations to below Washington State acute and chronic water quality criteria.

Wastewater Bioassays

- Additional bioassays should be conducted to determine the impact of identified effluent toxicants.
- Additional bioassays should be performed to determine specific effects on marine organisms.
- The need for the addition of a pretreatment program to reduce concentrations of influent metals should be evaluated.

Sediment Bioassays

- Characterization of outfall deposition should be undertaken to determine the outfall's effects on sediment toxicity.

Introduction

A Class II Inspection was conducted at the Kitsap County Sewer District No. 5 (Port Orchard) Sewage Treatment Plant (STP) on March 14-16, 1994. Guy Hoyle-Dodson, environmental engineer for the Washington State Department of Ecology's Toxics Investigations Section, and Ed Abbasi, municipal permit manager for the Department of Ecology's Northwest Regional Office, conducted the investigation. Plant Superintendent, Richard A. Fitzwater, and Lab Supervisor, Mark Morgan, provided information on facility operation and assistance on site.

The Port Orchard STP serves the City of Port Orchard, surrounding county residences, and a local Veterans Administration convalescence facility. The plant provides secondary treatment for a population of more than 5,000, consisting mainly of private residences and light commercial businesses. The plant discharges treated effluent to Puget Sound's Sinclair Inlet, southeast of the Bremerton Navel Shipyard. An NPDES Permit (No. WA-002034-6) was issued May 28, 1993 with an expiration date of May 28, 1998.

The Class II inspection was initiated by the Department of Ecology to evaluate permit compliance and to provide information about facility loading and performance. Also of interest was the effluent's impact on Sinclair Inlet sediment. Specific objectives of the inspection included:

1. Assess NPDES permit compliance;

2. Evaluate wastewater toxicity by comparisons of effluent bioassays with Washington State whole effluent toxicity limits;

3. Evaluate wastewater toxicity by comparisons of priority pollutant organic and metal scans with EPA and Washington State water quality criteria;

4. Evaluate treatment plant performance;

5. Evaluate sludge toxicity by comparisons of priority pollutant organic and metal scans with pertinent EPA land application standards. Identify potentially deleterious concentrations of non-priority pollutant organic compounds by selective organic scans;

6. Assess permittee's self-monitoring with split samples; and

7. Evaluate sediment toxicity by bioassays and by comparisons of metals scans with marine sediment criteria.

Setting

The Port Orchard treatment facility is located east of the city of Port Orchard (*Figure 1*) in Kitsap County, Washington. The facility uses a conventional activated sludge treatment system followed by chlorine disinfection. The system consists of: headworks with a mechanical barscreen and a grit chamber, three rectangular primary sedimentation tanks, six diffused-air aeration tanks, two center feed secondary clarifiers, two chlorine disinfection chambers, two anaerobic sludge digesters with a belt press dewaterer, and a twelve port diffuser (*Figure 2*).

Raw wastewater enters the headworks via three lines, one from the City of Port Orchard, one from Kitsap County Sewer District #5, and one from the Veterans Administration convalescence facility. Pretreated leachate from the Kitsap County Landfill is injected into the county line several miles upstream from the plant. Filtrate from the sludge belt press is returned to the influent box, upstream of the plant's influent composite sampler. Leachate from the grit dewaterer is also returned here. The influent flow rate is not monitored.

Two of the plant's three primary sedimentation tanks are operated in parallel at any one time. Scum is skimmed from the surface of the tanks by water spray and mechanical skimmer. Skimmer sludge is returned to the headworks. Composite samples are collected from the primary clarifier effluent.

Aerobic treatment is typically provided by three of the six aeration basins operated in series. Bottom air diffusers supply aeration to the tanks. An open channel transports wastewater from the aeration basin to two circular secondary clarifiers.

After sedimentation, supernatant from both clarifiers is combined, injected with chlorine from a flow proportional injection system, and returned to two circular chlorine contact chambers situated on the perimeters of the secondary clarifiers. Effluent passes through an 18-inch Parshall flume with a bubbler flow meter and cascades over a final weir. Treated wastewater is discharge via a 36-inch-diameter, 1600-foot-long submerged pipe to a multiport diffuser. The outfall is to Sinclair Inlet at a depth of approximately 52 feet.

Sludge is collected from the primary and secondary clarifiers and pumped to a two-stage anaerobic digester. Treated sludge is dewatered by a continuous belt press and hauled by truck to the Kitsap County Landfill.

Procedure

Ecology collected both grab and composite samples at the STP. Composite samples were collected from wastewater at three stations (*Figure 2 & Appendix A*): the headworks influent just past the barscreen, the primary sedimentation tank effluent, and the disinfected effluent at the final weir. A duplicate for general chemistry, solids, nutrients, and metals parameters was split from the final Ecology effluent composite sample. A second duplicate for oxygen demand parameters was split from the Ecology primary clarifier effluent composite sample. All composite samples were collected using Ecology ISCO composite samplers with equal volumes of the sample collected every 30 minutes over a 24-hour period.

Grab samples were collected at the same locations as the composite stations, both in the morning and the afternoon. Another grab was taken of the plant's sludge just after anaerobic digestion, but prior to the belt press. Bioassay grab-composites were taken of the secondary clarifier effluent, prior to chlorine injection. Sediment samples were taken the week following the inspection, at three locations near the outfall.

Port Orchard personnel collected composite samples at the influent headworks, at the primary clarifier effluent, and from the final disinfected effluent. The Port Orchard samples' locations, durations, and aliquots were similar to those collected by Ecology's composite samplers. Starting times for Port Orchard compositors were within a half hour of Ecology's starting times.

Ecology composite samples and Port Orchard grab samples were split for analysis by both Ecology and Port Orchard laboratories. Parameters analyzed, samples collected, and the sampling schedule appear in Appendix B.

Samples for Ecology analysis were put in appropriate containers and preserved as necessary. The samples were packed in ice and delivered to the Ecology Manchester Laboratory. Analytical procedures and laboratories performing the analyses are summarized in Appendix C.

Quality Assurance / Quality Control

Sampling quality assurance included priority pollutant cleaning of sampling equipment (*Appendix D*). One duplicate of a composite sample was analyzed to assess sample splitting and analytical consistency. Sampling in the field followed all protocols for holding times, preservation, and chain-of-custody set forth in the Manchester Lab Laboratory Users Manual (Ecology, 1994).

Laboratory QA/QC including holding times, spike and duplicate spike sample analyses, precision data, and control sample (LCS) analyses were, with a few exceptions, within appropriate ranges. Initial calibration verification standards and the majority of continuing calibration standards were within relevant control limits. The percent deviation between initial and continuing calibration standards exceeded the maximum range for several organics. Procedural blanks were predominantly free from contamination. Qualifiers are included in the data table where appropriate. Specific QA/QC concerns are noted in Appendix D.

Results and Discussion

Flow Measurements

Effluent totalized flows were measured by bubbler flow meter in conjunction with an 18-inch Parshall flume located at the end of the chlorine contact chamber. At the time of the inspection, the flow recorded by the effluent totalizer was used as plant flow for NPDES permit reporting purposes. The effluent flume was visually inspected by Ecology and it appeared to be properly configured. The Port Orchard meter lacked an instantaneous flow measurement capacity, and an independent manual calibration of the meter at the Parshall flume was not performed. Documentation was presented by the facility operator reporting that the system had been calibrated by a factory representative on March 11, 1994, three days previous to the inspection. Average daily flow rate calculated from totalizer values over a three-day period was 1.19 MGD. Port Orchard does not presently monitor influent flows, and comparisons to NPDES influent load limits are determined with effluent flow measurements. Losses due to evaporation, infiltration, and wasting were not evaluated.

Wastewater General Chemistry

Influent

BOD_5 concentration in the influent (235 mg/L) fell within the typical medium concentration range for untreated domestic wastewater (*Table 1*). TOC influent concentration (110 mg/L) fell into the upper end of the "weak" range and BOD_5/TOC ratio (2.14) was higher than typical (*Metcalf & Eddy, 1991).* TOC analysis measures biologically inactive as well as biologically active organic carbon (APHA, 1992), and the higher ratio indicates a smaller biologically inactive organic carbon load than would typically be expected for domestic sanitary sewage.

Influent total solids (TS - 625 mg/L) and total non-volatile solids (TNVS - 285 mg/L) (*Table 1*) fell into "medium" concentration ranges for typical domestic influent (*Metcalf & Eddy, 1991*). For influent TS to achieve this conventional range, the inferred deficient of biologically inactive

organic carbon would likely need to be offset by a larger proportion of inorganic constituents. The makeup of these suspected inorganic constituents was not fully determined; however, the alkalinity ($CaCO_3$) concentration was higher than typically found in domestic treatment plant influents.

Primary Clarifier Effluent

Sedimentation across the primary clarifier reduced the BOD_5 concentration by 39% and the TSS concentration by 55% *(Table 2)*. These removal efficiencies compare well with the efficiencies of typical primary sedimentation tank designs (*Metcalf & Eddy, 1991*). Ammonia nitrogen concentration remained largely unaffected.

Effluent

Ecology composite sample results showed a BOD_5 reduction from 235 mg/L in the influent to 12 mg/L in the effluent (95% removal) (*Tables 1&2*). BOD_5 removal efficiency was excellent compared to other conventional activated sludge designs (*Metcalf & Eddy, 1991*). Other oxygen demand parameters, TOC and COD, also displayed robust removal efficiencies. Ecology inspection results showed a decrease in total suspended solids (TSS) from 196 mg/L to 11 mg/L with a removal efficiency of approximately 94% across the plant (*Tables 1&2*). Total phosphorous removal efficiency was 32%, from 5.13 mg/L in the influent to 3.5 mg/L in the effluent.

Ammonia nitrogen (NH_3-N) concentration decreased across the plant from 21.5 mg/L in the influent to 21.1 mg/L in the effluent, with a removal efficiency of only 2% (*Tables 1 & 2*). Nitrite+nitrate-nitrogen (NO_2&NO_3) concentration did not increase, but instead was reduced by almost 0.2 mg/L (*Table 1*). A concurrent small reduction in alkalinity confirms the absence of nitrification. Typically, conventional secondary treatment processes alone should remove up to 10% of ammonia nitrogen (*Metcalf & Eddy, 1991*). Effluent concentrations exceeded the State of Washington marine water quality criteria for ammonia, which are 0.233 mg/L and 0.035 mg/L for acute and chronic criteria respectively (WAC 173-201A). The establishment of a mixing zone in the discharge permit may be appropriate for Port Orchard. Such zones are allowable when supporting information clearly indicates that the mixing zone would not have a reasonable potential to adversely impact public health, biota habitat, ecosystem, or characteristic uses of the water body (WAC 173-201A-100). A dilution of 90/1 and 600/1 would be required at the edge of the acute and chronic mixing zone respectively to meet water quality criteria.

Tentative analysis of the Port Orchard discharge by the software package (3PLUMES) approved by the EPA for effluent discharge dilution modeling (EPA, 1993B) suggests that conditions may exist where dilution of ammonia is insufficient at the edge of the chronic dilution zone. A chronic dilution factor of 246 was estimated for critical ambient conditions at the discharge. This analysis was performed with critical values from 4-year ambient data collected monthly at a site

approximately 1600 meters west of the discharge (Albertson, 1994), and incorporated inlet current speed estimates cited in the Puget Sound Estuary Program, Sinclair and Dyes Inlets Action Program (PSEP, 1988). Effluent characteristics are based upon the results of the inspection. A multiplication factor was employed as recommended by the Ecology Permit Writers Manual (Ecology, 1994) to estimate upper quantiles for effluent concentrations using limited data. This analysis is a rough estimate and further studies would be needed to develop a calibrated model. It is recommended that Port Orchard investigate methods for reducing ammonia nitrogen concentration in the effluent. Specifically, increasing retention time in the aeration basins may afford increased nitrification across the plant. It is recommended that ammonia nitrogen be included as a NPDES permit limitation, if a fully developed analysis of receiving water dilution indicates a reasonable potential for exceedence.

NPDES Permit Comparisons

Table 3 compares inspection results to NPDES permit limits. Effluent 24-hour composite BOD_5 and TSS concentrations were all well within NPDES permit monthly and weekly average limits. Calculated loads for Ecology and Port Orchard BOD_5 sample results (119 lb/day & 298 lb/day) were both within NPDES permit monthly and weekly average load limits. The Port Orchard sample BOD_5 effluent result was 18% of the influent concentration. If the Port Orchard sample was representative, then this concentration failed to meet the NPDES monthly permit limit which restricts the effluent concentration to no more than 15% of the influent concentration. The Ecology sample result for BOD_5 was 5% of the influent result. It is recommended that this inconclusive result be clarified by further monitoring and by review of past Port Orchard daily monitoring reports.

The totalizer effluent flow rate of 1.19 MGD was well below the NPDES permit average limit of 2.8 MGD. This limit is based upon the month with the maximum average flow, which has historically been January or February. Flows in March are also typically wet weather flows, and can be considered a close approximation of the maximum flow month. One Ecology effluent grab fecal coliform count (370 colonies/100ml) exceeded the permit monthly average limit, but was within the weekly average. The total chlorine residual concentration in the effluent grab sample (0.6 mg/L) was 86% of the monthly average permit limit. Excessive fecal coliform counts with a relatively high chlorine residual concentration may indicate less than adequate contact time in the chlorine contact chamber. It is suggested this possibility be investigated.

Split Samples

Sample Comparisons

Ecology lab results for effluent samples collected by Ecology and Port Orchard were somewhat divergent, with a relative percent difference between samples of 67% for TSS and 86% for BOD_5 (*Table 4*). Influent TSS results for Ecology and Port Orchard samples were close, but influent

BOD_5 results had a relative percent difference of 36%. Ecology analysis of primary clarifier effluent TSS samples also produced dissimilar results.

The Port Orchard laboratory results for effluent TSS and BOD_5 produced a relative percent difference between the Ecology and Port Orchard samples of 60% and 66% respectively. Relative percent difference found by the Port Orchard analysis of influent BOD_5 samples was 28%. Primary clarifier effluent TSS results closely mirrored Ecology lab results.

The results of Port Orchard sampling were consistently different from Ecology samples and may lack representativeness. It is recommended that Port Orchard review their sampling protocols to identify potential improvements in sampling techniques. Particular attention should be paid to the proper cleaning of collection equipment.

Laboratory Comparisons

Agreement between Ecology and Port Orchard analytical results were generally good. The TSS and BOD_5 results from the two labs were in close agreement (*Table 4*). Wilcoxon nonparametric statistical analysis of the paired results at all stations found no significant difference at a 95% level of confidence. Ecology and Port Orchard pH results also agreed closely. The Port Orchard lab fecal coliform results produced an average relative percent difference from the Ecology lab results of more than 100%. Port Orchard should review their laboratory's fecal coliform analysis protocol. If needed, they can contact the Ecology Laboratory Accreditation Section for assistance.

Wastewater Organic and Metal Scans

Wastewater was analyzed for volatile compounds (VOA), semi-volatile compounds (BNA), pesticides/PCB, and metals. Table 5 summarizes the concentrations of compounds detected during the inspection. Appendix E contains the results of all targeted compounds, including detection limits. Tentatively identified compounds are presented in Appendix F.

Three VOAs, methylene chloride (1.0 µg/L), acetone (16 µg/L), and chloroform (1.8 µg/L), were detected in the effluent; but none exceeded the EPA water quality criteria for marine receiving waters (*Table 5*). The only BNA detected in the effluent was bis(2-ethylhexyl)phthalate (6.4 µg/L), and this did exceed the EPA acute and chronic water quality criteria (2.9 µg/L and 3,4 µg/L) for marine receiving waters. Although previous Class II Inspections have identified this compound as common to most domestic sanitary treatment plant wastewater, it is partially susceptible to biological degradation by microorganisms (Verschueren, 1983). Treatment strategies for reducing effluent concentrations should be investigated. Pesticide/PCB compounds were not detected. Several VOAs and BNAs were detected in the influent, all in low concentrations.

Copper (9 µg/L) exceeded the State of Washington acute water quality standards (2.5 µg/L) for marine receiving waters by greater than a factor of three (WAC 173-201A). Arsenic, cadmium, silver, and zinc were also detected in the effluent samples (*Table 5*). None exceeded either the EPA marine water quality criteria (EPA, 1986) or the state marine water quality standards. Mercury was detected in the effluent duplicate at 0.054 µg/L, a concentration that exceeded the chronic state marine water quality standard of 0.025 µg/L. Lack of concurrence in the corresponding effluent sample result brings into question the validity of both results, and further testing may be necessary to clarify the issue.

Tentative modeling using the PLUMES mixing zone software package suggest that dilution for copper is sufficient to meet the State water quality criteria. Estimated dilution factors for critical conditions were approximately 215 at the acute boundary (6.58 m) and approximately 247 at the chromic boundary (65.8 m). This analysis is a rough estimate and further studies are recommended to develop a calibrated model before final dilution zones are permitted.

Bioassays

Acute toxicity was evident in several bioassays (*Table 6*). The *Daphnia magna* 48-hour survival test produced a NOEC at 50% and a LC50 at 77.1% effluent. The fathead minnow 96-hour larval survival test found a NOEC at 50% and a LC50 at 72% effluent.

Chronic toxicity was even more severe (*Table 6*). The *Ceriodaphnia dubia* 7-day survival and reproduction tests found effects in both survival and reproduction, with NOECs at 50% and 6.25% effluent respectively. The *ceriodaphnia* survival LC50 was at 41.2% effluent and the reproduction LOEC was at 6.25% effluent. The fathead minnow 7-day survival and growth test found a survival NOEC at 50% effluent and a survival LC50 at 56.3% effluent. Fathead minnow growth exhibited a NOEC and LOEC at 50% effluent.

Bioassays revealed serious and pervasive toxic effects. It is noted in the QA/QC review that the dilution water used in the test was not in strict conformance to EPA protocol. Water hardness ranged from 142 to 185 mg/L $CaCO_3$ compared to the 80-100 mg/L $CaCO_3$ called for by test methods. Since increased hardness is generally protective against the toxic effects of many compounds, the results are likely conservative.

Possible causes of this toxicity include ammonia, a constituent found in the effluent at concentrations exceeding water quality criteria. Other contributors to bioassay toxicity may include copper and mercury. Bioassay toxicity for several acute tests exceed the performance standard cited in the Washington State Whole Effluent Toxicity Testing and Limits (WAC 173-205). It is recommended that the effluent be characterized by further toxicity testing, as outlined in section 050 of WAC 173-205. It is also recommended that bioassays be conducted to evaluate the potential for effluent toxicity at the edge of the dilution zone, particularly for marine

organisms. The need for a facility pretreatment program to control metals concentrations should be evaluated.

Sludge

General Chemistry

Table 1 presents the general chemical composition of the sludge. Total percent solids (1.1%) was below the range typically found in anaerobically digested primary and waste activated sludge (Metcalf & Eddy, 1991). Volatile percent solids (66% of Total solids) was slightly higher than typical (WPCF, 1987), possibly due to lower process efficiency. Kjeldahl nitrogen concentration (94,600 mg/L - dry wt.) as a percent of total solids was higher (9.5%) than typical digested sludge. A component of Kjeldahl nitrogen, ammonia, is known to have an inhibitory effect on anaerobic sludge digestion at concentrations above 1500 mg/L and at moderate pH (WPCF, 1987). Cyanide was not detected.

Organic and Metal Scans

Sludge samples were analyzed for VOAs, BNAs, pesticides/PCBs, and metals. VOAs detected include acetone (3400 µg/Kg), toluene (2200 µg/Kg), and total xylenes (2500 µg/Kg) (*Table 5*). Di-n-octyl phthalate (10000 µg/Kg) was the only BNA detected. A complete list of target compounds and results is included in Appendix E. Tentatively identified compounds are presented in Appendix F.

Most priority pollutant metals were detected in the sludge (*Table 5*). Copper (285 mg/Kg-dry wt.) and zinc (716 mg/Kg-dry wt.) were detected at the highest concentrations. Arsenic, chromium, and nickel concentrations did not exceed pollutant limits for the surface disposal of sewage sludge to active sewage sludge units (EPA, 1993). No metal exceeded the concentration that may severely inhibit anaerobic digestion (WPCF, 1987).

Sediments

General Chemistry

Grain sizes were fairly consistent for all samples. Average particle sizes (600-220 sieve size) predominated, making up 73-74% of the grain sizes in all samples (*Table 1*). Silt was the next most prevalent constituent at 12-13% . Percent solids for the three samples ranged from 63% to 67%. Percent volatiles was less than 2% for all samples. TOC comprised slightly more than 1% of the total dry weight carbon in all samples, a concentration that falls into a typical range for

marine sediments (Norton, 1994). Cyanide concentrations were below detection limits for all samples.

Metal Scans

Metal scans were compared to the Marine Sediment Quality Standards (WAC 173-204). Concentrations were well below the metals criteria (Table 7).

Sediment Bioassays

Toxicity testing was performed with the amphipod (*Rhepoxynius abornius)* 10-day emergence and survival test and the microtox test (Table 8). *Rhepoxynius* results showed significant mortality (95%) for the sediment sample collected at Sed-2, a site located at the middle of the diffuser length. This site would presumable accumulate sedimentation at a higher rate than the other sites. The Sed-2 sample *Rhepoxynius* test results was greater than the 10% marine sediment quality minimum biological effects criteria (Ecology, 1990). Amphipod mean mortality was greater than the reference control mortality by more than 30%, exceeding the marine sediment cleanup screening levels and minimum cleanup biological criteria. Other sediment samples displayed no significant *Rhepoxynius* mortality. Microtox displayed an EC50 greater than 50% in the sediment sample at Sed-3 (end of diffuser length). Microtox results for all samples failed the marine sediment quality minimum biological effects criteria (WAC 173-204).

The cause of sediment toxicity is not apparent. Amphipod toxicity may be related to proximity to the outfall depositional area, but additional sampling would be required to confirm this. Microtox toxicity was pervasive, with the greatest impact closest to the outfall. Sinclair Inlet is subject to many other sources of pollution and currents could conceivably transport pollutants throughout the waterway. However, since the effluent exhibited toxicity, it is recommended that Port Orchard more completely characterize outfall deposition toxicity to determine the outfall's effects on the sediment.

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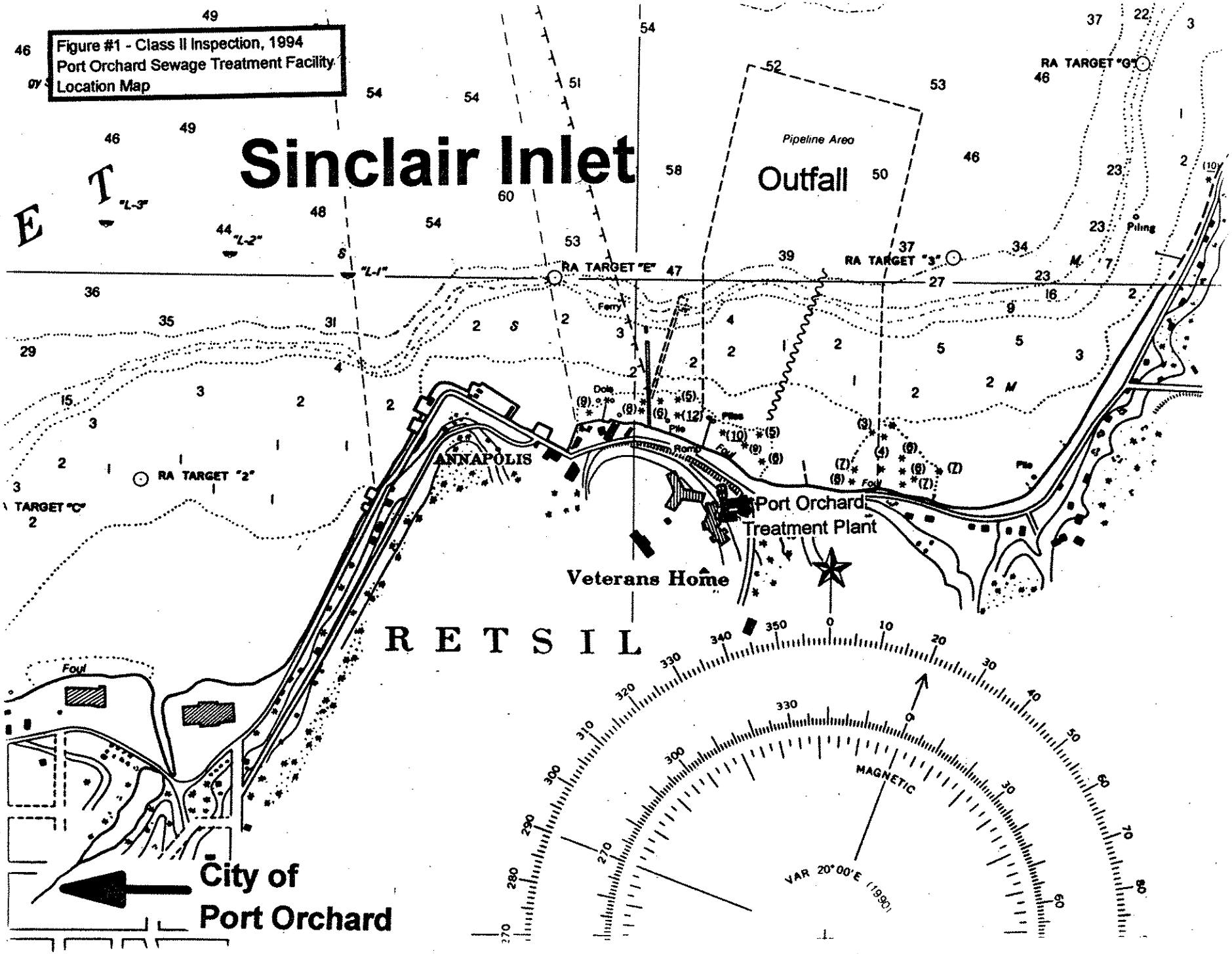
Figure #1 - Class II Inspection, 1994
Port Orchard Sewage Treatment Facility
Location Map
Sinclair Inlet
Pipeline Area
Outfall
RA TARGET "G"
RA TARGET "E"
RA TARGET "3"
RA TARGET "2"
TARGET "C"
"L-1"
"L-2"
"L-3"
ANNAPOLIS
Port Orchard
Treatment Plant
Veterans Home
RETSIL
Foul
Ferry
Piling
Pile
Dolp
MAGNETIC
VAR 20° 00' E (1990)
City of
Port Orchard

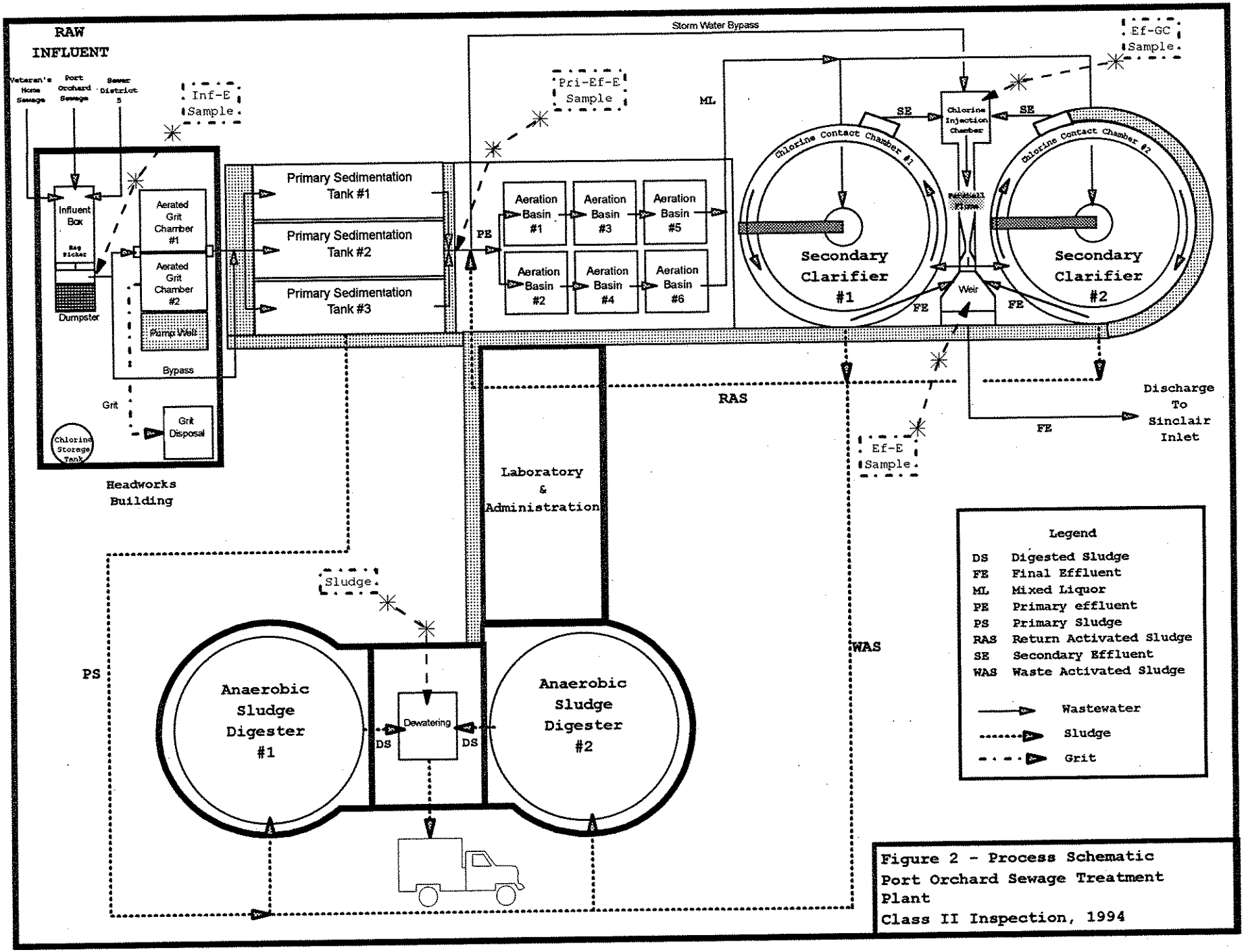

Figure 2 - Process Schematic
Port Orchard Sewage Treatment Plant
Class II Inspection, 1994

Table 1 - Ecology General Chemistry Results - Port Orchard, 1994

Parameter	Location:	Inf-E-1	Inf-E-2	Inf-E	Inf-P	Pri-Ef-E-1	Pri-Ef-E-2	Pri-Ef-E	Pri-Ef-P	Ef-GC
	Type:	grab	grab	comp	comp	grab	grab	comp	comp	grab/comp
	Date:	03/15	03/15	03/15-16	03/15-16	03/15	03/15	03/15-16	03/15-16	03/16
	Time:	1000	1440	@	@	1020	1445	@	@	09:00&1215
	Lab Log #:	118280	118281	118282	118283	118284	118285	118286	118287	118288
GENERAL CHEMISTRY										
Conductivity (umhos/cm)		753	770	694	670	653	762	718	710	
Alkalinity (mg/L CaCO3)				226	220			234	233	
Hardness (mg/L CaCO3)				114 J	113 J			103	103	
Grain Size (%)										
Gravel:	(4-10 Sieve Size)									
Sand:	(20-40 Sieve Size)									
Average	(60-220 Seive Size)									
Silt:	(4-8 Phi Size)									
Clay:	(9-10 Phi Size)									
SOLIDS 4										
TS (mg/L)				625				499		
TNVS (mg/L)				285				269		
TSS (mg/L)		131	200	196	188	66	92	88	161	
TNVSS (mg/L)				44				16		
% Solids										
% Volatile Solids										
OXYGEN DEMAND PARAMETERS										
BOD5 (mg/L)				235	164			144	133	
COD (mg/L)				424	337			333	328	
TOC (water mg/L)		80	140	110	97	85	93	100	93	
TOC (soil/sed mg/Kg-dry wt.)										
NUTRIENTS										
Total Kjeldahl N (mg/Kg-dry wt.)										
NH3-N (mg/L)				21.5	18.4			21.7	22.2	
NO2+NO3-N (mg/L)				0.219	0.154			0.017	0.01 U	
Total-P (mg/L)				5.13	5.02			5.46	5.34	
MISCELLANEOUS										
F-Coliform MF (#/100mL)										
Cyanide (wk & dis mg/L)		0.014 UJ	0.004 UJ	0.005 UJ						
Cyanide (Total mg/L)										
Cyanide (wk & dis mg/kg dry wt)										
FIELD OBSERVATIONS										
Temperature (C)		13.7	9.9			13.7	9.9			
Temp-cooled (C)*+				3.7	4.9			3.7	10.5	14.3
pH		7.58	6.93	8.06	7.59	7.35	7.41	7.52	7.52	7.18
Conductivity (umhos/cm)		729	526	405	414	633	536	426	509	554
Chlorine Total (mg/L)		<0.1	<0.1	<0.1				0.1	<0.1	

E	Ecology sample.
P	Port Orchard sample.
Inf	Influent sampl.
Ef	Effluent sample.
grab	Grab sample.
comp	Composite sample.
grab/composite	Grab -composite sample.
*+	Refrigerated sample.
Pri	Primary clarifier.
GC	Bioassay grab composite sample.
J	The analyte was positively identified. The associated numerical result is an estimate.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.
@	Composite sample period: 08:00-08:00.

Table 1 - Ecology General Chemistry Results - Port Orchard, 1994

Parameter II	Location	Ef-E-1&3	Ef-E-2&4	Ef-E	Ef-P	Sludge	Sed-1	Sed-2	Sed-3	Duplicate-1	Duplicate-2
	Type:	grab	grab	comp	comp	grab	grab	grab	grab	comp	grab
	Date:	03/15	03/15	03/15-16	03/15-16	03/15	03/23	03/23	03/23	03/15-16	03/15
	Time:	1040	1505	@	@	1258	1310	1400	1430	@	1100
	Lab Log #:	118289	118290	118291	118292	118293	118294	118295	118296	118297	118298
GENERAL CHEMISTRY											
Conductivity (umhos/cm)		714	676	707	698						
Alkalinity (mg/L CaCO3)				223	220						
Hardness (mg/L CaCO3)				96.3	95.8					95.3	
Grain Size (% phi size)											
Gravel:	(4-10 Sieve Size)						0	1	1		
Sand:	(20-40 Sieve Size)						5	7	6		
Average	(60-220 Seive Size)						73	73	74		
Silt:	(4-8 Phi Size)						15	12	13		
Clay:	(9-10 Phi Size)						5	5	5		
SOLIDS 4											
TS (mg/L)				387							
TNVS (mg/L)				257							
TSS (mg/L)		16	15	11	22						
TNVSS (mg/L)				1							
% Solids						1.1	63	64	67		
% Volatile Solids						0.66	1.89	1.28	1.34		
OXYGEN DEMAND PARAMETERS											
BOD5 (mg/L)				12	30						139
COD (mg/L)				71.9	77.8						335
TOC (water mg/L)		27	23	31	27						100
TOC (soil/sed mg/Kg-dry wt.)						39000	11100	10000	11500		
NUTRIENTS											
Total Kjeldahl N (mg/Kg-dry wt.)						94600					
NH3-N (mg/L)		21.7	21.0	21.1	20.5					21.1	
NO2+NO3-N (mg/L)		0.034	0.058	0.038	0.144					0.035	
Total-P (mg/L)		3.53	3.46	3.50	3.47					3.32	
MISCELLANEOUS											
F-Coliform MF (#/100mL)		370	110								
Cyanide (wk & dis mg/L)		0.004								0.004 UJ	
Cyanide (Total mg/L)			0.013 J	0.005 J							
Cyanide (wk & dis mg/kg dry wt)						8.63 UJ	0.16 UJ	0.15 UJ	0.15 UJ		
FIELD OBSERVATIONS											
Temperature (C)		13.7	14.1								
Temp-cooled (C)*+				5.7	4.9					5.7	3.7
pH		7.08	7.19	6.96	7.59					6.96	7.52
Conductivity (umhos/cm)		718	532	466	470					466	426
Chlorine, Total (mg/L)		0.5	0.6	0.1							

E	Ecology sample.
P	Port Orchard sample.
Inf	Influent sample.
Ef	Effluent sample.
grab	Grab sample.
comp	Composite sample.
grab/composite	Grab -composite sample.
*+	Refrigerated sample.
@	Composite sample period: 08:00-08:00.

Sludge	Ecology sludge sample.
Sed-1	Sediment sample 300 ft. East of outfall into Sinclair Inlet.
Sed-2	Sediment sample 50 ft. South of outfall into Sinclair Inlet.
Sed-3	Sediment sample near outfall into Sinclair Inlet.
Duplicate-1	Duplicate of Ecology effluent composite sample for blind analysis.
Duplicate-2	Duplicate of Ecology primary clarifier effluent sample for blind analysis.
J	The analyte was positively identified. The associated numerical result is an estimate.
UJ	The analyte was not detected at or above the reported estimated result.

Table 2 - General Chemistry Percent Reduced - Port Orchard, 1994

Parameter	Location:	Inf-E	Pri-Ef-E	Ecology Percent Reduced Across Primary Clarifier	Ef-E	Ecology Percent Reduced Across Treatment Plant	Inf-P	Pri-Ef-P	Port Orchard Percent Reduced Across Primary Clarifier	Ef-P	Port Orchard Percent Reduced Across Treatment Plant
	Type:	comp	comp		comp		comp	comp		comp	
	Date:	03/15-16	03/15-16		03/15-16		03/15-16	03/15-16		03/15-16	
	Time:	@	@		@		@	@		@	
	Lab Log #:	11828	118286		118291		118283	118287		118292	
GENERAL CHEMISTRY											
Conductivity (umhos/cm)		694	718	-3%	707	-2%	670	710	-6%	698	-4%
Alkalinity (mg/L CaCO3)		226	234	-4%	223	1%	220	233	-6%	220	0%
Hardness (mg/L CaCO3)		114 J	103	10%	96.3	16%	113 J	103	9%	95.8	15%
SOLIDS 4											
TSS (mg/L)		196	88	55%	11	94%	188	161	14%	22	88%
OXYGEN DEMAND PARAMETERS											
BOD5 (mg/L)		235	144	39%	12	95%	164	133	19%	30	82%
COD (mg/L)		424	333	21%	71.9	83%	337	328	3%	77.8	77%
TOC (water mg/L)		110	100	9%	31	72%	97	93	4%	27	72%
NUTRIENTS											
NH3-N (mg/L)		21.5	21.7	-1%	21.1	2%	18.4	22.2	-21%	20.5	-11%
NO2+NO3-N (mg/L)		0.219	0.017	92%	0.038	83%	0.154	0.01 U	94%	0.144	6%
Total-P (mg/L)		5.13	5.46	-6%	3.5	32%	5.02	5.34	-6%	3.47	31%

E Ecology sample
P Port Orchard sample
Inf Influent sample
Ef Effluent sample
Pri Primary clarifier
comp Composite sample
@ Composite sample period: 08:00-08:00.

J The analyte was positively identified. The associated numerical result is an estimate.
U The analyte was not detected at or above the reported result.

Table 3 - NPDES Limits Inspection Results - Port Orchard, 1994

Parameter	NPDES Permit Limits		Inspection Data					
				Ecology Composite		STP Composite		Ecology Grab	
	Monthly Average	Weekly Average	Location:	Inf-E	Ef-E	Inf-P	Ef-P	Ef-E-1&3	Ef-E-2&4
			Type:	comp	comp	comp	comp	grab	grab
			Date:	03/15-16	03/15-16	03/15-16	03/15-16	03/15	03/15
			Time:	@	@	@	@	1040	1505
			Lab Log #:	11828	118291	118283	118292	118289	118290
Effluent BOD5									
(mg/L)	30	45		235	12	164	30		
(lbs/day)	700	1050			119		298		
% of Influent	Monthly effluent concentration limits shall not exceed 30 mg/L or 15% of the influent concentration, whichever is more stringent.				5%		18%		
Influent Loading (lbs/day)**	5400			2332		1628			
Effluent TSS									
(mg/L)	30	45		196	11	188	22		
(lbs/day)	700	1050			109		218		
% of Influent	Monthly effluent concentration limits shall not exceed 30 mg/L or 15% of the influent concentration, whichever is more stringent.				6%		12%		
Influent Loading (lbs/day)**	5400			1945		1866			
Effluent Fecal coliform									
(#/100 mL)	200	400						370	110
Effluent pH									
(S.U.)	6.0 ≤ pH ≤ 9.0				6.69		7.39	7.08	7.19
Average Flow*									
(MGD)	2.8			1.19 ***	1.19 ***	1.19 ***	1.19 ***	1.19 ***	1.19 ***
Effluent Total Chlorine Residual									
(mg/L)	0.7	1.5			0.1			0.5	0.6
(lbs/day)	16	35			1.0			5.0	6.0

E	Ecology sample	*	Average flow for the maximum month.
P	Port Orchard sample	**	Average loading for the maximum month.
Inf	Influent sample	***	24-hour average over the three day inspection
Ef	Effluent sample		
grab	Grab sample		
comp	Composite sample		
@	Composite sample period: 08:00-08:00		

Table 4 - Split Sample Result Comparison - Port Orchard,1994

Parameter		Location:	Inf-E	Inf-P	Pri-Ef-E	Pri-Ef-P	Ef-E	Ef-P	Ef-E-1&3	Ef-E-2&4
		Type:	comp	comp	comp	comp	comp	comp	grab	grab
		Date:	03/15-16	03/15-16	03/15-16	03/15-1	03/15-16	03/15-16	03/15	03/15
		Time:	@	@	@	@	@	@	1040	1505
		Lab Log #:	11828	118283	118286	118287	118291	118292	118289	118290
	Laboratory									
TSS (mg/L)	Ecology		196	188	88	161	11	22		
	Port Orchard		213	225	96	121	11.1	20.7		
BOD5 (mg/L)	Ecology		235	164	144	133	12	30		
	Port Orchard		244	184	153	136	12.7	25.2		
F-Coliform MF	Ecology								370	110
(#/100ml)	Port Orchard								117	18
pH	Ecology		8.06	7.59	7.52	7.52	6.96	7.59		
	Port Orchard		7.5	7.5	7.6	7.6	7.5	7.5		

E	Ecology sample	Inf	Influent samples.
P	Port Orchard sample	Ef	Effluent samples
grab	grab sample	Pri	Primary clarifier effluent sample
Comp	Composite sample		
@	24 hour composite. Collection period: 0800 - 0800.		

Table 5 - Detected VOA, BNA, Pesticide/PCB and Metals Scan Results - Port Orchard, 1994.

Location:	Inf-E-1	Inf-E-2	Ef-E-1&3	Ef-E-2&4	EPA Water Quality Criteria Summary		Sludge
Type:	grab	grab	grab	grab	Acute Marine	Chronic Marine	grab
Date:	03/15	03/15	03/15	03/15			03/15
Time:	1000	1440	1040	1505			1258
Lab Log#:	118280	118281	118289	118290			118293
VOA Compounds	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/Kg
Carbon Disulfide							290
Chloroform		1.9	1.7	1.8	12000 *(a	6400 *(a)	
2-Butanone (MEK)		75					710
Tetrachloroethene		2.4			10200 *	450 *	
Toluene	2.9	27			6300 *	5000 *	2200
Ethylbenzene					430 *		350
Total Xylenes		1.8 J					2500
1,1,2-Trichlorotrifluoroethane							160

Location:	Inf-E	Ef-E	EPA Water Quality Criteria Summary		Sludge
Type:	comp	comp	Acute Marine	Chronic Marine	grab
Date:	03/15-16	03/15-16			03/15
Time:	@	@			1258
Lab Log#:	118282	118291			118293
BNA Compounds	µg/L	µg/L	µg/L	µg/L	µg/Kg
Phenol	5.8		5800 *		
Benzyl Alcohol	8.2				
4-Methylphenol	35				
Benzoic Acid	19 N				
Diethyl Phthalate	13		2.944 *(i)	3.4 *(i)	
Di-n-Butyl Phthalate	2.0		2.944 *(i)	3.4 *(i)	
Butylbenzyl Phthalate	8.2		2.944 *(i)	3.4 *(i)	
Bis(2-Ethylhexyl)Phthalate	27	6.4	2.944 *(i)	3.4 *(i)	
Di-n-Octyl Phthalate	3.8 J		2.944 *(i)	3.4 *(i)	10000

Location:	Inf-E	Inf-P	Ef-E	Ef-P	Duplicate-1	State & EPA Water Quality Criteria Summary		Sludge	Sed-1	Sed-2	Sed-3
Type:	comp	comp	comp	comp	comp	Acute Marine	Chronic Marine	grab	grab	grab	grab
Date:	03/15-16	03/15-16	03/15-16	03/15-16	03/15-16			03/15	03/23	03/23	03/23
Time:	@	@	@	@	@			1258	1310	1400	1430
Lab Log#:	118282	118283	118291	118292	118297			118293	118294	118295	118296
Metals (Total Recoverable)	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/Kg-dry wt.	mg/Kg-dry wt.	mg/Kg-dry wt.	mg/Kg-dry wt.
Hardness = 96											
Arsenic (Total)	3.2 P	1.5 P	2.4 P	2.6 P	2.2 P	69.0 c	36.0 cc	5.27 J		6.3 P	
Beryllium									0.16 P	0.16 P	0.17 P
Cadmium	0.58 P	0.60 P		0.11 P		37.20 c	8.00 d	4.18 P			0.35 P
Chromium (Total)									30.2	33	30.3
Hexavalent						1100.0 c,l	50.0 d				
Copper		40	9.0 P	9.8 P	9.3 P	2.5 c		285	20.9	20.4	33.7
Lead	5.6 P	5.9 P				151.0 c	5.8 d	46.4 P	20	19 P	20.4
Mercury					0.054 P	2.1 c	0.025 d	3.33 N		0.108	0.159
Nickel						71.3 c	7.9 d	26.4 P	26.7	28.4	25.8
Selenium						300.0 c	71.0 x	3.36 J	0.44 P	0.41 P	0.44 P
Silver	2.2 P	2.4 P	0.51 P	0.61 P	0.52 P	1.2 z				0.4 P	0.35 P
Zinc	103	121	33 P		34 P	84.6 c	76.6 d	716		48	50.9

E	Ecology sample	J	The analyte was positively identified. The associated numerical result is an estimate.
P	Port Orchard sample	N	The spike sample recovery is not within control limits
Inf	Influent Sample	P	The analyte was detected above the instrument detection limit, but below the established minimum quantitation limits.
Ef	Effluent Sample		
comp	Composite sample	U	The analyte was not detected at or above the reported result..
@	Composite sample period: 08:00-08:00.	Sed-1	Sedimant sample taken 300 ft NNE from outfall
grab	Grab sample	Sed-2	Sedimant sample taken at south end of diffuser outfall
Sludge	Ecology sludge sample	Sed-3	Sediment sample taken at north end of diffuser outfall
*	Insufficient data to develop criteria. Value presented is the LOEL - Lowest Observed Effect Level.		

c	A 1-hour average concentration not to be exceeded more than once every three years on the average.	a	Total Halomethanes
d	A 4-day average concentration not to be exceeded more than once every three years on the average.	i	Total Phthalate Esters
l	At low salinity the 1-hour average may not be sufficiently protective.		Exceeds criteria
x	The status of the fish community should be monitored when concentrations exceed 5.0 µg/L in salt water.		
z	The instantaneous concentration not to be exceeded at any time.		
cc	Where practical the ambient concentrations should not be allowed to exceed 21 µg/L		

Table 6 - Effluent Bioassay Results - Port Orchard, 1994.

NOTE: all tests were run on the effluent (Ef-GC sample) - lab log # 118288

Ceriodaphnia dubia - Survival and Reproduction 7-day Chronic Test

(Ceriodaphnia dubia)

Sample	Number Tested *	Percent Survival	Average Number Reproduced Per Female
Control, 0% Effluent	10	80	14.3
6.25 % Effluent	10	80	6.3
12.5 % Effluent	10	60	3.5
25 % Effluent	10	80	7.8
50 % Effluent	10	60	7.3
100 % Effluent	10	0	0.8

Survival
NOEC = 50% effluent
LOEC = 100 % effluent
LC50 = 41.2 % effluent

Reproduction
NOEC < 6.25% effluent
LOEC = 6.25 % effluent

* Ten replicates of one organism

Daphnia magna - 48-hour Acute Toxicity Test

(Daphnia magna)

Sample	Number Tested	Percent Survival
Control	20	100%
6.25 % Effluent	20	95%
12.5 % Effluent	20	95%
25 % Effluent	20	90%
50 % Effluent	20	75%
100 % Effluent	20	35%

Survival
NOEC = 50 % effluent
LOEC = 100 % effluent
LC50 = 77.1 % effluent

Fathead Minnow - Larval Survival and Growth 7-day Chronic Test

(Pimephales promelas)

Sample	Number Tested *	Percent Survival	Average Final Weight per Fish (mg)
Control	40	93	0.677
6.25 % Effluent	40	98	0.491
12.5 % Effluent	40	95	0.495
25 % Effluent	40	93	0.334
50 % Effluent	40	75	0.647
100 % Effluent	40	0	0

Survival
NOEC = 50 % effluent
LOEC = 100 % effluent
LC50 = 56.3 % effluent

Growth
NOEC = 50 % effluent
LOEC = 50 % effluent

* four replicates of 10 organisms

Fathead Minnow - 96-hour Acute Test - Larval Survival

(Pimephales promelas)

Sample	Number Tested *	Percent Survival
Control	20	100%
6.25 % Effluent	20	100%
12.5 % Effluent	20	100%
25 % Effluent	20	100%
50 % Effluent	20	100%
100 % Effluent	20	5%

Survival
NOEC = 50 % effluent
LOEC = 100 % effluent
LC50 = 72 % effluent

* 2 replications of 10 organisms

NOEC - no observable effects concentration
LOEC - lowest observable effects concentration
LC50 - lethal concentration for 50% of the organisms
EC50 - effect concentration for 50% of the organisms

Table 7 - Comparison of Detected Sediment Metals to Marine Sediment Quality Standards - Port Orchard, 1994

	Location:	Sed-1	Sed-2	Sed-3	Marine Sediment Quality Standards Metal Criteria
	Type:	grab	grab	grab	
	Date:	03/23	03/23	03/23	
	Time:	1310	1400	1430	
	Lab Log#:	118294	118295	118296	
Metals (Total Recoverable)		mg/Kg-dry wt.	mg/Kg-dry wt.	mg/Kg-dry wt.	mg/Kg-dry wt.
Arsenic (Total)			6.3 P		57
Cadmium				0.35 P	5.1
Chromium		30.2	33	30.3	260
Copper		20.9	20.4	33.7	390
Lead		20	19 P	20.4	450
Mercury			0.108	0.159	0.41
Silver			0.4 P	0.35 P	6.1
Zinc			48	50.9	410

P	The analyte was detected above the instrument detection limit, but below the established minimum quantitation limits.
Sed-1	Sediment sample taken 300 ft NNE from outfall
Sed-2	Sediment sample taken at south end of diffuser outfall
Sed-3	Sediment sample taken at north end of diffuser outfall
grab	Ecology grab sample

Table 8 - Sediment Bioassay Results - Port Orchard, 1994.

Microtox

Parameter	Control	Location Type: Date: Time: Lab Log #:	Sed-1 grab 03/23 1310 118294	Sed-2 grab 03/23 1400 118295	Sed-3 grab 03/23 1430 118296	
Mean Percent Decrease in Luminescence (15 min)*	-0.3%		25.1%	22.0%	38.3%	
EC50* (% extract)			NG	NG	>50%	
Exceeds Marine Sediment Qualitry Minimum Biological Effects Criteria (WAC-173-204-320)			Yes	Yes	Yes	
Significant t-Test Value compared with Control for Lumenescence Decrease			Yes	Yes	Yes	

NG Microtox analysis resulted in negative gammas at lower concentrations, which makes statistical analysis of dilution series impractical.

* 50% test concentration

Amphipod/Rhepoxynius - 10 day Emergence and Survival Test

(Rhepoxynius abornius)

Parameter	Control	Location Type: Date: Time: Lab Log #:	Sed-1 grab 03/23 1310 118294	Sed-2 grab 03/23 1400 118295	Sed-3 grab 03/23 1430 118296	
Average Percent Survival*	91.0-95.0%		91.0%	5.0%**	95.0%	
Exceeded Marine Sediment Quality Minimum Biological Effects Criteria (WAC-173-204-320)			No	Yes	No	
Exceeds Marine Sediment Cleanup Screening Levels and Minimum Cleanup Biological Criteria (WAC-173-204-520)			No	Yes	No	

* 5 replicates of 10 organisms

** Statistically significant ($p <= 0.05$) from the control

EC50 Effect concentration for 50% of the organisms
Sed-1 Sediment sample 300 ft east of outfall into Sinclair Inlet
Sed-2 Sediment sample 50 ft. south of outfall into Sinclair Inlet
Sed-3 Sediment sample near outfall into Sinclair Inlet
grab Grab sample

Appendices

Appendix A - Sampling Stations Descriptions - Port Orchard, 1994

Inf-E-#	Grab sample of influent wastewater collected from the headworks, just after the mechanical barscreen - Collected in both A.M. and P.M.
Inf-E	Ecology 24-hour composite sample of influent wastewater collected from the headworks, just after the mechanical barscreen.
Inf-P	Port Orchard 24-hour composite sample of influent wastewater collected from the headworks, just after the mechanical barscreen.
Pri-Ef-E-#	Grab sample of primary clarifier effluent collected from the overflow of the primary clarifier's tank, just prior to the aeration basins - Collected in both A.M. and P.M.
Pri-Ef-E	Ecology 24-hour composite sample of primary clarifier effluent collected from the overflow of the primary clarifier tank, just prior to the aeration basins.
Pri-Ef-P	Port Orchard 24-hour composite sample of primary clarifier effluent collected from the overflow of the primary clarifier tank, just prior to the aeration basins.
Ef-#	Grab sample of disinfected effluent collected from the weir overflow just past the Parshall flume - Collected in both A.M. and P.M.
Ef-E	Ecology 24-hour composite sample of disinfected effluent collected from weir overflow just past the Parshall flume.
Ef-P	Port Orchard 24-hour composite sample of disinfected effluent collected from weir overflow just past the Parshall flume.
Ef-GC	Bioassay grab from channel just after the secondary clarifiers and prior to chlorine injection.
Sludge	Sample of liquid digested sludge drawn from the anaerobic digester
Sed-1	Composite grabs collected from the sediment in Sinclair Inlet 300 feet NNE of outfall, approximately 1826 feet offshore from the treatment plant. (Long: 122°- 36′- 34″ W., Lat: 47°- 33′- 08″ N.). This represents a background sample of Sinclair Inlet.
Sed-2	Composite grabs collected from the sediment in Sinclair Inlet 50 feet south of the end of the outfall diffuser, approximately 1550 feet offshore from the treatment plant. (Long: 122°- 36′- 41″ W., Lat: 47°- 33′- 04″ N.). This location is near the fifth port, about in the middle of the discharge span.
Sed-3	Composite grabs collected from the sediment in Sinclair Inlet at the far end of the outfall diffuser, approximately 1600 feet offshore from the treatment plant. (Long: 122°- 36′- 40″ W., Lat: 47°- 33′- 07″ N.). This location is at the farthest extent of the discharge span.

Appendix B - Sampling Schedule - Port Orchard, 1994

Parameter	Location:	Inf-E-1	Inf-E-2	Inf-E	Inf-P	Pri-Ef-E-1	Pri-Ef-E-2	Pri-Ef-E	Pri-Ef-P	Ef-GC
	Type:	grab	grab	comp	comp	grab	grab	comp	comp	grab/comp
	Date:	03/15	03/15	03/15-16	03/15-16	03/15	03/15	03/15-16	03/15-16	03/16
	Time:	1000	1440	@	@	1020	1445	@	@	09:00&1215
	Lab Log #:	118280	118281	11828	118283	118284	118285	118286	118287	118288
GENERAL CHEMISTRY										
Conductivity		E	E	E	E	E	E	E	E	
Alkalinity				E	E			E	E	
Hardness				E	E			E	E	
Grain Size										
SOLIDS-4										
TS				E				E		
TNVS				E				E		
TSS		E	E	EP	EP	E	E	EP	EP	
TNVSS				E				E		
% Solids										
% Volatile Solids										
OXYGEN DEMAND PARAMETERS										
BOD5				EP	EP			EP	EP	
COD				E	E			E	E	
TOC (water)		E	E	E	E	E	E	E	E	
TOC (soil/sed)										
NUTRIENTS										
Total Kjeldahl N										
NH3-N				E	E			E	E	
NO2+NO3-N				E	E			E	E	
Total-P				E	E			E	E	
MISCELLANEOUS										
F-Coliform MF										
Cyanide (wk & dis)		E	E	E						
Cyanide (wk & dis soil/sed)										
ORGANICS										
VOC (water)		E	E							
VOC (soil/sed)										
BNAs (water)				E						
BNAs (soil/sed)										
Pest/PCB (water)				E						
Pest/PCB (soil/sed)										
METALS										
PP Metals (water)				E	E					
PP Metals (soil/sed)										
BIOASSAYS										
Daphnia magna (acute)										E
Ceriodaphnia (chronic)										E
Fathead Minnow (acute)										E
Fathead Minnow (chronic)										E
Rhepoxinius (solid acute)										
Microtox (solid acute)										
FIELD OBSERVATIONS										
Temperature		E	E			E	E			
Temp-cooled*+				E	E			E	E	E
pH		E	EP	EP	E	E	E	EP	EP	E
Conductivity		E	E	E	E	E	E	E	E	E
Chlorine		E	E	E						E

E	Ecology sample & analysis	Pri	Primary clarifier
P	Port Orchard sample & analysis	GC	Bioassay grab composite sample
Inf	Influent sample	@	Ecology composite sample period: 08:00-08:00
Ef	Effluent sample	*+	Refrigerated sample
grab	Grab sample		
comp	Composite sample		
grab/composite	Grab -composite sample		

Appendix B - Sampling Schedule - Port Orchard, 1994

Parameter II	Location	Ef-E-1&3	Ef-E-2&4	Ef-E	Ef-P	Sludge	Sed-1	Sed-2	Sed-3	Duplicate-1	Duplicate-2
	Type:	grab	grab	comp	comp	grab	grab	grab	grab	comp	grab
	Date:	03/15	03/15	03/15-16	03/15-16	03/16	03/18	03/18	03/18	03/15-16	03/15
	Time:	1040	1505	@	@	1258	1310	1400	1430	@	1100
	Lab Log #:	118289	118290	118291	118292	118293	118294	118295	118296	118297	118298
GENERAL CHEMISTRY											
Conductivity		E	E	E	E					E	
Alkalinity				E	E					E	
Hardness				E	E					E	
Grain Size							E	E	E		
SOLIDS-4											
TS				E						E	
TNVS				E						E	
TSS		E	E	EP	EP					E	
TNVSS				E						E	
% Solids						E	E	E	E		
% Volatile Solids						E	E	E	E		
OXYGEN DEMAND PARAMETERS											
BOD5				EP	EP						E
COD				E	E						E
TOC (water)		E	E	E	E						E
TOC (soil/sed)						E	E	E	E		
NUTRIENTS											
Total Kjeldahl N						E					
NH3-N		E	E	E	E					E	
NO2+NO3-N		E	E	E	E					E	
Total-P		E	E	E	E					E	
MISCELLANEOUS											
F-Coliform MF		EP	EP								
Cyanide (wk & dis)		E	E	E						E	
Cyanide (wk & dis soil/sed)						E	E	E	E		
ORGANICS											
VOC (water)		E	E								
VOC (soil/sed)						E					
BNAs (water)				E							
BNAs (soil/sed)						E					
Pest/PCB (water)				E							
Pest/PCB (soil/sed)						E					
METALS											
PP Metals (water)				E	E					E	
PP Metals (soil/sed)						E	E	E	E		
BIOASSAYS											
Daphnia magna (acute)											
Ceriodaphnia (chronic)											
Fathead Minnow (acute)											
Fathead Minnow (chronic)											
Rhepoxinius (solid acute)							E	E	E		
Microtox (solid acute)							E	E	E		
FIELD OBSERVATIONS											
Temperature		E	E								
Temp-cooled* +				E	E					E	
pH		E	E	EP	EP					E	
Conductivity		E	E	E	E					E	
Chlorine		E	E								

E	Ecology sample	Sludge	Ecology sludge sample
P	Port Orchard sample	Sed-1	Sediment sample 300 ft. East of outfall into Sinclair Inlet.
Inf	Influent sample	Sed-2	Sediment sample 50 ft. South of outfall into Sinclair Inlet.
Ef	Effluent sample	Sed-3	Sediment sample near outfall into Sinclair Inlet.
grab	Grab sample	Duplicate-1	Duplicate of Ecology effluent composite sample for blind analysis.
comp	Composite sample	Duplicate-2	Duplicate of Ecology primary clarifier effluent composite sample for blind analysis.
grab/composite	Grab -composite sample	*+	Refrigerated sample

Appendix C - Laboratory Methods - Port Orchard Class II Inspection, 1994

Parameter IV	MANCHESTER_METHODS	Lab Used
GENERAL CHEMISTRY		
Conductivity	EPA, Revised 1983: 120.1	Ecology
Alkalinity	EPA, Revised 1983: 310.1	Ecology
Hardness	EPA, Revised 1983: 130.2	Ecology
Grain Size	Tetra Tech, 1986:TC-3991-04	Soil Technology, Inc.
SOLIDS-4		
TS	EPA, Revised 1983: 160.3	Ecology
TNVS	EPA, Revised 1983: 106.3	Ecology
TSS	EPA, Revised 1983: 160.2	Ecology
TNVSS	EPA, Revised 1983: 106.2	Ecology
% Solids	APHA, 1989: 2540G.	Analytical Resources, Inc.
% Volatile Solids	EPA, Revised 1983: 160.4	Analytical Resources, Inc.
OXYGEN DEMAND PARAMETERS		
BOD5	EPA, Revised 1983: 405.1	Ecology
COD	EPA, Revised 1983: 410.1	Analytical Resources, Inc.
TOC (water)	EPA, Revised 1983: 415.1	Analytical Resources, Inc.
TOC (soil/sed)	EPA, Revised 1983: 415.1	Analytical Resources, Inc.
NUTRIENTS		
Total Kjeldahl N	EPA, Revised 1983: 351.3	Analytical Resources, Inc.
NH3-N	EPA, Revised 1983: 350.1	Ecology
NO2+NO3-N	EPA, Revised 1983: 353.2	Ecology
Total-P	EPA, Revised 1983: 365.3	Ecology
MISCELLANEOUS		
F-Coliform MF	APHA, 1989: 9222D.	Ecology
Cyanide (wk & dis)	APHA, 1989: 4500-CNI.	Analytical Resources, Inc.
Cyanide (wk & dis soil/sed)	APHA, 1989: 4500-CNI.	Analytical Resources, Inc.
ORGANICS		
VOC (water)	EPA, 1986: 8260	Analytical Resources, Inc.
VOC (soil/sed)	EPA, 1986: 8240	Analytical Resources, Inc.
BNAs (water)	EPA, 1986: 8270	Analytical Resources, Inc.
BNAs (soil/sed)	EPA, 1986: 8270	Analytical Resources, Inc.
Pest/PCB (water)	EPA, 1986: 8080	Analytical Resources, Inc.
Pest/PCB (soil/sed)	EPA, 1986: 8080	Analytical Resources, Inc.
METALS		
PP Metals (water)	EPA, Revised 1983: 200-299	Ecology
PP Metals (soil/sed)	EPA, Revised 1983: 200-299	Ecology
BIOASSAYS		
Daphnia magna (acute)	EPA 1985	Beak Consultants, Inc.
Ceriodaphnia (chronic)	EPA 1989: 1002.0	Beak Consultants, Inc.
Fathead Minnow (acute)	EPA 1989: 1000.0	Beak Consultants, Inc.
Fathead Minnow (chronic)	EPA, 1991	Beak Consultants, Inc.
Rhepoxinius (solid acute)	ASTM, 1990: E1367	Beak Consultants, Inc.
Microtox (solid acute)	PTI. 1991.	Beak Consultants, Inc.

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Appendix D - Port Orchard Class II Inspection, 1993

Priority Pollutant Metal Cleaning Procedures for Wastewater and Sediments Collection Equipment.

1. Wash with laboratory detergent
2. Rinse several times with tap water
3. Rinse with 10% HNO_3 solution
4. Rinse three (3) times with distilled/deionized water
5. Rinse with high purity methylene chloride
6. Rinse with high purity acetone
7. Allow to dry and seal with aluminum foil

Specific QA/QC Concerns

1. Three samples for weak and dissociated cyanide were not preserved within the required 24-hour holding time. All results for CN in these samples have been qualified with a "UJ" to indicate a possible low bias.

2. Analytic Resources Incorporated, the lab that conducted the cyanide analyses, erroneously analyzed several samples for total cyanide instead of weak and dissociated cyanide. Cyanide was detected in only two of these samples. The amount of weak and dissociated CN can be assumed to be less than the amount of total CN, and those samples for which no total CN was detected (qualified with a "U") would also have had no weak and dissociated CN detected.

3. TOC samples were not frozen prior to analysis as required by the Puget Sound Estuary Program protocol. The samples were stored prior to analysis at 4 degrees C, and no studies have been conducted that indicate the effect of holding time on samples that have not been stored frozen prior to analysis. An evaluation with regards to holding time is not feasible for these samples.

4. The percent deviation between the initial and continuing calibration standards were not within the maximum 25% for one volatile and five semi-volatiles. Four non-detects were qualified with a "UJ" and the one detected semi-volatile was qualified with a "J".

5. Spiked recoveries were outside CLP acceptance limits for several sludge metals analyses. These have been qualified with a "N" or "J" depending on the severity of the noted interferences and the judgement of the analyst.

6. Bioassay tests dilution water were not strictly in conformance with EPA protocols. Hardness in the dilution water ranged from 142 to 185 mg/L $CaCO_3$, whereas the protocol calls for 80-100 mg/L $CaCO_3$. The differences may not be substantial, however, the possibility exists that the tests may have underestimated the toxic effects of the samples.

Appendix E - VOA, BNA, Pesticide/PCB and Metals Scan Results - Port Orchard, 1994.

Location:	Inf-E-1	Inf-E-2	Ef-E-1&3	Ef-E-2&4	Sludge
Type:	grab	grab	grab	grab	grab
Date:	03/15	03/15	03/15	03/15	03/15
Time:	1000	1440	1040	1505	1258
Lab Log#:	118280	118281	118289	118290	118293
VOA Compounds	µg/L	µg/L	µg/L	µg/L	µg/Kg
Chloromethane	2.0 U	2.0 U	2.0 U	2.0 U	160 U
Bromomethane	2.0 U	2.0 U	2.0 U	2.0 U	160 U
Vinyl Chloride	2.0 U	2.0 U	2.0 U	2.0 U	160 U
Chloroethane	2.0 U	2.0 U	2.0 U	2.0 U	160 U
Methylene Chloride	2.0 U	1.8 J	1.0 J	2.0 U	350
Acetone	53	REJ	15	16	3400
Carbon Disulfide	1.0 U	1.0 U	1.0 U	1.0 U	290
1,1-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
1,1-Dichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	80 U
trans-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
cis-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Chloroform	1.0 U	1.9	1.7	1.8	80 U
1,2-Dichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	80 U
2-Butanone (MEK)	5.0 U	75	5.0 U	5.0 U	710
1,1,1-Trichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Carbon Tetrachloride	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Vinyl Acetate	5.0 U	5.0 U	5.0 U	5.0 U	400 U
Bromodichloromethane	1.0 U	1.0 U	1.0 U	1.0 U	80 U
1,2-Dichloropropane	1.0 U	1.0 U	1.0 U	1.0 U	80 U
cis-1,3-Dichloropropene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Trichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Dibromochloromethane	1.0 U	1.0 U	1.0 U	1.0 U	80 U
1,1,2-Trichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Benzene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
trans-1,3-Dichloropropen	1.0 U	1.0 U	1.0 U	1.0 U	80 U
2-Chloroethylvinyl Ether	5.0 UJ	5.0 UJ	5.0 UJ	5.0 UJ	400 U
Bromoform	1.0 U	1.0 U	1.0 U	1.0 U	80 U
4-Methyl-2-Pentanone (	5.0 U	5.0 U	5.0 U	5.0 U	400 U
2-Hexanone	5.0 U	5 U	5.0 U	5.0 U	400 U
Tetrachloroethene	1.0 U	2.4	1.0 U	1.0 U	80 U
1,1,2,2-Tetrachloroethan	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Toluene	2.9	27	1.0 U	1.0 U	2200
Chlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Ethylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	350
Styrene	1.0 U	1.0 U	1.0 U	1.0 U	80 U
Total Xylenes	5.1 U	1.8 J	2.0 U	2.0 U	2500
Trichlorofluoromethane	2.0 U	2.0 U	2.0 U	2.0 U	160 U
1,1,2-Trichlorotrifluoroet	2.0 U	2.0 U	2.0 U	2.0 U	160

E	Ecology sample
P	Port Orchard sample
Inf	Influent Sample
Ef	Effluent Sample
grab	Grab sample
REJ	The data are unusable for all purposes
U	The analyte was not detected at or above the reported result..
UJ	The analyte was not detected at or above the reported estimated result..
Sludge	Ecology sludge sample

Appendix E (cont'd) - Port Orchard, 1994.

Location:	Inf-E	Ef-E	Sludge
Type:	comp	comp	grab
Date:	03/15-16	03/15-16	03/15
Time:	@	@	1258
Lab Log#:	118282	118291	118293
BNA Compounds	µg/L	µg/L	µg/Kg
Phenol	5.8	2.0 U	3100 U
Bis(2-Chloroethyl)Ether	1.0 U	1.0 U	1600 U
2-Chlorophenol	1.0 U	1.0 U	1600 U
1,3-Dichlorobenzene	1.0 U	1.0 U	1600 U
1,4-Dichlorobenzene	1.0 U	1.0 U	1600 U
Benzyl Alcohol	8.2	5.0 U	7900 U
1,2-Dichlorobenzene	1.0 U	1.0 U	1600 U
2-Methylphenol	1.0 U	1.0 U	1600 U
Bis(2-Chloroisopropyl)Ether	1.0 U	1.0 U	1600 U
4-Methylphenol	35	1.0 U	1600 U
N-Nitroso-di-n-Propylamine	1.0 U	1.0 U	1600 U
Hexachloroethane	2.0 U	2.0 U	3100 U
Nitrobenzene	1.0 U	1.0 U	1600 U
Isophorone	1.0 U	1.0 U	1600 U
2-Nitrophenol	5.0 U	5.0 U	7900 U
2,4-Dimethylphenol	2.0 U	2.0 U	3100 U
Benzoic Acid	19 N	10 U	16000 U
Bis(2-Chloroethoxy)Methane	1.0 U	1.0 U	1600 U
2,4-Dichlorophenol	3.0 U	3.0 U	4700 U
1,2,4-Trichlorobenzene	1.0 U	1.0 U	1600 U
Naphthalene	1.0 U	1.0 U	1600 U
4-Chloroaniline	3.0 U	3.0 U	4700 U
Hexachlorobutadiene	2.0 U	2.0 U	3100 U
4-Chloro-3-Methylphenol	2.0 U	2.0 U	3100 U
2-Methylnaphthalene	1.0 U	1.0 U	1600 U
Hexachlorocyclopentadiene	5.0 U	5.0 U	7900 U
2,4,6-Trichlorophenol	5.0 U	5.0 U	7900 U
2,4,5-Trichlorophenol	5.0 U	5.0 U	7900 U
2-Chloronaphthalene	1.0 U	1.0 U	1600 U
2-Nitroaniline	5.0 U	5.0 U	7900 U
Dimethyl Phthalate	1.0 U	1.0 U	1600 U
Acenaphthylene	1.0 U	1.0 U	1600 U
3-Nitroaniline	5.0 U	5.0 U	7900 UJ
Acenaphthene	1.0 U	1.0 U	1600 U
2,4-Dinitrophenol	10 U	10 U	16000 UJ
4-Nitrophenol	5.0 U	5.0 U	7900 U

E	Ecology sample
P	Port Orchard sample
Inf	Influent Sample
Ef	Effluent Sample
comp	Composite sample
@	Composite sample period: 08:00-08:00.
N	There is evidence that the analyte is present in this sample.
U	The analyte was not detected at or above the reported result..
UJ	The analyte was not detected at or above the reported estimated result..
Sludge	Ecology sludge sample

Appendix E (cont'd) - Port Orchard, 1994.

Location:	Inf-E	Ef-E	Sludge
Type:	comp	comp	grab
Date:	03/15-16	03/15-16	03/15
Time:	@	@	1258
Lab Log#:	118282	118291	118293
BNA Compounds	µg/L	µg/L	µg/Kg
Dibenzofuran	1.0 U	1.0 U	1600 U
2,6-Dinitrotoluene	5.0 U	5.0 U	7900 U
2,4-Dinitrotoluene	5.0 U	5.0 U	7900 U
Diethyl Phthalate	13	1.0 U	1600 U
4-Chlorophenyl Phenylether	1.0 U	1.0 U	1600 U
Fluorene	1.0 U	1.0 U	1600 U
4-Nitroaniline	5.0 U	5.0 U	7900 UJ
4,6-Dinitro-2-Methylphenol	10 U	10 U	16000 U
N-Nitrosodiphenylamine	1.0 U	1.0 U	1600 U
4-Bromophenyl Phenylether	1.0 U	1.0 U	1600 U
Hexachlorobenzene	1.0 U	1.0 U	1600 U
Pentachlorophenol	5.0 U	5.0 U	7900 U
Phenanthrene	1.0 U	1.0 U	1600 U
Carbazole	1.0 U	1.0 U	1600 UJ
Anthracene	1.0 U	1.0 U	1600 U
Di-n-Butyl Phthalate	2.0	1.0 U	1600 U
Fluoranthene	1.0 U	1.0 U	1600 U
Pyrene	1.0 U	1.0 U	1600 U
Butylbenzyl Phthalate	8.2	1.0 U	1600 U
3,3'-Dichlorobenzidine	5.0 U	5.0 U	7900 UJ
Benzo(a)Anthracene	1.0 U	1.0 U	1600 U
Bis(2-Ethylhexyl)Phthalate	27	6.4	REJ U
Chrysene	1.0 U	1.0 U	1600 U
Di-n-Octyl Phthalate	3.8 J	1.0 U	10000
Benzo(b)Fluoranthene	1.0 U	1.0 U	1600 U
Benzo(k)Fluoranthene	1.0 U	1.0 U	1600 U
Benzo(a)Pyrene	1.0 U	1.0 U	1600 U
Indeno(1,2,3-cd)Pyrene	1.0 U	1.0 U	1600 U
Dibenzo(a,h)Anthracene	1.0 U	1.0 U	1600 U
Benzo(g,h,i)Perylene	1.0 U	1.0 U	1600 U

E	Ecology sample
P	Port Orchard sample
Inf	Influent Sample
Ef	Effluent Sample
comp	Composite sample
@	Composite sample period: 08:00-08:00.
J	The analyte was positively identified. The associated numerical result is an estimate.
U	The analyte was not detected at or above the reported result..
UJ	The analyte was not detected at or above the reported estimated result..
Sludge	Ecology sludge sample

Appendix E (cont'd) - Port Orchard, 1994.

Location:	Inf-E	Ef-E	Sludge
Type:	comp	comp	grab
Date:	03/15-16	03/15-16	03/15
Time:	@	@	1258
Lab Log#:	118282	118291	118293
Pesticide/PCB Compounds	µg/L	µg/L	µg/Kg
alpha-BHC	0.050 U	0.050 U	56 U
beta-BHC	0.050 U	0.050 U	56 U
delta-BHC	0.050 U	0.050 U	56 U
gamma-BHC (Lindane)	0.050 U	0.050 U	56 U
Heptachlor	0.050 U	0.050 U	56 U
Aldrin	0.050 U	0.050 U	56 U
Heptachlor Epoxide	0.050 U	0.050 U	56 U
Endosulfan I	0.050 U	0.050 U	56 U
Dieldrin	0.10 U	0.10 U	110 U
4,4'-DDE	0.10 U	0.10 U	110 U
Endrin	0.10 U	0.10 U	110 U
Endosulfan II	0.10 U	0.10 U	110 U
4,4'-DDD	0.10 U	0.10 U	110 U
Endosulfan Sulfate	0.10 U	0.10 U	110 U
4,4'-DDT	0.10 U	0.10 U	110 U
Methoxychlor	0.50 U	0.50 U	560 U
Endrin Ketone	0.10 U	0.10 U	110 U
Endrin Aldehyde	0.10 U	0.10 U	110 U
alpha-Chlordane	0.050 U	0.050 U	56 U
gamma-Chlordane	0.050 U	0.050 U	56 U
Toxaphene	5.0 U	5.0 U	5600 U
Aroclor-1016	1.0 U	1.0 U	1100 U
Aroclor-1221	2.0 U	2.0 U	2200 U
Aroclor-1232	1.0 U	1.0 U	1100 U
Aroclor-1242	1.0 U	1.0 U	1100 U
Aroclor-1248	1.0 U	1.0 U	1100 U
Aroclor-1254	1.0 U	1.0 U	1100 U
Aroclor-1260	1.0 U	1.0 U	1100 U

E	Ecology sample
P	Port Orchard sample
Inf	Influent Sample
Ef	Effluent Sample
comp	Composite sample
@	Composite sample period: 08:00-08:00.
grab	Grab sample
U	The analyte was not detected at or above the reported result..
Sludge	Ecology sludge sample

Appendix E (cont'd) - Port Orchard, 1994.

Location:	Inf-E	Inf-P	Ef-E	Ef-P	Sludge	Sed-1	Sed-2	Sed-3	Duplicate-1
Type:	comp	comp	comp	comp	grab	grab	grab	grab	comp
Date:	03/15-16	03/15-16	03/15-16	03/15-16	03/15	03/23	03/23	03/23	03/15-16
Time:	@	@	@	@	1258	1310	1400	1430	@
Lab Log#:	118282	118283	118291	118292	118293	118294	118295	118296	118297
Metals (Total Recoverable)	µg/L	µg/L	µg/L	µg/L	mg/Kg-dry	mg/Kg-dry	mg/Kg-dry	mg/Kg-dry	µg/L
Antimony	30 U	30 U	30 U	30 U	27.3 UN	3 UJ	3 UJ	3 UJ	30 U
Arsenic	3.2 P	1.5 P	2.4 P	2.6 P	5.27 J	8.7 U	6.3 P	9.8 U	2.2 P
Beryllium	1 U	1 U	1 U	1 U	0.909 U	0.16 P	0.16 P	0.17 P	1 U
Cadmium	0.58 P	0.60 P	0.10 U	0.11 P	4.18 P	0.49 U	0.3 U	0.35 P	0.10 U
Chromium	5 U	5 U	5 U	5 U	22.7 U	30.2	33	30.3	5 U
Copper	33.6 U	40	9 P	9.8 P	285	20.9	20.4	33.7	9.3 P
Lead	5.6 P	5.9 P	1.0 U	1.0 U	46.4 P	20	19 P	20.4	20 U
Mercury	0.865 U	0.629 U	0.05 U	0.11 U	3.33 N	0.131 U	0.108	0.159	0.054 P
Nickel	25 U	25 U	25 U	25 U	26.4 P	26.7	28.4	25.8	25 U
Selenium	2.0 U	2.0 U	2.0 U	2.0 U	3.36 J	0.44 P	0.41 P	0.44 P	2.0 U
Silver	2.2 P	2.4 P	0.51 P	0.61 P	2.73 U	0.3 U	0.4 P	0.35 P	0.52 P
Thallium	2.5 U	2.5 U	2.5 U	2.5 U	2.27 U	0.50 U	0.50 U	0.50 U	2.5 U
Zinc	103	121	33 P	42.3 U	716	49.4 U	48	50.9	34 P

E	Ecology sample
P	Port Orchard sample
Inf	Influent Sample
Ef	Effluent Sample
comp	Composite sample
@	Composite sample period: 08:00-08:00.
grab	Grab sample
Sludge	Ecology sludge sample
Sed-1	Sedimant sample taken 300 ft NNE from outfall
Sed-2	Sedimant sample taken at south end of diffuser outfall
Sed-3	Sediment sample taken at north end of diffuser outfall

J	The analyte was positively identified. The associated numerical result is an estimate.
N	The spike sample recovery is not within control limits
P	The analyte was detected above the instrument detection limit, but below the established minimum quantitation limits.
U	The analyte was not detected at or above the reported result..

Appendix F - Tentatively Identified Compounds - Port Orchard, 1994

Sample Location:	Inf-E-2
Type:	grab
Date:	03/15
Time:	1440
Sample ID:	118280

Volatile Organics:

Compound Name	Estimated Concentration (µg/L.)	Qualifier
1. Unknown Hydrocarbon	9	J
2. Unknown Cyclic Hydrocarbon	11	J

Sample Location:	Sludge
Type:	grab
Date:	03/15
Time:	1258
Sample ID:	118293

Volatile Organics:

Compound Name	Estimated Concentration (µg/Kg-dry wt.)	Qualifier
1. Unknown	1,600	J
2. Unknown	7,900	J
3. Unknown	630	J
4. Unknown	2,700	J
5. Trimethyl Benzene Isomer	15,000	J
6. Benzene, 1-Methyl-4-(1-ME)	18,000	JN
7. 2-Methyl-Nonane	20,000	JN
8. Unknown	10,000	J

J The analyte was identified. The associated numerical result is an estimate.

N The spike sample recovery is not within control limits.

Appendix F - Tentatively Identified Compounds (cont.) - Port Orchard, 1994

Sample Location:	Inf-E
Type:	comp
Date:	03/15-16
Time:	08:00-08:00
Sample ID:	118282

Semivolatile Organics:

Compound Name	Estimated Concentration (µg/L)	Qualifier
1. Unknown	35	J
2. Unknown_Acid_Type	140	JN
3. Unknown_Alcohol_Type	63	JN
4. Unknown_Acid_Type	280	JN
5. Unknown	120	J
6. Unknown	110	J
7. Unknown_Alcohol_Type	31	JN
8. Unknown_Acid_Type	1,400	JN
9. Unknown_Acid_Type	62	JN
10. Unknown	78	J
11. Unknown	2,600	J
12. Unknown_Acid_Type	770	JN
13. Unknown_Acid_Type	65	JN
14. Unknown	89	J
15. Unknown	44	J
16. Unknown	80	J
17. Unknown_Hydrocarbon	140	JN
18. Unknown_Sterol	150	JN
19. Unknown	58	J
20. Unknown_Sterol	140	JN

Appendix F - Tentatively Identified Compounds (cont.) - Port Orchard, 1994

Sample Location:	Ef-E
Type:	comp
Date:	03/15-16
Time:	08:00-08:00
Sample ID:	118291

Semivolatile Organics:

Compound Name	Estimated Concentration (µg/L)	Qualifier
1. Unknown	10	J
2. Unknown	11	J
3. Unknown	12	J
4. Unknown	29	J
5. Unknown_Acid_Type	57	JN
6. Unknown	75	J
7. Unknown_Acid_Type	60	JN
8. Unknown	12	J
9. Unknown	14	J
10. Unknown	17	J
11. Unknown	19	J
12. Unknown	16	J
13. Unknown	26	J
14. Unknown	14	J
15. Unknown_Sterol	21	JN
16. Unknown_Sterol	36	JN
17. Unknown	22	J

Appendix F - Tentatively Identified Compounds (cont.) - Port Orchard, 1994

Sample Location:	Sludge
Type:	grab
Date:	03/15
Time:	1258
Sample ID:	118293

Semivolatile Organics:

Compound Name	Estimated Concentration (μg/Kg-dry wt.)	Qualifier
1. Unknown_Hydrocarbon_BP_43	71,000	JN
2. Unknown_Hydrocarbon_BP_43	52,000	JN
3. Unknown_Hydrocarbon_BP_57	34,000	JN
4. Unknown	53,000	J
5. Unknown	31,000	J
6. Unknown	53,000	J
7. Unknown_Acid_Type	59,000	JN
8. Unknown	54,000	J
9. Unknown	200,000	J
10. Unknown	1,200,000	J
11. Unknown	470,000	J
12. Unknown	150,000	J
13. Unknown	82,000	J
14. Unknown	710,000	J
15. Unknown	76,000	J
16. Unknown	380,000	J
17. Unknown	82,000	J
18. Unknown	68,000	J
19. Unknown	150,000	J
20. Unknown	210,000	J

Appendix G - GLOSSARY

BNA	Base-neutral acids, semivolatiles, see ABN
BOD	Biological Oxygen Demand
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
CVAA	Cold Vapor Atomic Absorption
GC	Gas Chromatography
ICP	Inductively Coupled Plasma
kg	kilogram (1×10^3 grams)
L	Liter (1×10^3 milliliters)
LC50	Concentration which is lethal to 50% of the test organisms
LOD	Limit of Detection
LOEC	Lowest Observable Effect Concentration
m^3	Cubic meter (1×10^3 liters)
MF	Membrane Filter
mg	milligram (1×10^{-3} grams)
mL	Milliliter (1×10^{-3} liters)
MPN	Most Probable Number
NOEC	No Observable Effect Concentration
NPDES	National Pollution Discharge Elimination System
NPOC	Non-Purgeable Organic Carbon
PCB	Polychlorinated Biphenyl
pH	Hydrogen Ion Concentration
POC	Purgeable Organic Carbon
PP	Priority Pollutant
ppm	Parts per million (1×10^{-6} ug/L or ug/kg)
ppt	Parts per thousand (1×10^{-3} ug/L or ug/kg)
TIC	Total Inorganic Carbon or for GCMS Tentatively Identified Compound
TNVS	Total Non-Volatile Solids
TNVSS	Total Non-Volatile Suspended Solids
TOC	Total Organic Carbon
TP	Total Phosphorous
TPH	Total Petroleum Hydrocarbons
TS	Total Solids
TSS	Total Suspended Solids
TVS	Total Volatile Solids
ug	Microgram (1×10^{-6} grams)
ug/m^3	Microgram per cubic meter
VOA	Volatile Organic Analysis
VOC	Volatile Organic Carbon