ENVIRONMENT CANADA
CONSERVATION AND PROTECTION
ENVIRONMENTAL PROTECTION
PACIFIC AND YUKON REGION

STUDY OF PEDDER BAY: DND ROCKY POINT, DOJ WILLIAM HEAD INSTITUTION, LESTER B. PEARSON COLLEGE AND PEDDER BAY TRAILER PARK OCTOBER-NOVEMBER 1986

Regional Program Report 87-04

By

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ABSTRACT

Environmental Protection (EP), Conservation and Protection, staff conducted a study of Pedder Bay October 20-22 and November 17-21, 1986. This report includes: 1) an assessment of the new wastewater treatment system at the Department of National Defense (DND), Canadian Force Base (CFB), Rocky Point installation, 2) an evaluation of the Department of Justice (DOJ) William Head Institution Sewage Treatment Plant (STP) and review of a consultant's report, 3) an update on Lester B. Pearson College and Pedder Bay Trailer Park wastewater treatment systems, and 4) a bacteriological study to classify Pedder Bay under the Pacific Shellfish Regulations.

Recommendations are made to improve final effluents quality and to protect fishery resources in the Pedder Bay area.

RÉSUMÉ

Le personnel de la Protection de l'Environnement (PE), Conservation et Protection, a conduit une étude de la baie Pedder du 20 au 22 octobre et du 17 au 21 novembre. Ce rapport comprend: 1) une évaluation du nouveau système de traitement d'eaux usées aux installations de Rocky Point, département de la défense nationale (DN), base des forces canadiennes (BFC), 2) une évaluation de l'usine de traitement d'eaux usées de l'instituteion William Head du département de justice (Jus) et révision du rapport d'un consultant, 3) une mise à jour des usines de traitement d'eaux usées du collège Lester B. Pearson et du parc des maisons mobiles Pedder Bay, et 4) une étude bactériologique afin de classifier la baie Pedder sous le réglement de pêche des mollusques et crustacés du Pacifique.

Des recommendations sont apportées afin d'améliorer la qualité des effluents finaux et de protéger les ressources des pêcheries dans la région de la baie Pedder.

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LIST OF ABBREVIATIONS

m	Meter
km	Kilometer
cm	Centimeter
mm	Millimeter
cu·m	Cubic meter
m^3	Cubic meter
m^2	Square meter
in	Inch
Imp·gpd	Imperial gallons per day
BOD	Biochemical oxygen demand
NFR	Non-filterable residue
VNFR	Volatile non-filterable residue
ML	Mixed liquor
F/M	Food/microogranisms ratio
D.O.	Dissolved oxygen
NH_3	Ammonia
PO_4	Phosphate
N	Nitrogen
P	Phosphorus
mg	Milligram
Kg	Kilogram
l	Liter
ppt	Parts per thousand
d	Day
MF	Membrane filtration
MPN	Most probable number
FC	Fecal coliforms

1 INTRODUCTION

An assessment of the operation and performance of DND Rocky Point sewage lagoon was carried out from October 20-22 and November 18-20, 1986. This new treatment system, in operation since November 1985, has replaced three septic tank effluent discharges to Peddar Bay and three septic tank-tile field systems.

An evaluation of the William Head Institution STP was carried out from October 20-22 and November 18-20, 1986, to determine upgrade needs to the treatment system for possible expansion of the institution. A consultant's report was also reviewed and comments were generated.

Lester B. Pearson College and Pedder Bay Trailer Park wastewater treatment systems were also assessed November 18-20, 1986, to determine their final effluent quality and the degree of compliance with their respective provincial permits.

A bacteriological study of Pedder Bay was carried out November 17-21, 1986, to assess the impact of the discharges and to classify the status of Pedder Bay under the Pacific Shellfish Regulations.

2 DND ROCKY POINT

2.1 Introduction

The Department of National Defense (DND), Canadian Force Base (CFB), Rocky Point installation is located on the south side of Pedder Harbour south-west of Victoria (Figure 1). The new lagoon in operation since November 1985 was evaluated by EPS staff October 20-22, 1986 and November 18-20, 1986.

Samples were taken for BOD and NFR analyses. These samples were kept cool until delivery at the EP West Vancouver Laboratory. Temperature, pH, D.O. and nutrients (NH_3 and $O\text{-}PO_4$) test were performed on site. Hach kits were used for nutrients, Corning Scientific Model 610A pH meter for pH levels and YSI Model 51B oxygen meter for dissolved oxygen measurements. Flow was determined using the bucket-stop watch technique. A fish bioassay was performed on the final effluent at the EP North Vancouver laboratory.

Fecal coliform tests on the final effluent and in Pedder Bay samples were performed during the November study using the Membrane Filtration (MF) and Most Probably Number (MPN) techniques respectively. These samples were run the same day at the EP mobile laboratory located at Sooke.

2.2 Description

Three septic tank effluent discharges to Pedder Bay and three septic tank-tile field systems in the laboratory area were eliminated and replaced by only one discharge to Pedder Bay from an aerated lagoon through a long outfall. The disused septic tanks were pumped out and filled with sand. The sewerage system (Figure 2) includes only one sewage lift station located at the PMQ (Personnel Married Quarters). An existing septic tank next to the lift station is used for emergency overflow to Pedder Bay.

The aerated lagoon is separated into two sections by a full baffle in which there is a centrally located 0.9 m x 0.3 m opening starting 1 m under the water surface to allow flow-through from the first to the second section. Two blowers supply air through two parallel systems equipped with bubbler tubes located on either sides of the baffle (Figure 3). The first section of the aerated lagoon is more aerated (27 bubbler tubes) than the

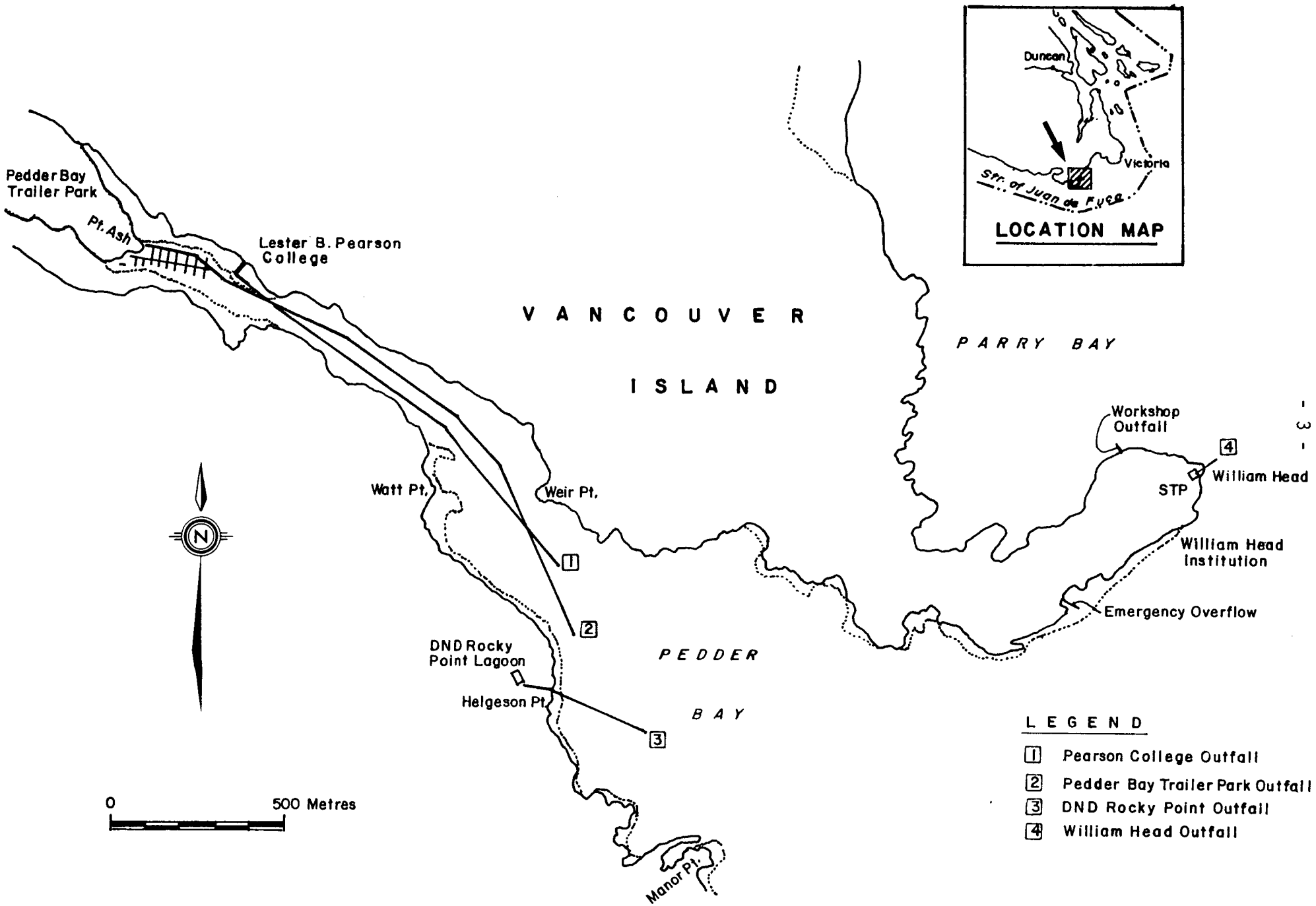

FIGURE 1 PEDDER BAY MAP LOCATION AND OUTFALLS

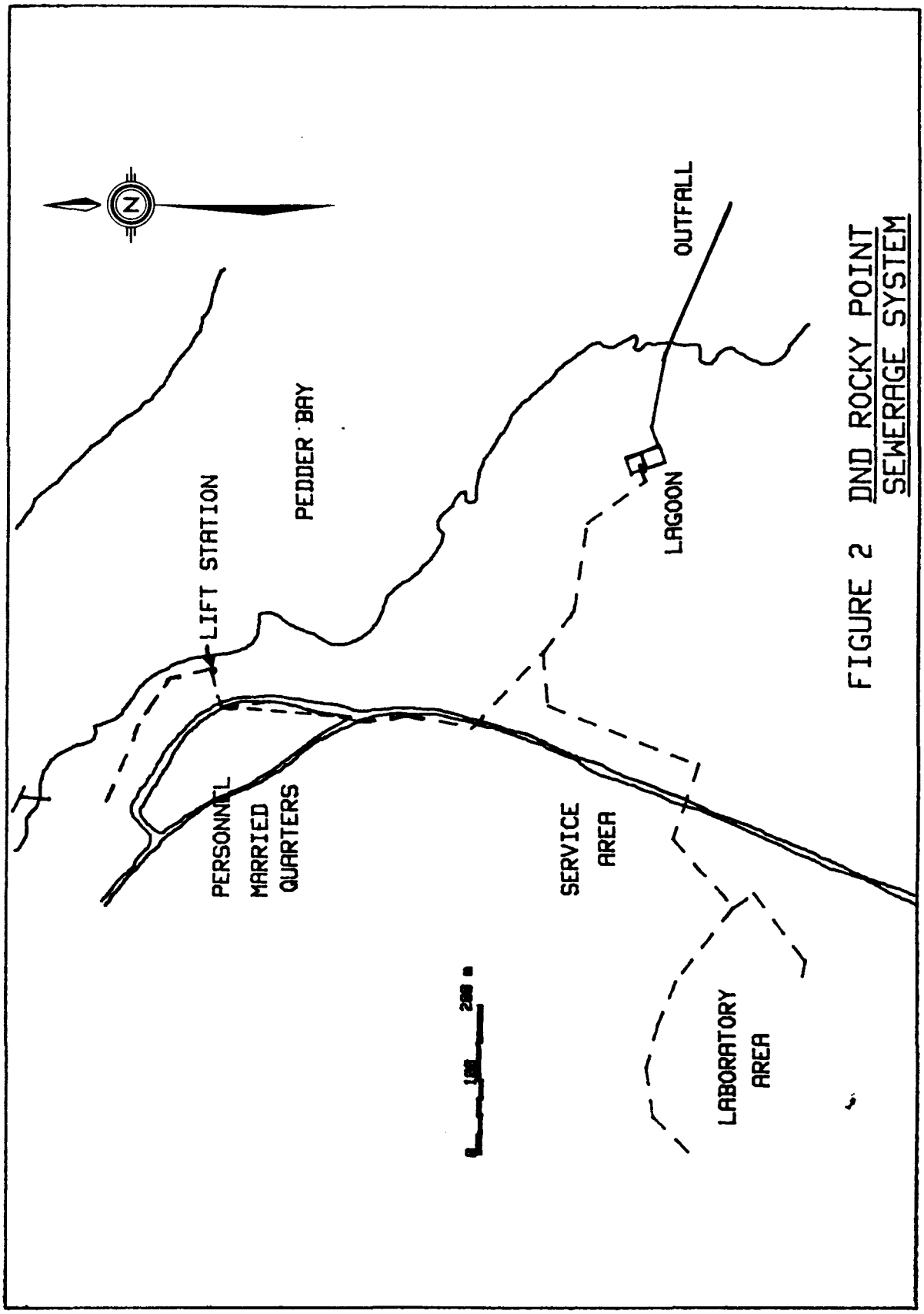

FIGURE 2 DND ROCKY POINT
SEWERAGE SYSTEM

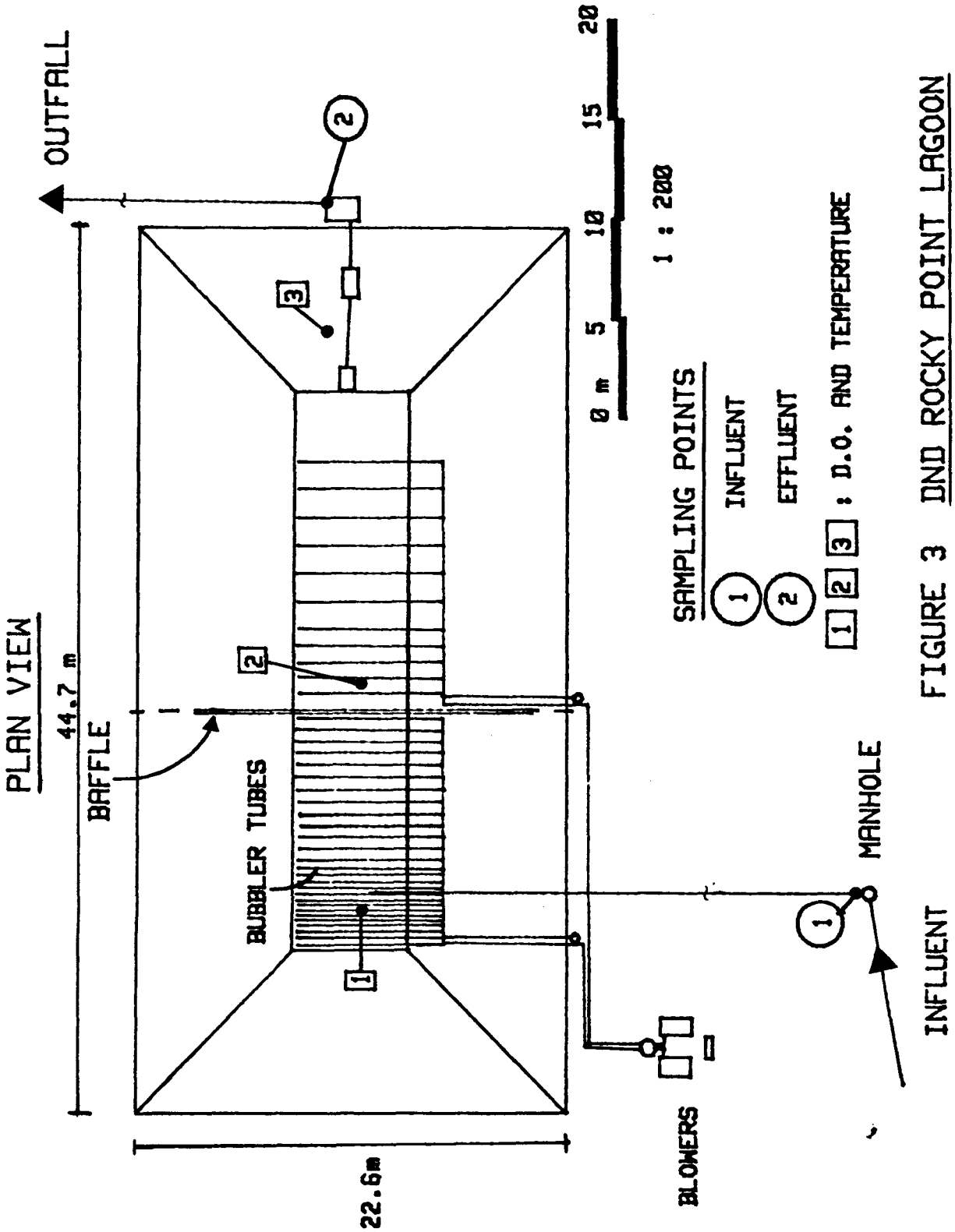

FIGURE 3 DND ROCKY POINT LAGOON

second section (11 bubbler tubes). Both aeration systems are equipped with chlorine gas cleaning connections to the bubbler tubes to clean out the tubes' ports. The upper outlet pipe, used for final effluent discharge, is located approximately 9 meters from the last bubbler tube.

The outlet structure has two interconnected 100 mm diameter pipes separated by a vertical distance of 1.3 m.

The final effluent is discharged through a 275 m long 150 mm diameter outfall to a 6.7 m depth below low water level. A 60 mm diameter reducer is installed on the outfall in order to increase velocity and achieve larger dilution.

During the second inspection, the aeration had been shut down because of back-pressure at the air blowers due to bubbler tubes being plugged. The chlorine solution used for cleaning the tubes had been ordered but not yet delivered. Samples were taken under this non-aerated mode of operation and compared with the results obtained in October.

2.3 Results and Discussion

2.3.1 First Part: October 20-22, 1986. The flow averaged 20 cu·m/d (4300 Imp·gpd) during the survey. Table 1 shows the lagoon characteristics. The lagoon detention time was 43 days. Dissolved oxygen levels (Table 2) were high ranging from 9.5 to 11.3 mg/l (86% to 100% saturation).

TABLE 1 DND ROCKY POINT LAGOON CHARACTERISTICS

DEPTH:	2.13 m
WIDTH:	18.76 m
LENGTH:	37.52 m
VOLUME:	856.8 cu·m
FLOW - DRY WEATHER:	20 cu·m/d (October 20-22, 1986)
- WET WEATHER:	35 cu·m/d (November 17-21, 1986)
DETENTION TIME - DRY WEATHER:	43 days
- WET WEATHER:	24 days

TABLE 2 DND ROCKY POINT LAGOON: DISSOLVED OXYGEN AND TEMPERATURE OCTOBER 20-22, 1986

	OCTOBER 20		OCTOBER 21		OCTOBER 22		AVERAGE	
	D.O.	TEMP.	D.O.	TEMP.	D.O.	TEMP.	D.O.	TEMP.
Station 1	11.2	11	10	11.3	11.1	10	10.8	10.8
Station 2	11.0	10	9.5	11.2	10.8	10	10.4	10.4
Station 3	11.2	11	9.5	10.4	10.6	10	10.4	10.5

See Figure 3 for station locations
D.O. in mg/l and temperatere in deg. Celcius (°C)

BOD and NFR were reduced in average by 74% and 35% respectively to levels of 31 and 89 mg/l (Table 3). The solids levels (87 to 90 mg/l) in the effluent were particularly high and can partially be explained by the presence of algae. The BOD values ranging from 28 to 33 mg/l were high considering the low organic loadings and the good aeration in the lagoon.

TABLE 3 DND ROCKY POINT: ANALYTICAL RESULTS - OCTOBER 20-22, 1986

PARAMETER*	I N F L U E N T				E F F L U E N T			
	OCT. 20	OCT. 21	OCT. 22	AVG.	OCT. 20	OCT. 21	OCT. 22	AVG.
Temp.	17	14	15	15	10	11	10	10
pH	6.8	6.5	6.0	6.4	6.5	6.5	6.0	6.3
NH_3 (N)	17.1	7.3	9.8	11.4	11.0	12.2	12.2	11.8
O-PO_4 (P)	3.0	1.3	8.6	4.3	2.6	1.7	2.8	2.4
D.O.	9.7	8.0	13.0	10.2	11.2	8.0	7.0	8.7
BOD	66	186	104	119	28	33	32	31
NFR	102	49	259	137	90	89	87	89

* units are mg/l except Temperature (°C) and pH (relative units)
Flow = 20 cu·m/d (4300 Imp·gpd)

These effluent characteristics did not meet the guideline values for effluent quality and wastewater treatment (BOD: 20 mg/l and NFR: 25 mg/l) at federal establishments (5) as shown in Table 4. The Waste Management Branch (WMB) Pollution Control Objectives (4) for municipal discharges to marine embayed waters (BOD: 45 mg/l and NFR: 60 mg/l) were met at all times for BOD but were not met for NFR (Table 5).

TABLE 4 DND ROCKY POINT: COMPLIANCE WITH FEDERAL GUIDELINES

BOD: 20 mg/l
NFR: 25 mg/l
pH: 6 to 9

	OCTOBER 20-22, 1986		NOVEMBER 18-20, 1986	
	Number of Samples	% Compliance	Number of Samples	% Compliance
BOD	3	0	3	0
NFR	3	0	3	0
pH	3	3	3	100

TABLE 5 DND ROCKY POINT: COMPLIANCE WITH WMB EFFLUENT QUALITY OBJECTIVES

BOD: 45 mg/l*
NFR: 60 mg/l*

	OCTOBER 20-22, 1986		NOVEMBER 18-20, 1986	
	Number of Samples	% Compliance	Number of Samples	% Compliance
BOD	3	100	3	100
NFR	3	0	3	100

* Effluent Quality Objectives for Municipal Discharges to Embayed Marine Waters

The distance separating the last bubbler tube and the final effluent outlet is about 9 m. This distance is insufficient to allow suspended solids to settle effectively.

Ammonia was not reduced through the lagoon. Ortho-phosphate was reduced by 44%.

The fish bioassay LT_{50} test indicated that the final effluent was not toxic to fish at a 100% concentration over a 96 hour period.

2.3.2 Second Part: November 18-20, 1986. Due to heavy precipitation (Table 8), the average flow was considerably higher around 35 cu·m/d (7700 Imp·gpd). The dissolved oxygen levels were about 1 mg/l in the lagoon due to cessation of aeration a few days prior to and during the survey (Table 6).

TABLE 6 DND ROCKY POINT LAGOON: DISSOLVED OXYGEN AND TEMPERATURE, NOVEMBER 18-20, 1986

	NOVEMBER 19	
	DISSOLVED OXYGEN (mg/l)	TEMPERATURE (°C)
Station 1	1.0	9.5
Station 2	1.0	8.5
Station 3	1.0	8.5

See Figure 3 for station locations

The final effluent characteristics were about the same as found during the first part of the survey for BOD, ranging from 23 to 35 mg/l (Table 7). This can be explained by the fact that the samples still represented the aerated mode of operation because the lagoon detention time is much longer than the few days when aeration had been ceased. The ceased aeration also provided a longer settling period and lower solids in the final effluent. Final effluent NFR values (40 to 52 mg/l) were 50% of the values found during the first part of the survey.

The fecal coliforms reduction reflects a normal operation for lagoons with a reduction factor of 100 (Table 7).

TABLE 7 DND ROCKY POINT: ANALYTICAL RESULTS - NOVEMBER 18-20, 1986

PARAMETER*	FINAL EFFLUENT			
	NOVEMBER 18	NOVEMBER 19	NOVEMBER 20	AVERAGE
Temp. (°C)	9.0	8.5	-	8.8
pH (rel. units)	6.5	6.5	-	6.5
NH_3 (N)	14.6	17.6	-	16.1
D.O.	7.0	5.0	-	6.0
BOD	35	35	23	31
NFR	49	52	40	47
Fecal coliforms (FC/100 ml)	260000	170000	100000	176667

* units in mg/l unless otherwise stated
Flow = 35 cu·m/d (7700 Imp·gpd)

TABLE 8 PRECIPITATION - PEDDER BAY

Atmospheric Environment Service, Environment Canada, weather station located at William Head

Readings at 08:00.

DATE	PRECIPITATION (mm)	DATE	PRECIPITATION (mm)
October 18	0	November 15	4.2
October 19	0	November 16	6.0
October 20	0	November 17*	13.6
October 21*	0	November 18*	6.6
October 22*	0	November 19*	47.6
October 23*	0	November 20*	14.0
October 24	3.5	November 21*	5.4
October 25	23.5	November 22	50.0

* Survey days

These effluent characteristics did not meet the guidelines values for effluent quality and wastewater treatment (BOD: 20 mg/l and NFR: 25 mg/l) at federal establishments (5) as shown in Table 4. The Waste Management Branch (WMB) Pollution Control Objectives (4) for municipal discharges to marine embayed waters (BOD: 45 mg/l and NFR: 60 mg/l) were met at all times for BOD and NFR (Table 5).

Table 9 shows the water column stratification at the end of the Rocky Point outfall at the time of the survey. Under the worst case conditions without current, the dilution computer model OUTPLM predicted a dilution of 500 to 1 with the effluent plume reaching the water surface (Appendix II).

TABLE 9 WATER COLUMN STRATIFICATION AT ROCKY POINT OUTFALL

Date: November 18, 1986

DEPTH (m)	TEMPERATURE (°C)	DISSOLVED OXYGEN (mg/l)	SALINITY (ppt)
0	8.7	8.0	27.0
2	8.6	7.3	27.0
4	8.7	6.9	27.0
6	8.6	6.6	27.1
8	8.6	5.8	27.0
10	8.4	5.8	27.5

2.4 Conclusions

1. The final effluent characteristics did not meet the Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments for BOD and NFR, but should be met with the recommended changes.

2. The final effluent characteristics met the B.C. Provincial Pollution Control Objectives (BOD: 45 mg/l and NFR: 60 mg/l) during the second part of the survey. The objectives will be met constantly with the recommended changes.

3. The final effluent was not toxic to fish.

4. Under the aerated mode, too much aeration was provided leading to poor settling and waste of energy.

5. The use of both aeration systems in the first and second section of the lagoon did not allow enough settling to remove the solids. BOD was not reduced to lower values because of high solid levels in the final effluent.

6. This new lagoon system effluent quality can be improved with a minimum changes.

2.5 Recommendations

1. Aeration should be used only on the first side of the lagoon prior to the baffle leaving the second portion for settling.

2. Monthly final effluent monitoring for BOD and NFR should be conducted under the modified conditions to determine the optimum treatment level.

3. A flowmeter device should be installed on the final effluent.

3 DOJ WILLIAM HEAD INSTITUTION

3.1 Introduction

The William Head Institution is located 30 km south west of Victoria on the north side of Pedder Bay (Figure 1). An assessment of the operation and performance of the William Head Institution sewage treatment plant (STP) was carried out by Environmental Protection (EP), Conservation and Protection (C&P), staff from October 20 to 22, 1986. Sampling for fecal coliforms was also performed on the final effluent and around William Head in the marine environment from November 18-20, 1986.

This report discusses the EP evaluation as well as the report from NovaTec Consultants Inc. entitled "Capacity Assessment and Upgrading Options for the William Head Institution Sewage Treatment Plant, May 1986" (3).

3.2 STP Evaluation

3.2.1 Description. The majority of the sewage flows to a central pump station. There are still several small septic tanks discharging to ground (No. 2 Tower) or into Parry Bay (Works Office and Shops).

Figure 4 shows a schematic of the sewage collection and treatment system. The sewage flows through one of two macerators prior to reaching the wet well. An emergency overflow pipe from the wet well leads to a two compartment septic tank equipped with a short 0.9 meter deep outfall to Pedder Bay.

The sewage is pumped by one of two pumps located next to the wet well to a manhole from where it flows by gravity to the treatment plant.

The sewage is then aerated in a race-track shape aeration tank by two submersible pumps equipped with individual aspirators which entrain air to provide aeration and mixing. Foam is controlled by spraying final effluent on the water surface.

The effluent from the aeration tank flows to the clarifier through a submerged pipe. A rotating skimmer cleans the clarifier's surface. The scum is collected in a cylindrical hopper and sent to the sludge holding tank by manual operation. The sludge is returned to the aeration tank or wasted to the sludge holding tank. Sludge is pumped out on a regular basis

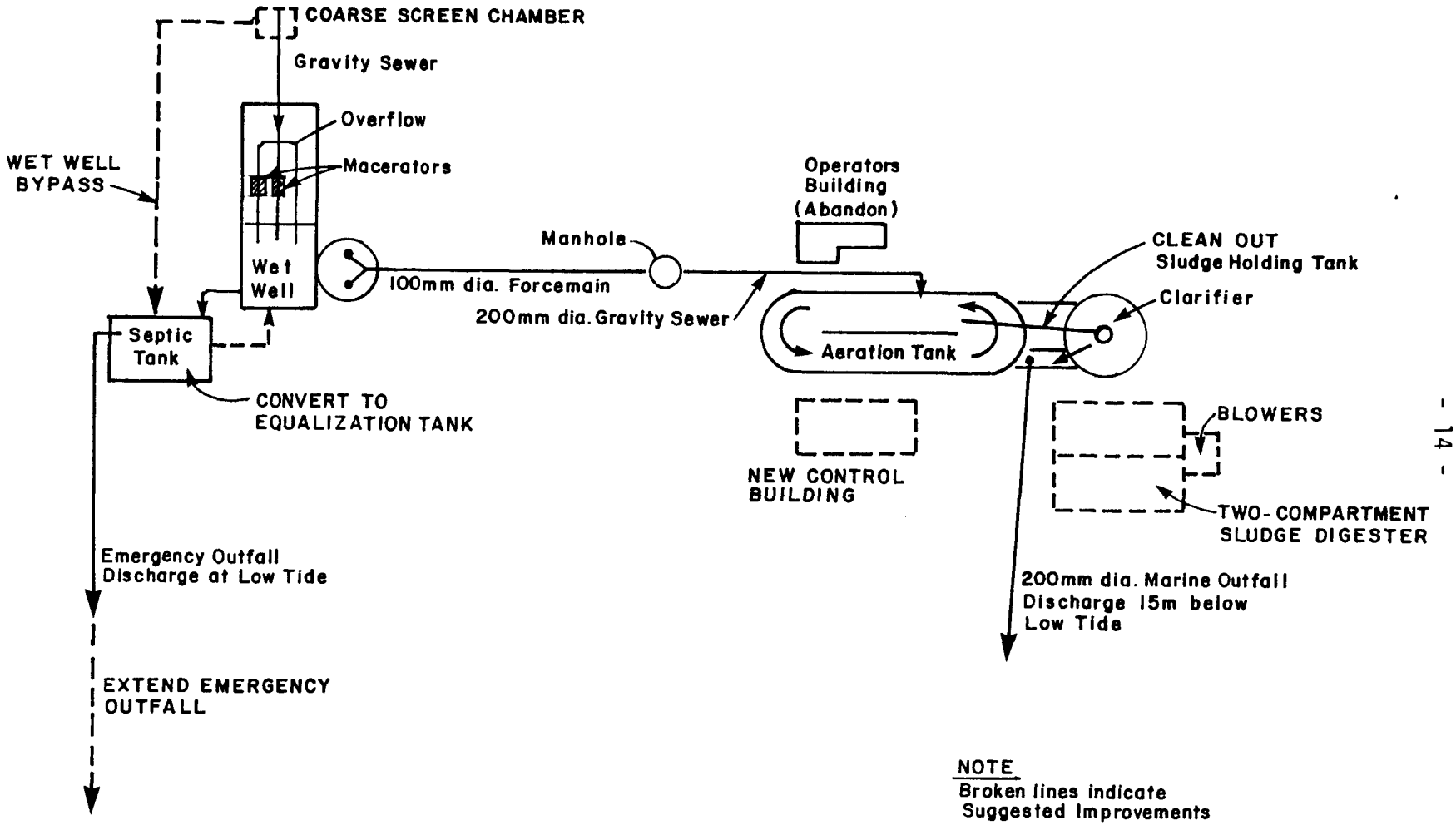

FIGURE 4 WILLIAM HEAD INSTITUTION- SCHEMATIC OF SEWAGE TREATMENT PLANT

(bi-weekly to monthly) from the sludge holding tank and is disposed of in the Capital Regional District (CRD) sewage collection system.

The clarified effluent flows to the chlorine contact chamber which has not been used for chlorination for several years. A V-notch weir allows flow measurement. The present flowmeter is unreliable and was not in working condition during the survey.

The final effluent is discharged by gravity to Juan de fuca Strait through a 200 mm diameter open ended outfall to a 15 meter depth.

3.2.2 **Results and Discussion.** Table 10 shows a reduction of 95% and 94% for BOD and NFR respectively. Ammonia level was reduced by 80%. Table 12 indicates that the final effluent characteristics met the "Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments" at all time during the survey. According to the consultant's study from July 1985 to November 1986 (17 samples), the federal guidelines for BOD and NFR were met respectively 60% and 70% of the time. The WMB effluent quality objectives for discharges to open marine waters (BOD: 130 mg/l and NFR: 130 mg/l) were met at all times during the survey and were met at all times since July 1985 according to the consultant's sampling program.

TABLE 10 WILLIAM HEAD INSTITUTION: ANALYTICAL RESULTS

Units in mg/l unless otherwise stated	INFLUENT				EFFLUENT			
	OCT. 20	OCT. 21	OCT. 22	AVG.	OCT. 20	OCT. 21	OCT. 22	AVG.
Temp. (°C)	17	16	18	17	17	18	17	17.3
pH (rel. unit)	6.0	6.0	6.0	6.0	6.5	6.0	6.0	6.2
NH_3	9.8	19.5	18.3	15.9	3.7	2.7	2.8	3.1
O-PO_4	3.0	1.0	3.0	2.3	3.5	3.6	2.4	3.2
D.O.	9.3	6.0	3.0	6.1	7.8	3.0	3.0	4.6
BOD	130	262	184	192	12	7	10	10
NFR	146	144	591	294	25	16	17	19
VNFR	122	99	569	233	14	16	9	13
Flow (m^3/d)	-	-	-	-	-	230	220	225
" (Imp·gpd)	-	-	-	-	-	51,000	48,000	49,500

CONTINUED...

TABLE 10 Continued

	OCT. 20	OCT. 21	OCT. 22	AVERAGE
Mixed Liquor NFR (mg/l)	2728	2644	2806	2726
Mixed Liquor VNFR (mg/l)	2540	2462	2597	2533

	NOV. 18	NOV. 19	NOV. 20	AVERAGE
Final Effluent				
Fecal Coliform Counts (MPN/100 ml)	33,000	19,000	5,000	19,000

The average flow through the plant during the survey was 225 cu·m/d (49500 Imp·gpd). Table 11 shows the treatment plant characteristics compared to typical values for extended aeration. Undersizing of the aeration tank is shown by the short detention time and the high F/M ratio. High F/M ratios can result in dispersed bacterial growth which will not settle properly. The oxygen levels in the aeration tank were kept in an appropriate range (greater than 1 mg/l). According to the consultant's report monitoring, the D.O. in the aeration tank cannot be kept over 1.0 mg/l at all times with the aeration system used. Temperature and solids level influence D.O. level. Lower D.O.'s could create odor problems and reduce plant efficiency.

The clarifier has enough capacity to accept up to 4 times the flow experienced during the survey (up to 900 cu·m/d).

The final effluent was not toxic to fish over a 96 hour exposure period.

TABLE 11 WILLIAM HEAD INSTITUTION STP CHARACTERISTICS

Population Served : 310 (Inmates - 175; Staff - 135)
Average Flow : 225 m^3/d (49,500 IMP·gpd)
Average Flow Per Capita: 0.73 m^3/d·c (160 IMPgpd·c)

		AVERAGE	TYPICAL VALUES FOR EXTENDED AERATION[1]
AERATION SECTION			
Depth (m)	3		
Volume (cu·m)	148		
Detention Time (hr)			
- Avg. flow	16		18-36
MLSS (mg/l)	2728-2644-2806	2726	3000-6000
MLVSS (mg/l)	2540-2462-2597	2533	
F/M			
(Kg BOD_5/Kg MLVNFR·day)	0.08-0.17-0.11	0.12	0.05-0.15
Volumetric Loading			
(Kg BOD_5/m^3·day)	0.20-0.41-0.27	0.29	0.16-0.40
Dissolved Oxygen (mg/l)	2.4-2.6-2.5	2.5	
			TYPICAL VALUES[2]
CLARIFICATION SECTION			
Volume (m^3)	93.6		
Depth (m)	3		
Diameter (m)	6.3		
Detention Time (hr)	10		2-3
Hydraulic Loading			
($m^3/d/m^2$)	7.2		12-41
Weir Loading (m^3/m·day)	11.4		max. 125-250
SLUDGE HOLDING TANK			
Volume (m^3)	11.4		
CHLORINE CONTACT TANK			
Depth (m)	2.5		
Volume (m^3)	6.3		
SEPTIC TANK			
Volume (m^3)	40		

TABLE 12 WILLIAM HEAD INSTITUTION: COMPLIANCE WITH FEDERAL GUIDELINES

BOD_5: 20 mg/l
NFR : 25 mg/l
pH : 6 to 9

	VALUES	% COMPLIANCE
BOD_5 (mg/l)	12-7-10	100 %
NFR (mg/l)	25-16-17	100 %
pH (rel. unit)	6.5-6.0-6.0	100 %

3.3 Comments on Consultant's Report

The consultant presents a good overview of the operation. Recommendations were made (Appendix I). The following comments are made indicating the works priority.

1. A reliable flowmeter should be installed to measure total flow through the plant and to monitor progress with the sewer rehabilitation program.

2. The discharge from the Works Office to Parry Bay and other direct discharges should be directed to the sewage treatment plant.

3. A comprehensive sewer rehabilitation (item 9) should be the prime consideration. The aeration tank, close to design capacity, is the limiting flow element. Any increase in capacity would be expensive. Therefore, flow reduction is primordial.

4. The installation of a coarse screen upstream of the pump station macerators (item 1) would reduce repair costs.

5. The pump station and flow equalization package (items 2, 3 and 4) consisting of the construction of a wet well bypass line, the conversion of the septic tank into an equalization tank and replacement of one of the two pumps at the lift station, should be implemented next. It would facilitate servicing in the wet well and maintain a more constant flow to the aeration tank.

6. Sludge digestion and construction of a new control building (items 6, 7 and 8) should be next on the priority list. Extra aeration from the new air blowers in the digesters could be used to maintain sufficient dissolved oxygen levels in the aeration tank all year around. Drying beds construction should be included in the overall planning. The main benefits would be: 1) elimination of sludge hauling costs, 2) beneficial use of the sludge as a soil amendment or fertilizer product, and 3) independance from CRD policies regarding sludge disposal to the sewer system.

7. Extension of the shallow emergency outfall would come last on the priority list. Overflows would occur rarely thanks to the improvements to the system and the general maintenance program.

3.4 Conclusions

1. The final effluent characteristics met the federal guidelines (BOD: 20 mg/l and NFR: 25 mg/l) during the survey.

2. The final effluent characteristics met the B.C. Provincial Pollution Control Objectives (BOD: 130 mg/l and NFR: 130 mg/l) during the survey.

3. The final effluent was not toxic to fish at a 100% concentration over a 96 hour period.

4. Improvements to the system are needed to satisfy final effluent guidelines all year around.

3.5 Recommendations

1. The flowmeter at the V-notch weir should be replaced or fixed.

2. The recommendations listed in the consultant's report should be implemented in the order described in Section 2 of this report as money is made available.

3. Drying beds should be included in the overall project.

4. All the wastewater should be directed to the sewage treatment plant.

5. The operator should be certified under the British Columbia Water and Waste Association operators' certification system.

4 LESTER B. PEARSON COLLEGE OF THE PACIFIC

4.1 Introduction

Pearson College is located on the north shore of Pedder Bay 30 km south west of Victoria (Figure 1). Two hundred and fifty students and staff live on site while another 70 are present only 8 hours a day. The discharge to Pedder Bay is under the Waste Management Branch Provincial Permit PE-2689.

Samples of the final effluent were taken for BOD, NFR and ammonia analyses. These samples were kept cool until delivery and testing at EP's West Vancouver Laboratory. Temperature, pH and dissolved oxygen analyses were performed on site using Hach kits.

Fecal coliforms testings on the final effluent were performed at the EP mobile laboratory on the day of sampling.

The final effluent was sampled for fish bioassay testing at EP's North Vancouver Laboratory.

4.2 Description

All the wastewater is directed to a three-compartment septic tank. This system was built four years ago to replace a rotating biological contactor (RBC) which was not performing adequately (1974 to 1982). The septic tank total capacity is 270 cu·m (60,000 Imp·gallons).

The average daily flow ranges from 90 to 95 cu·m/d (20,000 to 21,000 Imp·gpd). A V-notch is installed at the end of the last compartment for flow measurements.

The final effluent is discharged through a 10 cm (4 in) 1368 m oufall pipe to a 7.3 m depth below mean low water level.

Sludge is pumped out every 30 days on average. Dye testing and diving inspection of the outfall are performed at least once a year. Boats anchoring in the bay represent a major source of problems (anchors poking holes or dragging the pipe).

4.3 Results and Discussion

The septic tank system had an average detention time of 3 days. Dissolved oxygen, pH, ammonia, BOD and fecal coliform levels were typical for a septic tank effluent (Table 13). NFR values were low for a septic tank system. It indicated good settling, efficient baffling and a clean operation.

TABLE 13 PEARSON COLLEGE: ANALYTICAL RESULTS

Units are mg/l unless otherwise stated	FINAL EFFLUENT			
	NOV. 18	NOV. 19	NOV. 20	AVERAGE
Temperature (°C)	19	19	17.5	18.5
D.O.	< 1	< 1	< 1	< 1
pH (relative units)	6.5	6.5	7.0	6.7
NH_3 (N)	31.8	33.8	31.4	32.3
BOD	130	155	120	135
NFR	47	36	36	40
Fecal coliforms (FC/100 ml)	760,000	350,000	180,000	430,000

The final effluent was toxic to fish at a concentration of 42.3% (50% mortality over a 96 hour period).

The V-notch used for flow measurements, located at the end of the last septic tank, is not positioned properly. Free fall of water over the weir is not allowed bacause of the high water level in the small chamber downstream of the V-notch.

Table 14 shows the water column stratification at the end of the Pearson College outfall. Under the worst case conditions without current, the dilution computer model OUTPLM predicted a dilution of 170 to 1 with the effluent plume trapped 1.7 m under the water surface (Appendix III).

TABLE 14 WATER COLUMN STRATIFICATION AT PEARSON COLLEGE OUTFALL

Date: November 18, 1986

DEPTH (m)	TEMPERATURE (°C)	DISSOLVED OXYGEN (mg/l)	SALINITY (ppt)
0	8.5	8.4	26.6
2	8.6	7.2	26.8
4	8.6	6.8	27.0
6	8.6	6.7	27.3
9	8.5	6.3	27.3

4.4 Conclusions

1. The discharge characteristics met the provincial permit requirements for flow and effluent quality of typical septic tank effluent listed in permit PE-2689.

2. The degree of treatment does not meet the required level (BOD: 45 mg/l and NFR: 60 mg/l) for a discharge to a marine embayed area according to the Provincial Pollution Control Objectives.

3. The final effluent was toxic to fish at 42.3% concentration.

4.5 Recommendations

1. The V-notch weir should be positioned differently to allow free fall of water.

2. The final effluent quality should be upgraded or the outfall extended to open waters to comply with the WMB Effluent Quality Objectives.

5 PEDDER BAY TRAILER PARK

5.1 Introduction

The Pedder Bay Trailer Park is located about 20 miles south west of Victoria at the mouth of Pedder Bay (Figure 1). The discharge is under the provincial permit PE-237 issued in June 1968. The last amendment took place August 1972.

Final effluent samples for BOD and NFR analyses were taken for 3 days from November 18 to 20, 1986. These samples were kept cool until delivery at EP West Vancouver Laboratory. Temperature, dissolved oxygen, pH and ammonia analyses were run using field equipment (Hach kits). Fecal coliform analyses of the final effluent were performed at EP mobile laboratory the same day of the collection.

5.2 Description

Two 41 cu·m (9000 Imp·gallons) septic tanks in parallel serve a total of 34 permanent mobile home units and 6 recreational vehicles 6 months of the year. The 6.3 cm (2.5 inches) diameter outfall pipe from the septic tank extends 1800meters (6000feet) into Pedder Bay to a depth of 7.3 meters (24 feet) below low water level. The septic tanks are pumped out once a year.

The discharge flow, based on water consumption, averages 25 cu·m/d (5400 Imp·gpd).

5.3 Results and Discussion

Table 15 shows the analytical results. The dissolved oxygen was low at 1 mg/l as expected from a septic tank. Ammonia, BOD, NFR and fecal coliform values were within the large range of typical septic tank efluent characteristics.

The detention time averaged 3.3 days based on the water consumption flow and the septic tanks size. This detention time was greater than the recommended two day detention time.

TABLE 15 PEDDER BAY TRAILER PARK: ANALYTICAL RESULTS

Units are mg/l unless otherwise stated	FINAL EFFLUENT			
	NOV. 18	NOV. 19	NOV. 20	AVERAGE
Temperature (°C)	14	14	--	14
D.O.	--	1.0	--	1.0
pH (relative units)	6.5	6.5	--	6.5
NH_3 (N)	17.6	21.5	--	19.6
BOD	105	108	44	86
NFR	105	114	[illegible]	96
Fecal coliforms (FC/100 ml)	560,000	180,000	40,000	260,000

Table 16 shows the water column stratification at the end of the outfall at the time of the survey. Under the worst case conditions without current, The dilution computer model OUTPLM predicted a dilution of 250 to 1 with the effluent plume trapped 3 meters under the water surface (Appendix IV).

TABLE 16 WATER COLUMN STRATIFICATION AT PEDDER BAY TRAILER PARK OUTFALL

Date: November 18, 1986

DEPTH (m)	TEMPERATURE (°C)	DISSOLVED OXYGEN (mg/l)	SALINITY (ppt)
0	8.5	8.4	26.6
2	8.6	7.2	26.8
4	8.6	6.8	27.0
6	8.6	6.7	27.3
9	8.5	6.3	27.3

5.4 Conclusions

1. The discharge met the provincial permit requirements for flow and effluent characteristics (typical septic tank effluent) listed in the permit PE-237.

2. The degree of treatment does not meet the required level (BOD: 45 mg/l and NFR: 60 mg/l) for a municipal discharge to a marine embayed area according to the Provincial Pollution Control Objectives.

5.5 Recommendations

1. The outfall should be inspected annually due to the heavy anchorage occuring in Pedder Bay.

2. The final effluent quality should be upgraded or the outfall extended to open waters to comply with the WMB Effluent Quality Objectives.

The stream at the head of Pedder Bay was not flowing even though heavy precipitation was recorded during the second part of the survey (Table 8).

6.3 Bacteriological Study

The fecal coliform Most Probable Number (MPN) per 100 ml was determined using the multiple tube fermentation technique for marine samples (three decimal dilutions of five tubes each as described in Part 908 of the 15th Edition of Standard Methods for the Examination of Water and Wastewater (6)). All freshwater samples were tested using the Membrane Filtration (MF) method as described in Part 909 and 910 of the 15th Edition of Standard Methods (6).

As shown in Figure 5, stations 1 to 9, 14, 15, 17 and 19 exceeded the shellfish growing water criteria (median MPN > 14 and/or more than 10% of the samples exceed 43/100 ml). Tables 18 and 19 show respectively the summary and the daily bacteriological results.

TABLE 18 SUMMARY MPN BACTERIOLOGICAL RESULTS FOR MARINE STATIONS

STATION	NUMBER OF SAMPLES	MEDIAN (FC/100 ml)	90 PERCENTILE (FC/100 ml)
1	5	33	88
2	5	49	64
3	5	79	130
4	5	79	99.5
5	5	49	104.5
6	5	22	64
7	5	21	294.5
8	5	33	100
9	5	26	41
10	5	17	33
11	5	11	18
12	5	8	20.5
13	5	8	20.5
14	3	22*	22.7*
15	4	31*	85.6*
16	4	8.5*	11.4*
17	4	18*	56.2*
18	2	7.5*	7.8*
19	2	19*	23.8*

* less than 5 samples collected

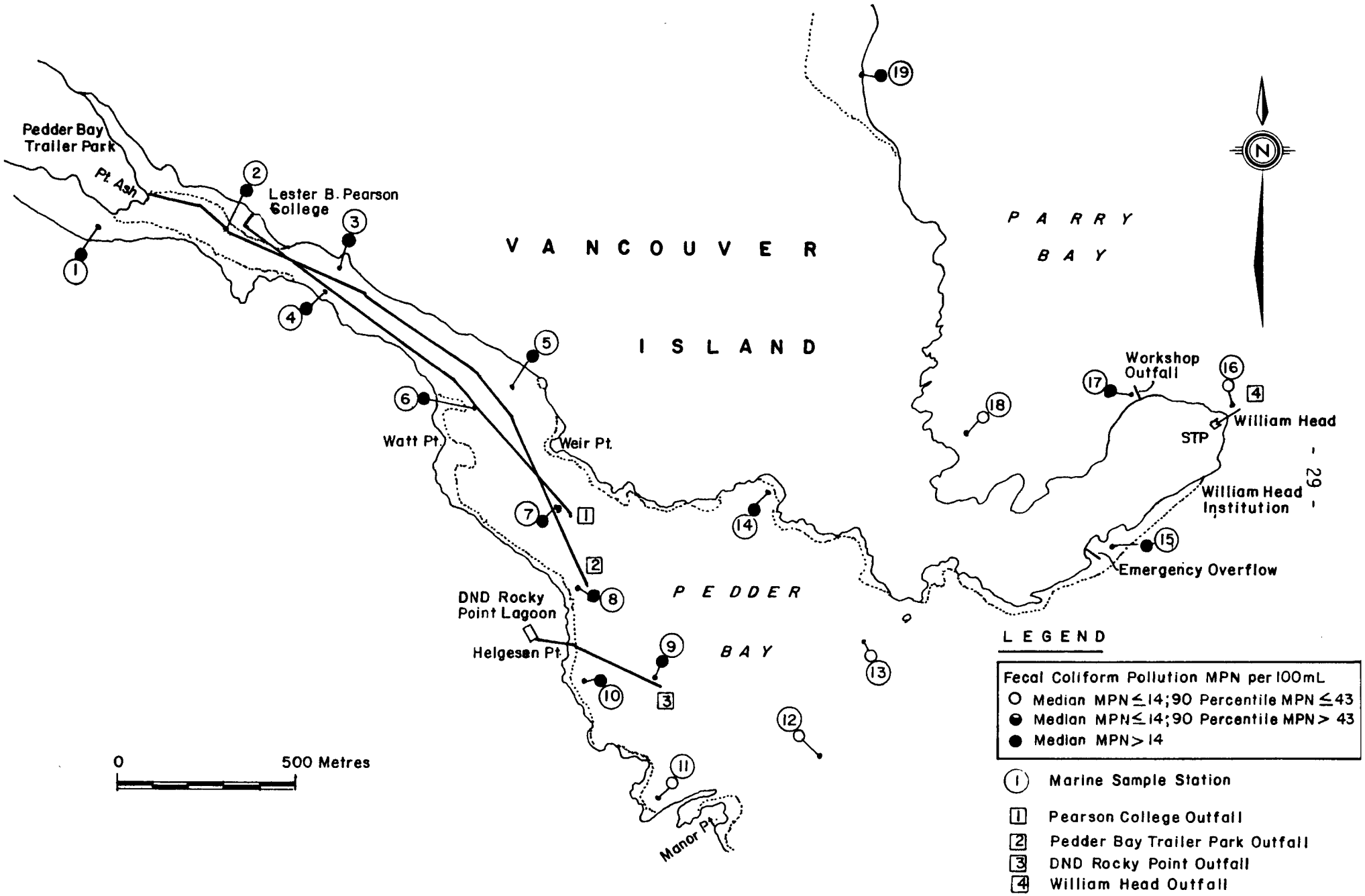

FIGURE 5 PEDDER BAY - MARINE SAMPLE STATIONS AND OUTFALL LOCATIONS

TABLE 19 DAILY MPN BACTERIOLOGICAL RESULTS FOR MARINE STATIONS

DATE (Y/M/D)	STATION NUMBER	TIME (24 hr)	TIDE*	FECAL COLIFORM (FC/100 ml)	SALINITY (ppt)
86/11/17	1	1535	1	22.0	27.5
86/11/18	1	1300	0	23.0	26.0
86/11/19	1	930	0	130.0	27.0
86/11/20	1	1130	0	33.0	31.0
86/11/21	1	930	0	46.0	31.0
86/11/17	2	1530	1	5.0	27.5
86/11/18	2	1255	0	49.0	25.5
86/11/19	2	935	0	33.0	27.5
86/11/20	2	1130	0	79.0	28.5
86/11/21	2	930	0	49.0	31.5
86/11/17	3	1530	1	11.0	27.5
86/11/18	3	1250	0	130.0	25.5
86/11/19	3	940	0	130.0	27.0
86/11/20	3	1135	0	79.0	30.5
86/11/21	3	935	0	31.0	31.5
86/11/17	4	1525	1	13.0	27.0
86/11/18	4	1245	0	79.0	26.5
86/11/19	4	945	0	120.0	27.0
86/11/20	4	1135	0	79.0	31.5
86/11/21	4	935	0	23.0	31.5
86/11/17	5	1525	1	6.0	27.0
86/11/18	5	1240	0	130.0	26.0
86/11/19	5	945	0	49.0	27.5
86/11/20	5	1140	0	79.0	32.0
86/11/21	5	940	0	13.0	31.5
86/11/17	6	1520	1	2.0	27.5
86/11/18	6	1235	0	49.0	26.5
86/11/19	6	945	0	49.0	27.5
86/11/20	6	1140	0	79.0	31.0
86/11/21	6	940	0	22.0	31.5
86/11/17	7	1520	1	13.0	27.0
86/11/18	7	1230	0	49.0	26.5
86/11/19	7	950	0	21.0	27.5
86/11/20	7	1145	0	540.0	32.0
86/11/21	7	940	0	17.0	31.5
86/11/17	8	1515	1	< 2.0	27.0
86/11/18	8	1225	0	33.0	26.0
86/11/19	8	950	0	130.0	27.5
86/11/20	8	1145	0	23.0	30.5
86/11/21	8	945	0	70.0	31.5

* Tides: 0 - slack flood
1 - ebbing

CONTINUED...

TABLE 19 (Continued)

DATE (Y/M/D)	STATION NUMBER	TIME (24 hr)	TIDE*	FECAL COLIFORM (FC/100 ml)	SALINITY (ppt)
86/11/17	9	1515	1	5.0	27.0
86/11/18	9	1220	0	17.0	27.0
86/11/19	9	955	0	33.0	27.5
86/11/20	9	1150	0	49.0	30.5
86/11/21	9	945	0	26.0	31.5
86/11/17	10	1510	1	< 2.0	27.0
86/11/18	10	1215	0	33.0	27.0
86/11/19	10	955	0	8.0	27.5
86/11/20	10	1150	0	33.0	32.0
86/11/21	10	945	0	17.0	31.5
86/11/17	11	1510	1	2.0	27.0
86/11/18	11	1210	0	13.0	27.0
86/11/19	11	1000	0	23.0	27.5
86/11/20	11	1150	0	11.0	31.5
86/11/21	11	950	0	11.0	31.5
86/11/17	12	1505	1	2.0	27.0
86/11/18	12	1210	0	2.0	27.0
86/11/19	12	1000	0	8.0	27.5
86/11/20	12	1150	0	14.0	12.5
86/11/21	12	950	0	27.0	31.5
86/11/17	13	1505	1	2.0	27.0
86/11/18	13	1205	0	5.0	27.5
86/11/19	13	1000	0	8.0	28.0
86/11/20	13	1155	0	14.0	32.0
86/11/21	13	950	0	27.0	31.5
86/11/17	14	1500	1	< 2.0	27.0
86/11/20	14	1215	0	22.0	30.0
86/11/21	14	950	0	23.0	31.5
86/11/18	15	1200	0	110.0	27.5
86/11/19	15	1005	0	13.0	28.0
86/11/20	15	1155	0	49.0	32.0
86/11/21	15	955	0	4.0	31.5
86/11/18	16	1200	0	13.0	27.5
86/11/19	16	1010	0	8.0	28.0
86/11/20	16	1200	0	9.0	32.0
86/11/21	16	955	0	8.0	31.5
86/11/18	17	1155	0	79.0	27.0
86/11/19	17	1015	0	14.0	27.5
86/11/20	17	1200	0	22.0	32.0
86/11/21	17	1000	0	2.0	31.5

* TIDES: 0 - slack flood
1 - ebbing

CONTINUED...

TABLE 19 (Continued)

DATE (Y/M/D)	STATION NUMBER	TIME (24 hr)	TIDE*	FECAL COLIFORM (FC/100 ml)	SALINITY (ppt)
86/11/18	18	1150	0	8.0	27.5
86/11/19	18	1015	0	7.0	27.5
86/11/20	19	1205	0	27.0	32.5
86/11/21	19	1005	0	11.0	32.0

* TIDES: 0 - slack flood
1 - ebbing

There was no other major source of fecal contamination identified during the survey other than the described outfalls. During the summer, boat anchorage is popular in Pedder Bay and could represent another source of pollution.

According to the Department of Fisheries and Oceans (DFO), the shellfish resources are limited in the Pedder Bay area.

6.4 Conclusions

1. Pearson College is the major fecal coliform contributor to Pedder Bay accounting for 76% of the total input.

2. The MPN fecal coliform counts exceeded the shellfish growing water standards for most of Pedder Bay.

6.5 Recommendations

1. Pedder Bay should be closed under Schedule I of the Pacific Shellfish Regulations.

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APPENDIX I

CONSULTANT'S RECOMMENDATIONS FOR WILLIAM HEAD INSTITUTION STP

APPENDIX I CONSULTANT'S RECOMMENDATIONS FOR WILLIAM HEAD INSTITUTION STP

1. Install a coarse screen in a chamber (or manhole) upstream of the pump station macerators.

2. Construct a pump station wet well bypass line, preferably connecting an upstream chamber (or manhole) to the septic tank.

3. Convert the septic tank beside the pump station into a sewage equalization tank.

4. Replace one of the two 7.5 HP pumps at the pump station with a smaller 3 HP capacity one and undertake the necessary modifications to piping, controls and electrical circuitry.

5. Extend the shallow emergency outfall serving the pump station into deeper water.

6. Replace the existing operators building with a more suitable control building which would house the electrical controls presently located in the open.

7. Construct a two-compartment sludge digester.

8. Provide a two-blower aeration system for sludge digestion and for future aeration needs, complete with a separate enclosure beside the sludge holding tank, and sufficiently removed from the control building to reduce noise problems.

9. Undertake a comprehensive sewer inflow detection and rehabilitation program.

APPENDIX II

COMPUTER DILUTION SIMULATION FOR DND ROCKY POINT OUTFALL

OUTFALL PLUME IN A FLOWING STRATIFIED MEDIA - MODEL OUTPLM

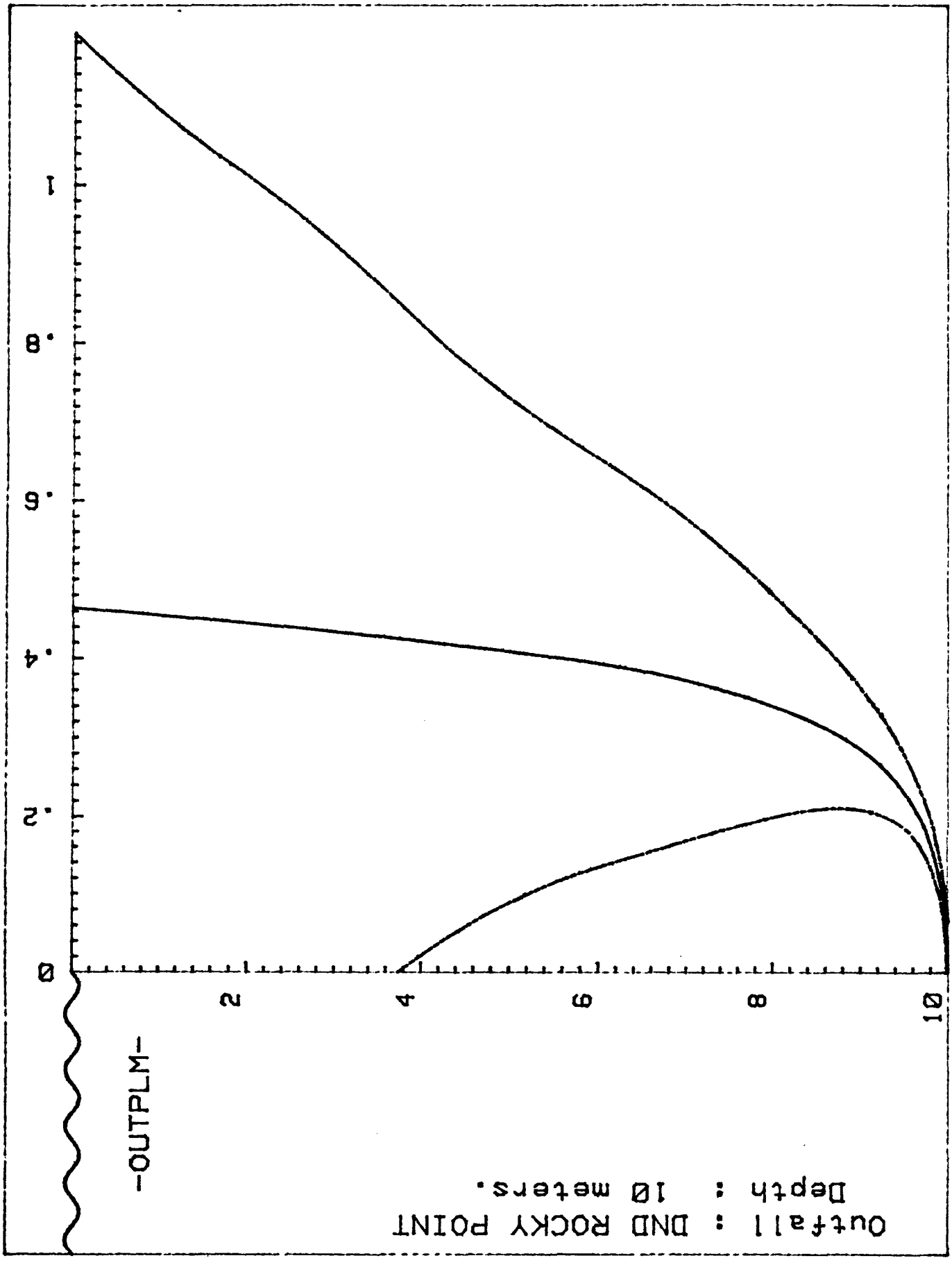
INITIAL DATA - ROCKY POINT			
Outfall Depth	10.00 m	Max. Horizontal Distance	10,000 m
Diameter	.060 m	Vertical Distance	500 m
Angle	0.00 deg. up	Max. No. of Calculations	1,000
Effluent Flow Rate	35.0 cu·m/d	Calculations Per Line	50
Hor. Vel.	.143 m/sec		
Ver. Vel.	0.000 m/sec	Impingement Coefficient	1.000
Plume Radius	.030 m	Aspiration Coefficient	.100
Thickness	.030 m		
Temperature	8.80 °C	Velocity Factor (K)	9999.000
Salinity	1.000 ppt	Froude Number (FR)	1.298
Density	1.001 gm/cu·cm	Volume Rate of Discharge	0.000
Current Velocity	0.000 m/sec		

AMBIENT CONDITIONS

POINT	DEPTH (m)	TEMPERATURE (°C)	SALINITY (ppt)	SIGMA (T)	DENSITY (gm/cu·cm)
1	0.0	8.70	27.000	20.942	1.021
2	2.0	8.60	27.000	20.956	1.021
3	4.0	8.70	27.000	20.942	1.021
4	6.0	8.60	27.100	21.034	1.021
5	8.0	8.60	27.000	20.956	1.021
6	10.0	8.40	27.500	21.373	1.021

PLUME SIMULATION												
DISTANCE (m)	DEPTH (m)	RADIUS (m)	THICK (m)	MASS (gm)	EINS	ZWEI	DILUTION	DENDIFF	HOR. VEL. (m/s)	VER. VEL. (m/s)	TOT. VEL. (m/s)	TEMP. DIFF. (°C)
0.00	10.00	.03	.03	.1	0.0	.08	1.00	20.73	.1	0.0	.1	.4000
0.00	10.00	.03	.03	.1	0.0	.08	1.01	20.58	.1	0.0	.1	.3972
.06	9.98	.04	.03	.1	0.0	0.00	1.41	14.64	.1	.1	.1	.2813
.10	9.93	.04	.03	.2	0.0	0.00	1.98	10.34	.1	.1	.1	.1946
.14	9.86	.05	.03	.2	0.0	0.00	2.79	7.30	.1	.1	.1	.1314
.18	9.76	.06	.03	.3	0.0	0.00	3.94	5.15	0.0	.1	.1	.0850
.20	9.65	.08	.03	.5	0.0	0.00	5.56	3.62	0.0	.1	.1	.0503
.23	9.50	.09	.02	.7	0.0	0.00	7.86	2.53	0.0	.1	.1	.0234
.25	9.33	.11	.02	1.0	0.0	.01	11.10	1.76	0.0	.1	.1	.0016
.28	9.11	.14	.02	1.4	0.0	.01	15.70	1.21	0.0	.1	.1	-.0174
.30	8.84	.17	.02	1.9	0.0	.01	22.19	.81	0.0	.1	.1	-.0352
.32	8.50	.22	.02	2.7	0.0	.02	31.38	.51	0.0	.1	.1	-.0533
.34	8.08	.27	.02	3.8	0.0	.03	44.37	.29	0.0	.1	.1	-.0732
.36	7.55	.34	.01	5.4	0.0	.04	62.74	.20	0.0	.1	.1	-.0581
.37	6.88	.42	.01	7.7	0.0	.05	88.72	.17	0.0	.1	.1	-.0411
.39	6.07	.51	.01	10.9	0.0	.07	125.46	.14	0.0	.1	.1	-.0290
.41	5.08	.63	.01	15.4	0.0	.11	177.42	.07	0.0	.1	.1	-.0590
.42	3.83	.83	.01	21.7	0.0	.15	250.90	.01	0.0	0.0	0.0	-.0810
.44	2.15	1.11	.01	30.7	0.0	.21	354.83	.02	0.0	0.0	0.0	.0139
.46	-.05	1.46	.01	43.5	0.0	.30	498.33	-0.00	0.0	0.0	0.0	-.0696

Number of Steps = 900


Outfall : DND ROCKY POINT
Depth : 10 meters.
-OUTPLM-
0
.2
.4
.6
.8
1
2
4
6
8
10

APPENDIX III

COMPUTER DILUTION SIMULATION FOR PEARSON COLLEGE OUTFALL

OUTFALL PLUME IN A FLOWING STRATIFIED MEDIA - MODEL OUTPLM

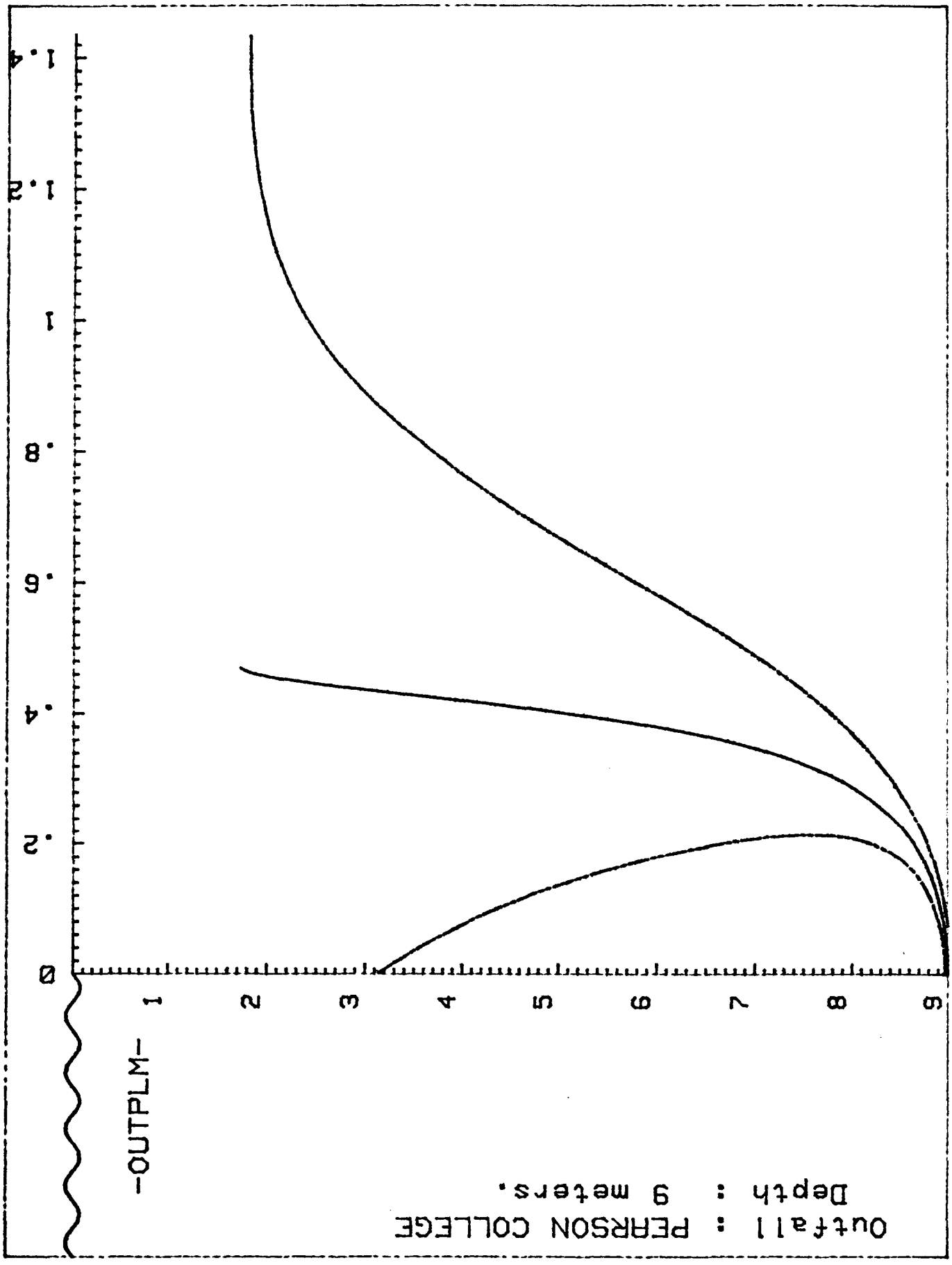
INITIAL DATA - PEARSON COLLEGE			
Outfall Depth	9.00 m	Max. Horizontal Distance	10,000 m
Diameter	.100 m	Vertical Distance	500 m
Angle	0.00 deg. up	Max. No. of Calculations	1,200
Effluent Flow Rate	90.0 cu·m/d	Calculations Per Line	50
Hor. Vel.	.133 m/sec		
Ver. Vel.	0.000 m/sec	Impingement Coefficient	1.000
Plume Radius	.050 m	Aspiration Coefficient	.100
Thickness	.050 m		
Temperature	18.50 °C	Velocity Factor (K)	9999.000
Salinity	1.000 ppt	Froude Number (FR)	.906
Density	.999 gm/cu·cm	Volume Rate of Discharge	.001
Current Velocity	0.000 m/sec		

AMBIENT CONDITIONS

POINT	DEPTH (m)	TEMPERATURE (°C)	SALINITY (ppt)	SIGMA (T)	DENSITY (gm/cu·cm)
1	0.0	8.50	26.600	20.658	1.021
2	2.0	8.60	26.800	20.800	1.021
3	4.0	8.60	27.000	20.956	1.021
4	6.0	8.60	27.300	21.190	1.021
5	9.0	8.50	27.300	21.204	1.021

PLUME SIMULATION												
DISTANCE (m)	DEPTH (m)	RADIUS (m)	THICK (m)	MASS (gm)	EINS	ZWEI	DILUTION	DENDIFF	HOR. VEL. (m/s)	VER. VEL. (m/s)	TOT. VEL. (m/s)	TEMP. DIFF. (°C)
0.00	9.00	.05	.05	.4	0.0	.21	1.00	21.87	.1	0.0	.1	10.0000
0.00	9.00	.05	.05	.4	0.0	.21	1.01	21.72	.1	0.0	.1	9.9309
.08	8.96	.06	.05	.6	0.0	0.00	1.41	15.45	.1	.1	.1	7.0698
.13	8.87	.06	.06	.8	0.0	.01	1.98	10.92	.1	.1	.2	4.9967
.17	8.76	.07	.06	1.1	0.0	.01	2.79	7.72	0.0	.2	.2	3.5300
.21	8.62	.09	.06	1.6	0.0	.01	3.94	5.46	0.0	.2	.2	2.4923
.24	8.45	.11	.06	2.2	0.0	.02	5.46	3.86	0.0	.2	.2	1.7576
.26	8.24	.13	.05	3.1	0.0	.02	7.85	2.73	0.0	.1	.1	1.2369
.29	7.99	.16	.05	4.4	0.0	.03	11.09	1.93	0.0	.1	.1	.8675
.31	7.67	.20	.05	6.3	0.0	.04	15.68	1.36	0.0	.1	.1	.6045
.33	7.29	.25	.05	8.9	0.0	.06	22.16	.96	0.0	.1	.1	.4166
.36	6.81	.30	.04	12.6	0.0	.09	31.33	.68	0.0	.1	.1	.2812
.37	6.22	.38	.04	17.8	0.0	.12	44.31	.48	0.0	.1	.1	.1823
.39	5.50	.47	.04	25.1	0.0	.17	62.65	.29	0.0	.1	.1	.1231
.41	4.59	.59	.03	35.5	0.0	.24	88.59	.11	0.0	.1	.1	.0870
.43	3.39	.81	.02	50.2	0.0	.34	125.29	-.02	0.0	.1	.1	.0615
.47	1.73	1.94	0.00	69.6	0.0	.20	172.34	-.12	0.0	-0.0	0.0	.0575

Number of Steps = 747


Outfall : PEARSON COLLEGE
Depth : 9 meters.
-OUTPLM-
0
.2
.4
.6
.8
1
1.2
1.4
1
2
3
4
5
6
7
8
9

APPENDIX IV

COMPUTER DILUTION SIMULATION FOR PEDDER BAY TRAILER PARK

OUTFALL PLUME IN A FLOWING STRATIFIED MEDIA - MODEL OUTPLM

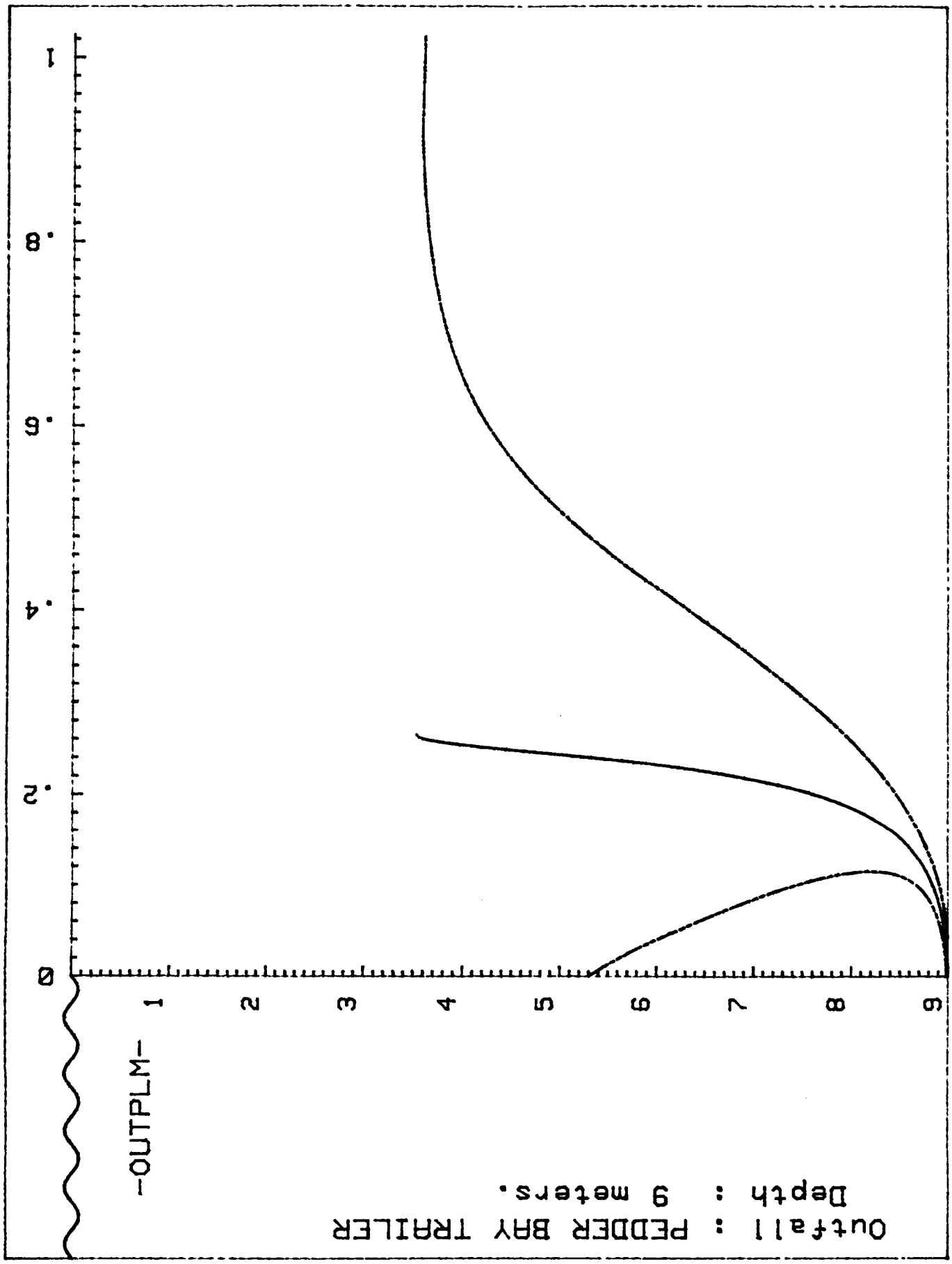
INITIAL DATA - PEDDER BAY TRAILER			
Outfall Depth	9.00 m	Max. Horizontal Distance	10,000 m
Diameter	.063 m	Vertical Distance	500 m
Angle	0.00 deg. up	Max. No. of Calculations	1,200
Effluent Flow Rate	25.0 cu·m/d	Calculations Per Line	50
Hor. Vel.	.093 m/sec		
Ver. Vel.	0.000 m/sec	Impingement Coefficient	1.000
Plume Radius	.032 m	Aspiration Coefficient	.100
Thickness	.032 m		
Temperature	14.00 °C	Velocity Factor (K)	9999.000
Salinity	1.000 ppt	Froude Number (FR)	.813
Density	1.000 gm/cu·cm	Volume Rate of Discharge	0.000
Current Velocity	0.000 m/sec		

AMBIENT CONDITIONS

POINT	DEPTH (m)	TEMPERATURE (°C)	SALINITY (ppt)	SIGMA (T)	DENSITY (gm/cu·cm)
1	0.0	8.50	25.600	20.658	1.021
2	2.0	8.60	26.800	20.800	1.021
3	4.0	8.60	27.000	20.956	1.021
4	6.0	8.60	27.300	21.190	1.021
5	9.0	8.50	27.300	21.204	1.021

PLUME SIMULATION												
DISTANCE (m)	DEPTH (m)	RADIUS (m)	THICK (m)	MASS (gm)	EINS	ZWEI	DILUTION	DENDIFF	HOR. VEL. (m/s)	VER. VEL. (m/s)	TOT. VEL. (m/s)	TEMP. DIFF. (°C)
0.00	9.00	.03	.03	.1	0.0	.06	1.00	21.12	.1	0.0	.1	5.5000
0.00	9.00	.03	.03	.1	0.0	.06	1.01	20.98	.1	0.0	.1	5.4620
.05	8.87	.03	.04	.1	0.0	0.00	1.41	14.95	.1	.1	.1	3.8882
.08	8.92	.04	.04	.2	0.0	0.00	1.98	10.58	0.0	.1	.1	2.7479
.10	8.85	.05	.04	.3	0.0	0.00	2.79	7.49	0.0	.1	.1	1.9411
.12	8.76	.05	.04	.4	0.0	0.00	3.94	5.30	0.0	.1	.1	1.3703
.13	8.66	.07	.04	.6	0.0	0.00	5.56	3.75	0.0	.1	.1	.9661
.15	8.54	.08	.04	.8	0.0	.01	7.86	2.65	0.0	.1	.1	.6769
.16	8.38	.10	.04	1.1	0.0	.01	11.10	1.88	0.0	.1	.1	.4762
.17	8.19	.12	.03	1.6	0.0	.01	15.69	1.33	0.0	.1	.1	.3314
.19	7.96	.15	.03	2.2	0.0	.02	22.18	.94	0.0	.1	.1	.2278
.20	7.67	.18	.03	3.1	0.0	.02	31.36	.66	0.0	.1	.1	.1530
.21	7.32	.23	.03	4.4	0.0	.03	44.34	.47	0.0	.1	.1	.0982
.22	6.88	.28	.03	6.3	0.0	.04	62.70	.33	0.0	.1	.1	.0572
.23	6.35	.34	.03	8.9	0.0	.06	88.66	.23	0.0	.1	.1	.0253
.24	5.68	.43	.02	12.6	0.0	.09	125.37	.12	0.0	.1	.1	.0086
.24	4.84	.56	.02	17.8	0.0	.12	177.30	.01	0.0	.1	.1	.0061
.26	3.60	1.18	0.00	25.1	0.0	.14	250.74	-.10	0.0	0.0	0.0	.0043
.26	3.54	1.52	0.00	25.7	0.0	.03	254.24	-.11	0.0	-0.0	0.0	.0042

Number of Steps = 803


Outfall : PEDDER BAY TRAILER
Depth : 9 meters.
-OUTPLM-
0
.2
.4
.6
.8
1
1
2
3
4
5
6
7
8
9