Environmental Protection
Protection de l'environnement

Sanitary Survey of The Municipality of The District of Campbell River, British Columbia, 1976

Surveillance Report
EPS 5-PR-76-5

Pacific Region
September, 1976

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SANITARY SURVEY OF THE MUNICIPALITY OF THE DISTRICT OF CAMPBELL RIVER, BRITISH COLUMBIA, 1976

by

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for the
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Environmental Protection Service
Pacific Region

Report Number EPS 5-PR-76-5
September, 1976

ABSTRACT

A sanitary survey of the Municipality of the District of Campbell River was conducted by the author in conjunction with a Shellfish Growing Water Sanitary Survey conducted by personnel of the Environmental Protection Service, Pacific Region.

The purpose of the survey, conducted during February, 1976, was to assess the effects of pollution sources located within the Municipality on the bacteriological water quality of the adjacent foreshore areas.

The operation of the sewage treatment plant was evaluated, and a dye tracer study of the marine sewage outfall was conducted.

An assessment of the pollution contributions from 10 freshwater inputs located within the Municipality was conducted, involving sample collection, bacteriological analysis, flow estimation, and fecal contamination source determination.

RÉSUMÉ

L'auteur a mené une étude sanitaire de la municipalité du district de Campbell River pendant que le personnel du Service de protection de l'environnement (région du Pacifique) se chargeait de mener une étude sur la salubrité des eaux servant à la culture des mollusques et des crustacés.

L'étude, menée durant février 1976, avait pour objet d'évaluer les effets que produisent des sources de pollution situées dans la Municipalité, sur la qualité de l'eau des grèves et des environs immédiats, du point de vue bactériologique.

On a évalué le fonctionnement des stations d'épuration des eaux usées et effectué des traçages, à l'aide de colorants, de la décharge marine de ces eaux.

En plus, on a évalué les apports en pollution provenant de 10 entrées d'eau douce situées dans la Municipalité, y compris la prise d'échantillons, l'analyse bactériologique, l'estimation du débit et la détermination de la source de contamination fécale.

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LIST OF ABBREVIATIONS

BOD_5	5 day biochemical oxygen demand
cfs	cubic feet per second
COD	chemical oxygen demand
FC:FS	fecal coliform to fecal streptococci ratio
gal	gallon (s)
gpd	gallons per day
hr	hour (s)
ℓ/min	liters per minute
lb/day	pounds per day
LWM	low water mark
m	metre (s)
MF	membrane filtration
mg/ℓ	milligrams per liter
mgd	million gallons per day
MLSS	mixed liquor suspended solids
mm	millimeter (s)
MPN	most probable number
SS	suspended solids
WPCC	water pollution control centre

CONCLUSIONS

The major identified contributors of bacterial pollution to Discovery Passage from the District of Campbell River were:

1. the Campbell River Water Pollution Control Centre final effluent;
2. the 6th Avenue storm drain;
3. Simms Creek;
4. Willow Creek.

The mean population equivalent of the Campbell River WPCC final effluent was 360; however, the relative degree of influence of this input is significantly reduced by its discharge through a marine outfall into a strong tidal current. The population equivalents of the other three major contributors were insignificant in comparison to the Campbell River WPCC effluent, but could be expected to reduce bacteriological water quality in the localized intertidal zones.

A suspected source of bacterial pollution to the tidal foreshore was the septic tank - absorption field seepage from the unsewered houses located on Island Highway from 3rd Avenue to 6th Avenue. This was confirmed by visual observation and the fecal coliform results obtained from marine sample stations located adjacent to this area (1).

1 INTRODUCTION

The Municipality of the District of Campbell River had an estimated population of 12,640 in 1975 (2). The unorganized districts of Quinsam and North Campbell River, located adjacent to the municipality, had an estimated combined population of 4,410 in 1975. The Campbell River Water Pollution Control Centre treats all sewage from the municipality except for a few isolated areas which are still in the process of connecting to the sewerage system. Economic activity in the area is concentrated in the forest, fishing, tourism, and service industries.

The purpose of this survey was to evaluate the influence of municipal, domestic and freshwater discharges from the Municipality of the District of Campbell River on the bacteriological water quality of the adjacent foreshore areas. This survey was carried out concurrently with a shellfish growing water sanitary survey (1).

2 PROCEDURES AND METHODS

All samples for chemical analyses were collected in 1-litre bottles. Most of the sewage treatment plant samples were approximate 24 hr composites collected using an ISCO Continuous Sampler. Samples were stored at $4^{o}C$ and submitted to the Environmental Protection Service Laboratory, West Vancouver. pH was determined on site, using a Radiometer pH meter (Type PHM29). Samples for bacteriological analyses were collected in sterile 170 and 340 cc wide-mouthed bottles and submitted to the Environmental Protection Service mobile laboratory, located during the survey at Campbell River. The sewage treatment plant fecal coliform MPNs were determined using the multiple tube fermentation technique, while the freshwater sample fecal coliforms and fecal streptococci were determined using the membrane filtration technique. Flow estimates of the creek, storm ditch, and storm drain sample stations were determined using an estimated cross-sectional area and current velocity. Daily flow data for the Campbell River Water Pollution Control Centre was provided by the operator. Data obtained from the total flow recorder was assumed to represent the actual flow into the treatment section since: (1) there was no significant accumulation of sewage in the storm clarifier during the survey, and (2) information obtained from the treatment section flow recorder was deemed unreliable due to mechanical operation problems.

2.1 Population Equivalents

The population equivalent of a source of fecal organisms can be calculated by determining a standardized value for the fecal coliform contribution per capita to the sewage system. The standard total coliform contribution is 1.6×10^{11} total coliforms/person/day.*

* U.S. Public Health Publication No. 33.

The fecal coliform concentration in domestic sewage has been estimated at 20% of the total coliform concentration (3). This yields a value of 3.2×10^{10} fecal coliforms/person/day.

Example: Population Equivalent of Campbell River WPCC Effluent
February 5, 1976

Plant Flow = 1.21 MGD

Fecal Coliform Count = 5.0×10^4 MPN/100 mℓ

$$\text{Population Equivalent} = \frac{\text{Fecal Coliforms Discharged per Day}}{\text{Fecal Coliforms/Person/Day}}$$

$$= \frac{1.21 \times 10^6 \times 5 \times 10^4 \times 45.45}{3.2 \times 10^{10}}$$

$$= 86$$

Therefore, on February 5, 1976, the fecal coliform content of the Campbell River WPCC Effluent was equivalent to the raw sewage contribution of 86 people. Mean population equivalent figures presented in Appendices III, IV, and VI are calculated using the average fecal coliform concentration of the samples taken and the average flow during the survey period.

2.2 Fecal Streptococci

Membrane filtration fecal streptococci analyses were performed on all freshwater samples to determine the origin of fecal contamination observed in the major freshwater inputs. Geldreich and Kenner (4) have found that fecal streptococci densities were significantly higher than fecal coliform densities in all warm-blooded animal feces, except for that of humans. In humans, the FC:FS ratio was 4.4, whereas in other warm-blooded animals, the ratio was less than 0.7. A summary of the results of the fecal coliform and fecal streptococci analyses for the freshwater sample stations is given in Appendix II.

3 RESULTS AND DISCUSSION

A list of sample station locations is given in Appendix I, and a summary of membrane filtration bacteriological data, including fecal streptococci results, appears in Appendix II. A summary of the results from all freshwater sample stations appears in Appendix III. The bacteriological analyses results from the individual freshwater sample stations are presented in Appendix IV.

The results of the chemical and bacteriological analyses from the sewage treatment plant effluent are presented in Appendix V. Appendix VI lists the population equivalents and loadings.

The results of a dye tracer study on the Campbell River WPCC outfall are presented in Appendix VII.

Maps of the Municipality of the District of Campbell River appear in Figures 1 and 2. The maps, divided into north and south sections, illustrate the location of the sewage treatment plant and outfall, the location of lift stations, and the location of all storm ditch, storm drain, and creek sample stations within the municipality. The Campbell River Water Pollution Control Centre was the only major pollution source recognized prior to the survey. Descriptions of the other major pollution sources, as determined by the survey, are included in this section.

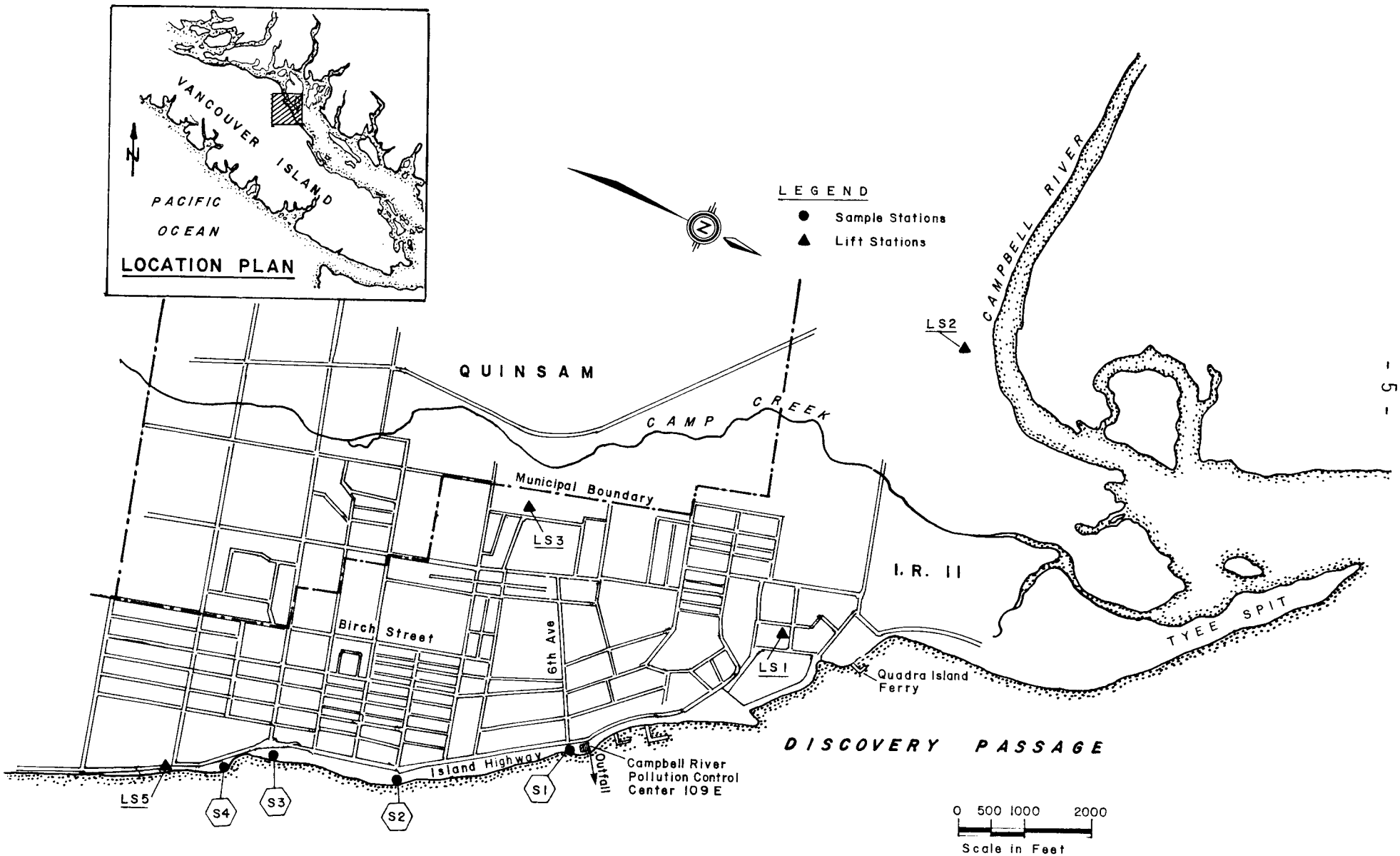

FIGURE 1 DISTRICT OF CAMPBELL RIVER - SAMPLE STATION LOCATIONS (North Section)

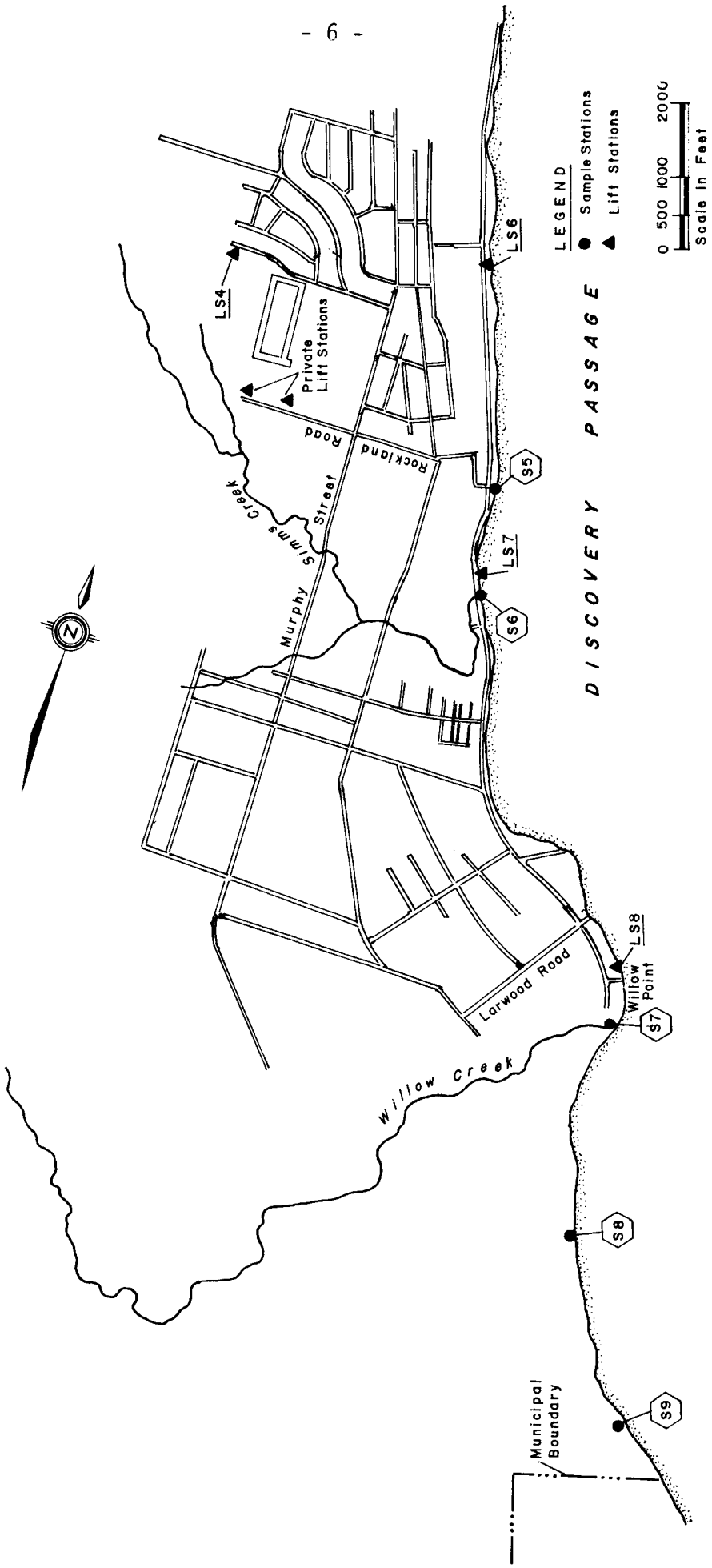

FIGURE 2 DISTRICT OF CAMPBELL RIVER - SAMPLE STATION LOCATIONS (South Section)

3.1 Campbell River Water Pollution Control Centre

3.1.1 Plant Description. The Campbell River WPCC is an activated sludge sewage treatment plant consisting of headworks, an aerated grit tank, an aeration tank, a final clarifier, an aerobic digester, and a storm clarifier. At the design dry weather flow of 1.5 mgd, the aeration tank has a hydraulic retention time of 2.8 hr. Oxygen and mixing are supplied by five submerged air diffuser assemblies. The final clarifier provides a retention time of 4.0 hr, with an overflow rate of 520 gpd/sq ft. The flow rate of sewage to the treatment section of the plant is controlled by an inlet gate valve. Sewage overflow to the storm clarifier occurs when the level of sewage in the inlet channel ahead of the control gate exceeds the level of two side weirs. Sewage is returned to the treatment section from the storm clarifier by means of float-controlled pumps, which operate at pre-set intervals. At the design peak flow of 2.4 mgd, the storm clarifier, having a capacity of ∿15,400 gal, provides a hydraulic retention time of 2.3 hr. The storm clarifier was designed to include a chain driven sludge collector mechanism to transport settled solids to the clarifier wet wells. This mechanism has not yet been available for installation, and presently settled solids are hosed to the wet well when the tank is empty.

Activated sludge is drawn from the final clarifier to the aeration tank by means of an airlift reciprocating bridge collector. Excess activated slude is wasted to a 28,000 gal aerobic digester, which includes five air diffuser assemblies. Supernatant is returned to the aeration tank from the digester by shutting off the air diffusers, allowing the heavy solids to settle, and using a swing decanting pipe and wet well. If the digester solids concentration increases so that a low solids supernatant can not be decanted in a reasonable settling period, aerobic sludge is wasted directly to the outfall.

Flow measurement is accomplished with two Parshall flumes: the first, located between the grit tank and the storm clarifier inlet weirs, measures the total flow entering the plant; and the second,

located in the inlet channel between the storm clarifier and the aeration tank, measures the sewage flow to the treatment section. Both Parshall flumes are connected to strip chart recorders located in the control building. Final effluent, storm clarifier overflow, and waste aerobic sludge are discharged through a 21 in. diameter marine outfall, terminating 180 ft from LWM and 12 ft below LWM.

3.1.2 Campbell River WPCC Sampling Results. The Campbell River WPCC final effluent exhibited an average BOD_5 of 17.2 mg/ℓ, and a mean fecal coliform MPN of 1.68×10^5/100 mℓ. BOD and solids loading (based on SS) of the final effluent were 259.7 and 404.7 lb/day respectively, and the mean population equivalent was 360.

Total plant flows during the survey were too low to cause storm clarifier overflow or even a significant accumulation of sewage in the storm clarifier. It was estimated that the treatment section of the plant handled approximately 1.7 mgd during the survey period, 13% over design levels. An estimate of storm clarifier overflow occuring during a period of heavy rainfall (January, 1976) is presented in the following section.

The Campbell River WPCC produced a good quality effluent throughout the survey period. The MLSS in the aeration tank was maintained at a high level, 4730 mg/ℓ with 83.1% volatile. The treatment plant reduced BOD by 80%, SS by 75%, and fecal coliform concentrations by 92%.

3.1.3 Storm Clarifier Overflow Estimate. A graph of total daily precipitation for Campbell River during the period November 1, 1975 - February 29, 1976, is given in Figure 3. A comparison of the monthly totals experienced during this period and the 30-year averages is included. Total precipitation during the month of February, 1976, was 113.8 mm; this was 31 percent less than the mean total precipitation for February (1940-1970) of 165.6 mm.

Excessive sewer line infiltration normally occurs during periods of continuous heavy rainfall and, in turn, causes increased hydraulic loading on a sewage treatment system, at which time sewage bypass occurs. However, the rainfall received during the month of February was insufficient to cause the Campbell River WPCC storm clarifier to overflow.

Rainfall and plant flow data for the month of January, 1976, was evaluated to obtain an estimate of the bacteriological loadings that could be expected from storm clarifier overflow during a period of continuous rainfall. During the month of November, 1975, the area received 393.2 mm of precipitation; however, the sewage treatment plant was inoperative due to mechanical problems with the reciprocating bridge collector. Sewage was bypassed directly to the marine outfall without flow measurement.

During January, the average total daily flow was 2.19 MGD. Assuming that the treatment section daily flow was 1.7 mgd (value observed during February), the average daily overflow from the storm clarifier would be 0.49 mgd. A fecal coliform concentration of 10^6 MPN/100 mℓ in the overflow would yield a population equivalent from the storm clarifier overflow of 696. The combined population equivalent from the clarifier overflow and final effluent would be approximately 1000, and the combined fecal coliform concentration would be 3.5×10^5 MPN/100 mℓ. Total daily flows for the Campbell River WPCC during January and February are presented in Figures 4 and 5 respectively.

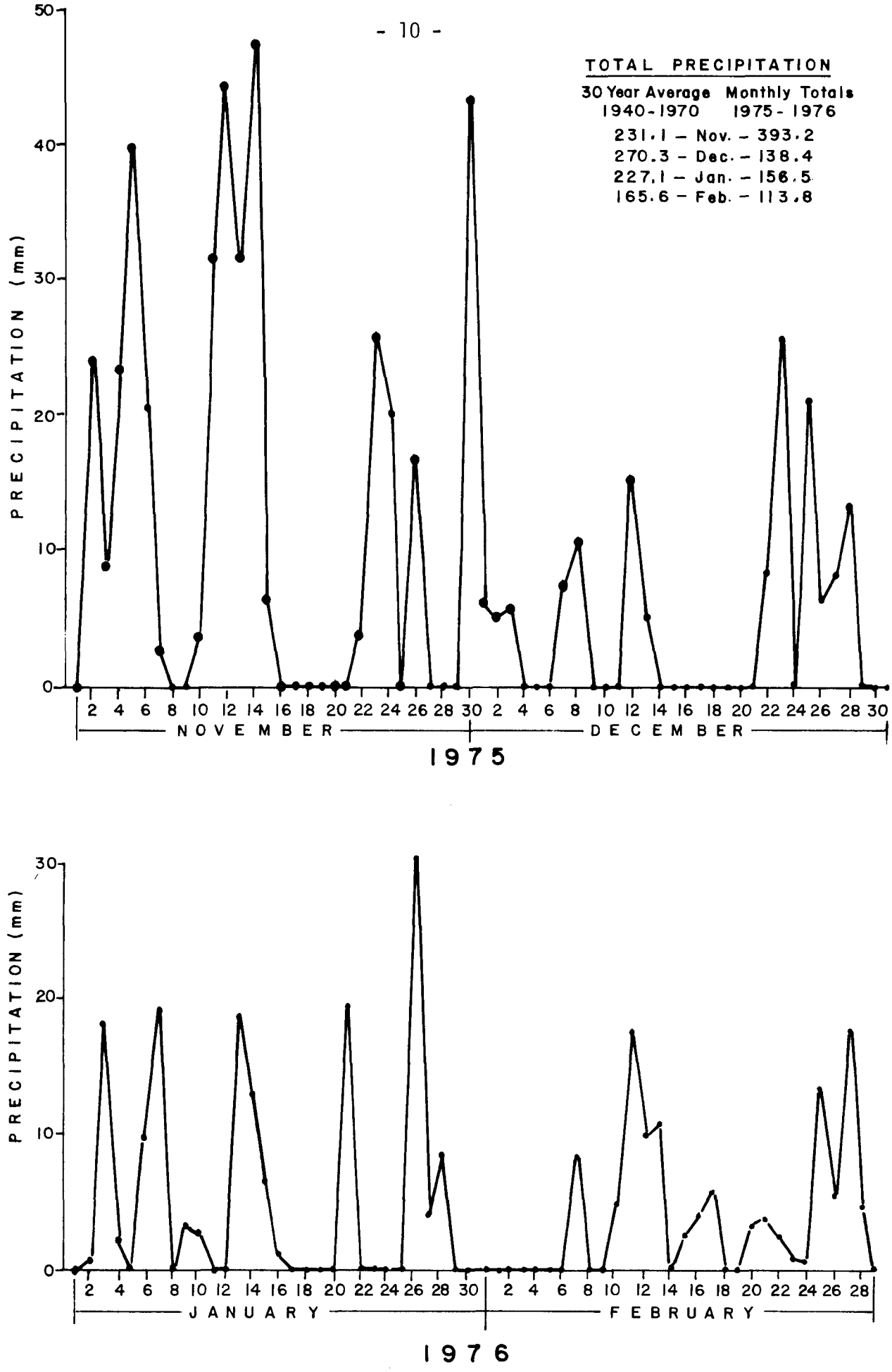

FIGURE 3 TOTAL PRECIPITATION - CAMPBELL RIVER

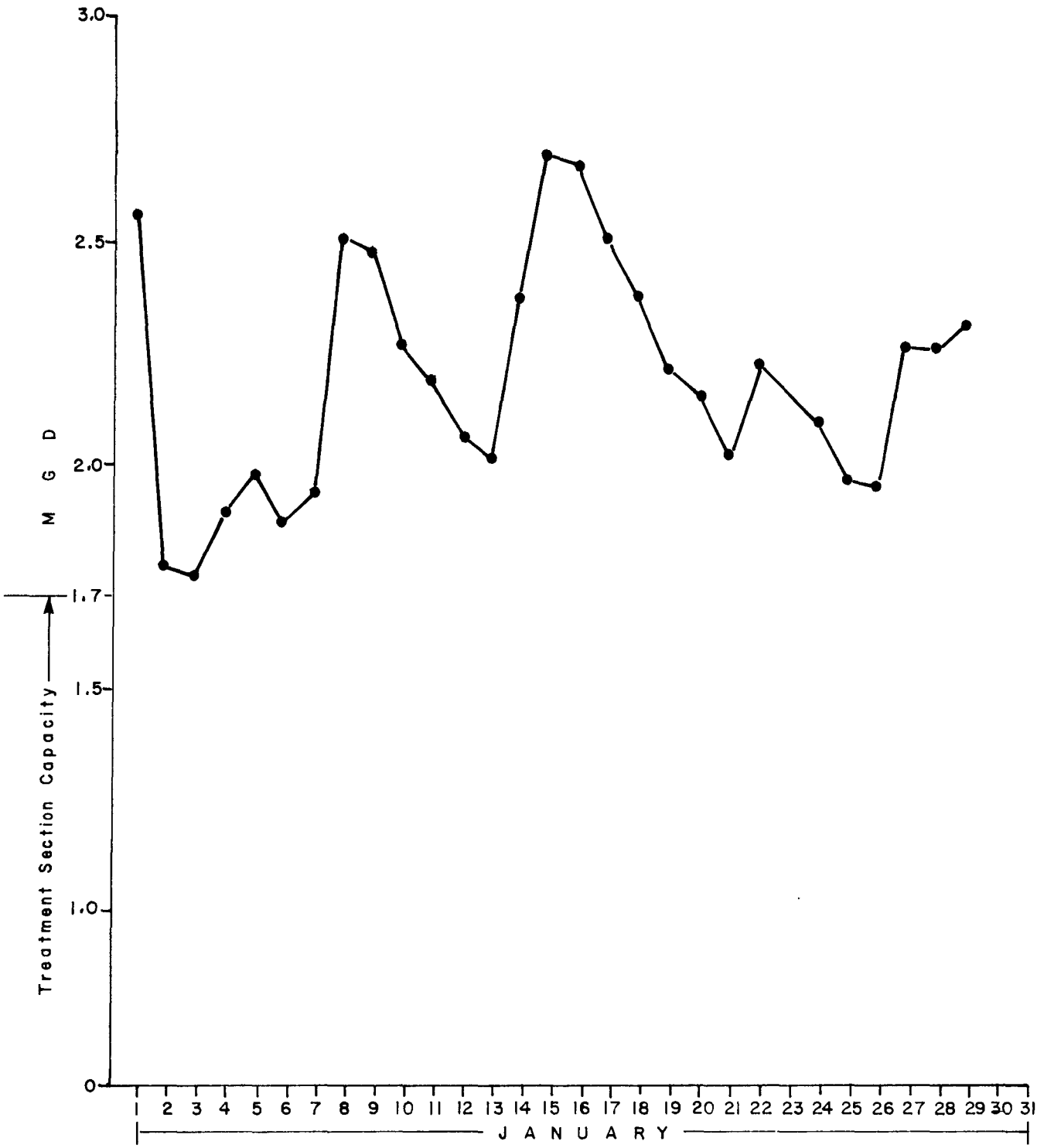

FIGURE 4 CAMPBELL RIVER WATER POLLUTION CONTROL CENTER - TOTAL DAILY FLOW, JANUARY 1976

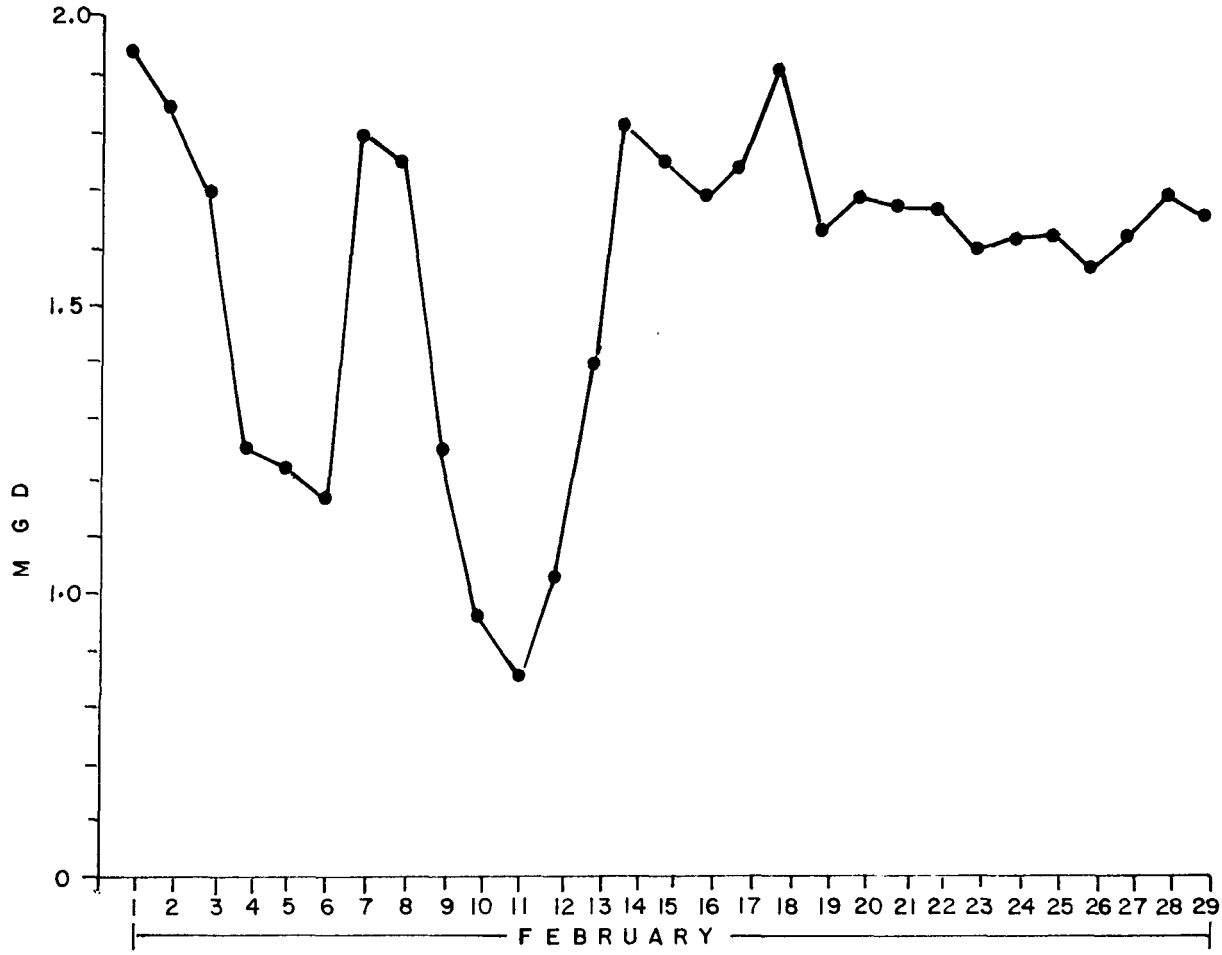

FIGURE 5 CAMPBELL RIVER WATER POLLUTION CONTROL CENTER - TOTAL DAILY FLOW, FEBRUARY 1976

3.2 6th Avenue Storm Drain (S1)

Samples taken at sample station S1 exhibited a mean fecal coliform MF count of 9.08 x 10^3/100 mℓ, and a population equivalent of 9.8. The FC:FS ratio was 10.1, indicating fecal pollution almost entirely from human sources.

This storm drain serves an area of approximately 61 acres, containing 210 single family dwellings and 4 multiple dwellings (5). The significant amount of fecal contamination evident in the samples taken from this storm drain would indicate the presence of several illegal cross connections between the sanitary and storm sewers.

3.3 Simms Creek (S6)

Simms Creek had a mean fecal coliform MF count of 94.5/100 mℓ, and a mean population equivalent of 2.0 during the survey. The FC:FS ratio was 1.8, indicating fecal pollution from both animal and human sources. Appendix IV lists the results of fecal coliform analysis and the sampling conditions for the individual samples taken. Fecal coliform counts reached a peak value on February 6, and then decreased to background levels by the end of the survey period. This intermittent fecal contamination can be attributed to sewage overflow from a private lift station located near the west end of Rockland Road. The location of the two private lift stations operated by Pardo Verde Mobile Home Park is illustrated in Figure 2. Sewage is collected at the station located at the western extremity of Rockland Road and pumped up the slope to the second station, which in turn pumps the sewage up the slope further to join the municipal sewer line at Murphy Street. Both lift stations contain two float-controlled pumps. After the survey period, the operator determined that one pump in the upper lift station was partially plugged and unable to deliver full capacity. Sewage overflowed the upper station when the delivery from the lower station exceeded the upper lift station's reduced capacity. This problem has now been remedied.

The private lift stations operated by Pardo Verde will eventually be removed from service when a sanitary sewer trunk is constructed along Simms Creek in the summer of 1976.

Other possible sources of fecal pollution to Simms Creek are:

1. septic tank - absorption field seepage from several unsewered houses located on Rockland Road;
2. landwash from several small livestock enclosures located near the west end of Rockland Road; and
3. hinterland drainage.

3.4 Willow Creek (S7)

Willow Creek had a mean fecal coliform MF count of 29.1/100 mℓ, and a mean population equivalent of 0.56. The FC:FS ratio was 0.74, indicating that the source of fecal pollution is primarily animal. Appendix IV lists the results of fecal coliform analysis and the sampling conditions for the individual samples taken. Fecal coliform counts reached a peak value on February 13, after a period of several days of continuous rainfall. Landwash from several small hobby farms located on Erickson Road adjacent to Willow Creek would explain the fecal coliform counts and the FC:FS ratio observed in the samples taken. Samples taken upstream at Harrogate Road, above the hobby farms, yielded low fecal coliform counts that would be mainly attributable to hinterland drainage.

3.5 Freshwater Sample Stations with Low Population Equivalents (S2, S3, S4, S5, S8, and S9)

The location of these sample stations is given in Appendix I. A summary of the results appears in Appendix III. A summary of the membrane filtration bacteriological data, including fecal coliform to fecal streptococci ratios, appears in Appendix II. All these sample stations exhibited low FC:FS ratios, indicating fecal pollution primarily from animal sources. The population equivalents of the fecal contamination of these stations were insignificant in comparison

to S1, S6, S7, and 109E. Sample stations S2, S3, S4, S5, S8, and S9 would not be expected to adversely affect the bacteriological water quality of their adjacent foreshore areas.

3.6 Shoreline, 3rd Avenue to 6th Avenue

Approximately 12 dwellings, located on the east side of Island Highway between 3rd and 6th Avenues, are not connected to the sewer system, and presently are serviced by individual septic tanks. These dwellings are all situated below the elevation of the existing sewer line, making gravity flow impossible. The Municipality of the District of Campbell River plans to connect them to the sewer line with individual pumps (5).

An investigation of the shoreline indicated that septic tank effluent was seeping onto the foreshore from these dwellings. This seepage would tend to adversely affect the bacteriological water quality of the adjacent foreshore area.

4 COMMENTS

4.1 Lift Stations

The locations of all lift stations serving the Municipality of the District of Campbell River are illustrated in Figures 1 and 2.

All lift stations would overflow in the case of pump failure or a major electrical power interruption. Each station is connected to an alarm to warn of pump failure, and is designed to provide 4 hr of hydraulic retention before overflow occurs. However, lift stations no. 1, 2, and 3 do not have a retention of 4 hr due to storm water infiltration/inflow. The municipality is presently conducting an engineering study to correct the infiltration/inflow problems.

The lift stations are inspected by the operators daily for mechanical or electrical problems. The pumps are generally lifted and inspected twice yearly for evidence of oil leaks or damaged seals. The lift stations, their locations, and overflow facilities are listed below:

1. Lift Station No. 1, located off Cedar Street between 11th and 13th Avenue, is fitted with a bell alarm and would overflow to the storm sewer, which discharges to Discovery Passage on the northerly side of Discovery Crescent.
2. Lift Station No. 2, located off Island Highway east of Redwood Street, is fitted with a bell alarm, and would overflow to Campbell River.
3. Lift Station No. 3, located west of Ridge Road, is fitted with a bell alarm and would overflow down the slope to Camp Creek.
4. Lift Station No. 4, located at the west end of Niluht Road, is fitted with a warning light and would overflow down the slope, eventually reaching Simms Creek.
5. Lift Station No. 5, located off Island Highway at Pinecrest Road, is fitted with a warning light and would overflow in the immediate area.

6. Lift Station No. 6, located off Island Highway 0.6 miles north of Rockland Road, is fitted with a warning light and would overflow in the immediate area.

7. Lift Station No. 7, located off Island Highway south of the Marina Motel, is fitted with a warning light and would overflow to Simms Creek.

8. Lift Station No. 8, located off Island Highway between Larwood and Erickson Road, is fitted with a warning light and would overflow in the immediate area.

9. Two private lift stations operated by Pardo Verde Mobile Home Park are located, as indicated in Figure 2, on Rockland Road, west of Murphy. The lift station at the lower level contains a 10,000 gal holding reservoir to store sewage in the case of pump failure or a power interruption. These stations serve 65 mobile homes containing approximately 150 people. The stations are checked twice weekly for operational problems.

4.1.1 Electrical Power Outages. In the event of a major power interruption, sewage overflow from the municipal lift stations located along Island Highway and the private lift stations operated by Pardo Verde Mobile Home Park could either directly or indirectly produce a serious health hazard in the municipal foreshore areas.

B.C. Hydro and Power Authority at Campbell River reported that major power failures occur very infrequently; the last incidence of wide-spread interruption occurred in 1971 due to high winds. Since that time, many power lines have been replaced and the number of main circuits increased. Small, localized power outages occur every 2-3 years; however, power is generally restored under these circumstances in 2 hours.

4.2 Infiltration/Inflow

By comparing daily precipitation data with daily plant flow information, it is evident that the sewer treatment system receives

excessive infiltration/inflow contributions during periods of continuous rainfall. The major causes of infiltration are leaky manholes, faulty lateral connections, and leaky pipe joints; while the sources of excessive inflow are illegal downspouts, foundation drains, cross-connections with storm sewers, and surface runoff into poorly placed manholes (6).

The Municipality of the District of Campbell River has separate storm and sanitary sewer systems. However, as mentioned in section 3.2, it is probable that some cross-connections between the storm and sanitary sewers exist, expecially in the original townsite. The municipality is presently carrying out a survey of the sewer system to locate the major sources of infiltration/inflow.

Excessive infiltration/inflow contributions to the sewer system cause the sewage treatment plant to be hydraulically overloaded, which in turn results in large quantities of raw sewage being bypassed to the receiving waters. Since secondary treatment produces a significant reduction in bacteriological and viral concentrations, the use of bypasses to alleviate the problems encountered during high flow periods should be avoided as much as possible.

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ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of the following people:

B. Kay, D. Schroeder, and P.A. Gilmour, Environmental Protection Service, Water Bacteriology, for conducting the bacteriological analyses in the Environmental Protection Service mobile laboratory located at Campbell River.

F. Greig, and C. Riga, Sewage Treatment Plant Operators, Municipality of the District of Campbell River, for providing operating data from the water pollution control centre.

D.H. Mawdsley, Superintendent, Municipality of the District of Campbell River, for providing valuable information and assistance concerned with the municipal sewerage system.

T.J. Tevendale, Senior Project Engineer, Shellfish Water Quality Program, Environmental Protection Service, for assistance in planning the survey and compiling this report.

APPENDICES

APPENDIX I FRESHWATER AND SEWAGE EFFLUENT SAMPLE STATION LOCATIONS

Sample Station	Location
109E	Campbell River Water Pollution Control Centre Final Effluent
S1	Storm Drain Foot of 6th Avenue
S2	Storm Drain Behind Skyline Beach Motel, Foot of 3rd Avenue
S3	Storm Drain Foot of Evergreen Road
S4	Storm Ditch North of Driftwood Beach Trailer Park
S5	Storm Ditch Foot of Rockland Road
S6	Mouth of Simms Creek
S7	Mouth of Willow Creek
S8	Storm Ditch Foot of Dahl Road
S9	Storm Ditch North of Foot of Washington Drive

APPENDIX II SUMMARY OF MEMBRANE FILTRATION BACTERIOLOGICAL DATA FOR FRESHWATER SAMPLE STATIONS

Sample Station	Mean Fecal Coliform (F.C.) Count/100 mℓ	Mean Fecal Streptococci (F.S.) Count/100 mℓ	FC:FS Ratio
S1	9.08×10^3 (7)*	9.03×10^2 (7)	10.1
S2	10.3 (6)	7.2 (5)	1.4
S3	16.0 (5)	13.2 (5)	1.2
S4	1.4 (5)	0.8 (5)	1.8
S5	29.8 (6)	2.8 (5)	10.6
S6	84.0 (9)	46.0 (9)	1.8
S7	29.1 (9)	39.6 (9)	0.7
S8	107.0 (7)	169.0 (5)	0.6
S9	4.5 (6)	6.2 (6)	0.7

* Denotes number of samples.

APPENDIX III SUMMARY OF FRESHWATER SAMPLE STATION MEAN POPULATION EQUIVALENTS

Sample Station	Location	Average Estimated Flow		Mean Fecal Coliform MF Count/100 mℓ	Mean Population Equivalent
		cfs	mgd		
S1	6th Avenue Storm Drain	1.41	0.76	9.08×10^{3}	9.8
S2	Storm Drain Foot of 3rd Avenue	0.025	1.3×10^{-2}	10.3	0.2×10^{-3}
S3	Storm Drain Foot of Evergreen Road	0.24	0.13	16.0	3.0×10^{-3}
S4	Storm Ditch North of Driftwood Beach Trailer Park	0.14	7.5×10^{-2}	1.4	0.1×10^{-3}
S5	Storm Ditch Foot of Rockland Road	0.01	5.4×10^{-3}	29.8	2.0×10^{-3}
S6	Simms Creek	28.4	15.3	94.5	2.0
S7	Willow Creek	25.3	13.6	29.1	0.6
S8	Storm Ditch Foot of Dahl Road	1.07	0.58	107.	8.8×10^{-2}
S9	Storm Ditch North of	1.18	0.64	4.5	4.1×10^{-3}

APPENDIX IV BACTERIOLOGICAL ANALYSES RESULTS AND SAMPLING CONDITIONS FOR FRESHWATER SAMPLE STATIONS

SAMPLE STATION S1 LOCATION: STORM DRAIN FOOT OF 6th AVENUE

Date 1976	Time of Collection	Estimated Flow		Precipitation mm	Fecal Coliform Count/100 mℓ	Population Equivalent
		cfs	mgd			
Feb. 5	1015	0.23	0.12	nil	TNTC*	-
Feb. 6	0845	-	-	nil	11,000	-
Feb. 9	1415	-	-	trace	16,900	-
Feb. 10	1025	0.35	0.19	4.6	33,000	8.9
Feb. 11	0845	2.0	1.08	17.5	400	-
Feb. 12	1500	-	-	9.7	1,400	-
Feb. 13	1015	1.96	1.05	10.7	300	0.4
Feb. 24	1115	2.50	1.35	0.5	540	1.0
Average		1.41	0.76		9.08×10^3	9.8

* TNTC Too Numerous To Count

APPENDIX IV BACTERIOLOGICAL ANALYSES RESULTS AND SAMPLING CONDITIONS FOR FRESHWATER SAMPLE STATIONS

SAMPLE STATION S6 LOCATION: MOUTH OF SIMMS CREEK

Date 1976	Time of Collection	Estimated Flow		Precipitation mm	Fecal Coliform Count/100 mℓ	Population Equivalent
		cfs	mgd			
Feb. 4	1330	11.9	6.4	nil	0	0
Feb. 5	1315	13.7	7.4	nil	29	0.3
Feb. 6	1030	-	-	nil	TNTC*	-
Feb. 9	1525	-	-	trace	340	-
Feb. 10	1120	23.7	12.8	4.6	120	2.2
Feb. 11	0915	52.5	28.3	17.5	146	5.9
Feb. 12	0930	-	-	9.7	45	-
Feb. 13	0940	52.5	28.3	10.7	64	4.8
Feb. 23	1135	23.8	12.8	0.8	3	0.05
Feb. 24	1530	20.6	11.1	0.5	9	0.14
Average		28.4	15.3		94.5	2.05

* TNTC Too Numerous To Count

APPENDIX IV BACTERIOLOGICAL ANALYSES RESULTS AND SAMPLING CONDITIONS FOR FRESHWATER SAMPLE STATIONS

SAMPLE STATION S7 LOCATION: MOUTH OF WILLOW CREEK

Date 1976	Time of Collection	Estimated Flow		Precipitation mm	Fecal Coliform Count/100 mℓ	Population Equivalent
		cfs	mgd			
Feb. 4	1415	17.7	9.5	nil	3	0.04
Feb. 5	1320	13.4	7.2	nil	5	0.05
Feb. 6	1035	-	-	nil	18	-
Feb. 9	1535	-	-	trace	12	-
Feb. 10	1135	20	10.8	4.6	3	0.05
Feb. 11	0930	20	10.8	17.5	86	1.32
Feb. 13	0940	50	26.9	10.7	119	4.55
Feb. 23	1145	27	14.5	0.8	10	0.21
Feb. 24	1545	29.3	15.6	0.5	6	-
Average		25.3	13.6		29.1	0.56

APPENDIX V CHEMICAL AND BACTERIOLOGICAL RESULTS FROM CAMPBELL RIVER WPCC FINAL EFFLUENT

SAMPLE STATION 109E

Date 1976	Time of Collection	Discharge mgd	pH 0-14	BODs mg/ℓ	COD mg/ℓ	SS mg/ℓ	Fecal Coliform MPN/100 mℓ
Feb. 4 G*	900	1.24	7.2	11	73	5	4.9×10^5
Feb. 5	930	1.21	7.4	17	94	18	5.0×10^4
Feb. 6	1000	1.16	7.7	16	98	18	9.0×10^4
Feb. 9 G	1530	1.23	7.0	16	120	10	5.4×10^5
Feb. 10	1530	0.95	7.2	18	110	20	4.9×10^4
Feb. 11	1530	0.86	7.2	18	110	20	1.7×10^4
Feb. 12	1500	1.02	7.3	19	150	10	7.0×10^4
Feb. 13	1100	1.38	7.2	22	30	20	3.5×10^4
Feb. 23 G	1120	1.58	7.8	16.5	38	130	-
Feb. 24	1330	1.60	8.0	19	69	26	-
Feb. 25	1430	1.60	7.8	16	54	26	-
Feb. 26 G	1625	1.55	7.2	17.5	65	19	-
Average		1.51		17.2	84.3	26.8	1.68×10^5

* G Grab Sample

APPENDIX VI POPULATION EQUIVALENTS AND LOADINGS FOR CAMPBELL RIVER WPCC FINAL EFFLUENT

SAMPLE STATION 109E

Date 1976	Discharge mgd	Precipitation mm	BOD Loading lb/day	Solids Loading lb/day	Population Equivalent
Feb. 4	1.24	nil	136.4	62.0	863
Feb. 5	1.21	nil	205.7	217.8	86
Feb. 6	1.16	nil	185.6	208.8	148
Feb. 9	1.23	trace	196.8	123.0	943
Feb. 10	0.95	4.6	171.0	190.0	66
Feb. 11	0.86	17.5	154.8	172.0	21
Feb. 12	1.02	9.7	193.8	102.0	101
Feb. 13	1.38	10.7	303.6	276.0	69
Feb. 23	1.58	0.8	260.7	2054.0	-
Feb. 24	1.60	0.5	264.3	416.0	-
Feb. 25	1.60	13.2	256.0	416.0	-
Feb. 26	1.55	5.1	271.3	294.5	-
Average	1.51		259.7	404.7	360

APPENDIX VII DYE STUDY OF CAMPBELL RIVER WATER POLLUTION CONTROL CENTRE OUTFALL

A dye study was conducted on February 26, 1976, to determine the dispersion characteristics of the Campbell River Water Pollution Control Centre outfall in Discovery Passage.

The aims of this study were the following:

1. to determine the initial dilution that can be expected over the outfall;
2. to determine the path taken by the sewage field during flood tide, i.e. southward movement; and
3. to determine the influence of the sewage treatment plant effluent on the bacteriological water quality of the foreshore areas south of the water pollution control centre.

METHODS AND MATERIALS

A 4% solution of fluorescein dye was added to the sewage effluent at the plant outlet at a flow rate of 2.3 ℓ/min. A G.K. Turner Model 110 fluorometer was used to measure dye concentrations in the seawater. Two single lens reflex cameras were used to photograph the dispersion pattern. Pumping of the dye solution commenced at 0930 hr, prior to a low slack water of 3.2 m at 1005 hours. The tide range was 0.7 m, with a high water of 3.9 at 1400 hours.

Water samples were collected at predetermined locations, using the Shellfish Water Quality Survey boat "Klebsiella." The samples were analyzed with the fluorometer at the Environmental Protection Service mobile laboratory located at Campbell River. Concentrations as low as 0.01 ppB are detectable with the Turner fluorometer. Fluorescein dye is visually detectable at 30 ppB in a water sample, and at 10 ppB in a large body of water.

APPENDIX VII DYE STUDY OF CAMPBELL RIVER WATER POLLUTION CONTROL CENTRE OUTFALL (Continued)

Two flights were made over the dyed sewage effluent field at 1100 and 1200 hrs. One of the dye study personnel photographed and sketched the path of the dyed sewage field.

DISCUSSION OF RESULTS

During the dye study, the sewage effluent flow rate was 1.5 mgd, or 4740 ℓ/min, resulting in a dye concentration of 1.2 ppm. Due to operational difficulties with the Turner fluorometer and sampling difficulties, dye concentrations in the seawater could not be obtained. An outline of the path of the sewage field, as observed from the air, appears in Figure 6. The sewage field tended to remain submerged with little lateral dispersion, and extended along a path approximately 600 feet from the shoreline. As shown in Figure 6, the sewage field remained parallel to the foreshore until just north of Willow Point, where it moved distinctly towards the middle of Discovery Passage.

Discovery Passage develops currents of 5-7 knots during flood and ebb tides, which provide an excellent flushing action of the sewage treatment plant effluent. Due to the nature of the currents in Discovery Passage, it can be expected that sewage treatment plant effluent, including waste digester sludge, will have little effect on the bacteriological water quality of the nearby foreshore areas.

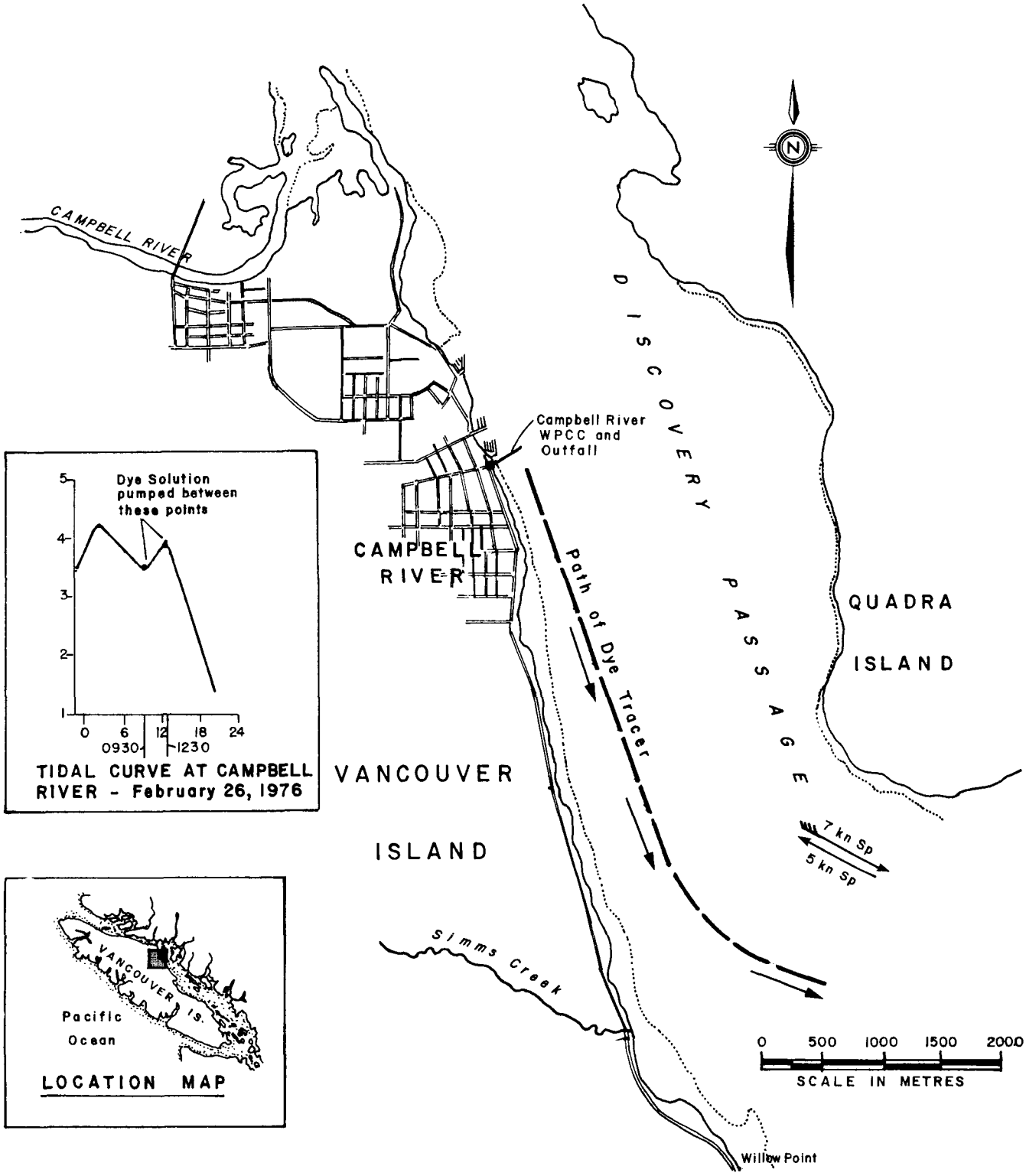

FIGURE 6 CAMPBELL RIVER WPCC OUTFALL DYE TRACER STUDY