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Sanitary Survey of Malaspina Strait From Sliammon Point to Grief Point, British Columbia, 1975

Surveillance Report
EPS 5-PR-75-13

Pacific Region
March 1975

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SANITARY SURVEY OF MALASPINA STRAIT
FROM SLIAMMON POINT TO GRIEF POINT,
BRITISH COLUMBIA, 1975

by

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Submitted to: Environment Canada
Environmental Protection Service
Water and Land Quality Group
Shellfish Water Quality Program

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ABSTRACT

A sanitary survey of the area adjacent to Malaspina Strait between Sliammon Point and Grief Point was conducted by the author in conjunction with personnel of the Environmental Protection Service, Pacific Region.

The purpose of the survey, conducted during November 1975, was to assess the effects of pollution sources located in the survey area on the bacteriological water quality of adjacent foreshore areas. This report concludes that the major sources of bacterial pollution are the storm tank overflow from the Powell River Water Pollution Control Plant and the sewage bypass from the Westview Water Pollution Control Plant. The sewage treatment facilities in the survey area are evaluated and recommendations are made for methods to improve the level of treatment accomplished.

RÉSUMÉ

En collaboration avec le personnel du Service de protection de l'environnement (région du Pacifique), l'auteur a effectué une étude sanitaire de la zone adjacente au détroit de Malaspina, entre la pointe Sliammon et la pointe Grief.

Cette étude, effectuée en novembre 1975, avait pour but de déterminer les effets que les sources de pollution situées dans la zone d'étude avaient sur la qualité bactériologique de l'eau, près des plages environnantes. D'après ce rapport, les principales sources de pollution bactériologique sont le trop-plein du bassin d'eaux de pluie, provenant de l'usine de traitement des eaux usées de la rivière Powell et le conduit de dérivation des eaux d'égout de l'usine de traitement Westview. On a évalué les résultats obtenus avec les installations de traitement des eaux usées dans la zone d'étude. On recommande l'utilisation de certaines méthodes pour améliorer ces résultats.

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LIST OF ABBREVIATIONS

| | |
|------------------|---------------------------------|
| BOD ₅ | 5 day biochemical oxygen demand |
| cfs | cubic feet per second |
| COD | chemical oxygen demand |
| Cunit | one hundred cubic feet |
| dia. | diameter |
| DO | dissolved oxygen |
| gal | gallon (s) |
| gpd | gallons per day |
| hr | hour (s) |
| lb/day | pounds per day |
| LWM | low water mark |
| mi. | mile (s) |
| mg/l | milligrams per liter |
| mgd | million gallons per day |
| MLSS | mixed liquor suspended solids |
| mm | millimeter |
| MPN | most probable number |
| SS | suspended solids |
| STP | sewage treatment plant |
| TPD | tons per day |
| WPCP | water pollution control plant |

CONCLUSIONS

The primary contributors of bacterial pollution to Malaspina Strait during this survey were, in order of magnitude:

- (1) Powell River Water Pollution Control Plant storm flow sewage holding tank overflow,
- (2) Westview Water Pollution Control Plant sewage bypass,
- (3) Powell River Water Pollution Control Plant final effluent,
- (4) Westview Water Pollution Control Plant final effluent.

The total population equivalent of these sources was 3,027. The Powell River Water Pollution Control Plant storm flow sewage holding tank overflow is a major threat to the adjacent foreshore areas since, not only is it the largest source of fecal organisms found during the survey, it is discharged through a short outfall (300' from LWM) which terminates in shallow water. The relative degree of influence from the other primary contributors is significantly reduced by being discharged through long outfalls into deep water.

The secondary contributors of bacterial pollution, with possible major localized effects were, in order of magnitude:

- (1) Sliammon Creek (S2)
- (2) Sliammon Sewage Treatment Plant
- (3) MacMillan Bloedel Ltd. Mill effluent
- (4) Unnamed creek (S6)
- (5) Willingdon Creek (S4)
- (6) Unnamed creek (S3)

These sources which discharge directly to Malaspina Strait had a combined population equivalent of 64.8.

1 INTRODUCTION

The Powell River area contains an important segment of British Columbia's forest industry. The Powell River Division of MacMillan Bloedel Ltd., which employs approximately 2,700 people, is the largest producer of newsprint in Canada. In addition, this area supports significant recreational and service industries. Due to this high level of activity, a large population is concentrated in the Powell River-Westview area. This study was contracted to (1) evaluate the influence of municipal, domestic and industrial discharges to Malaspina Strait in the Powell River area and (2) to contribute to a shellfish growing water quality survey conducted by personnel of the Environmental Protection Service.

1.1 Population

The 1971 Census determined the population of the Municipality of Powell River to be 13,726 with a 1975 projection of 14,726 (1). The Municipality can be divided, as follows, into four main areas with 1971 Census figures in brackets; Wildwood (1,345), Westview (8,355), Cranberry (2,320) and Powell River Townsite (1,705).

Domestic sewage from the Wildwood area is treated in the Wildwood Sewage Lagoon. The Powell River WPCP treats domestic sewage from the MacMillan Bloedel Ltd. Pulp and Paper Mill, plus all the sewage from the Cranberry area and the Powell River Townsite. The Westview WPCP treats all the sewage from the Westview area.

The Sliammon STP treats domestic sewage from the village of Sliammon, which has an estimated population of 400. The municipality experienced a growth rate of 27.7% from 1961 to 1971, while the Regional District of Powell River, excluding the municipality, registered a gain of 45%. This trend towards rapid growth outside the municipality and slow growth within could

continue. In 1971 the Regional District had a population of 4,820 and a 1975 projection of 5,180. The total survey area from Saltery Bay to Scuttle Bay has a population in excess of 20,000.

2 DESCRIPTION OF MAJOR POLLUTION SOURCES

A map of the Powell River area appears in Figure 1. The map illustrates the sewage treatment facilities, marine outfalls, location of pumping stations, storm drain and creek sample stations and the location of MacMillan Bloedel Ltd. Pulp and Paper Mill. Sample station locations covered in this report are presented in Appendix I.

2.1 Westview WPCP

The Westview WPCP is an extended aeration activated sludge plant consisting of a wet well, grit chamber, two aeration tanks, four final clarifiers and four aerobic sludge digesters. At the design flow of 1.2 MGD each of the aeration tanks has a retention time of 3.2 hr. Oxygen and mixing are supplied by submerged air diffusers. Each final clarifier provides a retention time of 1.6 hr. with an overflow rate of 462 gpd/sq. ft.

Sludge digestion occurs in four 50,000 gal. aerobic digestion tanks with a normal retention time of 30 days. Excess activated sludge from the final clarifiers is wasted to the aerobic digesters and clarified supernatant is fed from there back to the aeration tanks. A Parshall flume located ahead of the grit chamber measures instantaneous flows which are subsequently recorded on a circular chart recorder located in the control building. During the month of December, 1974 a bypass line was installed to bypass raw sewage to the outfall during periods of high flows which normally occurred during the months of heavy rainfall. Excess sewage was designed to be bypassed by means of a screened overflow from the grit chamber. However, due to problems associated with constant plugging of the screens, a section of screening at the head of the grit chamber was removed and replaced by a side weir. Sewage is bypassed to the outfall when the level in the grit chamber exceeds the level of the side weir. Sewage bypass, final effluent and waste

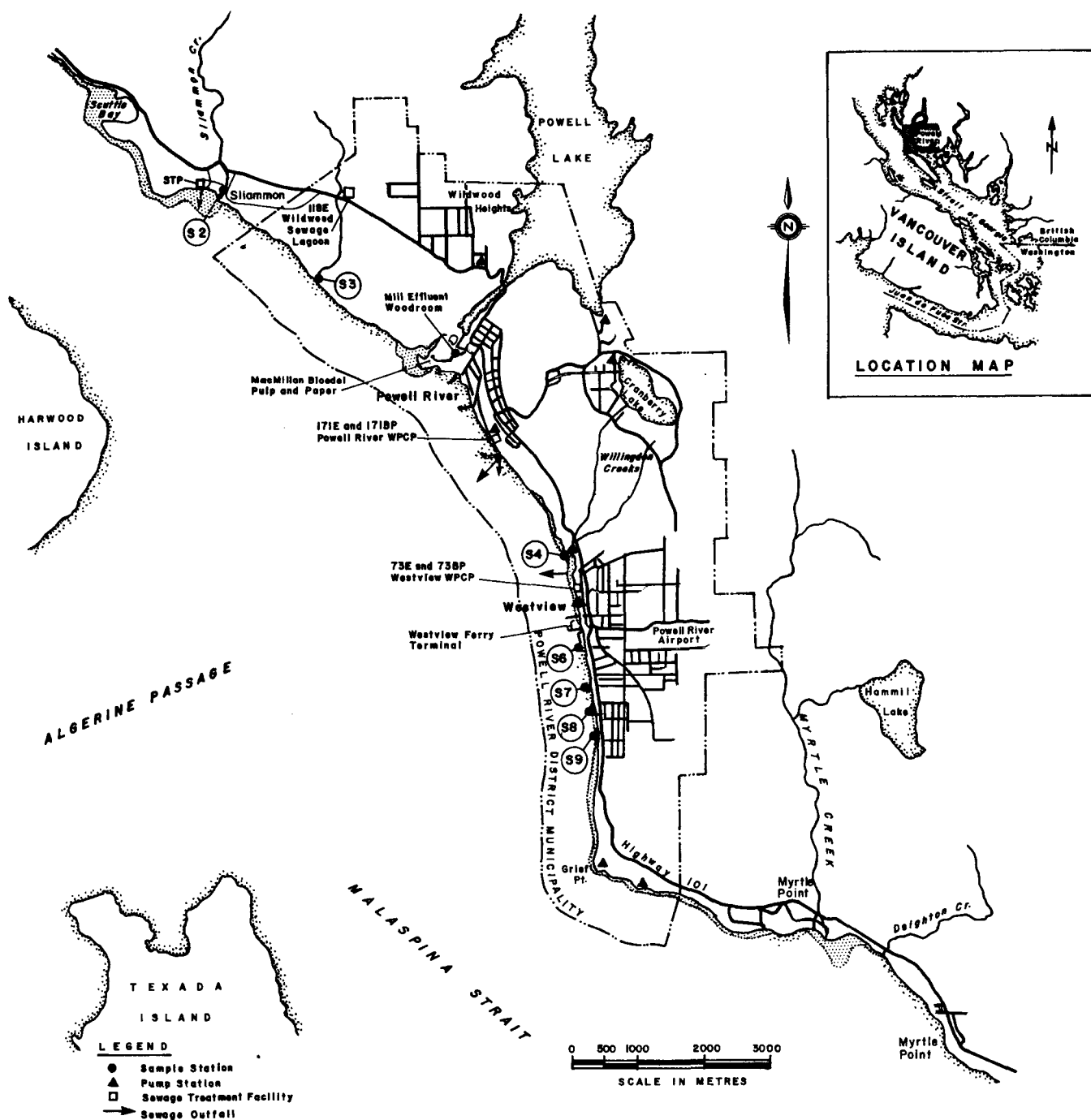


FIGURE 1 POWELL RIVER AREA SAMPLE STATION LOCATIONS

digester sludge are discharged to Malaspina Strait through a 24" dia. marine outfall terminating at 1400' from LWM and 192' below LWM.

2.2 Powell River WPCP

The Powell River WPCP is an extended aeration activated sludge plant consisting of two aeration tanks, two final clarifiers and two aerobic sludge digestors. The treatment section, which is identical to one half the Westview WPCP, has a design flow of 0.6 MGD.

The pollution control plant includes two 72' x 15' x 15' storm flow sewage holding tanks with a total capacity of 210,000 gal. Sewage flow to the treatment section is controlled by a gate valve with excess flow bypassed to the storm tanks. The storm tanks are designed to store excess sewage during periods of high flow and to discharge to the treatment section, by means of a wet well and float controlled pumps, during periods of low flow. However, during periods of continuous heavy rainfall as experienced during this survey, the storm tanks remain full and overflow to a 48" dia. marine outfall terminating 300' from LWM and 1' below LWM. Final effluent and waste digester sludge are discharged separately to Malaspina Strait through a 12" dia. marine outfall terminating 1540' from LWM and 157' below LWM.

2.3 Wildwood Sewage Lagoon

The Wildwood Sewage Lagoon is a 6 acre waste stabilization pond with a design flow of 158,000 gpd and a hydraulic retention of 50-60 days.

A single floating aerator located near the sewage inlet in the middle of the lagoon provides oxygen to the sewage. The lagoon effluent is discharged through an 8" dia. line to an unnamed creek which enters Malaspina Strait 1.2 miles NW of the mouth of Powell

River. Chlorination facilities and a new effluent discharge line to the creek were under construction at the time of the survey.

2.4 Sliammon STP

The Sliammon STP is an extended aeration activated sludge package plant with a design flow of 15,000 gpd. It consists of a wet well, two aeration tanks, two clarifiers and a chlorine contact chamber. Sodium hypochlorite solution (12%) is fed to the head of the contact chamber using a manually adjusted metering pump, providing a dry flow residence time of approximately 15 minutes. A bypass line, connected to the outfall, is provided near the top of the wet well. Environmental Protection Service Federal Activities Pollution Group reported that 20% of the influent is bypassed during periods of high flow. Sewage bypass, final effluent and waste activated sludge are discharged to Malaspina Strait through a 6" dia. 500' marine outfall terminating approximately 6' below LWM.

2.5 MacMillan Bloedel Ltd., Powell River Division

The MacMillan Bloedel Ltd. Pulp and Paper complex is comprised of a kraft semi-bleach pulp mill, four stone groundwood mills, a refiner groundwood mill, eight paper machines and a saw mill. The paper machines produce an average of 1650 TPD of newsprint and specialty grade paper (2). During the survey the total effluent discharge from the mill was approximately 73.5 MGD from six discharge points; the average total suspended solids was 70.8 TPD and the average BOD₅ loading was 35.6 TPD.

Effluent from the Powell River mill tends to be swept northward by prevailing counter-clockwise Gulf of Georgia surface currents. Some westward movement also occurs through Algerine and Shearwater passages. The mill zone of influence extends further than 10 miles to the north and more than 8 miles to the south (3). Figure 2 shows the zones of influence, depending on the tidal conditions, of the Powell River mill effluent discharge.

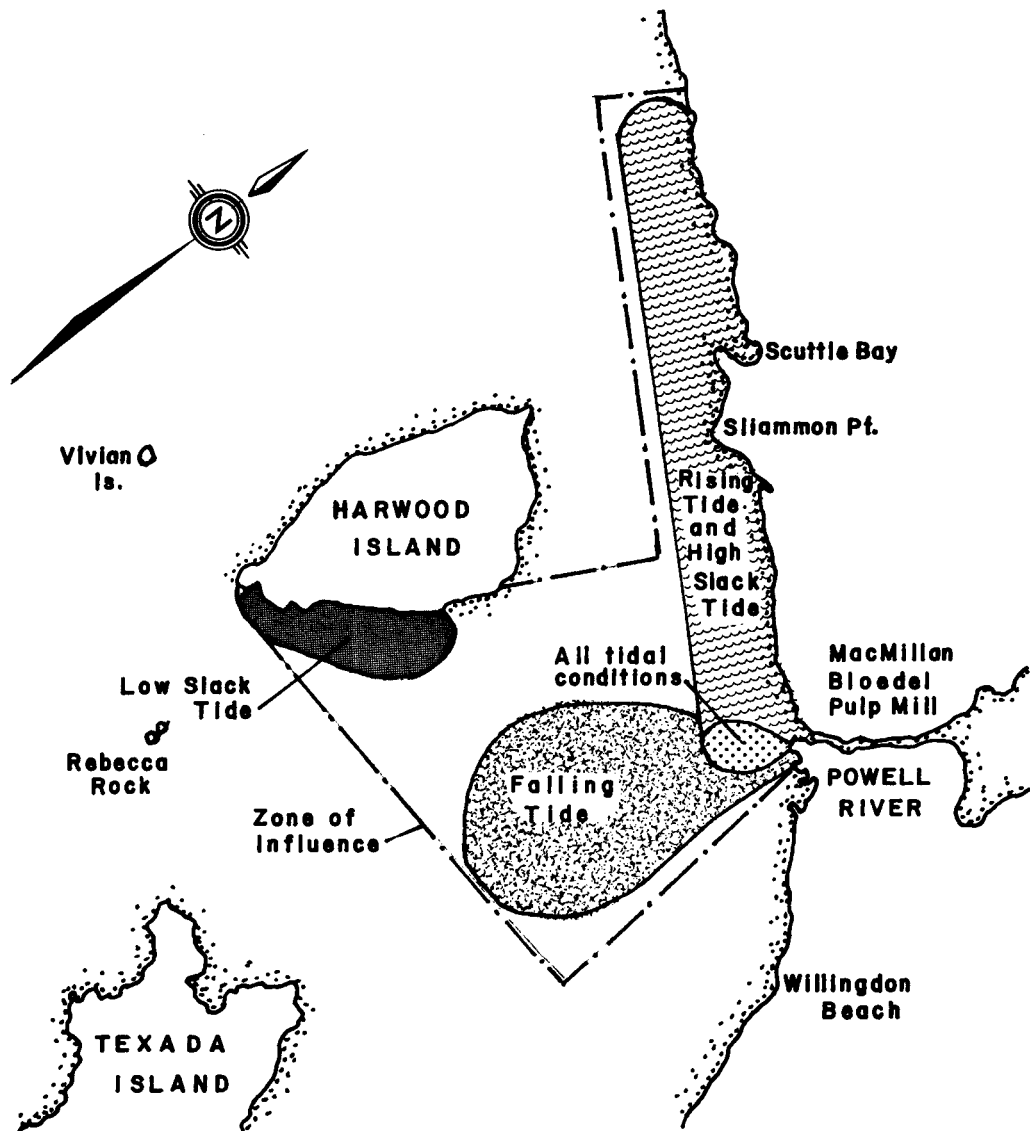


FIGURE 2. RECEIVING WATER REPORT
MacMILLAN BLOEDEL, POWELL RIVER DIVISION (4)

No solid wastes are disposed of in the Strait. Wastes, such as fly ash, are trucked inland to a landfill site.

The mill effluent does not represent a major contribution of fecal organisms to the Strait. Domestic mill sewage is pumped to the Powell River WPCP for treatment.

3 PROCEDURES AND METHODS

All samples for chemical analyses were collected in 0.5 and 1.0 litre bottles. Most of the samples were grab; samples listed in the appendices with the letter "C" prefixing the time of collection are 24 hour composites. Composite samples were collected using an ISCO Continuous Sampler. pH was determined using a Radiometer pH meter (Type PHM29). All Samples were stored at 4⁰ C and submitted to the Environmental Protection Service Laboratory, West Vancouver, for chemical analyses. Samples for bacteriological analyses were collected in sterile 170 cc wide-mouthed bottles and submitted to the Environmental Protection Service mobile laboratory located during the survey at Westview for fecal coliform determinations. Residual chlorine measurements of the Sliammon STP effluent were made in the mobile laboratory using the Amperometric Titration Method as described in the Wallace and Tiernan, Amperometric Titrator Instruction Book (#WIA 790-1-2) pp. 16-20.

Effluent DO's for the Westview WPCP, in the Powell River WPCP and the Wildwood Sewage Lagoon were provided by the plant operator.

4 RESULTS AND DISCUSSION

The chemical and bacteriological analyses results of sampling the sewage treatment effluents are presented in Appendices III and IV. Appendix III lists the results of chemical and fecal coliform analysis on individual samples while Appendix IV lists the loading factors to Malaspina Strait of each source of pollutants. A list of the sample station locations is given in Appendix I. A summary of flow estimates, mean fecal MPN's and corresponding population equivalents for sample stations excluding the sewage treatment stations is given in Appendix II. These sample stations include four creeks, four storm drains and the woodroom effluent of the MacMillan Bloedel Ltd. Pulp and Paper Mill. All of these sources discharge directly to Malaspina Strait.

A four cycle log histogram comparing average population equivalents from each fecal coliform source appears in Figure 3. The abscissa illustrates the distance in yards along the shoreline of each source with the Sliammon STP outfall referenced at 0.

4 .1 Sewage Treatment Systems

4.1.1 Sliammon STP. During the survey the Sliammon STP produced a final effluent with an average BOD_5 of 41.5 mg/ℓ, an average SS of 54.3 mg/ℓ and an average fecal coliform MPN of $4.9 \times 10^5/100$ mL. The MLSS was very low at 220 mg/ℓ. The plant experienced excessive hydraulic loadings from the sewer system throughout most of the survey period. The Sliammon sewer system is plagued with high infiltration during periods of heavy rainfall. Tests conducted by Environmental Protection Service Federal Activities Pollution Abatement Group to locate the sources of infiltration have been unsuccessful to date. High clarifier overflow rates result in direct carry-over of solids into the effluent. Due to a high solids level in the effluent, chlorine feed rates were difficult to maintain so as to satisfy an abnormally high chlorine demand. This in turn permits a high fecal coliform MPN in the effluent. The effluent exhibited an average population equivalent

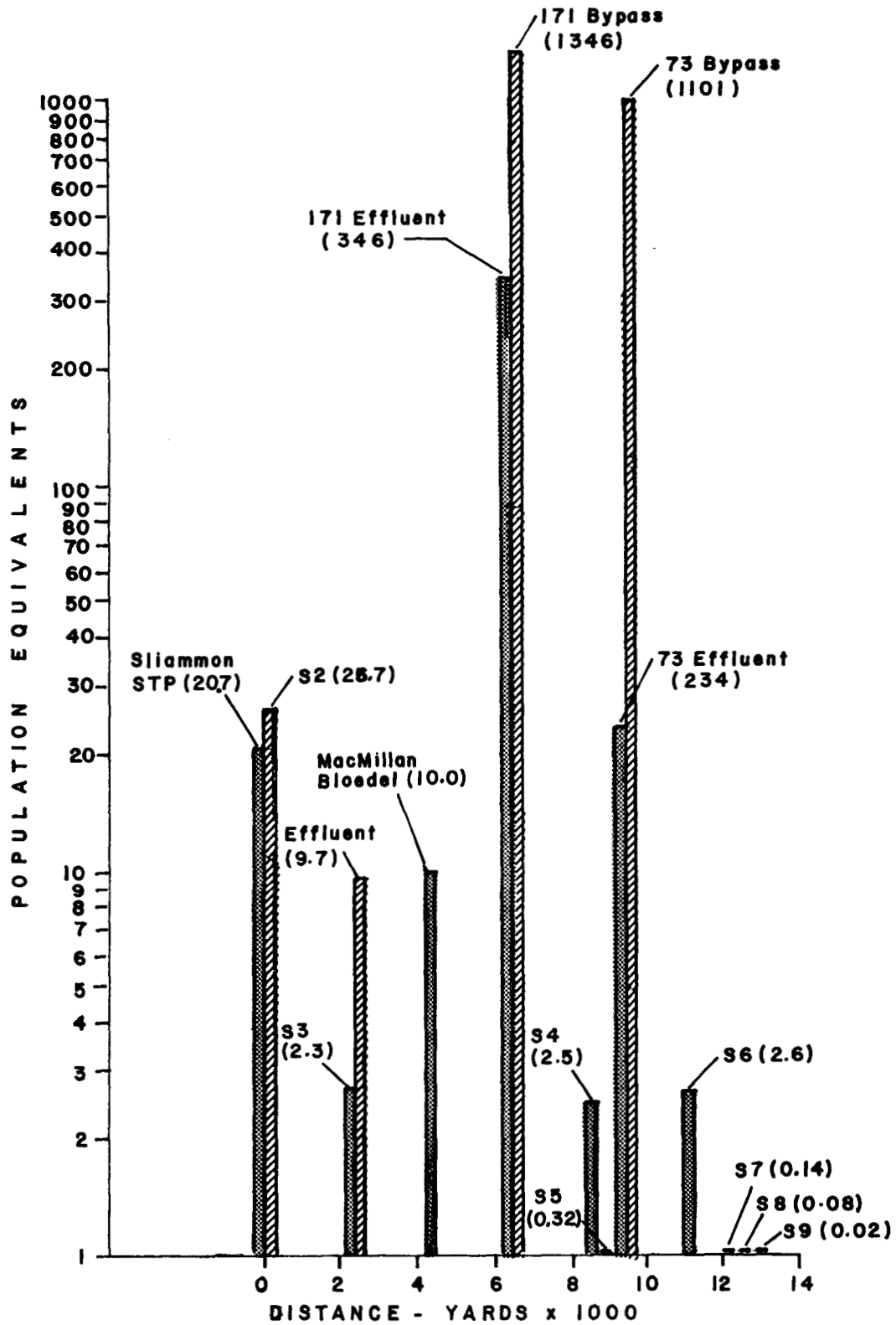


FIGURE 3 POPULATION EQUIVALENTS HISTOGRAM

of 20.7 during the survey. As shown in Figure 3, the Sliammon STP effluent is a major source of bacterial contamination in this area.

4.1.2 Wildwood Sewage Lagoon. The Wildwood Sewage Lagoon produced a good quality effluent throughout the survey. The effluent exhibited an average BOD_5 of 12 mg/l, an average DO of 8.5 mg/l, an average SS of 51 mg/l and an average fecal coliform MPN of 4.3×10^4 /100 ml. This is equivalent to an average BOD loading of the effluent of 22 lb/day, an average solids loading (based on SS) of 105 lb/day and an average population equivalent of 10.7. On November 13, 1975 during a period of heavy rainfall, the discharge increased to 366,000 gpd, more than twice the design flow. However, the effluent quality was maintained; the BOD loading was 29 lb/day and the population equivalent was 10.4. The unnamed creek into which Wildwood discharges exhibited an average population equivalent at the mouth of 2.3. The distance along the creek from the point of lagoon discharge to Malaspina Strait is approximately 3/4 miles. The detention time provided by the creek facilitates increased treatment of the lagoon effluent and results in a fairly low fecal coliform input to the marine environment from this source. However during the summer months the creek flow diminishes to zero and undiluted lagoon effluent flows through the creek to the receiving water, posing a potential health hazard in the adjacent foreshore area. A graph of daily effluent discharges from Wildwood Sewage Lagoon appears in Figure 4.

4.1.3 Powell River WPCP. The Powell River WPCP final effluent exhibited an average BOD_5 of 31.2 mg/l, a DO of 6.1 mg/l, an average SS of 18.5 mg/l and a mean fecal coliform MPN of 2.51×10^5 /100 ml. BOD and solids loadings of the final effluent were 300 and 179 lb/day respectively. The average population equivalent of the final effluent was 346. The plant operated well considering that the hydraulic loadings exceeded design by 60% throughout the

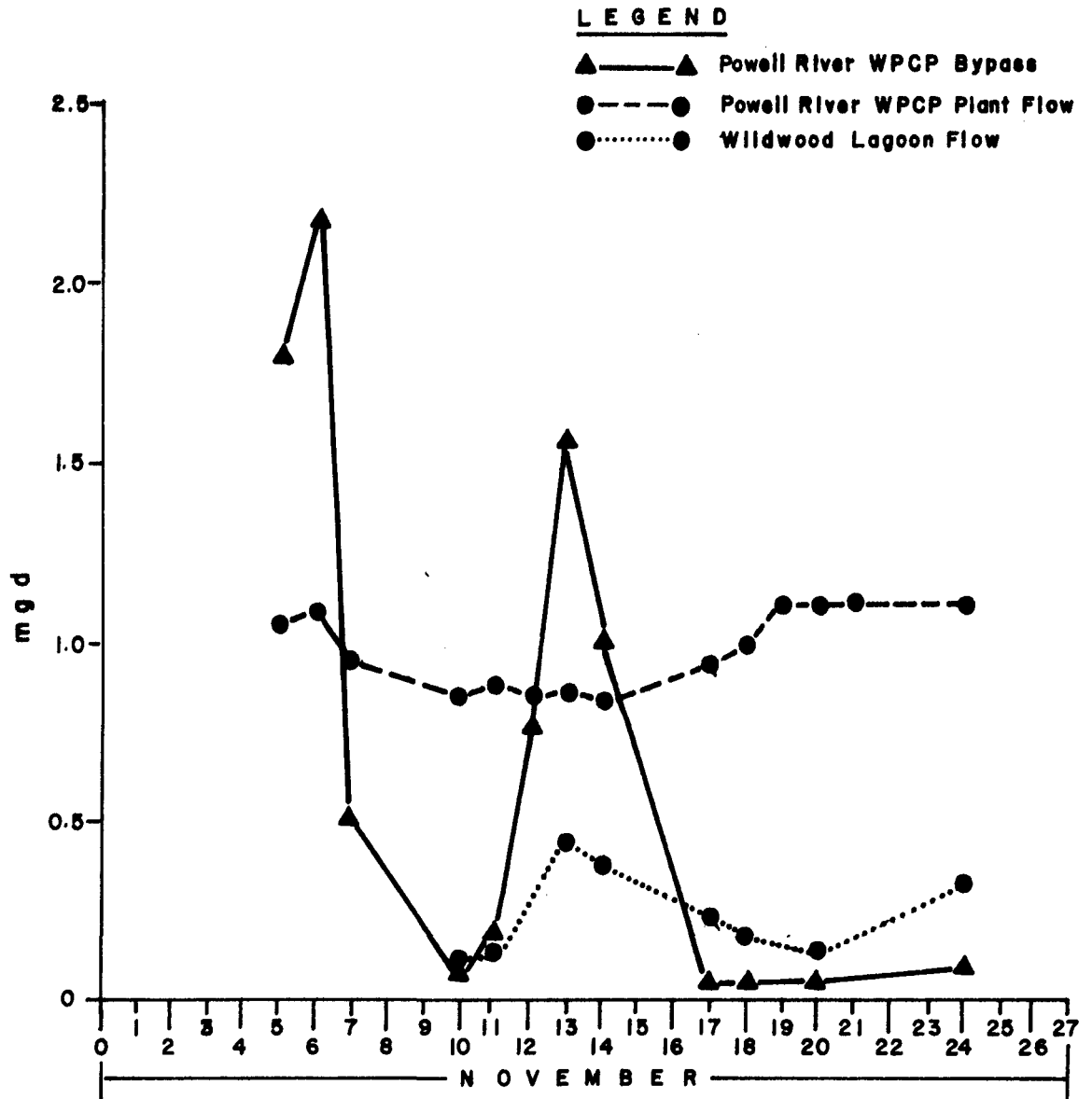


FIGURE 4 DAILY FLOWS - POWELL RIVER WPCP AND WILDWOOD SEWAGE LAGOON

survey period. The MLSS was 2800 mg/l with 71% volatile.

The storm flow sewage holding tank overflow exhibited an average BOD_5 of 9.1 mg/l, an average SS of 20.9 mg/l and a mean fecal coliform MPN of 1.48×10^6 . BOD and solids loadings of the storm tank overflow were 92 and 278 lb/day, respectively.

The average population equivalent was 1346. The low BOD_5 and SS levels can be explained by (1) the dilute sewage entering the treatment plant during periods of heavy rainfall and (2) the clarification of solids produced by storm tank retention times in excess of 2 hours. However, the fecal coliform content was about the same as raw sewage. The storm flow sewage holding tank overflow is a major source of bacterial pollution to the foreshore of Malaspina Strait since it is discharged over 300' from LWM and 1' below LWM. Aerobic digested sludge is wasted through the effluent outfall generally every 30 days. The sludge is approximately 0.3% solids with a fecal coliform MPN of 1.2×10^5 /100 ml. Calculated over a 30 day period, this represents a solids loading of 101 lb/day and a population equivalent of 0.005. In practice each sludge digester is emptied over a 24 hour period, this yields a solids loading of 1514 lb/day and a population equivalent of 0.86. In this respect wasted aerobic sludge cannot be considered a major contributor of fecal organisms to the receiving waters. The viral content of the wasted sludge will be discussed in section 7.1.

On an overall basis the Powell River WPCP final effluent and storm flow sewage holding tank overflow, with an approximate BOD_5 loading of 475 lb/day, a solids loading of 558 and a population equivalent of 1692, represents the largest source of fecal bacterial contamination in the Powell River area.

The Rawn Palmer Formula for Sewage Dispersion (9) predicts a dilution at the shoreline of effluent discharged from the outfall

of 11805. Based on average flows and coliform data this dilution would yield a fecal coliform concentration of 21 MPN/100 ml at the shoreline.

The storm flow sewage outfall terminates in 1' of water making a dilution calculation based on the Rawn Palmer Formula impossible. Using a liberal dilution estimate of 1000 the fecal coliform concentration at the shoreline would be 1480 MPN/100 ml, therefore in excess of swimming water standards. This would indicate that storm tank overflow is the major source of fecal organisms near the shoreline in the area of the Powell River WPCP. A graph of daily effluent discharges and stormtank overflow from the Powell River WPCP appears in Figure 4.

4.1.4 Westview WPCP. The Westview WPCP final effluent exhibited an average BOD_5 of 38.0 mg/l, an average SS of 26.5 mg/l and an average fecal coliform MPN of 1.65×10^5 /100 ml. BOD and solids loadings of the final effluent were 359 and 278, respectively. The average population equivalent of the final effluent was 234. The MLSS was 3000 mg/l with 76% volatile and the aeration DO was 4.3 mg/l. The plant was unable to operate at flows exceeding design due to poor hydraulic distribution to the clarifiers from the aeration tanks. This resulted in the carry over of biological solids from the southeast clarifier's sludge blanket to the effluent.

The sewage bypass exhibited an average BOD_5 of 40.1 mg/l, an average SS of 125.8 mg/l and an average fecal coliform MPN of 1.67×10^6 /100 ml. BOD and solids loading of the bypass averaged 173 and 202 lb/day, respectively. The average population equivalent of the bypass was 1101.

The configuration of the grit chamber side weir caused an excessive amount of sewage to be bypassed to the outfall. Pump surges occurring when sewage was pumped from the wet well caused the level in the grit chamber to exceed the level of the side weir during each pumping cycle. Therefore, the plant treated on the average 1.00 MGD

of sewage and bypassed 0.5 MGD during the survey period. In addition the high liquid level in the grit chamber maintained by an inlet control gate valve causes sewage to back up into the Parshall flume and results in inaccurate flow rate measurements.

Aerobic digested sludge is wasted to the marine outfall normally at 30 day intervals. The sludge is approximately 0.3% solids with a fecal coliform MPN of $1.2 \times 10^5/100 \text{ mL}$. Calculated over a 30 day period this represents a solids loading of 202 lb/day and a population equivalent of 0.1. As mentioned earlier, wasted aerobic digester sludge does not represent a major source of fecal organisms. The 30 day residence time provided by the digesters reduces fecal coliform levels through the mechanisms of bacterial die-off and predation to the point where wasted digester sludge represents no greater a fecal coliform source than treatment plant effluent.

In general the Westview WPCP total effluent which includes final effluent, sewage bypass and wasted digester sludge represents BOD and solids loadings of 692 and 682 lb/day respectively, with a total population equivalent of 1,335.

The Rawn Palmer Formula for Sewage Dispersion predicts a dilution at the shoreline from the outfall of 11,940. Based on average flows and fecal coliform data this dilution would yield a fecal coliform concentration of 52 MPN/100 mL at the shoreline nearest the outfall. This model assumes that no bacterial die-away occurs between the end of the outfall and the shoreline. Total daily flow from the Westview WPCP is illustrated in Figure 5 and an estimate of daily sewage bypass appears in Figure 6.

4.2 Creek and Storm Drain Sample Stations

4.2.1 Slammon Creek (S2). Slammon Creek had a mean fecal MPN of 70/100 mL and an estimated population equivalent of 26.7. There is little development on upper Slammon Creek to explain the high

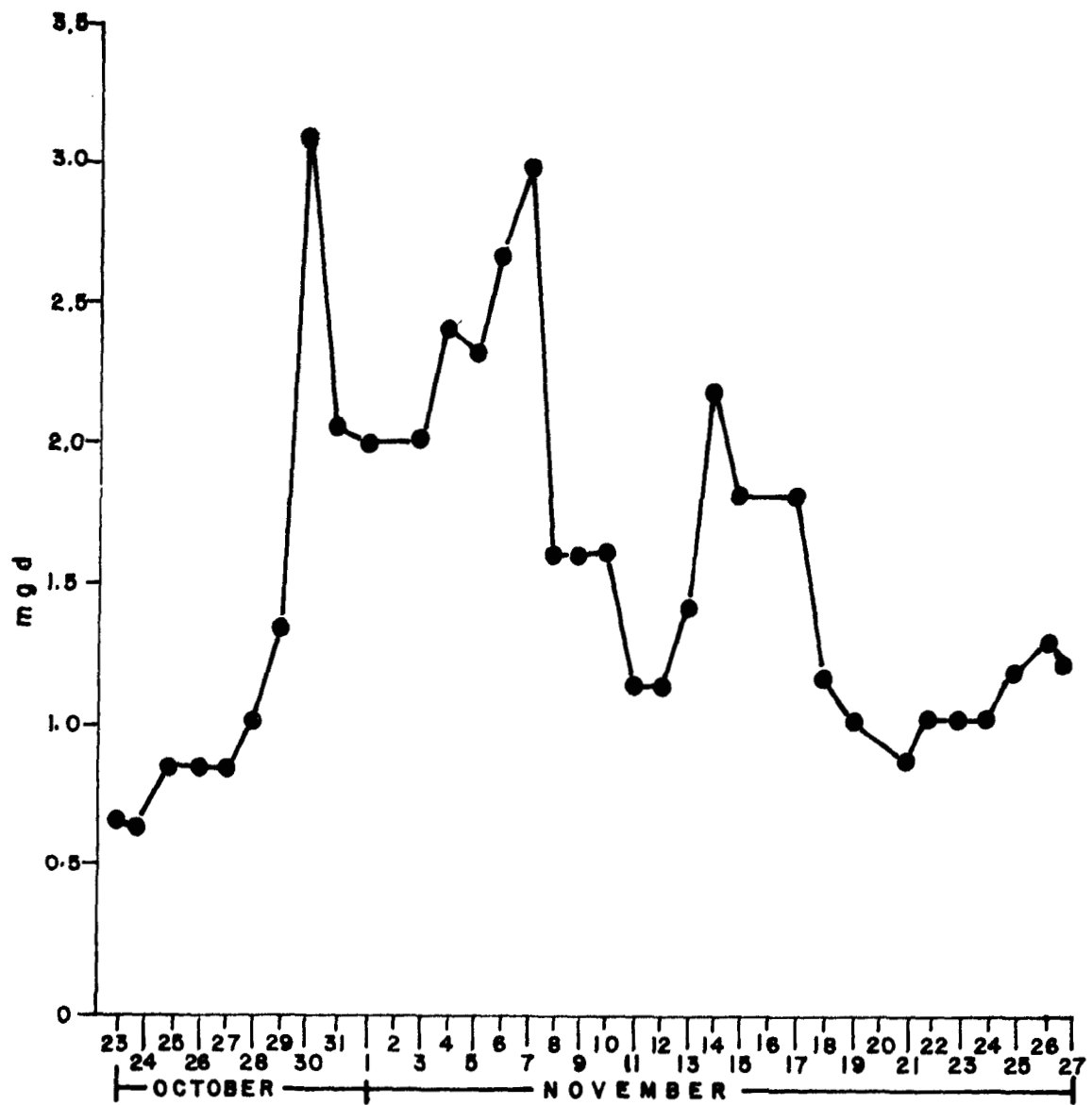


FIGURE 5 WESTVIEW TOTAL DAILY FLOW

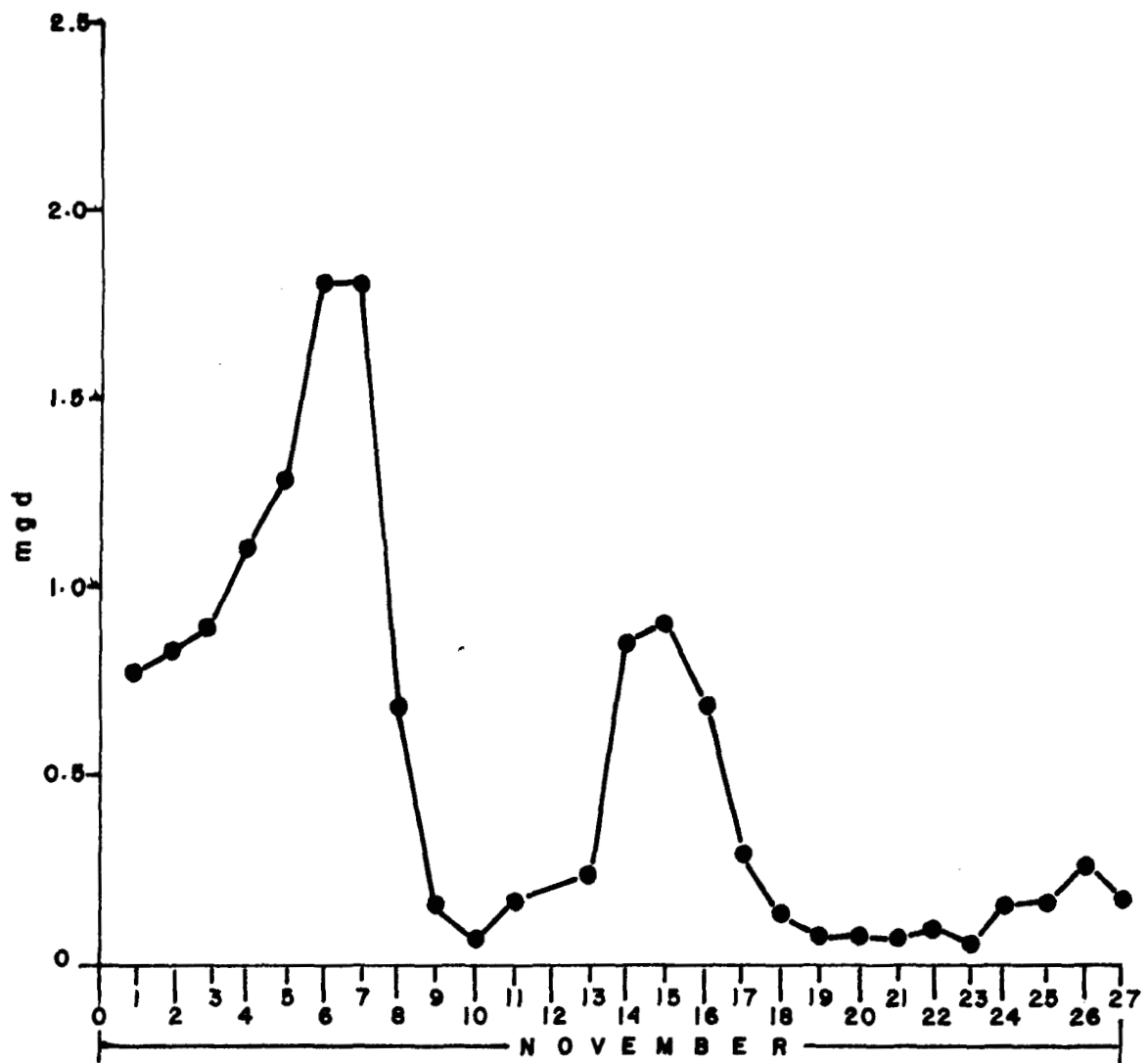


FIGURE 6 WESTVIEW BYPASS ESTIMATE

fecal coliform counts found at the mouth. The village of Sliammon is all sewerred except for a septic tank-absorption field owned by C. Peterson. Seepage from this tile field would not account for a population equivalent of 26.7. Possible explanations for this fecal organism contamination are:

- 1) landwash from the watershed,
- 2) exfiltration on the sewer line crossing the creek,
- 3) backflow of contamination from the sewage outfall into the mouth of the creek.

4.2.2. Unnamed Creek (S3). This creek, which accepts the discharge from the Wildwood Sewage Lagoon, had an average population equivalent of only 2.3. However, the creek had a mean fecal MPN of 936/100 ml and would therefore cause considerable bacterial contamination in the foreshore area adjacent to the mouth. Upstream of the lagoon discharge the stream had a mean fecal MPN of 730/100 ml. This contamination can be explained by the fact that the stream drains a large number of small farms supporting livestock.

4.2.3 Willingdon Creek (S4). Willingdon Creek consists of two branches; the north branch drains Cranberry Lake from the north end while the south branch drains a large low lying area south of Cranberry Lake. The combined flow of Willingdon Creek had a population equivalent of 2.5 based on a single fecal MPN count of 110/100 ml. A sample taken at the point where Cranberry Lake drains into the north branch had a fecal MPN of 31/100 ml. Both branches of Willingdon Creek drain wooded areas before entering Malaspina Strait. In addition, the north branch drains approximately 20 acres of pasture before entering the wooded area.

4.2.4 Unnamed Creek (S6). This creek had an estimated flow of 7.6 CFS during periods of steady rainfall. It is approximately 2 1/2 miles in length, divides into two branches at the upper end and empties into Malaspina Strait near the foot of Hammond Avenue. The source of the creek is a large low-lying wooded area between

Ontario Avenue, Joyce Avenue, Alberni Street and Barnet Street. The mean fecal MPN at the mouth was in excess of 873/100 ml, while the fecal MPN of a sample taken upstream after the creek leaves the wooded area was 140/100 ml. The high counts found at the mouth could be explained by the fact that the creek flows through many private lots before entering Malaspina Strait, and is therefore susceptible to contamination from domestic animal waste.

4.2.5 Alberni Street Storm Drain (S5). This creek originates as a spring 0.5 miles from the shoreline. The creek is open for most of its course except for the last approximate 200 yards. Storm drains connect to the creek at Marine Avenue and Willingdon greatly increasing its flow. A sample taken at the source had a fecal MPN of <2/100 ml, while the mean fecal count at the mouth was in excess of 482/100 ml. The drain passes through many private lots and could be contaminated by animal excreta. The Alberni Street storm drain had an average population equivalent of 0.32. This, therefore, represents an insignificant source of fecal organisms in comparison to other nearby sources.

4.26 Storm Drains (S7, S8, S9). Three small storm drains located at the feet of Nootka, Oliver and Penticton Streets were sampled. These drains, carrying mainly surface water from street ditches, had mean fecal MPN's of 361, 200 and 145 per 100 ml, respectively. However, due to the small volume of water carried by these drains, their population equivalents are insignificant. However, a reconnaissance of the shoreline area revealed the presence of at least 15 additional similar small storm drains between Willingdon Park and Grief Point. Cumulatively these drains could represent a source of fecal bacteria contamination of the immediate shoreline area, since all the drains cross the foreshore before entering Malaspina Strait.

4.3 MacMillan Bloedel Ltd., Powell River Division

Samples taken from the woodroom effluent exhibited a mean fecal MPN of 766/100 ml. With an estimated flow of 10 MGD this

source represents a population equivalent of 10. This source of fecal organisms could be explained by (1) the existence of domestic sewage lines that have not been connected to the Powell River sanitary sewer system and (2) a high fecal coliform concentration in the Powell River Townsite stormwater, which discharges to the receiving waters with the woodroom effluent. A summary of total BOD and SS discharges from the mill appears in Appendix V. Included in this summary is a population equivalent calculation based on BOD.

4.4 Precipitation

A graph of daily precipitation in the Powell River area for October 23 - November 27, 1975 is given in Figure 7. By comparing this graph with flow records for Powell River WPCP, Westview WPCP and the Wildwood Sewage Lagoon (Figures 3, 4 and 5), it can be seen that flows increase dramatically during periods of continuous heavy rainfall. This points to an excessive infiltration/inflow contribution to the sewer line since theoretically, sewage flowrates are independent of rainfall. Total precipitation during the month of November, 1975 was 279.5 mm; this far exceeds the mean total precipitation for November (1941-1970) of 158.2 mm. The weather conditions experienced during this survey therefore represent the worst possible conditions with respect to bacteriological water quality, since during the periods of high flowrates increasing amounts of sewage are bypassed. By comparing fecal coliform data for final effluent and sewage bypass it is noted that final effluent has approximately 10% the fecal coliform content of bypass.

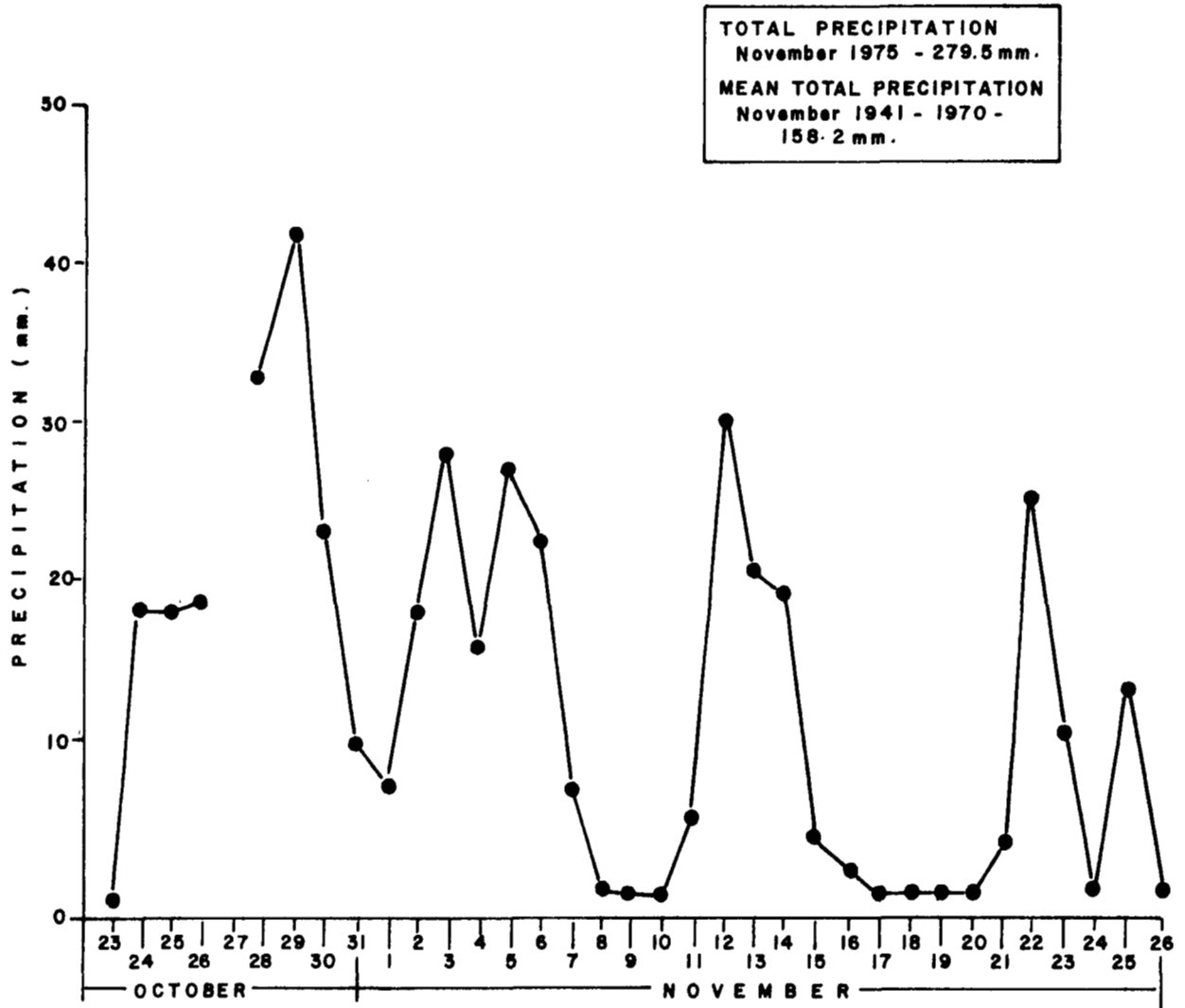


FIGURE 7 TOTAL PRECIPITATION - POWELL RIVER

5 CALCULATIONS

5.1 Flow Determination

5.1.1 Westview WPCP. The Westview WPCP is equipped with a Fischer-Porter Circular Flow Recorder which records instantaneous flow measurements produced by a Parshall flume. This flume measures total incoming sewage flow which includes plant influent flow and sewage bypass. Total flows (Figure 5) are recorded daily by the plant operator. Bypass estimates (Figure 6) were determined using the circular flow recorder charts and estimating the amount exceeding 1.2 MGD, the design flow. The plant flow was established by a manually controlled inlet gate valve. Copies of the Westview WPCP flow records appear in Figure 8, extending from October 31 - November 28, 1975.

5.1.2 Powell River WPCP. A Parshall flume measures the instantaneous flow of raw sewage and storm tank discharge. The flume is connected to a strip chart recorder located in the control building. However, this instrument was not operational at the time of the survey and is scheduled for replacement. Daily plant flow (Figure 4) was determined by taking an average flow level off the Parshall flume. The storm tank overflow rate (Figure 4) was calculated using a formula;

$$Q = 3.33 L h^{3/3} \quad (5)$$

where Q = discharge cfs

L = length of crest of weir

h = head upon crest of weir

which expresses the discharge over a rectangular weir, neglecting velocity of approach. The plant flow level was controlled by a manually set inlet gate valve.

5.1.3 Wildwood Sewage Lagoon. The lagoon effluent discharge flow (Figure 4) was estimated by taking the average height of effluent overflowing a rectangular weir located at the lagoon outlet. The

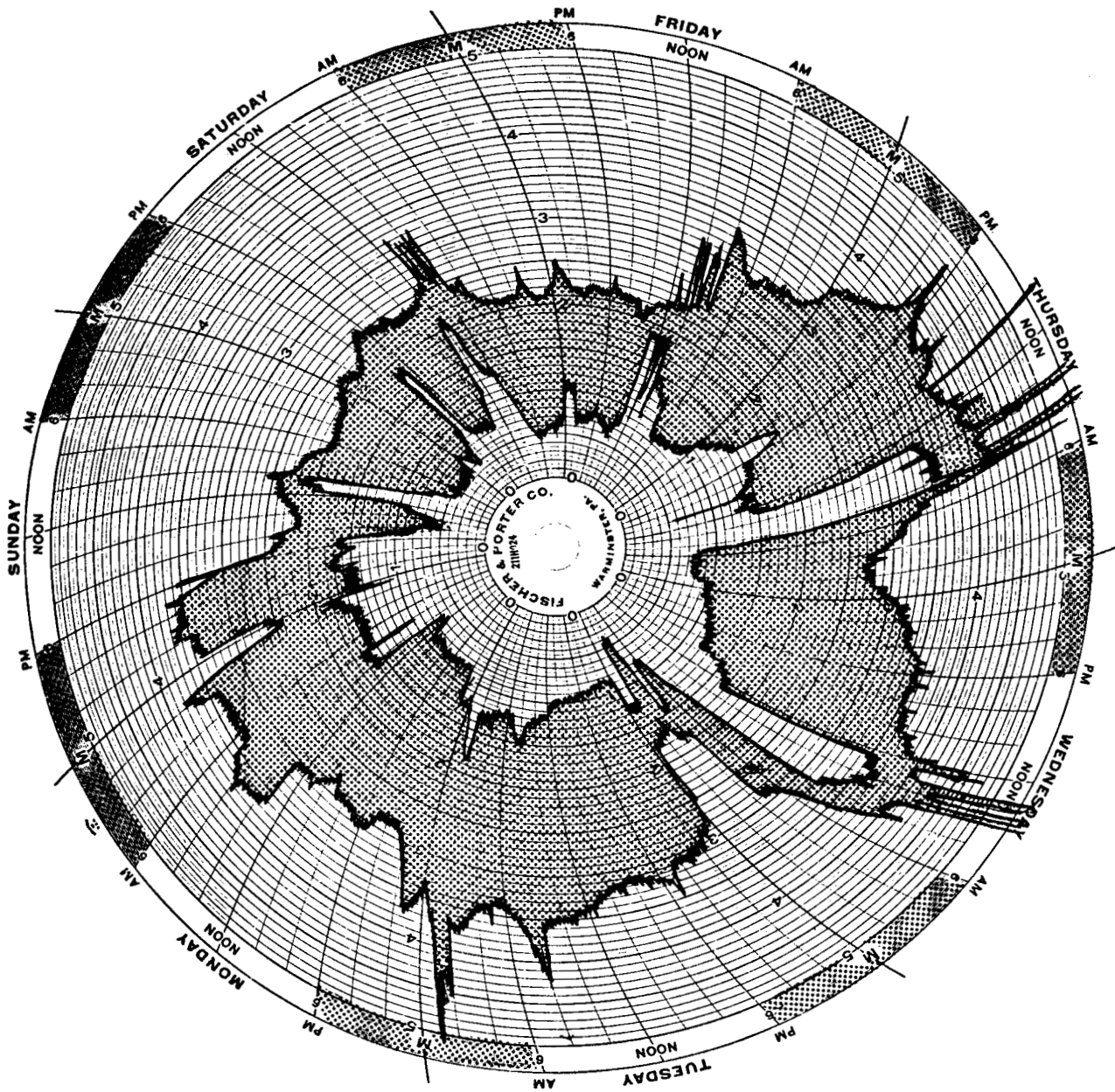


FIGURE 8 WESTVIEW WPCP TOTAL FLOW - OCTOBER 31 - NOV. 7, 1975

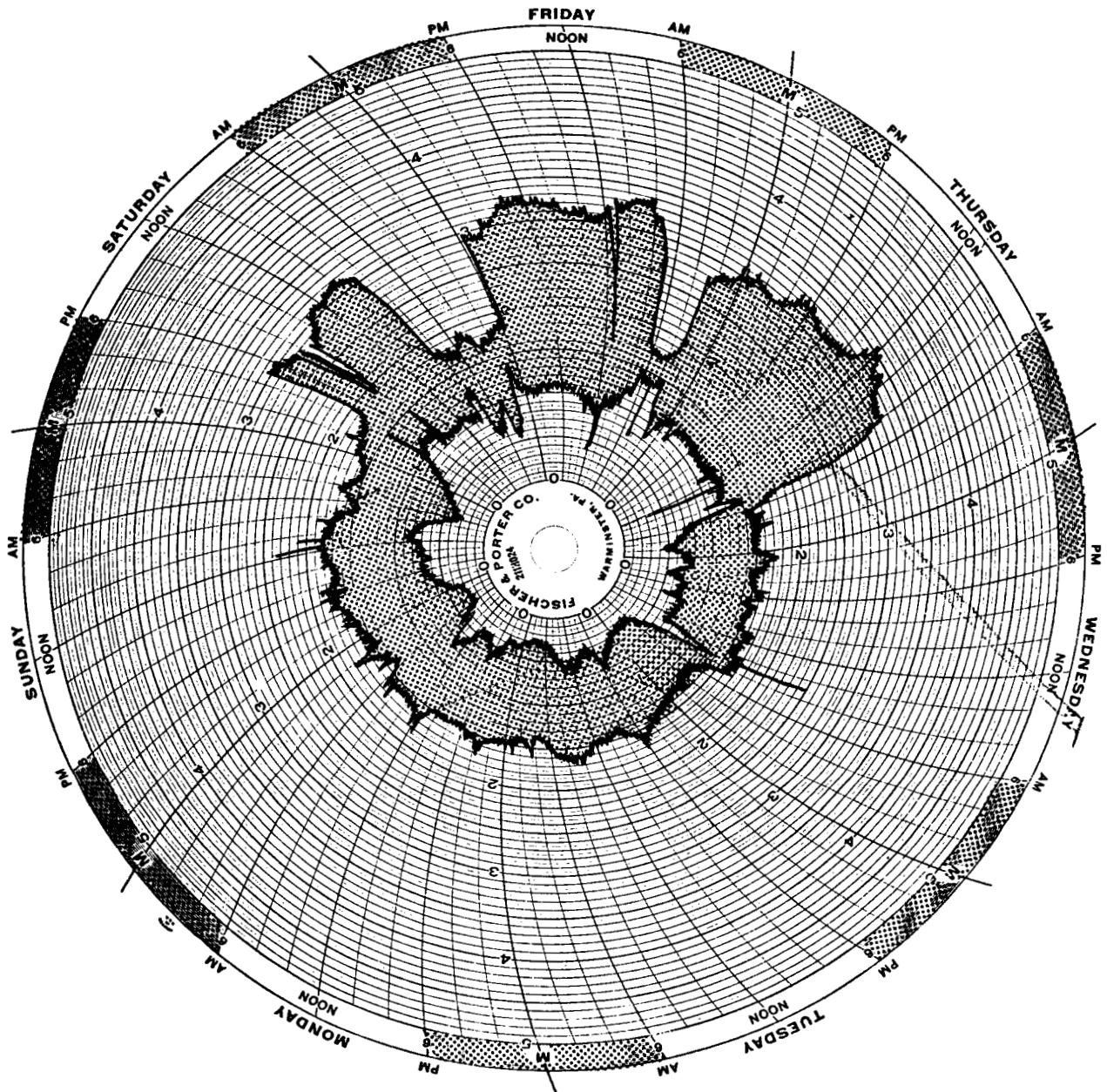


FIGURE 8 WESTVIEW WPCP TOTAL FLOW - NOVEMBER 7-14, 1975

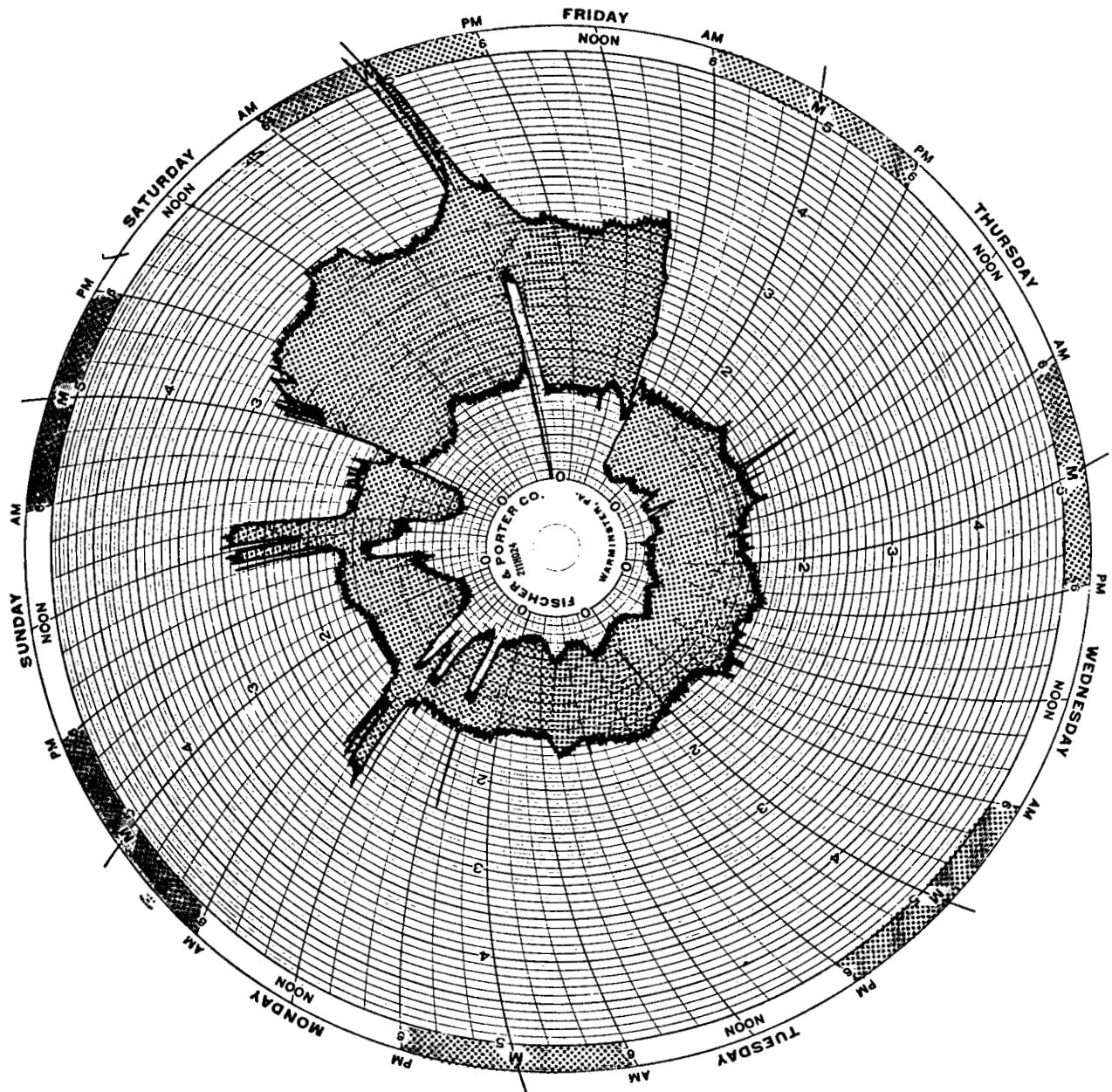


FIGURE 8 WESTVIEW WPCP TOTAL FLOW - NOVEMBER 14-21, 1975

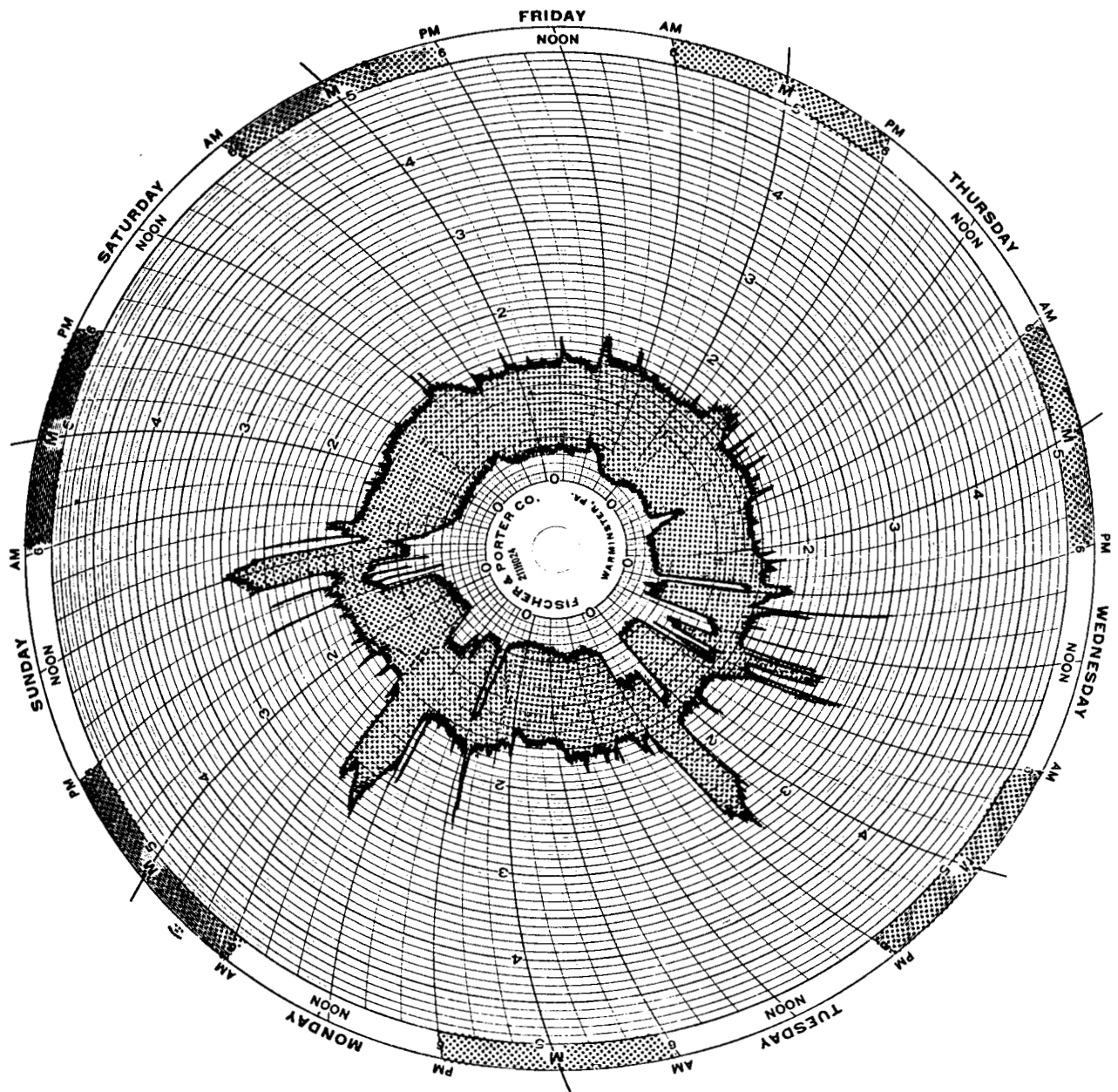


FIGURE 8 WESTVIEW WPCP TOTAL FLOW - NOVEMBER 21-28, 1975

weir formula, given in section 5.1.2, was used in the discharge calculation. Flow estimates of the unnamed creek were determined using an estimated cross-sectional area and an average velocity at a location upstream of the lagoon discharge.

5.1.4 Sliammon STP. The flow recording device at the Sliammon STP was not operational during the survey. Flow estimates were provided by Environmental Protection Service, Federal Activities, Pollution Abatement Group, who estimated the plant flow to be 30,000 GPD during periods of continuous heavy rainfall as experienced during this survey.

5.2 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.*

Hunt and Springer (10) estimate that the fecal coliform content is 20% of the total coliform count. This yields a value of 3.2×10^{10} fecal coliforms/person/day.

Example: Population Equivalent of Westview WPCP Effluent
November 5, 1975

Total Flow = 2.67 MGD

Bypass Estimate = 1.80 MGD

Plant Flow = 0.87 MGD

Fecal Coliform Count = 7×10^4 MPN/100 ml

Population Equivalent = $\frac{\text{No. Fecal Coliforms Discharged per day}}{\text{Standardized Fecal Coliform Value}}$

$$= \frac{0.87 \times 10^6 \times 7 \times 10^4 \times 45.45}{3.2 \times 10^{10}}$$

$$= 86.5$$

* U.S. Public Health Publication No. 33

Therefore, on November 5, 1975 the fecal coliform content of the Westview WPCP effluent was equivalent to the raw sewage contribution of 86.5 people.

Note: Daily flow from the Westview WPCP is taken from the following day's records. Powell River WPCP and Wildwood Sewage Lagoon flows are taken on the day recorded. Average population equivalent figures presented in Appendix IV are calculated using the average fecal coliform concentration of the samples taken and the average daily plant flow.

6 COMMENTS AND RECOMMENDATIONS

6.1 Viruses

The use of fecal coliform organisms as indicators of pollution gives little information on pathogenic viruses. Viruses may survive undetected under conditions that result in the elimination of coliform organisms. As an example, waste stabilization ponds generally reduce coliform concentrations by 99% but do not significantly reduce virus content (6). The average enteric virus density in domestic sewage has been estimated as 600 TCID₅₀^{*}/100 ml during warm months and 30 TCID₅₀/100 ml during cold months. In addition evidence has been presented to suggest that a single TCID₅₀ may be sufficient to infect man if placed in contact with susceptible cells.

A list of the six major enteric virus subgroups is given in Table 1. Enteric viruses survive longer in clean water than in heavily polluted water and survival time is reduced even more in moderately polluted water. With bacteria the opposite is true; the longest survivals occur with the greatest pollution. The survival time of viruses and bacteria lengthen with lowered temperatures; generally a 10⁰ C rise in water temperature doubles the average rate at which viruses are destroyed. Activated sludge sewage treatment generally results in significant virus removal, with the viruses being absorbed to the biological solids. Experiments with coxsackie virus B5 have shown 94% - 99% removal by the activated sludge process (6).

A report by Subrahmanyam (7) points out that digested sludge is almost virus free; this is probably due to the long retention times involved. This then would indicate that waste aerobic sludge from the Powell River WPCP and Westview WPCP does

* Tissue culture infectious dose.

TABLE 1 HUMAN ENTERIC VIRUSES IN WASTEWATER AND ASSOCIATED
DISEASES (6)

| Virus Subgroup | Number of Types | Disease |
|----------------------|--------------------|--|
| Poliovirus | 3 | Paralytic poliomyelitis, aseptic meningitis |
| Coxsackievirus | | |
| Group A | 24 | Herpangina, aseptic meningitis, paralysis |
| Group B | 6 | Pleurodynia (Bornholm disease) aseptic meningitis, acute infantile myocarditis |
| Echovirus | 30 | Aseptic meningitis, rash and fever, diarrhoeal disease, respiratory illnesses |
| Infectious hepatitis | 1 | Infectious hepatitis |
| Reovirus | 3 | Fever, respiratory infections and diarrhoea |
| Adenovirus | 30 | Respiratory and eye infections |

not pose a serious virological hazard. Waste stabilization ponds such as the Wildwood Sewage Lagoon provide little significant viral reduction. However, completion of the chlorination facilities there should reduce the concentration of viruses entering the receiving waters.

The primary health hazard posed by viruses results from the large amount of sewage bypassed by the Westview WPCP and the Powell River WPCP. In the event of an outbreak of viral infection in this area, this bypass would pose a serious health hazard.

6.2 Infiltration/Inflow

By comparing daily precipitation data (Figure 7) with daily plant and bypass flow information (Figures 4, 5, and 6), it is evident that all the sewage treatment systems involved received excessive infiltration/inflow contributions during periods of heavy 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.

Part of the high flows received by the Powell River WPCP can be explained by the fact that some portions of the townsite still have combined storm and sanitary sewers. The Westview sewer system, however, is completely separated into storm and sanitary sewers. Therefore, a survey of the sewer systems involved is required to locate the major sources of infiltration/inflow. The most common techniques available to remedy the situation after the sources of infiltration/inflow have been located are: (8)

- (1) internal or external grouting with chemical sealants,
- (2) manhole grouting,
- (3) replacement, elevating and/or sealing of manhole covers,

- (4) replacement of severely damaged sewer sections,
- (5) insertion of sewer liners, and
- (6) removal or plugging of illegal inflow connections.

Observations made during the survey point towards large inflow contributions (i.e. illegal downspouts, etc.) since plant flows increased dramatically within a short period after heavy rainfall had commenced. Excess sewage hydraulic loadings to the Powell River WPCP and Westview WPCP are bypassed to Malaspina Strait; through the 300' storm outfall in the case of Powell River WPCP and through the 1400' marine outfall in the case of Westview WPCP. These bypasses represent the two largest sources of bacterial pollution to Malaspina Strait and therefore present significant health hazards to the adjacent foreshore areas.

The following suggestions should be considered to reduce bacterial pollution of Malaspina Strait due to excessive infiltration/inflow:

- (1) Powell River Water Pollution Control Plant
 - (i) Extension of storm flow sewage outfall to increase the effects of dilution and die-away on fecal coliform concentrations.
 - (ii) Completion of the separation of storm and sanitary sewers in the Powell River Townsite.
- (2) Westview Water Pollution Control Plant
 - (i) Initiate an infiltration/inflow study to locate major sources.
 - (ii) Upon locating these sources, proceed to remove illegal connections and reduce infiltration through insertion of sewer liners or replacement of damaged sewer sections.

- (iii) Study the flow distribution problem of mixed liquor to the clarifiers so that the plant can be operated above design capacity during periods of high flows.
 - (iv) Consider construction of a surge tank ahead of the Parshall Plume to,
 - (1) smooth out pump surges from the wet well, and
 - (2) equalize diurnal and storm flow to the plant thereby increasing total daily flows.
 - (v) Rearrange the screened grit chamber overflow, so that overflow occurs through a horizontal screen. This would facilitate gross solids removal from the bypass and a self-cleaning mechanism.
- (3) Sliammon Sewage Treatment Plant
- Construction of a sewage bypass should be considered so that hydraulic loadings to the treatment plant can be preset. This would facilitate continued operation of the treatment section and allow effective chlorination of the final effluent. In addition increased operator diligence and training is required to maintain an adequate chlorine residual in the effluent.

6.3 Pumping Stations

The locations of all pumping stations serving the Powell River District Municipality are illustrated in Figure 1.

All stations are provided with overflow devices in case of pump failure or a major power interruption. Each station is connected

to an alarm system and provides approximately four hours of hydraulic retention time before overflow occurs. The operator reported that since installation none of the pumping stations have been out of order long enough for overflow to occur. The pumping station, their locations and overflow facilities are listed below:

- (1) Cariboo Avenue pumping station, located directly east of Grief Point, overflows to a 12" diameter outfall terminating 600' from LWM and 60' below LWM.
- (2) Grief Point pumping station, located at Grief Point, overflows to a 12" diameter outfall terminating 500' from LWM and 50' below LWM.
- (3) Marine Avenue pumping station, located directly north of Grief Point, overflows across the foreshore to Malaspina Strait.
- (4) Westview pumping station, located adjacent to the Westview WPCP, overflows directly to the Westview WPCP 1400' marine outfall.
- (5) Powell River pumping station, located adjacent to the Powell River WPCP, overflows across the foreshore to Malaspina Strait.
- (6) Lindsay Park pumping station, located near the north end of Cranberry Lake, overflows into Cranberry Lake.
- (7) Mowat Bay pumping station, located near the south-eastern extremity of Powell Lake, overflows into Powell Lake.
- (8) Wildwood pumping station, located on Lund Street in Wildwood Heights, overflows down a slope approximately 500 metres in length to Powell Lake.

In the event of overflow occurring, the immediate foreshore areas would receive a high concentration of bacterial pollution, making the area unsafe for any recreational use.

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APPENDICES

APPENDIX I FRESHWATER AND SEWAGE EFFLUENT SAMPLE STATION
LOCATIONS

| Sample Station | Location |
|----------------|--|
| S2 | Mouth of Sliammon Creek |
| Sliammon E | Sliammon Indian Reserve Sewage Treatment Plant Final Effluent |
| 118E | Wildwood Sewage Lagoon Effluent |
| S3 | Mouth of Unnamed Creek south of Gibson's Beach |
| MEW | MacMillan Bloedel Woodroom Effluent |
| 171E | Powell River Sewage Treatment Plant Final Effluent |
| 171BP | Powell River Sewage Treatment Plant Storm Tank Overflow |
| S4 | Mouth of Willingdon Creek |
| S5 | Mouth of Storm Drain foot of Alberni Street |
| 73E | Westview Sewage Treatment Plant Final Effluent |
| 73BP | Westview Sewage Treatment Plant Sewage Bypass |
| S6 | Mouth of Creek foot of Hammond Street |
| S7 | Mouth of Storm Drain foot of Nootka Street |
| S8 | Mouth of Storm Drain foot of Oliver Street |
| S9 | Mouth of Storm Drain foot of Penticton Street |

APPENDIX II

SUMMARY OF BACTERIOLOGICAL RESULTS FROM CREEKS, STORM DRAINS AND PULP MILL
EFFLUENT SAMPLE STATIONS

| Sample Station | Location | Estimated Flow CFS | MGD | Mean Fecal MPN/100 ml | Population Equivalent |
|----------------|-------------------------------------|--------------------|------|-----------------------|-----------------------|
| S2 | Slammon Creek | 500 | 269 | 70 | 26.7 |
| S3 | Unnamed Creek | 3.2 | 1.7 | 936 | 2.3 |
| MEW | MacMillan Bloedel Woodroom Effluent | 18.6 | 10.0 | 706 | 10.0 |
| S4 | Willington Creek | 30 | 16.1 | 110 | 2.5 |
| S5 | Alberni St. Storm | 0.9 | 0.48 | 482 | 0.32 |
| S6 | Unnamed Creek | 7.6 | 4.1 | 456 | 2.66 |
| S7 | Nootka St. Storm | 0.5 | 0.27 | 361 | 0.14 |
| S8 | Oliver St. Storm | 0.5 | 0.27 | 200 | 0.08 |
| S9 | Penticton St. Storm | 0.15 | 0.08 | 145 | 0.02 |

APPENDIX III CHEMICAL AND BACTERIOLOGICAL RESULTS FROM SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 73E Location: Westview Sewage Treatment Plant Effluent

| Date 1975 | Time of Collection | DO mg/l | pH 0-14 | BOD ₅ mg/l | COD mg/l | SS mg/l | Fecal Coliform MPN/100 ml |
|--------------|-----------------------|------------|------------|--------------------------|-------------|------------|------------------------------|
| Nov. 5 | 1400 | n.a. | 7.0 | 19 | 81 | <10 | 7 X 10 ⁴ |
| Nov. 6 | *C 1000 | n.a. | 7.1 | 50 | 150 | 35 | 2.3 X 10 ⁵ |
| Nov. 7 | 800 | n.a. | 7.3 | 21 | 150 | <10 | 8 X 10 ⁴ |
| Nov. 10 | 1500 | 3.7 | 7.9 | 65 | 36 | 45 | - |
| Nov. 11 | 1130 | n.a. | 7.6 | 34 | <20 | - | 1.2 X 10 ⁵ |
| Nov. 12 | 1100 | 3.2 | 6.9 | 29 | 32 | 40 | 3.3 X 10 ⁵ |
| Nov. 13 | 1100 | 3.0 | 6.8 | 19 | 28 | 10 | 1.7 X 10 ⁵ |
| Nov. 14 | 930 | 4.0 | 6.9 | 18 | 12 | 10 | - |
| Nov. 17 | 1500 | n.a. | 6.9 | - | 28 | 10 | - |
| Nov. 18 | 1100 | n.a. | 7.0 | 35 | 44 | 15 | 9 X 10 ⁴ |
| Nov. 19 | 1400 | 3.5 | 7.1 | 47 | 150 | 65 | 2.3 X 10 ⁵ |
| Nov. 20 | 1300 | 2.8 | 6.8 | 23 | 44 | <10 | - |
| Nov. 21 | 915 | 3.0 | 7.0 | 22 | 20 | <10 | - |
| Nov. 24 | 1630 | 3.7 | 7.0 | 113 | - | 84 | - |
| Average | | 3.4 | | 38.0 | 58.1 | 26.5 | 1.65 X 10 ⁵ |

*C - Composite sample

APPENDIX III CHEMICAL AND BACTERIOLOGICAL RESULTS FROM SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 73BP Location: Westview Sewage Treatment Plant Sewage Bypass

| Date 1975 | Time of Collection | DO mg/ℓ | pH 0-14 | BOD ₅ mg/ℓ | COD mg/ℓ | SS mg/ℓ | Fecal Coliform MPN/100 ml |
|--------------|-----------------------|------------|------------|--------------------------|-------------|------------|------------------------------|
| Nov. 5 | 1400 | - | 6.9 | 19 | 120 | 35 | 1.1 X 10 ⁶ |
| Nov. 6 | *C 1000 | - | 6.7 | 42 | 180 | 33 | 2.4 X 10 ⁶ |
| Nov. 7 | 800 | - | 7.4 | 39 | 160 | 45 | 1.7 X 10 ⁶ |
| Nov. 10 | 1500 | - | 7.9 | 23 | 140 | 75 | - |
| Nov. 11 | 1130 | - | 7.7 | 53 | 190 | 160 | 2.4 X 10 ⁶ |
| Nov. 12 | *C 1100 | - | 7.3 | 37 | 120 | 70 | - |
| Nov. 13 | 1100 | - | 7.1 | 38 | 130 | <10 | 1.7 X 10 ⁶ |
| Nov. 14 | 930 | - | 7.1 | 33 | 90 | 50 | - |
| Nov. 17 | 1500 | - | 7.2 | 43 | 84 | 40 | - |
| Nov. 18 | 1100 | - | 7.2 | 50 | 160 | 70 | 7.9 X 10 ⁵ |
| Nov. 19 | 1400 | - | 7.0 | 28 | 32 | <10 | 7.9 X 10 ⁵ |
| Nov. 20 | 1300 | - | 7.2 | 51 | 130 | 65 | - |
| Nov. 21 | 915 | - | 7.3 | 54 | 100 | 75 | - |
| Nov. 24 | 1630 | - | 7.1 | 52 | - | 52 | - |
| Average | | | | 40.1 | 125.8 | 61.8 | 1.67 X 10 ⁶ |

*C Composite sample

APPENDIX III CHEMICAL AND BACTERIOLOGICAL RESULTS FROM SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 171E Location: Powell River Sewage Treatment Plant Effluent

| Date 1975 | Time of Collection | DO mg/l | pH 0-14 | BOD ₅ mg/l | COD mg/l | SS mg/l | Fecal Coliform MPN/100 ml |
|--------------|-----------------------|------------|------------|--------------------------|-------------|------------|------------------------------|
| Nov. 5 | 1430 | n.a. | 7.0 | 30 | 85 | 25 | 4.9 X 10 ⁵ |
| Nov. 6 | 1030 | n.a. | 6.9 | 20 | 35 | 20 | 3.3 X 10 ⁵ |
| Nov. 7 | 830 | n.a. | 7.2 | 8 | 85 | 20 | 8 X 10 ⁴ |
| Nov. 10 | 1430 | 7.1 | 7.6 | 60 | 45 | 30 | - |
| Nov. 11 | 1100 | n.a. | 7.5 | 50 | <20 | 10 | 2.3 X 10 ⁵ |
| Nov. 12 | 1030 | 7.1 | 6.9 | 24 | 40 | 30 | - |
| Nov. 13 | 1030 | 5.7 | 6.8 | 32 | 32 | 15 | 8 X 10 ⁴ |
| Nov. 14 | 900 | 5.7 | 7.1 | 20 | 32 | 10 | - |
| Nov. 17 | 1445 | n.a. | 7.0 | 49 | 98 | 25 | - |
| Nov. 18 | 1130 | n.a. | 6.9 | 26 | 59 | 15 | 2.2 X 10 ⁵ |
| Nov. 19 | 1030 | 5.9 | 7.2 | 20 | 43 | <10 | 3.3 X 10 ⁵ |
| Nov. 20 | 1130 | 5.3 | 7.0 | 32 | 48 | 15 | - |
| Nov. 21 | 900 | 5.0 | 7.5 | 21 | 24 | 10 | - |
| Nov. 24 | 1530 | 7.0 | 7.0 | 45 | - | 24 | - |
| Average | | 6.1 | | 31.2 | 49.7 | 18.5 | 2.51 X 10 ⁵ |

APPENDIX III CHEMICAL AND BACTERIOLOGICAL RESULTS FROM SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 171BP Location: Powell River Storm Tank Overflow

| Date 1975 | Time of Collection | DO mg/l | pH 0-14 | BOD ₅ mg/l | COD mg/l | SS mg/l | Fecal Coliform MPN/100 ml |
|--------------|-----------------------|------------|------------|--------------------------|-------------|------------|------------------------------|
| Nov. 5 | 1430 | - | 7.1 | 15 | 96 | 15 | 1.1×10^6 |
| Nov. 6 | 1030 | - | 7.4 | 6 | 62 | 35 | - |
| Nov. 7 | 830 | - | 7.5 | 10 | 31 | 10 | 4.9×10^5 |
| Nov. 10 | 1430 | - | 7.8 | - | 76 | - | - |
| Nov. 11 | 1100 | - | 7.6 | 15 | 36 | 11 | 2.4×10^6 |
| Nov. 12 | 1030 | - | 7.1 | 8 | 40 | 30 | - |
| Nov. 13 | 1030 | - | 6.9 | 5 | 12 | 30 | 1.7×10^6 |
| Nov. 14 | 900 | - | 7.1 | 5 | 16 | 15 | - |
| Nov. 17 | - | - | - | - | - | - | - |
| Nov. 18 | - | - | - | - | - | - | - |
| Nov. 19 | - | - | - | - | - | - | 1.7×10^6 |
| Nov. 24 | - | - | - | - | - | - | - |
| Average | | | | 9.1 | 46.1 | 20.9 | 1.48×10^6 |

APPENDIX III CHEMICAL AND BACTERIOLOGICAL RESULTS FROM SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 118E Location: Wildwood Lagoon Effluent

| Date 1975 | Time of Collection | DO mg/l | pH 0-14 | BOD5 mg/l | COD mg/l | SS mg/l | Fecal Coliform MPN/100 ml |
|--------------|-----------------------|------------|------------|--------------|-------------|------------|------------------------------|
| Nov. 6 | 1130 | n.a. | 7.6 | 13 | 115 | 35 | 2.4×10^4 |
| Nov. 7 | 900 | n.a. | 7.5 | 10 | 100 | 40 | 2.0×10^4 |
| Nov. 10 | 1400 | 10.8 | 7.9 | 15 | <20 | 65 | - |
| Nov. 11 | 930 | n.a. | 7.7 | 15 | 89 | 55 | 8×10^4 |
| Nov. 13 | 900 | 10.0 | 7.2 | 7 | 80 | 65 | 2×10^4 |
| Nov. 14 | *C 830 | 9.3 | 7.3 | 9 | 72 | 40 | - |
| Nov. 17 | 1430 | 6.7 | 7.2 | 4 | 120 | 80 | - |
| Nov. 18 | 930 | 7.8 | 7.1 | 16 | 130 | 50 | 7×10^4 |
| Nov. 19 | 930 | 7.5 | 7.4 | 10 | 100 | 45 | $<2 \times 10^4$ |
| Nov. 20 | 1100 | n.a. | 7.3 | 13 | 88 | 40 | - |
| Nov. 21 | 900 | n.a. | 7.4 | 15 | 110 | 50 | - |
| Nov. 24 | 1430 | 7.2 | 7.3 | 17 | - | 48 | - |
| Average | | 8.5 | | 12 | 93 | 51 | 4.3×10^4 |

*C Composite sample

APPENDIX III CHEMICAL AND BACTERIOLOGICAL RESULTS FROM SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: Sliammon E Location: Sliammon Sewage Treatment Plant Effluent

| Date 1975 | Time of Collection | pH 0-14 | BOD ₅ mg/ℓ | COD mg/ℓ | SS mg/ℓ | Fecal Coliform MPN/100 ml | Residual Chlorine ppm |
|--------------|-----------------------|------------|--------------------------|-------------|------------|------------------------------|-----------------------------|
| Nov. 11 | 1030 | 7.8 | 20 | 130 | <40 | 1600 | - |
| Nov. 12 | 930 | 7.4 | - | - | - | 1.1 X 10 ⁵ | <0.1 |
| Nov. 13 | 930 | 7.1 | 29 | 100 | 45 | 4.6 X 10 ⁵ | - |
| Nov. 14 | 845 | 7.4 | 29 | 100 | 45 | - | - |
| Nov. 17 | *C 1400 | 7.3 | 21 | 110 | 25 | - | 5.5 |
| Nov. 18 | 900 | 7.1 | 48 | 150 | 85 | >1.6 X 10 ⁵ | <0.1 |
| Nov. 19 | 915 | 7.1 | 31 | 120 | 45 | 1.7 X 10 ⁶ | <0.1 |
| Nov. 20 | 930 | 7.0 | 76 | 200 | 60 | - | <0.1 |
| Nov. 24 | 1400 | 7.1 | 78 | - | 90 | - | - |
| Average | | | 41.5 | 130 | 54.3 | 4.9 X 10 ⁵ | |

*C Composite sample

APPENDIX IV POPULATION EQUIVALENTS AND LOADINGS FOR SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 73E Location: Westview Sewage Treatment Plant Effluent

| Date 1975 | Discharge MGD | Precipitation mm | BOD Loading lb/day | Solids Loading lb/day | Population Equivalent |
|--------------|------------------|---------------------|--------------------------|-----------------------------|--------------------------|
| Nov. 5 | 0.87 | 26.4 | 165 | 87 | 86 |
| Nov. 6 | 1.19 | 22.1 | 595 | 417 | 428 |
| Nov. 7 | 0.93 | 6.4 | 191 | 93 | 106 |
| Nov. 10 | 1.07 | Nil | 696 | 482 | - |
| Nov. 11 | 0.98 | 4.8 | 328 | - | 167 |
| Nov. 12 | 1.16 | 29.7 | 336 | 464 | 544 |
| Nov. 13 | 1.32 | 20.1 | 244 | 132 | 319 |
| Nov. 14 | 0.90 | 18.3 | 158 | 90 | - |
| Nov. 17 | 1.03 | Nil | - | 103 | - |
| Nov. 18 | 0.93 | Nil | 321 | 140 | 119 |
| Nov. 19 | 0.87 | Nil | 405 | 566 | 284 |
| Nov. 20 | 0.80 | Nil | 184 | 80 | - |
| Nov. 21 | 0.93 | 3.0 | 205 | 93 | - |
| Nov. 24 | 1.04 | Nil | 1175 | 874 | - |
| Average | 1.00 | | 359 | 278 | 234 |

APPENDIX IV POPULATION EQUIVALENTS AND LOADINGS FOR SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 73BP Location: Westview Sewage Treatment Plant Sewage Bypass

| Date 1975 | Discharge MGD | Precipitation mm | BOD Loading lb/day | Solids Loading lb/day | Population Equivalent |
|--------------|------------------|---------------------|--------------------------|-----------------------------|--------------------------|
| Nov. 5 | 1.8 | 26.4 | 333 | 630 | 2813 |
| Nov. 6 | 1.8 | 22.1 | 756 | 594 | 6136 |
| Nov. 7 | 0.68 | 6.4 | 265 | 306 | 1642 |
| Nov. 10 | 0.07 | Nil | 16 | 53 | - |
| Nov. 11 | 0.16 | 4.8 | 85 | 256 | 546 |
| Nov. 12 | 0.23 | 29.7 | 84 | 161 | - |
| Nov. 13 | 0.85 | 20.1 | 319 | 85 | 2053 |
| Nov. 14 | 0.90 | 18.3 | 297 | 450 | - |
| Nov. 17 | 0.13 | Nil | 54 | 50 | - |
| Nov. 18 | 0.07 | Nil | 34 | 47 | 75 |
| Nov. 19 | 0.07 | Nil | 19 | 7 | 75 |
| Nov. 20 | 0.06 | Nil | 31 | 39 | - |
| Nov. 21 | 0.09 | 3.0 | 48 | 68 | - |
| Nov. 24 | 0.15 | Nil | 78 | 78 | - |
| Average | 0.50 | | 173 | 202 | 1101 |

APPENDIX IV POPULATION EQUIVALENTS AND LOADINGS FOR SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 171E Location: Powell River Sewage Treatment Plant Effluent

| Date 1975 | Discharge MGD | Precipitation mm | BOD Loading lb/day | Solids Loading lb/day | Population Equivalent |
|--------------|------------------|---------------------|--------------------------|-----------------------------|--------------------------|
| Nov. 5 | 1.05 | 26.4 | 315 | 263 | 731 |
| Nov. 6 | 1.08 | 22.1 | 216 | 216 | 506 |
| Nov. 7 | 0.96 | 6.4 | 77 | 192 | 109 |
| Nov. 10 | 0.86 | Nil | 516 | 258 | - |
| Nov. 11 | 0.86 | 4.8 | 430 | 86 | 281 |
| Nov. 12 | 0.88 | 29.7 | 207 | 264 | - |
| Nov. 13 | 0.86 | 20.1 | 275 | 129 | 98 |
| Nov. 14 | 0.84 | 18.3 | 168 | 84 | - |
| Nov. 17 | 0.94 | Nil | 461 | 235 | - |
| Nov. 18 | 0.98 | Nil | 255 | 147 | 306 |
| Nov. 19 | 0.96 | Nil | 196 | 96 | 450 |
| Nov. 20 | 1.10 | Nil | 352 | 165 | - |
| Nov. 21 | 1.10 | 3.0 | 231 | 110 | - |
| Nov. 24 | 1.10 | Nil | 495 | 264 | - |
| Average | 0.97 | | 300 | 179 | 346 |

APPENDIX IV POPULATION EQUIVALENTS AND LOADINGS FOR SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 171BP Location: Powell River Storm Tank Overflow

| Date 1975 | Discharge MGD | Precipitation mm | BOD Loading lb/day | Solids Loading lb/day | Population Equivalent |
|--------------|------------------|---------------------|--------------------------|-----------------------------|--------------------------|
| Nov. 5 | 1.50 | 26.4 | 261 | 270 | 2342 |
| Nov. 6 | 1.81 | 22.1 | 119 | 760 | - |
| Nov. 7 | 0.42 | 6.4 | 50 | 50 | 290 |
| Nov. 10 | 0.07 | Nil | - | - | - |
| Nov. 11 | 0.16 | 4.8 | 29 | 21 | 551 |
| Nov. 12 | 0.64 | 29.7 | 58 | 231 | - |
| Nov. 13 | 1.29 | 20.1 | 78 | 465 | 3117 |
| Nov. 14 | 0.83 | 18.3 | 50 | 150 | - |
| Nov. 17 | 0.04 | Nil | - | - | - |
| Nov. 18 | 0.04 | Nil | - | - | - |
| Nov. 19 | 0.04 | Nil | - | - | 101 |
| Nov. 24 | 0.08 | Nil | - | - | - |
| Average | 0.64 | | 92 | 278 | 1346 |

APPENDIX IV POPULATION EQUIVALENTS AND LOADINGS FOR SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: 118E Location: Wildwood Lagoon Effluent

| Date 1975 | Discharge GPD X1000 | Precipitation mm | BOD Loading lb/day | Solids Loading lb/day | Population Equivalent |
|--------------|---------------------------|---------------------|--------------------------|-----------------------------|--------------------------|
| Nov. 6 | 210 | 22.1 | 31 | 88 | 7.1 |
| Nov. 7 | 210 | 6.4 | 25 | 100 | 5.9 |
| Nov. 10 | 100 | Nil | 15 | 65 | - |
| Nov. 11 | 127 | 4.8 | 19 | 70 | 12.0 |
| Nov. 13 | 366 | 20.1 | 29 | 285 | 10.4 |
| Nov. 14 | 299 | 18.3 | 31 | 144 | - |
| Nov. 17 | 181 | Nil | 9 | 174 | - |
| Nov. 18 | 141 | Nil | 27 | 85 | 14.1 |
| Nov. 19 | 141 | Nil | 17 | 77 | 4.0 |
| Nov. 20 | 138 | Nil | 21 | 64 | - |
| Nov. 21 | 105 | 3.0 | 19 | 64 | - |
| Nov. 24 | 83 | Nil | 17 | 48 | - |
| Average | 175 | | 22 | 105 | 9.7 |

APPENDIX IV POPULATION EQUIVALENTS AND LOADINGS FOR SEWAGE TREATMENT SAMPLE STATIONS

Sample Station: Sliammon E Location: Sliammon Sewage Treatment Plant Effluent

| Date 1975 | Discharge GPD X1000 | Precipitation mm | BOD Loading lb/day | Solids Loading lb/day | Population Equivalent |
|--------------|---------------------------|---------------------|--------------------------|-----------------------------|--------------------------|
| Nov. 11 | *30 | 4.8 | 6.0 | 12.0 | 0.07 |
| Nov. 12 | - | 29.7 | - | - | 4.7 |
| Nov. 13 | - | 20.1 | 8.7 | 13.5 | 19.6 |
| Nov. 14 | - | 17.8 | 8.9 | 13.5 | - |
| Nov. 17 | - | Nil | 6.3 | 7.5 | - |
| Nov. 18 | - | Nil | 14.4 | 25.5 | 6.8 |
| Nov. 19 | - | Nil | 9.3 | 13.5 | 72.4 |
| Nov. 20 | - | Nil | 22.8 | 18.0 | - |
| Nov. 24 | - | Nil | 23.5 | 27.0 | - |
| Average | 30 | | 12.5 | 16.3 | 20.7 |

*Estimate

APPENDIX V MACMILLIAN BLOEDEL LTD. PULP AND PAPER MILL;
SUMMARY OF DAILY DISCHARGES

| Month | Total Flow MGD | SS TPD | BOD ₅ TPD | Production Cunits | ¹ Population Equivalent X1000 |
|---------|-------------------|-----------|-------------------------|----------------------|--|
| Jan. | 73.8 | 70.9 | 28.3 | 3672 | 283 |
| Feb. | 72.2 | 67.5 | 25.5 | 3491 | 255 |
| Mar. | 71.9 | 70.8 | 35.4 | 3694 | 354 |
| April | 72.3 | 66.7 | 36.5 | 3612 | 365 |
| May | 62.0 | 70.3 | 35.5 | 3407 | 355 |
| June | 61.3 | 69.6 | 37.2 | 3522 | 372 |
| July | 73.9 | 69.5 | 32.1 | 3613 | 321 |
| Oct. | 73.9 | 72.3 | ² n.a. | 3488 | ² n.a. |
| Nov. | 73.0 | 69.2 | 35.6 | 3450 | 356 |
| Average | 70.5 | 69.6 | 33.2 | 3550 | 332 |

¹Population equivalent based on contribution of 0.2 lb BOD₅/person/day.

²n.a. Not available.