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A Preliminary Total Residual Chlorine Study of Selected Sewage Treatment Facilities in B.C., 1975

Surveillance Report
EPS 5-PR-77-4

Pacific Region
February 1977

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A PRELIMINARY TOTAL RESIDUAL CHLORINE
STUDY OF SELECTED SEWAGE TREATMENT
FACILITIES IN B.C., 1975

by
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Pollution Abatement Branch
Environmental Protection Service
Pacific Region

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ABSTRACT

The final effluents from 11 sewage treatment facilities in the province of British Columbia have been analyzed to determine the levels of total residual chlorine (TRC) being discharged in sewage effluent.

The results of this study show that out of the 11 sewage treatment facilities studied, five were found to exceed the 1.0 mg/l level in more than 40% of the samples. Nine were found to exceed the 0.02 mg/l level in 50% of the samples, and four were found to exceed the 0.02 mg/l level in at least 90% of the samples. At two sites, TRC levels of 0.17 mg/l (15 metres downstream) and 0.41 mg/l (25 metres downstream) were found in the receiving waters.

RESUME

Les effluents terminaux de 11 usines d'épuration en Colombie-Britannique ont fait l'objet d'analyses pour déterminer les niveaux de résidus totaux de chlore (RTC) contenus dans les effluents d'eaux usées.

Les résultats ont établi que, des 11 usines contrôlées cinq avaient un niveau supérieur à 1.0 mg/l dans plus de 40 p.100 des échantillons, que neuf avaient un niveau supérieur à 0.02 mg/l dans 50 p. 100 des prélèvements et que quatre dépassaient ce dernier niveau dans 90 p. 100 au moins des échantillons. En deux points de déversement, le niveau du RTC, mesuré dans les eaux réceptrices, a atteint respectivement 0.17 mg/l à 15 m en aval et 0.41 mg/l à 25 m en aval de la bouche.

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CONCLUSIONS

Based on the data contained in this report, the following conclusions can be made:

1. Chlorine Addition System

The variation in the results obtained show that most of the sewage treatment facilities studied do not adequately control the TRC levels in the sewage effluent. Specifically, the flow-proportional method of controlling chlorine addition is not sensitive enough to maintain a set TRC level. As a result, the graphs generally show that the chlorine dosage does not fluctuate proportionally with changing flows. In addition, most of the chlorine addition systems do not compensate for changes in the organic loading of the sewage effluent.

2. TRC Monitoring Procedure

In general, the operators use some variation of the orthotolidine method which is considered unreliable in providing accurate TRC data. In addition, most of the sewage treatment facilities studied did not have an adequate schedule for monitoring TRC in the sewage effluent.

3. TRC Levels in Receiving Waters

The limited receiving water data obtained indicates that TRC can be detected in the vicinity of chlorinated sewage outfalls, and should be further assessed to determine the impact on the receiving waters.

1 INTRODUCTION

Toxicity of TRC to Fish

Much concern has been expressed regarding the effects of chlorinated sewage effluent on fresh water systems and the fish frequenting these water systems. Extensive research carried out by Servizi (1974), has indicated that TRC levels as low as 0.02 mg/l, in sewage effluent⁽²⁾, are toxic to some species of fish, e.g., sockeye salmon (Oncorhynchus nerka), and pink salmon (O. gorbuscha). Since the concentrations of TRC are so critical, it is most important to use an adequately sensitive analytical method, when monitoring TRC levels in sewage effluent.

Orthotolidine Method vs. Amperometric Titration Method

The most popular method used by municipalities for monitoring TRC is the orthotolidine method (in the form of colorimetric test kits). This method, which suffers from several interferences such as colour and turbidity, is not adequate in providing meaningful analytical results. Accuracy varies with several factors such as sample interferences and range of comparator used. Studies have indicated that in a sample having 1.83 mg/l TRC, the orthotolidine method has a relative error of 41.4% TRC versus 8.8% with the amperometric titration method.⁽⁴⁾ Other studies have shown that the amperometric titration method gives the most accurate results, because of its freedom from interferences (detection limit is 0.02 mg/l with ± 0.02 mg/l accuracy),⁽²⁾ and adaptability to field conditions.

TRC Study Conducted by EPS

During the summer of 1975, the Environmental Protection Service conducted a study to determine the levels of TRC, in sewage effluent, being discharged by selected sewage treatment facilities in British Columbia. This study consisted of hourly monitoring of TRC in the final effluent, using the amperometric titration method. Periodic sampling of the receiving waters above and below the dis-

charges was done where feasible. In addition, bacteriological samples were taken before and after chlorination to give an indication of the effectiveness of disinfection.

Study Area

Through consultation with the Provincial Pollution Control Branch, the B.C. Fish and Wildlife Branch, and the Fisheries Service, a list of typical sewage treatment facilities was compiled. The list comprised the following sites:

North Cowichan, Duncan, Kelowna, Oliver, Penticton, Prince George, Smithers, Squamish-Central, Squamish-Mamquam, Vernon and Westbank.

2 SAMPLING PROGRAMME

2.1 Effluent Sampling

The sampling period for each site consisted of four consecutive days, from Sunday to Wednesday. Samples were collected and analyzed for TRC once every hour, from about 0800 hours to 1600 hours, as well as during one 24 hour period. Flow data was recorded later where available from the municipalities.

2.2 Receiving Water Sampling

Where possible, at those sites where the effluent was being discharged into a creek or river, the receiving water was sampled and analyzed for TRC. The frequency and extent of this sampling changed from site to site.

2.3 Bacteriological Sampling

Twice at each site, pre-chlorination and post-chlorination bacteriological samples were collected, then shipped to Vancouver for analysis.

3 MATERIALS AND METHODS

3.1 Effluent Sampling

The final effluent samples were taken as hourly grab samples, using a one-litre polyethylene bottle. When sampling from manholes, a polyethylene bucket with nylon rope was used. Samples were collected as close to the outfall as possible.

Receiving Water Sampling

The receiving water samples were taken using separate rinsed bottles or, where necessary, a rinsed bucket with rope. Bottle sampling, for outfalls near the shore, was done facing upstream, in line with the outfall. Bucket sampling, for outfalls farther away from the shore, was done by tossing the bucket into the receiving water, in line with the outfall.

Bacteriological Sampling

The pre-chlorination and post-chlorination bacteriological samples were taken twice at each facility from the treated effluent, before and after chlorination, respectively. However, at some facilities, the sampling sites were shifted to obtain better representative samples.

The sample containers used were 125 ml sterile glass jars with metal lids and aluminum foil protective hoods. Post-chlorination sampling jars were pre-treated with a 10% sodium thiosulphate solution to neutralize any residual chlorine, and to prevent further bactericidal action of the chlorine. The jars were filled to the neck-line, sealed, and refrigerated (Standard Methods for the Examination of Water and Wastewater, 13th Ed., pp. 657-660).⁽¹⁾ Samples were shipped in ice, at a temperature not exceeding 10°C, and received at the Vancouver laboratory within 6 hours of collection.

Some of the facilities sampled apply chlorination to the raw sewage before treatment (pre-treatment chlorination), as well as after treatment (post-treatment chlorination). In these cases, the samples were taken before (pre-chlorination) and after (post-chlorination) the final chlorination. These plants are described in the Appendix.

3.3 TRC Analysis

Determination of TRC was done using the Wallace and Tiernan Amperometric Titrator Series A-790013. This procedure is a Back-Titration method involving the neutralization of an oxidizing agent (free iodine) with a reducing agent (phenylarsene oxide solution) of known strength, in the presence of potassium iodide. The pH is strictly maintained between 3.5 and 4.5 to eliminate interferences. Below 3.5 results in interference from manganese. Above 4.5 prevents di-chloramine from giving a rapid and quantitative release of iodine from potassium iodide. Results are expressed as mg/litre Cl. The detection limit is 0.02 mg/l (Standard Methods for the Examination of Water and Wastewater, 13th Ed., pp. 112-116).⁽¹⁾

3.4 Bacteriological Analysis

Determination of total confirmed coliforms (MPN/100ℓ) was made using the multiple tube fermentation technique (at least three decimal dilution of five tubes each).⁽¹⁾ The media used was Bacto-lauryl Tryptose Broth and Brilliant Green Bile (2%) Broth.

Determination of fecal coliforms (MPN/100 ml) was made as described in Part 407C.⁽¹⁾ Incubation was 24 ± 2 hours in a circulating water bath at $44.5 \pm 0.2^{\circ}\text{C}$. The media used was Bacto-EC medium.

4 SELECTED SEWAGE TREATMENT FACILITIES

4.1 District of North Cowichan Sewage Lagoons

4.1.1 Sampling Sites. See Figure 1 for locations of the sampling sites.

Effluent sampling. The effluent samples were taken from an overflowing manhole located about 4.5 metres (15 feet) from a tributary ("Fish-Gut Alley") of Somenos Creek, and about 60 metres (200 ft.) from the chlorine contact pond. Normally, the submerged outfall empties into the Cowichan River about 335 metres (1,100 feet) from the lagoons. However, during the sampling period, the discharge pipe was plugged.

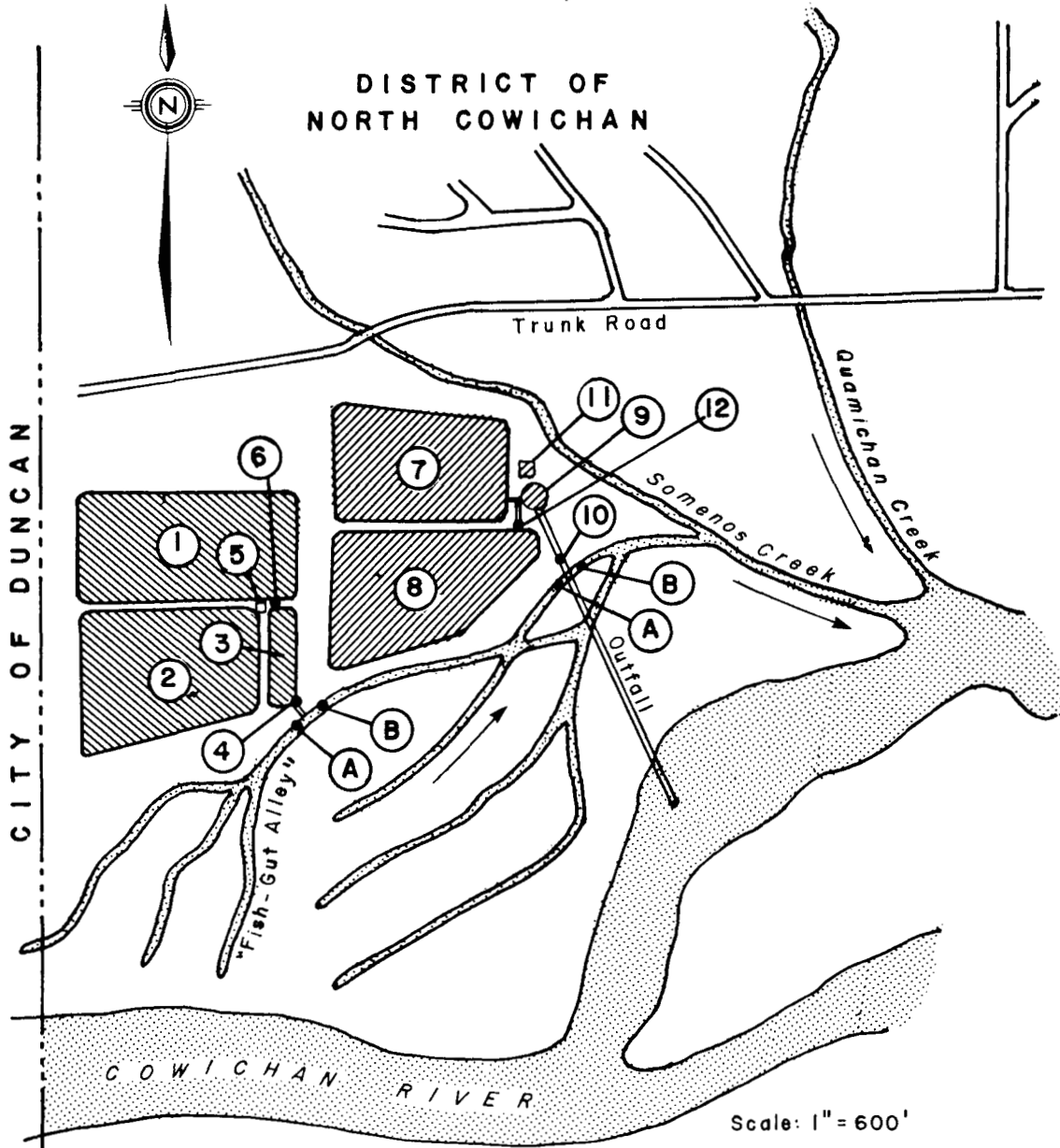
Receiving water sampling. The receiving water samples were taken above and below the confluence of the overflow and "Fish-Gut Alley".

Bacteriological samples. The pre-chlorination bacteriological samples were taken from a weir between Lagoon B and the chlorinator. Lagoon A closed off to chlorination but emptied into Lagoon B.

The post-chlorination bacteriological samples were taken from the overflow.

4.1.2 Sample Results

Effluent sample results. The effluent sample results are presented in Table 1, and illustrated in Figure 2. See Appendix A for further chlorination data.



LEGEND

DUNCAN

- 1 Polishing Cell
- 2 Aerated Lagoon
- 3 Chlorination Cell
- 4 Outfall to Ditch (Effluent and Post-Chlorination Sampling Site)
- 5 Chlorinator
- 6 Pre-Chlorination Sampling Site

NORTH COWICHAN

- 7 Aerated Lagoon A
- 8 Aerated Lagoon B
- 9 Chlorine Contact Pond
- 10 Manhole Overflow (Effluent and Post-Chlorination Sampling Site)
- 11 Chlorinator
- 12 Pre-Chlorination Sampling Site

RECEIVING WATER SAMPLING SITES

- A Before Discharge
- B After Discharge

FIGURE 1 SAMPLING SITES AT THE NORTH COWICHAN AND DUNCAN SEWAGE LAGOONS

TABLE 1 DISTRICT OF NORTH COWICHAN SEWAGE LAGOONS:
EFFLUENT SAMPLE RESULTS

Date (1975)	Time (Hours)	T.R.C. (mg/ℓ)	Date (1975)	Time (Hours)	T.R.C. (mg/ℓ)
July 20	0800	0.22	July 22	0100	0.39
	0900	N/D*		0200	0.49
	1000	N/D		0300	0.44
	1100	N/D		0400	0.29
	1200	N/D		0500	0.32
	1300	N/D		0600	0.55
	1400	N/D		0700	0.60
	1500	N/D		0800	0.44
1600	N/D	0900		0.11	
July 21	0800	N/D		1000	0.46
	0900	N/D	1100	0.26	
	1000	N/D	1200	0.19	
	1100	N/D	1300	N/D	
	1200	N/D	1400	0.39	
	1300	N/D	1500	0.24	
	1400	N/D	1600	0.11	
	1500	N/D	July 23	0800	0.63
	1600	0.30		0900	0.51
	1700	0.47		1000	0.39
	1800	0.49		1100	0.28
	1900	N/D		1200	0.18
	2000	N/D		1300	0.18
	2100	0.44		1400	0.03
	2200	0.39		1500	N/D
2300	0.55	1600	0.03		
2400	0.44				

*Not detectable.

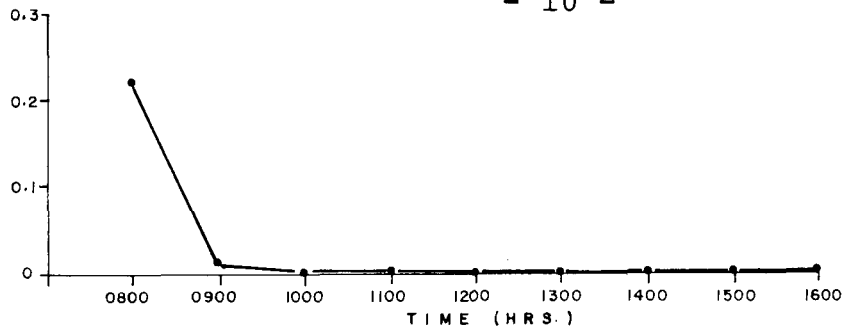
Note: Flows were not recorded by the municipality.

Receiving water sample results. Non-detectable values were determined at the confluence of "Fish-Gut Alley" and the overflow, as well as 8 and 15 metres downstream from the confluence.

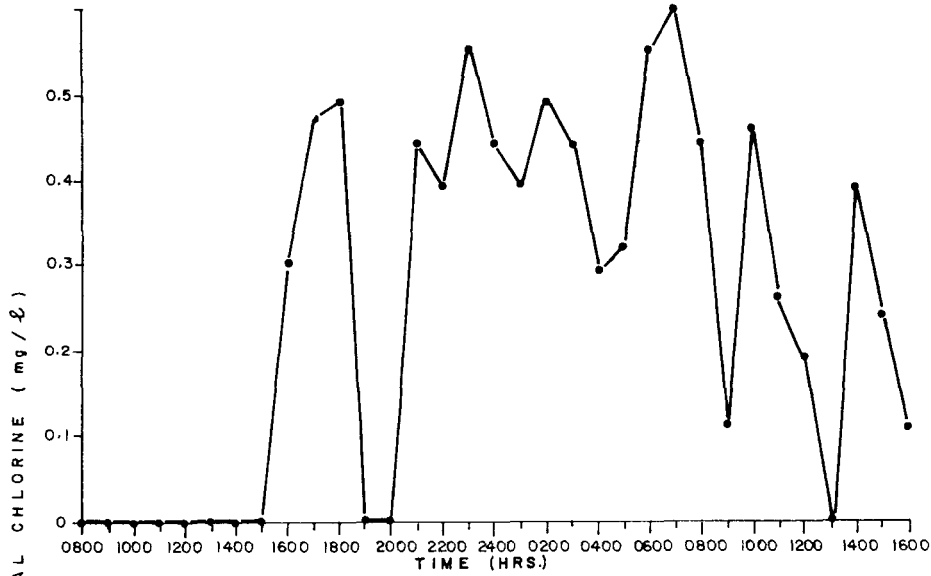
Bacteriological sample results. See Table 2 bacteriological sample results.

TABLE 2 DISTRICT OF NORTH COWICHAN SEWAGE LAGOONS:
BACTERIOLOGICAL SAMPLE RESULTS

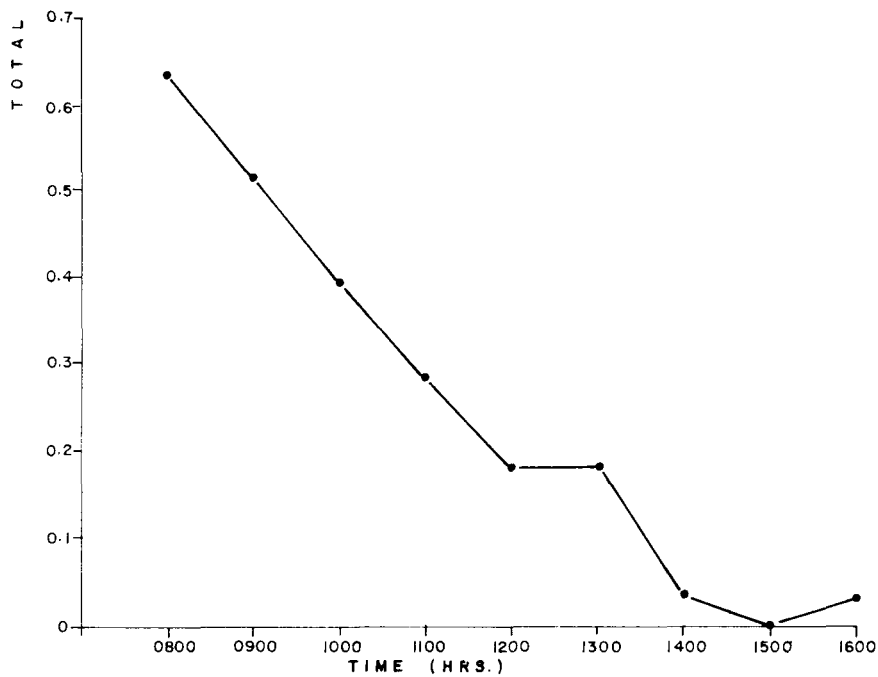
Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
July 21	0800	Pre	1.3×10^5	5.0×10^4
	0800	Post	1300	< 20
July 22	0700	Pre	$< 2.0 \times 10^4$	$< 2.0 \times 10^4$
	0700	Post	490	20



(a) JULY 20, 1975



(b) JULY 21 - 22, 1975



(c) JULY 23, 1976

FIGURE 2 DISTRICT OF NORTH COWICHAN SEWAGE LAGOONS
TOTAL RESIDUAL CHLORINE RESULTS VERSUS TIME

4.2 City of Duncan Sewage Lagoons

4.2.1 Sampling Sites. See Figure 1 for location of the sampling sites.

Effluent sampling. The total effluent samples were taken from the chlorine contact pond overflow. The discharge flows about 30 metres (100 feet) along a ditch and enters "Fish-Gut Alley".

Receiving water sampling. The receiving water was not sampled due to the N/D values determined in the effluent.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from a weir between the polishing cell and the chlorine contact pond.

The post-chlorination bacteriological samples were taken from the chlorine contact pond overflow.

4.2.2 Sample Results.

Effluent sample results and flow data. Non-detectable values were determined in the effluent during the period July 20 - 23, 1975. The flows were constant during the sampling hours, at about $2.2 \text{ IGPD} \times 10^5$. The average daily flows ($\text{IGPD} \times 10^5$ for 24 hours) were:

July 20	-	3.8
21	-	3.8
22	-	3.4
23	-	3.3

See Appendix B for further chlorination data.

Bacteriological sample results. See Table 3 for bacteriological sample results.

TABLE 3 CITY OF DUNCAN SEWAGE LAGOONS:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
July 21	0700	Pre	$<2.0 \times 10^4$	$<2.0 \times 10^4$
	0700	Post	9200	<20
July 22	0745	Pre	$<2.0 \times 10^4$	$<2.0 \times 10^4$
	0745	Post	>16,000	310

4.3 City of Kelowna Sewage Treatment Plant

4.3.1 Sampling Sites.

Effluent sampling. The outfall, located about 900 metres (3,000 feet) from the plant, is submerged in the Okanagan Lake. Therefore, the effluent samples were taken from a manhole located about 550 metres (1,800 feet) from the plant and about 45 metres (150 feet) from the lake.

Receiving water sampling. The outfall, which extends about 370 metres (1,200 feet) into Okanagan Lake, was inaccessible for representative sampling by boat.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the effluent channel preceding the first chlorine contact tank. Pre-treatment chlorination bacteriological samples were not taken. (See Appendix C).

The post-chlorination bacteriological samples were taken after the second chlorine contact tank just before discharge.

4.3.2 Sample Results

Effluent sample results and flow data. The effluent sample results are presented in Table 4. The relationship between these results and the average flow is shown in Figure 3. See Appendix C for further chlorination data.

TABLE 4 CITY OF KELOWNA SEWAGE TREATMENT PLANT:
EFFLUENT SAMPLE RESULTS AND FLOW DATA

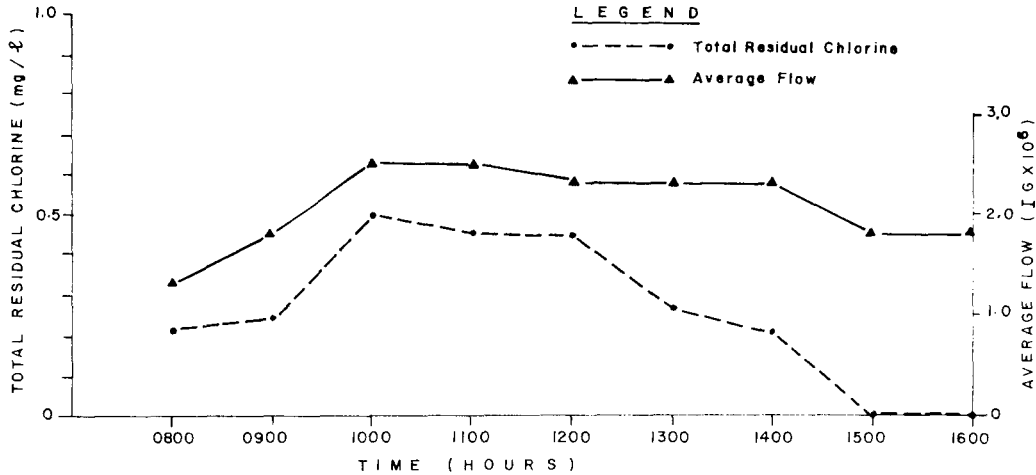
Date (1975)	Time (Hours)	T.R.C. (mg/l)	Average Flow (IGPD x 10 ⁶)	Average Daily Flow (IG x 10 ⁶)
August 3	0800	0.21	1.3	1.6
	0900*	0.24	1.8	
	1000	0.49	2.5	
	1100*	0.45	2.5	
	1200*	0.44	2.3	
	1300*	0.27	2.3	
	1400*	0.21	2.3	
	1500*	N/D	1.8	
	1600*	N/D	1.8	
August 4	0800	0.73	1.3	1.5
	0900	0.66	2.0	
	1000*	0.77	2.3	
	1100*	0.70	2.7	
	1200*	0.56	2.4	
	1300*	0.38	2.2	
	1400*	0.52	2.3	
	1500*	N/D	1.7	
	1600*	N/D	1.7	
August 5	0600*	N/D	0.9	1.8
	0700*	0.20	1.1	
	0800	0.24	1.3	
	0900	N/D	2.0	
	1000	N/D	2.8	
	1100	N/D	2.8	
	1200	N/D	2.8	
	1300	0.04	2.7	
	1400	N/D	2.7	
	1500	N/D	2.3	
	1600	N/D	2.1	
	1700	N/D	1.8	
	1800	0.59	2.3	
	1900	0.52	2.2	
	2000	0.42	2.1	
	2100	0.56	2.0	
2200	0.56	1.8		
2300	0.31	1.7		
2400	0.17	1.8		
August 6	0100	0.28	1.3	1.7
	0200	N/D	1.0	
	0300	N/D	1.0	
	0400	N/D	0.8	
	0500	N/D	0.8	
	0600	-	0.8	
	0700	-	1.0	
	0800	0.80	1.7	
	0900	0.66	2.3	
	1000	0.38	2.7	
	1100	0.45	2.7	
	1200	0.61	2.5	
	1300	0.51	2.5	
	1400	0.27	2.5	
	1500	0.21	2.3	
	1600	0.17	2.1	

*Effluent seemed to be in reverse flow in the discharge pipe. The T.R.C. results may be diluted by the receiving water.

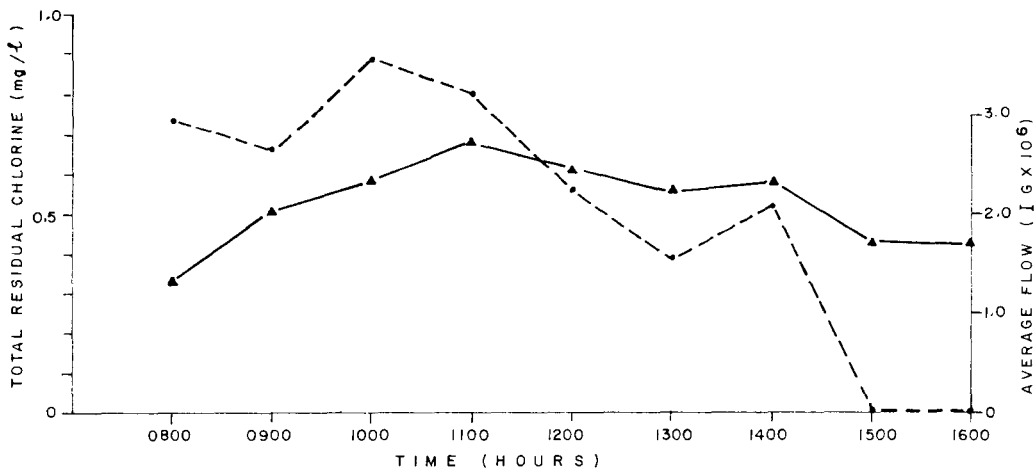
Bacteriological sample results. See Table 5 for bacteriological sample results.

TABLE 5 CITY OF KELOWNA SEWAGE TREATMENT PLANT:
BACTERIOLOGICAL SAMPLE RESULTS

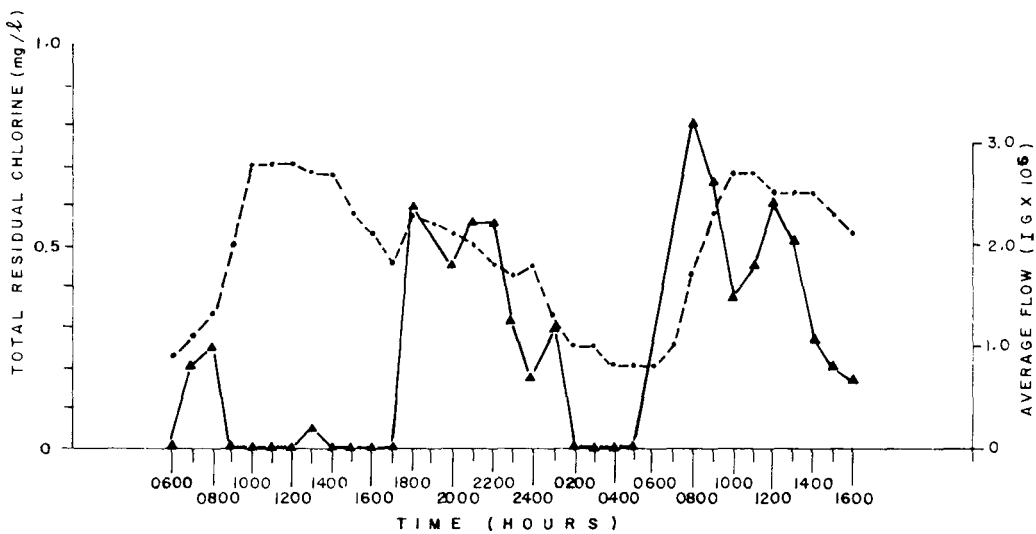
Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
August 5	0645	Pre	3.5×10^6	4.6×10^5
	0645	Post	340	<20
August 6	0630	Pre	7.9×10^6	8.0×10^5
	0630	Post	790	20



(a) AUGUST 3, 1975



(b) AUGUST 4, 1976



(c) AUGUST 5 - 6, 1975

FIGURE 3 CITY OF KELOWNA SEWAGE TREATMENT PLANT RELATIONSHIPS BETWEEN TOTAL RESIDUAL CHLORINE RESULTS AND AVERAGE FLOW VERSUS TIME.

4.4 Village of Oliver Sewage Treatment Plant

4.4.1 Sampling Site.

Effluent sampling. The effluent samples were taken from a manhole located about 90 metres (300 feet) from the plant, and about 9 metres (30 feet) from the outfall. The outfall was inaccessible for sampling since it was submerged in the Okanagan River.

Receiving water sampling. The receiving water was not sampled due to the N/D values determined in the effluent.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the effluent channel preceding the chlorine contact tank.

The post-chlorination bacteriological samples were taken after the contact tank just before discharge.

4.4.2 Sample Results

Effluent sample results. Non-detectable values were determined in the effluent during the sampling period, August 24 - 27, 1975, except for the following:

August 27	0800 hours	-	0.10	mg/ℓTRC
	0900 hours	-	0.07	mg/ℓTRC

Flow data was not available from the municipality. See Appendix D for further chlorination data.

Bacteriological sample results. See Table 6 for bacteriological sample results.

TABLE 6 VILLAGE OF OLIVER SEWAGE TREATMENT PLANT:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
August 26	0600	Pre	2.0×10^5	$<2.0 \times 10^5$
	0600	Post	>1600	>1600
August 27	0600	Pre	1.7×10^5	2.0×10^4
	0600	Post	3.5×10^4	4.9×10^3

4.5 City of Penticton Sewage Treatment Plant.

4.5.1 Sampling Sites.

Effluent sampling. The effluent samples were taken from the outfall pipe discharging to the Okanagan River, located about 90 metres (300 feet) from the plant.

Receiving water sampling. The receiving water was sampled above and below the outfall to the river.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the effluent channel preceding the chlorine contact tank.

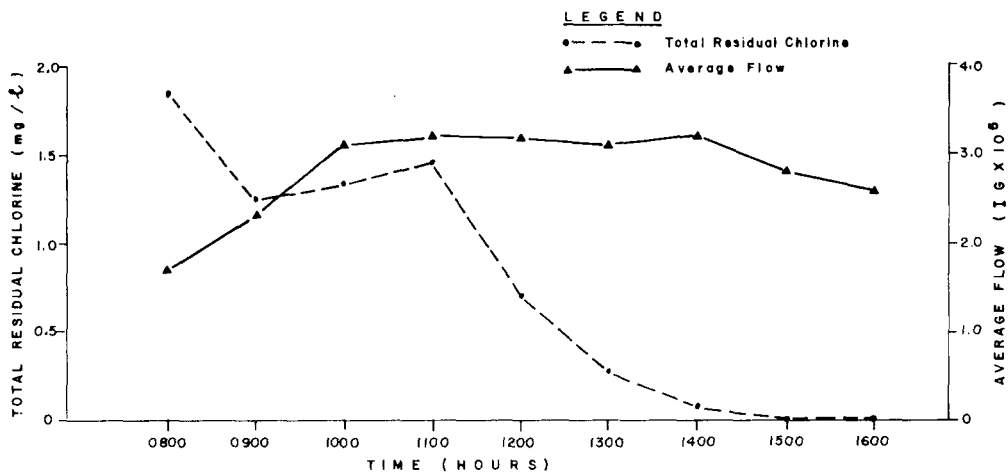
The post-chlorination bacteriological samples were taken from the outfall.

4.5.2 Sample Results.

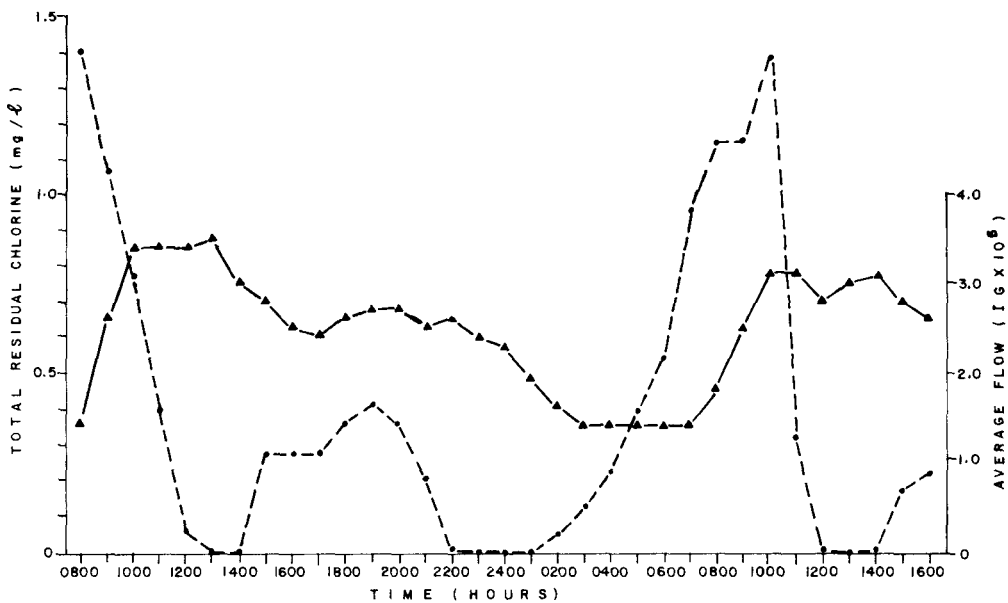
Effluent sample results and flow data. The effluent sample results are presented in Table 7. The relationship between these results and the average flow is shown in Figure 4. See Appendix E for further chlorination data.

TABLE 7 CITY OF PENTICTON SEWAGE TREATMENT PLANT:
EFFLUENT SAMPLE RESULTS AND FLOW DATA

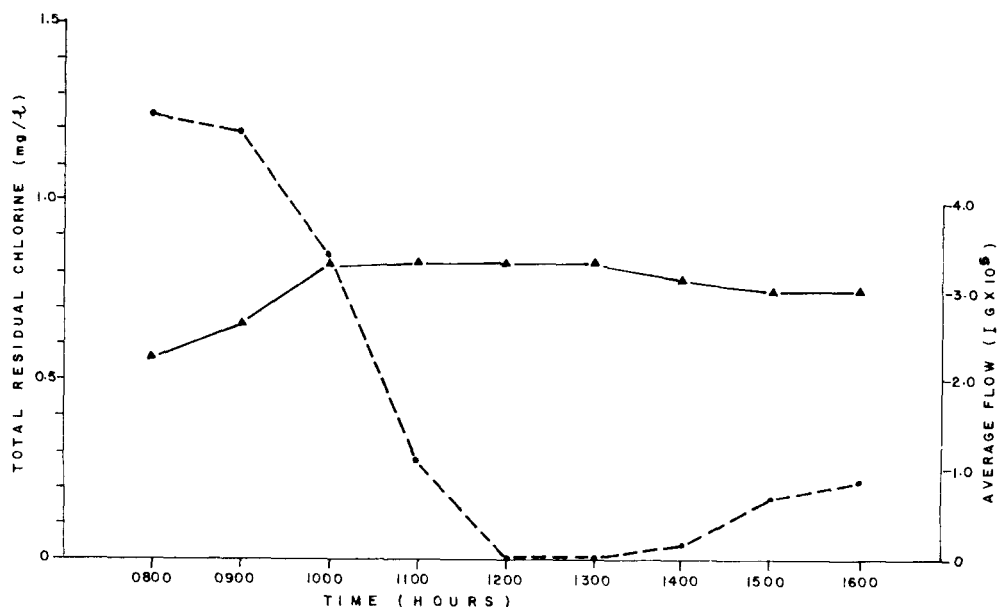
Date (1975)	Time (Hours)	T.R.C. (mg/l)	Average Flow (IGPD x 10 ⁶)	Average Daily Flow (IG x 10 ⁶)
August 24	0800	1.83	1.7	2.1
	0900	1.24	2.3	
	1000	1.33	3.1	
	1100	1.45	3.2	
	1200	0.70	3.2	
	1300	0.27	3.1	
	1400	0.07	3.2	
	1500	N/D	2.7	
	1600	N/D	2.6	
August 25	0800	1.40	1.4	2.0
	0900	1.07	2.6	
	1000	0.77	3.4	
	1100	0.38	3.4	
	1200	0.05	3.4	
	1300	N/D	3.5	
	1400	N/D	3.0	
	1500	0.27	2.8	
	1600	0.27	2.5	
	1700	0.27	2.4	
	1800	0.36	2.6	
	1900	0.41	2.7	
	2000	0.34	2.7	
	2100	0.19	2.5	
	2200	N/D	2.6	
	2300	N/D	2.4	
2400	N/D	2.3		
August 26	0100	N/D	1.9	2.1
	0200	0.03	1.6	
	0300	0.12	1.4	
	0400	0.22	1.4	
	0500	0.38	1.4	
	0600	0.53	1.4	
	0700	0.95	1.4	
	0800	1.14	1.8	
	0900	1.15	2.5	
	1000	1.38	3.1	
	1100	0.31	3.1	
	1200	N/D	2.8	
	1300	N/D	3.0	
	1400	N/D	3.1	
	1500	0.17	2.8	
	1600	0.22	2.6	
August 27	0800	1.24	2.2	2.1
	0900	1.19	2.6	
	1000	0.84	3.3	
	1100	0.27	3.3	
	1200	N/D	3.3	
	1300	N/D	3.3	
	1400	0.03	3.1	
	1500	0.17	3.0	
	1600	0.22	3.0	



(a) AUGUST 24, 1975



(b) AUGUST 25 - 26, 1975



(c) AUGUST 27, 1975

FIGURE 4 CITY OF PENTICTON SEWAGE TREATMENT PLANT RELATIONSHIPS BETWEEN TOTAL RESIDUAL CHLORINE RESULTS AND AVERAGE FLOW VERSUS TIME.

Receiving water sample results. See Table 8 for receiving water sample results.

TABLE 8 CITY OF PENTICTON SEWAGE TREATMENT PLANT:
RECEIVING WATER SAMPLE RESULTS*

Date (1975)	Time (Hours)	Downstream from Outfall (Metres)	TRC (mg/l)
August 24	1030	6	0.84
August 25	0900	6	0.39
	1100	15	0.17
August 26	0700	6	0.08
August 27	0900	6	0.31
	1100	6	0.10

* Detected values only.

Bacteriological sample results. See Table 9 for bacteriological sample results.

TABLE 9 CITY OF PENTICTON SEWAGE TREATMENT PLANT
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
August 26	0600	Pre	2.3×10^6	2.0×10^5
	0600	Post	27	<2.0
August 27	0725	Pre	5.0×10^5	$<2.0 \times 10^5$
	0725	Post	8.0	<2.0

4.6 City of Prince George Sewage Treatment Plant

4.6.1 Sampling Sites.

Effluent sampling. The submerged outfall, going to the Fraser River, is located about 180 metres (600 feet) from the plant. Therefore, the effluent samples were taken after the last chlorine contact tank just before discharge.

Receiving water sampling. The receiving water was not sampled, due to the inaccessible location of the sewage outfall by the river.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the effluent channel preceding the first chlorine contact tank.

The post-chlorination bacteriological samples were taken after the last chlorine contact tank just before discharge.

4.62 Sample Results.

Effluent sample results and flow data. The effluent sample results are presented in Table 10. The relationship between these results and the average flow is shown in Figure 5. See Appendix F for further chlorination data.

TABLE 10 CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT:
EFFLUENT SAMPLE RESULTS AND FLOW DATA

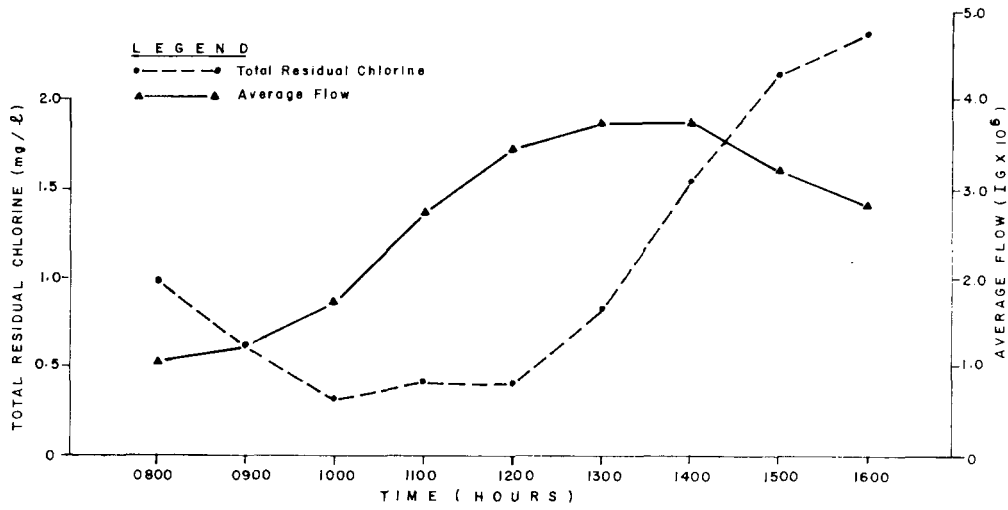
Date (1975)	Time (Hours)	T.R.C. (mg/ℓ)	Average Flow (IGPD x 10 ⁶)	Average Daily Flow (IG x 10 ⁶)
Sept. 14	0800	0.96	1.0	2.3
	0900	0.59	1.2	
	1000	0.30	1.7	
	1100	0.40	2.7	
	1200	0.38	3.4	
	1300	0.81	3.6	
	1400	1.53	3.6	
	1500	2.13	3.2	
	1600	2.37	2.8	
Sept. 15	0800	N/D	1.2	2.5
	0900	N/D	2.6	
	1000	N/D	3.6	
	1100	0.24	3.7	
	1200	0.83	3.7	
	1300	2.07	3.5	
	1400	2.57	3.4	
	1500	2.50	3.3	
	1600	2.43	3.1	
	1700	2.40	2.9	
	1800	2.34	3.0	
	1900	2.26	3.3	
	2000	2.21	3.6	
	2100	2.15	3.6	
2200	2.17	2.9		
2300	2.14	2.9		
2400	1.98	2.6		
Sept. 16	0100	2.10	2.1	2.5
	0200	2.12	1.4	
	0300	1.96	1.2	
	0400	1.58	1.0	
	0500	1.27	1.0	
	0600	1.00	1.1	
	0700	0.62	1.3	
	0800	0.46	1.8	
	0900	0.05	3.1	
	1000	0.38	3.5	
	1100	0.57	3.4	
	1200	0.98	3.3	
	1300	1.98	3.4	
	1400	2.45	3.2	
1500	2.29	3.0		
1600	2.07	2.6		
Sept. 17	0800	0.29	1.6	2.7
	0900	N/D	2.9	
	1000	0.17	3.4	
	1100	0.77	3.4	
	1200	1.41	3.4	
	1300	1.34	3.8	
	1400	1.67	3.8	
	1500	1.52	3.6	
1600	1.81	3.3		

Bacteriological sample results. See Table 11 for bacteriological sample results.

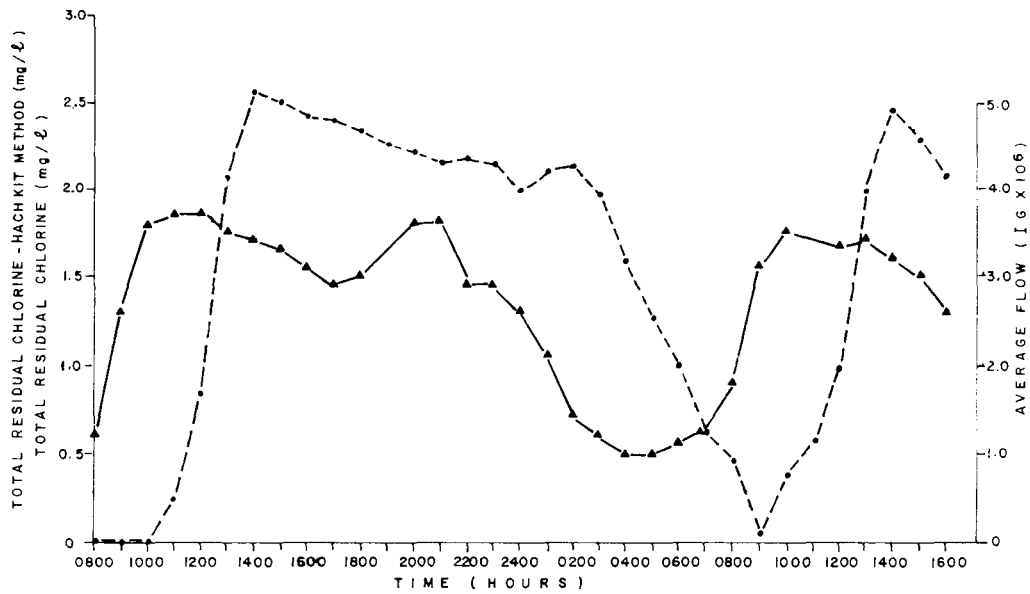
TABLE 11 CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	*Coliforms (MPN/100 ml)	
			Confirmed	Fecal
Sept. 15	0800	Pre	2.4×10^7	7.9×10^6
	0800	Post	$>1.6 \times 10^6$	1.1×10^5
Sept. 16	0800	Pre	2.4×10^7	2.2×10^6
	0800	Post	5.4×10^5	5.0×10^3

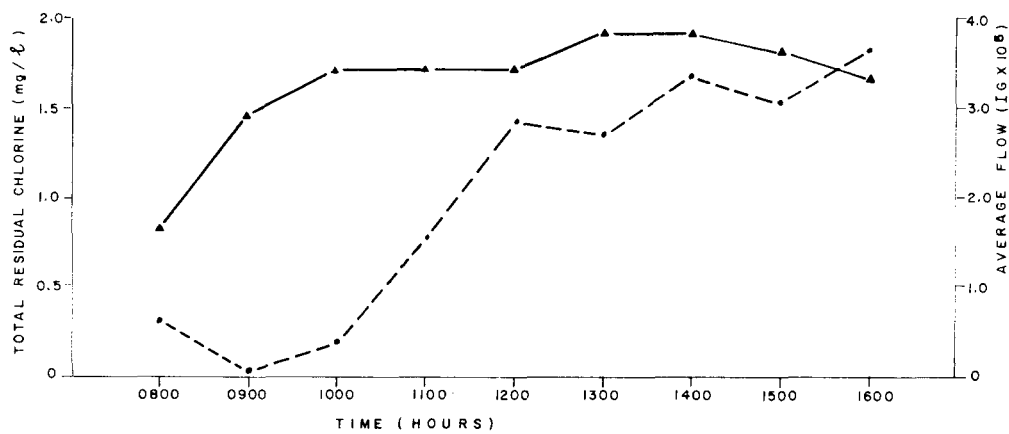
* Results are questionable due to delivery problems which may have caused sample deterioration before analysis could be performed.



(a) SEPTEMBER 14, 1975



(b) SEPTEMBER 15 - 16, 1975



(c) SEPTEMBER 17, 1975

FIGURE 5 CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT RELATIONSHIPS BETWEEN TOTAL RESIDUAL CHLORINE RESULTS AND AVERAGE FLOW VERSUS TIME.

4.7 Town of Smithers Sewage Treatment Plant

4.7.1 Sampling Sites.

Effluent sampling. The outfall, located about 213 metres (700 feet) from the plant, is submerged in the Bulkley River. Therefore, the effluent samples were taken from a manhole located about 60 metres (200 feet) from the river.

Receiving water sampling. The receiving water was not sampled, due to the inaccessible and indeterminate location of the outfall to the river.

Bacteriological sampling. The pre-chlorination samples were taken from the effluent channel preceding the chlorine contact tank.

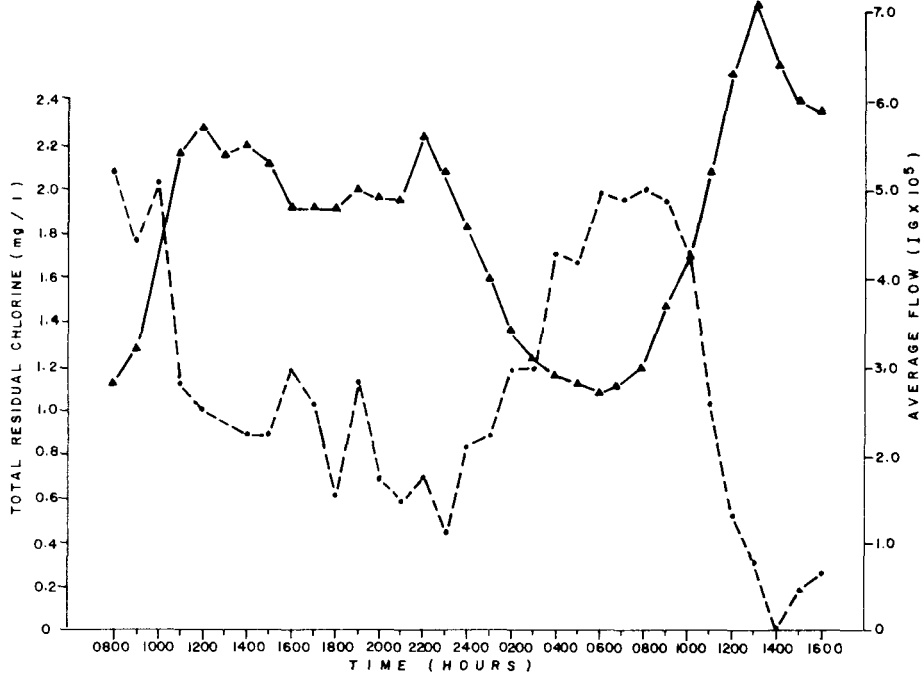
The post-chlorination bacteriological samples were taken from the manhole.

4.7.2 Sample Results.

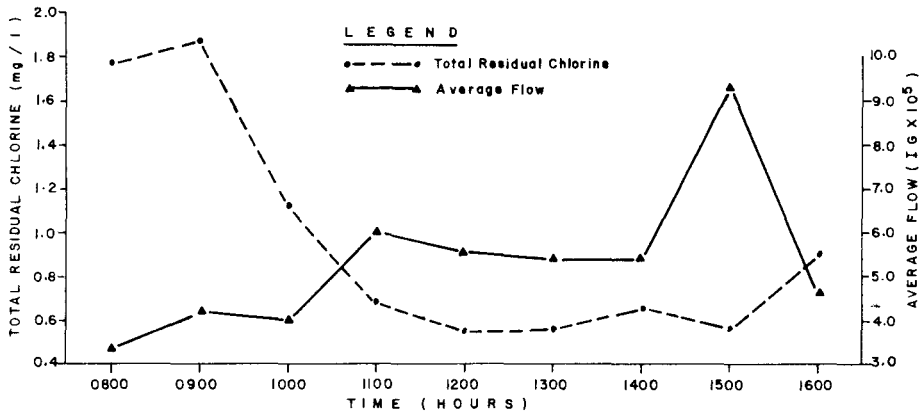
Effluent sample results and flow data. The effluent sample results are presented in Table 12. The relationship between these results and the average flow is shown in Figure 6. See Appendix G for further chlorination data.

TABLE 12 TOWN OF SMITHERS SEWAGE TREATMENT PLANT:
EFFLUENT SAMPLE RESULTS AND FLOW DATA

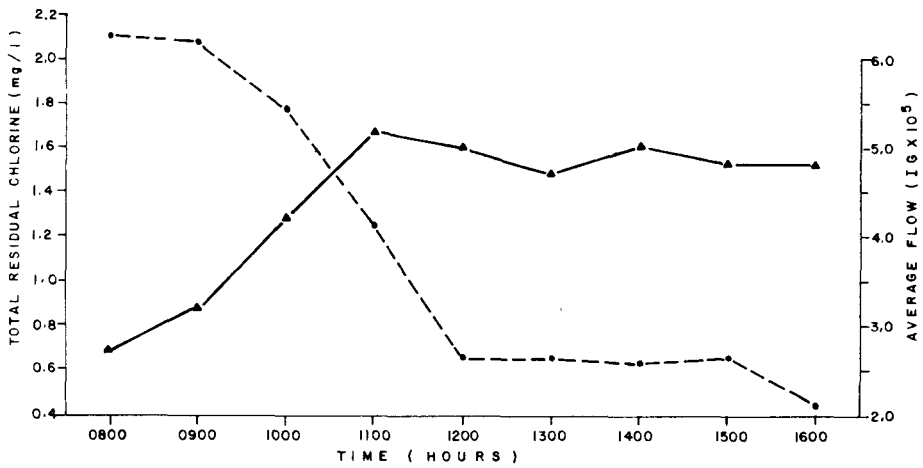
Date (1975)	Time (Hours)	T.R.C. (mg/l)	Average Flow (IGPD x 10 ⁵)	Average Daily Flow (IG x 10 ⁵)
September 7	0800	2.08	2.8	4.2
	0900	1.76	3.2	
	1000	2.03	4.4	
	1100	1.12	5.4	
	1200	1.00	5.7	
	1300	-	5.4	
	1400	0.89	5.5	
	1500	0.89	5.3	
	1600	1.18	4.8	
	1700	1.03	4.8	
	1800	0.62	4.8	
	1900	1.13	5.0	
	2000	0.69	4.9	
	2100	0.58	4.9	
2200	0.70	5.6		
2300	0.45	5.2		
2400	0.84	4.6		
September 8	0100	0.89	4.0	4.0
	0200	1.19	3.4	
	0300	1.19	3.1	
	0400	1.71	2.9	
	0500	1.67	2.8	
	0600	1.98	2.7	
	0700	1.96	2.8	
	0800	2.00	3.0	
	0900	1.95	3.7	
	1000	1.72	4.2	
	1100	1.03	5.2	
	1200	0.52	6.3	
	1300	0.31	7.1	
	1400	N/D	6.4	
1500	0.19	6.0		
1600	0.27	5.9		
September 9	0800	1.77	3.2	4.3
	0900	1.87	4.2	
	1000	1.12	4.0	
	1100	0.68	6.0	
	1200	0.55	5.6	
	1300	0.56	5.4	
	1400	0.65	5.4	
	1500	0.56	9.3	
1600	0.90	4.6		
September 10	0800	2.10	2.7	4.3
	0900	2.07	3.2	
	1000	1.77	4.2	
	1100	1.24	5.2	
	1200	0.65	5.0	
	1300	0.65	4.7	
	1400	0.62	5.0	
	1500	0.65	4.8	
1600	0.24	4.8		



(a) SEPTEMBER 7 - 8, 1975



(b) SEPTEMBER 9, 1975



(c) SEPTEMBER 10, 1975

FIGURE 6 TOWN OF SMITHERS SEWAGE TREATMENT PLANT RELATIONSHIPS BETWEEN TOTAL RESIDUAL CHLORINE RESULTS AND AVERAGE FLOW VERSUS TIME.

Bacteriological sample results. See Table 13 for bacteriological sample results.

TABLE 13 TOWN OF SMITHERS SEWAGE TREATMENT PLANT:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	*Coliforms (MPN/100 ml)	
			Confirmed	Fecal
Sept. 8	1200	Pre	3.1×10^5	1.3×10^5
	1200	Post	9.2×10^5	7.9×10^4
Sept. 9	1200	Pre	1.7×10^6	1.7×10^5
	1200	Post	1.3×10^4	<2000

*Results are questionable due to the frozen condition in which the samples arrived at the laboratory.

4.8 District of Squamish-Central Sewage Treatment Plant

4.8.1 Sampling Sites

Effluent sampling. The outfall, located about 300 metres (1,000 feet) from the plant, is submerged in the Squamish River. No manholes were available for sampling. Therefore, the effluent samples were taken after the chlorine contact tank, just before discharge.

Receiving water sampling. The receiving water could not be sampled, due to the inaccessible and indeterminate location of the outfall to the river.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the effluent channel preceding the chlorine contact tank.

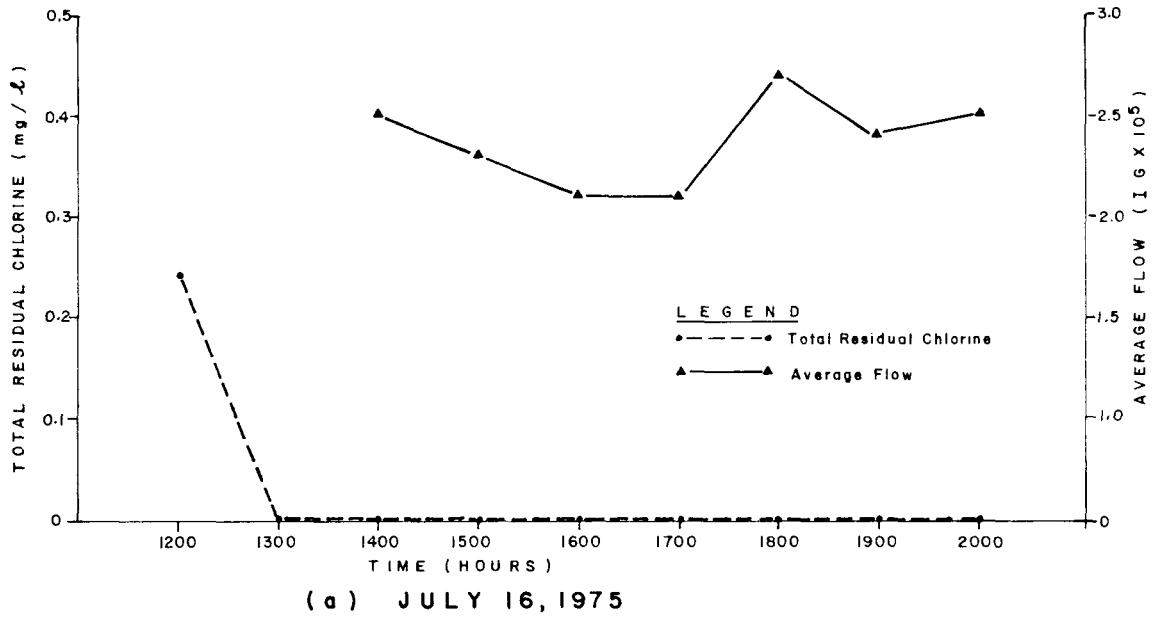
The post-chlorination bacteriological samples were taken after the chlorine contact tank just before discharge.

4.8.2. Sample Results.

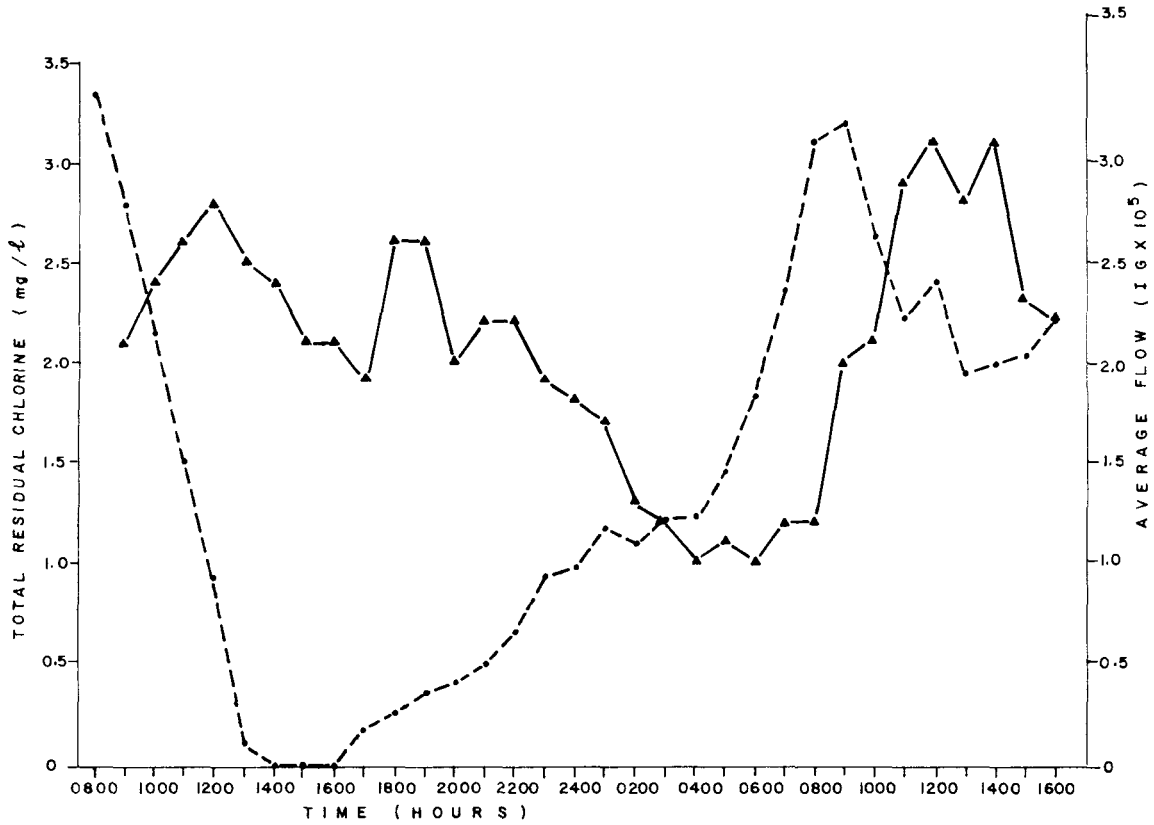
Effluent sample results and flow data. The effluent sample results are presented in Table 14. The relationship between these results and the average flow is shown in Figure 7. See Appendix H for further chlorination data.

TABLE 14 DISTRICT OF SQUAMISH-CENTRAL SEWAGE TREATMENT PLANT:
EFFLUENT SAMPLE RESULTS AND FLOW DATA

Date (1975)	Time (Hours)	T.R.C. (mg/ℓ)	Average Flow (IGPD x 10 ⁵)	Average Daily Flow (IG x 10 ⁵)
July 16	1200	0.24	-	1.1
	1300	N/D	-	
	1400	N/D	2.5	
	1500	N/D	2.3	
	1600	N/D	2.1	
	1700	N/D	2.1	
	1800	N/D	2.7	
	1900	N/D	2.4	
	2000	N/D	2.5	
	July 17	0800	3.33	
0900		2.79	2.1	
1000		2.14	2.4	
1100		1.50	2.6	
1200		0.92	2.8	
1300		0.10	2.5	
1400		N/D	2.4	
1500		N/D	2.1	
1600		N/D	2.1	
1700		0.17	1.9	
1800		0.24	2.6	
1900		0.34	2.6	
2000		0.39	2.0	
2100		0.48	2.2	
2200		0.64	2.2	
2300		0.92	1.9	
2400	0.97	1.8		
July 18	0100	1.16	1.7	1.6
	0200	1.09	1.3	
	0300	1.21	1.2	
	0400	1.22	1.0	
	0500	1.45	1.1	
	0600	1.82	1.0	
	0700	2.36	1.2	
	0800	3.10	1.2	
	0900	3.19	2.0	
	1000	2.62	2.1	
	1100	2.21	2.9	
	1200	2.40	3.1	
	1300	1.93	2.8	
	1400	1.98	3.1	
	1500	2.03	2.3	
	1600	2.21	2.2	



(a) JULY 16, 1975



(b) JULY 17 - 18, 1975

FIGURE 7 DISTRICT OF SQUAMISH-CENTRAL SEWAGE TREATMENT PLANT RELATIONSHIPS BETWEEN TOTAL RESIDUAL CHLORINE RESULTS AND AVERAGE FLOW VERSUS TIME.

Bacteriological sample results. See Table 15 for bacteriological sample results.

TABLE 15 DISTRICT OF SQUAMISH-CENTRAL SEWAGE TREATMENT PLANT:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
July 16	1400	Pre	9.2×10^6	2.4×10^6
	1400	Post	1.6×10^4	790
July 18	0730	Pre	*	4.9×10^5
	0730	Post	*	3.5×10^3

*Not available due to media shortage.

4.9 District of Squamish-Mamquam Sewage Treatment Plant

4.9.1 Sampling Sites.

Effluent sampling. The outfall, located about 300 metres (1,000 feet) from the plant, is submerged in the Mamquam River. No manholes were available for sampling. Therefore, the effluent samples were taken after the chlorine contact tank just before discharge.

Receiving water sampling. The receiving water was sampled above and below the approximate location of the outfall.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the effluent channel preceding the chlorine contact tank.

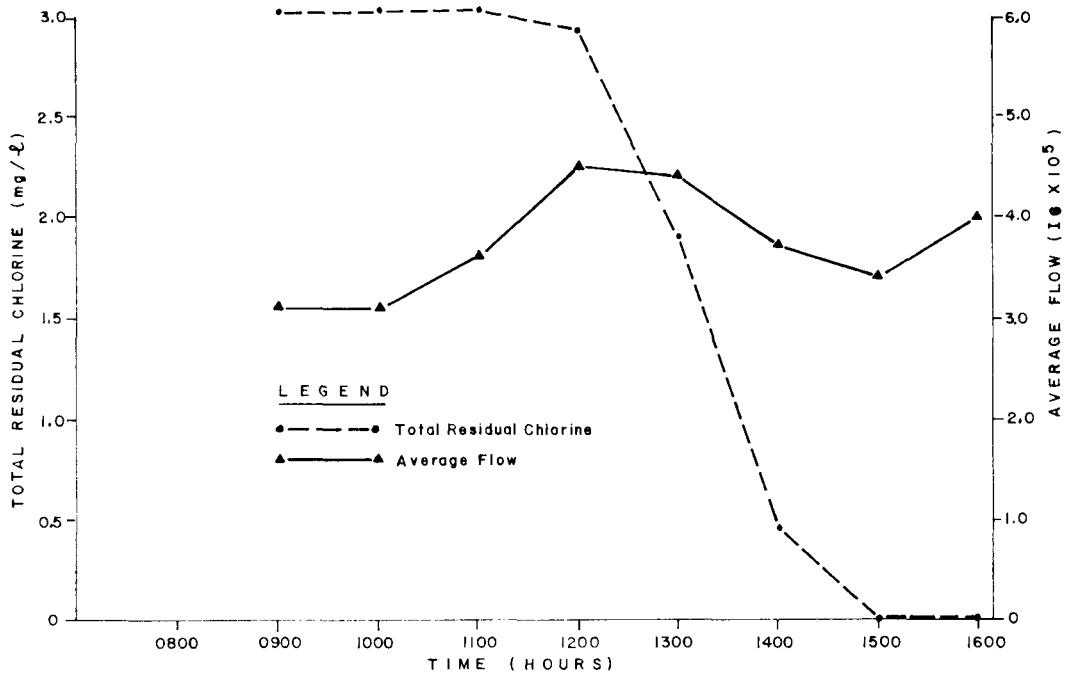
The post-chlorination bacteriological samples were taken after the chlorine contact tank, just before discharge.

4.9.2 Sample Results.

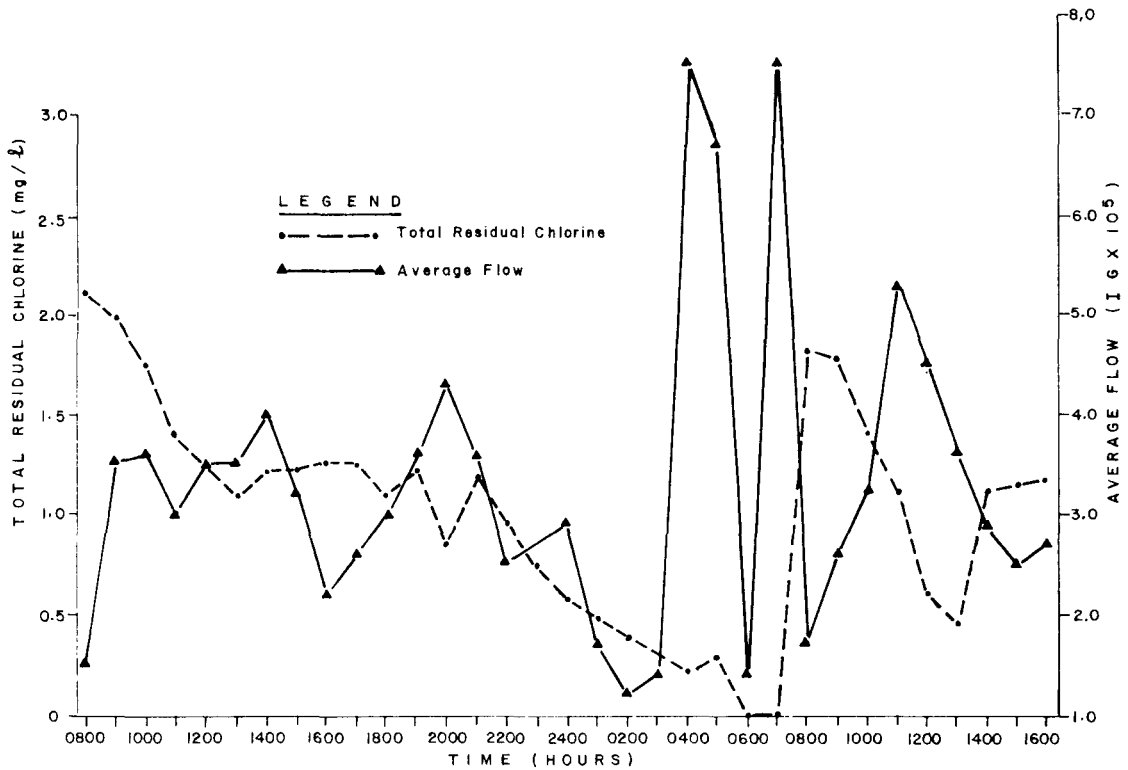
Effluent sample results and flow data. The effluent sample results are presented in Table 16. The relationship between these results and the average flow is shown in Figure 8. See Appendix I for further chlorination data.

TABLE 16 DISTRICT OF SQUAMISH-MAMQUAM SEWAGE TREATMENT PLANT:
EFFLUENT SAMPLE RESULTS AND FLOW DATA

Date (1975)	Time (Hours)	T.R.C. (mg/l)	Average Flow (IGPD x 10 ⁵)	Average Daily Flow (IG x 10 ⁵)
July 14	0900	3.03	3.1	3.0
	1000	3.03	3.1	
	1100	3.03	3.6	
	1200	2.93	4.5	
	1300	1.90	4.4	
	1400	0.45	3.7	
	1500	N/D	3.4	
	1600	N/D	4.0	
July 15	0800	2.12	1.5	2.7
	0900	1.99	3.5	
	1000	1.75	3.6	
	1100	1.38	3.0	
	1200	1.25	3.5	
	1300	1.08	3.5	
	1400	1.21	4.0	
	1500	1.21	3.2	
	1600	1.25	2.2	
	1700	1.25	2.6	
	1800	1.08	3.0	
	1900	1.21	3.5	
	2000	0.85	4.3	
	2100	1.18	3.6	
	2200	0.95	2.5	
2300	0.75	2.7		
2400	0.58	2.9		
July 16	0100	0.48	1.7	2.7
	0200	0.38	1.2	
	0300	0.31	1.4	
	0400	0.21	7.5	
	0500	0.28	6.7	
	0600	N/D	1.4	
	0700	N/D	7.5	
	0800	1.82	1.7	
	0900	1.77	2.6	
	1000	1.40	3.2	
	1100	1.11	5.3	
	1200	0.61	4.5	
	1300	0.45	3.6	
	1400	1.11	2.9	
	1500	1.14	2.5	
1600	1.17	2.7		



(a) JULY 14, 1975



(b) JULY 15 - 16, 1975

FIGURE 8 DISTRICT OF SQUAMISH-MAMQUAM SEWAGE TREATMENT PLANT RELATIONSHIPS BETWEEN TOTAL RESIDUAL CHLORINE RESULTS AND AVERAGE FLOW VERSUS TIME.

Receiving water sample results. Non-detectable values were determined during the sampling period, July 15-16, 1975, at a distance of 25 metres downstream from the outfall.

Bacteriological sample results. See Table 17 for bacteriological sample results.

TABLE 17 DISTRICT OF SQUAMISH-MAMQUAM SEWAGE TREATMENT PLANT:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
July 16	1400	Pre	5.4×10^6	7.0×10^5
	1400	Post	350	2.0
July 18	0730	Pre	*	2.1×10^5
	0730	Post	*	<20

*Not available due to media shortage.

4.10 City of Vernon Sewage Treatment Plant

4.10.1 Sampling Sites.

Effluent sampling. The outfall, located about 290 metres (950 feet) from the plant, was visible but partially submerged in the Vernon Creek. Therefore, the effluent samples were taken from a manhole located about 15 metres (50 feet) up from the outfall.

Receiving water sampling. The receiving water was sampled above and below the outfall.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the effluent channel preceding the post-treatment chlorine contact tank. Pre-treatment chlorination bacteriological samples were not taken.

The post-chlorination bacteriological samples were taken from the outfall.

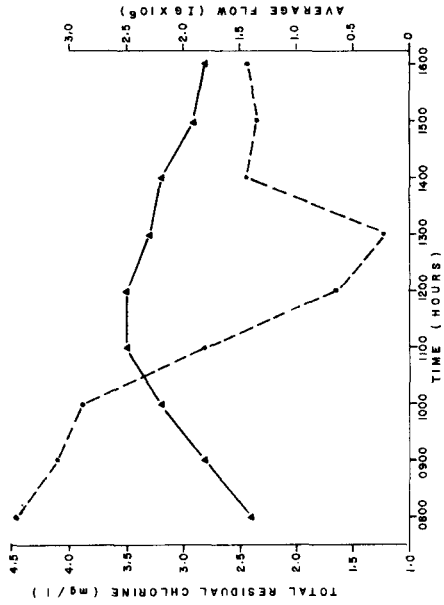
4.10.2 Sample Results.

Effluent sample results and flow data. The effluent sample results are presented in Table 18. The relationship between these results and the average flow is shown in Figure 9. See Appendix J for further chlorination data.

TABLE 18 CITY OF VERNON SEWAGE TREATMENT PLANT:
EFFLUENT SAMPLE RESULTS AND FLOW DATA

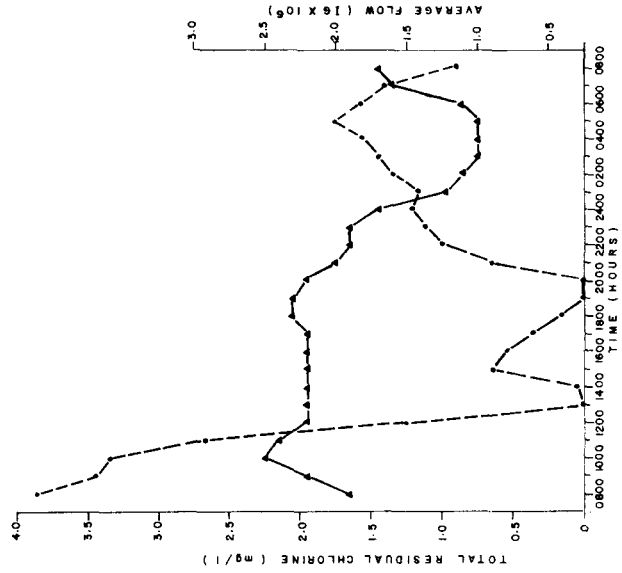
Date (1975)	Time (Hours)	T.R.C. (mg/l)	Average Flow (IGPD x 10 ⁶)	Average Daily Flow (IG x 10 ⁶)
August 3	0900	4.20	1.7	* 1.7
	1000	3.98	2.1	
	1100	3.48	2.2	
	1200	2.96	2.3	
	1300	2.19	2.2	
	1400	2.44	2.2	
	1500	2.52	2.0	
	1600	2.69	1.7	
	1700	2.97	1.7	
August 4	0800	4.47	1.4	* 1.7
	0900	4.09	1.8	
	1000	3.85	2.2	
	1100	2.81	2.5	
	1200	1.63	2.5	
	1300	1.22	2.3	
	1400	2.44	2.2	
	1500	2.34	1.9	
	1600	2.44	1.8	
August 5	0900	3.76	2.2	1.6
	1000	2.92	2.5	
	1100	1.54	2.6	
	1200	N/D	2.6	
	1300	N/D	2.5	
	1400	0.33	2.4	
	1500	0.30	2.2	
	1600	0.20	2.2	
	1700	0.18	2.2	
August 6	0800	3.86	1.9	1.8
	0900	3.45	2.2	
	1000	3.35	2.5	
	1100	2.67	2.4	
	1200	1.24	2.2	
	1300	N/D	2.2	
	1400	0.03	2.2	
	1500	0.63	2.2	
	1600	0.53	2.2	
	1700	0.36	2.2	
	1800	0.15	2.3	
	1900	N/D	2.3	
	2000	N/D	2.2	
	2100	0.63	2.0	
	2200	0.99	1.9	
2300	1.12	1.9		
2400	1.21	1.7		
August 7	0100	1.17	1.2	1.7
	0200	1.34	1.1	
	0300	1.44	1.0	
	0400	1.57	1.0	
	0500	1.77	1.0	
	0600	1.57	1.1	
	0700	1.40	1.6	
	0800	0.89	1.7	

* Average flow based on 5.1×10^6 IG total for August 2, 3, and 4, 1975.

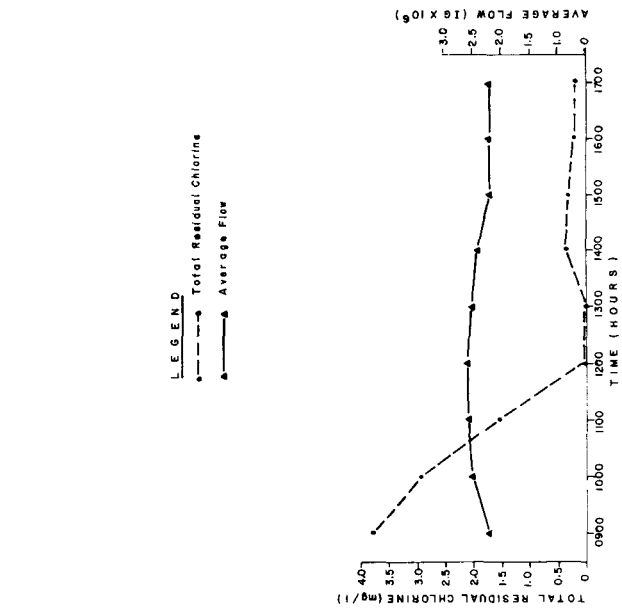


(a) AUGUST 3, 1975

(b) AUGUST 4, 1975



(d) AUGUST 6 - 7, 1975



(c) AUGUST 5, 1975

FIGURE 9 CITY OF VERNON SEWAGE TREATMENT PLANT - RELATIONSHIPS BETWEEN TOTAL RESIDUAL CHLORINE RESULTS AND AVERAGE FLOW VERSUS TIME.

LEGEND
—•— Total Residual Chlorine
- - - Average Flow

Receiving water sample results. See Table 19 for receiving water sample results.

TABLE 19 CITY OF VERNON SEWAGE TREATMENT PLANT:
RECEIVING WATER SAMPLE RESULTS *

Date (1975)	Time (Hours)	Downstream from Outfall (metres)	T.R.C. (mg/l)
August 3	1000	3	1.20
	1400	3	0.88
	1700	8	0.44
August 4	1000	15	0.68
	1600	25	0.08
August 5	1000	25	0.41

* Detected values only.

Bacteriological sample results. See Table 20 for bacteriological sample results.

TABLE 20 CITY OF VERNON SEWAGE TREATMENT PLANT:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
August 6	0600	Pre	2.3×10^5	2.3×10^5
	0600	Post	20	<20
	0630	Pre	2.4×10^6	4.9×10^5
	0630	Post	26	<2.0

4.11 Westbank Waterworks District Sewage Lagoon

4.11.1 Sampling Sites.

Effluent sampling. The effluent samples were taken from the overflow of the chlorine contact tank. The overflow drains to a ditch, about 300 metres (1,000 feet) long, leading to Westbank Creek. However, during the sampling period, all the effluent went to ground drainage only.

Receiving water sampling. The receiving water was not sampled due to ground drainage conditions.

Bacteriological sampling. The pre-chlorination bacteriological samples were taken from the edge of the lagoon, just before entering the chlorine contact tank.

The post-chlorination bacteriological samples were taken from the overflow of the chlorine contact tank.

4.11.2 Sample Results.

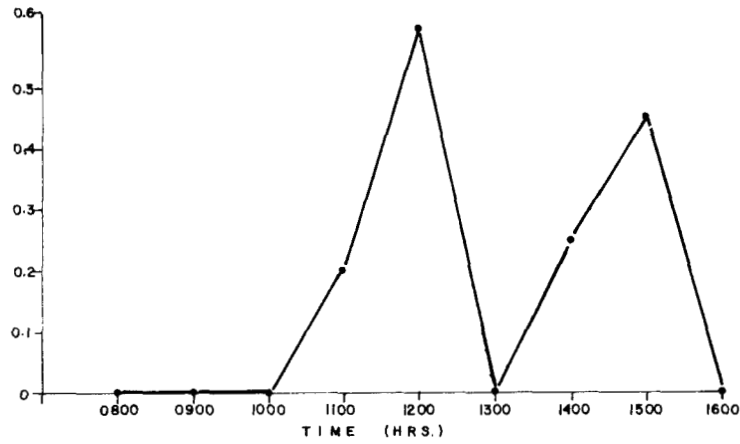
Effluent sample results. The effluent sample results are presented in Table 21, and illustrated in Figure 10. See Appendix K for further chlorination data.

TABLE 21 WESTBANK WATERWORKS DISTRICT SEWAGE LAGOON:
EFFLUENT SAMPLE RESULTS

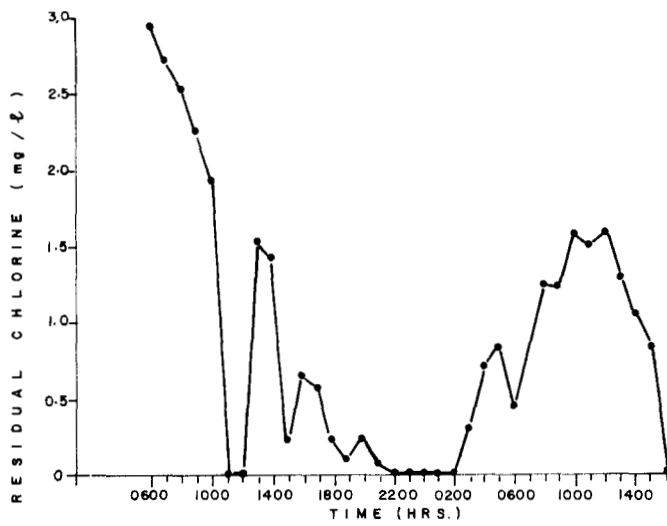
Date (1975)	Time (Hours)	T.R.C. (mg/l)
August 10	0800	*
	0900	*
	1000	N/D
	1100	0.19
	1200	0.59
	1300	N/D
	1400	0.24
	1500	0.35
	1600	N/D
August 11	0600	2.93
	0700	2.81
	0800	2.52
	0900	2.26
	1000	0.93
	1100	N/D
	1200	N/D
	1300	1.53
	1400	1.43
	1500	0.22
	1600	0.65
	1700	0.57
	1800	0.23
	1900	0.09
	2000	0.23
	2100	0.06
2200	N/D	
2300	N/D	
2400	N/D	
August 12	0100	N/D
	0200	N/D
	0300	0.29
	0400	0.70
	0500	0.82
	0600	0.44
	0700	-
	0800	1.24
	0900	1.22
	1000	1.57
	1100	1.50
	1200	1.58
	1300	1.29
	1400	1.05
	1500	0.83
1600	N/D	
August 13	0800	2.77
	0900	2.72
	1000	2.36
	1100	2.29
	1200	1.72
	1300	1.93
	1400	2.19
	1500	1.90
1600	1.88	

* Chlorinator was not functioning.

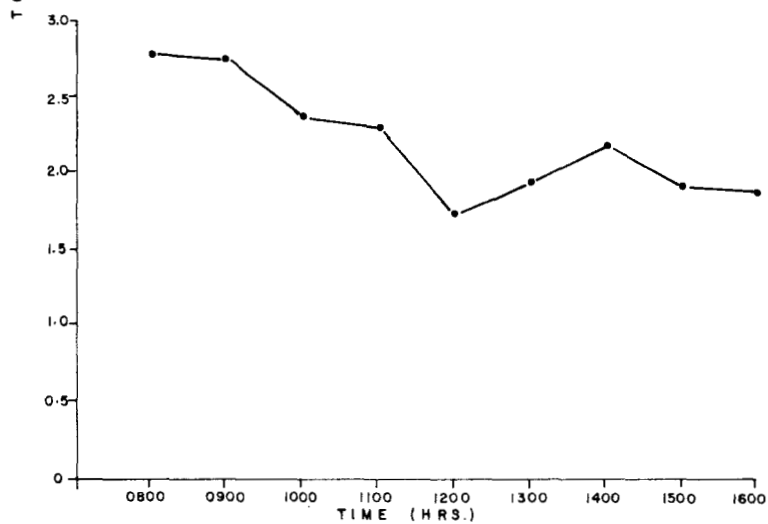
Average daily flows for each day estimated to be approximately 7.1 to $7.5 \text{ IG} \times 10^5$.



(a) AUGUST 10, 1975



(b) AUGUST 11 - 12, 1975



(c) AUGUST 13, 1975

FIGURE 10 WESTBANK WATERWORKS DISTRICT SEWAGE LAGOON - TOTAL RESIDUAL CHLORINE RESULTS VERSUS TIME

Bacteriological sample results. See Table 22 for bacteriological sample results.

TABLE 22 WESTBANK WATERWORKS DISTRICT SEWAGE LAGOON:
BACTERIOLOGICAL SAMPLE RESULTS

Date (1975)	Time (Hours)	Chlorination	Coliforms (MPN/100 ml)	
			Confirmed	Fecal
August 12	0540	Pre	1.3×10^6	7.0×10^4
	0540	Post	1.3×10^3	< 200
August 14	0630	Pre	3.5×10^5	1.7×10^4
	0630	Post	840	2.0

5 GENERAL SUMMARY OF RESULTS

5.1 Effluent Sample Results

See Table 23 for a general summary of results determined during this study.

TABLE 23 SUMMARY OF EFFLUENT SAMPLE RESULTS*

	Maximum	Average	Results (%)	
			⁺ Over 0.02 mg/ℓ	Over 1.0 mg/ℓ
1. North Cowichan	0.63	0.21	61	0
2. Duncan	0	0	0	0
3. Kelowna	0.80	0.29	67	0
4. Oliver	0.10	0	5	0
5. Penticton	1.83	0.46	75	22
6. Prince George	2.57	1.34	92	57
7. Smithers	2.10	1.08	98	48
8. Squamish-Central	3.33	1.12	74	48
9. Squamish-Mamquam	3.03	1.16	90	61
10. Vernon	4.47	1.79	90	83
11. Westbank	2.93	0.74	73	32

* N/D values assumed to be 0.

+ Threshold of fish toxicity as determined by Dr. Servizi.⁽²⁾

5.2 Receiving water sample results. Detectable amounts of TRC in the receiving waters were determined at two of the four sewage treatment facilities sampled. See Table 24 for the sample results.

TABLE 24 SUMMARY OF RECEIVING WATER SAMPLE RESULTS

	Downstream from Outfall (metres)	Maximum (mg/l)
Penticton	6	0.84
	15	0.17
Vernon	3	1.20
	8	0.44
	15	0.68
	25	0.41

5.3 Bacteriological sample results. Insufficient data was obtained to make a statement.

REFERENCES

1. Standard Methods for the Examination of Water and Wastewater.
13th Edition, American Public Health Association, New York, Part 114, pp. 112-116; Part 405, pp. 657-660; Part 407, pp. 662-676, (1971).
2. Servizi, J.A. and Martens, D.W. Preliminary Survey of Toxicity of Chlorinated and Sewage to Sockeye and Pink Salmon.
International Pacific Salmon Fisheries Commission, Progress Report No. 30, pp. 30, 33, 37, (1974).
3. White, G.C. Handbook of Chlorination. pp. 236-243 (1972).
4. Mattice, J.S. and Zittel, H.E. "Site-Specific Evaluation of Power Plant Chlorination", Water Pollution Control Federation Journal, 48 (10), 2286 (1976).

ACKNOWLEDGEMENTS

The assistance of the staff of the various municipalities and sewage treatment plants is gratefully acknowledged. Appreciation is also extended to the Fisheries Service, the B.C. Fish and Wildlife Branch, and the Pollution Control Branch for their input and assistance.

Special appreciation to Dr. M. Clark of the Pollution Control Branch for the computer print-out data supplied on each plant.

APPENDIX

SEWAGE TREATMENT FACILITY DESIGN AND CHLORINATION DATA

- A. District of North Cowichan Sewage Lagoons.
- B. City of Duncan Sewage Lagoons.
- C. City of Kelowna Sewage Treatment Plant.
- D. Village of Oliver Sewage Treatment Plant.
- E. City of Penticton Sewage Treatment Plant.
- F. City of Prince George Sewage Treatment Plant.
- G. Town of Smithers Sewage Treatment Plant.
- H. District of Squamish-Central Sewage Treatment Plant.
- I. District of Squamish-Mamquam Sewage Treatment Plant.
- J. City of Vernon Sewage Treatment Plant.
- K. Westbank Waterworks District Sewage Lagoon.

A. DISTRICT OF NORTH COWICHAN SEWAGE LAGOONS

Type of Treatment	- Secondary
Treatment Method	- Aerated lagoons (2) in parallel
Design Flow	- 430,000 IGPD
Operating Level (July 1975)	- ~300,000 IGPD
Type of Chlorine Used	- Gas
Term of Addition	- Injection
* Average Contact Time	- Not available (theoretical) - ~4.1 hours (actual)
Chlorine Contact Tank Capacity	- 51,768 IG
Chlorinator Brand	- Advance
Chlorine Addition Control	- Manual control, checked and adjusted daily
+ Chlorine Dosage:	
July 19 & 20/75	- 4.3 mg/l
July 21/75	- 3.0 mg/l
July 22/75	- 2.7 mg/l
July 23/75	- 2.3 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit.

* Theoretical - given by municipality.
Actual - calculated using operating level and chlorine contact tank capacity figures.

+ Calculated from quantities (lb.) given by municipality.

B. CITY OF DUNCAN SEWAGE LAGOONS

Type of Treatment	- Secondary
Treatment Methods	- Aerated lagoon and polishing cell
Design Flow	- 800,000 IGPD
Operating Level (July 1975)	- >1,000,000 IGPD
Type of Chlorine Used	- Gas
Term of Addition	- Solution feed
* Average Contact Time (July 1975)	- >3 days (theoretical) - >24 hours (actual)
Chlorine Contact Tank Capacity	- 1,000,000 IG
Chlorinator Brand	- Fischer and Porter
Chlorine Addition Control	- Automatic flow regulated, checked daily
+ Chlorine Dosage:	
July 20/75	- 1.8 mg/l
July 21/75	- 1.8 mg/l
July 22/75	- 1.8 mg/l
July 23/75	- 1.5 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit.

* Theoretical - given by municipality.
Actual - calculated using operating level and chlorine contact tank capacity figures.

+ Calculated from quantities (lb.) given by municipality.

C. CITY OF KELOWNA SEWAGE TREATMENT PLANT

Type of Treatment	-	Secondary
Treatment Method	-	Conventional activated sludge
Design Flow	-	2,100,000 IGPD
Operating Level (August 1975)	-	1,800,000 IGPD
Type of Chlorine Used	-	Gas
Term of Addition	-	Injection
* Average Contact Time(August 1975)	-	~1/2 hour (theoretical) - 0.7 hour (actual)
Chlorine Contact Tank Capacity (2)	-	53,600 IG (total)
Chlorinator Brand	-	Fischer and Porter
Chlorine Addition Control	-	Automatic flow regulated, checked daily
+ Chlorine Dosage:	<u>Pre-Treatment</u>	<u>Post-Treatment</u>
August 3/75	13.4 mg/l	4.4 mg/l
August 4/75	15.3 mg/l	4.6 mg/l
August 5/75	12.7 mg/l	3.9 mg/l
August 6/75	12.3 mg/l	4.1 mg/l
T.R.C. Monitoring Method Used	-	Orthotolidine using colorimetric test kit.

* Theoretical - given by municipality
Actual - calculated using operating level and chlorine contact tank capacity figures.

+ Calculated from quantities (lb.) given by municipality.

D. VILLAGE OF OLIVER SEWAGE TREATMENT PLANT

Type of Treatment	- Secondary
Treatment Methods	- Conventional activated sludge with extended aeration
Design Flow	- ~145,000 IGPD
Operating Level (August 1975)	- ~200,000 IGPD
Type of Chlorine Used	- Gas
Term of Addition	- Water pressure
* Average Contact Time(August 1975)	- ~25 minutes (theoretical) - ~1.4 hours (actual)
Chlorine Contact Tank Capacity	- 11,600 IG
Chlorinator Brand	- Fischer and Porter
Chlorine Addition Control	- Automatic flow regulated, checked daily
+ Chlorine Dosage (Aug. 24-27/75)	- ~5.2 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit.

* Theoretical - given by municipality
Actual - calculated using operating level and chlorine contact tank capacity figures.

+ Calculated from quantities (lb.) given by municipality.

E. CITY OF PENTICTON SEWAGE TREATMENT PLANT

Type of Treatment	- Tertiary
Treatment Methods	- Conventional activated sludge with phosphorous removal
Design Flow	- 1,500,000 IGPD
Operating Level (August 1975)	- 2,490,000 IGPD
Type of Chlorine Used	- Liquid
Term of Addition	- Injection
* Average Contact Time(August 1975)	- ~45 minutes (theoretical) - 0.4 hours (actual)
Chlorine Contact Tank Capacity	- 37,500 IG
Chlorinator Brand	- Fischer and Porter
Chlorine Addition Control	- Automatic flow regulated, checked twice per day
+ Chlorine Dosage:	
August 24/75	- 3.7 mg/l
August 25/75	- 3.5 mg/l
August 26/75	- 3.5 mg/l
August 27/75	- 3.6 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit

* Theoretical - given by municipality.
Actual - calculated using operating level and chlorine contact tank capacity figures.

+ Calculated from quantities (lb.) given by municipality.

F. CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT

Type of Treatment	- Secondary
Treatment Method	- High-rate activated sludge
Design Flow	- 5,100,000 IGPD
Operating Level (September 1975)	- 3,000,000 IGPD
Type of Chlorine Used	- Gas
Term of Addition	- Solution feed
* Average Contact Time:	
September 14/75	- 2.1 hours
September 15/75	- 1.9 hours
September 16/75	- 1.9 hours
September 17/75	- 1.8 hours
Chlorine Contact Tank Capacity (2)	- 198,700 IG (total)
Chlorinator Brand	- Fischer and Porter
Chlorine Addition Control	- Automatic flow regulated, checked daily
+ Pre/Post Treatment	
Chlorine Dosage:	
September 14/75	- 5.4 mg/l
September 15/75	- 5.8 mg/l
September 16/75	- 5.4 mg/l
September 17/75	- 5.9 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit.

* Calculated by municipality.

+ Calculated from quantities (lb.) given by municipality.

G. TOWN OF SMITHERS SEWAGE TREATMENT PLANT

Type of Treatment	- Secondary
Treatment Methods	- Conventional activated sludge with extended aeration
Design Flow	- 624,500 IGPD
Operating Level (September 1975)	- 416,000 IGPD
Type of Chlorine Used	- Liquid
Term of Addition	- Injection
Average Contact Time	- 1.5 hours (theoretical and actual)
Chlorine Contact Tank Capacity	- 26,200 IG
Chlorinator Brand	- Fischer and Porter
Chlorine Addition Control	- Automatic flow regulated, checked infrequently
* Chlorine Dosage:	
September 7/75	- 2.0 mg/l
September 8/75	- 2.1 mg/l
September 9/75	- 1.9 mg/l
September 10/75	- 1.7 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit.

* Calculated from quantities (lb.) given by municipality.

H. DISTRICT OF SQUAMISH-CENTRAL SEWAGE TREATMENT PLANT

Type of Treatment	- Secondary
Treatment Method	- High-rate activated sludge
Design Flow	- 832,700 IGPD
Operating Level (July 1975)	- 416,300 IGPD
Type of Chlorine Used	- Liquid
Term of Addition	- Injection
* Average Contact Time	- ~4.5 hours (theoretical) - ~1.2 hours (actual)
Chlorine Contact Tank Capacity	- 21,500 IG
Chlorinator Brand	- Wallace and Tiernan
Chlorine Addition Control	- Automatic flow regulated, checked daily
+ Chlorine Dosage (July 16-18/75)	- ~12.3 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit

-
- * Theoretical - given by municipality.
Actual - calculated using operating level and chlorine contact tank capacity figures.
- + Calculated from quantities (lb.) given by municipality.

I. DISTRICT OF SQUAMISH-MAMQUAM SEWAGE TREATMENT PLANT

Type of Treatment	- Secondary
Treatment Method	- High-rate activated sludge
Design Flow	- 832,700 IGPD
Operating Level (July 1975)	- 416,300 IGPD
Type of Chlorine Used	- Liquid
Term of Addition	- Injection
* Average Contact Time	- ~4.5 hours (theoretical) - ~1.2 hours (actual)
Chlorine Contact Tank Capacity	- 21,500 IG
Chlorinator Brand	- Wallace and Tiernan
Chlorine Addition Control	- Automatic flow regulated, checked daily
+ Chlorine Dosage (July 14-16/75)	- 6.3 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit

* Theoretical - given by municipality.
Actual - calculated using operating level and chlorine contact tank capacity figures.

+ Calculated from quantities (lb.) given by municipality.

J. CITY OF VERNON SEWAGE TREATMENT PLANT

Type of Treatment	- Secondary																		
Treatment Method	- Trickling filtration																		
Design Flow	- 1,665,300 IGPD																		
Operating Level (August 1975)	- 1,713,000 IGPD																		
Type of Chlorine Used	- Gas																		
Term of Addition	- Injection																		
* Average Contact Time	- 1.5 hours (theoretical) - 1.3 hours (actual)																		
Chlorine Tank Capacity (3)	- 94,725 IG (total)																		
Chlorinator Brand	- Fischer and Porter																		
Chlorine Addition Control	- Automatic flow regulated, checked daily																		
+ Pre/Post Treatment Chlorine Dosage:																			
	<table><thead><tr><th></th><th><u>Pre-Treatment</u></th><th><u>Post-Treatment</u></th></tr></thead><tbody><tr><td>August 3/75</td><td>4.4 mg/l</td><td>4.4 mg/l</td></tr><tr><td>August 4/75</td><td>4.4 mg/l</td><td>4.4 mg/l</td></tr><tr><td>August 5/75</td><td>4.2 mg/l</td><td>4.2 mg/l</td></tr><tr><td>August 6/75</td><td>4.4 mg/l</td><td>4.4 mg/l</td></tr><tr><td>August 7/75</td><td>4.6 mg/l</td><td>4.6 mg/l</td></tr></tbody></table>		<u>Pre-Treatment</u>	<u>Post-Treatment</u>	August 3/75	4.4 mg/l	4.4 mg/l	August 4/75	4.4 mg/l	4.4 mg/l	August 5/75	4.2 mg/l	4.2 mg/l	August 6/75	4.4 mg/l	4.4 mg/l	August 7/75	4.6 mg/l	4.6 mg/l
	<u>Pre-Treatment</u>	<u>Post-Treatment</u>																	
August 3/75	4.4 mg/l	4.4 mg/l																	
August 4/75	4.4 mg/l	4.4 mg/l																	
August 5/75	4.2 mg/l	4.2 mg/l																	
August 6/75	4.4 mg/l	4.4 mg/l																	
August 7/75	4.6 mg/l	4.6 mg/l																	
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit.																		

- * Theoretical - given by municipality.
Actual - calculated using operating level and chlorine contact tank capacity figures.
- + Calculated from quantities (lb.) given by municipality.

K. WESTBANK WATERWORKS DISTRICT SEWAGE LAGOON

Type of Treatment	- Secondary
Treatment Method	- Aerated lagoon
Design Flow	- 37,500 IGPD
Operating Level (August 1975)	- 74,900 IGPD
Type of Chlorine Used	- Liquid
Term of Addition	- Injection
* Average Contact Time	- ~1.3 hours (theoretical) - ~1.9 hours (actual)
Chlorine Contact Tank Capacity	- 6,000 IG
Chlorinator Brand	- Fischer and Porter
Chlorine Addition Control	- Automatic flow regulated, checked daily
+ Chlorine Dosage	- ~9.3 mg/l
T.R.C. Monitoring Method Used	- Orthotolidine using colorimetric test kit.

* Theoretical - given by municipality.
Actual - calculated using operating level and chlorine contact tank capacity figures.

+ Calculated from quantities (lb.) given by municipality.