Environment Canada
Environnement Canada

Environmental Protection
Protection de l'environnement

# A PRELIMINARY STUDY on WASTEWATER CHARACTERISTICS of PRINCE GEORGE STORMWATER and SEWAGE DISCHARGES

Manuscript Report
EPS 5-PR-75-[redacted]
-2

Pacific Region
June 1975

# A Preliminary Study on Wastewater Characteristics of Prince George Stormwater and Sewage Discharges

by

S.T. Sidhu

Canada

Department of the Environment

Environmental Protection Service

Pacific Region

Vancouver, B.C.

Manuscript Report Number EPS 5-PR-75-[illegible]

June, 1975

Environmental Protection Service Report Series

Manuscript Reports are primarily of local interest only. They generally describe a part of a larger program and list results only without discussion or conclusions.

Other categories in the E.P.S. series include such groups as Regulations, Codes and Protocols, Policy and Plannings, Technical Appraisals, Technology Development, Surveillance, and Reprints of Published Papers.

Inquiries pertaining to Environmental Protection Service Reports should be directed to the Environmental Protection Service, Department of the Environment, Kapilano 100 - Park Royal, West Vancouver, B.C. V7T 1A2.

ABSTRACT

Prior to this study only limited information was available regarding Prince George stormwater and sewage discharge characteristics such as toxicity, heavy metals and chemical contaminants. Results from the bioassay determinations show that the majority of the storm sewers tested as well as the Prince George Sewage Treatment Plant discharge were toxic to juvenile coho salmonids (Oncorhynchus nerka). Effluent from the Prince George Sewage Treatment Plant was also shown to contain high levels of residual chlorine. The treated sewage discharges from Prince George Pulp and Paper Limited, Intercontinental Pulp Limited which have a combined treatment system, and Northwood Pulp and Timber Limited were non-toxic and contained few chemical contaminants.

The results of this study will provide some of the information required to assist in the development of adequate standards and/or guidelines for environmental controls applicable to municipal wastewater quality.

TABLE OF CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

# 1. INTRODUCTION

During 1971 and 1972 Environment Canada conducted a study to document a number of specific wastewater characteristics of discharge from the Greater Vancouver Sewage treatment plants and major sewers. The study was undertaken to provide baseline data required to assist Environment Canada in the development of reasonable and attainable standards or guidelines with respect to domestic and municipal wastes.

To supplement the information collected in the Vancouver area, a study on the Prince George area was conducted during the summer of 1973. As with the Vancouver study, the Prince George study is essentially an extensive sampling and testing program to document existing characteristics of local storm and sewer systems and treatment facilities. A total of eleven effluent quality parameters were measured including heavy metals BOD, COD, solids, pH, temperature and toxicity.

# 2. STUDY AREA

During the time of this survey the City of Prince George had a population of approximately 35,000 people. The city is heavily industrialized and is serviced by both storm and sanitary sewers. The flows from the above sewers are kept separate and as far as the city is aware, no wastewater is being discharged into the storm sewers.

## 2.1 Storm Sewers

During the study a total of eleven storm sewer outfalls were monitored. Storm flows consisted primarily of yard drainage and street runoff with discharges from car wash operations included. Except for sample points 6,7,8,9, and 10, all stormwater outfalls monitored during the survey discharged directly into either the Fraser or Nechako Rivers. The remaining five outfalls discharged to Patricia Boulevard Canal and Hudson's Bay Slough and from there into the Fraser River.

## 2.2 City of Prince George Sewage Treatment Plant

During the sampling program, the degree of treatment provided for wastes emanating from the City of Prince George was primary

treatment.+ Incoming wastewater consisted largely of sewage and industrial wastewater. No attempt was made during this survey to determine the approximate contribution to the Prince George Sewage Treatment Plant total discharge of either industrial wastewater or sewage. The total volume of flow from the Sewage Treatment Plant was approximately 2.5 million Imp. Gal/day. As previously mentioned stormwater is collected separately and discharged without treatment.

The primary treatment plant was designed to screen, barminute and chlorinate sewage prior to discharge to the Fraser River. The influent to the headworks passed through a coarse screen where solids of 3" diameter or larger were trapped and removed. Downstream of the coarse screen was the pre-chlorination injection point and diffuser. The flow then passed through the barminuator which shreds solids to 3/8" nominal size or smaller. Following barmination, the sewage passed through a Parshall flume and the flow was automatically recorded. At ths point an electronic signal activates the chlorinator. The chlorine injection point and diffuser are located at the entrance to the contact tank and chlorine is added proportional to the flow. In the chlorine contact tank, mechanical paddles continuously stir the sewage to provide adequate mixing and prevent solids from settling out. Chlorinated sewage was then discharged to the Fraser River. A bypass around the chlorine contact tank has been provided for emergency use during maintenance operations. Discharge is to the Fraser River south of the City. (See Figure I).

2.3. Sewage Treatment Facilities for Pulp and Paper Mills

Prince George Pulp and Paper Co. Limited and Intercontinental Pulp Co. Limited jointly share domestic waste treatment facilities. The treatment system consists of two anaerobic lagoons. Overflow from the two lagoons is allowed to cascade over a series of aeration riffles and is subsequently discharged into the Fraser River. Also there was no disinfection of the 16,000 Imp. Gal/day discharge. At the time of this study, a spirogester has been provided to treat sewage from the Northwood Pulp and Timber Ltd. mill complex prior to discharge into the Fraser River. The approximate flow is 32,000 Imp. Gal/day and the discharge was not disinfected.

+ A new secondary treatment plant was completed during the latter part of 1974.

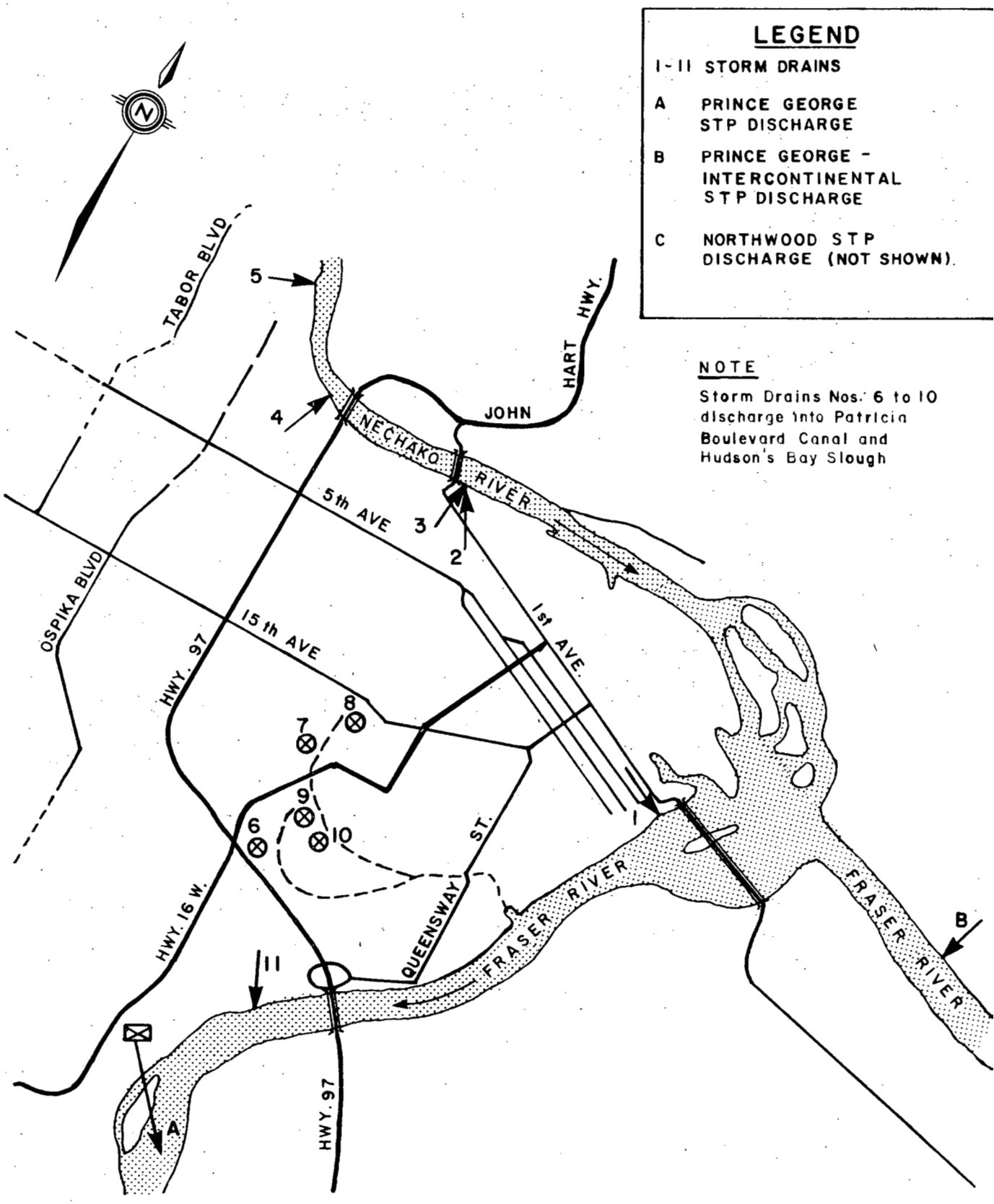


FIGURE I LOCATION OF SAMPLING STATIONS

Table 1: STORM SEWER SAMPLING STATIONS

| Sample Station | Description + |
|---|---|
| 1 | East end of 1st Ave., near Patricia St.<br>Discharge primarily street runoff.<br>Continuously flowing. |
| 2 | West end of 1st Ave., near old Fraser River bridge.<br>Discharge primarily industrial yard drainage.<br>Continuously flowing. |
| 3 | West end of 1st Ave., near old Fraser River bridge.<br>Discharge primarily runoff from residential areas and possibly includes runoff from service stations.<br>Occasionally flowing, mainly during wet periods. |
| 4 | North end of Lyon St. near the new Fraser River bridge.<br>Discharge primarily runoff from residential areas.<br>Flows only during wet periods. |
| 5 | North end of Ospika Boulevard.<br>Discharge primarily runoff from residential areas.<br>Flows only during wet periods. |

*Note: Due to variability in weather conditions which affected flows of storm sewers flow volumes were not estimated.

---

+ Information from personal communication with City of Prince George engineering department.

| | |
|---|---|
| 6 | Close to Bypass and No. 16 Hwy. near senior secondary school.<br>Discharge primarily runoff from carwash on 15th Ave. Spruceland Shopping Centre, Motels on 15th Ave. and Central Way.<br>Continuously flowing. |
| 7 | Carney Hill and 20th Ave.<br>Discharge primarily runoff from residential areas.<br>Flows only during wet periods. |
| 8 | Winnipeg and 15th Ave.<br>Discharge primarily runoff from residential areas and carwash operation.<br>Flows during wet periods and occasionally during other times. |
| 9 | West end of Strathcona Ave., near No. 16 Hwy.<br>Discharge primarily runoff from residential areas.<br>Flows only during wet periods. |
| 10 | Milburn St. near MacDonald Ave.<br>Discharge primarily runoff from residential areas.<br>Flows only during wet periods. |
| 11 | Ferry Ave. near Williams St.<br>Discharge primarily runoff from residential areas.<br>Flows only during wet periods. |

## 3. MATERIALS AND METHODS

The 1973 preliminary effluent quality survey of the Prince George municipal and stormwater discharges was carried out during the period June 6 - July 24.

### 3.1 Sample Stations

The designated study area included the monitoring of 11 storm sewer outfalls, the City of Prince George sewage treatment plant discharge and the domestic sewage discharge from the three pulp-mills - Prince George Pulp and Paper Limited, Intercontinental Pulp Limited, and Northwood Pulp and Timber Limited. The locations of the sampling sites are illustrated in Figure 1, and described in Table 1.

### 3.2. Sampling Program

Because of the variability of sewage, industrial wastewater and stormwater characteristics due to the actions of the user or weather conditions, irregular sampling dates and times were scheduled in attempts to obtain more representative results. All sampling procedures and techniques were as prescribed by "Standard Methods", 13th Edition. All samples collected were grab samples and were collected over a period of approximately 10 minutes.

Due to the time factor involved in shipping samples from Prince George to Vancouver for analysis, field preservation was necessary. Every sample was received at the Vancouver laboratory within 24 hours of collection.

Even with the limitations inherent in a brief two week summer sampling program, the data does provide some measure of the concentrations of contaminants and toxicity levels to be expected.

### 3.3. Notes on Analytical Methods

Further to the methods outlined in Standard Methods, 13th Edition, the following notes are added for further clarification;

3.3.1 Metals. Samples for metal analysis may be classified under four distinct categories, namely dissolved, suspended, total and extractable metals. The metal results reported in this study are dissolved and extractable. Dissolved metals are known to be responsible for much of

the toxicity of wastewater to fish (McKee & Wolf, 1963) while extractable metals are more of a potential threat to the fishery resources and therefore must be controlled very carefully.

For the measurement of the dissolved portion of metals, each sample upon collection was acidified with nitric acid to pH 5. Since proper equipment was not available for field filtration the sample was filtered upon arrival in the Vancouver Laboratory and was further acidified to pH 1.5 with concentrated nitric acid

For the measurement of the extractable portion of metals, each sample was acidified directly in the field with concentrated nitric acid down to a pH of 1.5.

Method: The following table gives detailed information on the laboratory procedure used for specific metals analysis. All metal analysis were carried out with a Jarrell-Ash Model 82-800 atomic absorption spectrophotometer.

TABLE 2: INSTRUMENT PARAMETERS

| Metal | Method | Primary | Band Pass | Back Ground Correction | Band Pass | Oxidant Fuel |
|---|---|---|---|---|---|---|
| Pb | AA,APDC-MIBK | 2170A | 10A | 2204 (Pb) | 10A | $C_2H_2$/air |
| 2n | AA | 2139A | 10A | Continuous | 10A | $C_2H_2$/air |
| Cd | AA | 2288A | 10A | Continuous | 10A | $C_2H_2$/air |
| Cu | AA | 3247A | 10A | - | - | $C_2H_2$/air |
| Cr | AE | 4254A | 0.5A | 4254A | 0.5A | $C_2H_2/N_2O$ |
| Ni | AA | 2320A | 2A | 2316A | 2A | $C_2H_2$/air |

Results

The symbol N/D indicates that the specific metal was not detected. The limits indicated below are not necessarily detection limits but are levels which are meaningfully determined with direct aspiration and background correction techniques. The limits are in micrograms/ml and apply to fresh water samples only.

| | |
|---|---|
| Cu - 0.01 | Pb - 0.1 (extraction 0.02) |
| Cr - 0.02 | Zn - 0.01 |
| Cd - 0.01 | Ni - 0.1 |

The following table gives some indication of how well a metal sample can be preserved at various pH values.

TABLE 3: Concentration of Ions In Solution versus pH*
(measured 24 hours after preparation of solutions)

| Element | Concentration present initially/ ug ml-1 | Concentration of ions in the range 0.2 to 1 ug ml-1 in solution measured at various pH values 24 hours after preparation of solutions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | pH | 1.5 | 3.5 | 5.0 | 6.5 | 8.0 | 9.5 | 11.0 | 12.0 |
| Pb | 1.0 | 1.0 | 1.0 | ND | ND | ND | ND | ND | ND |
| Cr | 1.0 | 1.0 | 1.0 | 0.25 | 0.15 | 0.15 | 0.20 | 0.20 | 0.20 |
| Cu | 1.0 | 1.0 | 1.0 | 0.95 | 0.45 | 0.15 | ND | ND | ND |
| Ni | 1.0 | 1.0 | 1.0 | 1.0 | 0.90 | 0.75 | 0.05 | ND | ND |
| 2n | 0.50 | 0.50 | 0.50 | 0.50 | 0.45 | 0.25 | ND | ND | 0.25 |
| Cd | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.06 | | 0.06 | |

3.3.2 Phenols. Phenols are defined as hydroxy derivatives of aromatic compounds. The 4 aminoantipyrine test currently used to quantitate phenols, measures only those phenols which react with the reagent readily and which are initially co-distillable with water.

Method: The sample is co-distilled with water and the distillate reacts with 4 aminoantipyrine at pH of 10 in the presence of potassium ferricyanide. This forms a yellow or orange antipyrine dye. This dye is extracted into chloroform and its absorbance is measured at 460 mu. It should be noted that this method of analysis does not measure all forms of phenols and only gives an indication of the amount of phenols present in the sample.

Results: The result is reported in mg/l of phenol or phenol equivalents present in the sample.

Detection Limit: 0.015 mg/l phenol (measured for phenol itself). Results are reported as "less than" (<) when it appeared as if some phenols were present but the concentration was below the level for which meaningful values could be taken but was above the detection limit. N/D indicates that phenols were not detected.

*Analyst, March, 1973, Vol. 98.

3.3.3 Petroleum Ether Extractable Substances.

Large quantities of petroleum ether extractables are found in wastes from packing plants, slaughter houses, rendering plants, refineries, cotton seed processing plants, textile mills, milk processing plants and chemical works.

Petroleum oil may be found in water wherever an agency is engaged in production, transportation, oil loading points, refineries, civic dumps, salvage dumps, garages and industries.

Method: The acidified sample is filtered and the residue dried. Using a Soxlet Extractor, the ether extractable portion is removed by continuous extraction.

Results: Expressed as mg/litre petroleum ether extractable oil.

Detection Limit: 5 mg/l.

3.3.4 Cyanide. Cyanide (CN) occurs in effluents from gas works and coke ovens; from scrubbing of gases at seal plants; from metal cleaning and electroplating processes; and from chemical industries. If present in water, it is usually in the form of hydrogen cyanide (HCN) at lower pH's.

Method: The sample containing concentrated sulfuric acid and a catalyst is refluxed and distilled. The simple and complex cyanides are converted into HCN gas, which is bubbled through a sodium hydroxide (NaOH) solution. The resultant sodium cyanide is chlorinated with chloramine T and reacted with a solution of pyridine-pyrozolone to form a blue complex dye. This is measured colorimetrically.

Results: Reported in mg/litre CN

Detection Limit: 0.006 mg/l CN

3.3.5 Residue Analysis. (a) Total Residue (TR)

The term "total residue" refers to the material left in the vessel after evaporation of all water. All natural waters have some residue left after evaporation and any effluent discharged into a stream or lake will likely change this natural total residue content. Total residue includes all inorganic salts, organic substances not volatilized at 103°C, and suspended matter.

Method: 100 mls of sample are placed in a pre-weighed evaporating dish and the sample is evaporated to dryness at 90°C. The temperature is then increased to 103°C for 2 hours and the dish is desiccated and weighed. The increase in weight is used to calculate the total residue.

Results: Expressed in mg/litre

Detection Limit: 2.5 mg/l per 100 ml sample.

(b) Non Filterable Residue (NFR)

NFR is that portion of the total residue retained by a specific filter. The filter type and size must be specified. Non-filterable residue is also called "suspended matter".

Method: Samples with high NFR values are filtered through a pre-weighed buchner funnel, containing a GF/C paper. The funnel is dried at 103°C and re-weighed. The increase in weight is used to calculate the NFR value in mg/litre. Samples with low NFR values are run for total residue and filterable residue. The difference is taken to be the NFR value.

Results:

Detection Limit: 2.5 mg/l per 100 ml sample.

3.3.6 Residual Chlorine. Chlorine is not a normal constituent of natural waters. Chlorine may be present in water as free available chlorine in the form of hypochlorous acid and/or hypochlorite ion, or as a chloramine. Chlorine is a bactericidal agent used in swimming pools, disinfection of water and wastewater and is also used to improve water quality.

Free available chlorine may also be found in industrial processes employing bleaching, e.g. pulp mills.

Method: Amperometric titration method was used to determine chlorine residuals. Chlorine is titrated in the presence of potassium iodide in the pH range of 3.5 - 4.5. The proper pH range was carefully maintained to eliminate interferences. The instrument used was a Wallace & Tiernan Amperometric Titrator Series A - 790013.

Results: Expressed as mg/litre Cl.

Detection Limit: 0.02 mg/l.

3.3.7. Bioassay. The bioassay test employed by E.P.S. gives an approximate value of the biological toxicity of an effluent to salmonids. Bioassays are useful in determining the harmful effects of pesticides, cleaning agents, oil dispersants, effluents, or any deleterious substance.

Bioassay results are not absolute values. The results should be viewed as guides only and are subject to water temperature, test concentration, the species of fish, size, age and condition of fish, as well as other parameters at the time of testing.

Method: The Bioassays at the Environment Canada Laboratory in West Vancouver are performed in twenty-two litre glass aquaria using five to twenty coho fry depending on their size. The aquaria are placed in a constant temperature bath and are aerated through the ninety-six hour test period.

In the bioassay lab two different tests are commonly performed -96 hr $LC_{50}$'s and 96 hr $LT_{50}$'s.

96 hour $LC_{50}$ - This term refers to Median Lethal Concentration or that level or a measurable lethal agent required to kill the 50th percentile in a group of test organisms, over the time period of 96 hours. The 50th percentile is meant to represent the average organism. The $LC_{50}$ consists of a series of dilutions which allow a semi-log plot of the percent mortality for each concentration. From the plot it is determined at which concentration the 50th percentile organism would die. The terms 96 hour $LC_{50}$, $TL_{50}$ and $TL_m$ give the same numerical value, and can be used interchangeably.

96 hour $LT_{50}$ - This term refers to Median Lethal Time or the time to death of the 50th percentile organism in a specific concentration or level of measurable lethal agent (used interchangeably with MST, Median Survival Time). The exposure time must be specified, and, in this case is 96 hours. The $LT_{50}$ consists of a single concentration on which frequent observations of mortalities are made. A semi-log plot of the percent mortalities determines the time to death of the 50th percentile organism.

For the foregoing tests, fish loading density is important and it should be noted that for high fish loading densities (i.e. greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated. No fewer than 5 fish were used per concentration with 10-20 being desirable to achieve a statistically valid result. The fish stock is acclimated to the test temperature and dilution water at least two weeks before being used in a bioassay. The temperature during any single bioassay is not varied more than 2 degrees and is maintained within the range of 7 to 15 degrees centigrade for survival of cold water fish species.

If aeration is used, it is kept to a minimum to reduce the volatization of toxicants such as phenols, chlorides, hydrogen sulfide etc.

Results: Reported at 96 hr TL (used interchangeably with 96 hour $LC_{50}$), threshold, and/or 96 hr $LT_{50}$. For example: $TL_m$ 96 - 32% (also 96 hr $LC_{50}$ = 32%) means that at a concentration containing 32% effluent, the median test fish would die in 96 hours.

A reported threshold value of 10% means that at a concentration containing 10% effluent, no test fish would die over the exposure period of 96 hours.

In a concentration of 32% effluent a 96 hr $LT_{50}$ = 60 hrs means that at the specified concentration (32%) the median of the test fish would die in 60 hours over a total test period of 96 hours.

# 4.1 BIOASSAY DETERMINATIONS

TABLES 4- 17

TABLE 4: BIOASSAY DETERMINATIONS - STORM SEWER NO. 1

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | 0815 | 7.21 | 7.03 | Non-toxic | 1.7* | 8.5 | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | 1045 | 7.15 | 7.27 | 10% Mort.at 100% in 96hrs | 1.7* | 8.5 | <0.01 |
| 19/06/73 | | | | | | | 0.27 |
| 20/06/73 | 1105 | 7.04 | 7.01 | $LC_{50}$=80% | 2.7* | 8.5 | 0 |
| 21/06/73 | | | | | | | 0 |
| 22/06/73 | 1220 | 7.58 | 7.54 | Non-toxic | 2.7* | 8.5 | 0 |

1. Grams of fish per litre of bioassay solution.

2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 5: BIOASSAY DETERMINATIONS - STORM SEWER NO. 2

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | 1115 | 8.02 | 7.73 | Non-toxic | 1.7* | 8.5 | <0.01 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | 1115 | 8.04 | 7.78 | Non-toxic | 2.7* | 8.5 | 0.27 |
| 20/06/73 | 1040 | 8.02 | 7.73 | Non-toxic | 2.7* | 8.5 | 0 |
| 21/06/73 | | | | | | | 0 |
| 22/06/73 | 1205 | 7.25 | 7.54 | Non-toxic | 2.7* | 8.5 | 0 |

1. Grams of fish per litre of bioassay solution.

2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 6: BIOASSAY DETERMINATIONS - STORM SEWER NO. 3

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Biosassay Temp. (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 11/06/73 | | | | | | | 0 |
| 12/06/73 | 1915 | 6.86 | 6.52 | $LC_{50}$=22% | 1.7* | 8.5 | 0.14 |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | No Flow | | | | | | <0.01 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | No Flow | | | | | | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | No Flow | | | | | | 0 |
| 23/06/73 | | | | | | | 0.07 |
| 24/06/73 | 1120 | 6.88 | 6.59 | $LC_{50}$=56% | 2.7* | 8.5 | 0.30 |

1. Grams of fish per litre of bioassay solution.

2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 7: BIOASSAY DETERMINATIONS - STORM SEWER NO. 4

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 11/06/73 | | | | | | | 0 |
| 12/06/73 | 2010 | 6.98 | 6.82 | $LC_{50}$=42% | 1.7* | 8.5 | 0.14 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | No Flow | | | | | | < 0.01 |
| 19/06/73 | | | | | | | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | No Flow | | | | | | 0 |
| 23/06/73 | | | | | | | 0.07 |
| 24/06/73 | 1050 | 7.05 | 6.63 | $LC_{50}$=80% | 2.7* | 8.5 | 0.30 |

1. Grams of fish per litre of bioassay solution.
2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e. Greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 8: BIOASSAY DETERMINATIONS - STORM SEWER NO. 5

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | No Flow | | | | | | <0.01 |
| 17/06/73 | 1015 | 6.90 | 6.60 | Not Estab. 20% mort.at 100% in 48 hours | 1.7* | 8.5 | 0.94 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | No Flow | | | | | | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | No Flow | | | | | | 0 |

1. Grams of fish per litre of bioassay solution.

2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 9: BIOASSAY DETERMINATIONS - STORM SEWER NO. 6

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | 0900 | 8.13 | 7.27 | Non-toxic | 1.7* | 8.5 | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | 1150 | 7.53 | 7.55 | $LC_{50}$=47% | 1.7* | 8.5 | <0.01 |
| 19/06/73 | | | | | | | 0.27 |
| 20/06/73 | 1155 | 7.93 | 7.46 | $LC_{50}$=86% | 2.7* | 8.5 | 0 |
| 21/06/73 | | | | | | | 0 |
| 22/06/73 | 1255 | 7.35 | 6.78 | $LC_{50}$=16% | 2.7* | 8.5 | 0 |

1. Grams of fish per litre of bioassay solution
2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 10: BIOASSAY DETERMINATIONS - STORM SEWER NO. 7

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | No Flow | | | | | | <0.01 |
| 17/06/73 | 1035 | 6.93 | 6.70 | $LC_{50}$=44% | 2.7* | 8.5 | 0.94 |
| 19/06/73 | | | | | | | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | No Flow | | | | | | 0 |
| 23/06/73 | | | | | | | 0.07 |
| 24/06/73 | No Flow | | | | | | 0.30 |

1. Grams of fish per litre of bioassay solution.

2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 11: BIOASSAY DETERMINATIONS - STORM SEWER NO. 8

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp ($^{o}C$) | Precip.[2] (in) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06 | | | | | | | 0.01 |
| 14/06 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | No Flow | | | | | | < 0.01 |
| 17/06/73 | 1050 | 7.04 | 6.58 | $LC_{50}$=39% | 1.7* | 8.5 | 0.94 |
| 19/06/73 | | | | | | | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | 1315 | 8.64 | 6.78 | $LC_{50}$=2.6% | 2.7* | 8.5 | 0 |
| 23/06/73 | | | | | | | 0.07 |
| 24/06/73 | No Flow | | | | | | 0.30 |

1. Grams of fish per litre of bioassay solution.
2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 12: BIOASSAY DETERMINATIONS - STORM SEWER NO. 9

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | No Flow | | | | | | <0.01 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | 1410 | 8.98 | 7.26 | $LC_{50}$=72% | 1.7* | 8.5 | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | No Flow | | | | | | 0 |
| 23/06/73 | | | | | | | 0.07 |
| 24/06/73 | No Flow | | | | | | 0.30 |

1. Grams of fish per litre of bioassay solution.

2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 13: BIOASSAY DETERMINATIONS - STORM SEWER NO. 10

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | No Flow | | | | | | <0.01 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | 1430 | 7.14 | 7.05 | $LC_{50}$=70% | 2.7* | 8.5 | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | No Flow | | | | | | 0 |
| 23/06/73 | | | | | | | 0.07 |
| 24/06/73 | No Flow | | | | | | 0.30 |

1. Grams of fish per litre of bioassay solution
2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than o.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 14: BIOASSAY DETERMINATIONS - STORM SEWER NO. 11

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 13/06/73 | | | | | | | 0.01 |
| 14/06/73 | No Flow | | | | | | 0.04 |
| 15/06/73 | | | | | | | 0.02 |
| 16/06/73 | | | | | | | <0.01 |
| 17/06/73 | 1230 | 7.22 | 6.95 | Not.estab. 10% mort. at 100% in 24 hours. | 1.7* | 8.5 | 0.94 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | No Flow | | | | | | 0.27 |
| 20/06/73 | No Flow | | | | | | 0 |
| 21/06/73 | No Flow | | | | | | 0 |
| 22/06/73 | No Flow | | | | | | 0 |
| 23/06/73 | | | | | | | 0.07 |
| 24/06/73 | No Flow | | | | | | 0.30 |

1. Grams of fish per litre of bioassay solution.
2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 15: BIOASSAY DETERMINATIONS - CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT

| Date | Time | Flow | pH | | Toxicity | Fish Loading Density[2] (gm/l) | Bioassay Temp ($^{o}C$) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|---|
| | | | Initial | Final | | | | |
| 14/06/73 | | | | | | | | 0.04 |
| 15/06/73 | 0530 | Low | 7.42 | 6.72 | $LC_{50}$=18% | 1.7* | 8.5 | 0.02 |
| | 1245 | High | 7.38 | 7.45 | $LC_{50}$=42% | 1.7* | 8.5 | 0.02 |
| 16/06/73 | | | | | | | | <0.01 |
| 17/06/73 | 0515 | Low | 7.16 | 6.73 | $LC_{50}$=7.7% | 1.7* | 8.5 | 0.94 |
| | 1250 | High | 7.57 | 7.46 | $LC_{50}$=42% | 1.7* | 8.5 | 0.94 |
| 20/06/73 | | | | | | | | 0 |
| 21/06/73 | 0515 | Low | 7.22 | 7.17 | $LC_{50}$=72% | 2.7* | 8.5 | 0 |
| | 1245 | High | 7.26 | 7.35 | $LC_{50}$=42% | 2.7* | 8.5 | 0 |
| 23/06/73 | | | | | | | | 0.30 |
| 24/06/73 | 0505 | Low | 7.10 | 7.13 | $LC_{50}$=72% | 2.2* | 8.5 | 0.30 |
| | 1300 | High | 7.26 | 7.32 | $LC_{50}$=42% | 2.7* | 8.5 | 0.30 |
| 18/06/73 | 1505[a] | | 7.16 | 7.15 | $LC_{50}$=26% | 1.8* | 8.5 | 0.94 |
| | 1525[b] | | 7.19 | 7.14 | $LC_{50}$=24% | 1.8* | 8.5 | 0.94 |

1. Flow conditions at treatment plant. Flow recorder down for repair: High flow approximately 6-7 cfs; Low flow approximately 2-3 cfs.
2. Grams of fish per litre of bioassay solution.
3. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

a. Pre-chlorination sample.
b. Post - chlorination sample.

* It should be noted for high fish loading densities (i.e. greater than o.5 = 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 16: BIOASSAY DETERMINATIONS - PRINCE GEORGE PULP AND PAPER LTD, AND INTERCONTINENTAL PULP LTD. DOMESTIC SEWAGE TREATMENT SYSTEM

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 14/06/73 | | | | | | | 0.04 |
| 15/06/73 | 1200 | 9.39 | | Non-toxic | 1.7* | 8.5 | 0.02 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | 1050 | 7.99 | 7.53 | Non-toxic | 2.7* | 8.5 | 0.27 |
| 20/06/73 | | | | | | | 0 |
| 21/06/73 | 1035 | 7.86 | 7.53 | Non-toxic | 2.7* | 8.5 | 0 |
| 25/06/73 | | | | | | | 0.12 |
| 26/06/73 | 1505 | 8.44 | 7.56 | Non-toxic | 2.7* | 8.5 | 0 |

1. Grams of fish per litre of bioassay solution.
2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

TABLE 17: BIOASSAY DETERMINATIONS - NORTHWOOD PULP AND TIMBER LTD. DOMESTIC SEWAGE TREATMENT SYSTEM.

| Date | Time | pH | | Toxicity | Fish Loading Density[1] (gm/l) | Bioassay Temp. (°C) | Precip.[2] (in.) |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | | | | |
| 14/06/73 | | | | | | | 0.04 |
| 15/06/73 | 1115 | 7.09 | 7.08 | Non-toxic | 1.7* | 8.5 | 0.02 |
| 18/06/73 | | | | | | | 0.01 |
| 19/06/73 | 0950 | 6.91 | 6.96 | Non-toxic | 2.7* | 8.5 | 0.27 |
| 20/06/73 | | | | | | | 0 |
| 21/06/73 | 1010 | 7.04 | 7.10 | Non-toxic | 2.7* | 8.5 | 0 |
| 25/06/73 | | | | | | | 0.12 |
| 26/06/73 | 1440 | 7.14 | 7.10 | Non-toxic | 2.7* | 8.5 | 0 |

1. Grams of fish per litre of bioassay solution.
2. Data from Atmospheric Environment Service. Readings taken from gauging station for Prince George.

* It should be noted for high fish loading densities (i.e.: greater than 0.5 - 1.0 gm/l) the toxicity of the sample may have been underestimated.

# 4.2 HEAVY METAL ANALYSIS

TABLES 18 - 31

TABLE 18: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 1

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | ZN ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | Dissolved | 0.01 | 0.08 | 0.02 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 0.23 | 0.03 | <0.06 | <0.03 | <0.02 |
| 16/06/73 | Dissolved | 0.01 | 0.46 | 0.04 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 1.03 | 0.03 | <0.06 | <0.03 | <0.02 |
| 20/06/73 | Dissolved | 0.02 | 0.85 | 0.03 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | | 0.05 | <0.06 | <0.03 | <0.02 |
| 22/06/73 | Dissolved | <0.01 | 0.63 | 0.02 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 0.84 | <0.01 | <0.06 | <0.03 | <0.02 |

TABLE 19: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 2

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.1 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | | No Flow | | | | | |
| 16/06/73 | Dissolved | 0.02 | 0.05 | 0.03 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.03 | 0.15 | 0.04 | <0.06 | <0.03 | <0.02 |
| 19/06/73 | Dissolved | 0.08 | 0.04 | 0.03 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.08 | 0.06 | <0.02 | <0.06 | <0.03 | <0.02 |
| 20/06/73 | Dissolved | 0.06 | 0.49 | 0.61 | <0.06 | <0.03 | 0.02 |
| | Extractable | 0.07 | | 0.60 | <0.06 | <0.03 | <0.02 |
| 22/06/73 | Dissolved | 0.01 | <0.01 | 0.01 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.02 | 0.03 | 0.02 | <0.06 | <0.03 | <0.02 |

TABLE 20: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 3

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 11/06/73 | | No Flow | | | | | |
| 12/06/73 | Dissolved | 0.01 | 0.06 | 0.02 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.02 | 0.19 | <0.02 | <0.06 | <0.03 | 0.14 |
| 16/06/73 | | No Flow | | | | | |
| 19/06/73 | | No Flow | | | | | |
| 20/06/73 | | No Flow | | | | | |
| 21/06/73 | | No Flow | | | | | |
| 22/06/73 | | No Flow | | | | | |
| 24/06/73 | Dissolved | 0.02 | 0.02 | <0.01 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.01 | 0.07 | <0.01 | <0.06 | <0.03 | 0.02 |

TABLE 21: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 4

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 12/06/73 | Dissolved | <0.01 | <0.01 | 0.04 | <0.06 | <0.03 | 0.02 |
| | Extractable | 0.03 | 0.11 | 0.03 | <0.06 | <0.03 | 0.13 |
| 16/06/73 | | No Flow | | | | | |
| 20/06/73 | | No Flow | | | | | |
| 21/06/73 | | No Flow | | | | | |
| 22/06/73 | | No Flow | | | | | |
| 24/06/73 | Dissolved | <0.01 | <0.01 | 0.01 | <0.06 | <0.03 | 0.02 |
| | Extractable | 0.01 | 0.07 | <0.01 | <0.06 | <0.03 | 0.02 |

TABLE 22: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 5

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | | No Flow | | | | | |
| 16/06/73 | | No Flow | | | | | |
| 17/06/73 | Dissolved | <0.01 | 0.05 | 0.03 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 0.16 | <0.02 | <0.06 | <0.03 | <0.02 |
| 19/06/73 | | No Flow | | | | | |
| 20/06/73 | | No Flow | | | | | |
| 21/06/73 | | No Flow | | | | | |
| 22/06/73 | | No Flow | | | | | |

TABLE 23: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 6

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | Dissolved | 0.02 | 0.30 | 0.04 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.02 | 0.41 | 0.03 | <0.06 | <0.03 | <0.02 |
| 16/06/73 | Dissolved | 0.14 | 2.33 | 0.11 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.38 | 6.50 | 0.11 | <0.06 | <0.03 | <0.60 |
| 20/06/73 | Dissolved | 0.04 | 0.02 | <0.02 | <0.06 | <0.03 | 0.02 |
| | Extractable | 0.04 | 0.03 | <0.02 | <0.06 | <0.03 | <0.02 |
| 22/06/73 | Dissolved | 0.06 | | <0.01 | <0.06 | <0.03 | 0.04 |
| | Extractable | 0.12 | | 0.07 | <0.06 | <0.03 | <0.02 |

TABLE 24: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 7

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | | No flow | | | | | |
| 16/06/73 | | No flow | | | | | |
| 17/06/73 | Dissolved | <0.01 | 0.04 | 0.03 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.01 | 0.10 | 0.02 | <0.06 | <0.03 | <0.02 |
| 20/06/73 | | No flow | | | | | |
| 21/06/73 | | No flow | | | | | |
| 22/06/73 | | No flow | | | | | |
| 24/06/73 | | No flow | | | | | |

TABLE 25: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 8

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06 | | No flow | | | | | |
| 16/06/73 | | no flow | | | | | |
| 17/06/73 | Dissolved | 0.01 | 0.18 | 0.04 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.01 | 0.18 | 0.04 | <0.06 | <0.03 | <0.02 |
| 20/06/73 | | No flow | | | | | |
| 21/06/73 | | No flow | | | | | |
| 22/06/73 | Dissolved | 0.02 | 0.02 | 0.01 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.02 | 0.08 | <0.01 | <0.06 | <0.03 | <0.02 |
| 24/06/73 | | No flow | | | | | |

TABLE 26: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 9

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | | No flow | | | | | |
| 16/06/73 | | No flow | | | | | |
| 19/06/73 | Dissolved | 0.01 | <0.01 | 0.02 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 0.06 | 0.03 | <0.06 | <0.03 | 0.04 |
| 20/06/73 | | No flow | | | | | |
| 21/06/73 | | no flow | | | | | |
| 22/06/73 | | No flow | | | | | |
| 24/06/73 | | No flow | | | | | |

TABLE 27: HEAVY METAL CONCENTRATIONS - STORM SEWER No. 10

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | | No flow | | | | | |
| 16/06/73 | | No flow | | | | | |
| 19/06/73 | Dissolved | 0.01 | <0.01 | <0.02 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 0.02 | <0.02 | <0.06 | <0.03 | 0.05 |
| 20/06/73 | | No flow | | | | | |
| 21/06/73 | | No flow | | | | | |
| 22/06/73 | | No flow | | | | | |
| 24/06/73 | | No flow | | | | | |

TABLE 28: HEAVY METAL CONCENTRATIONS - STORM SEWER NO. 11

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 14/06/73 | | No flow | | | | | |
| 16/06/73 | | No flow | | | | | |
| 17/06/73 | Dissolved | <0.01 | 0.05 | <0.02 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.01 | 0.14 | 0.03 | <0.06 | <0.03 | <0.02 |
| 19/06/73 | | No flow | | | | | |
| 20/06/73 | | No flow | | | | | |
| 21/06/73 | | No flow | | | | | |
| 22/06/73 | | No flow | | | | | |
| 24/06/73 | | No flow | | | | | |

TABLE 29: HEAVY METAL CONCENTRATIONS - CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT

| Date | Flow[2] | | Concentration mg/I | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Cu ±o.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 15/06/73 | Low | Dissolved | 0.12 | 0.07 | 0.05 | <0.06 | <0.03 | <0.02 |
| | | Extractable | 0.13 | 0.07 | 0.05 | <0.06 | <0.03 | 0.11 |
| | High | Dissolved | 0.32 | 0.11 | 0.18 | <0.06 | <0.03 | <0.02 |
| | | Extractable | 0.37 | 0.18 | 0.18 | 0.14 | <0.03 | <0.02 |
| 17/06/73 | Low | Dissolved | 0.18 | 0.13 | 0.07 | <0.06 | <0.03 | <0.02 |
| | | Extractable | 0.19 | 0.15 | 0.05 | <0.06 | <0.03 | <0.02 |
| | High | Dissolved | 0.25 | 0.24 | 0.06 | <0.06 | <0.03 | <0.02 |
| | | Extractable | 0.31 | 0.32 | 0.05 | <0.06 | <0.03 | <0.02 |
| 21/06/73 | Low | Dissolved | 0.15 | 0.08 | <0.01 | <0.06 | <0.03 | <0.02 |
| | | Extractable | 0.23 | 0.14 | 0.01 | <0.06 | <0.03 | <0.02 |
| | High | Dissolved | 0.37 | 0.43 | 0.02 | <0.06 | <0.03 | <0.02 |
| | | Extractable | 0.41 | 0.50 | 0.03 | <0.06 | <0.03 | <0.02 |
| 26/06/73 | Low | Dissolved | 0.20 | 0.08 | 0.03 | <0.06 | <0.03 | 0.03 |
| | | Extractable | 0.21 | 0.09 | 0.02 | <0.06 | <0.03 | <0.02 |
| | High | Dissolved | 0.12 | 0.16 | 0.03 | <0.06 | <0.03 | <0.02 |
| | | Extractable | 0.06 | 0.18 | <0.02 | <0.06 | <0.03 | <0.02 |

2. Flow conditions at treatment plant. Flow recorder down for repair. High flow approximately 6-7 cfs; low flow approximately 2-3 cfs.

TABLE 30: HEAVY METAL CONCENTRATIONS - PRINCE GEORGE PULP AND PAPER LIMITED AND INTERCONTINENTAL PULP LIMITED DOMESTIC SEWAGE TREATMENT SYSTEM

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 15/06/73 | Dissolved | 0.02 | <0.01 | 0.03 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.02 | <0.01 | <0.02 | <0.06 | <0.03 | <0.02 |
| 19/06/73 | Dissolved | <0.01 | <0.01 | <0.04 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | <0.01 | <0.02 | <0.06 | <0.03 | <0.02 |
| 21/06/73 | Dissolved | 0.02 | <0.01 | 0.01 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.03 | 0.02 | <0.01 | <0.06 | <0.03 | <0.02 |
| 26/06 | Dissolved | 0.02 | 0.04 | 0.01 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.02 | <0.01 | 0.01 | <0.06 | <0.03 | <0.02 |

TABLE 31: HEAVY METAL CONCENTRATIONS - NORTHWOOD PULP AND TIMBER LIMITED DOMESTIC SEWAGE TREATMENT SYSTEM.

| Date | | Concentration mg/l | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cu ±0.01 | Zn ±0.01 | Cr ±0.02 | Ni ±0.01 | Cd ±0.01 | Pb ±0.01 |
| 15/06/73 | Dissolved | 0.01 | 0.05 | 0.03 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 0.05 | 0.04 | <0.06 | <0.03 | <0.02 |
| 19/06/73 | Dissolved | 0.01 | 0.03 | 0.04 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.01 | 0.09 | 0.19 | <0.06 | <0.03 | <0.02 |
| 21/06/73 | Dissolved | 0.01 | 0.01 | <0.01 | <0.06 | <0.03 | <0.02 |
| | Extractable | <0.01 | 0.04 | 0.01 | <0.06 | <0.03 | <0.02 |
| 26/06/73 | Dissolved | 0.01 | <0.01 | <0.01 | <0.06 | <0.03 | <0.02 |
| | Extractable | 0.01 | 0.06 | 0.01 | <0.06 | <0.03 | <0.02 |

## 4.3 ADDITIONAL ANALYTICAL RESULTS

TABLES 32 - 45

TABLE 32: CHEMICAL RESULTS - STORM SEWER No.1

| Date | Temp. (°C) | pH | $BOD_5$ (mg/l) | | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Avg. | Range | | | | | | |
| 14/06/73 | 14.0 | 7.21 | - | (>32) | 82.0 | 242.2 | 10.5 | <0.015 | - | <0.006 |
| 16/06/73 | 15.0 | 7.15 | 29 | (12-75) | 104.2 | 203.7 | - | 0.03 | 6.0 | 0.008 |
| 20/06/73 | 9.5 | 7.04 | - | (<25) | 14.6 | 213.1 | 100.0 | <0.015 | 5.4 | N/D |
| 22/06/73 | 11.0 | 7.58 | 22 | (11-34) | 27.1 | 303.4 | 34.0 | 0.015 | <5 | N/D |

TABLE 33: CHEMICAL RESULTS - STORM SEWER No. 2

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols Mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | 9.0 | 8.02 | 33 | (11-69) | 15.4 | 240.3 | - | <0.015 | 8.0 | 0.024 |
| 19/06/73 | 9.0 | 8.04 | 43 | (22-63) | 44.3 | 298.1 | 11.5 | <0.015 | 11.6 | <0.006 |
| 20/06/73 | 6.0 | 8.02 | 42 | (17-75) | 149.2 | 675.0 | 437.1 | N/D | 21.5 | N/D |
| 22/06/73 | 10.5 | 7.25 | 42 | (25-60) | 7.7 | 180.0 | 31.6 | <0.015 | <5 | <0.006 |

TABLE 34: CHEMICAL RESULTS-STORM SEWER NO. 3

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/06/73 | 14.0 | 6.86 | 48 | (39-57) | 158.8 | 374.0 | 147.8 | - | 10.8 | <0.006 |
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | No Flow | | | | | | | | | |
| 19/06/73 | No Flow | | | | | | | | | |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | No Flow | | | | | | | | | |
| 24/06/73 | 8.5 | 6.88 | 38 | (9-75) | 58.1 | 108.4 | 143.3 | <0.015 | <5 | N/D |

TABLE 35: CHEMICAL RESULTS - STORM SEWER No. 4

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/06/73 | 13.0 | 6.98 | 19 | (16-25) | 95.9 | 162.0 | 61.2 | - | < 5 | < 0.006 |
| 16/06/73 | No Flow | | | | | | | | | |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | No Flow | | | | | | | | | |
| 24/06/73 | 9.0 | 7.05 | 33 | (7-66) | 104.5 | 424.8 | 635.1 | < 0.015 | < 5 | N/D |

TABLE 36: CHEMICAL RESULTS - STORM SEWER NO. 5

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | No Flow | | | | | | | | | |
| 17/06/73 | 13.0 | 6.90 | - | <5 | 31.4 | 51.4 | 3.2 | N/D | < 5 | < 0.006 |
| 19/06/73 | No Flow | | | | | | | | | |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | No Flow | | | | | | | | | |

TABLE 37: CHEMICAL RESULTS - STORM SEWER NO. 6

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | 8.19 | 8.13 | - | <50 | 19.2 | 273.6 | <2.5 | <0.015 | - | <0.006 |
| 16/06/73 | 10.0 | 7.53 | - | 84 | 276.8 | 541.6 | - | 0.022 | 40.0 | 0.016 |
| 20/06/73 | 9.5 | 7.93 | - | <30 | 14.6 | 222.6 | 108.8 | N/D | 5.0 | N/D |
| 22/06/73 | 6.0 | 7.35 | 75 | (40-111) | 189.7 | - | 187.4 | <0.015 | 12.1 | <0.006 |

TABLE 38: CHEMICAL RESULTS - STORM SEWER No.7

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | No Flow | | | | | | | | | |
| 17/06/73 | 13.0 | 6.73 | - | <10 | 57.2 | 128.1 | 67.2 | < 0.015 | 19.0 | < 0.006 |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | No Flow | | | | | | | | | |
| 24/06/73 | No Flow | | | | | | | | | |

TABLE 39: CHEMICAL RESULTS - STORM SEWER No.8

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | No Flow | | | | | | | | | |
| 17/06/73 | 12.5 | 7.04 | - | <10 | 51.7 | 122.3 | 54.2 | <0.015 | 20.0 | <0.006 |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | 9.5 | 8.64 | 45 | (16-87) | 89.0 | - | 70.5 | <0.015 | 5.3 | <0.006 |

TABLE 40: CHEMICAL RESULTS - STORM SEWER NO. 9

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | No Flow | | | | | | | | | |
| 19/06/73 | 10.0 | 8.98 | 24 | (19-29) | 94.1 | 282.3 | 197.9 | 0.015 | 6.8 | <0.006 |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | No Flow | | | | | | | | | |
| 24/06/73 | No Flow | | | | | | | | | |

TABLE 41: CHEMICAL RESULTS - STORM SEWER No.10

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | No Flow | | | | | | | | | |
| 19/06/73 | 10.0 | 7.14 | 18 | (12-24) | 88.6 | 115.2 | 109.0 | 0.015 | 9.4 | <0.006 |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | No Flow | | | | | | | | | |
| 24/06/73 | No Flow | | | | | | | | | |

TABLE 42: CHEMICAL RESULTS - STORM SEWER NO. 11

| Date | Temp. (°C) | PH | $BOD_5$ (mg/l) Avg. | Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 14/06/73 | No Flow | | | | | | | | | |
| 16/06/73 | No Flow | | | | | | | | | |
| 17/06/73 | 13.0 | 7.20 | 13.5 | (12-15) | 44.3 | 252.6 | 138.7 | <0.015 | <5 | <0.006 |
| 19/06/73 | No Flow | | | | | | | | | |
| 20/06/73 | No Flow | | | | | | | | | |
| 21/06/73 | No Flow | | | | | | | | | |
| 22/06/73 | No Flow | | | | | | | | | |
| 24/06/73 | No Flow | | | | | | | | | |

TABLE 43: CHEMICAL RESULTS - CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT

| Date | Flow | Temp. (°C) | pH | $BOD_5$ (mg/l) Avg. | Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15/06/73 | Low | 11.0 | 7.42 | 11 | (10-12) | 50.2 | 305.5 | 16.2 | 0.023 | 16.0 | 0.088 |
| | High | 15.0 | 7.38 | 265 | (248-288) | 643.3 | 667.4 | 140.3 | 0.064 | 217.0 | 0.016 |
| 17/06/73 | Low | 14.5 | 7.16 | 29 | (18-41) | 230.6 | 542.1 | 47.5 | 0.020 | 17.0 | <0.006 |
| | High | 13.5 | 7.57 | 157 | (147-162) | 470.5 | 641.8 | 166.0 | 0.049 | 56.0 | <0.006 |
| 21/06/73 | Low | 10.0 | 7.22 | 203 | (198-207) | 274.3 | 530.8 | 80.3 | 0.020 | 61.5 | 70.4 |
| | High | 11.0 | 7.26 | - | >250 | 829.1 | 763.0 | 340.6 | 0.075 | 387.9 | 14.4 |
| 24/06/73 | Low | 10.0 | 7.10 | 129 | (123-138) | 218.2 | 457.5 | 73.9 | 0.032 | 23.3 | 0.006 |
| | High | 10.0 | 7.26 | 168 | (138-198) | 468.2 | 558.5 | 110.9 | 0.064 | 54.8 | <0.006 |

TABLE 44: CHEMICAL RESULTS - PRINCE GEORGE PULP AND PAPER LIMITED & INTERCONTINENTAL PULP LIMITED - DOMESTIC SEWAGE TREATMENT

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | $BOD_5$ (mg/l) Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15/06/73 | 15.0 | 9.39 | - | <50 | 61.8 | 197.1 | 5.4 | 0.017 | <5 | 0.008 |
| 19/06/73 | 10.0 | 7.99 | - | <10 | 62.7 | 172.4 | <2.5 | 0.025 | <5 | <0.006 |
| 21/06/73 | 10.5 | 7.86 | 20 | (8-32) | 81.9 | 155.0 | 40.0 | 0.017 | <5 | N/D |
| 26/06/73 | 12.0 | 8.44 | 27 | (17-37) | 66.4 | 210.3 | 24.6 | 0.020 | <5 | N/D |

TABLE 45: CHEMICAL RESULTS - NORTHWOOD PULP AND TIMBER LIMITED - DOMESTIC SEWAGE TREATMENT

| Date | Temp (°C) | pH | $BOD_5$ (mg/l) Avg. | Range | COD (mg/l) | T R (mg/l) | NFR (mg/l) | Phenols (mg/l) | Oils (mg/l) | Cyanide (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15/06/73 | 12.0 | 7.09 | 18 | (14-24) | 46.3 | 127.3 | 23.6 | 0.024 | 5.0 | 0.008 |
| 19/06/73 | 7.0 | 6.91 | 17 | (11-24) | 101.5 | 130.4 | 75.9 | 0.022 | <5 | <0.006 |
| 21/06/73 | 7.5 | 7.04 | - | - | 23.6 | 75.9 | < 2.5 | <0.015 | <5 | N/D |
| 26/06/73 | 8.5 | 7.14 | 75 | (73-78) | 105.4 | 174.0 | 40.0 | 0.017 | <5 | N/D |

# 4.4 RESIDUAL CHLORINE DETERMINATIONS

TABLE 46: CITY OF PRINCE GEORGE SEWAGE TREATMENT PLANT - TOTAL RESIDUAL CHLORINE+

| Date | Time | Chlorine Residual (mg/l) | Flow (cfs) |
|---|---|---|---|
| 12/07/73 | 0800 | 6.82 | 3.6 |
| | 0900 | 4.77 | 4.5 |
| | 1000 | 2.09 | 5.1 |
| | 1100 | 4.27 | 5.9 |
| | 1200 | 4.18 | 6.4 |
| | 1300 | 3.59 | 6.0 |
| | 1400 | 3.82 | 6.0 |
| | 1500 | 2.91 | 5.9 |
| | 1600 | 3.36 | 5.4 |
| 13/07/73 | 0800 | 7.19 | 2.9 |
| | 0900 | 5.91 | 4.6 |
| | 1000 | 2.91 | 5.4 |
| | 1100 | * | 6.0 |
| | 1200 | 0.23 | 6.6 |
| | 1300 | 2.68 | 6.5 |
| | 1400 | 2.24 | 6.1 |
| | 1500 | 2.91 | 5.8 |
| | 1600 | 3.26 | 5.4 |
| 16/07/73 | 2400 | 4.97 | 5.0 |
| | 0100 | 4.97 | 4.8 |
| | 0200 | 4.39 | 3.3 |
| | 0300 | 5.46 | 2.6 |
| | 0400 | 6.75 | 2.2 |
| | 0500 | 6.93 | 2.1 |
| | 0600 | 7.86 | 2.0 |
| | 0700 | 8.98 | 2.2 |
| | 0800 | 7.95 | 2.5 |

(continued)

| | | | |
|---|---|---|---|
| 17/07/73 | 2400 | 0.51 | 5.7 |
| | 0100 | 0.65 | 4.9 |
| | 0200 | 1.27 | 3.8 |
| | 0300 | 1.58 | 2.8 |
| | 0400 | 1.14 | 2.4 |
| | 0500 | 1.49 | 2.2 |
| | 0600 | 1.94 | 2.3 |
| | 0700 | 2.92 | 2.4 |
| | 0800 | 2.65 | 2.9 |

---

+ Amperometric determination of chlorine residuals. Sampling point at end of mixing chamber which is approximately 200 yards from Fraser River. Time required for discharge to reach the Fraser River from the Sampling point is approximately 2 - 3 minutes.

* Chlorinator down for repairs.

Note: Of the 44 residual chlorine readings taken 41 exceeded the Pollution Control Branch permit level of 1.0 mg/l

Due to the high toxic effects of residual chlorine Environment Canada recommends the level of 0.02 mg/l of residual chlorine as the requirement for discharge to waters habitable by fish (Servizi and Martens P.R. 29, 1974; Servizi and Martens 1975).

## 5. SUMMARY OF RESULTS

5.1 Results of the bioassay determinations show that the majority of the storm sewers were toxic to fish.

Some unusually high metal and oil concentrations were reported in the storm sewers; Zn - 6.50 ppm; Cr - 0.61 ppm; Cu - 0.38 ppm; Oils - 40.0 ppm, 21.5 ppm, 20.0 ppm.

Chemical and metal concentration and bioassay toxicity data indicate the possibility of industrial wastes entering the storm sewers.

5.2 The Prince George Primary Sewage Treatment Plant discharge was found to be toxic, and contained periodic high levels of metals and chemical contaminants: Cu - 0.41 ppm, 0.37 ppm; Zn - 0.50 ppm, 0.43 ppm; Cr - 0.18 ppm; COD - 829.1 ppm; Oil - 387.9 ppm; CN - 70.4 ppm.*

During the four days that residual chlorine determinations were performed on the Prince George Sewage Treatment Plant discharge, readings as high as 8.98 ppm and 7.95 ppm were recorded. The accepted level according to the Pollution Control Branch permit is 1.0 mg/l

5.3 Results indicate that the treated sewage discharges from the pulp mills are non-toxic and contain low levels of those chemical contaminants measured during this study.

## 6. OBSERVATIONS

1. Future studies are needed to pinpoint the origin of toxicity in individual storm sewers and sewage treatment plant effluent.

2. When the Prince George Sewage Treatment Plant's operational problems are solved, a residual chlorine monitoring program should be undertaken.

* Result rechecked and verified.

## 7. ACKNOWLEDGEMENTS

I wish to thank the engineering staff of the City of Prince George for their generous assistance. I would also like to extend thanks to the laboratory personnel for completing the sample analysis. Special appreciation is also due to Mr. L. Nemeth who assisted the author in compiling this report, and to Mr. R. Cook for his field assistance.