Environment Canada
Environmental Protection Service
Pacific and Yukon Region
Yukon Branch

START-UP CHARACTERISTICS AND PERFORMANCE EVALUATION OF AN ANAEROBIC SEWAGE LAGOON NORTH OF 60°, WHITEHORSE, YUKON TERRITORY

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ABSTRACT

The City of Whitehorse, Yukon, Canada, is located at 60°43'N, 135°03'W and has a population of 16,000.

The water distribution system was installed prior to total management of water utilities, including wastewater treatment, and resulted in a continual flow, or bleeding, system to overcome freezing in the pipes. Daily water usage is approximately 300 gallons per capita. The increased concerns with the quality of wastewater discharged has presented the problem of how to treat this dilute -- cold wastewater in this case -- using a conventional anaerobic lagoon facility.

The present study describes the start-up characteristics of a conventional anaerobic lagoon and follows performance for two years.

The temperature of the raw wastewater entering the treatment facility varies from 3° to 13°C and this has significant physical influence on the biological component and hence performance. BOD_5 removal efficiencies appear to vary independently of temperature and average 41% removal. The non-filterable residue essentially exhibits standard design removal efficiencies. The characteristics of filterable residue make it difficult to determine if the increased viscosity of the low-temperature sewage affects the settling characteristics.

As with the other parameters, the organic carbon removal is potentially similar to those for conventional design, however, radical fluctuations occur.

Other parameters measured include nutrients, ammonia, surfactants, heavy metals, conductivity, alkalinity and pH. They have all been influenced by the low temperature and/or the dilute nature of the raw wastewater.

The total and faecal coliform bacterial removal efficiencies indicate one order of magnitude reduction plus exhibiting a slight

seasonal variance suggesting increased survival during extremely low temperatures around 0°C.

Essentially, the study indicates that the design criteria used do not accommodate the climatic conditions north of 60° latitude nor does it address aquatic life and public health, the two most important elements of the receiving environment.

RESUME

La ville de Whitehorse (Yukon) est située à 60°43' de latitude nord et 135°03' de longitude ouest et a une population de 16 000 habitants.

L'installation d'un réseau de distribution d'eau dans cette ville a précédé la création d'un service public des eaux, incluant le traitement des eaux usées. Ainsi, un flot continuel circule dans les tuyaux afin d'éviter le gel de ces derniers. La consommation quotidienne est d'environ 300 gallons par personne. La qualité des eaux usées est devenue un sujet de préoccupation et a soulevé le probléme du traintement de ces eaux usées - froides dans ce cas - par l'utilisation de la technique habituelle de l'étang anaérobie.

La présente étude illustre la mise en service d'un étang anaérobie et son rendement étalé sur les deux années suivantes.

La température des eaux usées brutes qui proviennent aux installations de traitement varie entre 3° et 13° C; cette basse température a une grande influence physique sur l'élément biologique, partant le rendement. Le pouvoir d'élimination de la DBO_5 (demande biochimique en oxygéne) senble varier indépendamment dela température et conserve un taux moyen de 41%. Les résidus non filtrables indiquent un taux d'élimination mornal pour les installations. Enraison des caractéristiques des résidus filtrables, il est difficile d'établir si la plus grande viscosité des eaux usées à basse température affecte les propriétés de dépôt.

Comme pour les autres éléments, l'élimination du carbone organique est potentiellement similaire à celle des systèmes habituels; toutefois, on enregistre parfois des fluctuations radicales.

Parmi les autres éléments, soulignons les matiéres nutritives, l'ammoniaque, les substances tensio-actives, les métaux lourds, la counductivité, l'alcalinitéet le pH. Tous ces éléments ont subi l'influence de la basse température et dela dilution des eaux usées brutes, ou des deux.

Le taux d'élimination des coliformes fécaux et totaux est réduit d'un ordre de grandeur; une légère variation saisonnière, indique un taux de survie accrue durant les températures très basses, autour de 0°C.

L'étude montre essentiellement que les normes choisies ne répondent pas uax conditions atmosphériques au nord du 60e parallèle ni ne conviennent aux impératifs de vie aquatique et de santé publique, les deux plus importants éléments de tout milieu récepteur.

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1 INTRODUCTION

The Whitehorse sewage lagoon facility is located within the metropolitan area of the City of Whitehorse (60°43'N, 135°3'W; Figure 1), approximately 4 miles northeast of downtown Whitehorse on the east bank of the Yukon River. The sewage treatment facility presently serves a population of approximately 10,000 and was designed for a maximum population of 29,700. The service connections are primarily residential and commercial with a small number of service industry establishments, e.g., restaurants, hotels.

The Whitehorse area has a climate fairly typical for northern Canada even though there is significant moderation of prolonged cold weather by southerly winds. The winters are harsh with temperatures dropping as low as -45°C, but the summer months are more pleasant, enhanced by long daylight hours and temperatures of 30°C and above. The annual average frost free period is 78 days for Downtown Whitehorse (elevation 2100) and approximately 60 days at the lagoons which are elevated approximately another 100 feet. Annual average precipitation, in cm of water, is 25.95 cm with 12.25 cm as snowfall and 13.7 cm as rain.

The City of Whitehorse is characterized by a very high rate of water consumption per capita which can be related to climatic conditions. Residents bleed water continuously to the sewer system to prevent freezing of water service lines during winter. This results in water consumption of about 300 GPCD compared to 60-100 GPCD for southern communities(1). Often the bleeders are not turned off during the summer, thus maintaining the high consumption of water per capita and resulting in a most important feature, that of low-temperature dilute sewage. Presently the sewage treatment lagoons receive on average 2.9 MIGD and continually discharge to the Yukon River, which has a controlled low flow, past the City of Whitehorse, of approximately 2318 MIGD(2). The Yukon River thus has a controlled

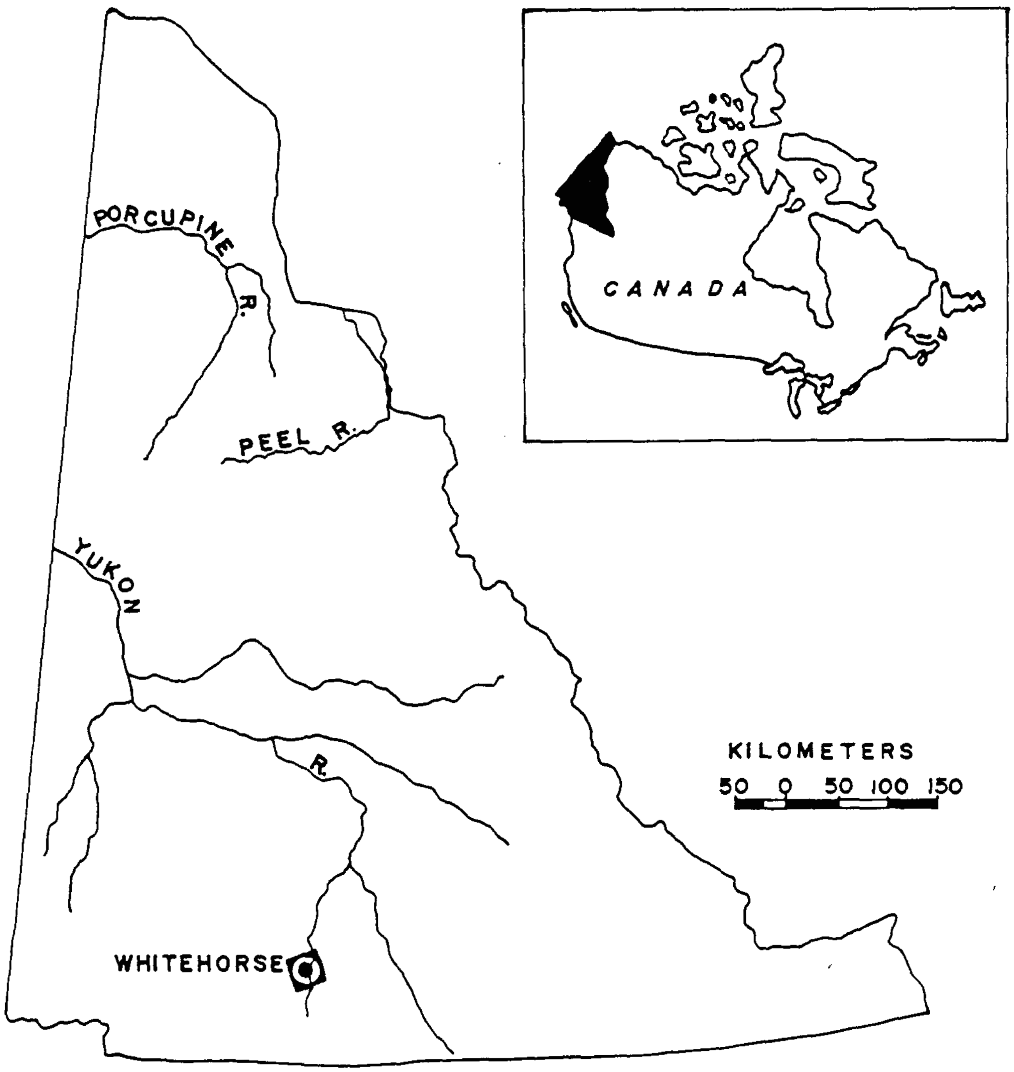


FIG. 1 WHITEHORSE (CITY OF) YUKON TERRITORY

low flow dilution ratio to the average daily sewage discharge of 800:1.

The design criteria used to prepare the construction drawings for the sewage treatment lagoons are as follows:

1. Design period of 20 years.
2. Sewage characteristics (dilute low temperatures).
3. Volume of sewage to be treated (6MIGD).
4. Treatment requirements (BOD60, SS50).

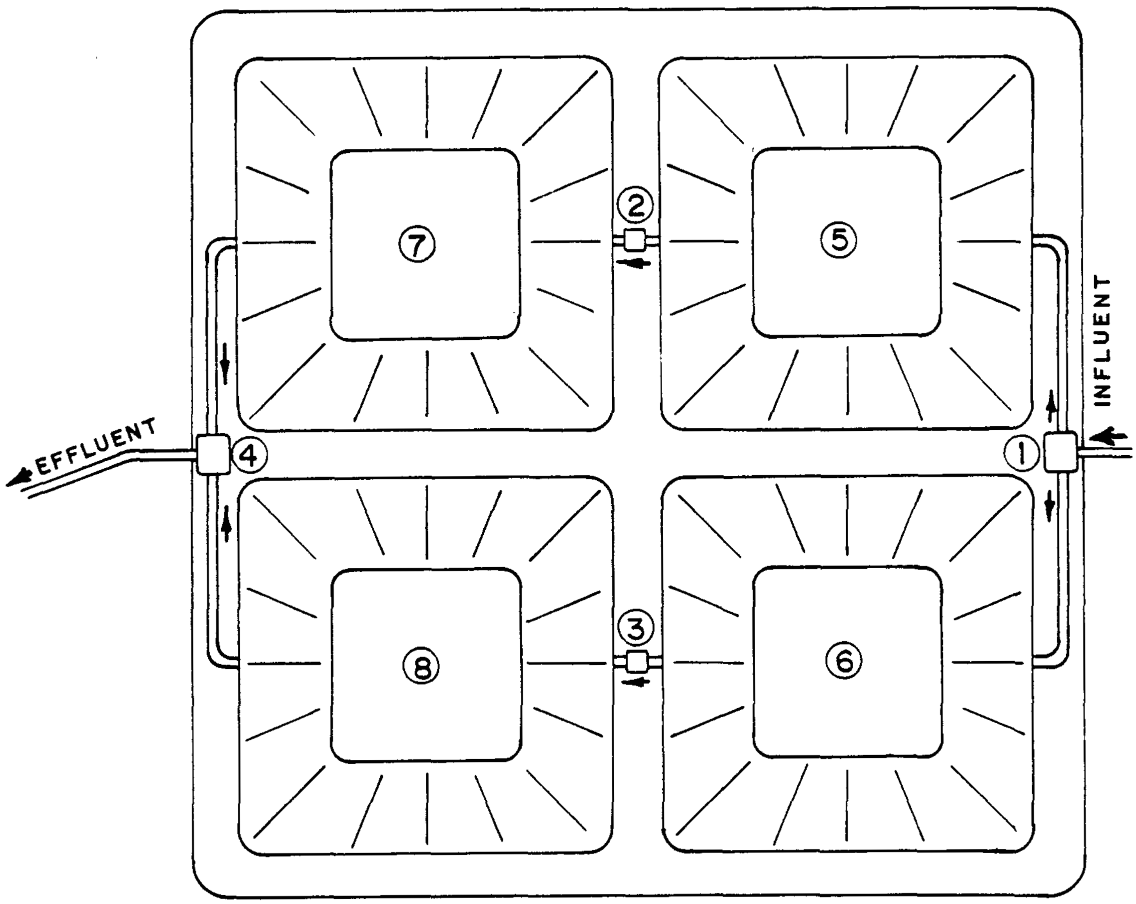
The City of Whitehorse sewage lagoons consist of four anaerobic cells (Figure 2). Each cell has a liquid volume of 68.1 million litres (15.0 million gallons) and a liquid depth of 6.1 m (20 feet)(1). Detention time at present average sewage flows split for parallel operation is approximately 10 days per cell giving a total detention of just over 20 days in each pair of cells. The unusual depth of 6 m for these lagoons is a design feature incorporated to conserve heat which will be beneficial to the anaerobic metabolic processes and to aid in sludge storage because the accumulation rates in northern short retention anaerobic lagoons are high when compared to similar lagoons in the provinces of Canada(3).

Soil material at the treatment facility site is a fine to medium silty sand. The permeability of the sand required the use of "Hypalon", 20 mil membrane, to reduce seepage losses. Side slopes of 4:1 on the interior slopes and 3:1 on the exterior slopes were used for berm construction. Erosion protection was enhanced by rock rip rap at the liquid surface zone(1).

Operation of the lagoons began in January 1979 with each cell being filled individually with sewage in order that the ice cover would establish itself at operating levels on the berms.

Monitoring of the Whitehorse sewage lagoons was conducted for a two year period by the Environmental Protection Service (EPS) from March 1, 1979 to December 31, 1980 inclusive. The monitoring program was established to examine the start-up characteristics of a primary

FIG. 2 CITY OF WHITEHORSE SEWAGE LAGOON DESIGN SHOWING SAMPLE STATION LOCATIONS



1- INFLUENT MANHOLE	5 - SOUTHEAST LAGOON (AUG. 79)
2- INTERMEDIATE MANHOLE	6 - SOUTHWEST " "
3- INTERMEDIATE MANHOLE	7 - NORTHEAST " "
4- EFFLUENT MANHOLE	8 - NORTHWEST " "

anaerobic facultative sewage lagoon north of 60° latitude and to evaluate operational performance of the lagoons following the start-up phase.

2 METHODS

Both sample collection and analytical techniques are described in detail in Appendix IV. Suffice to say here that current procedures recommended by EPS were utilized at all times.

3 RESULTS AND DISCUSSION

The results of the study have been grouped into seasons in order to get a representation of what occurs by way of trends rather than exact numbers for any one moment. It is intended to minimize extreme, non-representative results.

3.1 Start-Up Characteristics

For analysis of the start-up characteristics the seasons are defined as follows:

Winter	December - February
Spring	March - May
Summer	June - August
Fall	September - November

The start-up characteristics for 1979 of each cell and the lagoon facility in general have been assessed from the following parameters:

BOD,
NFR,
Faecal Coliforms.

The results gathered during the study for the other parameters sampled were sufficiently low as to not provide much detail on start-up characteristics. All parameters have been assessed in detailing the performance (Section 3.2).

The lagoons were initially filled mid-January 1979, thus by March 1, 1979 the facility was in hydraulic steady state, operating with about 20 days detention. The lagoon is operated in parallel with two cells connected in series. The influent is split between the first two cells which individually discharge to the second two cells as shown in Figure 2. The effluent is a combination of the second two cells (Figure 2). Thus the monthly (1979) results from Appendix III have been tabulated by listing the influent (Station 1), averaging the results obtained from the intermediary cells (Stations 2 and 3), and listing the data recorded for the effluent (Station 4). Removal efficiencies experienced in the first pair of cells (intermediate station) and in the second pair of cells have been calculated separately in order to assess start-up characteristics over the first year of operation.

3.1.1 BOD. A summary of the analysis is presented in Table 3.1.1 (Appendix I). Appendix III contains the individual monthly recordings for the influent (Station 1), the intermediary station (Stations 2 and 3) and the effluent (Station 4). The percentage removal in the first pair of cells is generally slightly less than for the second pair of cells. The conclusion drawn is that the low temperature and dilute nature of the sewage essentially eliminates much of the biological treatment experienced in more temperate climates and these anaerobic lagoons function almost exclusively as sedimentation basins. Therefore, the characteristic "slow" start to new lagoon operation in temperate climates is not experienced in these lagoons, especially during winter and spring (the start-up period for these lagoons).

It is noted in the literature[8] that the optimal temperature range for methane fermentation for anaerobic sludge digestion is between 14-30°C and has a permissible range from 6-50°C. The temperature of this entire facility during winter can be expected to be less than 6°C. Hence anaerobic decomposition can be expected to occur only during the summer and fall periods when surface temperatures reach 14°C. Due to the low temperature even throughout summer, methane fermentation is difficult to establish and possibly through the winter is completely eliminated and must re-establish in the following summer.

Therefore, the start-up characteristics experienced by lagoon facilities in temperate regions may in fact be occurring annually in northern lagoon facilities as they warm-up to late spring and summer temperatures.

3.1.2 NFR. A summary of the analysis is presented in Table 3.1.2 (Appendix I). Appendix III contains the individual monthly data recorded for the influent, the intermediary station (during 1979 and January 1980 this was an average of Station 2 and 3 and for remainder of study station 2 only) and the effluent. The removal efficiencies of the first two cells in parallel, and between the second pair of cells has been calculated along with the total removal efficiency.

The removal efficiencies of the first pair of cells have generally been in the same range over the two year period and a start-up period was not evident. The percentage removal between the first pair of cells and the second pair was initially very erratic, often demonstrating more NFR in the effluent than between pairs of cells within the facility. After the first summer this erratic performance was moderated substantially with occasionally low removal performance between cells in the system. A late spring early summer "turnover" may be exhibited yearly because in both 1979 and 1980 the summer total removal efficiency is relatively poor. Also some of this may be due to algae growth. Table 3.1.2 (Appendix I) confirms that following the summer 1979 the first pair of cells remove the bulk of the NFR(16, 17).

3.1.3 Faecal Coliform Count. The summary of the faecal coliform count analysis in Table 3.1.3 (Appendix I) was compiled from Appendix III and the removal efficiencies calculated for each monthly sample. During the spring 1979 the percentage removal in the first pair of cells was fairly consistent and averaged 73.1% whereas the removal in the second pair of cells, as measured in the effluent, was more erratic and averaged 56.7%. There appears to be a trend which indicates that the first pair of cells remove more faecal coliforms than the second pair. This is consistent with the literature[8]. The 1980 data in all seasons demonstrates far more variable removal efficiencies as well as generally poorer performance than the 1979 data. This could be due to sludge build-up and less retention time.

There does not appear to be any significant start-up period demonstrated from the data gathered. The general lack of biological activity results in bacterial removal being dependent primarily on sedimentation. A reduced efficiency can be expected when compared to lagoon performance in temperate zones.

3.2 Performance Evaluation

For the analysis of the performance evaluation the seasons are defined as follows:

Summer	April - October
	(mean air temperature = 8.4°C)
Winter	November - March)
	(mean air temperature = -14.4°C

All of the data collected in both 1979 and 1980 on the influent and effluent has been analyzed to evaluate the performance of the anaerobic lagoon facility. The data was again grouped and evaluated on a seasonal basis.

3.2.1 Temperature. Temperature is a very important factor in the environment of the lagoon[8], because surface temperatures determine the succession of predominant species of bacteria and other aquatic organisms. The influent is the major source of heat in the lagoons and is particularly evident during the colder months from November to April (Figure 3.2.1, Appendix I).

Solar radiation is an important source of heat throughout the summer, in particular, to the surface layers.

Temperature is also one of the most important physical parameters influencing the efficiency of the anaerobic process of converting organic wastes to stable end products.

Although the literature(8, 9) suggests optimum temperature ranges between 20°-40°C, the Whitehorse lagoons have an influent summer temperature around 13.5°C and 4°C during the winter. While the effluent summer temperature is about 14°C, the winter temperature drops to 0°C.

The practical operating temperatures for these lagoons are undoubtedly less than optimum and have resulted in reduced performance.

In the winter the lagoons are completely ice covered and have upwards of 50-72 cm (20-30 inches) of snow cover. The lagoons at this time are strictly anaerobic. During the summer, however, the long daily solar radiation ensures photosynthetic production of oxygen transforming the lagoons into facultative systems, with the oxygen layer in the top 2-3 m and an interface zone before the anaerobic layer forms beneath (Section 3.2.5).

3.2.2 pH. The hydrogen-ion concentration is an important wastewater quality parameter and is controlled by the buffering system represented by the following equation:

$$CO_2 + H_2O = H_2CO_3 = HCO_3^- + H^+$$

The equilibrium of this system is affected by algal photosynthesis(7) The pH range suitable for the existence of the biological life in the lagoons is quite narrow and critical(9).

Seasonal changes through winter, spring, summer and fall are shown on Figure 3.2.2 (Appendix I) and are attributed to the background pH of the influent.

The average influent pH value from the spring of 1979 to the winter of 1980 equals 7.4 and the average effluent pH over the same period equals 7.4 which is in the normal range for anaerobic lagoon facility operating efficiently(8).

It has been reported that temperatures above 18°C are required, in an anaerobic or facultative lagoon facility, to provide a favourable environment for the conversion or organic solids into methane[8]. It is suggested that at low temperatures (below 15°C) the organic solids are partially converted to acid. This phenomena is not clearly demonstrated in the data collected to date (the effluent average pH for the winter/spring 1979/80 equals 7.4 and for the fall/winter 1980 equals 7.25, a decrease of 2%).

Since photosynthesis tends to increase the pH, it might be expected to see higher pH values in the effluent during the summer period. However, this is not the case and might be attributed to the depth from which the effluent is decanted, this being approximately 3 m below the surface in or near the anaerobic zone. Table 3.2.1 (Appendix I) shows that composite pH samples do confirm increased pH due to photosynthesis.

3.2.3 Dissolved Oxygen (DO). In the lagoons, dissolved oxygen is required for the respiration of aerobic microorganisms as well as all other aerobic life forms. The only substantial source of DO is from photosynthetic oxygenation, thus it is directly dependent upon solar radiation (May to October operation). During the period of solar radiation DO varies with depth. This is caused by vertical stratification of algal activity. Table 3.2.2 (Appendix I) lists the results of the DO variation with depth during the summer season of August 1979 and shows the surface layers to be supersaturated with oxygen. The effluent is essentially devoid of all oxygen year round (Appendix III), which is obviously a function of the below-surface (3 m) decant outfall structure. In general, the continuous discharge of anaerobic effluent may not be a suitable design feature for northern sewage lagoon systems because receiving streams exhibit a natural oxygen depletion phenomena during the period of ice-cover[11]. Particulary for small receiving streams, the addition of degradable organic material, ammonia, hydrogen sulphide and other substances may deplete the DO, at these times, to such an extent as to suffocate fish species. Grainge[3] suggests all municipal sewages discharges should contain not less than 5 mg/l oxygen which eliminates all winter discharges and summer discharges if drawn off within or near the anaerobic zone about three meters below the surface of a primary lagoon facility.

3.2.4 Biochemical Oxygen Demand - Five Day (BOD_5). The DO was found, during the summer season, to vary with depth (Section 3.2.3). The surface becomes supersaturated with oxygen, due to algal photosynthesis. This process has a significant effect on depth composite BOD measurements. The composite BOD samples were made up from 0, 1, 2 and 3 m depths. The results for composite BOD measurements are shown in Table 3.2.1 (Appendix I) along with pH, Non-Filterable Residue, Ammonia and Total Phosphate results. Other composite chemistry and biological (coliform counts) results are presented in Appendix II.

The depth composite DO and BOD samples confirm that the lagoons become partially facultative during the summer and utilize the soluble BOD to a much greater extent than during the winter, especially in the second pair of cells.

The influent BOD concentration varies throught the day and hourly grab samples from 08:00 to 15:00 inclusive show that in the morning the BOD is low (27 mg/l), rising to a peak (87.5 mg/l) at around 13:00 and again declining a little through to 15:00 (Figure 3.2.3, Appendix I). This is extremely important and can be explained by noting that the residents of Whitehorse bleed fresh water to the sewer system to prevent freezing during winter (Section 1.0) and, unfortunately, these systems are rarely turned off during the summer. Consequently, during the night (or from 24:00 through until 06:00) the sewer system is effectively being flushed with fresh water. From 06:00 until around 22:00 normal sewage is being added, which itself has been shown to fluctuate with the normal defecation times of the resident population[9].

The City of Whitehorse sewage concentration did not clearly demonstrate peaking following both breakfast and lunch periods which may be attributed to the intermittent pumping sequence that occurs. For example, during September 25, 1980, pumping was essentially continuous from 08:00 until 12:30, then it stopped for about 1 hour. After restarting, it stopped again at 14:30 for another 1 hour period and then continued until after 15:30. During October 29, 1980, pumping stopped at 12:20 for about 50 minutes and after restarting stopped again at 13:45 for 30 minutes. This intermittent pumping sequence may mask any daily fluctuations that occur.

Although monthly influent BOD concentrations varied from 42-85 mg/l (Appendix III), the average seasonal concentrations did not vary quite so much and only ranged from 53.6-60.2 mg/l (Table 3.2.4, Appendix I). The monthly effluent BOD concentrations varied between 24-40 mg/l (Appendix III) and the average seasonal concentration only varied from approximately 30.3-35.3 mg/l (Table 3.2.4, Appendix I), demonstrating a very consistent discharge with a BOD concentration more representative of a secondary treatment facility from a more temperate climate than an anaerobic lagoon north of 60° latitude[14].

The study confirmed that average effluent BOD concentration does not appear to be either a function of influent BOD concentration from residential services or significantly affected by seasonal changes in temperature[13].

The following list is a recording of the quantity of sewage pumped to the sewage lagoons on the days sampled in 1980:

March 7	-	3,692,000 gallons/day
April 24	-	3,267,000 gallons/day
May 23	-	2,762,000 gallons/day
June 19	-	2,541,000 gallons/day
July 17	-	2,580,000 gallons/day
August 20	-	2,728,000 gallons/day
September 25	-	2,782,000 gallons/day
October 28	-	2,514,000 gallons/day
November 26	-	2,850,000 gallons/day
December 31	-	3,429,000 gallons/day
Average	=	2,914,500 gallons/day
	=	13,249,300 litres/day

The BOD loading can be calculated by using the overall average influent BOD concentration and the volume of the first two cells.

Quantity of influent BOD per day equals:

$54.5 \times 13.25 \times 10^6$ mg/day

$= 722.125 \times 10^6$ mg/day

= 722.125 kg/day

Volume of Cell #1 + #2 = 15 x 2 million gallons

$= 136.4 \times 10^6$ litres

= 136,400 cubic m

therefore BOD loading $= \frac{722.125}{136,400}$ kg/day/cubic m

= <u>0.0053</u> kg/day/cubic m

Short retention ponds operating under severe winter weather conditions have achieved satisfactory treatment when the loadings are in the range of 0.1-0.15 kg/day/cubic m(3).

The efficiency of the lagoons is shown in Table 3.2.4 (Appendix I) and indicates that the overall average BOD removal equals about 40%. During winter season the BOD removal efficiency is around 39% and during summer season the BOD removal is around 42%. BOD removal efficiencies for an anaerobic lagoon in Yellowknife, Northwest Territories, was recorded as 36% for both winter and summer periods(3). While in Stettler, Alberta, the sewage treatment facility demonstrated 63.6% BOD removal during summer and 37.3% BOD removal over winter, for the anaerobic lagoon component(15). A two cell anaerobic lagoon system at Sutherland, Saskatchewan, demonstrated 30-50% BOD removal during the summer and 20-35% BOD removal during winter(16). Thus the City of Whitehorse's sewage treatment lagoons perform within the range established for other cold regions.

3.2.5 Filterable Residue (FR) and Non-Filterable Residue (NFR). The filterable residue represents the solids that pass through Watman GF/C filter paper and are mostly in the colloidal solids size range. This very fine-sized matter is not particularly important in the present study for evaluating lagoon performance. All of the data collected is presented in Appendix III.

The non-filterable residue is equivalent to the more familiar suspended solids and is measured as the solids fraction retained by Watman CF/C filter paper. The range of influent NFR concentration was between 22 and 94 mg/l and overall averaged 47 mg/l. The effluent NFR concentration ranged between 11.0 and 33 mg/l and had an overall average of 19 mg/l (Table 3.2.5, Appendix I).

The overall average NFR removal efficiency equals 60% which compares remarkably well with other cold regions which demonstrate a range between 55-76% removal(3, 15). NFR removal is affected by seasonal temperature variations(13) and data from Alberta suggests that the winter removal is better than summer(15). In the present study the winter average NFR removal equals approximately 65% and the summer period averages around 56% removal. This may be reflecting the influence of algae in the summer effluent. This difference is larger than the data reported for Alberta which averages 62% and 77% NFR removal for summer and winter respectively. At Sutherland, Saskatchewan the range for NRF removal was between 55-70% for both summer and winter(15).

3.2.6 Total Inorganic Carbon (TIC) and Total Organic Carbon (TOC). Inorganic carbon is essentially a measure of the inorganic salts such as magnesium and sodium carbonates and bicarbonates. As observed for the hardness and conductivity, the influent sewage exhibits quite an ideal inorganic carbon concentration for microbiological metabolism. A full listing of the data is presented in Appendix III. Table 3.2.6 (Appendix I) presents the seasonal variations in the concentrations and percentage removals for total inorganic carbon.

Organic carbon is essential for all biological metabolism and although the influent organic carbon concentrations are very low for domestic sewage(9), they are possibly not a limiting component of metabolism. Combining the effects of low temperature, near neutral pH, low hardness, low conductivity and anaerobic conditions for the most part, it is not difficult to conceive of an ecological environment in which a number of parameters are limiting the optimum metabolic conditions.

These conditions also suggest that short retention sewage lagoons in the north do not have substantial biological treatment processes functioning as might be expected in more moderate climatic conditions.

Table 3.2.7 (Appendix I) shows the seasonal variations for influent and effluent, total organic carbon concentrations and the percentage removal for each seasonal period.

3.2.7 Ortho and Total Phosphate. Phosphorus is essential for the metabolic processes of algae and other biological organisms found in lagoons. The phosphorus concentrations, particularly orthophosphates from household detergents, in the influent sewage are sufficiently high as to not be a limiting factor in biological growth. The orthophosphates are available for biological metabolism without further breakdown(9).

A complete listing of all data is presented in Appendix III. Again, the dilute nature of the wastewater can be seen by comparing the total average concentration of influent orthophosphate (2.02 mg/l) and total phosphate (3.01 mg/l) to typical concentrations found in domestic wastewater which ranges from 4-15 mg/l (orthophosphate) and 6-20 mg/l for total phosphate(9). Overall, about 16% orthophosphate and 26% total phosphate are removed in the facility.

3.2.8 <u>Nitrite, Nitrate and Ammonia</u>. The elements nitrogen and phosphorus are essential for biological metabolism and as such are known as nutrients. Although other elements, such as trace metals and organic carbon, are required for biological growth, nitrogen and phosphorus are considered the major nutrients(9). The nitrogen present in fresh sewage is primarily combined of proteinaceous matter and urea. Bacterial decomposition readily changes the form to ammonia. Then by bacterial oxidation (aerobic conditions) the ammonia nitrogen can be converted firstly to nitrites and then further oxidized to nitrates. Nitrates are the end product of aerobic stabilization and thus should be found in higher concentrations in the effluent during the summer periods than during the ice-covered winter periods. However, the data (Appendix III) shows very low concentrations for both nitrites and nitrates (influent nitrite range <0.005 mg/l - 0.05 mg/l and effluent range 0.01 to 0.1 mg/l) and theoretical trends simply cannot be observed.

Table 3.2.8 presents the seasonal concentrations of ammonia and the percentage removal for each season. A complete list of all the ammonia data is contained in Appendix III. Again, this data is representative of dilute sewage. Typical raw domestic sewage contains between 12-50 mg/l ammonia(9).

In lagoons, the oxidation of ammonia is often accompanied by a net loss of nitrogen. It is suggested that both algal and bacterial metabolism attribute to this loss. The removal efficiencies for ammonia in the present study average about 26%. Again, this value possibly reflects the nature of treating dilute low temperature sewage.

3.2.9 Surfactants. Since the conversion of synthetic detergents to the more biodegradable linear-alkyl-sulphonate, surfactants have become a rather minor functional problem in sewage treatment facilities and receiving streams. However, they do still exhibit a toxicity to aquatic biology, possibly because the wetting action of the detergents adversely affects respiratory gas exchange(10). Further, it is reported that the toxicity effect increases with increasing the softness of water. The same could be applied to sewage lagoons and for the present study would mean that because the hardness is in the moderate to low range(9) the toxicity will be enhanced. However, the data collected (Appendix III) shows very low surfactant concentrations. The range of influent surfactant concentrations are between 0.27-4.15 mg/l with an average of 1.8 mg/l and effluent concentrations range between 0.11-1.0 mg/l with an average of 0.65 mg/l. These values are quite low for domestic sewage and the overall average removal efficiency of 64% is in a range that appears to be normal for the study lagoons when comparing other parameters of the present study to literature values.

3.2.10 Total and Faecal Coliforms. Possibly the most important parameter to be considered when addressing sewage treatment above 60°N is the public health aspect against the release of excessive numbers of pathogenic microorganisms. To assess this question an indicator bacterial type is normally measured and in the present study both total and faecal coliform counts were routinely determined. Tables 3.2.9 and

3.2.10 (Appendix I) summarize the daily results recorded in Appendix III.

The overall average influent total coliform counts equals 43.0×10^5 organisms/100 ml while the effluent averages 14.6×10^5/100 ml, representing 66% removal efficiency. Normal raw sewage contains in the order of 5×10^7 organism/100 ml. Although the detention time is unknown anaerobic lagoons at Sutherland, Saskatchewan demonstrated 80-90% removal during summer and 70-80% removal during winter(16). The present study demonstrates an average of 65.3% removal for summer periods. This value is substantially less than that reported for the Sutherland anaerobic lagoon facility. During winter periods the present study averages 66.5% removal. This result is slightly less than the Saskatchewan data(16).

Although the presence of total coliform bacteria indicates contamination by enteric bacteria they are not specific to human faeces contamination, whereas faecal coliforms are more (although still not exclusively) representative of the presence of human faecal waste. The overall average faecal coliform count of the influent equals 10.6×10^5/100 ml while on average there are 2.5×10^5/100 ml being discharged in the effluent, representing 76.4% removal. Normal sewage contains in the order of 5×10^6 organisms per 100 ml. Removal efficiencies during the summer periods average 78%. During winter periods average removal efficiencies equalled 75.2%.

The total coliform counts in the effluent are one power of ten higher than that reported by Grainge(3) for northern lagoons and two powers of ten higher than those reported for Sutherland, Saskatchewan(16). There are no comparisons in the literature cited to compare effluent faecal coliform counts.

Die-off of faecal coliform bacteria is temperature dependent with a low water temperature reducing the die-off rate(17). Anaerobic conditions also reduce the die-off rate. The present study shows marginally higher die-off in the effluent for summer periods at

1.8 x 10^5 faecal coliforms/100 ml compared to 3.2 x 10^5 faecal coliforms/100 ml for winter periods (Table 3.2.10, Appendix I).

Combining the effects of low temperature, anaerobic conditions and dilute sewage, all characteristics of the City of Whitehorse's sewage, may provide part of the explanation as to why coliform counts are higher in the present study when compared to the literature[3, 15, 16].

Finally, the dilution ratio, with the controlled low flow of the Yukon river, indicates that the average total coliform counts in the river after mixing, would theoretically equal around 2000/100 ml and 340/ml for faecal coliform counts. Grainge[3] suggests that total coliform counts in the receiving stream, after mixing, should not exceed 2400 total coliforms/100 ml for minimal public health protection.

3.2.11 Metals. A number of metals were routinely analyzed and the results are presented in Appendix III. Metals, in excessive concentrations, are toxic to all forms of biological life. However, the average concentrations found in the study wastewater are not considered to be excessive and acutely toxic at all (Table 3.2.11, Appendix I). The metal concentrations are consistent with what might be discharged from essentially residential, commercial and service oriented industrial activities.

4 CONCLUSIONS

There was some erratic behaviour of the facility regarding NFR suggestive of start-up phenomena but this was not exhibited for BOD or faecal coliform counts. The dilute nature of the sewage coupled with the low temperature possibly mask any start-up phenomena. Also starting the lagoons during the winter effectively eliminates any demonstrable biological treatment start-up irregularities simply because very little, if any, will occur normally at 0°C.

The City of Whitehorse lagoons do exhibt very low temperatures ranging from 0°C during winter to only about 13°C throughout the summer.

The seasonal variations in the pH suggest higher levels during summer than for winter. Certainly the photosynthetically active layer turns quite alkaline with pH values as high as 9.8 during periods of extensive solar radiation (summer). Winter pH averages about 7.4.

The effluent is devoid of oxygen year round which is a function of depth from which the discharge is drawn off. The surface is supersaturated with oxygen (16 mg oxygen/ml) and at the 2 m depth contains 10.2 mg oxygen/ml during the summer season.

All of the chemical parameters confirm the dilute nature of this sewage. Average influent BOD equals 55.3 mg/l; NFR equals 47.0 mg/l; TIC equals 40 mg/l; TOC equals 30 mg/l; total phosphate equals 3.0 mg/l; ammonia equals 10.5 mg/l and surfactants equals 1.8 mg/l. The influent total and faecal coliform counts (43.0 x 10^5/100 ml and 10.6 x 10^5/100 ml respectively) also appear to reflect a dilute nature to the sewage.

Removal efficiencies are summarized below:

	WINTER	SUMMER	OVERALL AVERAGE
BOD	39.5	42.3	40.9
NFR	65.0	56.0	60.0
TIC	5.3	4.8	5.0
TOC	45.8	54.3	50.0
P TOTAL	--	--	26.0
AMMONIA	28.1	22.9	25.7
TOTAL COLIFORM/100ml	66.5	65.3	66.0
FAECAL COLIFORM/100 ml	75.2	78.0	76.4

There appears to be an increase in the survival of coliform bacteria during low temperature periods (winter).

During the winter the total coliforms discharge at 18.0 x 10^5 coliforms/100 ml and during the summer they discharge at only 11.2 x 10^5 coliforms/100 ml. Faecal coliforms discharge at 3.2 x 10^5/100 ml and 1.8 x 10^5/100 ml during winter and summer respectively.

The design features, such as depth to conserve heat and store non-degraded sludge, below-surface decant structure, retention time, and loading rates, have mixed success. The most important parameters for municipal discharges north of 60° latitude are dissolved oxygen, toxicity and pathogenic bacterial contamination. The present system, as designed, does not completely address these parameters. Therefore, in the final analysis, although anaerobic sewage lagoons perform relatively well, they do not protect the two most important elements of the receiving environment, namely the aquatic life and public health.

REFERENCES

1. Stanley Associates Engineering Ltd., City of Whitehorse, Wastewater Treatment Project Pre-Design Report (November 1976).

2. Historic Stream Flow Summary for Yukon and Northwest Territories, Inland Waters Directorate, DOE, Vancouver, B.C. (1979).

3. Dawson, R.N. and J.W. Grainge, "Proposed Design Criteria for Wastewater Lagoons in Arctic and Sub-Arctic Regions", Journal WPCF, Vol. 41, No. 2, Part 1, February 1969.

4. Environmental Protection Service, Pollution Sampling Handbook, Department of the Environment, Environmental Protection Service, Pacific Region, Vancouver, B.C. (1976).

5. Environmental Protection Service, Environmental Laboratory Manual, Department of the Environment, Environmental Protection Service, Pacific Region, Vancouver, B.C. (1979).

6. American Public Health Association et al, Standard Methods for the Examination of Water and Wastewater, 14th Edition, Washington, D.C. (1975).

7. Klein, R.L.; Gibbs, C.R., Graphical Method for Calculating Biochemical Oxygen Demand, Journal Water Pollution Control Federation, Vol. 51, No. 9, pp 2257-2266 (September 1979).

8. E.J. Middlebrooks, et al, Lagoon Information Source Book, Ann Arbor Science, Michigan (1978).

9. Metcalf and Eddy Inc., Wastewater Engineering, McGraw-Hill Book Company, Montreal (1972).

10. United States, Environmental Protection Service, "Water Quality Criteria 1972", Ecological Protection Series, EPA-R3-73, March 1973.

11. Schallock, E.W. and F.B. Lotspeich, "Low Winter Dissolved Oxygen in Some Alaskan Rivers", EPS-600/3-74-008, April 1974.

12. Assenzo, J.R. and G.W. Reid, "Removing Nitrogen and Phosphorus by Bio-oxidation Ponds in Central Oklahoma", Water and Sewage Works, 13 (8); 294-299, August 1966.

13. Annual Literature Review, Journal Water Pollution Control Federation, Vol. 51, No. 6, 1197, Lagoons and Oxidation Ponds, 1979.

14. Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments, Report EPS-1-EC-76-1, Environment Canada, April 1976.

15. Clark, S.E., H.J. Coutts and R.L. Jackson, "Alaska Sewage Lagoons", United States EPA, Arctic Environmental Research Laboratory, College, Alaska, Working Paper No. 8, August 1970.

16. Sentis, V.J., "Anaerobic Stabilization Ponds", Thesis, Department of Civil Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, March 1964.

17. Annual Literature Review, Journal Water Pollution Control Federation, Vol. 47, No. 6, 1269, 1975.

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APPENDIX I

FIGURES AND TABLES
REFERENCED IN THE TEXT

APPENDIX I TABLE 3.1.1 A SUMMARY OF THE MONTHLY BOD REMOVAL EFFICIENCIES

SEASON	INFLUENT	INTER-MEDIATE STATION*	% REMOVAL	EFFLUENT	% REMOVAL	TOTAL % REMOVAL
1979						
SPRING	50.2	39.9	20.5	29.0	27.3	42.3
	60.2	41.8	30.6	24.0	42.6	60.1
	42.0	40.2	4.3	29.8	25.9	29.0
	49.8	41.8	16.1	36.2	13.4	27.3
			17.9		27.3	39.7
SUMMER	47.8	43.6	8.9	28.4	34.9	40.6
	54.4	39.3	27.8	35.4	9.9	34.9
			18.4		22.4	37.8
FALL	60.1	46.5	22.6	31.6	32.0	47.4
	62.4	46.0	26.3	31.0	32.6	50.3
	60.0	49.6	17.3	38.2	23.0	36.3
			22.1		29.2	44.7
WINTER	59.7	47.1	21.1	32.1	31.8	46.2
	57.1	46.9	17.9	38.9	17.1	31.9
	47.3	43.6	7.8	34.9	20.0	26.2
			15.6		23.0	34.7
1980						
SPRING	48.6	41.6	14.3	38.0	8.6	21.8
	44.8	36.1	19.4	27.4	24.1	38.8
			16.8		16.4	30.3
SUMMER	59.0	47.6	19.3	36.2	23.9	38.6
	52.9	39.0	26.3	25.1	35.6	52.6
			22.8		29.8	45.6
FALL	49.6	42.1	15.1	31.0	26.4	37.5
	55.7	40.6	27.1	33.5	17.5	39.9
	58.6	45.3	22.7	32.0	29.4	43.4
			21.6		24.4	40.3
WINTER	51.5	38.3	25.6	35.5	7.3	31.1

* Intermediate station = average of Stations 2 & 3.

APPENDIX I TABLE 3.1.2 A SUMMARY OF THE MONTHLY NFR REMOVAL EFFICIENCIES

SEASON	INFLUENT	INTER-MEDIATE STATION*	% REMOVAL	EFFLUENT	% REMOVAL	TOTAL % REMOVAL
1979						
SPRING	22	13	40.9	16	-23.1	27.3
	68	20	70.6	25	-25.0	63.2
	58	24	58.6	19	20.8	65.5
	74	37	50.0	24	35.1	67.6
SUMMER	32	17	46.9	24	-41.2	25.0
	47	11	76.6	13	-18.2	72.3
	30	21	30.0	22	- 4.8	26.7
FALL	94	29	69.1	22	24.1	76.6
	34	19	44.1	18	5.3	47.1
	26	15	42.3	11	26.7	57.7
WINTER	35	18	48.6	13	27.8	62.9
	52	27	48.1	12	55.6	76.9
	52	17	67.3	14	17.6	73.1
1980						
SPRING	30	16	46.7	16	0	46.7
	146	17	88.4	15	11.8	89.7
SUMMER	48	31	35.4	31	0	35.4
	57	36	36.8	33	8.3	42.1
	42	23	45.2	17	26.1	59.5
FALL	40	23	42.5	22	4.3	42.8
	46	26	43.5	23	11.5	50.0
	43	19	55.8	12	36.8	72.1

* Intermediate station = average of Stations 2 and 3.

APPENDIX I TABLE 3.1.3 A SUMMARY OF THE MONTHLY FAECAL COLIFORM REMOVAL EFFICIENCIES

	$x\ 10^5/100$ ml			$x\ 10^5/100$ ml		
SEASON	INFLUENT	INTER-MEDIATE STATION*	% REMOVAL	EFFLUENT	% REMOVAL	TOTAL % REMOVAL
1979						
SPRING	20.0	10.9	45.5	1.9	82.6	90.5
	11.9	1.9	84.0	2.1	-10.5	82.4
	6.25	1.5	76.0	0.6	60.0	90.4
	14.5	1.9	86.9	0.5	73.7	96.6
SUMMER	7.0	4.4	37.1	2.0	54.5	71.4
	20.0	4.1	79.5	2.0	51.2	90.0
	10.6	4.1	61.3	2.1	48.8	80.2
FALL	45.0	4.8	89.3	2.6	45.8	94.2
	3.1	5.7	-83.9	1.5	73.7	51.6
WINTER	4.8	3.1	35.4	4.6	-48.4	4.2
	6.1	3.2	47.5	4.6	-43.7	24.6
	12.0	3.2	73.3	2.2	31.3	81.7
1980						
SPRING	7.4	2.6	64.9	2.2	18.2	70.3
	3.5	1.3	62.9	1.5	-15.4	57.1
SUMMER	5.5	4.0	27.3	2.5	37.5	54.5
	20.0	16.0	20.0	2.8	82.5	86.0
	2.2	2.0	9.1	2.2	-10.0	0.0
FALL	10.9	4.4	59.6	2.9	34.1	73.4
	1.9	2.0	- 5.3	0.65	67.5	65.8
	4.1	1.2	70.7	2.1	-75.0	48.8
WINTER	4.8	3.45	28.1	3.6	- 4.3	25.0

* Intermediate station = average of Stations 2 and 3.

FIG. 3·2·1 TEMPERATURE CHANGE FROM MAY, 1979 THROUGH DECEMBER, 1980

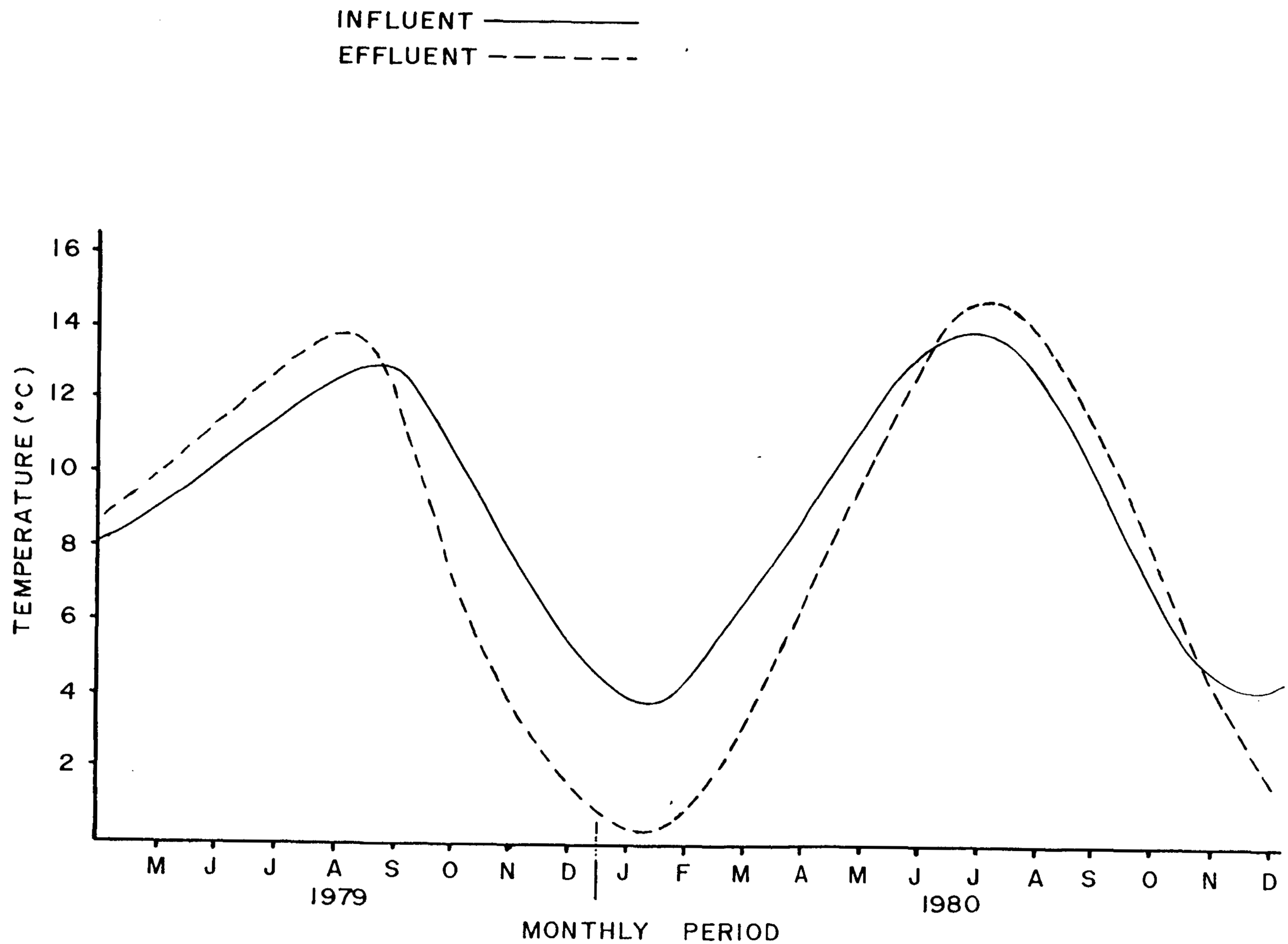
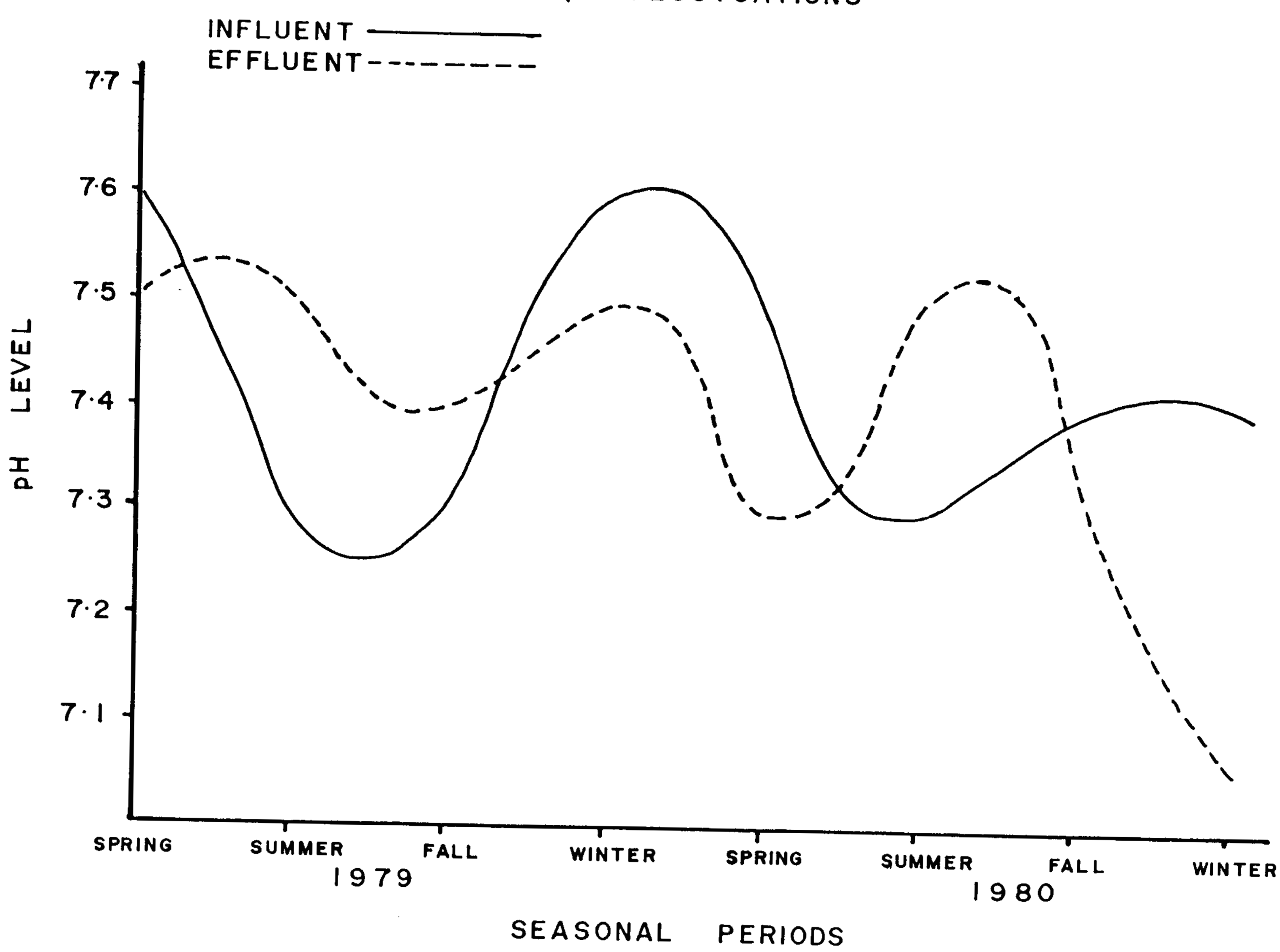


FIG. 3·2·2 AVERAGE pH FLUCTUATIONS



APPENDIX I TABLE 3.2.1 SOME CHEMISTRY RESULTS OF DEPTH COMPOSITE SAMPLES (SAMPLES ARE COMPOSED OF SUBSAMPLES FROM 0, 1, 2 AND 3 m DEPTHS). AUGUST 1979.

	CELL NUMBER			
PARAMETER	1	2	3	4
pH	7.7	7.6	8.8	9.8
BOD_5	33.4	27.9	10.8	11.4
NFR	23	27	14	14
AMMONIA (as N)	3.93	3.84	2.08	2.16
TOTAL PHOSPHATE (as P)	2.39	1.63	1.85	1.30

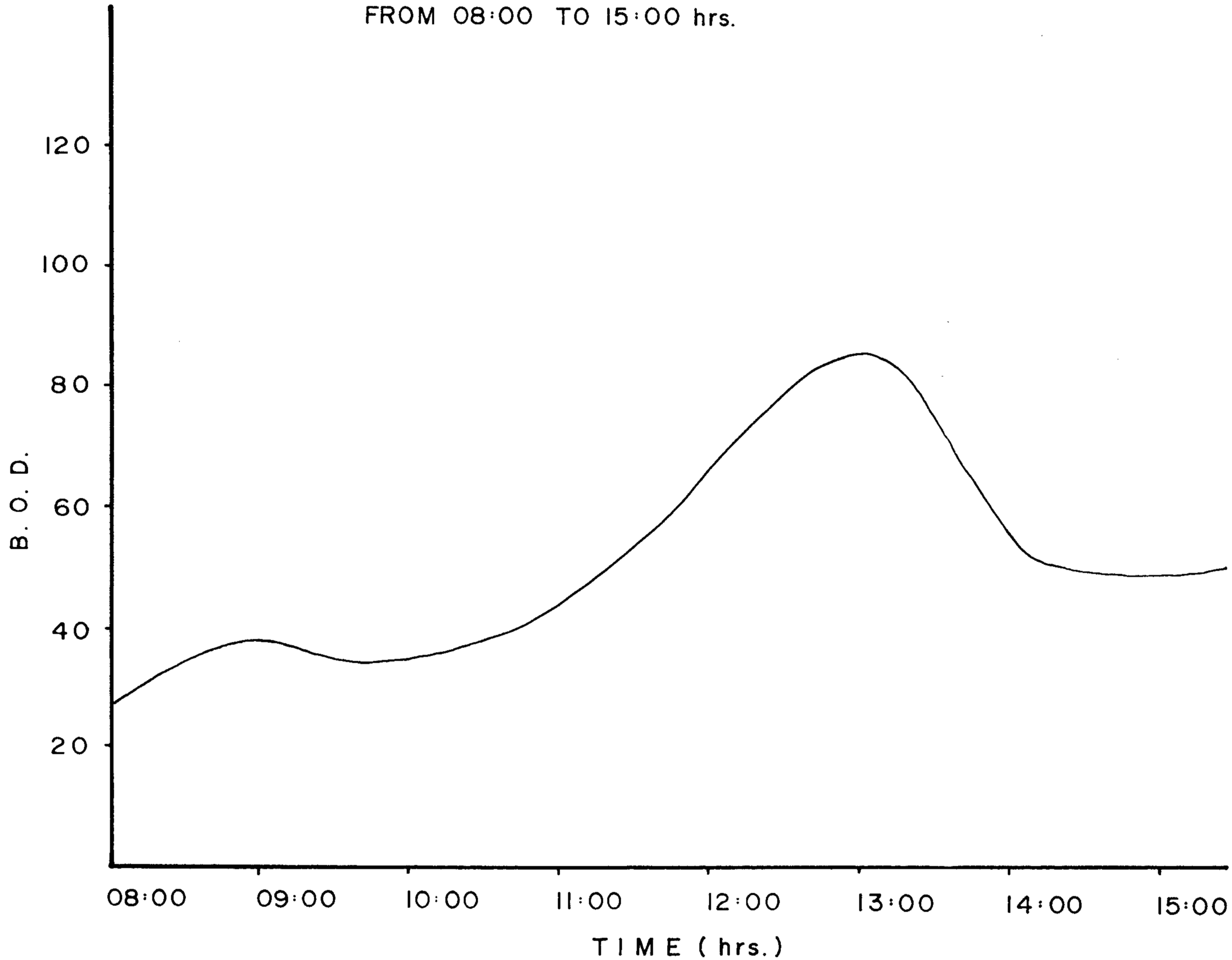
All measurements mg/l

APPENDIX I TABLE 3.2.2 DECREASES IN THE DISSOLVED OXYGEN CONCENTRATION WITH INCREASING DEPTH WITHIN THE LAGOON CELLS

DEPTH (m)	DISSOLVED OXYGEN (mg/l) CELL 1	CELL 2	CELL 3	CELL 4
0	8.4	9.6	15.2	16.00
1	2.4	3.3	4.4	5.15
2	0	0	0.2	1.2
3	0	0	0	0

All measurements mg/l

FIG. 3·2·3 VARIATION IN THE AVERAGE B.O.D. CONCENTRATION FROM 08:00 TO 15:00 hrs.



APPENDIX I TABLE 3.2.3 CHANGES IN THE BOD CONCENTRATION (mg/l) OVER AN 8 HOUR PERIOD FROM 08:00 TO 15:00, CITY OF WHITEHORSE SEWAGE, 1980.

TIME	BOD CONCENTRATION SEPTEMBER 25 INFL	SEPTEMBER 25 EFFL	OCTOBER 29 INFL	OCTOBER 29 EFFL	8 HOUR AVERAGE INFL	8 HOUR AVERAGE EFFL
08:00	18.2		36.5		27.4	
09:00	23.5		53.2		38.4	
10:0	35.2	31.0	37.8	35.0	36.5	33.0
11:00	65.4		31.4		48.4	
12:00	69.9		72.0		71.0	
13:00	50.9		121.6		86.7	
14:00	66.8		48.8		57.8	
15:00	67.1	31.2	44.4	29.9	55.8	30.6
AVERAGE	49.6	31.1	55.7	32.5	52.7	31.8

All measurements mg/l

TABLE 3.2.4 SEASONAL VARIATION IN THE INFLUENT AND EFFLUENT BOD AND THE REMOVAL EFFICIENCY, CITY OF WHITEHORSE SEWAGE

SEASON	INFLUENT	AVERAGE	EFFLUENT	AVERAGE	% REMOVAL
WINTER 79	60.2		33.5		
80	53.6		35.3		
		56.9		34.4	39.5
SUMMER 79	50.8		30.3		
80	56.6		31.7		
		53.7		31.0	42.3
OVERALL AVERAGE		55.3		32.7	40.9

All measurements mg/l

APPENDIX I TABLE 3.2.5 SEASONAL VARIATIONS IN THE NFR CONCENTRATION AND THE REMOVAL EFFICIENCY

SEASON	INFLUENT	AVERAGE	EFFLUENT	AVERAGE	% REMOVAL
WINTER 79	37		17		
80	48		15		
		43		15	65
SUMMER 79	56		21		
80	44		22		
		50		22	56
OVERALL AVERAGE		47		19	60

All measurements mg/l

APPENDIX I TABLE 3.2.6 SEASONAL VARIATIONS IN THE CONCENTRATIONS OF TOTAL INORGANIC CARBON AND THE REMOVAL EFFICIENCY FOR EACH SEASON

SEASON	INFLUENT	AVERAGE	EFFLUENT	AVERAGE	% REMOVAL
WINTER 79	36		37		
80	39		33		
		38		36	5.3
SUMMER 79	41		40		
80	43		39		
		42		40	4.8
OVERALL AVERAGE		40		38	5

All measurements mg/l

APPENDIX I TABLE 3.2.7 SEASONAL VARIATIONS IN THE CONCENTRATION OF TOTAL ORGANIC CARBON AND THE REMOVAL EFFICIENCY FOR EACH SEASON

SEASON	INFLUENT	AVERAGE	EFFLUENT	AVERAGE	% REMOVAL
WINTER 79	31		14		
80	17		11		
		24		13	45.8
SUMMER 79	39		15		
80	31		17		
		35		16	54.3
OVERALL AVERAGE		30		15	50

All measurements mg/l

APPENDIX I TABLE 3.2.8 SEASONAL CONCENTRATIONS (mg/l) AND PERCENT REMOVAL FOR AMMONIA

SEASON	INFLUENT	AVERAGE	EFFLUENT	AVERAGE	% REMOVAL
WINTER 79	8.3		8.3		
80	14.4		8.0		
		11.4		8.2	28.1
SUMMER 79	8.6		6.4		
80	10.8		8.4		
		9.6		7.4	22.9
OVERALL AVERAGE		10.5		7.8	25.7

All measurements mg/l as NH_3 nitrogen

APPENDIX I TABLE 3.2.9 SEASONAL VARIATIONS IN THE TOTAL COLIFORM COUNTS AND THE REMOVAL EFFICIENCY

SEASON	INFLUENT $\times 10^5$/100 ml	AVERAGE	EFFLUENT $\times 10^5$/100 ml	AVERAGE	% REMOVAL
WINTER 79	53.4		18.6		
80	54.3		17.5		
		53.8		18.0	66.5
SUMMER 79	34.0		7.5		
80	30.6		14.8		
		32.3		11.2	65.3
OVERALL AVERAGE		43.0		14.6	66.0

APPENDIX I TABLE 3.2.10 SEASONAL VARIATIONS IN THE FAECAL COLIFORM COUNTS AND THE REMOVAL EFFICIENCY

SEASON	INFLUENT $\times 10^5$/100 ml	AVERAGE	EFFLUENT $\times 10^5$/100 ml	AVERAGE	% REMOVAL
WINTER 79	19.0		2.5		
80	6.8		3.9		
		12.9		3.2	75.2
SUMMER 79	9.1		1.4		
80	7.3		2.1		
		8.2		1.8	78.0
OVERALL AVERAGE		10.6		2.5	76.4

APPENDIX I TABLE 3.2.11 AVERAGE CONCENTRATIONS OF HEAVY METALS FOUND IN THE INFLUENT AND EFFLUENT OF THE CITY OF WHITEHORSE SEWAGE (1979 AND 1980).

METAL	INFLUENT	#*	EFFLUENT	#*
Ag	<0.03		<0.03	
Al	0.22	(11/22)	0.14	(8/21)
As	<0.15		<0.15	
Ba	0.06	(22/22)	0.04	(21/21)
Ca	30.7	(22/22)	30.3	(21/21)
Cd	<0.01		<0.01	
Co	<0.015		<0.015	
Cr	<0.015		<0.015	
Cu	0.05	(22/22)	0.025	
Fe	0.82	(22/22)	0.37	(20/21)
Hg	<0.1		<0.1	
K	3.4	(4/4)	4.4	(4/4)
Mg	16.3	(20/20)	15.4	(21/21)
Mn	0.09	(22/22)	0.12	(21/21)
Mo	<0.15		<0.15	
Na	21.5	(22/22)	20.4	(21/21)
Ni	<0.08		<0.08	
P	2.8	(22/22)	2.5	(21/21)
Pb	<0.08		<0.08	
Sb	<0.08		<0.08	
Se	<0.15		<0.15	
Si	5.24	(22/22)	5.05	(21/21)
Sn	<0.2		<0.2	
Sr	0.22	(22/22)	0.21	(21/21)
Ti	0.032	(6/22)	0.01	(15/21)
V	<0.05		<0.05	
Zn	0.5	(20/22)	0.05	(16/21)

#* = (a/b) where a = number of absolute values greater than detection limit.
b = total number of samples including those less than detection limit.

APPENDIX II

COMPOSITE STUDY OF WHITEHORSE SEWAGE LAGOONS

APPENDIX II COMPOSITE STUDY OF CITY OF WHITEHORSE SEWAGE LAGOONS

		AUGUST 15, 1979			
PARAMETERS		STATION 5	STATION 6	STATION 7	STATION 8
TEMPERATURE (°C)					
pH		7.7	7.6	8.3	9.8
CONDUCTIVITY (umhos/cm)		376	377	331	336
HARDNESS (mg/l $CaCo_3$)		137.0	135.0	123.0	128.0
B.O.D.		33.4	27.9	10.8	11.4
FILTERABLE RESIDUE		260	261	238	261
NON-FILTERABLE RESIDUE		23	27	14	14
TOTAL ORGANIC CARBON		25.0	27.0	18.0	16.0
TOTAL INORGANIC CARBON		32.0	32.0	29.0	29.0
ORTHO PHOSPHATE (mg/l as P)		1.63	1.63	1.12	1.30
TOTAL PHOSPHATE (mg/l as P)		2.39	1.63	1.85	1.30
NITRITE (mg/l as N)		0.0055	0.0090	0.0063	0.0063
NITRATE (mg/l as N)		<.010	<.010	<.010	<.010
AMMONIA (mg/l as N)		3.93	3.84	2.08	2.16
SURFACTANTS		0.27	0.28	0.15	0.11
TOTAL COLIFORMS/100 ml		1.3×10^5	2×10^4	2×10^4	2×10^4
FAECAL COLIFORMS/100 ml		1.34×10^5	5.38×10^4	1.5×10^4	1.0×10^4
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	<.09	<.09	<.09	<.09
	As	<.15	<.15	<.15	<.15
	Ba	0.0366	0.0342	0.0241	0.0302
	Ca	29.9	30.2	28.5	29.2
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.018	0.02	0.014	0.013
	Fe	0.169	0.161	0.118	0.07
	Hg	<.1	<.1	<.1	<.1
	K	4.23	4.45	4.04	4.12
	Mg	14.7	14.9	12.5	13.5
	Mn	0.0684	0.0529	0.049	0.0414
	Mo	<.15	<.15	<.15	<.15
	Na	21.0	20.8	20.1	20.3
	Ni	<.08	<.08	<.08	<.08
	P	1.8	1.97	1.29	1.49
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	4.41	4.24	3.82	3.84
	Sn	<.2	<.2	<.2	<.2
	Sr	0.202	0.206	0.182	0.192
	Ti	<.009	<.009	<.009	<.009
	V	<.05	<.05	<.05	<.05
	Zn	<.02	<.02	<.02	<.02

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III

WHITEHORSE SEWAGE LAGOON DATA

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA

PARAMETERS		MARCH 1, 1979 STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)					
pH		7.5	7.5	7.5	7.5
CONDUCTIVITY (umhos/cm)		409	404	401	390
HARDNESS (mg/l $CaCo_3$)		137.0	140.0	140.0	135.0
B.O.D.		50.5	43.2	36.6	29.0
FILTERABLE RESIDUE					
NON-FILTERABLE RESIDUE		22	10	15	16
TOTAL ORGANIC CARBON		35.0	10.0	9.0	10.0
TOTAL INORGANIC CARBON		35.0	39.0	42.0	39.0
ORTHO PHOSPHATE (mg/l as P)		1.17	1.34	1.36	1.39
TOTAL PHOSPHATE (mg/l as P)		1.87	1.78	1.73	1.68
NITRITE (mg/l as N)		0.0060	<.005	0.012	0.0083
NITRATE (mg/l as N)		<.010	.043	<.010	<.010
AMMONIA (mg/l as N)		5.68	6.15	5.88	6.05
SURFACTANTS					
TOTAL COLIFORMS/100 ml		118×10^5	20.5×10^5	33.8×10^5	16.5×10^5
FAECAL COLIFORMS/100 ml		20×10^5	13.7×10^5	8.06×10^5	1.9×10^5
METALS:	Ag				
	Al	<.09	<.09	<.09	<.09
	As	<.15	<.15	<.15	<.15
	Ba	0.0475	0.0422	0.0415	0.0392
	Ca	29.4	29.9	29.7	28.2
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.051	0.032	0.030	0.024
	Fe	0.274	0.174	0.174	0.18
	Hg	<.1	<.1	<.1	<.1
	K	4.84	4.27	4.19	4.12
	Mg		15.9	16.1	15.6
	Mn	0.0805	0.0928	0.0996	0.099
	Mo	<.15	<.15	<.15	<.15
	Na	22.9	20.9	17.2	13.5
	Ni	<.08	<.08	<.08	<.08
	P	1.92	1.85	1.78	1.67
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	5.02	5.07	4.76	4.52
	Sn				
	Sr	0.21	0.217	0.214	0.203
	Ti	<.009	<.009	<.009	<.009
	V	<.05	<.05	<.05	<.05
	Zn	0.037	0.023	<.02	<.02

NOTE: *All measurements mg/l unless otherwise noted.*

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	MARCH 15, 1979			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)				
pH	7.7	7.6	7.6	7.7
CONDUCTIVITY (umhos/cm)	445	388	388	388
HARDNESS (mg/l $CaCo_3$)	131.0	135.0	135.0	135.0
DISSOLVED OXYGEN	5.88	<1.00	<1.00	<1.00
B.O.D.	60.2	48.3	35.4	34.0
FILTERABLE RESIDUE	252	217	229	230
NON-FILTERABLE RESIDUE	68	20	20	25
TOTAL ORGANIC CARBON	19.0	9.0	11.0	12.0
TOTAL INORGANIC CARBON	43.0	37.0	37.0	38.0
ORTHO PHOSPHATE (mg/l as P)	1.95	1.30	1.30	1.50
TOTAL PHOSPHATE (mg/l as P)	3.00	1.65	1.65	1.80
NITRITE (mg/l as N)	<.0050	<.0050	<.0050	<.0050
NITRATE (mg/l as N)	0.072	0.014	0.042	0.0310
AMMONIA (mg/l as N)	5.80	5.35	5.95	11.4
SURFACTANTS	0.89	1.02	0.92	.300
TOTAL COLIFORMS/100 ml	34×10^5	15.4×10^5	8.5×10^5	11.4×10^5
FAECAL COLIFORMS/100 ml	11.9×10^5	2.19×10^5	1.58×10^5	2.08×10^5
METALS: Ag	<.030	<.030	<.030	<.030
Al	0.35	0.17	0.16	0.26
As	<.15	<.15	<.15	<.15
Ba	0.0537	0.0455	0.0441	0.0446
Ca	28.4	28.7	28.7	28.2
Cd	<.01	<.01	<.01	<.01
Co	<.015	<.015	<.015	<.015
Cr	<.015	<.015	<.015	<.015
Cu	0.068	0.031	0.031	0.033
Fe	0.552	0.34	0.329	0.552
Hg	<.1	<.1	<.1	<.1
K				
Mg		15.3	15.3	15.5
Mn	0.136	0.117	0.103	0.193
Mo	<.15	<.15	<.15	<.15
Na	22.8	18.3	18.7	16.7
Ni	<.08	<.08	<.08	<.08
P	3.03	1.76	1.71	1.75
Pb	<.08	<.08	<.08	<.08
Sb	<.08	<.08	<.08	<.08
Se	<.15	<.15	<.15	<.15
Si	6.11	5.16	5.17	5.10
Sn				
Sr	0.203	0.21	0.209	0.207
Ti	0.01	<.009	<.009	0.012
V	<.05	<.05	<.05	<.05
Zn	0.052	0.054	0.033	0.086

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

		APRIL 19, 1979			
PARAMETERS		STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)					
pH		7.8	7.6	7.7	7.6
CONDUCTIVITY (umhos/cm)		429	409	410	397
HARDNESS (mg/l $CaCo_3$)		132.0	136.0	134.0	130.0
B.O.D.		42.0	38.4	41.9	29.8
FILTERABLE RESIDUE		226	234	236	224
NON-FILTERABLE RESIDUE		58	25	23	19
TOTAL ORGANIC CARBON		16.0	11.0	10.0	7.0
TOTAL INORGANIC CARBON		42.0	41.0	40.0	40.0
ORTHO PHOSPHATE (mg/l as P)		1.42	1.45	1.45	1.38
TOTAL PHOSPHATE (mg/l as P)		1.90	1.56	1.56	1.65
NITRITE (mg/l as N)		<.0050	<.0050	<.0050	<.0050
NITRATE (mg/l as N)		0.0310	0.023	0.028	0.019
AMMONIA (mg/l as N)		11.4	5.59	5.62	5.59
SURFACTANTS		0.900	0.910	0.790	0.832
TOTAL COLIFORMS/100 ml					
FAECAL COLIFORMS/100 ml		6.25×10^5	1.5×10^5		5.8×10^4
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	0.26	0.19	0.14	0.15
	As	<.15	<.15	<.15	<.15
	Ba	0.0446	0.061	0.0428	0.042
	Ca	28.2	28.7	29.5	29.0
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.051	0.02	0.022	0.017
	Fe	0.449	0.324	0.329	0.33
	Hg	<.1	<.1	<.1	<.1
	K				
	Mg	14.6	15.2	25.0	14.4
	Mn	0.0767	0.0857	0.0855	0.0884
	Mo	<.15	<.15	<.15	<.15
	Na	15.2	16.4	16.6	16.1
	Ni	<.08	<.08	<.08	<.08
	P	1.89	1.53	1.54	1.53
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	5.01	5.15	5.13	5.03
	Sn				
	Sr	0.211	0.215	0.212	0.203
	Ti	0.01	0.018	0.018	0.015
	V	<.05	<.05	<.05	<.05
	Zn	0.021	0.02	<.02	<.02

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	MAY 24, 1979			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	8.9	9.3	9.3	10.1
pH	7.4	7.3	7.4	7.4
CONDUCTIVITY (umhos/cm)	510	442	438	434
HARDNESS (mg/l $CaCo_3$)	188.0	141.0	140.0	140.0
DISSOLVED OXYGEN	3.35	<1.00	<1.00	<1.00
B.O.D.	49.8	45.1	38.4	26.2
FILTERABLE RESIDUE	285	520	517	510
NON-FILTERABLE RESIDUE	74	43	30	24
TOTAL ORGANIC CARBON	54.0	14.0	20.0	16.0
TOTAL INORGANIC CARBON	50.0	44.0	40.0	40.0
ORTHO PHOSPHATE (mg/l as P)	2.32	1.95	1.91	1.86
TOTAL PHOSPHATE (mg/l as P)	5.15	2.25	2.10	2.11
NITRITE (mg/l as N)	<.0050	0.0077	<.0050	<.0050
NITRATE (mg/l as N)	<.010	0.0173	0.014	0.0350
AMMONIA (mg/l as N)	11.1	5.78	6.76	6.69
SURFACTANTS	1.11	0.94	0.95	0.93
TOTAL COLIFORMS/100 ml	4.7×10^6	1.21×10^6	5.2×10^5	18×10^5
FAECAL COLIFORMS/100 ml	1.45×10^6	2.35×10^5	1.53×10^5	4.63×10^4
METALS: Ag	<.030	<.030	<.030	<.030
Al	0.37	0.11	<.09	<.09
As	<.15	<.15	<.15	<.15
Ba	0.232	0.0363	0.0357	0.0346
Ca	38.4	30.1	30.2	30.0
Cd	<.01	<.01	<.01	<.01
Co	0.034	<.015	<.015	<.015
Cr	0.022	<.015	<.015	<.015
Cu	0.115	0.023	0.021	0.019
Fe	11.6	.341	.037	.263
Hg	<.1	<.1	<.1	<.1
K				
Mg	22.4	15.9	15.8	15.9
Mn	0.066	0.065	0.0705	0.0727
Mo	<.15	<.15	<.15	<.15
Na	20.7	18.2	18.6	17.6
Ni	<.08	<.08	<.08	<.08
P	3.36	2.13	2.17	2.1
Pb	0.17	<.08	<.08	<.08
Sb	<.08	<.08	<.08	<.08
Se	<.15	<.15	<.15	<.15
Si	16.2	5.39	5.40	5.32
Sn	<.2	<.2	<.2	<.2
Sr	0.27	0.214	0.215	0.212
Ti	0.108	0.009	<.009	0.009
V	<.05	<.05	<.05	<.05
Zn	0.024	0.025	0.022	<.02

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

PARAMETERS		JUNE 14, 1979 STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)					
pH		7.6	7.7	7.7	7.7
CONDUCTIVITY (umhos/cm)		307	423	426	437
HARDNESS (mg/l $CaCo_3$)		119.0	151.0	151.0	157.0
FILTERABLE RESIDUE		174	255	265	260
NON-FILTERABLE RESIDUE		32	21	13	24
TOTAL ORGANIC CARBON		70.0	17.0	17.0	17.0
TOTAL INORGANIC CARBON		30.0	41.0	41.0	41.0
ORTHO PHOSPHATE (mg/l as P)		1.725	1.83	1.84	1.86
TOTAL PHOSPHATE (mg/l as P)		2.795	2.20	2.15	2.10
NITRITE (mg/l as N)		0.0291	<.0050	0.0051	<.0050
NITRATE (mg/l as N)		0.109	<.010	0.0523	<.010
AMMONIA (mg/l as N)		6.89	6.67	7.57	9.47
SURFACTANTS		1.05	0.75	0.69	0.68
TOTAL COLIFORMS/100 ml		1.4×10^6	1.13×10^6	8.5×10^5	5.8×10^5
FAECAL COLIFORMS/100 ml		7.0×10^5	3.6×10^5	5.1×10^5	1.99×10^5
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	<.09	<.09	<.09	<.09
	As	<.15	<.15	<.15	<.15
	Ba	0.0412	0.0429	0.043	0.0421
	Ca	27.8	33.0	32.8	33.5
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.018	0.018	0.018	0.017
	Fe	0.198	0.3	0.317	0.3
	Hg	<.1	<.1	<.1	<.1
	K	2.45	4.33	4.34	4.41
	Mg	12.1	16.7	16.8	17.7
	Mn	0.0721	0.0793	0.078	0.084
	Mo	<.15	<.15	<.15	<.15
	Na	15.19	13.4	14.0	15.0
	Ni	<.08	<.08	<.08	<.08
	P	0.79	2.35	2.36	2.44
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	3.16	4.84	4.99	5.21
	Sn	0.38	0.40	0.26	1.22
	Sr	0.174	0.208	0.208	0.216
	Ti	<.009	0.015	0.015	0.015
	V	<.05	<.05	<.05	<.05
	Zn	0.023	0.042	0.037	0.046

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

PARAMETERS		JULY 18, 1979 STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		11.2	11.8	12.5	13.0
pH		7.1	7.1	7.3	7.4
CONDUCTIVITY (umhos/cm)		374	401	395	379
HARDNESS (mg/l $CaCo_3$)		144.0	131.0	130.0	124.0
DISSOLVED OXYGEN		5.20	<1.00	<1.00	1.50
B.O.D.		47.8	41.0	46.2	28.4
FILTERABLE RESIDUE		211	230	229	225
NON-FILTERABLE RESIDUE		47	10	11	13
TOTAL ORGANIC CARBON		50.0	16.0	13.0	11.0
TOTAL INORGANIC CARBON		38.0	52.0	48.0	46.0
ORTHO PHOSPHATE (mg/l as P)		2.550	1.99	1.88	1.73
TOTAL PHOSPHATE (mg/l as P)		2.800	2.32	2.30	2.25
NITRITE (mg/l as N)		<.0050	<.0050	<.0050	<.0050
NITRATE (mg/l as N)		0.011	0.016	0.011	<.010
AMMONIA (mg/l as N)		7.85	9.38	7.38	6.53
SURFACTANTS		1.060	.149	.735	.205
TOTAL COLIFORMS/100 ml		3.3×10^6	8.7×10^5	10.2×10^5	4.8×10^5
FAECAL COLIFORMS/100 ml		2.0×10^6	4.45×10^5	3.65×10^5	2×10^5
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	<.09	0.12	<.09	<.09
	As		<.15	<.15	<.15
	Ba	0.0495	0.0491	0.0459	0.0441
	Ca	32.0	30.0	29.5	28.4
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.033	0.026	0.033	0.024
	Fe	0.233	0.562	0.394	0.418
	Hg	<.1	<.1	<.1	<.1
	K				
	Mg	15.6	13.7	13.7	13.0
	Mn	0.089	0.114	0.116	0.245
	Mo	<.15	<.15	<.15	<.15
	Na	21.5	21.0	19.3	18.9
	Ni	<.08	<.08	<.08	<.08
	P	2.84	2.51	2.36	2.37
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	3.99	4.81	4.56	4.43
	Sn	<.2	<.2	<.2	<.2
	Sr	0.22	0.199	0.196	0.185
	Ti	<.009	0.013	0.018	0.01
	V	<.05	<.05	<.05	<.05
	Zn	0.22	0.047	0.074	0.096

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	AUGUST 15, 1979			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)				
pH	7.4	7.2	7.3	7.3
CONDUCTIVITY (umhos/cm)	446	428	230	417
HARDNESS (mg/l $CaCo_3$)	168.0	144.0	150.0	141.0
DISSOLVED OXYGEN	3.75	<1.00	<1.00	<1.00
B.O.D.	54.4	43.7	34.8	35.4
FILTERABLE RESIDUE	276	255	281	263
NON-FILTERABLE RESIDUE	30	23	20	22
TOTAL ORGANIC CARBON	18.0	15.0	24.0	18.0
TOTAL INORGANIC CARBON	43.0	40.0	38.0	37.0
ORTHO PHOSPHATE (mg/l as P)	2.37	2.16	2.10	2.22
TOTAL PHOSPHATE (mg/l as P)	4.31	2.23	2.21	2.30
NITRITE (mg/l as N)	0.0050	0.0050	0.0055	0.0055
NITRATE (mg/l as N)	<.010	<.010	<.010	<.010
AMMONIA (mg/l as N)	7.56	7.21	7.31	6.12
SURFACTANTS	2.11	0.74	0.78	0.61
TOTAL COLIFORMS/100 ml	4.2×10^6	1.12×10^6	6.8×10^5	1.3×10^5
FAECAL COLIFORMS/100 ml	1.06×10^6	4.9×10^5	3.24×10^5	2.13×10^5
METALS: Ag	<.030	<.030	<.030	<.030
Al	<.09	<.09	<.09	<.09
As	<.15	<.15	<.15	<.15
Ba	0.0449	0.0432	0.044	0.0437
Ca	32.8	20.4	32.2	30.7
Cd	<.01	<.01	<.01	<.01
Co	<.015	<.015	<.015	<.015
Cr	<.015	<.015	<.015	<.015
Cu	0.037	0.02	0.023	0.019
Fe	0.192	0.428	0.483	0.456
Hg	<.1	<.1	<.1	<.1
K	3.98	4.67	4.56	4.72
Mg	20.9	16.6	17.0	15.7
Mn	0.0925	0.198	0.14	0.224
Mo	<.15	<.15	<.15	<.15
Na	14.4	18.6	21.5	19.8
Ni	<.08	<.08	<.08	<.08
P	4.3	2.34	2.41	2.41
Pb	<.08	<.08	<.08	<.08
Sb	<.08	<.08	<.08	<.08
Se	<.15	<.15	<.15	<.15
Si	5.15	4.88	5.17	4.73
Sn	<.2	<.2	<.2	<.2
Sr	0.248	0.217	0.226	0.213
Ti	<.009	0.019	0.017	0.015
V	<.05	<.05	<.05	<.05
Zn	0.023	0.036	0.081	0.074

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

		SEPTEMBER 13, 1979			
PARAMETERS		STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		13.0	12.0	12.0	12.0
pH		7.1	7.1	7.2	7.5
CONDUCTIVITY (umhos/cm)		401	413	401	415
HARDNESS (mg/l $CaCo_3$)		138.0	153.0	152.0	161.0
DISSOLVED OXYGEN		1.10	<1.00	<1.00	<1.00
B.O.D.		60.1	37.4	55.6	31.6
FILTERABLE RESIDUE		247	249	245	261
NON-FILTERABLE RESIDUE		94	17	41	22
TOTAL ORGANIC CARBON		25.0	14.0	18.0	20.0
TOTAL INORGANIC CARBON		42.0	44.0	42.0	38.0
ORTHO PHOSPHATE (mg/l as P)		2.05	2.05	1.73	1.73
TOTAL PHOSPHATE (mg/l as P)		2.29	2.35	2.20	2.00
NITRITE (mg/l as N)		<.0050	0.0055	0.0050	0.0050
NITRATE (mg/l as N)		0.0110	<.010	<.010	0.0230
AMMONIA (mg/l as N)		7.72	7.72	5.84	4.27
SURFACTANTS		2.3	1.2	0.64	0.24
TOTAL COLIFORMS/100 ml					
FAECAL COLIFORMS/100 ml					
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	0.22	0.23	0.13	<.09
	As	<.15	<.15	<.15	<.15
	Ba	0.112	0.0541	0.0513	0.0469
	Ca	32.5	34.9	34.6	36.1
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.061	0.029	0.029	0.022
	Fe	0.526	0.672	0.48	0.274
	Hg	<.1	<.1	<.1	<.1
	K				
	Mg	13.9	16.0	16.0	17.2
	Mn	0.109	0.152	0.131	0.117
	Mo	<.15	<.15	<.15	<.15
	Na	26.7	21.5	21.3	24.7
	Ni	<.08	<.08	<.08	<.08
	P	2.37	2.43	2.21	2.17
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	4.89	4.96	4.77	5.15
	Sn	<.2	<.2	<.2	<.2
	Sr	0.196	0.213	0.213	0.224
	Ti	<.009	0.011	<.009	<.009
	V	<.05	<.05	<.05	<.05
	Zn	0.094	0.067	0.048	0.022

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

		NOVEMBER 1, 1979			
PARAMETERS		STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		7.2	5.0	4.8	3.5
pH		7.5	7.4	7.4	7.4
CONDUCTIVITY (umhos/cm)		340	384	382	393
HARDNESS (mg/l $CaCo_3$)		129.0	125.0	123.0	128.0
DISSOLVED OXYGEN		5.91	<1.00	<1.00	<1.00
B.O.D.		62.4	47.4	44.52	34.0
FILTERABLE RESIDUE		189	218	217	224
NON-FILTERABLE RESIDUE		34	17	21	18
TOTAL ORGANIC CARBON		30.0	14.0	13.0	17.0
TOTAL INORGANIC CARBON		33.0	34.0	33.0	31.0
ORTHO PHOSPHATE (mg/l as P)		2.650	1.84	1.88	1.88
TOTAL PHOSPHATE (mg/l as P)		2.950	2.14	1.96	1.96
NITRITE (mg/l as N)		0.0025	<.0050	<.0050	<.0050
NITRATE (mg/l as N)		0.0845	<.010	<.010	<.010
AMMONIA (mg/l as N)		6.38	7.55	6.95	7.44
SURFACTANTS		3.098	0.97	0.88	0.93
TOTAL COLIFORMS/100 ml		2.8×10^6	2.48×10^6	3×10^6	1.75×10^6
FAECAL COLIFORMS/100 ml		4.5×10^6	5×10^5	4.6×10^5	2.56×10^5
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	<.09	<.09	<.09	<.09
	As	<.15	<.15	<.15	<.15
	Ba	0.0425	0.0453	0.0429	0.0453
	Ca	27.7	27.5	270	28.0
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.024	0.032	0.031	0.026
	Fe	0.142	0.407	0.351	0.337
	Hg	<.1	<.1	<.1	<.1
	K				
	Mg	14.5	13.6	13.5	14.0
	Mn	0.0756	0.0895	0.0867	0.0992
	Mo	<.15	<.15	<.15	<.15
	Na	20.7	19.3	17.8	18.8
	Ni	<.08	<.08	<.08	<.08
	P	2.79	2.04	1.97	1.96
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	3.78	4.92	4.18	4.29
	Sn	<.2	<.2	<.2	<.2
	Sr	0.207	0.195	0.192	0.2
	Ti	<.009	0.016	0.013	0.011
	V	<.05	<.05	<.05	<.05
	Zn	<.02	0.028	0.023	0.02

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

PARAMETERS		NOVEMBER 15, 1979 STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		8.5	4.5	4.5	2.5
pH		7.4	7.4	.7.5	7.4
CONDUCTIVITY (umhos/cm)		307	372	372	385
HARDNESS (mg/l $CaCo_3$)		124.0	120.0	121.0	126.0
DISSOLVED OXYGEN		6.63	<1.00	<1.00	<1.00
B.O.D.		60.0	51.4	47.7	38.2
FILTERABLE RESIDUE		177	219	213	220
NON-FILTERABLE RESIDUE		26	14	15	11
TOTAL ORGANIC CARBON		39.0		22.0	18.0
TOTAL INORGANIC CARBON		32.0		36.0	38.0
ORTHO PHOSPHATE (mg/l as P)		2.500	2.05	2.90	2.25
TOTAL PHOSPHATE (mg/l as P)		2.780	2.30	3.00	2.25
NITRITE (mg/l as N)		0.0460	0.0070	0.0060	0.0070
NITRATE (mg/l as N)		0.120	0.0160	0.0135	0.0125
AMMONIA (mg/l as N)		13.50	7.55	7.68	7.90
SURFACTANTS		3.060	1.1	1.0	1.0
TOTAL COLIFORMS/100 ml		2.9×10^6	6.5×10^6	3.8×10^6	2.4×10^6
FAECAL COLIFORMS/100 ml		3.1×10^5	5.5×10^5	5.9×10^5	1.5×10^5
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	<.09	<.09	<.09	<.09
	As	<.15	<.15	<.15	<.15
	Ba	0.0415	0.044	0.0443	0.0437
	Ca	27.7	27.6	27.5	28.5
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.032	0.042	0.042	0.03
	Fe	0.173	0.37	0.373	0.337
	Hg	<.1	<.1	<.1	<.1
	K	2.44	4.28	4.33	4.43
	Mg	13.3	12.5	12.7	13.3
	Mn	0.0651	0.0718	0.0727	0.0846
	Mo	<.15	<.15	<.15	<.15
	Na	18.96	20.2	19.7	19.9
	Ni	<.08	<.08	<.08	<.08
	P	2.7	2.21	2.17	2.15
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	3.11	3.85	3.82	3.81
	Sn	<.2	<.2	<.2	<.2
	Sr	0.19	0.183	0.184	0.191
	Ti	<.009	0.018	0.015	0.013
	V	<.05	<.05	<.05	<.05
	Zn	<.024	0.023	0.024	<.02

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	DECEMBER 12, 1979			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	6.0	3.5	3.0	1.5
pH	7.6	7.5	7.6	7.6
CONDUCTIVITY (umhos/cm)	449	465	465	460
HARDNESS (mg/l $CaCo_3$)	166.0	165.0	166.0	164.0
DISSOLVED OXYGEN		<1.00	<1.00	<1.00
B.O.D.	59.7	48.9	45.2	32.1
FILTERABLE RESIDUE	243	275	280	270
NON-FILTERABLE RESIDUE	35	19	17	13
ORTHO PHOSPHATE (mg/l as P)	2.31	2.10	2.20	2.25
TOTAL PHOSPHATE (mg/l as P)	2.60	2.25	2.30	2.25
NITRITE (mg/l as N)	<.0050	<.0050	<.0050	<.0050
NITRATE (mg/l as N)	<.010	0.0140	0.0270	0.0200
AMMONIA (mg/l as N)	9.99	8.26	8.05	8.80
SURFACTANTS	2.27	0.91	0.87	0.97
TOTAL COLIFORMS/100 ml	5.8×10^6	15.8×10^6	5.8×10^6	2.34×10^6
FAECAL COLIFORMS/100 ml	4.85×10^5	3.30×10^5	2.95×10^5	4.63×10^5
METALS: Ag	<.030	<.030	<.030	<.030
Al	<.09	0.105	<.09	<.09
As	<.15	<.15	<.15	<.15
Ba	0.0426	0.0475	0.0453	0.0452
Ca	32.9	33.5	33.7	34.6
Cd	<.01	<.01	<.01	<.01
Co	<.015	<.015	<.015	<.015
Cr	0.015	0.017	<.015	<.015
Cu	0.053	0.044	0.039	0.034
Fe	0.287	0.512	0.38	0.395
Hg	<.1	<.1	<.1	<.1
K				
Mg	20.4	19.8	19.9	18.9
Mn	0.0505	0.0694	0.0659	0.0768
Mo	<.15	<.15	<.15	<.15
Na	26.7	24.7	24.8	25.7
Ni	<.08	<.08	<.08	<.08
P	1.94	2.92	2.78	3.01
Pb	<.08	<.08	<.08	<.08
Sb	<.08	<.08	<.08	<.08
Se	<.15	<.15	<.15	<.15
Si	5.29	6.04	6.02	5.9
Sn	<.2	<.2	<.2	<.2
Sr	0.231	0.229	0.23	0.228
Ti	<.0085	0.0179	0.0167	0.0189
V	<.05	<.05	<.05	<.05
Zn	0.028	0.05	0.045	0.036

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

		JANUARY 9, 1980			
PARAMETERS		STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		4.0	0.5	0.5	0.0
pH		7.6	7.5	7.5	7.5
CONDUCTIVITY (umhos/cm)		225	220	215	210
HARDNESS (mg/l $CaCo_3$)		145.0	152.0	148.0	148.0
DISSOLVED OXYGEN			<1.00	<1.00	<1.00
B.O.D.		57.1	48.4	45.48	38.9
FILTERABLE RESIDUE		232	244	243	243
NON-FILTERABLE RESIDUE		52	26	28	12
TOTAL ORGANIC CARBON					
TOTAL INORGANIC CARBON					
ORTHO PHOSPHATE (mg/l as P)		1.56	1.41	1.37	1.50
TOTAL PHOSPHATE (mg/l as P)		1.66	1.51	1.48	1.55
NITRITE (mg/l as N)		<.0050	<.0050	<.0050	.0565
NITRATE (mg/l as N)		0.080	<.010	0.0293	0.103
AMMONIA (mg/l as N)		29.9	5.75	5.89	5.53
SURFACTANTS		3.40	0.84	0.79	0.88
TOTAL COLIFORMS/100 ml		2.4×10^6	1.8×10^6	2.3×10^6	1.7×10^6
FAECAL COLIFORMS/100 ml		6.1×10^5	3.4×10^5	2.9×10^5	4.6×10^5
METALS:	Ag	<.030	<.030	<.030	<.030
	Al	0.092	0.18	<.09	<.09
	As	<.15	<.15	<.15	<.15
	Ba	0.0535	0.066	0.0457	0.0419
	Ca	28.7	29.4	28.3	28.6
	Cd	<.01	<.01	<.01	<.01
	Co	<.015	<.015	<.015	<.015
	Cr	<.015	<.015	<.015	<.015
	Cu	0.048	0.047	0.031	0.023
	Fe	0.22	0.379	0.221	0.207
	Hg	<.1	<.1	<.1	<.1
	K				
	Mg	17.1	19.0	78.8	18.7
	Mn	0.0805	0.0793	0.0705	0.0763
	Mo	<.15	<.15	<.15	<.15
	Na	19.5	20.7	17.9	20.3
	Ni	<.08	<.08	<.08	<.08
	P	1.82	1.55	1.42	1.49
	Pb	<.08	<.08	<.08	<.08
	Sb	<.08	<.08	<.08	<.08
	Se	<.15	<.15	<.15	<.15
	Si	5.23	5.83	5.44	5.66
	Sn	<.2	<.2	<.2	<.2
	Sr	0.21	0.221	0.215	0.217
	Ti	<.0085	.0085	<.0085	<.0085
	V	<.05	<.05	<.05	<.05
	Zn	0.059	0.201	0.042	<.02

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

PARAMETERS		FEBRUARY 29, 1980 STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		4.0	2.5	2.5	1.5
pH		7.6	7.3	7.3	7.3
CONDUCTIVITY (umhos/cm)		443	390	395	413
HARDNESS (mg/l $CaCo_3$)		140.0			
DISSOLVED OXYGEN		3.10	<1.00	<1.00	<1.00
B.O.D.		47.3	44.9	42.2	34.9
FILTERABLE RESIDUE		259	241	247	255
NON-FILTERABLE RESIDUE		52	19	15	14
TOTAL ORGANIC CARBON		16.0	8.0	7.0	7.0
TOTAL INORGANIC CARBON		28.0	22.0	27.0	21.0
ORTHO PHOSPHATE (mg/l as P)		1.97	1.49	1.62	1.51
TOTAL PHOSPHATE (mg/l as P)		2.29	1.79	1.64	1.55
NITRITE (mg/l as N)		<.0050	0.0051	0.0052	0.0056
NITRATE (mg/l as N)		<.010	<.010	<.010	<.010
AMMONIA (mg/l as N)		10.0	9.80	6.00	11.0
SURFACTANTS		0.67	0.65	0.69	0.54
TOTAL COLIFORMS/100 ml		1.4×10^7	4.0×10^6	4.0×10^6	2.0×10^6
FAECAL COLIFORMS/100 ml		1.2×10^6	3.0×10^5	3.3×10^5	5.2×10^5
METALS:	Ag	<.030			
	Al	<.09			
	As	<.15			
	Ba	0.049			
	Ca	28.1			
	Cd	<.01			
	Co	<.015			
	Cr	<.015			
	Cu	0.041			
	Fe	0.191			
	Hg	<.1			
	K				
	Mg	17.0			
	Mn	0.0855			
	Mo	<.15			
	Na	17.7			
	Ni	<.08			
	P	2.02			
	Pb	<.08			
	Sb	<.08			
	Se	<.15			
	Si	5.32			
	Sn	<.2			
	Sr	0.195			
	Ti	0.0468			
	V	<.05			
	Zn	0.062			

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III   WHITEHORSE SEWAGE LAGOON DATA (continued)

	APRIL 24, 1980			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	5.2	5.5		5.6
pH	7.4	7.2		7.3
CONDUCTIVITY (umhos/cm)	220	235		240
HARDNESS (mg/l $CaCo_3$)	154.0	145.0		143.0
DISSOLVED OXYGEN	7.10	<1.00		<1.00
B.O.D.	48.6	41.6		30.0
FILTERABLE RESIDUE	231	245		241
NON-FILTERABLE RESIDUE	30	16		16
TOTAL ORGANIC CARBON	14.0	12.0		11.0
TOTAL INORGANIC CARBON	36.0	36.0		37.0
ORTHO PHOSPHATE (mg/l as P)	1.720	1.30		1.31
TOTAL PHOSPHATE (mg/l as P)	2.27	2.10		1.85
NITRITE (mg/l as N)	0.0311	0.0102		0.0104
NITRATE (mg/l as N)	0.155	<.010		<.010
AMMONIA (mg/l as N)	6.89	6.36		6.09
SURFACTANTS	2.19	0.94		1.0
TOTAL COLIFORMS/100 ml	2.2×10^6	1.4×10^6		16.0×10^5
FAECAL COLIFORMS/100 ml	7.4×10^5	2.6×10^5		2.2×10^5
METALS: Ag	<.030	<.030		<.030
Al	<.09	0.135		0.142
As	<.15	<.15		<.15
Ba	0.0392	0.0419		0.0421
Ca	30.8	29.7		29.8
Cd	<.01	<.01		<.01
Co	<.015	<.015		<.015
Cr	<.015	<.015		<.015
Cu	0.034	0.032		0.026
Fe	0.089	0.263		0.18
Hg	<.1	<.1		<.1
K				
Mg	18.8	17.1		16.6
Mn	0.0631	0.0771		0.0919
Mo	<.15	<.15		<.15
Na	25.2	21.0		22.7
Ni	<.08	<.08		<.08
P	2.16	1.94		1.83
Pb	<.08	<.08		<.08
Sb	<.08	<.08		<.08
Se	<.15	<.15		<.15
Si	5.07	5.34		5.36
Sn	<.2	<.2		<.2
Sr	0.222	0.205		0.204
Ti	<.0085	0.0114		0.0103
V	<.05	<.05		<.05
Zn	0.032	0.082		0.059

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	MAY 23, 1980			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	5.2	7.0	8.5	9.3
pH	7.6	7.5	7.5	7.3
CONDUCTIVITY (umhos/cm)	255	263	262	267
HARDNESS (mg/l $CaCo_3$)	172.0	145.0	145.0	143.0
DISSOLVED OXYGEN	4.94	<1.00	<1.00	<1.00
B.O.D.	44.8	36.1		27.4
FILTERABLE RESIDUE	219	248	249	243
NON-FILTERABLE RESIDUE	46	19	15	15
TOTAL ORGANIC CARBON	68.0	12.0	10.0	14.0
TOTAL INORGANIC CARBON	48.0	42.0	41.0	37.0
ORTHO PHOSPHATE (mg/l as P)	2.09	1.61	1.70	1.54
TOTAL PHOSPHATE (mg/l as P)	2.92	1.89	1.97	1.81
NITRITE (mg/l as N)	0.0080	0.0060	0.0058	0.0106
NITRATE (mg/l as N)	<.010	<.010	<.010	<.010
AMMONIA (mg/l as N)	11.9	9.90	7.25	11.65
SURFACTANTS				
TOTAL COLIFORMS/100 ml	2.6×10^6	1.0×10^6		1.0×10^6
FAECAL COLIFORMS/100 ml	3.5×10^5	8.4×10^4	1.8×10^5	1.5×10^5
METALS: Ag				
Al	0.412	0.137	<.09	0.205
As	<.15	<.15	<.15	<.15
Ba	0.0872	0.0479	0.0429	0.0439
Ca	38.5	32.4	32.2	32.0
Cd	<.01	<.01	<.01	<.01
Co	<.015	<.015	<.015	<.015
Cr	<.015	<.015	<.015	<.015
Cu	0.133	0.038	0.028	0.027
Fe	0.917	0.279	0.213	0.27
Hg	<.1	<.1	<.1	<.1
K				
Mg	18.4	15.6	15.7	15.3
Mn	0.079	0.0731	0.0634	0.0688
Mo	<.15	<.15	<.15	<.15
Na	28.3	26.1	24.3	26.7
Ni	<.08	<.08	<.08	<.08
P	2.06	2.05	1.94	1.91
Pb	<.08	<.08	<.08	<.08
Sb	<.08	<.08	<.08	<.08
Se	<.15	<.15	<.15	<.15
Si	5.73	5.64	5.47	5.75
Sn	<.2	<.2	<.2	<.2
Sr	0.251	0.218	0.217	0.214
Ti	0.0091	0.0101	0.0095	<.0085
V	<.05	<.05	<.05	<.05
Zn	0.099	0.047	0.228	0.083

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (*continued*)

PARAMETERS		JUNE 19, 1980 STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		9.0	11.0		11.8
pH		7.6	7.2		7.3
CONDUCTIVITY (umhos/cm)		270	300		310
HARDNESS (mg/l $CaCo_3$)		161.0	149.0		147.0
DISSOLVED OXYGEN		5.67	<1.00		<1.00
B.O.D.		59.0	47.6		36.2
FILTERABLE RESIDUE		240	270		259
NON-FILTERABLE RESIDUE		48	31		31
TOTAL ORGANIC CARBON		47.0	24.0		22.0
TOTAL INORGANIC CARBON		37.0	42.0		41.0
ORTHO PHOSPHATE (mg/l as P)		2.66	2.15		2.20
TOTAL PHOSPHATE (mg/l as P)		2.82	2.37		2.39
NITRITE (mg/l as N)		<.0050	<.0050		<.0050
NITRATE (mg/l as N)		0.311	0.101		0.0847
AMMONIA (mg/l as N)		6.90	8.59		8.16
SURFACTANTS		1.18	0.62		0.53
TOTAL COLIFORMS/100 ml		2.4×10^6	1.9×10^6		2.0×10^6
FAECAL COLIFORMS/100 ml		5.5×10^5	4.0×10^5		2.5×10^5
METALS:	Ag	<.030	<.030		<.030
	Al	0.126	0.111		0.094
	As	<.15	<.15		<.15
	Ba	0.0511	0.0496		0.0476
	Ca	32.9	31.6		31.5
	Cd	<.01	<.01		<.01
	Co	<.015	<.015		<.015
	Cr	<.015	<.015		<.015
	Cu	0.034	0.025		0.016
	Fe	0.213	0.392		0.365
	Hg	<.1	<.1		<.1
	K				
	Mg	19.2	17.1		16.6
	Mn	0.15	0.108		0.095
	Mo	<.15	<.15		<.15
	Na	25.7	25.9		26.8
	Ni	<.08	<.08		<.08
	P	2.82	2.33		2.34
	Pb	<.08	<.08		<.08
	Sb	<.08	<.08		<.08
	Se	<.15	<.15		<.15
	Si	5.91	5.85		5.88
	Sn	<.2	<.2		<.2
	Sr	0.253	0.23		0.229
	Ti	<.0085	0.0141		0.0107
	V	<.05	<.05		<.05
	Zn	0.035	0.047		0.063

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	JULY 17, 1980			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	14.0	15.0		15.0
pH	7.2	7.1		7.3
CONDUCTIVITY (umhos/cm)	396	403		409
HARDNESS (mg/l $CaCo_3$)	124.0	127.0		132.0
DISSOLVED OXYGEN	3.20	<1.00		<1.00
B.O.D.	85.4			42.9
FILTERABLE RESIDUE	193	233		227
NON-FILTERABLE RESIDUE	57	36		33
TOTAL ORGANIC CARBON	16.0	20.0		28.0
TOTAL INORGANIC CARBON	38.0	42.0		42.0
ORTHO PHOSPHATE (mg/l as P)	2.68	2.41		2.05
TOTAL PHOSPHATE (mg/l as P)	5.46	4.22		4.27
NITRITE (mg/l as N)	<.0050	<.0050		0.0053
NITRATE (mg/l as N)	<.010	<.010		<.010
AMMONIA (mg/l as N)	10.6	8.10		8.65
SURFACTANTS				
TOTAL COLIFORMS/100 ml	2.4×10^6	5.4×10^6		1.2×10^6
FAECAL COLIFORMS/100 ml	2.0×10^6	1.6×10^6		2.8×10^5
METALS: Ag				
Al	0.125	0.121		0.094
As	<.15	<.15		<.15
Ba	0.0509	0.0459		0.0447
Ca	29.8	30.9		31.7
Cd	<.01	<.01		<.01
Co	<.015	<.015		<.015
Cr	<.015	<.015		<.015
Cu	0.057	0.027		0.022
Fe	0.288	0.493		0.409
Hg	<.1	<.1		<.1
K				
Mg	12.0	12.1		12.8
Mn	0.0924	0.116		0.103
Mo	<.15	<.15		<.15
Na	30.1	29.3		30.1
Ni	<.08	<.08		<.08
P	4.9	2.42		2.49
Pb	<.08	<.08		<.08
Sb	<.08	<.08		<.08
Se	<.15	<.15		<.15
Si	4.0	4.84		5.12
Sn	<.2	<.2		<.2
Sr	0.209	0.21		0.215
Ti	<.0085	0.0134		.0105
V	<.05	<.05		<.05
Zn	0.025	0.059		0.036

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

		AUGUST 20, 1980			
PARAMETERS		STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)		12.0	12.0		12.0
pH		7.1	7.0		7.8
CONDUCTIVITY (umhos/cm)		345	410		400
HARDNESS (mg/l $CaCo_3$)		144.0	133.0		133.0
DISSOLVED OXYGEN		4.18	0.00		0.00
B.O.D.		52.9	39.0		25.1
FILTERABLE RESIDUE		201	232		234
NON-FILTERABLE RESIDUE		42	23		17
TOTAL ORGANIC CARBON		27.0	28.0		9.0
TOTAL INORGANIC CARBON		31.0	42.0		38.0
ORTHO PHOSPHATE (mg/l as P)		2.310	2.15		2.06
TOTAL PHOSPHATE (mg/l as P)		3.510	2.54		2.73
NITRITE (mg/l as N)		0.0278	<.0050		<.0050
NITRATE (mg/l as N)		0.149	<.010		<.010
AMMONIA (mg/l as N)		15.05	10.0		6.58
SURFACTANTS		1.18	0.61		0.43
TOTAL COLIFORMS/100 ml		2.85×10^6	2.35×10^6		2.35×10^6
FAECAL COLIFORMS/100 ml		2.20×10^5	2.00×10^5		2.2×10^5
METALS:	Ag				
	Al	<.09	0.152		<.09
	As	<.15	<.15		<.15
	Ba	0.0504	0..0486		0.0466
	Ca	31.8	31.0		31.2
	Cd	<.01	<.01		<.01
	Co	<.015	<.015		<.015
	Cr	<.015	<.015		<.015
	Cu	0.019	0.021		0.019
	Fe	0.235	0.639		0.533
	Hg	<.1	<.1		<.1
	K				
	Mg	15.7	13.5		13.5
	Mn	0.144	0.129		0.132
	Mo	<.15	<.15		<.15
	Na	20.6	20.0		20.6
	Ni	<.08	<.08		<.08
	P	3.47	2.6		2.46
	Pb	<.08	<.08		<.08
	Sb	<.08	<.08		<.08
	Se	<.15	<.15		<.15
	Si	4.25	4.94		4.94
	Sn	<.2	<.2		<.2
	Sr	0.228	0.204		0.204
	Ti	<.0085	.0086		<.0085
	V	<.05	<.05		<.05
	Zn	0.022	0.045		0.021

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	SEPTEMBER 25, 1980			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	10	7		7
pH	7.4	7.2		7.8
CONDUCTIVITY (umhos/cm)	388	419		419
HARDNESS (mg/l $CaCo_3$)	122.0	124.0		126.0
DISSOLVED OXYGEN	4.12	<1.0		2.42
B.O.D.	49.6	42.1		27.0
FILTERABLE RESIDUE	197	228		226
NON-FILTERABLE RESIDUE	40	23		22
TOTAL ORGANIC CARBON	24.0	20.0		20.0
TOTAL INORGANIC CARBON	52.0	42.0		36.0
ORTHO PHOSPHATE (mg/l as P)	1.98	1.92		1.92
TOTAL PHOSPHATE (mg/l as P)	2.66	2.30		2.14
NITRITE (mg/l as N)	<.005	<.005		<.005
NITRATE (mg/l as N)	<.01	<.01		<.01
AMMONIA (mg/l as N)	8.51	7.85		7.81
SURFACTANTS	4.145	1.12		0.95
TOTAL COLIFORMS/100 ml	4.2×10^6	3.5×10^6		1.8×10^6
FAECAL COLIFORMS/100 ml	1.09×10^6	4.35×10^5		2.9×10^5
METALS: Ag				
Al	.168	.291		.132
As	<.15	<.15		<.15
Ba	.0458	.0465		.0468
Ca	27.1	27.9		28.1
Cd	<.01	<.01		<.01
Co	<.015	<.015		<.015
Cr	<.015	<.015		<.015
Cu	.042	.033		.027
Fe	.38	.791		.547
Hg	<.1	<.1		<.1
K				
Mg	13.2	13.2		13.5
Mn	.0974	.176		.249
Mo	<.15	<.15		<.15
Na	21.8	18.2		17.5
Ni	<.08	<.08		<.08
P	6.05	9.05		10.5
Pb	<.08	<.08		<.08
Sb	<.08	<.08		<.08
Se	.36	.23		<.15
Si	4.32	5.02		4.93
Sn	<.2	<.2		<.2
Sr	.203	.206		.214
Ti	<.0085	.0175		.0106
V	<.05	<.05		<.05
Zn	.023	.054		.041

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	OCTOBER 28, 1980			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	5	4		3
pH	7.6	7.20		7.3
CONDUCTIVITY (umhos/cm)	406	453		447
HARDNESS (mg/l $CaCo_3$)	168.0	152.0		148.0
DISSOLVED OXYGEN	4.54	1.60		<1.0
B.O.D.	55.7	40.6		33.5
FILTERABLE RESIDUE	232	247		238
NON-FILTERABLE RESIDUE	46	26		23
TOTAL ORGANIC CARBON	20.0	17.0		14.0
TOTAL INORGANIC CARBON	58.0	45.0		44.0
ORTHO PHOSPHATE (mg/l as P)	2.750	2.23		2.32
TOTAL PHOSPHATE (mg/l as P)	2.750	2.22		2.37
NITRITE (mg/l as N)	0.017	<.005		<.005
NITRATE (mg/l as N)	.0158	<.01		<.01
AMMONIA (mg/l as N)	15.41	7.06		9.64
SURFACTANTS				
TOTAL COLIFORMS/100 ml	4.8×10^6	1.4×10^6		4.0×10^5
FAECAL COLIFORMS/100 ml	1.9×10^5	2.0×10^5		6.5×10^4
METALS: Ag				
Al	<.09	.117		<.09
As	<.15	<.15		<.15
Ba	.0734	.0497		.0466
Ca	34.2	32.7		32.3
Cd	<.01	<.01		<.01
Co	<.015	<.015		<.015
Cr	<.015	<.015		<.015
Cu	.032	.033		.024
Fe	.187	.444		.430
Hg	<.1	<.1		<.1
K				
Mg	20.0	17.2		16.3
Mn	.102	.106		.118
Mo	<.15	<.15		<.15
Na	23.3	22.6		21.3
Ni	<.08	<.08		<.08
P	2.73	2.37		2.31
Pb	<.08	<.08		<.08
Sb	<.08	<.08		<.08
Se	<.15	<.15		<.15
Si	5.14	5.94		5.21
Sn	<.2	<.2		<.2
Sr	.252	.225		.22
Ti	<.0085	.0113		.0086
V	<.05	<.05		<.05
Zn	.063	.051		.025

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	NOVEMBER 26, 1980			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	6	3.5		2.0
pH	7.4	7.0		7.1
CONDUCTIVITY (umhos/cm)	175	190		204
HARDNESS (mg/l $CaCo_3$)	110.0	---		142
DISSOLVED OXYGEN	5.15	<1.0		<1.0
B.O.D.	58.6	45.33		32.0
FILTERABLE RESIDUE	164	208		229
NON-FILTERABLE RESIDUE	43	19		12
TOTAL ORGANIC CARBON	21.0	18.0		16.0
TOTAL INORGANIC CARBON	54.0	48.0		44.0
ORTHO PHOSPHATE (mg/l as P)	2.07	1.79		1.93
TOTAL PHOSPHATE (mg/l as P)	2.77	2.09		2.36
NITRITE (mg/l as N)	<.005	<.005		<.005
NITRATE (mg/l as N)	<.01	<.01		<.01
AMMONIA (mg/l as N)	10.1	9.01		9.12
SURFACTANTS				
TOTAL COLIFORMS/100 ml	2.1×10^6	2.05×10^6		2.0×10^6
FAECAL COLIFORMS/100 ml	4.1×10^5	1.2×10^5		2.1×10^5
METALS: Ag				
Al	.092	.137		.137
As	<.15	<.15		<.15
Ba	.0416	.048		.048
Ca	26.4	28.7		28.7
Cd	<.01	<.01		<.01
Co	<.015	<.015		<.015
Cr	<.015	<.015		<.015
Cu	.055	.042		.042
Fe	.416	.411		.411
Hg	<.1	<.1		<.1
K				
Mg	10.6	12.8		12.8
Mn	.0591	.0864		.0864
Mo	<.15	<.15		<.15
Na	20.9	18.5		18.5
Ni	<.08	<.08		<.08
P	2.98	2.48		2.48
Pb	<.08	<.08		<.08
Sb	<.08	<.08		<.08
Se	<.15	<.15		<.15
Si	3.18	4.48		4.48
Sn	<.2	<.2		<.2
Sr	.169	.189		.189
Ti	<.0085	.0158		.0158
V	<.05	.05		<.05
Zn	.035	.096		.096

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX III WHITEHORSE SEWAGE LAGOON DATA (continued)

	DECEMBER 31, 1980			
PARAMETERS	STATION 1	STATION 2	STATION 3	STATION 4
TEMPERATURE (°C)	5	2.5		1.0
pH	7.4	7.1		7.1
CONDUCTIVITY (umhos/cm)	218	215		218
HARDNESS (mg/l $CaCo_3$)	138.0	151.0		143.0
DISSOLVED OXYGEN	5.88	<1.0		<1.0
B.O.D.	51.5	38.30		35.5
FILTERABLE RESIDUE	211	241		229
NON-FILTERABLE RESIDUE	44	20		14
TOTAL ORGANIC CARBON	13.0	11.0		10.0
TOTAL INORGANIC CARBON	35.0	37.0		34.0
ORTHO PHOSPHATE (mg/l as P)	.86	1.10		1.20
TOTAL PHOSPHATE (mg/l as P)	2.5	1.7		1.6
NITRITE (mg/l as N)	<.005	<.005		<.005
NITRATE (mg/l as N)	<.01	<.01		<.01
AMMONIA (mg/l as N)	7.59	5.96		6.44
SURFACTANTS				
TOTAL COLIFORMS/100 ml	3.2×10^6	1.3×10^6		1.3×10^6
FAECAL COLIFORMS/100 ml	4.8×10^5	3.45×10^5		3.6×10^5
METALS: Ag				
Al	.146	<.09		<.09
As	<.15	<.15		<.15
Ba	.0449	.0445		.0438
Ca	28.6	30.4		28.0
Cd	<.01	<.01		<.01
Co	<.015	<.015		<.015
Cr	<.015	<.015		<.015
Cu	.043	.032		.025
Fe	.276	.256		.246
Hg	<.1	<.1		<.1
K				
Mg	16.1	18.2		16.8
Mn	.096	.104		.0916
Mo	<.15	<.15		<.15
Na	14.2	17.9		17.6
Ni	<.08	<.08		<.08
P	2.53	1.8		1.95
Pb	<.08	<.08		<.08
Sb	<.08	<.08		<.08
Se	<.15	<.15		<.15
Si	5.38	5.52		5.16
Sn	<.2	<.2		<.2
Sr	.215	.226		.216
Ti	.0102	.0088		.0104
V	<.05	<.05		<.05
Zn	.024	.041		.031

NOTE: All measurements mg/l unless otherwise noted.

APPENDIX IV

METHODS ON SAMPLE COLLECTION
AND ANALYTICAL TECHNIQUES

APPENDIX IV METHODS ON SAMPLE COLLECTION AND ANALYTICAL TECHNIQUES

Sample Collection

All samples were collected using the collection and preservation techniques described in the Environmental Protection Service Pollution Sampling Handbook(4). Samples were taken on either the second or third Thursday of each month from four stations (Figure 2).

Temperature, conductivity and pH values were taken in the field, using a Y.S.I. model 33 conductivity meter and a Radiometer type 298 pH meter. Station sampling consisted of sets of samples containing the following:

1 - 2 litre plastic jug for nutrients
1 - 200 ml plastic bottle for metals
1 - 100 ml glass jar for Total Inorganic Carbon (TIC) and Total Organic Carbon (TOC)
2 - 300 ml glass toppered bottles for Dissolved Oxygen (DO)
1 - 1 litre plastic bottle for Biochemical Oxygen Demand (BOD)
1 - 6 ounce glass bottle for Coliforms

Each container was rinsed 3 times, with aliquots of sample, before collecting the sample. Concentrated nitric acid (2.0 ml) was added as a preservative for the metals. The dissolved oxygen samples were fixed by adding 2.0 ml of a manganese sulfate solution followed by 2.0 ml of an alkaline iodide-sodium azide solution. The nutrients, metals and TIC and TOC containers were stored at 4°C and shipped to the EPS laboratory in West Vancouver, British Columbia for analysis.

Dissolved oxygen samples were collected in narrow, glass-stoppered, 300 ml BOD bottles. BOD samples were collected in one litre plastic bottles with subsamples taken for analyses. Bacteriological plating (total and faecal coliform) samples were taken from the remainder of the BOD samples. Care was taken not to allow the addition of atmospheric oxygen into both the DO and BOD bottles. Once the DO samples were properly preserved, by adding the preservatives below the liquid level, they were transported to the Whitehorse laboratory and analyzed.

Sample Analysis

Table 1 shows the methods used by the Vancouver laboratory to analyze nutrients (ortho-phosphate, total phosphate, nitrite, nitrate and ammonia), metals, surfactants, TIC and TOC. Analytical techniques are descried in the Environmental Laboratory Manual[5]. BOD, DO, Total and Faecal Coliform bacteria analyses were all performed in the Whitehorse EPS laboratory.

When analyzing for DO in either the DO or BOD samples, the analysis utilized the Iodometric-Azide Modification method (Winkler)[5, 6]. The samples were acidified by the addition of 2.0 ml of concentrated sulfuric aid. Through a series of chemical reactions, iodide (now present in the sample) was titrated with a standard sodium thiosulfate solution which indicated the amount of DO originally present in the samples.

The Whitehorse laboratory was not designed as a microbiology laboratory. Due to the small size and large volume of samples, every precaution available was adopted to insure non-contamination of the bacteriological samples, both in the laboratory and in the field. All bacteriological samples were analyzed for Total and Faecal Coliforms using the membrane filter technique as outlined in Standard Methods for the Examination of Water and Wastewater[6].

BOD samples were analyzed in a number of different ways during this study, however, the basic methods were the same. The main differences encountered in the BOD analysis were found in the actual calculations used to determine the BOD values. These calculations are explained later in this report.

Analysis of the BOD samples began on the same day that the sampling took place. Dilution water was prepared by adding phosphate buffer, magnesium sulfate, calcium chloride and ferric chloride (nutrients) to every one litre amount of distilled water. Dilutions of 5.0, 7.5, 10.0 and 23.5 percent sample were used for the sewage influent (Station 1) while dilutions of 7.5, 10.0, 12.5 and 15.0 percent sample were used for the remainder of the stations. Three 300 ml, glass-stoppered, bottles were prepared for each dilution. The DO was determined for one of these bottles and the other two bottles were incubated at 20°C for a five day period. After this incubation period the DO was determined for each bottle.

On August 15, 1979, a composite sample was collected from each of the four lagoons. These composite samples were collected using a van Dorn water sampler at depths of 1, 2 and 3 meters (surface samples were also taken). The surface and depth subsamples were then mixed together to constitute a composite sample. These composite samples were number Stations 5, 6, 7 and 8 (Figure 2).

For the months of September and October, 1980, eight separate BOD samples were taken hourly from the influent (Station 1), along with one morning and one afternoon effluent (Station 4) sample. In September and October DO samples were taken along with the BOD samples.

The calculations used by the EPS laboratory in Whitehorse are as follows:

APPENDIX IV METHODS ON SAMPLE COLLECTION AND ANALYTICAL TECHNIQUES (continued)

Dissolved Oxygen:

1 ml of 0.025 N $Na_2S_2O_3$ = 0.200 mg/DO

therefore 1 ml of 0.025 N $Na_2S_2O_3$ = 1 mg/l DO

if sample volume = 200 ml

Total and Faecal Coliforms Counts:

Plates are prepared using the membrane filtration techniques(6) with total coliforms incubated at 35°C and faecal coliforms incubated at 44.5°C for 24 hours before being counted. Total count numbers are converted to number of coliforms per 100 ml of sample.

BOD:

Method 1:

$$BOD = \frac{DO - [(1-P)(\text{Dilute Water})]}{P}$$

	Decimal Fraction	Sample Size	1-P
P =	0.025	2.5%	0.975
	0.05	5.0%	0.950
	0.075	7.5%	0.925
	0.10	10.0%	0.900
	0.125	12.5%	0.875
	0.150	15.0%	0.850

APPENDIX IV METHODS ON SAMPLE COLLECTION AND ANALYTICAL TECHNIQUES (continued)

Method 2:

$BOD = \frac{Dc - Df}{P}$

Df = final DO in incubated dilution

Dc = Dop + SP = initial DO of dilution H_2O

Do = DO of dilution water

$p = \frac{300 - V}{300}$ = fraction of dilution H_2O used

s = DO of undiluted sample

$p = \frac{v}{300}$ = fraction of sample used

v = volume of undiluted sample

Method 3(7):

BOD = 300 (slope) - y intercept + S

S = DO of undiluted sample

(used method of least squares when graphing results)

APPENDIX IV WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS

PARAMETER	DETECTION LIMIT	FIELD COLLECTION, SAMPLING PROCEDURES, PRESERVATION	ANALYTICAL PROCEDURE	METHOD SECTION[1]
Dissolved Oxygen (D.O.)	1.0 mg/l	Duplicate samples were collected at each station in 300 ml glass BOD bottles. The BOD bottle was rinsed 3 times with sample before filling. Subsurface samples were collected with a 3 litre van Dorn vessel. The D.O. samples were each preserved with 2 ml of manganese sulfate solution and 2 ml of alkali-iodide-azide solution. The samples were mixed by inverting them 15 times. D.O. analysis was done within 7 days.	Iodometric Azide Modification Winkler Titration Method.	048
pH		Small aliquots of sample were taken and read soon after collection at field camp. No preservatives were required, however, temperature was noted. Lab measurements were taken as well.	Potentiometric. pH meter determines the difference in e.m.f. developed by a reference electrode and the e.m.f. from the precision or calomel electrode. A change in 1 pH unit requires an electrical change of 59.1 mV at 25°C.	080
Conductivity	0.2 umhos/cm	In situ measurements, as well as lab measurements, were taken. The measurement was taken from the same sample as described in NH_3 below.	Conductivity Cell. This cell measures the solution's capacity for transmitting electricity.	044

APPENDIX IV WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	FIELD COLLECTION, SAMPLING PROCEDURES, PRESERVATION	ANALYTICAL PROCEDURE	METHOD SECTION[1]
Ammonia NH_3-N	0.005 mg/l	Single samples were collected in a 2 litre linear polyethylene container. The container was rinsed 3 times with sample before it was filled. Sub-surface samples were collected with a 3 litre van Dorn collecting vessel. No preservatives required. Stored at 4°C.	Phenol hypochlorite-colorimetric-automated. Under basic conditions ammonia reacts with phenol and is oxidized by sodium hypochlorite to form an organic complex, indolphenol blue. The intensity of indolphenol blue is measured at a wavelength of 630 nm. Reported as mg/l nitrogen. (1 mg/l N = 1.22 mg/l NH_3).	058
Filterable Residue (F.R.)	10 mg/l	Same sample as NH_3.	A well mixed known volume of sample is filtered through a standard glass fibre filter paper. The filtrate is then evaporated and dried at 103°C. This dry filtrate, when weighed, gives filterable residue (FR) in mg/l.	100
Non-filterable Residue (N.F.R.)	5 mg/l	Same sample as NH_3.	A known volume of sample is filtered through a pre-weighed, dried, standard glass fibre filter paper. The paper is then dried and weighed again. The difference in weight represents the non-filterable residue (NFR) in mg/l.	104
Total Organic Carbon (TOC)	1.0 mg/l	One sample was collected at each station using a 125 ml glass jar. The jar was rinsed 3 times with	Carbon infra red analyzer measures total and inorganic carbon. The difference of these two measurements	016

APPENDIX IV WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	FIELD COLLECTION, SAMPLING PROCEDURES, PRESERVATION	ANALYTICAL PROCEDURE	METHOD SECTION[1]
		sample before it was filled. Stored at 4°C.	is taken to get organic carbon.	
Total Inorganic Carbon (TIC)	1.0 mg/l	Same sample as TOC.		
Total Phosphate T PO_4^{+2}-P	0.005 mg/l	Same sample as NH_3.	Acid-persulfate, Autoclave Digestion. Total phosphate (T PO_4) is measured by converting all phosphorus compounds to orthophosphates by using an acid-persulfate digestion. Then the measurement of total phosphate is based on a reaction between phosphate and molybdate ion to form complex heteropoly-acids. This is then reduced with ascorbic acid to form a blue molybdophosphoric acid color and the absorbance is measured at a wavelength of 885 nm. A technicon automated system is used.	086
Nitrite NO_2-N	0.005 mg/l	Same sample as NH_3.	Diazotization-Colorimentric-Automated. Under acidic conditions nitrite ions react with sulfanilic acid to form a diazo compound. This compound, coupled with d-napthylamine, forms intense red azo dye which exhibits maximum absorb-	070

APPENDIX IV WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	FIELD COLLECTION, SAMPLING PROCEDURES, PRESERVATION	ANALYTICAL PROCEDURE	METHOD SECTION[1]
			ance at a wavelength of 520 nm. Reported as mg/l nitrogen. 3.29 mg/l NO_2^- = 1 mg/l N.	
Nitrate NO_3^--N	0.010 mg/l	Same sample as NH_3.	Cadmium-Copper Reduction-Colorimetric Automated. The sample was passed through a column containing cadmium granules coated with a porous layer of copper. The nitrate in the sample was reduced to nitrite. The sample was then	072
Extractable Metals		Single samples were collected at each station using a 200 ml linear polyethylene bottle. The sample bottle was rinsed 3 times with sample before filling. Subsurface samples were collected using a 3 litre van Dorn vessel. Each bottle was then preserved to a pH of <1.5 using 2.0 ml of concentrated nitric acid. The extractable method used measures the dissolved metals in addition to those (inorganic, organic, adsorbed, precipitated and particulate) which will be brought into solution by	An excitation source called the Inductively Coupled Argon Plasma (ICAP) combined with a computer controlled Optical Emission Spectrometer (OES) was used to measure the metal concentration.	210 592
Al	0.090			
As	0.15			
Ba	0.0030			
Ca	0.025			
Cd	0.010			
Co	0.015			
Cr	0.015			
Cu	0.010			
Fe	0.010			
Mg	0.025			
Mn	0.0040			
Mo	0.15			
Na	0.030			
Ni	0.0080			

APPENDIX IV WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	FIELD COLLECTION, SAMPLING PROCEDURES, PRESERVATION	ANALYTICAL PROCEDURE	METHOD SECTION[1]
Pb	0.080			
Sb	0.080			
Se	0.15			
Sn	0.20			
Sr	0.0040			
Ti	0.0085			
V	0.050			
Zn	0.020			
Total Hardness			Total hardness is computed in the ICAP by multiplying magnesium by a factor of 4.116 and calcium by a factor of 2.497. The resulting sum of these cations will give a $CaCO_3$ concentration equivalent which will be reported as mg/l $CaCO_3$.	
Silica Si	0.5 mg/l	Same sample as NH_3.	Ascorbic Acid Reduction - Colorimetric - Automated. This reaction is based upon the reduction by ascorbic acid of silicomolybdate in acidic solution to molybdenum blue. The color is measured at a wavelength of 660 nm.	118
Mercury Hg	0.00020 mg/l	Samples were collected at each station using a 200 ml linear polyethylene bottle. Each bottle was rinsed 3 times with sample	Open Flameless System for Hg - AAS Determination. Organo mercury compounds in the sample are oxidized to inorganic mercury compounds by the	211 224 284 411

APPENDIX IV WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	FIELD COLLECTION, SAMPLING PROCEDURES, PRESERVATION	ANALYTICAL PROCEDURE	METHOD SECTION[1]
		before being filled. Each sample was then preserved by the addition of 10 ml of 5% nitric dichromate solution.	use of sulfuric and nitric acid and potassium persulfate. The mercury is swept with argon from the solution and passed through an absorption cell which is situated in the light path of a mercury lamp. Mercury absorption is determined at a wavelength of 253.7 nm with a background absorbance measured at a wavelength of 254.7 nm, using a tin hollow cathode lamp.	
Silver Ag	0.030 mg/l	Same sample as metals.	Flame Atomic Absorption Spectrophotometry.	210 290
Potassium K	0.010 mg/l	Same sample as metals.	Flame Atomic Emission Spectrophotometry.	210 423

1 Department of the Environment, Department of Fisheries and Oceans, Laboratory Manual, Environmental Protection Service, Fisheries and Marine Service, (1979).