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Environment Canada
Environmental Protection Service
Pacific Region
Yukon Branch

A FOLLOW-UP WATER QUALITY AND
BIOLOGICAL SURVEY OF KING POINT AND
STOKES POINT, YUKON-BEAUFORT SEA COAST

Regional Program Report No. 86-23

by

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ABSTRACT

A baseline inventory survey of water chemistry, sediment and biological conditions was conducted by the Environmental Protection Service on the Yukon's Beaufort Sea coast in July 1984. Investigations were conducted at King Point and Stokes Point to follow-up previous studies (Allan and Mackenzie-Grieve 1983, 1984) and provide additional background information. Samples were collected from lake, lagoon and near-shore marine habitats.

The water chemistry data from the lake at King Point showed the nutrient and total metals levels were within the recommended levels for drinking water.

The lagoons at King Point and Stokes Point both have brackish water. The King Point lagoon is less saline (4.5 ‰) and has a lower conductivity (5800 umhos/cm) than the waters of Stokes Point lagoon which showed high salinity (up to 27‰) and conductivity (up to 30,300 umhos/cm). The lagoon sediments were characterized by a high proportion of silt and organic materials. One station at Stokes Point lagoon showed elevated oil and grease levels relative to other stations.

The nearshore marine stations exhibited lower salinity (12.1‰ to 22.4‰) and conductivity (13,100 umhos/cm to 19,700 umhos/cm) than observed in previous studies suggesting a mixing influence of freshwater from the Mackenzie River and Babbage River in the nearshore marine areas at King and Stokes Points respectively. Sediment composition showed considerable variation among stations at both King Point and Stokes Point however sediment composition was generally dominated by medium to very fine sand with occasional stations exhibiting a high proportion of gravels (>2.0mm).

The benthic invertebrate community at King Point was characterized by 20 different taxa with a density averaging 400 individuals/m². The polychaetes (Aonides sp. and Spio sp.) and copepods (Limnocalanus macrurus) were the dominant organisms. At Stokes Point the benthic invertebrate community was more diverse with 35 taxa being identified, and showed a higher density with an average of 1240 individuals/m². The polychaetes (Samytha californiensis, Scoloplos armiger) and copepods (Limnocalanus macrurus) were the dominant organisms.

RÉSUMÉ

En juillet 1984, le Service de la protection de l'environnement a conduit une étude de base des caractéristiques chimiques de l'eau, des sédiments et des conditions biologiques sur la côte de la mer de Beaufort au Yukon, aux pointes King et Stokes. L'étude faisait suite à des études antérieures (Allan et Mackenzie-Grieve, 1983, 1984) et visait aussi à obtenir des renseignements de base supplémentaires. Des échantillons ont été prélevés dans des habitats lacustres, lagunaires et marins près du rivage.

Les données sur les caractéristiques chimiques de l'eau lacustre, à la pointe King, ont montré que les concentrations d'éléments nutritifs et de métaux totaux se situaient dans les limites recommandées pour l'eau potable.

Les lagunes des pointes King et Stokes sont saumâtres. L'eau du lagune de la pointe King est moins salée (4,5 ‰) et moins conductrice (5 800 uS/cm) que l'eau de la lagune de la pointe Stokes (jusqu'à 27 ‰) et conductivité (jusqu'à 30 300 uS/cm). Les sédiments du lagune étaient caractérisés par une forte proportion de limon et de matières organiques. À une station de la lagune de la pointe Stokes, les concentrations d'huile et de graisse, relativement à celle des autres stations, étaient élevées.

Dans les stations marines près du rivage, la salinité (de 12,1 à 22,4 ‰) et la conductivité (de 13 100 à 19 700 uS/cm) étaient plus faibles que ce qu'on avait observé au cours d'études antérieures, ce qui porterait à croire à un effet de mélange d'eau douce du fleuve Mackenzie et de la rivière Babbage dans les secteurs marins près du rivage des pointes King et Stokes respectivement. La composition des sédiments variait considérablement d'une station à l'autre aux pointes King et Stokes, mais elle était généralement dominée par la présence de sable de granulométrie moyenne à très fine, les graviers (> 2,0 mm) atteignant dans certaines stations une proportion élevée.

A la pointe King, la communauté des invertébrés benthiques était caractérisée par 20 différents taxons avec une densité de 400 organismes/m². Les polychètes (Aonides sp. et Spiو sp.) ainsi que les copépodes (Limnocalanus macrurus) dominaient. A la pointe Stokes, cette communauté d'invertébrés benthiques était plus diversifiée (35 taxons) et d'un effectif plus dense (en moyenne 1 240 organismes/m²). Les polychètes (Samytha californiensis, Scoloplos armiger) et les copépodes (Limnocalanus macrurus) y dominaient.

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1 INTRODUCTION

In August of 1984 Environmental Protection Service staff conducted baseline inventory surveys similar to those carried out in 1982 and 1983 (Allan and Mackenzie-Grieve 1983, 1984) at King Point and Stokes Point on Yukon's north coast.

Deepwater port development has been proposed at both sites in support of Beaufort Sea oil and gas exploration, as well a quarry and associated port development has been proposed near King Point. The establishment in 1984 of a National Park along the western half of Yukon's north slope, including Stokes Point, has shifted the focus of attention to King Point for deepwater port development. In late 1985 there were two applications being considered by the Department of Indian and Northern Affairs for development of port facilities at King Point.

The information from Stokes Point and King Point reported by Allan and Mackenzie-Grieve (1983, 1984) shows considerable variation in the benthic community species composition and density. This variability indicated the need for additional baseline data at King Point and to substantiate the Stokes Point information to date.

The present survey at both locations included the investigation of nearshore marine and lagoon benthic invertebrate communities, measurement of marine and lagoon water quality (temperature, conductivity, pH, salinity and nonfilterable residue) and characterization of nearshore marine and lagoon sediments (particle size distribution, leachable metals, trace hydrocarbons and oils and greases). A freshwater lake near King Point was investigated for water quality, nutrients and total metals because of its potential use as a freshwater source.

2 STUDY AREA

The study areas, King Point (Latitude 69°06'N and Longitude 137°58'W) and Stokes Point (Latitude 69°20'N and Longitude 138°45'W) are located west of the Mackenzie River delta along Yukon's north coast.

The sample sites were located as close as possible to those established by Allan and Mackenzie-Grieve (1983) using land marks and compass direction to reference each location. Two additional nearshore marine stations (Stations 9 and 10) were established at King Point and one new nearshore marine station (Station 9) was established at Stokes Point.

The King Point freshwater lake (Latitude 69°06'48"N and Longitude 138°01'36"W) is located approximately 1.75 kilometers northwest of the King Point lagoon. Water samples and in situ measurements were collected from three locations on the lake.

Figures 1, 2 and 3 identify the study area and sample station location.

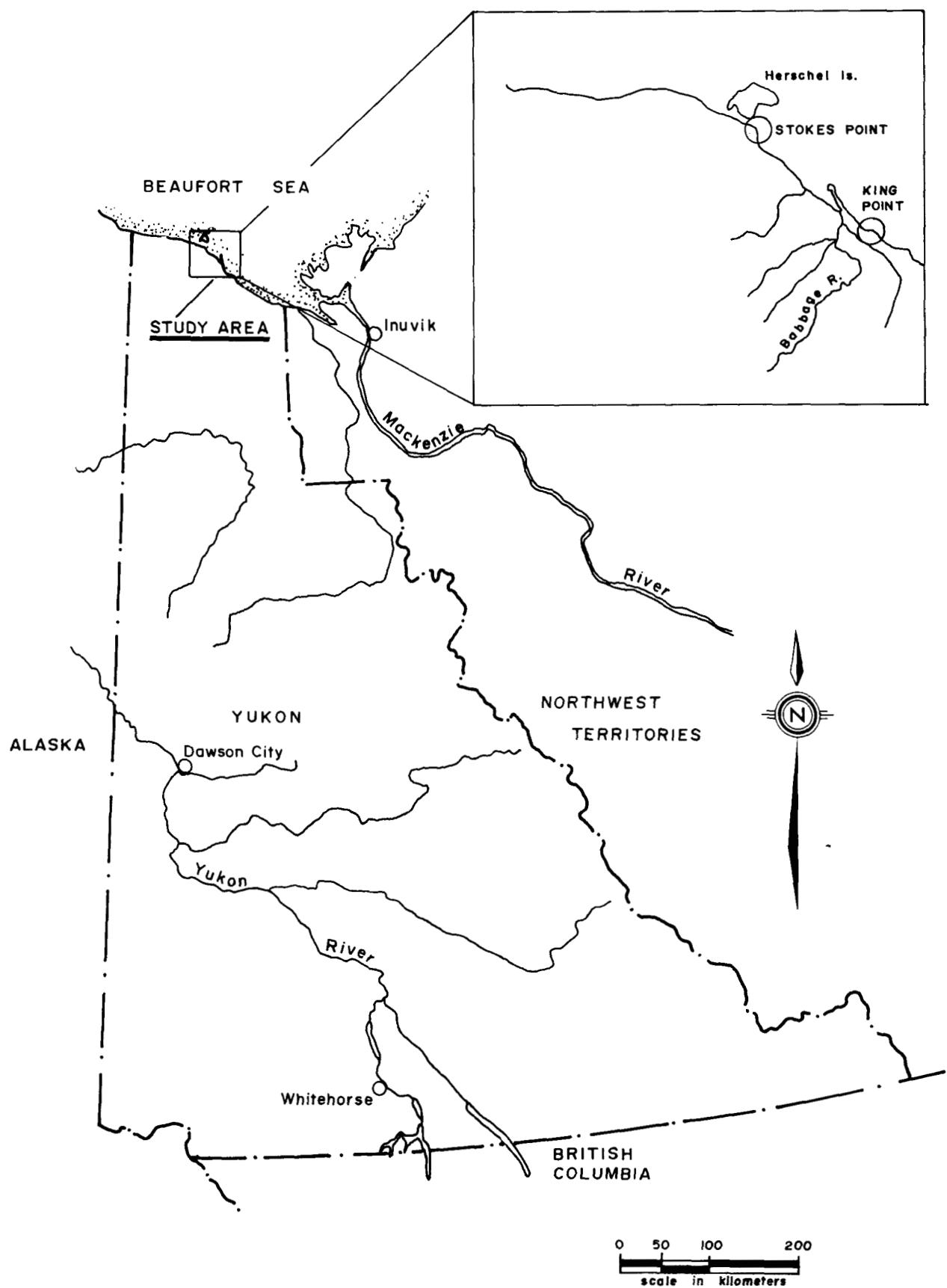


FIGURE 1 : LOCATION OF STUDY AREAS

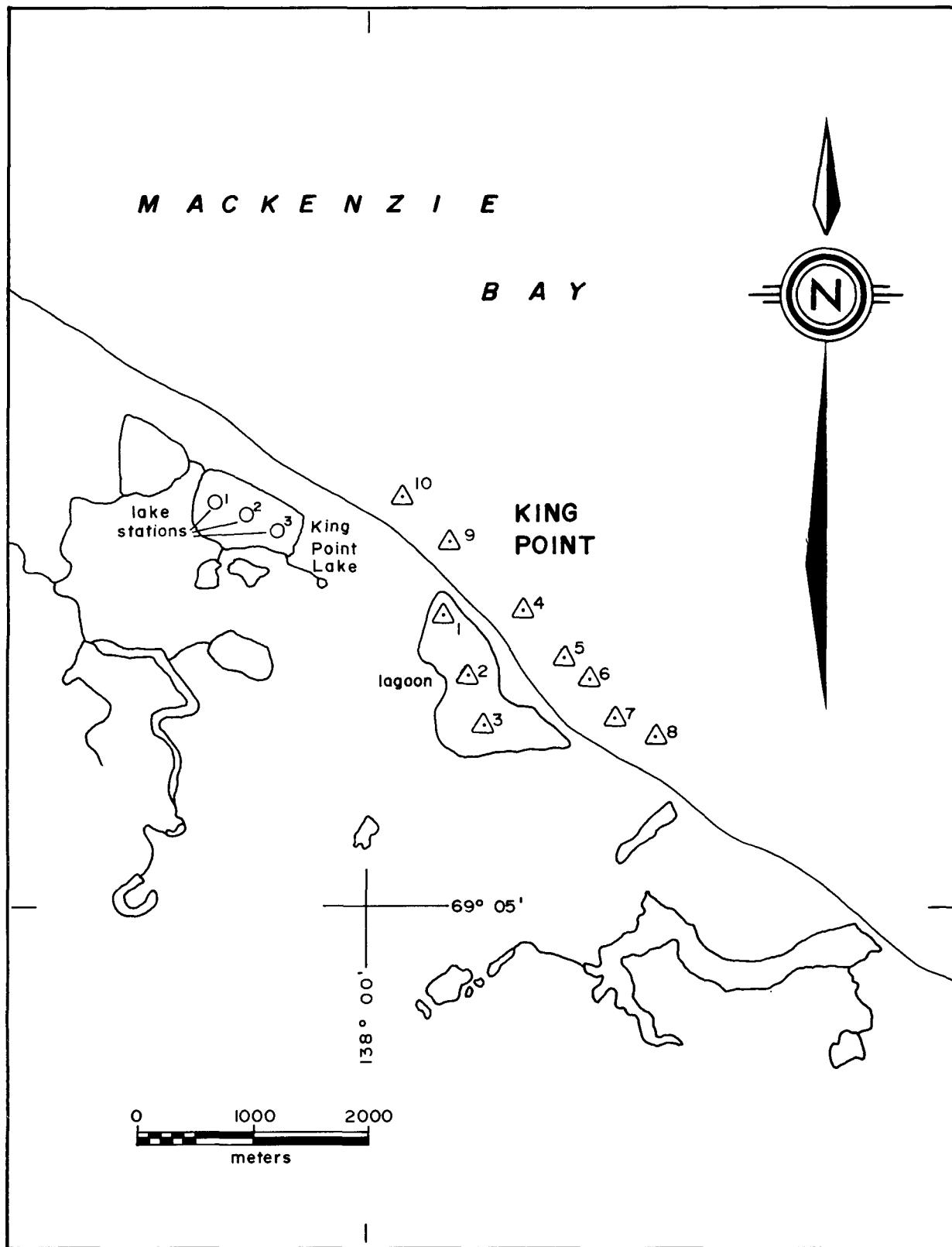


FIGURE 2 : LOCATION OF SAMPLING STATIONS
NEAR KING POINT.

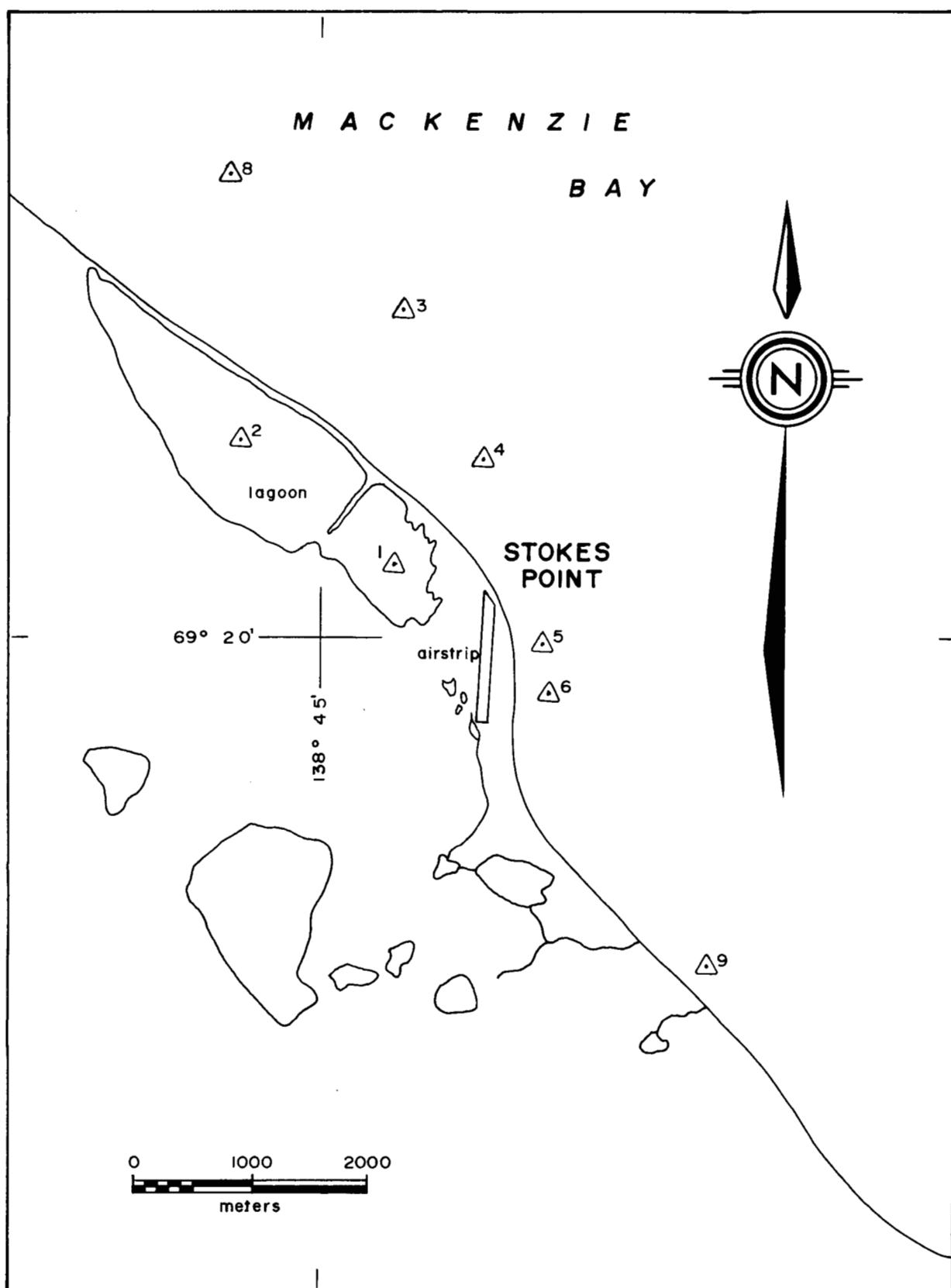


FIGURE 3 LOCATION OF SAMPLING STATIONS
NEAR STOKES POINT.

3 METHODS

Sample collection and in situ measurements at King Point stations were carried out August 1 and 2, 1984. Sample collection and measurements at the King Point freshwater lake were carried out August 5, 1984. At Stokes Point, sample collection and measurements were carried out August 6 and 7, 1984.

An inflatable boat was used at both locations to access nearshore marine and lagoon stations while a helicopter equipped with floats was used to access the freshwater lake stations.

The nearshore marine stations were positioned along the five (5) meter isobath which was located using a "Fish Ray" electronic depth sounder. An anchor was deployed at each station to prevent drifting during sample and data collection.

The following sections provide details of the methods and instrumentation used to collect water samples and in situ water quality measurements.

3.1 Water Quality

Water quality measurements for the nearshore marine and lagoon areas were made at the surface and at approximately 0.5 meters above bottom. The in situ measurements included temperature, conductivity and salinity. A YSI Model 33 Field Meter was used to obtain temperature (celsius), conductivity ($\mu\text{mhos/cm}$) and salinity (σ/σ_0) readings.

Water samples were collected from the surface and near bottom at all nearshore marine and lagoon stations for nonfilterable residue (NFR) analysis. Surface samples were collected from the boat by hand and a Niskin 2.5 Litre Sampler was used to obtain the water samples at depth. A litre of sample was filtered on site through a preweighed filter using a hand operated vacuum pump and filtering apparatus.

The NFR for each sample collected was later determined at the EPS Laboratory in Whitehorse using the procedure described in Appendix I, Tables 1 and 2.

Water samples and in situ measurements from the King Point lake were collected using the above methods. In addition to NFR analysis, samples were collected from the surface and near bottom for nutrient and total metals analysis. The specific parameters measured and methods of analysis are provided in Appendix I, Table 2. Analysis of water samples was subsequently carried out at the EPS Laboratory, 4195 Marine Drive, in West Vancouver, British Columbia.¹

3.2 Sediments

All sediment samples from nearshore marine and lagoon stations were collected using an Ekman Dredge (0.023 m^2). In most cases 3 grab samples were collected at each station but on some occasions coarse substrate prevented the dredge from closing properly therefore much or all the finer material was lost. Samples were not obtained at Station 5, King Point and at Station 4, Stokes Point for this reason.

Each grab sample was placed in a paper geochemical sediment bag and then packaged in plastic bags. The samples were kept cool or frozen until they were analysed at the EPS Chemistry Laboratory, 4195 Marine Drive, West Vancouver, B.C.¹ The samples were analysed for particle size distribution, oils and greases, trace hydrocarbons and leachable metals. It should be noted that the "oils and greases" analysis includes hydrocarbons as well as fatty acids, soaps, fats, waxes and oils. The hydrocarbon analysis is a qualitative test. The particle size distribution was described using the Wentworth Classification System. A description of sediment sample preparation and analysis is shown in Appendix I, Table 3.

¹ Systematic error and sample contamination during analysis at the EPS Laboratory are minimized through duplicate analysis, procedural blanks and the use of standard reference materials. Internal lab quality control is carried out in all water and sediment analysis before results are released.

3.3 Bottom Fauna

All benthic invertebrate samples were collected using an Ekman Dredge (0.023 m^2). Five replicate samples were collected at each station but, as previously explained in Section 3.2, coarse substrate occasionally prevented the dredge from closing properly. This resulted in fewer replicates being collected at Stations 6 and 7, King Point and Stations 4, 8 and 9, Stokes Point. There were no samples obtained at Station 5, King Point. Each sample was sieved on site through a 0.5 mm mesh opening Wildco wash bucket and then preserved with 10% formalin. The invertebrates were later sorted from the organic and sediment material and preserved with 70% methanol at the EPS Laboratory in Whitehorse.

The invertebrates were identified and enumerated by Dr. Charles Low, a consulting invertebrate biologist in Nanaimo, B.C. Any genus or species name shown in brackets indicates that identification was tentative.

4 RESULTS AND DISCUSSION

Sampling locations at King Point and Stokes Point are divided into two categories, nearshore marine and lagoon habitats, for discussion purposes. The nearshore marine habitat includes Stations 4 through 10 at King Point and Stations 4 through 9 at Stokes Point. Stations 1, 2 and 3 at King Point and Stations 1, and 2 at Stokes Point are located within the lagoon habitat. (See figures 2 and 3 for approximate location of stations.) Results from Allan and Mackenzie-Grieve (1983, 1984) will be included in the discussion for comparison. The present survey's water quality results for the freshwater lake at King Point will be discussed separately.

4.1 Nearshore Marine Habitat

4.1.1 King Point Water Quality. Water quality data of the King Point nearshore marine stations are presented in Appendix II, Table I. Water temperatures averaged 6.4°C at the surface and 2.0°C at 4.5 meters depth. The depth of the thermocline was not measured.

Conductivity averaged 13,100 umhos/cm at the surface and 19,700 umhos/cm at near bottom. Salinity readings corresponded with the difference in conductivity measurements, averaging 12.1 o/oo at the surface and 22.4 o/oo at near bottom. Allan and Mackenzie-Grieve (1983) reported an average conductivity of 28600 umhos/cm and an average salinity of 31.2 o/oo at both surface and near bottom. The lower conductivity and salinity readings in this survey suggest the nearshore environment was influenced by fresh water during the survey but the degree of influence cannot be determined from the available data. Calm ocean conditions prevailed during this survey. Nonfilterable residues in the present survey were comparable to those reported by Allan and Mackenzie-Grieve (1983). They averaged 10 mg/L at the surface and 16 mg/L at near bottom.

4.1.2 Stokes Point Water Quality. Water quality data of the Stokes Point nearshore stations are presented in Appendix II, Table 2. Water temperatures ranged from 6.0°C at the surface to 4.5°C at near bottom. Conductivity and salinity measurements show little difference between surface and near bottom indicating a well mixed unstratified water column.

Conductivity averaged 13,700 umhos/cm at the surface and 15,200 umhos/cm at near bottom. Salinity averaged 12.9 o/oo at the surface and 14.3 o/oo at near bottom. These readings, lower than those reported by Allan and Mackenzie-Grieve (1983, 1984), may be a result of calm ocean conditions which occurred before and during the time measurements were taken combined with a fresh water influence from the Babbage River.

Nonfilterable residue values averaged about 10 mg/L at the surface and near bottom. These levels are comparable to that found by Allan and Mackenzie-Grieve (1983, 1984).

4.1.3 King Point Sediments. The sediment particle size composition and chemical analysis results for King Point are provided in Appendix III, Table 1.

Particle size analysis results for King Point show good consistency among grab samples for each station except at Station 6 and 7 where the percentage of gravel material (>2.0 mm) varied considerably. Samples were not collected at Station 5 because coarse sediments prevented the dredge from closing properly thus most of the fine sediments were lost during retrieval of the dredge. This was also reported by Allan and Mackenzie-Grieve (1983) at the same location.

Sediment composition is dominated by fine to very fine sands at Stations 4 and 10. The mean percentage of fine sand at Station 10 was 71% which is unlike any other nearshore marine station from this survey or those reported in Allan and Mackenzie-Grieve (1983). Composition at Stations 6, 7, 8 and 9 was dominated by gravels (>2.0 mm) with averages ranging from 22% to 35%. All other size classes were evenly represented.

The detailed sediment chemistry results for King Point are provided in Appendix III, Table 4. Results of the oils and grease analysis reveal an average of 606 mg/kg compared to an average value of 206 mg/kg reported by Allan and Mackenzie-Grieve (1983). The greatest change occurred at Station 6 where the levels increased from 107 mg/kg to 1087 mg/kg. Trace amounts of hydrocarbons were detected in all nearshore marine samples except for one sample at Station 4. The presence of hydrocarbons and increased levels of oils and greases is suspected to be due to contamination during sample collection however increased industrial activity along the Yukon coastline and further offshore may be a potential factor also. Further detailed sampling and analysis should be carried out to verify the qualitative results.

Analysis results for leachable metals from the present study are comparable to those reported by Allan and Mackenzie-Grieve (1983) for King Point except that arsenic and lead were generally below detection in the present study. In the previous investigation at King Point both arsenic and lead were detected in marine sediments. A comparison of silver concentrations cannot be made due to the fact that the analysis detection level was much lower in the present survey than that used in analysing the sediments collected in 1982. Table 1 compares mean concentrations of selected leachable metals from King Point marine sediments collected in 1982 (Allan and Mackenzie-Grieve, 1983) and in the present survey.

TABLE 1 MEAN CONCENTRATIONS OF SELECTED LEACHABLE METALS
IN KING POINT MARINE SEDIMENTS

SAMPLE YEAR	NO. OF SAMPLES	Cr	Cu	Fe (mg/kg)	Hg	Mn	Ni	Zn
1982	X 11	34.2	24.7	29,700	0.26	455	31.0	108
	S.D.	7.52	6.99	3,830	0.01	61.6	4.90	16.8
1984	X 18	30.7	18.4	30,400	0.07	495	26.3	91.7
	S.D.	6.60	7.50	4,030	0.02	117	4.68	12.4

4.1.4 Stokes Point Sediments. Appendix III, Table 2 provides the detailed results of sediment particle size composition at Stokes Point. The nearshore marine sediments are composed primarily of medium to very fine sands. The highest percentages of these fractions were found at Stations 5 and 6 where medium to very fine sands made up 81% of the sample. Station 5 also contained 17% silt and 13% gravel. The sediment composition at Station 3 was 55% medium to very fine sand and 26% silt. At Station 8 coarse sediments prevented the dredge from working properly so only two grab samples were collected. They had a composition of 75% medium to very fine sand and 12% gravel. Composition at Station 9 was similar to Station 8 but only one sample was obtained because of the dredge not closing properly.

Appendix III, Table 6 provides the detailed sediment chemistry results for Stokes Point. Oils and greases analysis results show increases at all stations compared to levels found in the 1982 and 1983 surveys. The average level found in this survey was 560 mg/kg whereas Allan and Mackenzie-Grieve (1983 and 1984) reported less than 300 mg/kg at most nearshore marine stations. The grab samples collected at Station 8 in a 1983 survey contained 1100, 700 and less than 300 mg/kg. Samples collected during this survey near the same location were slightly lower at 220 and 260 mg/kg. Trace levels of hydrocarbons were present in sediment samples from all nearshore marine stations. This presence of trace hydrocarbons is attributed to the same possible factors as previously indicated for King Point. Further detailed sampling and analysis should be carried out to verify these qualitative results.

All extractable metals analysed for, as shown in Appendix III, Table 4, were found to be within the ranges detected in the previous two surveys except, as was found at King Point, arsenic and lead were below detection limits. Lead and arsenic were reported by Allan and Mackenzie-Grieve (1983 and 1984) in all nearshore marine and lagoon sediments. Table 2 compares mean concentrations of selected extractable metals from Stokes Point marine sediments collected in 1982 and 1983 (Allan and Mackenzie-Grieve, 1983, 1984) and in the present survey.

TABLE 2 MEAN CONCENTRATIONS OF SELECTED LEACHABLE METALS
IN STOKES POINT MARINE SEDIMENTS

SAMPLE YEAR	NO. OF SAMPLES	Cr	Cu	Fe (mg/kg)	Hg	Mn	Ni	Zn
1982	12	19.3	9.4	20,200	0.24	327	18.2	77.9
	S.D.	2.90	6.0	3,030	0.05	38.6	3.77	20.5
1983	15	17.1	7.7	19,800	0.04	304	18.0	58.2
	S.D.	1.56	1.4	2,960	<0.01	29.9	1.64	7.39
1984	*11	22.3	9.2	20,800	0.06	347	17.8	61.5
	S.D.	5.75	5.4	3,310	0.01	19.8	4.19	15.0

*Not including sample from Station 9

4.1.5 King Point Bottom Fauna. Appendix IV, Tables 1 and 2 provide the detailed benthic invertebrate data from King Point. The benthic invertebrate population density averaged 400 individuals/m², ranging from 200 to 652 individuals/m². This density, based on a larger sample size, is markedly higher than the density of 140 individuals/m² observed by Allan and Mackenzie Grieve (1983).

Overall, of the 20 different taxa identified from the nearshore marine benthic environment, 10 of these were indentified to species level and 15 to the genus level. The most abundant groups of organisms were from the Class Polychaeta and Class Crustacea Subclass Copepoda which made up 50% and 32% respectively of the sample population. Aonides sp. and Spio sp. were the dominant polychaete genera and Limnocalanus macrurus was the dominant copepod genus with the amphipod Pontoporeia sp. also being relatively abundant. There were an average of 8 taxa present per station.

4.1.6 Stokes Point Bottom Fauna. Appendix IV, Tables 3 and 4 provide the detailed benthic invertebrate data from Stokes Point. The population density at Stokes Point averaged about 1240 individuals/m² with a maximum density of 1991/m² at Station 8. In the previous surveys the average densities reported were 890/m² in 1982 and 1240/m² in 1983 (Allan and Mackenzie-Grieve 1983, 1984).

In all 35 taxa were identified, of which 9 were identified to the genus level and 16 of these to the species level. The average number of species per station was 12. Allan and Mackenzie-Grieve (1983, 1984) reported averages of 14 species per station in 1982 and 16 species per station in 1983. Only 4 genera in the present study were the same as those identified in 1982 and 8 were the same as those identified in 1983.

The most abundant group was the Class Polychaeta which made up 43% of the total sample collected. The species most prominent were Samytha californiensis (13%) and Scoloplos armiger (10%). In 1982 the Class Polychaeta represented 36% of the total sample while in 1983 they represented 60% of the total sample.

A species in the Subclass Copepoda, Limnocalanus macrurus, represented 24% of the individuals collected making it the most abundant species found in the marine environment at Stokes Point. Allan and Mackenzie-Grieve (1984) also reported this species as being the most abundant overall. In 1982, the species L. macrurus was not found in the samples collected from nearshore marine stations but was found in lagoon samples in small numbers (Allan and Mackenzie-Grieve 1983).

The Molluscs represented 54% of the total sample collected in a 1982 survey but in 1983 and the current survey they represented only 5% and 10%, respectively. A mollusc, Portlandia intermedia, reported by Allan and Mackenzie-Grieve (1983) as not previously recognized in other Beaufort literature occurred again at Stokes Point in the present study.

Two species of Amphipods, Monoculopsis (micros) and Mecocheirus sp., report by Allan and Mackenzie-Grieve (1984) as being new species reported for the area, were also found in the present study.

4.2 Lagoons Habitat

Lagoon stations are identified as Stations 1, 2 and 3 at King Point and Stations 1 and 2 at Stokes Point.

4.2.1 King Point Water Quality. Water quality data from King Point lagoon (Stations 1-3) is presented in Appendix II, Table 1. Lagoon depth averaged 3.3 meters among the three stations and the maximum depth measured was 3.5 meters. Water temperature averaged 13.0 °C at both surface and near bottom. Very little difference was found in conductivity, salinity and nonfilterable residues (NFR) among stations or between surface and samples taken at near bottom depths. Conductivity averaged 58 umhos/cm, salinity averaged 4.5 o/oo and NFR averaged 7.5 mg/L. Allan and Mackenzie-Grieve (1983) reported slightly higher average conductivity and salinity at 72 umhos/cm and 6.6 o/oo, respectively. Kendel et al. (1975) reported salinity: at 12.6 o/oo at the surface and 36.6 o/oo near bottom. The gradual decrease in salinity as reported by the two previous surveys mentioned and the present survey indicates the lagoon is becoming less saline since it has become physically separated from the Beaufort Sea and more influenced by surface run-off and precipitation.

4.2.2 Stokes Point Water Quality. Water quality data from Stokes Point lagoon (Stations 1 and 2) is presented in Appendix II, Table 2. The depths measured at the Stations 1 and 2 were 3.0 and 3.5 meters respectively. The Stokes Point lagoon temperature averaged 9.7 °C.

Surface and near bottom conductivity and salinity readings varied considerably between the two lagoon stations. At Station 1 surface conductivity and salinity were 12600 umhos/cm and 10.8 o/oo, respectively, while at near bottom they were 30300 umhos/cm and 27.0 o/oo, respectively. At Station 2 the surface measurements were 15000 umhos/cm and 13.0 o/oo while at near bottom they were 18700 umhos/cm and 16 o/oo.

In 1982 conductivity and salinity were slightly higher but there was little difference between surface and near bottom values. In 1983 the range between surface and near bottom was greater than that found in this survey. At Station 1 the conductivity and salinity were 13100 umhos/cm and 12.9 o/oo at the surface and 43200 umhos/cm and 40.0 o/oo near bottom. Similarly, surface readings at Station 2 were 14100 umhos/cm and 14.0 o/oo and the near bottom readings were 34900 umhos/cm and 37.0 o/oo (Allan and Mackenzie-Grieve 1984). The presence of a halocline in the Stokes Point lagoon was also reported by Kendel et al. (1975).

4.2.3 King Point Sediments. Particle size data for the lagoon sediments is provided in detail in Appendix III, Table 1. The coarse silt ((0.063 mm) size fraction, as defined by the Wentworth scale, was the major component of the sediments and averaged 26% of the total. Gravel sized material (>2.0 mm) averaged 17% composition, while other size fraction components were fairly equally represented but never as abundant as the gravel or coarse silt components. Allan and Mackenzie Grieve (1983) reported sediment composition of 59% very fine sand and coarse silt and less than 1% gravel for samples taken in the same approximate area.

Sediment chemistry data from King Point lagoon sediments is presented in Appendix III, Table 3. The oils and greases analysis of lagoon sediments from the present study revealed an average of 600 mg/kg which is slightly higher than the 437 mg/kg average reported by Allan and Mackenzie-Grieve (1983).

Trace amounts of hydrocarbons were observed in samples of King Point lagoon sediments as has also been observed from nearshore marine sediment samples at King Point. Because King Point lagoon has been physically separated from the marine environment for several years the results suggest that samples may have been contaminated during collection.

Leachable metals analysis results from the present survey show no substantial differences from those reported by Allan and Mackenzie-Grieve (1983) except that arsenic and lead were below detection limits. This characteristic was also noted in the nearshore marine sediments. Table 3 compares selected leachable metal concentrations from King Point lagoon sediments collected in 1982 (Allan and Mackenzie-Grieve, 1983) and during the present survey.

TABLE 3 MEAN CONCENTRATIONS OF SELECTED LEACHABLE METALS
IN KING POINT LAGOON SEDIMENTS

SAMPLE YEAR	NO. OF SAMPLES		(mg/kg)					
		Cr	Cu	Fe	Hg	Mn	Ni	Zn
1982	9	41.4	32.5	34,500	0.31	468	36.4	130
	S.D.	4.89	4.10	4,820	0.03	47.0	3.29	13.0
1984	9	39.2	27.8	36,100	0.09	450	32.2	118
	S.D.	6.56	5.41	4,970	0.01	30.2	4.76	16.4

4.2.4 Stokes Point Sediments. Particle size data for the lagoon sediments is provided in Appendix III, Table 2. The Stokes Point lagoon sediments were found to be composed mainly of silt (less than 0.063 mm) and coarse sand (1.0 to 2.0 mm) using the Wentworth classification system. The averages ranged from 27% silt and 22% coarse sand at Station 1 to 20% silt and 21% sand at Station 2. Allan and Mackenzie-Grieve (1983) reported 55% material less than 0.075 mm which is a combination of very fine sand and coarse silt.

Allan and Mackenzie-Grieve (1984) reported high percentages of gravel (greater than 1.0 mm), averaging 43%, and silt, averaging 17%, overall. This high percentage of gravel was not considered representative but due to clumping of materials during laboratory sieving and the presence of significant amounts of wood and other organic debris in the sample.

Sediment chemistry data from the Stokes Point lagoon is provided in Appendix III, Table 5. Oils and greases analysis from this survey found averages of 1857 mg/kg at Station 1 and 397 mg/kg at Station 2. Results almost identical to this surveys' findings were reported by Allan and Mackenzie-Grieve (1983) but Allan and Mackenzie-Grieve (1984) reported much higher concentrations (mean 4300 mg/kg) at Station 1 and slightly higher concentrations (mean 567 mg/kg) at Station 2.

Hydrocarbon analysis revealed trace amounts of hydrocarbons in the sediments as has been observed in other lagoon and nearshore marine samples. Potential causes for hydrocarbon presence have been discussed above.

Leachable metals analysis results from this survey are comparable with those reported by Allan and Mackenzie-Grieve (1983, 1984) except that arsenic and lead were below detection limits in the present samples whereas they were detected in two previous surveys. The absence of arsenic and lead is characteristic of all sediment samples collected by this survey and is believed to be the result of analytical error. Table 4 compares selected extractable metal concentrations from Stokes Point lagoon sediments collected in 1982 and 1983 (Allan and Mackenzie-Grieve, 1983, 1984) and during the present survey.

TABLE 4 MEAN CONCENTRATIONS OF SELECTED LEACHABLE METALS
IN STOKES POINT LAGOON SEDIMENTS

SAMPLE YEAR	NO. OF SAMPLES	Cr	Cu	Fe (mg/kg)	Hg	Mn	Ni	Zn
1982 X	6	34.0	29.0	30,900	0.32	377	30	114
1983 X	6	36.6	34.3	32,300	0.13	370	36	131
1984 X	6	49.2	34.3	36,100	0.12	459	27	101

Standard deviation not calculated because there are only 2 lagoon stations.

4.2.5 King Point Bottom Fauna. Appendix IV, Table 2 provides the detailed data for benthic invertebrates at King Point lagoon. The mean density of benthic invertebrates in the lagoon was 376 individuals/m², ranging from 0 to 2650/m².

A total of 13 invertebrate taxa were identified in the present survey, 10 of them to genus level and 5 to species level. The average number of genera per station was 7. The same pattern was observed by Allan and Mackenzie-Grieve (1983) where 13 taxa were identified, 10 to genus or species level and averaging 7 species per station.

The most abundant invertebrates in the present study were of the Class Polychaeta and Class Amphipoda making up 54% and 36% respectively, of the total sample collected. The most dominant species or genera were an Amphipod Pontoporeia femorata (32%) and two Polychaetes, Nephtys cornuta (27%) and Aonides sp. (21%). Allan and Mackenzie Grieve (1983) observed the most dominant genera was also an Amphipod, Byblis sp. which made up 53% of the total number of individuals collected.

4.2.6 Stokes Point Bottom Fauna. Appendix IV, Table 4 provides the detailed data for benthic invertebrates at Stokes Point lagoons. Invertebrate density was variable between the two lagoon stations. The mean number of individuals ranged from 4,704/m² at Station 1 to 14,791/m² at Station 2. Mean densities reported by Allan and Mackenzie-Grieve (1983 and 1984) were more uniform. They ranged from 4234/m² at Station 1 and 4313/m² at Station 2 in 1983.

A total of 17 taxa were identified in the present survey, 10 of them to genus level and 5 to species level. The number of genera per station varied from 5 at Station 1 to 12 at Station 2. Allan and Mackenzie-Grieve (1983, 1984) reported 5 and 7 genera, respectively, at Station 1 and 8 and 9 genera, respectively, at Station 2.

The most abundant group, Class Polychaeta (81%) was represented by 10 species with the most abundant being Nephtys cornuta (65%). Similarly, Allan and Mackenzie-Grieve (1983, 1984) both reported Class Polychaeta as the most abundant group and the species Nephtys cornuta as being the most abundant.

4.3 King Point Lake

4.3.1 Water Quality. The lake sampled ($69^{\circ}06' 48''N$, $138^{\circ}01' 36''W$) is located approximately 0.25 km. from the coastline and approximately 45 meters above sea level. It has a surface area estimated at 0.6 km^2 (1.0 km long and 0.6 km wide). The average depth, calculated from the three measurements taken, was 4.3 meters. A maximum depth of 5.5 meters was found at Station 2. The results for nutrient and total metals analysis for surface and near bottom water samples are presented for each station in Appendix II, Table 3 along with recommended levels for drinking water.

The water analysis results for nutrients and total metals show all parameters were below the recommended levels for drinking water. Sulfate average 1 mg/L, chloride average 13.6 mg/L, phosphate averaged 0.007 mg/L and ammonia averaged 0.002 mg/L. Nitrite and nitrate were below detection limit. Of the twenty-six metals analysed only boron, barium, calcium, magnesium, manganese, sodium and strontium were detected and all were well below the recommended levels for drinking water, where applicable.

Results reported by Allan and Mackenzie-Grieve (1983) for a freshwater lake near Stokes Point show that iron, copper, aluminum and zinc were detected but iron was the only metal to exceed drinking water standards.

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APPENDICES

APPENDIX I

COLLECTION, PREPARATION AND ANALYSIS
METHODS FOR WATER AND SEDIMENT SAMPLES

APPENDIX I TABLE 1 MARINE WATER SAMPLE COLLECTION, PREPARATION AND ANALYSIS METHODS

PARAMETER	DETECTION LIMIT	COLLECTION AND PREPARATION PROCEDURE ¹	ANALYTICAL PROCEDURE	METHOD SECTION ²
MARINE WATER STATIONS				
Depth		In situ using a Fish Ray™ electronic depth sounder.		
Temperature	<u>+0.5°C</u>	In situ temperature reading using electronic instrument probe.	<u>YSI Model 33 Conductivity, Temperature and Salinity Meter</u>	
Conductivity	<u>+ 5 umhos/cm</u>	In situ measurement by lowering the receptor to the station depth.	<u>YSI Model 33 Conductivity, Temperature and Salinity Meter</u>	
Salinity	<u>1.0 o/oo</u>	In situ measurement by lowering the receptor to the station depth.	<u>YSI Model 33 Conductivity, Temperature and Salinity Meter</u>	
Non-Filtrable Residue (NFR)	<u>1.00 mg/l</u>	In the field, a 1 litre water sample was filtered through a pre-weighed glass fibre filter with a 1.5 um pore size. The filter and residue was returned to the Lab for drying and weighing.	<u>Filtration, drying and weighing of residue on filter</u>	<u>104</u>

APPENDIX I

TABLE 2 FRESH WATER SAMPLE COLLECTION, PREPARATION AND ANALYSIS METHODS

PARAMETER	DETECTION LIMIT	COLLECTION AND PREPARATION PROCEDURE ¹	ANALYTICAL PROCEDURE	METHOD SECTION ²
FRESH WATER STATIONS				
Temperature	$\pm 0.5^{\circ}\text{C}$	In situ temperature reading using electronic instrument probe.	YSI Model 33 Conductivity, Temperature and Salinity Meter	
Conductivity	0.2 umhos/cm	In situ measurement at surface and below surface using 30 meter extension	YSI Model 33 Conductivity, Temperature and Salinity Meter	044
Non-Filterable Residue (NFR)	1 mg/l	Single samples collected in 2 litre linear polyethylene containers. The container was rinsed 3 times with sample before it was filled. No preservatives. Stored at 4°C.		104
Amonia	0.0050 mg/l	Same as sample	NFR. Phenol Hypochlorite-Colorimetric-Automated	058
Colour	5 (colour units)	Same sample as NFR.	Triton-X-100	042
Turbidity	1.0 (FTU)	Same sample as NFR.	Nephelometric Turbidity	130
Total Alkalinity	1.0 mg/l as CaCO_3	Same sample as NFR.	Potentiometric Titration	006
pH		Same sample as NFR.	Potentiometric	080

APPENDIX I TABLE 2 FRESH WATER SAMPLE COLLECTION, PREPARATION AND ANALYSIS METHODS (cont)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE ¹	ANALYTICAL PROCEDURE	METHOD SECTION ²
Total Phosphate T PO ₄ -P	0.0050 mg/l	Same sample as NFR	Acid-Persulphate, Autoclave Digestion	
Nitrite NO ₂ -N	0.010 mg/l	Same sample as NFR.	Cadmium Copper Reduction Colorimetric Automated	072
Nitrate NO ₃ -N	0.010 mg/l	Same sample as NFR.	Cadmium Copper Reduction Colorimetric Automated	072
Sulphate SO ₄	1.00 mg/l	Same sample as NFR.	Barium Chloranilate-UV Spectrophotometric	122
Chloride Cl	0.50 mg/l	Same sample as NFR.	Thiocyanate-Combined Reagent-Colorimetric	024
Silicon	0.50 mg/l	Same sample as NFR.	Ascorbic Acid Reduction - Colorimetric	118
Total Si				
Total Metals mg/l			Inductively Coupled Argon Plasma (ICAP) combined with Optical Emission Spectrometer (OES)	210
Al	0.050	The bottle was rinsed 3 times with sample before filling.		592
As	0.075	Preserved to a pH <1.5 using 2.0 ml concentrated HNO ₃ .		
Be	0.0015	Subsurface samples collected using 2.5 litre Niskin sampler.		
Ca	0.0010			
Cd	0.050			
Co	0.0040			
Cr	0.0075			
Cu	0.0050			

APPENDIX I TABLE 2 FRESH WATER SAMPLE COLLECTION, PREPARATION AND ANALYSIS METHODS (cont)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE ¹	ANALYTICAL PROCEDURE	METHOD SECTION ²
Extractable Metals (cont)	mg/l			
Fe	0.0050			
Mg	0.10			
Mn	0.0010			
Mo	0.015			
Na	0.050			
Ni	0.040			
Pb	0.040			
Sb	0.040			
Se	0.075			
Sn	0.10			
Sr	0.0020			
Tl	0.0040			
V	0.020			
Zn	0.0050			
Total Hardness	0.030 mg/l as CaCO ₃	Same sample as metals.		The sum of the ICAP results for Mg x 4.116 and Ca x 2.497 reported as mg/l CaCO ₃

¹ As described in Environment Canada (1976).² As described in Department of Environment (1979).

APPENDIX I

TABLE 3 SEDIMENT COLLECTION, PREPARATION AND ANALYSIS METHODS

PARAMETER	COLLECTION/PREPURATION	ANALYSIS	METHOD CODE
All Parameters	Samples were collected using an Ekman dredge. Each sample was placed in a paper geochemical sampling bag and individually packaged in plastic bags. Samples were kept cool or frozen until time of analysis.	Inductively Coupled Argon Plasma (ICAP) combined with Optical Emission Spectrometer (OES)	320
Leachable Metals Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Na, Ni, P, Pb, Si, Sn, Sr, Ti, V, Zn	A sediment sample was dried in a low temperature oven then screened through a 100 mesh (0.15 mm) sleeve. The material passing through the sleeve was then leached with HCl and HNO ₃ .	Atomic Absorption Graphite Furnace	330
Cd, Cu K, Ag	Same sample as metals.	Flame Atomic Absorption Spectrophotometry	340
As	Same sample as metals.	Hydride Generation - ICAP	350
Hg	The sample was sealed as described for metals and was completely oxidized by digestion with sulfuric acid peroxide.	Flameless Atomic Absorption	370

APPENDIX I TABLE 3 SEDIMENT COLLECTION, PREPARATION AND ANALYSIS METHODS (cont)

PARAMETER	COLLECTION/PREPURATION	ANALYSIS	METHOD CODE ¹
Particle Sizing	Same sample as metals. A dry, pre-weighed sample was passed through sieves of the following mesh size: 9.5 mm, 2.38 mm, 1.19 mm, .297 mm, .149 mm, and .074 mm.	Dry sieve	078
Oils and grease	Same sample as metals. A sample of air dried sediment was placed in the Soxhlet apparatus with petroleum ether solvent. The solvent dissolves the oils and grease which is then evaporated and the residue weighed.	Petroleum ether Soxhlet Extraction	725
Hydrocarbons	Same sample as metals. The sediment sample is dissolved in cyclo-hexane and the solution is analysed using the gas chromatograph and compared to the spectrum from known petroleum products.	Gas Chromatographic	700

¹ As described in Department of Environment (1979).

APPENDIX II

WATER QUALITY DATA

APPENDIX II TABLE 1 KING POINT LAGOON AND MARINE WATER QUALITY

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STATION	DATE	DESCRIPTION	DEPTH (m)	TEMPERA- TURE (°C)	pH	CONDUCTIVITY (umhos/cm)×100	SALINITY (‰)	NFR (mg/L)
			SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM
1	84-08-02	lagoon	3.0	13.0	7.98	8.21	60	49
2	84-08-02	lagoon	3.5	13.0	7.98	8.14	58	58
3	84-08-02	lagoon	3.5	13.0	8.07	8.07	58	58
4	84-08-01	nearshore marine	5.0	6.7	3.4	7.86	7.76	128
5	84-08-01	nearshore marine	5.0	6.4	5.0	7.65	7.80	125
6	84-08-01	nearshore marine	5.0	6.5	0.0	7.80	7.80	125
7	84-08-01	nearshore marine	5.0	6.0	1.5	7.80	7.89	124
8	84-08-01	nearshore marine	5.0	5.5	1.0	8.00	7.96	125
9	84-08-01	nearshore marine	5.0	6.8	2.0	7.81	7.81	129
10	84-08-01	nearshore marine	5.0	7.0	1.5	7.60	7.22	162

APPENDIX II

TABLE 2 STOKES POINT LAGOON AND MARINE WATER QUALITY

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STATION	DATE	DESCRIPTION	SAMPLE		TEMPERA-		pH		CONDUCTIVITY		SALINITY		NFR (mg/L)
			DEPTH (m)	DEPTH SURFACE	TEMPER- ATURE (°C)	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	SURFACE	BOTTOM	
1	84-08-07	lagoon	3.0	9.0	10.0	N/A	N/A	126	303	10.8	27.0	6.5	5.7
2	84-08-07	lagoon	3.5	10.0	9.8	N/A	N/A	150	187	13.0	16.0	6.4	6.7
3	84-08-06	nearshore marine	5.0	6.0	5.8	N/A	N/A	136	135	13.0	12.0	13.0	10.0
4	84-08-06	nearshore marine	5.0	6.0	5.5	N/A	N/A	137	137	12.8	12.8	7.9	8.8
5	84-08-06	nearshore marine	5.0	6.0	5.5	N/A	N/A	140	140	13.0	13.1	15.4	10.6
6	84-08-07	nearshore marine	5.0	6.0	4.5	N/A	N/A	137	172	12.8	16.3	10.3	9.1
8	84-08-06	nearshore marine	5.0	5.9	5.5	N/A	N/A	135	135	12.7	12.9	7.4	8.0
9	84-08-07	nearshore marine	5.0	6.0	4.5	N/A	N/A	140	193	13.2	18.5	9.7	10.1

N/A - Not Available

APPENDIX II

TABLE 3 KING POINT LAKE WATER QUALITY AND RECOMMENDED LEVELS FOR DRINKING WATER
 (Numbers in brackets indicate source of reference shown at the end of this Appendix)

STATION	DATE	DESCRIPTION	DEPTH (m)	TEMPERA- TURE (°C)		pH IN SITU	pH LAB	CONDUCTIVITY (umhos/cm)×100		COLOUR (FTU)	TURBIDITY (FTU)
				INSITU	LAB			IN SITU	LAB		
1	84-08-05	surface	3.2	11.5	N/A	7.00	50	91.2	<5	<0.1	<0.1
1	84-08-05	bottom			N/A	7.00		91.2	<5	<0.1	<0.1
2	84-08-05	surface	5.5	11.5	N/A	7.00	58	91.2	<5	<0.1	<0.1
2	84-08-05	bottom			N/A	7.00		90.7	<5	<0.1	<0.1
3	84-08-05	surface	4.2	11.5	N/A	7.00	58	90.6	<5	<0.1	<0.1
3	84-08-05	bottom			N/A	7.00		90.1	<5	<0.1	<0.1
Recommended levels for drinking water				6.5-9.0	(2)	--	--	25-75(1)	5(1)		
N/A - Not Available											
<u>NUTRIENTS</u>											
STATION	T. ALK. (as CaCO ₃)	SULFATE (mg/L)	CHLORIDE (mg/L)	TOTAL PHOSPHATE (mg/L)		NITRATE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)		
1	21.0	1	12.9	0.006		<0.005	<0.01	0.021	<5		
1	20.5	1	12.8	0.007		<0.005	<0.01	0.021	<5		
2	21.0	<1	13.3	0.007		<0.005	<0.01	0.022	<5		
2	21.0	1	14	0.007		<0.005	<0.01	0.022	<5		
3	21.0	1	14.1	0.008		<0.005	<0.01	0.023	<5		
3	21.0	1	14.3	0.008		<0.005	<0.01	<0.005	<5		
Recommended levels for drinking water				30-50(5)	250(1)	0.2(5)	1.0(1)	10.0(1)	0.005(1)	80(5)	

APPENDIX II TABLE 3 KING POINT LAKE WATER QUALITY AND RECOMMENDED LEVELS FOR DRINKING WATER (cont)
 (Numbers in brackets indicate source of reference shown at the end of this Appendix)

APPENDIX II TABLE 3 KING POINT LAKE WATER QUALITY AND RECOMMENDED LEVELS FOR DRINKING WATER (cont)
(Numbers in brackets indicate source of reference shown at the end of this Appendix)

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APPENDIX III
SEDIMENT DATA

APPENDIX III TABLE 1 KING POINT SEDIMENT; PARTICLE SIZE DISTRIBUTION (%)

STATION	PARTICLE SIZE							
	>2.0	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.125	0.125-0.063	<0.063	
	GRAVEL	V. COARSE SAND	COARSE SAND	MEDIUM SAND	FINE SAND	V. FINE SAND	COARSE SILT	
<u>LAGOON</u>								
1-1	45.3	1.1	2.2	11.2	6.5	8.8	24.9	
1-2	3.8	6.0	10.0	15.5	9.0	13.8	42.1	
1-3	0.9	10.9	11.8	13.6	9.3	14.8	38.7	
— x	16.7	6.0	8.0	13.4	8.3	12.5	35.2	
S.D.	24.8	4.9	5.1	2.2	1.5	3.2	9.1	
2-1	24.9	16.1	12.9	13.6	8.6	6.8	17.1	
2-2	13.1	22.0	15.6	11.7	9.1	7.2	21.4	
2-3	15.3	20.0	15.7	12.0	8.9	7.3	20.8	
— x	17.8	19.4	14.7	12.4	8.9	7.1	19.8	
S.D.	6.3	3.0	1.6	1.0	0.3	0.3	2.3	
3-1	15.1	16.2	11.7	10.2	10.0	11.6	25.1	
3-2	27.0	15.7	11.8	9.8	8.4	8.8	18.5	
3-3	10.9	14.4	14.3	11.9	10.4	11.0	27.0	
— x	17.7	15.4	12.6	10.6	9.6	10.5	23.5	
S.D.	8.4	0.9	1.5	1.1	1.1	1.5	4.5	
<u>NEARSHORE MARINE</u>								
4-1	0.8	0.7	1.8	9.0	41.2	41.5	4.9	
4-2	0.7	0.7	1.5	7.3	49.1	37.8	2.9	
4-3	0.7	1.2	2.1	9.0	37.8	43.5	5.7	
— x	0.7	0.9	1.8	8.4	42.7	40.9	4.5	
S.D.	0.1	0.3	0.3	1.0	5.8	2.9	1.4	
6-1	11.1	18.1	14.1	13.4	13.1	13.7	16.5	
6-2	20.9	8.3	9.3	19.2	13.4	12.1	16.8	
6-3	46.4	13.0	8.9	7.9	8.4	6.9	8.5	
— x	26.1	13.1	10.8	13.5	11.6	10.9	13.9	
S.D.	18.2	4.9	2.9	5.7	2.8	3.6	4.7	

APPENDIX III TABLE 1 KING POINT SEDIMENT; PARTICLE SIZE DISTRIBUTION (%) (cont)

STATION	PARTICLE SIZE							
	>2.0	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.125	0.125-0.063	<0.063	
	GRAVEL	V. COARSE SAND	COARSE SAND	MEDIUM SAND	FINE SAND	V. FINE SAND	COARSE SILT	
<u>NEARSHORE MARINE</u>								
7-1	10.0	16.4	14.2	16.4	14.4	15.0	13.7	
7-2	45.9	17.8	12.3	9.2	7.1	4.3	3.4	
7-3	9.9	13.8	13.5	17.4	15.2	15.7	14.6	
— x	21.9	16.0	13.3	14.3	12.2	11.7	10.6	
S.D.	20.8	2.0	1.0	4.5	4.5	6.4	6.2	
8-1	27.6	15.1	10.9	11.3	14.9	9.4	10.8	
8-2	46.1	2.4	12.2	8.3	12.5	7.5	11.0	
8-3	30.6	15.9	10.9	9.3	9.5	9.4	14.4	
— x	34.8	11.1	11.3	9.6	12.3	8.8	12.1	
S.D.	9.9	7.6	0.8	1.5	2.7	1.1	2.0	
9-1	21.2	3.4	15.5	13.2	14.9	14.7	17.2	
9-2	25.6	13.0	10.9	11.0	14.3	11.9	13.3	
9-3	29.4	4.0	7.0	12.4	22.3	15.2	9.6	
— x	25.4	6.8	11.1	12.2	17.2	13.9	13.4	
S.D.	4.1	5.4	4.3	1.1	4.5	1.8	3.8	
10-1	0.4	0.8	2.7	14.1	73.0	8.0	0.9	
10-2	1.8	1.4	4.2	16.4	67.7	7.5	1.1	
10-3	0.3	0.6	2.6	14.2	73.3	7.9	1.3	
— x	0.8	0.9	3.2	14.9	71.3	7.8	1.1	
S.D.	0.8	0.4	0.9	1.3	3.2	0.3	0.2	

APPENDIX III TABLE 2 STOKES POINT: SEDIMENT PARTICLE SIZE DISTRIBUTION (%)

STATION	PARTICLE SIZE							
	>2.0	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.125	0.125-0.063	<0.063	
	GRAVEL	V. COARSE SAND	COARSE SAND	MEDIUM SAND	FINE SAND	V. FINE SAND	COARSE SILT	
								<u>LAGOON</u>
1-1	4.0	10.1	23.8	13.8	10.9	10.3	27.2	
1-2	9.3	15.8	18.1	12.2	10.0	10.0	24.6	
1-3	1.0	1.2	24.3	18.4	13.8	11.6	29.6	
	\bar{x}	4.8	9.0	22.1	14.8	11.6	27.1	
	S.D.	4.2	7.4	3.4	3.2	2.0	0.9	2.5
2-1	3.2	15.9	23.1	15.2	12.0	10.3	20.3	
2-2	5.6	15.3	16.7	20.2	13.4	9.7	19.1	
2-3	3.4	17.1	22.0	15.1	11.8	9.7	21.0	
	\bar{x}	4.1	16.1	20.6	16.8	12.4	20.1	
	S.D.	1.3	0.9	3.4	2.9	0.9	0.3	1.0
								<u>NEARSHORE MARINE</u>
3-1	4.0	3.6	8.1	17.4	20.9	20.1	25.9	
3-2	1.9	4.1	5.2	5.1	13.8	38.1	31.8	
3-3	4.9	14.9	9.8	12.1	15.2	22.2	20.9	
	\bar{x}	3.6	7.5	7.7	11.5	16.6	26.8	26.2
	S.D.	1.5	6.4	2.3	6.2	3.8	9.8	5.5
5-1	0.3	0.4	0.8	2.1	26.7	64.4	5.3	
5-2	29.9	1.5	1.3	1.8	15.4	46.5	3.6	
5-3	7.5	1.2	1.2	1.6	28.6	54.9	5.2	
	\bar{x}	12.6	1.0	1.1	1.8	23.6	55.3	4.7
	S.D.	15.4	0.6	0.3	0.3	7.1	9.0	1.0
6-1	0.1	0.1	0.9	2.0	9.6	69.2	18.0	
6-2	0.3	0.2	1.3	2.4	12.1	67.8	15.8	
6-3	0.2	0.1	1.2	2.8	11.5	66.7	17.6	
	\bar{x}	0.2	0.1	1.1	2.4	11.1	67.9	17.1
	S.D.	0.1	0.1	0.2	0.4	1.3	1.3	1.2
8-1	7.2	3.5	6.9	13.0	36.7	29.7	2.9	
8-2	16.9	4.1	6.0	10.3	30.2	29.7	2.9	
	\bar{x}	12.1	3.8	6.5	11.7	33.5	29.7	2.9
9-1	8.8	5.9	8.1	7.1	58.8	8.6	2.6	

APPENDIX III TABLE 3 KING POINT LAGOON SEDIMENT CHEMISTRY

STATION	Date	Oils & Grease (mg/kg)	Hydrocarbons (trace-*)	LEACHABLE METALS				
				Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)
1-1	01-Aug-84	370	*	0.09	20400	<8.0	238	0.6
1-2		340	•	<0.08	18500	<8.0	228	0.5
1-3		860	•	0.09	18600	<8.0	228	0.6
<hr/>		— S.D.	523 292	<0.09 0.0	19167 1069	<8.0 0.0	231 6	0.6 0.1
2-1	02-Aug-84	430	*	0.15	26800	<8.0	302	0.8
2-2		690	•	0.12	26800	<8.0	285	0.8
2-3		600	•	0.12	27500	<8.0	301	0.8
<hr/>		— S.D.	573 132	0.13 0.02	27033 404	<8.0 0.0	296 10	0.8 .0
3-1	02-Aug-84	620	•	0.10	21300	<8.0	215	0.7
3-2		690	•	0.12	22100	<8.0	226	0.7
3-3		840	•	0.12	23000	<8.0	225	0.7
<hr/>		— S.D.	717 112	0.11 0.01	22133 850	<8.0 0.0	222 6	0.7 0

APPENDIX III TABLE 3 KING POINT LAGOON SEDIMENT CHEMISTRY (cont)

STATION	LEACHABLE METALS							
	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Mg (mg/kg)
1-1	8680	<0.3	11.3	35.6	23.6	31400	0.099	7150
1-2	8270	<0.3	6.5	32.8	22.6	32000	0.082	6960
1-3	8510	<0.3	11.2	32.9	23.0	30400	0.085	6930
— x	8490	<0.3	9.7	33.8	23.1	31300	0.089	7010
S.D.	206	0.0	2.7	1.6	0.5	808	0.009	119
2-1	8140	<0.3	14.4	46.8	34.7	40200	0.112	8430
2-2	7270	<0.3	13.4	45.8	32.4	41300	0.104	8030
2-3	7200	<0.3	13.4	46.8	34.0	42100	0.104	8270
— x	7540	<0.3	13.7	46.5	33.7	41200	0.107	8240
S.D.	524	0.0	0.6	0.6	1.2	954	0.005	201
3-1	7830	<0.3	12.6	36.1	26.2	36100	0.080	6560
3-2	7280	<0.3	8.4	37.5	27.3	35800	0.080	6690
3-3	7680	<0.3	13.7	38.2	26.4	35500	0.082	6780
— x	7600	<0.3	11.6	37.3	26.6	35800	0.081	6680
S.D.	284	0.0	2.8	1.1	0.6	300	0.001	111

APPENDIX III TABLE 3 KING POINT LAGOON SEDIMENT CHEMISTRY (cont)

STATION	LEACHABLE METALS							
	Mn (mg/kg)	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)
1-1	414	<0.8	1160	28.0	1330	<3.0	1530	<2.0
1-2	421	<0.8	1130	26.0	1340	<3.0	1560	<2.0
1-3	412	<0.8	1220	27.0	1280	<3.0	1540	<2.0
— x	416	<8.0	1170	27.0	1320	<3.0	1540	<2.0
S.D.	5	0.0	46	1.0	32	0.0	15	0.0
2-1	481	<0.8	2160	36.0	1410	<3.0	1570	<2.0
2-2	466	<0.8	1770	37.0	1490	<3.0	1630	4.0
2-3	467	<0.8	1800	36.0	1500	<3.0	1930	<2.0
— x	471	<0.8	1910	36.3	1470	<3.0	1570	<4.0
S.D.	8	0.0	217	0.6	49	0.0	193	0.0
3-1	461	<0.8	1900	34.0	1380	<3.0	1720	<2.0
3-2	454	<0.8	1830	32.0	1340	<3.0	1740	<2.0
3-3	477	<0.8	1890	34.0	1360	<3.0	1490	3.0
— x	464	<0.8	1870	33.3	1360	<3.0	1650	<3.0
S.D.	12	0.0	38	1.2	20	0.0	139	0.0

APPENDIX III TABLE 3 KING POINT LAGOON SEDIMENT CHEMISTRY (cont)

LEACHABLE METALS				
STATION	Sr (mg/kg)	Tl (mg/kg)	V (mg/kg)	Zn (mg/kg)
1-1	52.5	99.5	73.0	104.0
1-2	50.7	89.5	68.0	101.0
1-3	50.7	87.6	68.0	104.0
\bar{x}	51.3	92.2	69.7	103.0
S.D.	1.0	6.4	2.9	1.7
2-1	63.9	83.9	96.0	136.0
2-2	62.0	84.9	95.0	134.0
2-3	63.1	90.7	98.0	137.0
\bar{x}	63.0	86.5	96.3	135.7
S.D.	1.0	3.7	1.5	1.5
3-1	57.5	69.4	72.0	115.0
3-2	56.5	69.3	76.0	116.0
3-3	56.9	70.6	77.0	118.0
\bar{x}	57.0	69.8	75.0	116.3
S.D.	0.5	0.7	2.6	1.5

APPENDIX III TABLE 4 KING POINT NEARSHORE MARINE SEDIMENT CHEMISTRY

STATION	Date	Oils & Grease (mg/kg)	Hydrocarbons (trace-*)	LEACHABLE METALS				
				Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)
4-1	01-Aug-84	300	-	<0.08	13500	<8.0	176	0.4
4-2		410	*	<0.08	13500	<8.0	149	0.4
4-3		610	*	<0.08	13000	<8.0	148	0.4
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APPENDIX III TABLE 4 KING POINT NEARSHORE MARINE SEDIMENT CHEMISTRY (cont)

LEACHABLE METALS								
STATION	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Mg (mg/kg)
4-1	9550	<0.3	6.4	22.1	9.4	25900	0.044	4440
4-2	9200	<0.3	7.1	22.6	8.9	26300	0.039	4540
4-3	9560	<0.3	9.4	21.7	9.1	26300	0.037	4560
— x	9440	<0.3	7.6	22.1	9.1	26200	0.040	4510
S.D.	205	0.0	1.6	0.5	0.3	231	0.004	64
6-1	9720	<0.3	8.6	33.5	19.8	26600	0.071	5940
6-2	9020	<0.3	8.6	32.9	22.4	28800	0.077	6140
6-3	10200	<0.3	11.8	34.6	24.1	30700	0.078	6860
— x	9650	<0.3	9.7	33.7	22.1	28700	0.075	6310
S.D.	593	0.0	1.8	0.9	2.2	2052	0.004	484
7-1	8800	<0.3	13.2	43.2	32.4	34000	0.095	7800
7-2	8810	<0.3	17.9	33.3	23.7	30600	0.085	6320
7-3	8570	<0.3	15.5	43.9	29.9	32400	0.109	7540
— x	8730	<0.3	15.5	40.1	28.7	32300	0.096	7220
S.D.	136	0.0	2.4	5.9	4.5	1700	0.012	790
8-1	11600	<0.3	7.3	32.4	19.7	27900	0.075	6960
8-2	12100	<0.3	9.6	32.2	21.1	29000	0.082	7300
8-3	12200	<0.3	12.1	35.3	22.9	29300	0.099	7460
— x	12000	<0.3	9.7	33.3	21.2	28700	0.085	7240
S.D.	321	0.0	2.4	1.7	1.6	737	0.012	255
9-1	9370	<0.3	9.9	31.8	22.0	28500	0.075	6180
9-2	7830	<0.3	8.4	30.7	20.9	27900	0.072	5700
9-3	9280	<0.3	15.0	28.9	14.9	29600	0.065	5230
— x	8830	<0.3	11.1	30.5	19.3	28700	0.071	5700
S.D.	864	0.0	3.5	1.5	3.8	862	0.005	475
10-1	12500	<0.3	10.3	23.7	10.2	39300	0.040	5070
10-2	11500	<0.3	10.3	24.2	10.3	36700	0.060	4860
10-3	11700	<0.3	15.1	25.2	10.3	36600	0.060	4950
— x	11900	<0.3	11.9	24.4	10.3	37500	0.053	4960
S.D.	529	0.0	2.8	0.8	0.1	1530	0.012	105

APPENDIX III TABLE 4 KING POINT NEARSHORE MARINE SEDIMENT CHEMISTRY (cont)

LEACHABLE METALS								
STATION	Mn (mg/kg)	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)
4-1	480	<0.8	790	19.0	1850	<3.0	1710	<2.0
4-2	471	<0.8	1050	19.0	1690	<3.0	1650	<2.0
4-3	487	<0.8	930	19.0	1690	<3.0	1710	<2.0
— S.D.	479 8	<0.8 0.0	923 130	19.0 0.0	1740 92	<3.0 0.0	1690 35	<2.0 0.0
6-1	426	<0.8	1440	27.0	1030	<3.0	1590	<2.0
6-2	434	<0.8	1540	28.0	1020	<3.0	1970	<2.0
6-3	446	<0.8	2000	28.0	1180	<3.0	1810	<2.0
— S.D.	435 10	<0.8 0.0	1660 299	27.7 0.6	1080 90	<3.0 0.0	1790 191	<2.0 0.0
7-1	375	<0.8	2080	35.0	1090	<3.0	2010	<2.0
7-2	402	<0.8	1570	29.0	1280	5	1350	<2.0
7-3	367	<0.8	1960	34.0	1060	<3.0	1590	<2.0
— S.D.	381 18	<0.8 0.0	1870 267	32.7 3.2	1140 119	<5 0.0	1650 334	<2.0 0.0
8-1	478	<0.8	1620	27.0	1170	<3.0	1410	<2.0
8-2	483	<0.8	1910	28.0	1220	<3.0	1460	<2.0
8-3	485	<0.8	1620	30.0	1090	<3.0	1630	<2.0
— S.D.	482 4	<0.8 0.0	1720 167	28.3 1.5	1160 66	<3.0 0.0	1500 115	<2.0 0.0
9-1	459	<0.8	1550	29.0	1180	<3.0	1500	<2.0
9-2	450	<0.8	1590	27.0	1190	<3.0	1540	<2.0
9-3	506	<0.8	1590	25.0	1680	<3.0	1570	<2.0
— S.D.	472 30	<0.8 0.0	1580 23	27.0 2.0	1350 286	<3.0 0.0	1540 35	<2.0 0.0
10-1	751	<0.8	1190	24.0	3150	6	2140	<2.0
10-2	691	<0.8	1310	23.0	2950	<3.0	1900	<2.0
10-3	720	<0.8	990	23.0	2950	4	1510	<2.0
— S.D.	721 30	<0.8 0.0	1160 162	23.3 0.6	3020 115	<5 0.0	1850 318	<2.0 0.0

APPENDIX III TABLE 4 KING POINT NEARSHORE MARINE SEDIMENT CHEMISTRY

LEACHABLE METALS				
STATION	Sr (mg/kg)	Tl (mg/kg)	V (mg/kg)	Zn (mg/kg)
4-1	48.0	50.5	48.0	69.6
4-2	48.4	41.7	48.0	72.4
4-3	46.2	45.6	47.0	73.4
— x	47.5	45.9	47.0	71.8
S.D.	1.2	4.4	0.6	2.0
6-1	50.8	101.0	59.0	86.7
6-2	49.2	93.2	62.0	94.8
6-3	55.3	103.0	68.0	97.9
— x	51.8	99.1	63.0	93.1
S.D.	3.2	5.2	4.6	5.8
7-1	60.5	89.7	91.0	115.0
7-2	55.7	74.6	69.0	102.0
7-3	58.2	100.0	92.0	115.0
— x	58.1	88.1	84.0	110.7
S.D.	2.4	12.8	13.0	7.5
8-1	52.8	104.0	63.0	89.8
8-2	53.5	102.0	64.0	93.7
8-3	52.6	120.0	69.0	98.4
— x	53.0	108.7	65.3	94.0
S.D.	0.5	9.9	3.2	4.3
9-1	47.8	84.1	62.0	94.5
9-2	45.8	76.1	60.0	91.1
9-3	49.8	56.2	56.0	85.7
— x	47.8	72.1	59.3	90.4
S.D.	2.0	14.4	3.1	4.4
10-1	67.5	81.4	57.0	92.9
10-2	64.3	77.5	58.0	88.9
10-3	62.9	62.6	59.0	88.7
— x	64.9	73.8	58.0	90.2
S.D.	2.4	9.9	1.0	2.4

APPENDIX III TABLE 5 STOKES POINT LAGOON SEDIMENT CHEMISTRY

STATION	Date	Oils &	Hydro-	LEACHABLE METALS					
		Grease (mg/kg)	carbons (trace-*)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	
1-1	07-Aug-84	1160	-	0.15	27100	<8.0	239	0.8	
1-2		2170	-	0.15	26600	<8.0	234	0.7	
1-3		2240	*	0.16	29400	<8.0	261	0.8	
\bar{x}		1860		0.15	27700	<8.0	245	0.8	
S.D.		604		0.006	1490	0.0	14	0.0	
2-1	07-Aug-84	<200	*	0.20	32600	<8.0	272	0.9	
2-2		380	*	0.20	33000	<8.0	277	0.9	
2-3		810	*	0.20	31600	<8.0	268	0.9	
\bar{x}		<595	*	0.20	32400	<8.0	272	0.9	
S.D.		0	*	.00	721	0.0	5	0.0	
<hr/>									
STATION	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Mg (mg/kg)	
1-1	9290	<0.3	9.3	45.0	31.5	28300	0.114	8820	
1-2	9470	<0.3	12.8	44.2	29.1	28800	0.108	6250	
1-3	13300	<0.3	11.2	47.8	31.1	34600	0.119	7110	
\bar{x}	10700	<0.3	11.1	45.7	30.6	30600	0.114	7390	
S.D.	2260	0.0	1.8	1.9	1.3	3500	0.006	1310	
2-1	10000	<0.3	16.2	53.0	38.6	42200	0.135	10800	
2-2	9600	<0.3	14.5	53.4	38.2	42500	0.125	10700	
2-3	10600	<0.3	16.2	51.7	37.3	40200	0.120	10600	
\bar{x}	10100	<0.3	15.6	52.7	38.0	41600	0.127	10700	
S.D.	503	0.0	1.0	0.9	0.7	1250	0.008	100	

APPENDIX III TABLE 5 STOKES POINT LAGOON SEDIMENT CHEMISTRY (cont)

STATION	LEACHABLE METALS							
	Mn (mg/kg)	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)
1-1	340	<0.8	2140	25	1200	<3.0	1520	<2.0
1-2	327	<0.8	750	15	1070	<3.0	1570	<2.0
1-3	349	<0.8	820	15	1290	<3.0	1640	<2.0
\bar{x}	339	<0.8	1240	18	1190	<3.0	1580	<2.0
S.D.	11	0.0	783	6	111	0.0	60	0.0
2-1	628	<0.8	5430	37	1330	<3.0	1240	5.0
2-2	561	<0.8	5110	35	1340	<3.0	1480	5.0
2-3	538	<0.8	5020	36	1290	<3.0	1360	5.0
\bar{x}	576	<0.8	5190	36	1320	<3.0	1360	5.0
S.D.	47	0.0	215	1	26	0.0	120	0.0
STATION	Sr (mg/kg)	Tl (mg/kg)	V (mg/kg)	Zn (mg/kg)				
1-1	98.7	168	63	85.8				
1-2	104.0	123	34	49.8				
1-3	114.0	164	36	52.7				
\bar{x}	105.6	152	44	62.8				
S.D.	7.8	25	16	20.0				
2-1	70.0	140	110	140.0				
2-2	68.9	150	112	140.0				
2-3	68.6	149	107	137.0				
\bar{x}	69.2	146	110	139.0				
S.D.	0.7	6	3	1.7				

APPENDIX III TABLE 6 STOKES POINT NEARSHORE MARINE SEDIMENT CHEMISTRY

STATION	DATE	OILS &	HYDRO-	LEACHABLE METALS				
		GREASE (mg/kg)	CARBONS (trace-*)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)
3-1	06-Aug-84	990	•	0.12	20300	<8.0	226	0.5
3-2		540	•	<.08	16300	<8.0	185	0.4
3-3		1340	•	0.09	18600	<8.0	215	0.5
— x		957		0	18400	<8.0	209	0.5
S.D.		401		0	2001	0.0	21	0.1
5-1	06-Aug-84	353	*	<0.08	9830	<8.0	97	0.2
5-2		610	•	<0.08	10600	<8.0	135	0.2
5-3		400	*	<0.08	10400	<8.0	131	0.2
— x		454		0	10300	<8.0	121	0.2
S.D.		137		0	400	0.0	21	0.0
6-1	07-Aug-84	620	•	<0.08	12000	<8.0	133	0.3
6-2		680	•	<0.08	11700	<8.0	132	0.3
6-3		415	*	<0.08	11500	<8.0	129	0.3
— x		572		0	11700	<8.0	131	0.3
S.D.		139		0	252	0.0	2	0.0
8-1	06-Aug-84	260	•	<0.08	10500	<8.0	227	0.2
8-2		220	*	<0.08	10500	<8.0	248	0.2
— x		240		0.00	10500	<8.0	238	0.2
9-1	07-Aug-84	572	•	<0.08	12100	<8.0	229	0.3

APPENDIX III TABLE 6 STOKES POINT NEARSHORE MARINE SEDIMENT CHEMISTRY (cont)

STATION	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Mg (mg/kg)
3-1	29000	<0.3	12.0	33.6	19.1	26500	0.088	9060
3-2	35100	<0.3	8.2	27.8	14.8	24200	0.082	8490
3-3	30900	<0.3	8.3	31.1	17.7	25200	0.080	8820
— x	31700	<0.3	9.5	30.8	17.2	25300	0.083	8790
S.D.	3120	0.0	2.2	2.9	2.2	1150	0.004	286
5-1	37800	<0.3	3.8	17.0	5.5	17400	0.045	6250
5-2	42400	<0.3	2.4	19.0	5.9	18600	0.055	7110
5-3	43000	<0.3	10.0	18.6	6.6	19000	0.055	7160
— x	41100	<0.3	5.4	18.2	6.0	18300	0.052	6840
S.D.	2840	0.0	4.0	1.1	0.6	833	0.006	512
6-1	42200	<0.3	7.1	20.3	6.6	18400	0.050	7170
6-2	41700	<0.3	6.2	19.9	6.4	18200	0.060	7040
6-3	41800	<0.3	8.0	20.1	6.6	18300	0.059	7020
— x	41900	<0.3	7.1	20.1	6.5	18300	0.056	7080
S.D.	265	0.0	0.9	0.2	0.1	100	0.006	81
8-1	44400	<0.3	7.1	19.9	7.5	21400	0.057	7360
8-2	43600	<0.3	3.5	20.2	6.3	21400	0.057	7300
— x	44000	<0.3	5.3	20.0	6.9	21400	0.057	7330
9-1	46500	<0.3	10.1	23.2	11.2	25200	0.065	7920

APPENDIX III TABLE 6 STOKES POINT NEARSHORE MARINE SEDIMENT CHEMISTRY (cont)

STATION	LEACHABLE METALS							
	Mn (mg/kg)	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)
3-1	366	<0.8	2290	26	1200	11	1390	2.0
3-2	367	<0.8	1680	22	1230	<3.0	1400	2.0
3-3	340	<0.8	2140	25	1210	<3.0	1520	<2.0
— x	358	<0.8	2040	24	1210	<11	1440	<2.0
S.D.	15	0.0	318	2	15	0.0	72	0.0
5-1	327	<0.8	750	15	1070	<3.0	1570	<2.0
5-2	349	<0.8	820	15	1290	<3.0	1640	<2.0
5-3	348	<0.8	710	16	1300	<3.0	1370	<2.0
— x	341	<0.8	760	15	1220	<3.0	1530	<2.0
S.D.	12	0.0	56	1	130	0.0	140	0.0
6-1	326	<0.8	870	16	1060	<3.0	1400	<2.0
6-2	294	<0.8	810	15	1080	<3.0	1420	<2.0
6-3	346	<0.8	750	16	1060	<3.0	1180	<2.0
— x	322	<0.8	810	16	1070	<3.0	1330	<2.0
S.D.	26	0.0	60	1	12	0.0	133	0.0
8-1	375	<0.8	730	16	1490	<3.0	1730	<2.0
8-2	359	<0.8	790	17	1470	<3.0	1420	<2.0
— x	367	<0.8	760	16	1480	<3.0	1580	<2.0
9-1	460	<0.8	800	21	1530	<3.0	1360	2.0

APPENDIX III TABLE 6 STOKES POINT NEARSHORE MARINE SEDIMENT CHEMISTRY (cont)

LEACHABLE METALS				
STATION	Sr (mg/kg)	Tl (mg/kg)	V (mg/kg)	Zn (mg/kg)
3-1	95.8	162	68	88.9
3-2	104.0	161	56	76.2
3-3	98.7	168	63	85.8
— x	99.5	164	62	83.6
S.D.	4.2	4	6	6.6
5-1	104.0	123	34	49.8
5-2	114.0	164	36	52.7
5-3	114.0	176	36	54.6
— x	110.7	154	35	52.4
S.D.	5.8	28	1	4.0
6-1	113.0	137	39	53.0
6-2	111.0	134	38	51.3
6-3	112.0	130	39	52.7
— x	112.0	134	39	52.3
S.D.	1.0	4	1	0.9
8-1	119.0	235	41	57.4
8-2	117.0	229	40	57.9
— x	118.0	232	40	57.6
9-1	138.0	293	46	72.5

APPENDIX IV

BENTHIC INVERTEBRATE DATA

APPENDIX IV TABLE 1 KING POINT BENTHIC INVERTEBRATE TAXONOMY
(The numbers correspond to those used in
Table 2)

	Phylum	Class	Order	Family	<u>Genus species</u>
1.	Nematoda	Priapulida		Priapulidae	
2.					<u>Priapulus</u> sp.
	Mollusca	Pelecypoda	Protobranchia		
3.				Mytilidae; damaged shell	
	Annelida	Polychaeta			
		Subclass: Errantia		Nephtydiidae	
4.					<u>Nephtys cornuta</u>
				Phyllodocidae	
5.					<u>Eteone longa</u>
6.					<u>Eteone</u> sp. damaged
		Subclass: Sedentaria			
7.				Spionidae unidentified	
8.				<u>Aonides</u> sp.	
9.				<u>Spiro</u> sp.	
10.			Cirratulidae	damaged	
			Capitellidae		
11.				<u>Capitella capitata</u>	
	Oligochaeta	Haplotaxida			
12.			Tubificidae unidentified		
13.				<u>Monopylephorus</u> sp.	

APPENDIX IV TABLE 1 KING POINT BENTHIC INVERTEBRATE TAXONOMY
(The numbers correspond to those used in
Table 2) (cont)

	Phylum	Class	Order	Family	<u>Genus species</u>
14.				Enchytraeidae	
	Arthropoda				
	Crustacea				
	Subclass: Copepoda				
	Calanoida				
		Calanidae			
15.					(<u>Calanus</u> sp.) damaged
	Centropagidae				
16.					<u>Limnocalanus macrurus</u>
	Pseudocalanidae				
17.					<u>Pseudocalanus minutus</u>
	Subclass: Malacostraca				
	Mysidacea				
	Mysidae				
18.					<u>Mysis occulata</u>
	Isopoda				
	Idoteidae				
19.					<u>Saduria entomon</u>
	Cumacea				
	Distylidae				
20.					<u>Leptostyliis</u> sp.
	Amphipoda				
	Suborder: Gammaridea				
	Lysianassidae				
21.					<u>Omisus glacialis</u>

APPENDIX IV TABLE 1 KING POINT BENTHIC INVERTEBRATE TAXONOMY
(The numbers correspond to those used in
Table 2) (cont)

	Phylum	Class	Order	Family	<u>Genus species</u>
22.				Haustoriidae	
23.					<u>Pontoporeia femorata</u>
					<u>Pontoporeia sp.</u>
24.				Oedicerotidae	
25.					<u>Paroediceros lynceus</u>
					<u>Monoculopsis (micros)</u>
26.				Gammaridae	
					<u>(Eogammarus o'clairi)</u>
27.	Nemertea	Anoplia	Plaeonemertea	Carinomidae	
					<u>(Carinoma mutabilis)</u>
28.	Chordata	Ascidacea	Pleurogona	Pyuridae	
					<u>(Botenaria sp.)</u>

CLASSIFICATION	STATIONS LAGOON			STATIONS MARINE			LAGOON SPECIES DISTRIBUTION TOTAL NUMBERS			MARINE SPECIES DISTRIBUTION TOTAL NUMBERS		
	1	2	3	4	6	7	8	9	10	1	2	3
1. Nematoda							1			0	0.0	0.3
2. <u>Prilapulus</u> sp.	1							1	0	1	0.5	0.0
3. <u>Mytilidae</u> ; damaged shell										0	0.0	0.0
4. <u>Nephthys cornuta</u>	17	22	20					1	59	27.4	0	0.3
5. <u>Eteone longa</u>							2	0	0	0.0	2	0.0
6. <u>Eteone</u> sp. damaged								1	1	0	0.0	0.6
7. <u>Sploniidae</u> unidentified								2	0	0	0.0	0.6
8. <u>Aonides</u> sp.	4	42		2	17	28	17	1	22	46	21.4	1
9. <u>Spolio</u> sp.	1	5	2	1	14	6	18	5	3	8	3.7	0.3
10. <u>Cirratulidae</u> damaged	3									3	1.4	0.0
11. <u>Capitella capitata</u>							1			0	0.0	0.0
12. <u>Tubificidae</u> unidentified							3	8	9	0	0.0	0.0
13. <u>Monopylephorus</u> sp.	5							4	3	3	0	0.0
14. <u>Enchytraeidae</u>							4	4	6	1	0	0.0
15. <u>(Calanus</u> sp.) damaged							3			0	0.0	0.8
16. <u>Limnoecalanus macrurus</u>										0	0.0	0.8
17. <u>Pseudocalanus minutus</u>										5	2.3	0.0
18. <u>Mysis occulta</u>	2									0	0.0	19
19. <u>Saduria entomon</u>	1						1	1	1	0	0.0	5.3
20. <u>Lepostylis</u> sp.							3	2	3	0	0.0	0.0
21. <u>Onisimus glacialis</u>								3		0	0.0	0.8
22. <u>Pontoporella femorata</u>	31	37	1							69	32.1	0.0
23. <u>Pontoporella</u> sp.	9			1	1					3	4.2	0.0
24. <u>Paracilceros lynceus</u>							45	1	3	0	0.0	14.2
25. <u>Monoculopsis</u> (micros)								2	3	0	0.0	2.2
26. <u>(Eogammarus o'clairei)</u>								1	1	3	0	5.1
27. <u>(Carinoma mutabilis)</u>	4	1	1							6	2.8	0.0
28. <u>(Boletena</u> sp.)		3								3	1.4	0.0
TOTAL INDIVIDUALS	67	79	69	23	75	62	45	35	38	215		
DENSITY(m ²)	583	687	600	200	652	539	391	304	330	360		

APPENDIX IV TABLE 3 STOKES POINT BENTHIC INVERTEBRATE TAXONOMY
(The numbers correspond to those used in
Table 4)

	Phylum	Class	Order	Family	<u>Genus species</u>
	Protozoa				
	Rhizopoda				
	Foraminifera				
	Nonionidae				
1.					<u>Cornuspira involvans</u>
2.	Nematoda				
	Priapulida				
3.				Priapulidae	
					<u>Priapulus sp.</u>
	Mollusca				
	Pelecypoda				
	Heterodontia				
	Montacutidae				
4.					<u>Montacuta dawsoni</u>
	Tellinidae				
5.					<u>Macoma balthica</u>
	Mollusca				
	Bivalvia				
	Nuculoida				
	Nuculanidae				
6.					<u>Portlandia lenticula</u>
7.					<u>Portlandia intermedia</u>
	Myoida				
	Hiatellidae				
8.					<u>Cyrtodaria kurriana</u>
	Mollusca				
9.	Gastropoda (juv.)				

APPENDIX IV TABLE 3 STOKES POINT BENTHIC INVERTEBRATE TAXONOMY
(The numbers correspond to those used in
Table 4) (cont)

	Phylum	Class	Order	Family	<u>Genus species</u>
	Annelida				
	Polychaeta				
	Subclass: Errantia				
	Phyllodocida				
	Nephtyidae				
10.					<u>Nephtys cornuta</u>
11.					Nereidae damaged
	Phyllodocidae				
12.					<u>Eteone longa</u>
	Subclass: Sedentaria				
13.					Splionidae unidentified
14.					<u>Aonides</u> sp.
15.					<u>Prionospio cirrifera</u>
16.					<u>Spio</u> sp.
17.					Cirratulidae
	Terebellidae				
18.					<u>Terebellidris stroemii</u>
	Ampharetidae				
19.					<u>Samytha californiensis</u>
	Capitellidae				
20.					<u>Capitella capitata</u>
	Sabellidae				
21.					<u>Oriopsis</u> sp.
	Orbiniidae unidentified				
22.					
23.					<u>Scoloplos armiger</u>

APPENDIX IV TABLE 3 STOKES POINT BENTHIC INVERTEBRATE TAXONOMY
(The numbers correspond to those used in
Table 4) (cont)

	Phylum	Class	Order	Family	<u>Genus species</u>
	Oligochaeta				
24.		Haplotaxida		Tubificidae	
25.		Haplotaxida		Enchytraeidae	
	Arthropoda				
		Crustacea			
		Subclass: Copepoda			
26.			Centropagidae		<u>Limnocalanus macrurus</u>
27.			Harpacticidae		<u>Harpacticus</u> sp.
28.		Subclass: Malacostraca			
		Idoteidae			
			Saduria entomon		
29.		Diastylidea			
			Leptostyliis	sp.	
30.		Subclass: Ostracoda			
		Amphipoda			
		Suborder: Gammaridea			
31.			Lysianassidae		
					<u>Onismus galactalis</u>
32.			Haustoriidae		
33.					<u>(Pontoporela femorata)</u>
			unidentified		
34.			Oedicerotidae		
					<u>Monoculopsis (micros)</u>

APPENDIX-IV TABLE 3 STOKES POINT BENTHIC INVERTEBRATE TAXONOMY
(The numbers correspond to those used in
Table 4) (cont)

	Phylum	
	Class	
	Order	
	Family	
		<u>Genus species</u>
35.		<u>Mecochelrus</u> sp.
36.		unidentified
37.		Gammaridae
38.		(<u>Eogammarus o'clairi</u>)
	Atyidae	
39.		<u>Atylus</u> sp
	Nemertea	
	Anopla	
	Paleonemertea	
	Carinomidae	
40.		(<u>Carinoma mutabilis</u>)
	Chordata	
	Ascidacea	
	Pleurogona	
	Pyuridae	
41.		(<u>Boltenia</u> sp.)
	Molgulidae	
42.		(<u>Molgula</u> sp.)

APPENDIX IV TABLE 4 STOKES POINT BENTHIC INVERTEBRATE ABUNDANCE AND DISTRIBUTION

CLASSIFICATION	STATIONS LAGOON		STATIONS MARINE			LAGOON SPECIES DISTRIBUTION			MARINE SPECIES DISTRIBUTION			
	1	2	3	4	5	6	7	8	9	NUMBERS	% OF TOTAL	
1. <u>Cornuspira involvens</u>						1		0	0.0	1	0.1	
2. <u>Nematoidea</u>						2		0	0.0	2	0.2	
3. <u>Prilopulus sp.</u>	16				5	40	13	6	16	0.7	1	0.1
4. <u>Montacuta dawsoni</u>					1				0	0.0	64	7.5
5. <u>Macoma balthica</u>	3				2	1	3	0	3	0.1	0	0.0
6. <u>Portlandia lenticula</u>					14			0	0	0.0	6	0.7
7. <u>Portlandia intermedia</u>								0	0.0	14		1.6
8. <u>Cyrtodaria kurtiana</u>					1	2	0	0	0	0.0	2	0.2
9. <u>Gastropoda (juv)</u>								0	0.0	1	0.1	
10. <u>Nephrys cornuta</u>	506	951						1457	65.0	0	0.0	
11. <u>Nereidae: damaged</u>						2	0	0	0.0	2	0.2	
12. <u>Eteone longa</u>					4	1	5	0	0	15		1.8
13. <u>Sploniidae unidentified</u>	6				3	2	2	6	0.3	10		1.2
14. <u>Aonidae sp.</u>	1				6	2	21	3	14	1	0	46
15. <u>Prionospio clarifera</u>						1	3	1	0	0	4	0.5
16. <u>Spolio sp.</u>	1	2			7	3	3	6	3	0.1	23	2.7
17. <u>Cirratulidae</u>	360				5	5	20	7	7	360	16.1	44
18. <u>Terebellidae stromi</u>	34				1	1	3	1	34	1.5	1	0.1
19. <u>Samytha cellifornensis</u>					14	3	3	8†	9	0	110	12.9
20. <u>Capitella capitata</u>						2	2	1	0	0	5	0.6
21. <u>Drilopsis sp.</u>								3	0	0	5	0.6
22. <u>Orbiniidae unidentified</u>					1	2	13	5	4	0	25	2.9
23. <u>Scoloplos armiger</u>					3	15	29	20	15	0	82	9.6
24. <u>Tubificidae</u>						6	11	0	0	17		2.0
25. <u>Enchytraeidae</u>					1				0	0	1	0.1
26. <u>Limnocalanus macrurus</u>	3	4	15	21	44	40	78	3	0.1	202		23.6

CLASSIFICATION	STATIONS LAGOON		STATIONS MARINE			LAGOON SPECIES DISTRIBUTION			MARINE SPECIES DISTRIBUTION NUMBERS	% OF TOTAL
	1	2	3	4	5	6	7	8	9	
27. <u>Harpacticus</u> sp.					5				0	0.0
28. <u>Saduria entomon</u>					1	2			0	0.0
29. <u>Leptostylis</u> sp.					5	20	2		52	2.3
30. Subclass : Ostracoda	52	19	1	16	5				0	0.0
31. <u>Oithomus glacialis</u>					4	2			69	3.1
32. <u>(Pontoporela femorata)</u>	15	54							228	10.2
33. <u>Hastoridiae unidentified</u>					5				0	0.0
34. <u>Monoculopeltis (micros)</u>	2	3	13	17	19	9	15	2	0.1	76
35. <u>Mecochelirus</u> sp.									0	0.0
36. <u>Oedicerotidiae unidentified</u>	1							1	0	0.0
37. <u>Gammaridae unidentified</u>		1						1	.0	0.0
38. <u>(Eogammarus oclairi)</u>	3	1					2	4	0.2	2
39. <u>Atyidae</u> sp.								0	0.0	0.2
40. <u>(Carinoma mutabilis)</u>					1	4	1	2	0	0.0
41. <u>(Boltenia</u> sp.)								2	0.0	0.9
42. <u>(Molgula</u> sp.)							1	1	0	0.0
									2	0.2
TOTAL DENSITY(m ²)	541	1701	68	39	144	214	229	162	2242	856