Water Quality

Ambient Water Quality Objectives For Sechelt Inlet

Overview Report

Water Management Branch
Environment And Resource Division
Ministry Of Environment, Lands And Parks

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Original Signed By J. O'riordan
Assistant Deputy Minister
Environment And Lands Hq Division
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SUMMARY
This report assesses the marine water quality of Sechelt Inlet. Natural restrictions on water movements may lead to episodes of water quality deterioration. Human effects on ambient water quality have been relatively minor to date from existing point-sources (for example, permitted effluents) and from most diffuse sources. There is no evidence of significant long-term trends toward declining water quality, such as excessive accumulation of nutrients, which can be linked to human activities. This assessment identifies the primary water quality concern as localized bacteriological contamination from failed

residential septic systems, sewage wastes from vessels and other diffuse sources. Ammonia, dissolved oxygen, particulates and trace metals also were identified as potential water quality concerns. Sediment and biological accumulation of metals or other contaminants is largely unknown, and requires further study.

Current water quality is adequate for designated water uses in most of Sechelt Inlet. Water quality objectives are recommended to protect the most sensitive designated marine water uses, which include aquatic life and waterfowl, mariculture, shellfish harvesting for human consumption, and primary-contact recreation. A monitoring program is proposed to determine whether the recommended objectives are being met, and whether additional objectives should be considered in the future. These water quality objectives and monitoring recommendations are intended primarily for Porpoise Bay, which is most at risk from potential water quality impacts and water-use conflicts.

Natural characteristics of Sechelt Inlet give it a moderately high pollution potential. There will be continued pressures for residential, commercial and recreational growth, leading to increased conflicts with water uses and resources. Waste loadings from new or expanded activities could exceed the assimilative capacity of Sechelt Inlet unless prevented or properly managed. Recommendations of the 1987 *Sechelt Official Community Plan* and the 1990 *Sechelt Inlets Coastal Strategy* regarding appropriate land and water uses to protect and manage water quality should be support.

FIGURES

FIGURE 1. Sechelt Inlet Location Map

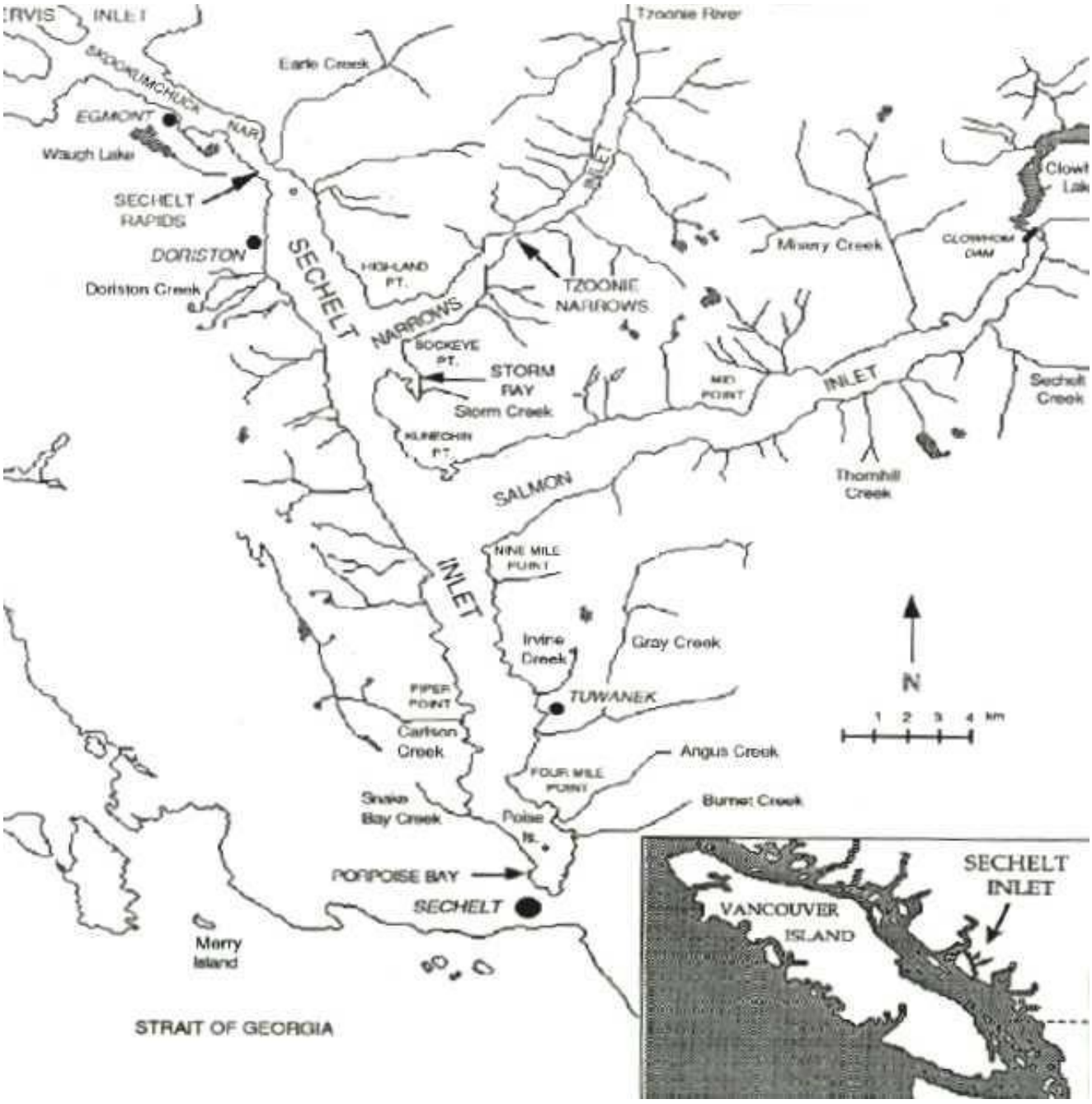
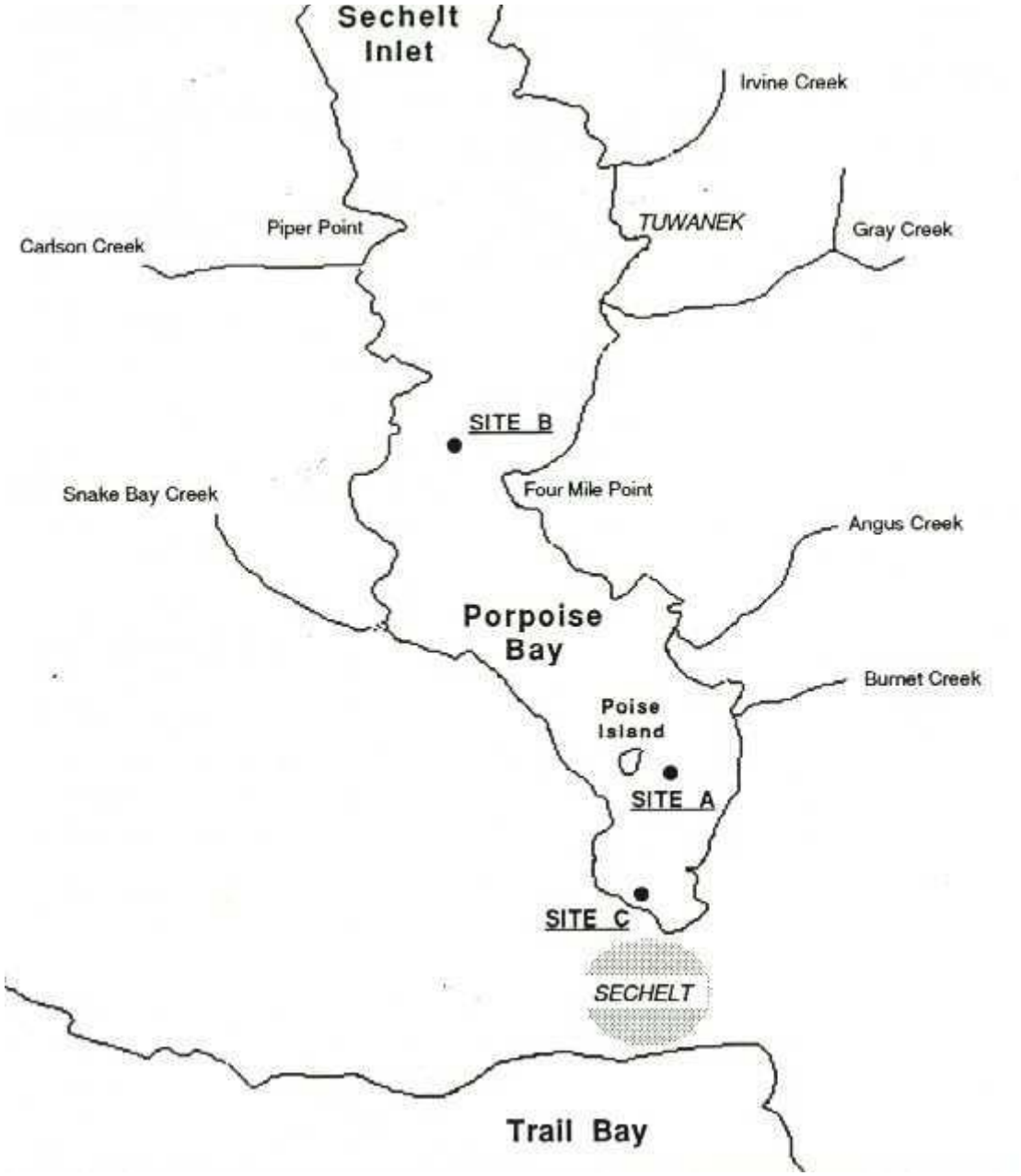


FIGURE 2. Sechelt Inlet Monitoring Map



PREFACE
Purpose of Water Quality Objectives

Water quality objectives are prepared for specific bodies of fresh, estuarine and coastal marine surface waters of British Columbia as part of the Ministry of Environment, Lands and Parks' mandate to manage water quality. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity now or in the near future.

How Objectives Are Determined

Water quality objectives are based the BC approved and working criteria as well as national water quality guidelines. Water quality criteria and guidelines are safe limits of the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment which protect water use. Objectives are established in British Columbia for waterbodies on a site-specific basis. They are derived from the criteria by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. A designated water use is one that is protected in a given location and is one of the following:

- raw drinking water, public water supply, and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial water supplies.

Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical or biological characteristics affecting that waterbody.

How Objectives Are Used

Water quality objectives routinely provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives guide the evaluation of water quality, the issuing of permits, licences and orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular waterbody can be checked, and help to determine whether basin-wide water quality studies should be initiated.

Water quality objectives are also a standard for assessing the Ministry's performance in protecting water uses. While water quality objectives have no legal standing and are not directly enforced, these objectives become legally enforceable when included as a requirement of a permit, licence, order, or regulation, such as the Forest Practices Code Act, Water Act regulations or Waste Management Act regulations.

Objectives and Monitoring

Water quality objectives are established to protect all uses which may take place in a waterbody. Monitoring (sometimes called sampling) is undertaken to determine if all the designated water uses are being protected. The monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. It is assumed that if all designated water uses are protected at the critical time, then they also will be protected at other times when the threat is less.

The monitoring usually takes place during a five week period, which allows the specialists to measure the worst, as well as the average condition in the water.

For some waterbodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses, and the way the objectives are expressed (*i.e.*, mean value, maximum value).

INTRODUCTION

The study area is situated on the Lower Mainland Coast about 80 km northwest of Vancouver, and encompasses Sechelt, Narrows and Salmon inlets (see Figure 1). These marine waters sustain important fisheries and recreational resources and, until recently, were not affected by major human activities. The rapid growth of salmon farming focussed attention on potential environmental impacts in Sechelt Inlet. Mariculture production remained lower than predicted, but concern about this and the impact of other actual or potential human activity on the inlet emphasized the need for a comprehensive water quality assessment. The potential effects of low dissolved oxygen, nutrient loading, bacteriological contamination, harmful phytoplankton blooms and sediment accumulation on recreational water uses and aquatic life (including mariculture) were identified as possible major water quality issues in Sechelt Inlet.

Resource managers, local authorities and the public agreed that priority should be given to protecting Sechelt Inlet water quality for sensitive designated marine uses such as aquatic life and recreation. To do this, information on water quality and resources needed to be compiled and assessed, and appropriate water quality objectives provided. A detailed report was prepared and forms the basis for the conclusions presented in this overview.

SECHELT INLET PROFILE (SUNSHINE COAST)

HYDROLOGY and OCEANOGRAPHY

The Sechelt Inlet watershed is approximately 1500 km^2. Freshwater discharges are based primarily on coastal rainfall patterns. Highest streamflows occur in winter when rainfall is heaviest. Another peak discharge may occur in late spring in any streams fed by snowmelt. The low flow period occurs from July

to September. Annual precipitation increases from about 1100 mm at Porpoise Bay to 2200 mm at Clowhom Falls, the head of Salmon Inlet. Average annual freshwater discharge into the system from all sources is estimated to be 110 m^3/s. This freshwater inflow has little effect on overall flushing from the system.

Hydrologic data are scanty for individual streams, but most tributaries to Sechelt Inlet are small and have a large seasonal variation in runoff. Flash-flooding and muddy flows may occur. The largest rivers are the Clowhom and the Tzoonie, which enter the heads of Salmon and Narrows inlets, respectively. Clowhom River discharge is controlled by a BC Hydro power dam. Releases to the head of Salmon Inlet could have water quality implications due to the possible surfacing of oxygen deficient water in upper portions of the system.

Sechelt Inlet is a typical fjord, with a shallow entrance sill at Skookumchuck Narrows, long, narrow channels, and deep basins. Inlet volume is estimated as 14 billion m^3 at average tides. Water exchange from the system is limited by the entrance sill to about 3% of the inlet's volume over an average tidal cycle. The main axis of water circulation is along Sechelt and Salmon inlets. The southern portion of Sechelt Inlet, particularly Porpoise Bay, has relatively poor water circulation and exchange, making this area sensitive to any water quality impacts. Upper Narrows Inlet is regarded as a distinct water body, since it is separated from the rest of the system by a sill at Tzoonie Narrows. Apart from Sechelt Rapids and Tzoonie Narrows, tidal currents within the inlets are weak, highly variable and play a minor role in overall inlet circulation. Average tidal ranges within the inlet are relatively small.

The natural cycle of water movement within the inlet provides the basic geographic and temporal pattern for water quality conditions and sets a limit to the inlet's overall assimilative capacity. Lower Sechelt Inlet is reasonably well mixed and supplied with nutrients and dissolved oxygen throughout the year by tidal transport through Skookumchuck Narrows. Upper parts of the system may stratify at certain times, or form layers preventing vertical mixing of water. In general, only surface or near-surface water is regularly replenished. Deep waters may become anaerobic, or very low in dissolved oxygen. These anaerobic waters may be pushed toward the head of the system and rise to the surface with detrimental effects on marine life. During high run-off periods, increased outflow of freshwater from the heads of Salmon and Narrows Inlets may promote such upwelling.

WATER USES

There are two useful overviews of Sechelt Inlet water resources, uses, needs and priorities. The first is the 1987 Sunshine Coast and Campbell River / Johnstone Strait Coastal Resource Interests Study (CRIS), undertaken to resolve potential conflicts between mariculture and competing coastal uses. The second is the 1990 Sechelt Inlets Coastal Strategy, commissioned by the Sunshine Coast Regional District to facilitate coastal land use designation plans and policies.

Biological Resources

Freshwater fisheries habitat is limited to tributaries near the heads of Narrows Inlet, Salmon Inlet and Porpoise Bay due to steep topography, confined channels and fast flows. Intertidal or shallow subtidal habitat is also restricted. Porpoise Bay has the largest amount of such fisheries habitat. Since this area has regional significance for waterfowl and fisheries production, and is subject to substantial residential,

commercial and recreational development pressures, user conflicts and environmental impacts are more likely in Porpoise Bay than elsewhere in the system.

Sechelt Inlet and its tributaries contribute to the regional fisheries resource, both for recreational catch opportunities and availability of spawning or rearing habitat, although there has been a substantial decline in wild salmon production since the late 1960s. Chum salmon are the main species, followed by pink, coho, sockeye and chinook. Tzoonie River accounts for the majority of long-term salmon runs in the entire system. Salmonid production is relatively low in other tributaries (the main fish-bearing streams are Angus, Storm, Carlson, Sechelt and Gray creeks). There is a locallyimportant recreational herring fishery in Sechelt Inlet, with spawning and rearing habitat in Porpoise and Storm bays. The inlet supports a variety of shellfish of local commercial and recreational significance. Commercial activity is focussed on intensive mariculture, and recreational and native food harvests of wild stocks are important locally. Porpoise and Storm bays have shellfish harvesting closures due to sewage contamination.

Industry

Tributary watersheds have been intensively logged in the past. The present estimated total area of timber harvest is 760 hectares, with an annual volume of about 500 000 m^3. Sechelt Inlet waters have been used for log storage, sorting and transportation, and several past and present logging camps and log-handling facilities are located at tidewater. Mining is relatively insignificant in the study area, and confined to the extraction of sand and gravel resources, together with gravel washing. There is no metallic mineral mining in the area.

Commercial fishing is relatively minor and dispersed in the study area, with a handful of small fish-processing plants and one commercial salmon hatchery currently operating. The main interest has been mariculture. This area was the first to experience the rapid expansion of fish farming in BC in the late 1980s. Peak production was reached in 1989 with 56 fish farms operating around the Sechelt Peninsula, and it was believed that salmon farming could expand to 3300 tonnes per year in Sechelt Inlet. The 1987 CRIS overview designated many areas within Sechelt Inlet as having limited or no opportunities for fish farming to avoid conflicts with other coastal uses. Many Sechelt Inlet fish farms have since closed or relocated. Shellfish growing prospects in Sechelt Inlet appear brighter with future expansion anticipated.

Recreation

The Sechelt inlets are an attractive area for marine recreation. Saltwater fishing opportunities are good, especially for coho and Chinook salmon. Freshwater fishing includes rainbow and cutthroat trout and Dolly Varden char. There are two provincial parks at Porpoise Bay and Skookumchuck, and eight provincial marine parks. Porpoise Bay Provincial Park is the largest developed provincial park on the Sunshine Coast, with a popular beach and swimming area. The marine parks are intended primarily for small boat access, and development has been limited to basic amenities like sanitary facilities. Fewer recreational vessels are found within the system than in the entrance area above Skookumchuck Narrows.

Domestic Water Supply

Surface freshwaters are the source of most domestic water supplies in the study area. Current water licences have not used up the available capacity. The main licensees are the Sunshine Coast Regional District (for community water supply purposes), BC Hydro (power generation at Clowhom Falls), and several industrial users (gravel washing, fish hatchery). Domestic water supplies for the village of Sechelt and adjacent areas come from Chapman Creek (which is outside the study area), with backup supplies from Gray Creek. There are,relatively few ground water users at the more developed southern end of

Sechelt Inlet, and there are no plans for future ground water use in Sechelt community water supplies

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WASTE WATER DISCHARGES

Documented point-source waste discharges in the study area include single residential sewage disposal, community sewage treatment systems and sanitary landfills, municipal storm sewers and various industrial effluent discharges. There are few permitted discharges, and most of these have modest volumes. Several flow into the ground and consequently have limited impact on surface waters. Permit-monitoring data are sparse. Potential diffuse sources of water quality contamination include sewage discharges from marinas, vessels or similar sources and seepage from residential septicfacilities. Mariculture operations, logging debris from logged watersheds and log handling areas, and upland runoff contaminated with toxic materials, nutrients or sediments are also potential diffuse sources of contamination. Many diffuse sources are intermittent, do not require permits and are poorly documented.

Sewage and Refuse Disposal

Point-source domestic sewage discharges comply with the requirements of their Waste Permits, and have not greatly affected marine receiving water quality or water uses. These discharges have small volumes, satisfactory quality and excellent dispersion.

The Sechelt sanitary landfill operation has been in compliance with its Waste Permit and no leachate contamination has been detected. However, there have been numerous problems with sporadic episodes of bacteriological contamination around Porpoise and Snake Bays and parts of the southern Sechelt Inlet shoreline. Such concerns would increase if substantial residential growth takes place. The District of Sechelt 1987 Official Community Plan (OCP) recommended shoreline policies such as minimum lot sizes or connection to the community sewage disposal system, in areas unable to accommodate on-site sewage disposal. Hence, the Sunshine Coast Regional District sewage treatment plant in Sechelt (which discharges to Trail Bay, outside the study area) is important in servicing future community expansion and reducing diffuse sources of sewage contamination in southern Sechelt Inlet.

Gravel Operations

Two major gravel-washing operations are in the study area: Canada Cement Lafarge Ltd., situated on the east side of Skookumchuck Narrows, and Rivtow Straits Ltd. in Porpoise Bay. The Waste Permit for the former authorizes settling pond overflow to marine waters, provided effluent quality (total suspended solids) remains satisfactory. Minimal receiving-water impacts are anticipated since overflows occur very infrequently, and Skookumchuck Narrows has a high assimilative capacity. The Waste Permit for Rivtow Straits Ltd. prohibits overflow from the settling ponds to the receiving environment except under very unusual circumstances. Potential overflows and resulting water-quality impacts in fish-bearing Angus Creek have been reduced since the settling ponds were relocated farther away. All gravel wash water is recycled and there is no net discharge.

Fish Hatcheries

A Waste Permit for the Scanmar Seafoods Ltd. hatchery at Gray Creek (capacity eight million fish) authorizes discharge of a maximum 48 000 m^3/day of treated effluent to marine waters. The Waste Permit stipulates compliance with Level A objectives in the Pollution Control Objectives for Food Processing, Agriculturally Oriented and Other Miscellaneous Industries of British Columbia. Impacts on the receiving environment have been minimal. Waste permits also were issued for smaller hatcheries (Sechelt United Hatcheries Ltd., and John L. Slind). Again, minimal impacts were anticipated given the small volume of treated effluent and ample dilution within the inlet.

Fish-Processing Plants
Waste permits have been issued for the discharge of fish-processing plant effluent to marine waters from Durango Enterprises Ltd. and Egmont Fish Plant Ltd., both at Egmont. Effluent treatment specified by the permits (fine screening and settling) is normal for small fish processing plants. Due to dilution and removal by tidal action in Skookumchuck Narrows, the effluent was not expected to be detectable in receiving waters.

Stormwater Discharge
A major municipal storm sewer discharges into Porpoise Bay. The quantity and quality of the discharge have not been documented, but it is not considered serious at the present time. The receiving environment in Porpoise Bay appears to have sufficient volume and tidal action to assimilate anticipated stormwater loadings. However, water quality objectives and monitoring are proposed for Porpoise Bay partly because of possible stormwater discharge concerns.

Recreational Boating
Most small craft do not have sewage-holding tanks and discharge sewage wastes directly into the ocean. Although recent legislation requiring holding tanks for small craft has not been applied to Sechelt Inlet, it could be if requested by residents of the area and if pump-out facilities were provided. Sewage pump-out facilities are generally lacking in the study area. However, the small marinas and scattered recreational boating probably have minor environmental effects within Sechelt Inlet at present. Trace metal and hydrocarbon contamination from antifouling paints, fuels and other materials associated with marinas, boatworks and similar commercial and industrial activities could be a potential concern in some areas of Porpoise Bay. Expansion or development of new marinas and related facilities in Porpoise Bay could have serious environmental effects.

Forestry
There are no site-specific studies or data available to confirm impacts of forest-harvesting activities on Sechelt Inlet water quality or aquatic resources, although there is indirect evidence that logging and related activities, such as road construction may have increased sediment loading to the inlets. Seasonally heavy rainfall, steep terrain and unstable soils contribute to turbid flows in upper Narrows and Salmon inlets. Other concerns include the possible effects of log dumping and storage at the six active log dumps in the studyarea. Intertidal or bottom habitat and organisms may be disturbed or destroyed by bark deposits, sediment removal, toxic substances, or decreased dissolved oxygen.

Mariculture
The 12 active salmon farm operations are concentrated in central Sechelt, lower Narrows and lower Salmon inlets. The 13 active shellfish tenures are clustered in southern Sechelt Inlet between Nine Mile Point and Tuwanek, and in the vicinity of Storm Bay. There has beenmuch concern over possible environmental effects of mariculture in Sechelt Inlet. However, mariculture depends on good water quality and cultured. Fish and shellfish are very sensitive to environmental degradation. Most of Sechelt Inlet has been rated as poor or unacceptable for salmon farming, partly because of adverse natural water quality conditions. Documented waste management practices and water quality monitoring at Sechelt Inlet salmon farms indicate that potential impacts on water quality or bottom life from this activity have been relatively minor and localized to date. Mariculture waste loadings have not had a significant impact on the overall system.

WATER QUALITY ASSESSMENT AND OBJECTIVES

WATER QUALITY ASSESSMENT

Microbiological Indicators

Bacteriological contamination was a main concern in Sechelt Inlet. Potential sources included leaching septic fields, marinas and recreational boating anchorages, landwash and storm drainage. Contamination was sporadic and limited in extent. Most of the inlet was relatively uncontaminated and sensitive designated water uses such as shellfish harvesting usually were unaffected. Sanitary surveys of shellfish growing areas by Environment Canada indicated that bacteriological problems with reference to federal coliform criteria were most persistent in Porpoise Bay, and to a lesser extent in Storm Bay. These areas remain closed to shellfish harvesting. Year-round shellfish harvesting closures also are in effect within 125 m of wharves or permanently anchored floating structures. Other shoreline areas in Sechelt Salmon and Narrows inlets, and bacteriological levels at mariculture operations, were within acceptable limits for shellfish-growing waters.

Nutrients

Levels of nutrients measured in Sechelt Inlet were similar to the normal seasonal range of nutrients measured elsewhere along the BC coast. Nutrient input to the inlet due to human activities was negligible compared to the large inlet volume, dilution and natural changes in nutrients. There was no evidence to suggest excessive accumulation of nutrients now or in the foreseeable future, at present rates of nutrient input. Effluents from point sources were within their allowable Waste Permit levels for nutrients. Nutrient accumulation from diffuse sources such as fish farms did not appear to produce significant effects in the inlet as a whole.

Ammonia was slightly elevated over background levels at some farm sites, but effects were very localized. Slightly higher ambient levels of ammonia also were observed in Porpoise Bay, but concentrations in both instances were consistent with normal coastal ranges for ammonia, and were well below provincial ammonia criteria for protection of marine life.

Phytoplankton

Sechelt Inlet has a high potential for phytoplankton blooms, including several potentially harmful species with significant health and economic implications. Fish kills and paralytic shellfish poisoning (PSP) are examples of potential problems. Record high levels of PSP toxin for waters in British Columbia have been reported in Sechelt Inlet, and the Department of Fisheries and Oceans frequently imposed shellfish harvesting closures. There is no evidence that blooms were stimulated by salmon-farms or other activities in Sechelt Inlet.

Dissolved Oxygen

Dissolved oxygen levels in surface and midwaters normally were sufficient for designated water uses in Sechelt Inlet. Effluent objectives for five-day biochemical oxygen demand (BODS) were in compliance for all discharges to the inlet. BODS loadings from these point sources were negligible, and diffuse sources such as fish farms did not affect surface oxygen levels significantly.

Non-filterable Residue (NFR)

Ambient non-filterable residue (suspended solids) concentrations were relatively low in Sechelt Inlet and

did not impair any designated water uses. Porpoise Bay, the most intensively developed part of the study area, did not show significant increases in ambient NFR concentrations. Permitted discharges were in compliance for suspended solids, and there were no documented sediment impacts from these or other site-specific sources, such as mariculture operations. The main source of NFR was diffuse loading from tributaries draining steep slopes, particularly those intersecting logged areas or other locations with unstable soils. Winter NFR concentrations were higher in Narrows and Salmon inlets, reflecting higher seasonal runoff and suspended sediment loads. There is some evidence that NFR levels have increased through time. Causes are not clear, but could be related to a combination of natural causes such as changes in precipitation patterns, and diffuse terrestrial sources such as increases and changes in logged areas and urban development.

Metals
None of the permitted waste discharges to Sechelt Inlet were major sources of trace metal contamination. Diffuse runoff such as storm drainage was the main human-generated source of trace metals from land. Potential marine sources of trace metal contamination included antifoulant paints (copper, lead), galvanized materials (zinc), and (formerly) fuel additives (lead). Limited ambient water data for trace metals indicated that most concentrations were low relative to provincial metal criteria for marine waters and did not pose a threat to water uses in Sechelt Inlet. Total copper, lead and zinc exceeded provincial metal criteria on a minor, infrequent basis, but average surface values were well within the criteria. There is sufficient volume and flushing to minimize potential impacts, assuming there are no major increases in trace metal-loadings to Sechelt Inlet from human sources.

Tributyltin (TBT)
There are no data available on TBT use or environmental impacts in Sechelt Inlet, but TBT is not expected to be a concern. Due to recent federal restrictions on its use, any levels of TBT accumulated in Porpoise Bay, the most likely area to accumulate TBT in sediment or marine organisms, probably are declining. TBT is no longer used on nets at fish farms.

Hydrocarbons
The main potential marine sources of hydrocarbons in Sechelt Inlet are fuel spills at marinas, wharves and similar facilities. Exhaust emissions are a lesser potential source. There are no data available on levels of hydrocarbon contamination in water or sediment, but this is probably not a major concern for water uses in the study area. All fuelling facilities are located in the well-flushed Egmont area. There are no fuel docks at present at the head of Porpoise Bay.

Chlorinated Organics
Limited tissue data are available on chlorinated organic contaminants (PCBS, chlorinated pesticides, chlorophenols) at operating fish farms in Sechelt Inlet. Potential sources of these compounds could include contaminants in commercial fish feeds or wood preservatives released from float structures. Maximum observed values from Sechelt Inlet were well below the draft provincial chlorophenol criteria recommended to avoid sub-lethal effects in aquatic organisms, and were also below flavour impairment thresholds for chlorophenols. Maximum PCB levels in fish tissue at fish farms were well below provincial PCB criteria.

WATER QUALITY OBJECTIVES

Designated Water Uses

Critical or important locations and their designated water uses were noted by the 1987 *Sunshine Coast and Campbell River/Johnstone Strait Coastal Resource Interests Study*, 1987 Sechelt Official Community Plan and the 1990 Sechelt Inlets Coastal Strategy. These studies included land use policies recognizing the environmental sensitivities of watercourses and marine foreshore areas and the need to protect them from habitat encroachment or pollution. Strategic planning objectives of the Coastal Strategy emphasize careful water management and thus complement the preparation of water quality objectives.

The most sensitive existing and future marine water uses designated in Sechelt Inlet are primary-contact recreation, other recreation (mainly boating), aquatic life, wildlife and their habitat,mariculture, and shellfish harvesting for human consumption. Water quality objectives are proposed to protect these uses. Objectives (see Table 1) include microbiological indicators, ammonia, particulate matter (nonfilterable residue), dissolved oxygen, copper, lead and zinc. Site-specific sediment and tissue objectives for trace metals would be contemplated if warranted by additional monitoring.

Microbiological Indicators

Porpoise Bay will experience bacteriological contamination problems in the future given its limited flushing and the continued existence or expansion of marinas, wharves, boating and residential development. Primary-contact recreation should be designated the most sensitive water use in this area, and the approved provincial microbiological criteria for primary-contact recreation should be used as the provisional objective. The primary-contact recreation objective should also apply to all locations included under the Federal Government's standard shellfish harvesting closure (moorage facilities, etc.). Microbiological objectives for the rest of Sechelt Inlet north of Porpoise Bay (including Storm Bay) should be based shellfish-harvesting criteria because of more favourable flushing conditions, lower development pressures and the importance of shellfish resources.

Nutrients

In most of Sechelt Inlet, nutrient impacts from human activity are small and difficult to distinguish from natural nutrient characteristics of the ocean. Thus nutrient objectives are not appropriate. Porpoise Bay is a special case, since it is more likely to receive nutrient input from human activities and exhibits slightly elevated ammonia concentrations. Provisional objectives for total ammonia nitrogen are recommended for Porpoise Bay, based on the approved provincial criteria for the protection of marine life. Specific values depend on ambient temperature, salinity and pH (**Table 2.** and **Table 3.**).

Particulates

Ambient objectives for particulate matter (based on the provincial aquatic life criterion for induced non-filterable residue) are proposed for Porpoise Bay and southern Sechelt Inlet to confirm any increases and to avoid possible future deterioration in these areas.

Dissolved Oxygen

Since dissolved oxygen levels in most of the inlet are determined by natural oceanography, dissolved oxygen objectives are not considered appropriate for the inlet as a whole. Dissolved oxygen objectives are proposed for a few areas near the head or in bays which may be poorly flushed and accumulate organic materials (*e.g.*, wood wastes) due to human activities, resulting in local dissolved oxygen decreases. The objectives are based on provincial working marine criteria for dissolved oxygen and are consistent with the near-surface average dissolved oxygen concentrations in most of Sechelt Inlet.

Metals
Metals objectives are not proposed for Sechelt Inlet north of Porpoise Bay. Since Porpoise Bay has a greater potential for metal contamination, water quality objectives (based on approved or working provincial criteria for protecting marine life) are proposed for total copper, total lead and total zinc. There are no data to indicate whether trace metals have accumulated in sediments and bottom-living organisms adjacent to marinas or similar facilities and in locations exposed to urban landwash and stormwater drainage. Site-specific sediment and tissue objectives would be contemplated if warranted by preliminary monitoring results.

MONITORING RECOMMENDATIONS
A summary of recommended routine water quality monitoring is given in Table 4, for sampling locations shown on Figure 2. Quality assurance for the monitoring program should be maintained by adequate sample replication and testing of field blanks and reference samples. Recommended monitoring is the minimum required to check whether objectives are being achieved, to finalize objectives that have been proposed or confirm whether they are needed, and to increase understanding of environmental quality in Sechelt Inlet.

The recommended monitoring program is based on technical considerations. Regional priorities and available resources are factors that could either limit or expand this program.

TABLES
Table 1. Provisional Water Quality Objectives for Sechelt Inlet

Characteristics	Sechelt Inlet	Porpoise Bay
Designated Water Uses	Aquatic life, wildlife, primary contact recreation, shellfish harvesting, mariculture	Aquatic life, wildlife, primary contact recreation
fecal coliforms	-less than or equal to 14/100 mL (median) -less than or equal to 43/100 mL (90th percentile)	-less than or equal to 200/100 mL (geometric mean)
enterococci	-less than or equal to 4/100	-less than or equal to

	mL (median) -less than or equal to 11/100 mL (90th percentile)	**20/100 mL (geometric mean)**
Pseudomonas aeruginosa	**not applicable**	**-less than or equal to 2/100 mL (75th percentile)**
total ammonia nitrogen	**not applicable**	**AMMONIA TABLES**
suspended solids	**-less than 10 mg/L increase over background when background is greater than or equal to 100 mg/L**	
total copper	**not applicable**	**-3 micrograms/L maximum -less than or equal to 2 micrograms/L as a 30-day mean**
total zinc	**not applicable**	**-15 micrograms/L maximum**
total lead	**not applicable**	**-140 micrograms/L maximum -less than or equal to 2 micrograms/L as a 30-day mean -less than or equal to 3 micrograms/L 80th percentile -less than or equal to 0.8 micrograms/g wet weight in fish tissue**
dissolved oxygen	**greater than 6.75 mg/L**	

The objectives apply to distinct samples from all parts of the waterbody except from initial dilution zones of effluents. These excluded zones extend up to 100 m from the point of discharge in all directions, from the surface to the bottom.
1. For fecal coliforms, enterococci and Pseudomonas the means and percentiles are calculated from at least 5 weekly samples taken in a 30-day period. For values below the detection limit the detection limit is used to calculate the statistic. These objectives apply to

those areas, wharves etc., covered by the standard 125m shellfish closure
2. The suspended solids objective applies only to the south part of Sechelt Inlet and to Porpoise Bay
3. The dissolved oxygen objective applies only to the surface waters of embayed or poorly flushed littoral areas
4. The lead objective for fish tissue is an alert lavel. It applies to the edible portion, is based on the wet weight and is for fish or shellfish collected at any point including initial dilution zones.

Table 4. Recommended Water Quality Monitorings for Sechelt Inlet

Characteristics	Frequency and Timing	Sampling Depths/Media	Proposed Sites
microbiological indicators (fecal coliforms, enterococci and *Pseudomonas aeruginosa*)	a minimum of 5 samples over a 30-day period in July and August	near the surface	to be determined: emphasis on shoreline areas in southern Sechelt Inlet, Porpoise Bay, Storm Bay, plus at least one in midchannel such as EP #65 in Porpoise Bay
temperature, salinity, dissolved oxygen	once a month for one year	profiles at 2m intervals from the surface to 30m	<u>SITE A</u> at 30m depth, midchannel in Porpoise Bay at
current speed and direction	continuously over one lunar month	midwater	

ammonia and nitrate	**5 samples in 30 days in late summer for 3 years**	**near surface, midwater and near-bottom**	**SEAM site #E207599**
temperature, salinity, dissolved oxygen	**once a month for one year**	**profiles at 2m intervals from the surface to 30m**	**<u>SITE B</u> at 80m depth, midchannel in southern Sechelt Inlet about midway between SEAM site #E207213 and EQUIS site #0300107**
current speed and direction	**continuously over one lunar month**	**midwater**	
ammonia; nitrate; total and dissolved copper, lead and zinc in water; nonfilterable residue	**5 samples in 30 days in late summer for 3 years**	**near surface, midwater and near-bottom**	
total and dissolved copper, lead and zinc in water	**5 samples in 30 days in late summer for 3 years**	**near surface, midwater and near-bottom**	**<u>SITE C</u> at 5m depth, head of Porpoise Inlet adjacent to the public wharf, marinas and stormwater outfalls**
total and dissolved copper, lead and zinc in sediment and tissues	**3 replicates in late summer for 3 years**	**sediment, edible crab and shellfish tissues**	

Fecal coliform monitoring by MELP is not proposed on the assumption that Environment Canmada will continue with its annual surveys. It is recommended that specific monitoring requirements be discussed between MELP, Environment Canada and the Ministry of Health

John C. Arber, R.P. Bio
Water Quality Branch
Environmental Protection Department
Ministry of Environment, Lands and Parks