PRELIMINARY IMPACT ASSESSMENTS OF

PROPOSED PORT DEVELOPMENT

IN THE MAMQUAM CHANNEL

AND

RAIL YARD EXPANSION

IN THE SQUAMISH ESTUARY

DEPARTMENT OF THE ENVIRONMENT, CANADA

VANCOUVER, BRITISH COLUMBIA

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INTRODUCTION

In October 1972 the Department of Environment prepared a report entitled "Effects of Existing and Proposed Industrial Development on the Aquatic Ecosystem of the Squamish Estuary". This report, based on studies undertaken between April and August 1972, assessed the impact of proposed port development on the fishery resource of the Squamish River system and upper Howe Sound. Particular emphasis was directed toward determining the ecological implications of constructing unit and bulk loading port facilities in the central portion of the estuary. The report documented the existence of a complex estuarine food web leading from primary producers (phyto-plankton, algae and marsh vegetation) through primary consumers (zooplankton and botton invertebrates) to fish. It further indicated that the central portion of the estuary is highly productive, that estuarine production in the westerly portion is endangered by recent river training and that productivity in the easterly sector has been reduced by industrial development. On the basis of this relatively short term study it was recommended that "industrial development be confined to those portions of the Squamish delta which do not contribute significantly to estuarine productivity". The scope of the study did not permit an evaluation of the broader environmental, social, land use and economic implications which are an integral part of comprehensive planning.

In November 1972, the B.C. Railway submitted an alternate proposal which involved the construction of a bulk coal terminal on the southeasterly portion of the (old) Mamquam River channel. (Fig.1).

This report presents a preliminary assessment of the biological implications and a general identification of some of the land use, social and recreational impacts imposed by this proposal and the co-incident expansion of rail yards in the central delta.

PROPOSED DEVELOPMENTS

PORT FACILITIES

The proposed bulk terminal will occupy approximately 70 acres of intertidal land. Fill will be obtained from the adjacent 30 acre deep-sea berth excavation. At ultimate development the terminal will have an annual shipping capacity of 10 million tons of coal. The first stage, scheduled for completion in 1974, will accommodate two million tons. Ships required to service the terminal will rise from 35 to 40 per year to 175 to 200 for ultimate development.

The proposal includes delivery of coal to the terminal in covered cars with the bulk of the coal storage in covered silos. Open storage will be confined to approximately 100,000 ton piles adjacent to each bank of storage silos. The piles are to be compacted and crusted for dust suppression and are intended for emergency use only.

Of the 70 acres of land fill, approximately 35 acres would be used initially for coal terminal operations and the barge slip, leaving 35 acres for dry-land log-sorting and other purposes. At full development the latter area would be reduced to about 17 acres which should fully compensate for the in-water log storage area displaced by the development.

The barge slip proposed for the bulk terminal area would replace a similar facility in North Vancouver now handling 2 to 4 barges of rail cars every day. If the slip were relocated at Squamish, 1 or 2 larger self-propelled barges per day could handle the present traffic volume.

RAIL YARD

The expansion of the railway marshalling yard will occupy approximately 55 acres of inter-tidal and flood channel

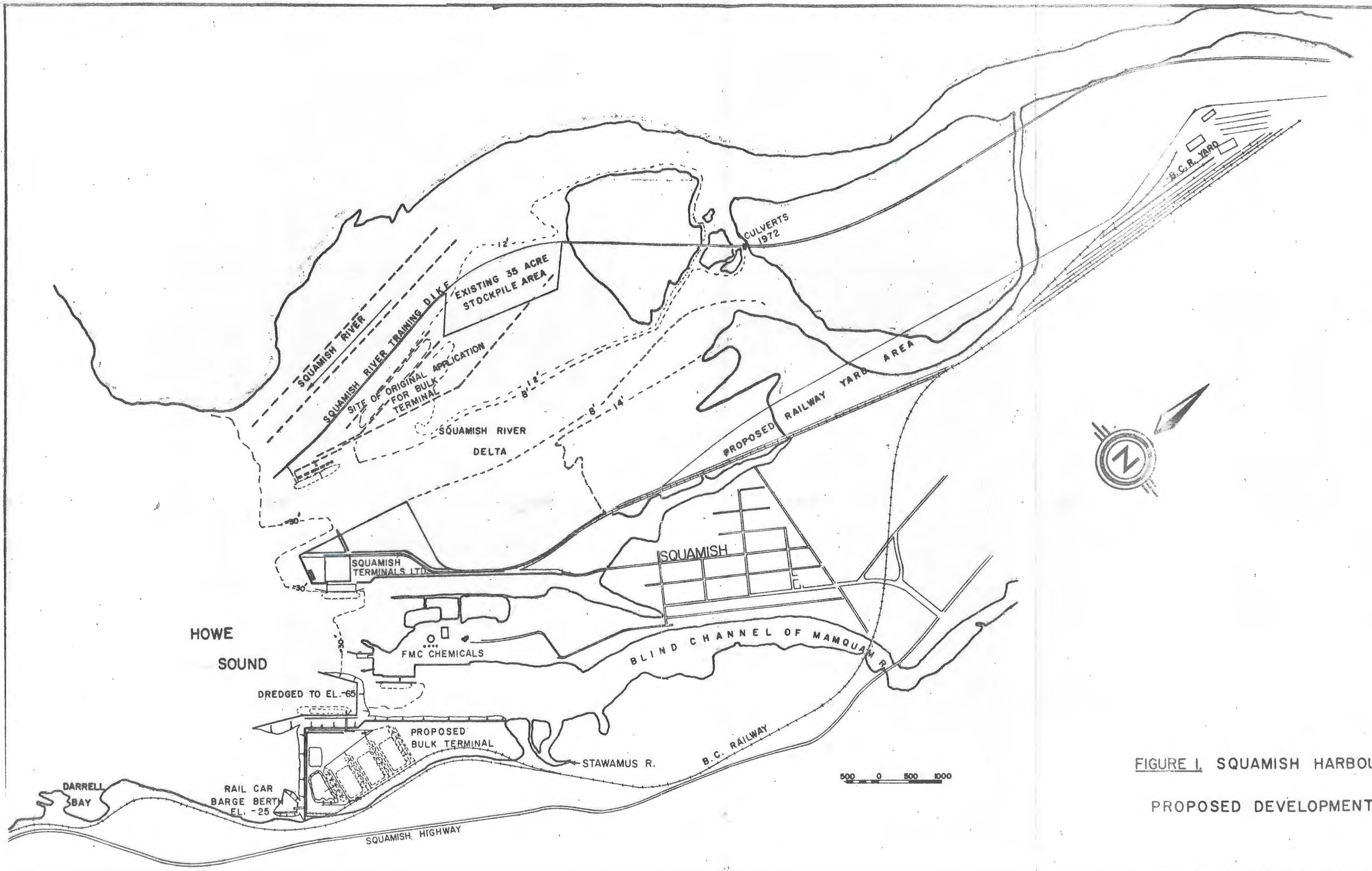


FIGURE I. SQUAMISH HARBOUR

PROPOSED DEVELOPMENT

area. The fill for this development would originate from the spoil area adjacent to the training wall (Fig. 1). The yard would serve as the southern terminus of the B.C. Railway since there is very limited potential for expansion of the existing yard in North Vancouver.

OCEANOGRAPHY

The data available to assess - quantitatively or even qualitatively - oceanographic trends or conditions in the Mamquam Channel is limited to utilizing two forms of information already available. A relatively small amount of current velocity data was obtained near the Squamish delta face in June 1972, and aerial photographs of the general delta area were taken over several years.

In spite of the paucity of information, several qualitative observations about the Mamquam Channel area are possible:

1. The channel appears to be well flushed, primarily by tidal action. Dissolved oxygen content within the main body of the channel appears to remain appreciable in spite of the considerable input of such material as organic "refuse" (bark and wood fragments). Values always fell within the range 3.5 to 11.0 ml O_2/l.

2. The Stawamus River, which is extremely modest in flow, can (during periods of maximum runoff) apparently generate an estuarine profile of increasing salinity and density with depth near the channel mouth. Any seaward contribution of associated brackish flow (a "flushing" effect) would tend to oppose up-channel (surface-layer) flow.

3. Current data indicates very small net flow at depth greater than a few feet, with apparently no preferred direction at any depth above 40 feet.

4. Aerial photographs confirm the occurrence at times of an eddy motion off the eastern portion of the delta which might draw water away from the immediate mouth of the Mamquam into the main jet flow. It might also, however, lead to some degree of retention of water off the Mamquam portion of the delta face. The strength and duration of such eddy movement would be affected by tide and by winds.

5. The "jet" motion associated with the Squamish

River outflow into Howe Sound has been enhanced by the presence of the training dyke. This fact, perhaps together with other man-made changes in the central delta, suggests an alteration in the transportation of the silt load within the river water; it would seem likely that less of the suspended silt in the river outflow (especially the material of larger size) will be carried to the Mamquam area. Such an altered pattern of siltation would, other conditions being unaltered, minimize the frequency of maintenance dredging.

BIOLOGICAL CONSIDERATIONS

BENTHIC ALGAE

Introduction

During the period May to October, 1972, the benthic algal study of the Squamish Estuary was centered on the inter-tidal areas west of F.M.C. Chemicals (Squamish estuary). The Mamquam Channel was not intensively studied. With the exception of two sampling periods (November 20-22 and 27-30) relatively little information regarding benthic algal communities in the Mamquam Channel is available. The following general statements are based on previous information and trends observed in the most recent sample.

Present Knowledge

In mid-June, the algal flora consisted primarily of the following marine forms: Fucus sp., Navicula grevellei (filamentous diatom), Ulva sp., and Laminaria sp.

A systematic examination of algal distribution was not possible due to the large number of log booms covering the area. Visual estimates of relative abundance of algae suggested that with the exception of Fucus sp. in the high inter-tidal zone, growth of benthic algae was low compared to that found in the Squamish estuary. It is considered likely that this is due to serious light reduction resulting from log booms in the mid and lower inter-tidal areas of the channel.

Recent studies of the Mamquam and Squamish estuaries suggest the following:

a) The algal flora of the Mamquam Channel in the area designated for development is typically marine and shows a characteristic pattern of distribution.

i) low inter-tidal (2.0 m depth); Laminaria sp. (sparce).

ii) mid-intertidal (1.0 - 2.0 m depth); Laminaria sp. and sparce growth of Antithamnion sp., Ulva sp. and Enteromorpha sp.
iii) upper intertidal; Fucus sp. (heavy growths) and sparce growths of those present in the mid-intertidal.

b) Growths of Laminaria sp. in the low and mid-intertidal zones showed biomass values of 3.00 gC/m^2 to 8.00 gC/m^2, respectively. Gross primary production averaged 1.61 gC/m^2/day.

c) The most abundant algae in the Mamquam Channel is Fucus sp. This occurs either free living or attached to rocks and logs. Coverage area is approximately 2,100 m^2. Fucus biomass ranges from 30.0 to 480.0 gC/m^2.

d) Primary production of benthic algae in the Mamquam Channel varied from 1.70 gC/m^2/day at surface to 1.20 gC/m^2/day at depth of 2 m. These compare with primary production of benthic algae on the Squamish estuary which ranged from 0.100 gC/m^2/day to approximately 1.20 gC/m^2/day.

Summary

During the winter months the primary production and biomass of benthic algae (Fucus) on the Mamquam Channel may be higher than that on the Squamish estuary. Thus, the area may be of importance in contributing organic material to the outer estuary food web during the winter months.

PELAGIC PRIMARY PRODUCTION

Primary production values adjacent to the Mamquam Channel were extremely variable (0.016 to 1.686 gC/m^2/day). In order to satisfactorily document the potential of the area proposed for development, it would be necessary to follow pelagic primary and secondary production for a full year. It can be hypothesized from data on light penetration that there is more available light due to less flushing of surface waters in this region. Consequently a full annual cycle may show primary production to be relatively high in the Mamquam Channel.

BENTHIC INVERTEBRATES

Virtually all of the area of the proposed coal dock site (east side of the Mamquam Channel) can be considered intertidal habitat. However, at zero tide, 3 or 4 feet of water remains in the main body of the Channel; deeper water is found near the F.M.C. loading dock. The study area, therefore, consists of subtidal and intertidal habitat. The following is a description of the benthic invertebrates which have been found in the Mamquam Channel. Particular emphasis is placed on fauna which are potentially available (e.g. amphipods, mysids) as food for young salmon and herring.

Subtidal Habitats

The subtidal parts of the Mamquam Channel (near the F.M.C. wharf) were sampled using Van Veen and Ekman grabs. Sediments in this area are blackened, reduced and smell of sulfides. Much wood debris is found in the samples. The fauna consists of marine (as opposed to fresh water) organisms, and is dominated by polychaete worms and bivalve molluscs (small clams). Some amphipods (Anisogammarus pugettensis) were also found. This amphipod was an important part of the diet of young salmonids caught in the area during the past summer.

Commercial crabs (Cancer magister) are found near the Channel, and some may enter the deeper parts of the Channel. These crabs can feed on worms and other benthic animals.

Amphipods have been observed living in the algal community on older boomsticks. Observations have been made primarily on boomsticks in the upper Mamquam Channel, near the B.C. Railway bridge.

Intertidal Habitats

In June, a brief survey was made of the intertidal fauna on the seaward (southern) slope of the Mamquam estuary.

Amphipods (A. confervicolus) were found in low abundance in the lower tide zone.

Recently, removal of a portion of the log booms on the east side of the Mamquam Channel has permitted a more complete inspection of the site. Extremely low tides occurred on Nov. 20 and 21 when the surveys were carried out. The low tide occurred at night, which considerably restricted visual inspection.

Table 1 shows the results of sampling on a transect on the east side of the Mamquam Channel, across from the north end of the F.M.C. loading dock. The transect extended from near the low water mark to the high intertidal zone, below the B.C. Railway line. Sample locations were selected by elevation above sea level (asl.). Quadrats (.06m^2) were used to sample the exposed sediments.

Oligochaetes, polychaetes, and tube-dwelling amphipods (Corophium spinicorne) dominated the fauna in the lower tide zone. Wood debris (chips, bark, branches) was common, mixed with coarse sand and silt. At elevations of 2.4 to 3.0 m asl, amphipods (A. confervicolus) and isopods (Exosphaeroma oregonensis) were found in dense concentrations under Fucus (marine algae). A variety of marine fauna (primarily polychaete worms) were found in association with the amphipods and isopods (Table 1).

Juvenile mysids (Neomysis sp.) were very abundant in tide pools in the lower intertidal zone but were not sampled quantitatively. These organisms are common in the diet of herring.

A shoreline survey of the Fucus (intermediate tide zone) habitat was carried out November 28, 1972. Samples were obtained using .06m^2 quadrat obtained every 30m. The survey was hampered by log booms, but it was possible to sample 580m of shoreline. It was impractical to measure the sinuosities of the shoreline, so measurements were made along the B.C. Railway tracks, above the habitat of interest. The survey started at a

Table 1. Number per m^2 of organisms obtained in an intertidal transect on the Mamquam delta, Nov. 22, 1972, 0005 to 0040 hrs. Explanation of terminology: Amphipods: Anisogammarus confervicolus, Corophium spinicorne, Anisogammarus sp: Isopod: Exosphaeroma oregonensis; Decapod: Crago sp.; Poluchaeta sedentaria: Spionidae; Dipteran insects: Chironomidae, Dolichopodidae; Mollusca: Macoma nasuta.

Height (a.s.l. in metres)	.09	1.37	2.13	2.74
Sediment type	Coarse sand	Coarse sand	Sand wood debris	Silt
Fauna				
A. confervicolus	-	-	112	336
Anisogammarus sp.	-	-	-	-
C. spinicorne	32	16	64	1520
Cumacea	-	-	16	-
Harpacticoid copepoda	-	-	16	-
Crago sp.	-	-	16	-
E. oregonensis	16	-	176	96
Oligochaeta	48	16	1344	480
Spionidae	16	-	-	32
Polychaeta (errant)	16	-	-	-
Nemertea	-	-	-	-
Chironomidae	-	-	-	32
Dolichopodidae	-	-	32	16
M. nasuta	16	-	32	32

Table 1. (continued) Number of organisms per m^2 in intertidal transect, Mamquam Delta.

Height (a.s.l., in metres)	2.89	3.04	3.04	3.20
Sediment Type	Silt, Wood, Debris	Fucus, Wood, Silt	Silt	Fucus, Silt
Fauna				
A. confervicolus	128	80	-	10496
Anisogammarus	-	-	-	272
C. spinicorne	5440	7408	2448	192
Cumacea	-	-	-	-
Harpacticoid copepoda	-	-	-	-
Crago sp.	16	-	-	-
E. oregonensis	96	16	-	3552
Oligochaeta	16	128	64	80
Spionidae	2000	3568	368	224
Polychaeta (errant)	240	304	64	16
Nemertea	16	-	-	-
Chironomidae	-	-	16	-
Dolichopodidae	-	64	16	-
M. nasuta	-	32	16	-

point approximately 260m south of the seaward edge of the proposed coal dock (near a signal, No. 37, on the rail line) and proceeded north.

Table 2 shows the results of the survey. It was not possible, because of time limitations, to account for all fauna in the sample, so the table only lists the biomass of A. confervicolus, the amphipod which was an important item in the diet of juvenile salmon in the Squamish estuary. It was observed, however, that the associated fauna were primarily marine organisms (e.g. polychaeta worms). The biomass of A. confervicolus under the Fucus was 2197.39 mg dry wt./100m.

The amphipod - Fucus habitat was observed to stop near the southern end of the old Stawamus river dock. The shoreline was qualitatively surveyed north of this point, and a few patches of sedge was the only vegetation observed, logs and bark were widespread.

THE FISHERY RESOURCE

The Squamish River system supports significant stocks of Pacific salmon and steelhead trout. For the period 1962-71, annual average escapements of Chinook, Coho, Pink and Chum salmon were 17,300, 19,200, 89,000 and 50,600, respectively. In addition, the Stawamus River which flows into the east side of the Mamquam channel supports small runs of Coho, Chum and Steelhead. Assuming catch-to-escapement ratios established in major west coast fisheries, the average annual wholesale value of pink and chum salmon is $3,200,000. Stocks of Chinook and Coho are subjected to commercial and sport fisheries in tidal waters and are caught by sport fishermen during upstream migration to the spawning grounds. The estimated average annual wholesale value of the commercial catch of Chinook and Coho is $1,287,000. The value of the salmon sport fish catch in tidal waters is calculated to be $2,325,000 annually. The steelhead

Table 2. Biomass of A. confervicolus (Amphipoda) in shoreline survey of the Mamquam delta.

Delta Sector: Mamquam Blind Channel (east shoreline)

Direction of Survey: North to South

Date: November 28, 1972

Time: 0400 to 0515

Distance from Start (m)	Wet Weight ($mg./.06m^2$)	Dry Weight ($mg./.06m^2$)
0	4075.2	855.79
30	3495.0	733.95
60	6256.5	1313.87
90	1501.8*	315.38
120	2070.3	434.76
150	2023.0	424.83
180	647.2	135.91
210	5625.0	1181.25
240	2158.7	453.33
270	2277.6	478.30
300	2047.3	429.93
330	sample not analyzed	sample not analyzed
360	1881.4	395.09
390	3525.4	740.33
410	2641.8	554.78
440	7217.6	1515.70
470	2204.3	462.90
500	1639.0	344.19
530	1031.7	216.66

* sieved incorrectly, value low.

sport fishery, in terms of fishing intensity and catch, ranks high in the province. The uniqueness of these recreational opportunities and their associated "preservation value" will increase in real value over time, relative to the developmental alternative proposed for the Squamish estuary.

Until recent years herring spawned on the eel grass and other rooted aquatic plants commonly found in the vicinity of the Mamquam Channel. The average annual magnitude of these stocks, based on spawn deposition during the 1960-70 period, was 387 tons, with a peak of 2,331 tons in 1962. Although significant numbers of juvenile herring have been observed periodically and recent sampling investigations have shown high concentrations of various age groups, no herring spawn has been observed in the area since 1969. The apparent extinction of this spawning stock may be largely attributable to the loss or degradation of spawning habitat occasioned by land fill and log storage in the areas originally used for egg deposition. It should be emphasized that herring spawning in the Mamquam Channel is considered to be potentially restorable.

Over a score of non-commercial fish species also utilize the marine and/or brackish waters of upper Howe Sound. These include stickleback, smelt, sand lance, sculpin, prickleback and poacher. Molluscan shellfish production is relatively insignificant. However, crabs and shrimp are present; the latter provided a commercial fishery prior to April, 1970, when a ban was imposed on shellfish and groundfish due to mercury contamination.

Studies of the distribution and relative abundance of juvenile fishes in the Squamish estuary and Mamquam Channel during the spring and summer indicated that the Mamquam Channel provided a less favourable habitat for juvenile salmon than the central portion of the Squamish estuary. These studies also showed that during the spring and summer juvenile salmon and

herring feed heavily on amphipods, mysids and other invertebrates associated with the intertidal and shallow sub-tidal portions of the estuary. The tidal flats in the area of the proposed port facility support a high standing crop of benthic algae upon which these organisms depend.

Beach seining during the early winter in the Mamquam Channel produced herring, perch, starry flounder, sculpins, whiting, stickleback and chinook salmon. Analysis of the diet of these fish revealed that benthic invertebrates (amphipods and mysids) are utilized as a food source by juvenile smelt, whiting and chinook salmon. Fish constituted a higher proportion of the chinook salmon diet in November than during the spring and summer months. This change in diet is considered a reflection of size-oriented ability and metabolic requirement to capture larger prey.

These data indicate that the area proposed for development provides a suitable habitat for juvenile salmon, herring and other fishes as well as the organisms utilized as food sources.

WILDLIFE

The Squamish Estuary, including the Mamquam Channel, is not a production area for waterfowl due to unfavourable spring breeding conditions occassioned by the advent of high water during the critical nesting period. The area is noteworthy, however, as a staging area for spring and fall migrants in their passage to and from the Pemberton Valley and interior of the province. Some of the migrants remain to overwinter in the estuary and these include a few geese, dabbling ducks, such as mallard, pintail and green-winged teal, as well as divers such as common golden-eye, bufflehead and mergansers. Trumpeter swans not uncommonly winter in the estuary, and numerous gulls

and scattered cormorants, grebes and herons make up the remaining aquatic bird life.

While man and wild birds are often able to co-exist harmoniouly, the major criteria necessary is suitable, undisturbed habitat. Man's activities in the delta in recent years has undoubtedly reduced bird numbers. This is believed to be true particularly in the Mamquam Channel where logging activities have usurped fairly extensive mud flats - feeding areas for dabbling ducks and shorebirds.

In representative December inventories of the Mamquam Channel (December 12, 13), it was noted that the ubiquitous gull was undeterred by man's activities and numbered up to 250 birds - most of which were glaucous-winged gulls and some mew gulls. It was also noted that the Stawamus River estuary, while very small, attracted up to 225 common mergansers and two trumpeter swans. It seems likely that the trumpeters would be feeding on aquatic seeds and vegetation but the mergansers were probably attracted by the salmon spawning and were feeding on drifting eggs. About 20 gold-eye and ten bufflehead ducks were counted as were five cormorants, four horned grebes and one great blue heron. Shorebirds were not in evidence perhaps because the high tides covered the feeding areas or more likely such species have by now moved out of the area in southward migration.

Wildlife observations in the Mamquam Channel also included three seals near the channel outlet and two river otters which are not uncommon, but rarely seen, in coastal river estuaries.

In summary, the actual site location of the proposed port facility probably supports relatively small permanent or transient wildlife populations. Log booming and other activities in the Channel have likely discouraged some wildlife usage of the area.

IMPACTS OF PROPOSED DEVELOPMENT

AIR POLLUTION

Initially the proposed terminal will handle two million tons of coal per year increasing to ten million tons at ultimate development. Delivery is by covered coal car and storage is in silos, excepting one pile initially increasing to four open piles containing a total of 400,000 tons. These piles are for emergency use only and will be compacted and crusted for dust abatement.

Details of the dumping, loading and conveying systems are not available. It is understood that every precaution will be taken to avoid exposure and resultant dispersion of coal dust.

At Squamish, northerly outflow, southerly inflow and sea breezes account for the bulk of the wind. Winds exceeding 20 m.p.h. are extremely common. The northerly outflow (Squamish winds) have great force and consist of cold, dry air. Once initiated these winds often persist for 3 to 5 days. Wind velocities commonly reach 35 to 40 miles per hour with gusts ranging from 50 - 70 m.p.h. Several years of record show that "Squamish" winds have occurred an average of 5 to 6 days in both December and January.

Southerly wind surges, while not as persistent as "Squamish" winds tend to occur more frequently. Inflow winds in excess of 20 m.p.h. are recorded on ten days each month during the winter. Wind speeds commonly reach 30 m.p.h. with gusts to 50 m.p.h. One recorded episode (Feb. 1972) registered gusts to 94 m.p.h.

During the summer period (May to August) thermal heating is strong thereby giving rise to land breeze - sea

breeze circulations along coastlines. Records indicate that the terrain in Howe Sound significantly increases the strength of winds normally associated with the sea breeze. A diurnal pattern is common. Typically, southwest winds commonly reach velocities of 25 m.p.h. with gusts to 35 m.p.h. during the afternoon and early evening.

Conditions promoting loss of water are known to be critical at most coal piles protected by water sprays containing crusting agents. Cold dry air will accentuate the dusting potential and can impose freezing problems in sprinkler systems. Local observations have shown that fugitive dust can occur at a wind speed of 22 m.p.h. when the spray system was inactivated by freezing. It is extremely difficult to estimate the potential loss of coal dust at the proposed site. The Roberts Bank terminal reports losses of "just about zero" when using a water spray and crusting agent. The quality of the coal in the terms of particle size representation is an important factor. Studies have shown that coal passing a 35 mesh screen is potentially fugitive. Unquestionably the effectiveness of crusting agents, the quality of coal and the frequency of emergency loading will largely influence the loss factor at Squamish. Since the wind direction at Squamish is dominantly North-South, following Howe Sound and the Squamish River and Valley, the bulk of the fugitive dust will deposit in these two aquatic environments. At Hamilton coal dust has been found up to 3/4 miles from the source. A more detailed estimate of the possible distribution and intensity of deposition in the Squamish area is not possible without additional information.

WATER POLLUTION

Effluent Sources

In addition to wind borne contamination, rainfall and dust reducing water sprays will result in coal-dust laden wastewater with high suspended solid levels and turbidity. A settling

pond is proposed. However, other coal transport operators have found it necessary to use clarifiers to satisfactorily control wastewater quality. A pH problem analogous to acid mine drainage is not anticipated since it does not occur at other B.C. coal operations. Confirmatory tests should however be made. The chemical characteristics of the crusting agent proposed are not known at this time. Some quantity of this agent will probably enter the waste stream and may require removal.

Physical Disturbance

The land fill associated with terminal construction on the eastern shore of the Mamquam Channel would markedly diminish the channel width. This should restrict the flushing of the channel with the attendant undesirable consequences.

The area to be dredged consists mainly of silt and sands. Dredging operations involving some two million cubic yards of this material will result in temporary high suspended solid (turbidity) levels in the broad general area and impose bottom siltation in adjacent areas. Dredging will also result in the release of toxic hydrogen sulphide gas present in organically contaminated sediments. Mercury has been established as a pollutant in the nearby foreshore area adjacent to the F.M.C. Chemicals plant. In the process of dredging there is a possibility that mercury held in the sediments may be released to be redistributed by both physical and chemical agents and thus available to aquatic organisms. It is also considered possible that the wash from large ship propellors might disturb the bottom and release mercury bearing sediments which might otherwise become buried by natural sedimentation.

FISHERIES RESOURCE

Land fill and construction of the coal loading facility would involve destruction of over 60% of the amphipod - Fucus

habitat (intermediate tide zone) surveyed in the present study. The importance of the amphipod biomass in the Mamquam Channel as an energy source for young salmon reared in the Squamish estuary has not been measured. However, it represents a considerable food source available to the salmonids. Considerable habitat for mysids would also be permanently eliminated, with the result that this food source would no longer be available for herring.

Dredging operations required to construct and maintain the ship berth have a number of potentially deleterious effects. Juvenile fishes can be directly affected by dredging. High suspended sediment levels would reduce primary productivity during the critical early spring and summer periods thus reducing the carrying capacity of the estuary for salmon, herring, crabs and other fishes. In addition, the subtidal fauna would be totally removed and intertidal amphipod habitats adjacent to the dredged areas could be smothered by the spillage and deposition of silt. Dredging activities will also release hydrogen sulphide present in the sediments. Hydrogen sulphide in concentration as low as 0.5 - 1.0 mg/l can be toxic to fish.

Wind-and-water-borne coal dust can adversely affect benthic invertebrates. Dust particles could smother Fucus plants, which provide habitat for the intertidal amphipods.

Coal dust in water may "sink out" in areas of slow current action, where it may smother subtidal benthic organisms. Observations have indicated that coal dust from the Roberts Bank coal operations is settling out in an area characterized by low current velocity.

Mercury is known to accumulate in aquatic animals which, when eaten in sufficient quantities by humans, results in severe neurological disorders. Crabs in the upper Howe Sound

area presently contain unacceptably high concentrations of mercury. Recent investigations have shown that sediments in the site proposed for development contain low levels of mercury. It is therefore anticipated that the amount of mercury made available to the food web by dredging would be minimal and of short duration.

In summary, the proposed port development in the Mamquam Channel will impose the following major impacts on the fishery resources of the Squamish system and upper Howe Sound.

1) Irreversable loss of about 70 (surface) acres of intertidal habitat.
2) Irreversable loss of fish food production in the area occupied by land fill and ship berth.
3) Loss of potentially restorable herring spawning area.

In addition, water-borne coal dust and increased water turbidity due to dredging can be expected to lower primary production. Spillage of silt from dredging operations and deposition of coal dust could have detrimental effects on benthic fish food sources. The release of H_2S and mercury during dredging operations is dependent on the concentrations of these materials in the sediment.

It is important to note that existing information does not permit quantifying those impacts in terms of their effect upon the total estuarine ecosystem or the stocks of commercially and recreationally valuable fishes.

Extension of the railway classification yard in the central delta will result in the permanent loss of some 55 acres of productive intertidal salt-marsh and flood channel habitat. The impact of this incremental loss of estuarine production on

the juvenile salmon which frequent the inner estuary is unquantifiable at this time.

WILDLIFE

The proposed port facility would have only minimal impact since the actual site location supports little wildlife.

LAND USE

Introduction

The development of methodology for conducting environmental impact assessments on major construction projects is still in its infancy. However, certain information requirements for this type of analysis have been identified. Descriptive information on the ecosystems that may be affected by a development project is essential. Also required is detailed information on the specific construction activities associated with the project and their magnitude. With this information it is possible to identify potential interactions between individual environmental components and specific construction activities. These interactions can then be assessed in terms of on-site or local "during construction" impacts (temporary), and "post construction" (permanent) impacts, at the local and regional scale.

Land Environment

From a preliminary review of available reports it appears that none have included detailed information on the impact or the implications for future development of the proposed terminal and ancillary activities on the Squamish River floodplain and its uses, or on human environmental

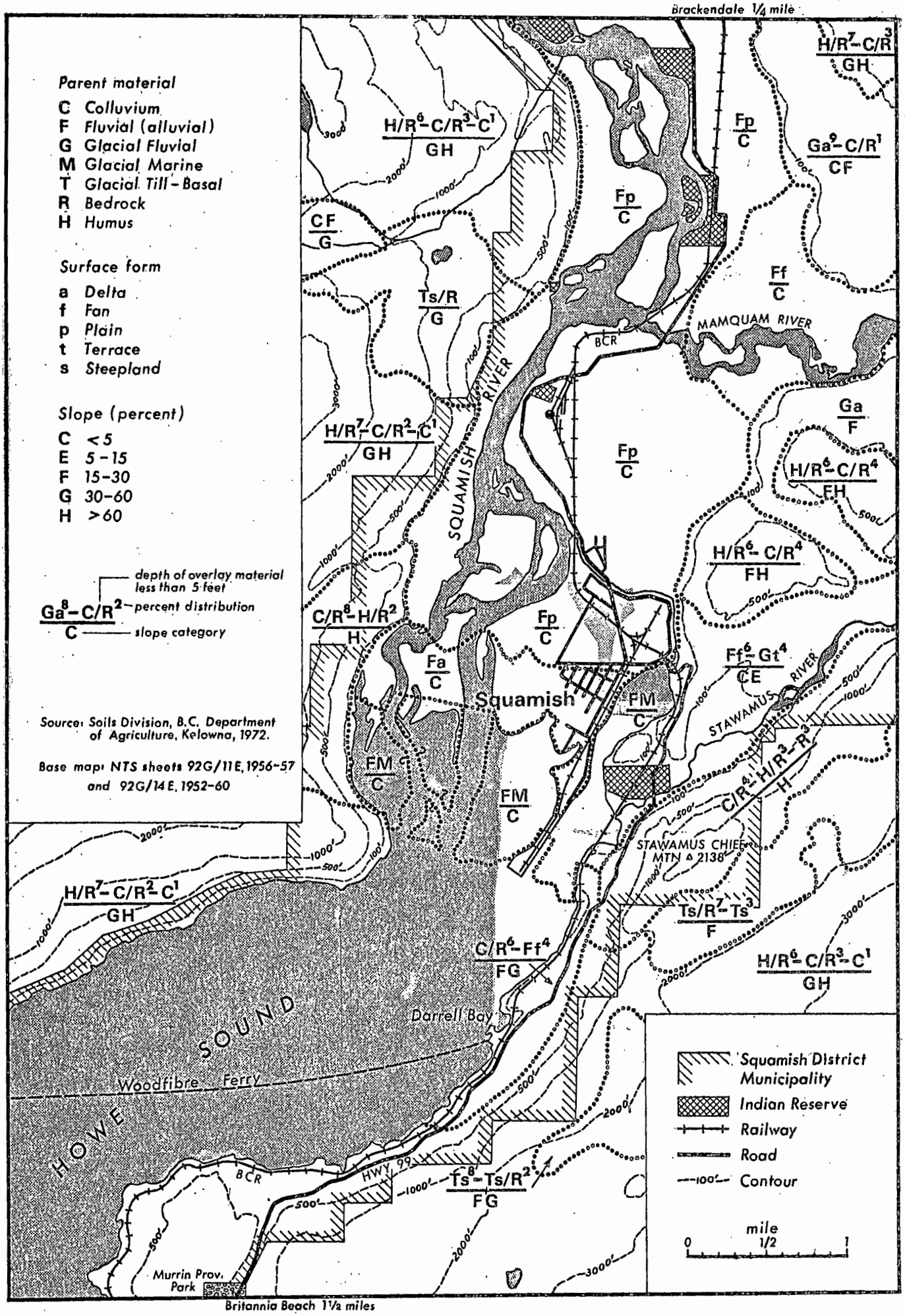
conditions in the town of Squamish. Moreover, it appears that very little of the necessary descriptive information on land characteristics and the construction activities associated with the project has been compiled in a form suitable for identifying the potential impact of the project on the area's land resources.

Studies have been completed recently by Environment Canada on the effects of existing and proposed development on the aquatic ecosystem of the Squamish Estuary. Other reports prepared to date on this project have paid little attention to the surrounding land resources, or the physical limitations on development schemes that may be imposed by the kinds of terrain present and their distribution.

It appears that the proposed facility is but a part of a broader long-term scheme of major industrial development, and that the completion of such a project will encourage residential, commercial and industrial growth in the area. The present population of Squamish is estimated to be approximately 1600. Recent estimates assume that the Squamish District population will grow to approximately 30,000. A major issue, therefore, is: Can this assumed growth be accomodated on the adjacent lands?

Recent airphoto interpretation studies combined with a review of available Canada Land Inventory and Soil Survey information (compiled as a base for recent impact studies) indicate the following:

a) In terms of physical characteristics much of the lowland terrain at the southern end of the Squamish Valley is either floodplain or part of an extensive alluvial fan (Figure 2) and the behaviour of the watercourses associated with these landforms (Squamish River and the Mamquam River) is unpredictable. A good portion of the land (notably in the areas designated for



SQUAMISH LANDFORMS: Surface Forms and Materials FIGURE 2

railway yards and future development) is on an active floodplain. An equally hazardous area is the alluvial fan associated with the Mamquam River which, for example, changed its channels dramatically following the 1921 flood. All of this terrain on the alluvial fan is subject to unpredictable hazards due to channel shifting.

b) Interpretations developed from the basic soil and landform surveys indicate the Squamish River floodplain to be of poor suitability for urban development. In this category the soil properties are so unfavourable as to require major reclamation or special protective designs. Overcoming these constraints is costly and may not be practical. For example, limitations for septic tank absorption fields, sewage lagoons, dwellings and other structures are often severe to moderate due to fluctuating water tables, high permeability and danger of flooding. Records reveal that the village of Squamish has been inundated to a depth of about 5 feet once every 16 years and has suffered flooding to some degree at least every 7 years. The Provincial Government and the Municipality have undertaken a program of constructing river control dykes and other structures, designed for 50-year flood protection. If much of the physical development associated with the assumed population base of 30,000 occurs on the floodplain, then the need for major additional protection- say for 100-year or 200-year floods - would be essential. However, in view of recent problems with developments on floodplains (e.g. Kamloops area), it would seem advisable to re-evaluate the entire future industrial development proposals for the Squamish area.

The land areas and slopes immediately east of the Squamish lowlands are rated as good to fair suitability for urban development and might be able to accommodate some residential developments.

c) The recent Canada Land Inventory survey of Land Capability for Recreation indicates that much of the area from

Darrell Bay northeastward along the shore to the proposed bulk terminal site is a shoreland area ideally suited to intensive recreation use and development (such as camping and cottaging).

The terrain is relatively level to gently sloping and well drained with minimal sensitivity to intensive human use. This site, which is close to recreational water, could also provide a base for popular forms of recreational activites such as fishing, boating, and viewing. This site is one of two sites on the east shore of Howe Sound between West Vancouver and Squamish designated as having this high capability rating for recreational use.

A major part of the Squamish area is also rated as being ideally suited to these intensive recreation uses. Because it is situated between the water-based recreation activities in Howe Sound and the upland activities associated with Garibaldi Park to the north and east, the Squamish area could be a major focal point of this recreation corridor complex.

- Human Environment

A preliminary review of background material available indicates that impacts of the project related to the human environment have not been examined in any depth. Some of the issues that require further consideration are:

a) Noise. i) Impact during construction. Because there is little information available on construction procedures and duration of activities for the bulk loading site, it is difficult to prepare an impact matrix that would clearly identify the actions and their potential impact on the environment. Relative to major projects such as the construction of the Third Crossing of Burrard Inlet, however, it would appear that impact in terms of construction noise would not be severe.

ii) Impact post-construction. Again, information on the continuing impact related to operation of the facility is not available. Actions and impacts that need identification are:

- The number of shifts that will be operating during loading (will there be a noise problem for 8, 16 or 24 hours a day?)
- Will shunting of rail cars be a major activity and at what times during the day?
- How often and at what times will bulldozers be used on open stockpiles of coal?
- How much noise will be generated by activities associated with rail yard back-up facilities and train traffic through Squamish?
- Will the barge slip next to the coal dock and activities associated with this facility lead to additional shunting of rail cars?

b) Indian Lands. The impact of the project and future back-up facility development on Indian rights and values and Indian reserves has not been identified nor considered in any of the regional study reports examined.

c) Air Pollution. The frequency of high winds suggests that the blowing of coal dust into the village or southward into the waters of Howe Sound could have adverse effects. The magnitude of this problem cannot be evaluated at this time.

ALTERNATE SITE CONSIDERATIONS

A deep-sea bulk loading facility has been proposed for the Prince Rupert area to facilitate shipment of potential cargoes of coal, potash, ore concentrates and grain. The site chosen includes the tidal flats between Ridley and Kaien Islands. It is generally protected from extreme wave action by the islands and rocky banks to the west. Previous reports provide details on site conditions which indicate that the site is suitable for a bulk terminal.

Access can be obtained by a branch from the existing road to Watson Island and rail access can be provided from the CNR Line which passes the northern end of the site. Electric power is available from the existing B.C. Hydro facilities in the Port Edward area. Three bulk terminal developmental stages have been identified. The projected 1972 costs are:

Phase 1 -	28 acres	$19,110,000
Phase 2 -	28 acres	8,800,000
Phase 3 -	50 acres	16,700,000
Ultimate development-	106 acres	$44,610,000

In 1971 and 1972, biological investigations were conducted in the Skeena River Estuary to document the importance of the estuary to its fisheries resources. The results of this investigation indicate that Flora Bank and many other shallow estuarine areas are critically important rearing areas for salmon juveniles and herring. Physical alteration or elimination of these areas could have deleterious effects on the associated fisheries resources. Surveys of the Ridley Island site revealed that it was not significantly utilized by fishes of any species. In addition the site offers the advantage that facilities could be greatly expanded without resorting to other locations where fisheries values are of much greater importance.

SUMMARY

In November 1972, the British Columbia Railway submitted a proposal for the construction of a bulk coal terminal on the south-easterly portion of the Mamquam Channel at Squamish. This report presents a preliminary assessment of biological and other implications imposed by this proposal and the co-incident expansion of rail yards in the central Squamish delta.

The proposed bulk terminal will occupy approximately 70 acres of intertidal land adjacent to a 30 acre deep-sea berth. At ultimate development it will have an annual capacity for 10 million tons of coal. Expansion of the railway marshalling yard will occupy approximately 55 acres of intertidal and flood channel area.

The Mamquam Channel appears to be well flushed and maintains acceptable dissolved oxygen levels. Circulation of surface water off the mouth of the Channel is predominately counterclockwise.

The aquatic environment of the Mamquam Channel contributes significantly to the total ecosystem of the Squamish estuary. Primary production and biomass of benthic algae at the proposed port site is high. Algae provides suitable habitat for amphipods, mysids, and other fish food resources. The abundance of amphipods was low in June, but dense concentrations were found in November.

The Squamish system supports an average annual escapement of 176,000 salmon. Juvenile chinook, coho, and chum salmon utilize the Mamquam Channel during their early sea life. The channel is also extensively used by herring, smelt, perch, flounder, whiting and needlefish.

The Mamquam Channel supports small permanent or transient wildlife populations.

Construction and maintenance dredging in the area of proposed development would result in a minimal short-term release of sediment-bound mercurials, and toxic hydrogen sulphide gas. Dredging also increases turbidity which reduces primary production.

High intensity of winds are likely to result in losses of coal dust from uncovered emergency storage piles. This could result in a reduction of primary productivity and a smothering of benthic invertebrates.

Coal-dust laden waste-water may necessitate the use of clarifiers in association with settling ponds.

The port would result in the irreversible loss of approximately 70 (surface) acres of intertidal habitat and associated fish food production. The option to restore herring spawning area will also be lost. Expansion of the railway classification yard in the Squamish estuary would result in permanent loss of some 55 acres of productive intertidal salt-marsh and flood channel habitat.

The Squamish-Mamquam delta is an active floodplain and is rated to be of poor suitability for urban development. Overcoming constraints associated with development on these lands is costly and may not be practical.

A deep-sea bulk loading facility has been proposed for the Prince Rupert area as a viable economic and operational alternate to the Mamquam Channel development. Ecologically detrimental effects associated with development of a site at Ridley Island are considered minimal.

RECOMMENDATION

Development of a port facility in the Mamquam Channel and expansion of rail yards in the central Squamish delta should be preceded by a comprehensive study of the broad natural resource, social, environmental and economic impacts.