A GEOGRAPHICAL INVESTIGATION OF DEVELOPMENT POTENTIAL IN THE SQUAMISH VALLEY REGION, BRITISH COLUMBIA

by

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ABSTRACT

During the past five years the Squamish valley has been the center of attention of a large amount of public interest. The extension of the Pacific Great Eastern Railway from the village of Squamish to Vancouver has been the cause of much of this public interest. The tremendous recreational potential of the beautifully scenic alpine country north of Squamish in Garibaldi Park has been brought most vividly to the fore. Partly as a result of this the provincial government began construction of a modern highway to the Squamish area, which in spite of much political debate, had hitherto been completely without a road connection of any kind.

Principally because of road and rail being extended to Squamish, politicians, financiers and industrialists have expressed the opinion that the vast expanse of vacant land of the Squamish river delta could be developed for industrial purposes. Some people have even suggested that a great sea port could be developed with the rugged and scenic valley providing the land for associated community areas.

This thesis is a study of the Squamish valley with respect to the probability of this development occurring.

Insofar as industrial development as a sea port is concerned the extent to which the area can develop seems to depend largely on a matter of timing. Not by coincidence but because the port facilities of metropolitan Vancouver are rapidly becoming overtaxed, several proposals are being aired

each of which seeks to develop further port facilities and land adjacent to Vancouver. Such land at Squamish would be competitive with that in these other proposed areas, but since Squamish is geographically separated from Vancouver it has some basic disadvantages. Conversely, however, due to the fact that the provincial government controls vast tracts of land at Squamish, port development on these lands may be fairly readily accomplished.

Squamish seems destined to expand fairly rapidly regardless of its industrial future. Its rate and ultimate pattern of development, however, will largely be determined by the extent of industrialization.

Since some form of growth is immediately eminent and particularly since the valley must be protected from flood-waters, regional development planning is direly needed. Because the prospects for industrial development are somewhat dependent on the nature of other local growth a regional plan is proposed which will ensure adequate industrial land at the waterfront.

EXAMINERS

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representative. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

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Date _____

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CHAPTER I

THE PROBLEM AND A DISCUSSION OF THE STUDY

I. THE PROBLEM

The research problem is one of gathering information of a geographical nature, analyzing it, and formulating conclusions with respect to the nature and possibility of further economic development of the Squamish region.

II. REASONS FOR SELECTION OF THE STUDY AREA

The reasons for selection of the study area are two-fold. First, residence in the Squamish valley over a continuous period of eighteen years and repeated visits to the area since that time have enabled the writer to base his research on a maximum of field experience.

The second and more important reason for selection of the area for study results from the fact that Squamish is of current general interest as a locality with a high potentiality for overall development. When research on the topic was started in September, 1956, Squamish seemed to have a promising although uncertain future. Attention had been directed to it by newspaper reports dealing with the current construction of the Squamish-Vancouver highway, the completion of the Pacific Great Eastern Railway[1] extension to Vancouver in

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[1] hereafter referred to as the P.G.E.

Photograph No. 1. The Squamish Valley, looking north (Photo courtesy of W. Dennett - The Vancouver Sun).

1956, and the possibility of the development of Garibaldi Park. There had been no definite move towards the directed development of the area. Speculation on its future, however, was mounting. On March 30, 1957, the provincial government made a public announcement that the P.G.E. was to be responsible for a vast development program for Squamish in which an approximate sum of $30,000,000 was to be spent over a period of twenty-five years.[1] Previous to this announcement there was a definite need for geographical study of the area. The announced intention of the government's concrete interest in Squamish further increased the need for research of the type presented in this thesis.

III. THE SCOPE OF THE RESEARCH

Since the purpose of the thesis is to evaluate the nature and extent of future economic development of the Squamish region from a geographic point of view only subjects of a geographic nature are pursued. This, of course, is the basic limitation of the thesis since the topic is sufficiently broad to warrent the skills of the planner, the engineer, and the economist as well as those of the geographer. Although the thesis does touch on matters commonly within the field of these first three professions, no attempt is made to produce authoratative statements. A sincere attempt has been made to exclude all material even within the field of geographic study that does not pertain specifically to the central theme of the research.

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1 News item in the Vancouver Sun, March 30, 1957.

IV. METHOD USED

Normally regional studies within the sphere of geography require many days of concentrated study of the problem area in the field. Since the writer had an intimate knowledge of the Squamish region at the outset of the research, a minimum amount of field study was required. Three field trips were made, however, primarily for the purpose of taking a critical look at the valley to dispel any undue sentimentality. As a result of these trips a new concept of the region evolved and subsequent study was placed on a more realistic foundation.

Very little has ever been written of the Squamish area and as a result of this little time was required to review existing literature. In place of this, trips were made to government offices in New Westminster and Victoria and interviews conducted to become familiar with all possible sources of information. In addition to these interviews, many more were conducted with all persons thought to have a prior interest in the valley. These interviews are listed in Appendix A.

The remainder of the time spent in research consisted of detailed map study in order to provide a knowledge of the regional geomorphology and associated problems. Throughout the entire research much original thought and study was required.

V. THE CONTRIBUTION OF THE STUDY

The fundamental contribution of the study is that of providing a geographical analysis and description of the Squamish region. This in itself is a worthwhile pursuit because there is a surprising lack of written material on the Squamish area. Publications such as the Transactions of the British Columbia Natural Resources Conference, the Regional and Industrial Index of British Columbia, the Annual Reports of the Forest Service, the Land Service Bulletin (The Lower Coast Bulletin Area Number 3), and texts on the geography of Canada and British Columbia provide general information on the region. A land-use study of the area (Squamish Area Survey-Draft 1949), other unpublished, and some confidential literature was consulted. An examination of the British Columbia Land Service file on Squamish provided further information applicable to detailed study. However, all this information is unrelated, and much of it incomplete. Consequently, it was not too valuable in the preparation of this thesis.

Another important contribution is that the information gathered can be applied to specific problems. The thesis provides a valid basis for planning the organized development of the region. It might also afford a sound basis for the study of investment feasibility.

A further contribution is that it provides an example of the way in which geography can be applied to a specific problem. It is a case study in area development analysis and

associated regional planning, a field of research still on the fringe of geography, and yet to be considered as a primary field of endeavor for the geographer.

CHAPTER II

THE REGION: LOCATION AND GENERAL SITUATIONAL FACTORS

I. THE GENERAL CHARACTER OF THE SQUAMISH REGION

In areas where geographic regions are sometimes difficult to define, for example, in portions of the Great Plains of North America, it is desirable and in fact at times necessary to resort to quantitative studies in order to arrive at a valid and meaningful definition of a region. Where settlement is sparse and the topography rugged there is less need of complex measures of the regional character of areas. This holds true particularly well in the case of the coastal region of British Columbia, for there, with mountainous terrain, settled areas are found in isolated valleys or pockets in the mountain system. The size and shape of geographic regions, the nuclei of which are such settlements, is dominantly controlled by the surrounding topography. Such is the case of the Squamish valley region. (see Figure 1).

The nature and extent of a geographic region is often best appreciated through an examination on the ground. At Squamish the mountains rise abruptly from the valley floor and the area which seems to belong to Squamish appears to be limited to that which can be seen from the valley bottom.

The location of Squamish, latitude 49° 45' North, longitude 123° 10' West, is shown in Maps 1 and 2. Since the

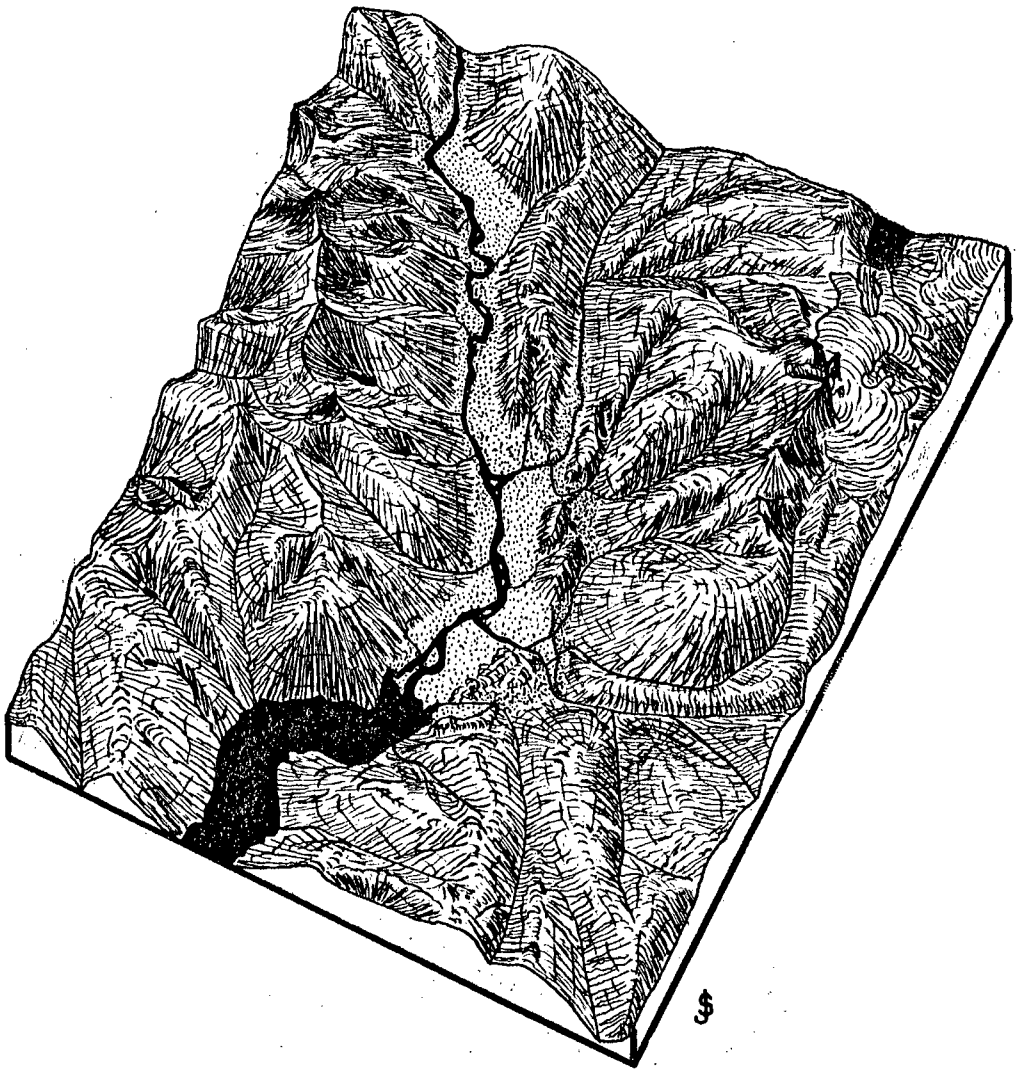


FIGURE I THE SETTING OF SQUAMISH

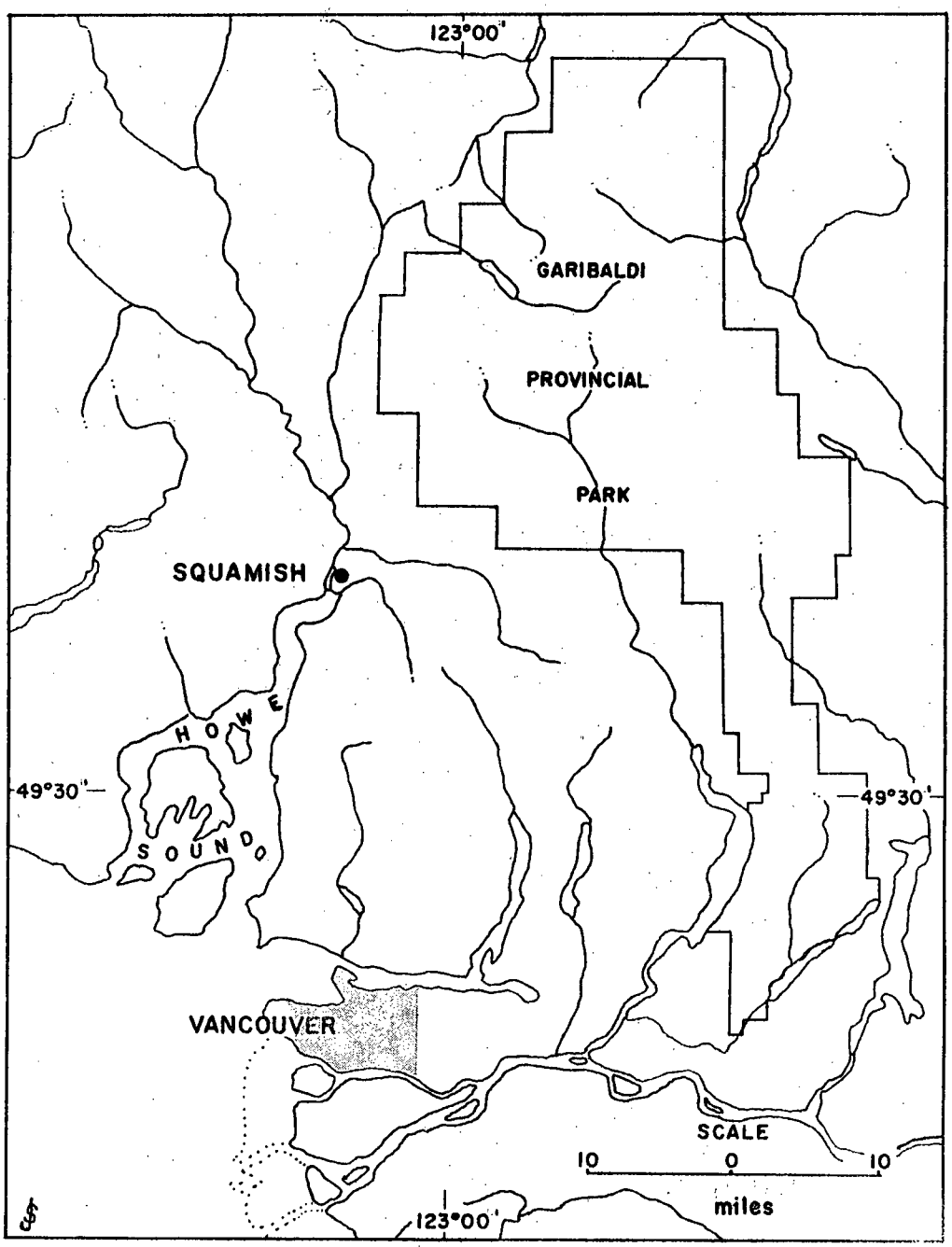
Photograph No. 2 View of the Squamish Valley from Watts Point

Photograph No. 3 Panorama View of the Squamish (left) and Stawamus (right) River Valleys, Showing a Portion of Squamish Village on the extreme left

region lies at the head of Howe Sound, it is a small portion of the larger coastal region of the province, which is characterized by a series of fiords separated by high and steep-sided mountain ranges. The Squamish region is one of many small, and to some extent, similar regions which could be recognized along the coastal mainland strip. It can be noted, however, that Howe Sound, the first inlet north of Vancouver, has the distinction of being rather dependent economically on the large and heavily populated lower mainland region. The village of Squamish is only thirty miles distant from Vancouver city centre. Although Squamish is close to Vancouver in miles it has a strikingly different character, which to a large degree is due to the influence of topography.

II. THE CORE AREA

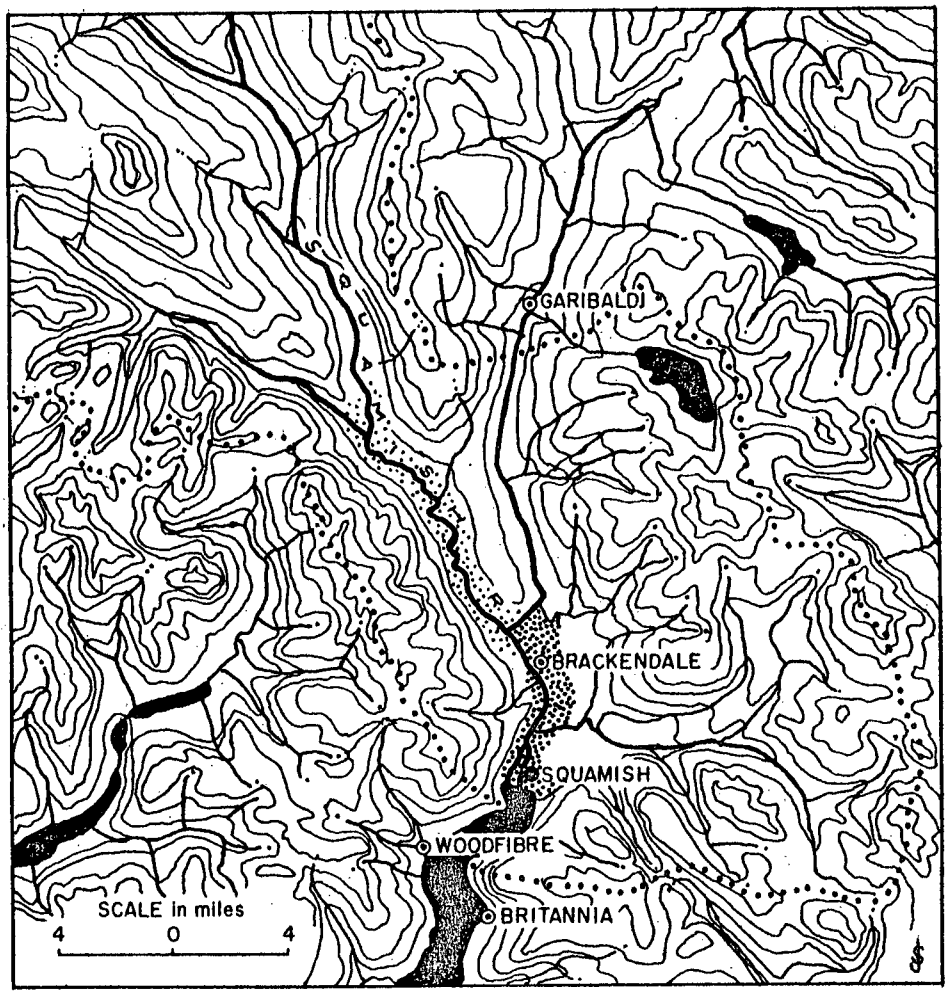
A geographic region is commonly defined with reference to its nucleus or core area. It is usually the core area that is the most significant part of the region. The maximum extent of the larger surrounding region is consequently determined by the sphere of influence of or similarity to the core area. The Squamish region has a distinct nucleus consisting of the flat land in the lower section of the Squamish river valley which is presently settled and has the greatest potentiality for future use (see Map 3). This nucleus or core area is bounded on the south by the head of Howe Sound, on the west by the base of the mountain slope, on the north by the Cheakamus and Cheekye



THE GEOGRAPHIC LOCATION OF THE

SQUAMISH REGION

MAP 1



LEGEND

THE CORE AREA – Lower Squamish Valley

THE UPPER SQUAMISH VALLEY

BOUNDARY of the Squamish Valley Region – the boundary is so placed as to include most of the watershed and forest land tributary to the core area – extends NW of the map area

THE SETTING AND CHARACTER OF THE SQUAMISH REGION

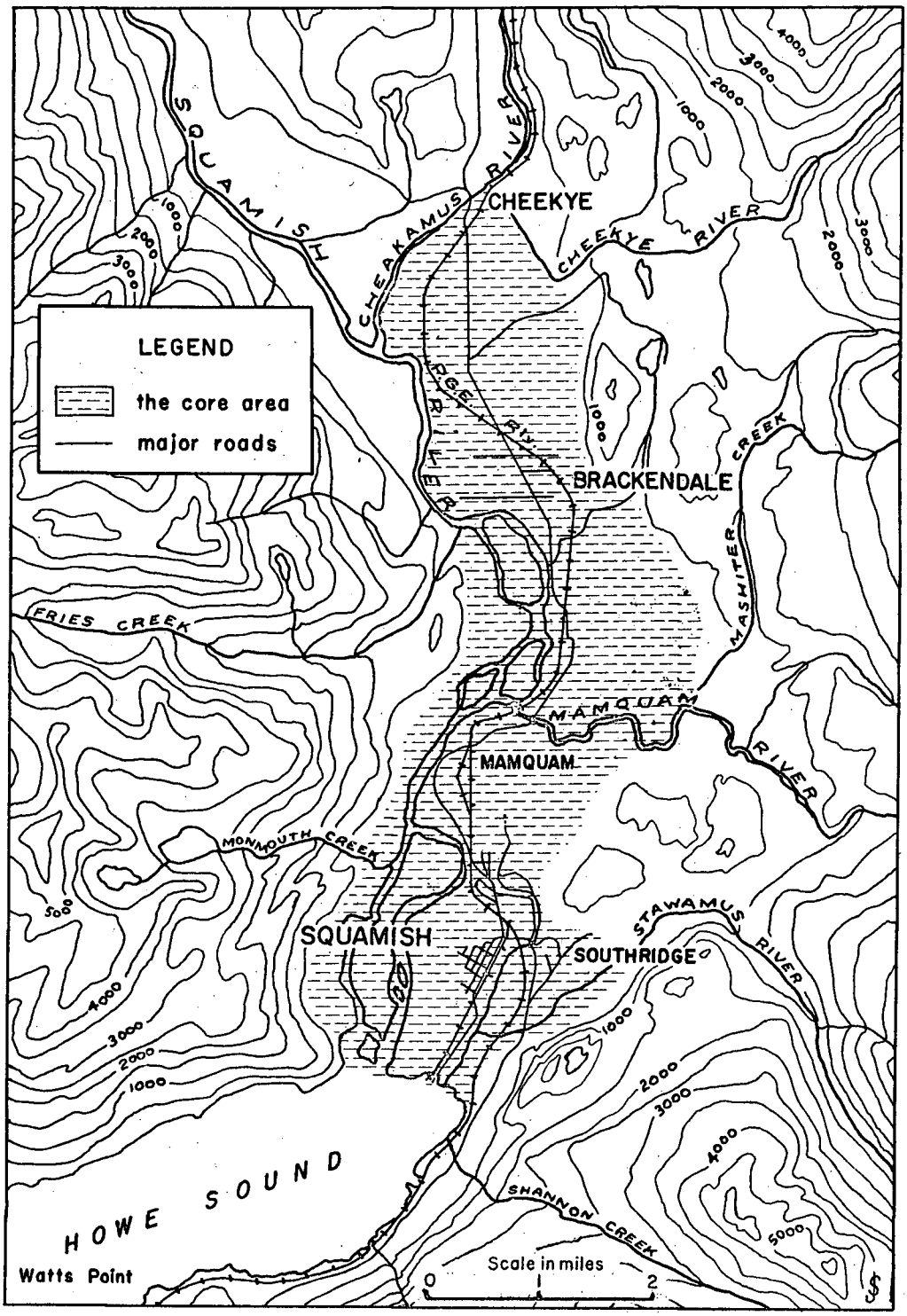
MAP 2

rivers, and on the east by the margin of the river floodplain and gravel terraces of the valley floor.

The village of Squamish is situated approximately one mile inland from the head of the sound because of poor drainage in the tidal flats at the mouth of Squamish river. At present, this intervening strip of land is unused. It is considered to be within the core area, however, because of the fact that it may provide land for industrial sites and port facilities.

The western boundary of the core area is taken as the base of the mountain slope. The only exception to this occurs near the mouth of the Cheakamus river where the Squamish river constitutes the remainder of the western boundary.

The core area terminates in its northward extent at the Cheakamus river. At this point the major valley divides. The Squamish river flows from the northwest in a long, straight, and steep-sided valley, hereafter referred to as the upper Squamish valley. The floodplain of the river in the upper valley is narrow and the channel is continually shifting. The river entirely dominates this section of the Squamish valley. There is no marked climatic change between the upper and lower sections of the valley, but the difference in climate is significant enough that the relative climatic severity of the upper valley contributes to its exclusion from the core region. Flat land in the upper valley is almost entirely taken up by Indian reserve thus precluding any significant development



THE CORE AREA OF THE

SQUAMISH REGION

MAP 3

similar to that possible for the lower Squamish valley. Overall contrast between the upper and lower Squamish valleys is sufficient to warrant the exclusion of the upper valley from the core area even though it too is river floodplain.

The eastern boundary of the core area is readily defined by the eastward extent of recent alluvial deposits which create the flat valley floor and gravel terraces. Although much of this land which has been included within the core area on the eastern side is presently devoid of settlement, there is a good possibility that this area will be utilized before other and more inhospitable parts of the larger region will experience development. Steep-sided mountains are found further to the east of the eastern boundary of the nucleus. The eastern boundary of the core area extends a short distance up the valley of the Stawamus river because of the existence of some settlement at the present time and the significance of this small area as a possible industrial site.

To summarize, the core area of the Squamish region is primarily the flat land of the valley bottom. It consists mainly of the settled portion of the region but does include additional lands that may also ultimately develop for industrial, residential and commercial use. The study is confined chiefly to this core area but does consider outlying portions of the larger region.

CHAPTER III

LOCAL REGIONAL CONDITIONS

I. GEOLOGICAL HISTORY AND EVOLUTION OF THE TOPOGRAPHY

The topography of the Squamish area plays a dominant role in the definition of the region. Similarly, this topography has greatly affected the pattern of development and will perhaps determine, to a large degree, the pattern and extent of future development. It is therefore desirable to account for the evolution of the topography in order to clearly understand the nature and significance of problems arising from the geomorphology of the area.

The Geological History

The recent geological history of the Squamish region can be conveniently divided into three periods: (1) the pre-glacial period, (2) the glacial period, and (3) the post-glacial period (see Figure 2).

The Pre-glacial Period. The valley system developed in the pre-glacial period to a large degree determined the pattern and extent of glacial erosion that followed. M.A. Peacock, who studied the fiord coast of British Columbia, states that "the fiords are pre-Glacial valleys whose troughed and basined forms are due to powerful glacial excavation,"[2] and

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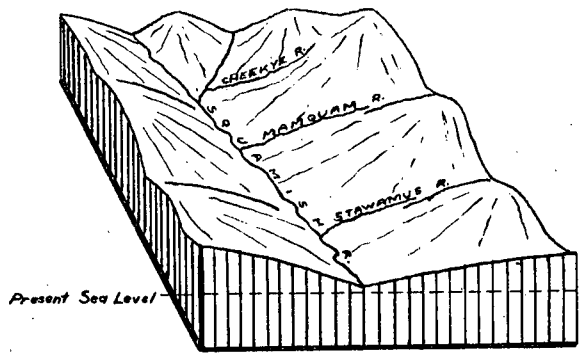
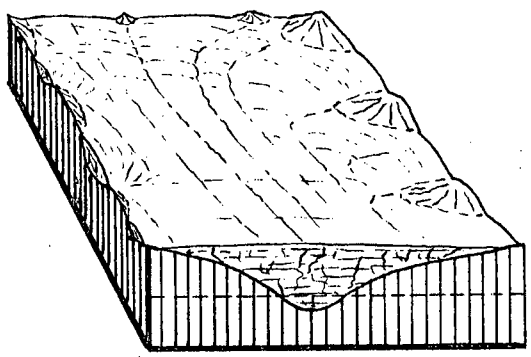
2 M.A. Peacock, "Fiord-land of British Columbia," Bulletin of the Geological Society of America, Vol. 46,1935, pp 694, 658.

pre-GLACIAL period



GLACIAL period



post-GLACIAL period

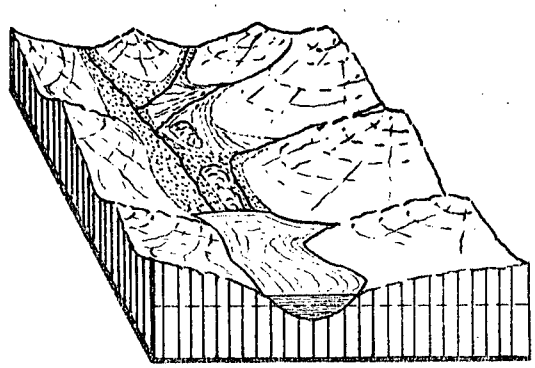


FIGURE 2 PERIODS IN THE EVOLUTION OF THE TOPOGRAPHY

further, that a "close inspection of the coast shows that, as in other fiord lands, the bed rock is riven with fractures, forming a pattern which is closely related to the fiord pattern." Peacock implies that in the pre-glacial period valley systems were developed in accordance with the fracture pattern of the bedrock.

The Glacial Period. In the glacial period the previously existing Squamish valley was filled with moving ice to an altitude which corresponds roughly to the present 6400 foot level.[3] This mass of ice, in its southward movement, scoured the valley in such a manner that it now exhibits steep walls, truncated spurs, and a generally straightened course characteristic of glacial erosion. It is not known how far below present sea-level glacial erosion occurred but presumably the bedrock has been eroded many tens or even hundreds of feet below the surface of the present valley floor.

During the glacial period, and shortly after the Wisconsin climax, the volcano which is known as Mount Garibaldi came into existence. This volcano formed partially on the surface of the ice sheet with the remainder on the adjoining bedrock surface. When the growth of the cone reached its maximum a section of it was supported by the ice which filled the valley.

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3 W.H.Mathews, "Mount Garibaldi, A Supraglacial Pleistocene Volcano in Southwestern British Columbia", American Journal of Science, Vol. 250, 1952, p. 97.

The ice retreated and this support was removed. A large portion of the volcanic material was carried away, leaving an over-steepened slope. This slope has been readily eroded since the time of its creation and some of the material removed has been deposited in the Squamish valley.[4]

The Post-glacial Period. The events which occurred in the post-glacial period are of most interest because it was during this period that the topography of the valley evolved to its present state. After the retreat of the glaciers, the present Squamish valley was presumably a fiord, assuming that glacial erosion occurred below present sea-level. The process of valley-filling then began with the rivers bringing detritus to the fiord, creating deltas and floodplains. The process of valley-filling has continued until, at the present, sediments have accumulated in the former glacial trough to depths of many hundreds of feet. This simplified pattern of events is complicated by successive ice advances and varying sea levels.

Along the eastern side of the Squamish valley, between the Cheekye river and the head of Howe Sound, there are alluvial deposits at elevations from 300 to 400 feet above the general level of the valley floor (see Map 4). These deposits were laid down during the retreat of the ice from the valley, when runoff from the east was prevented from reaching the valley bottom

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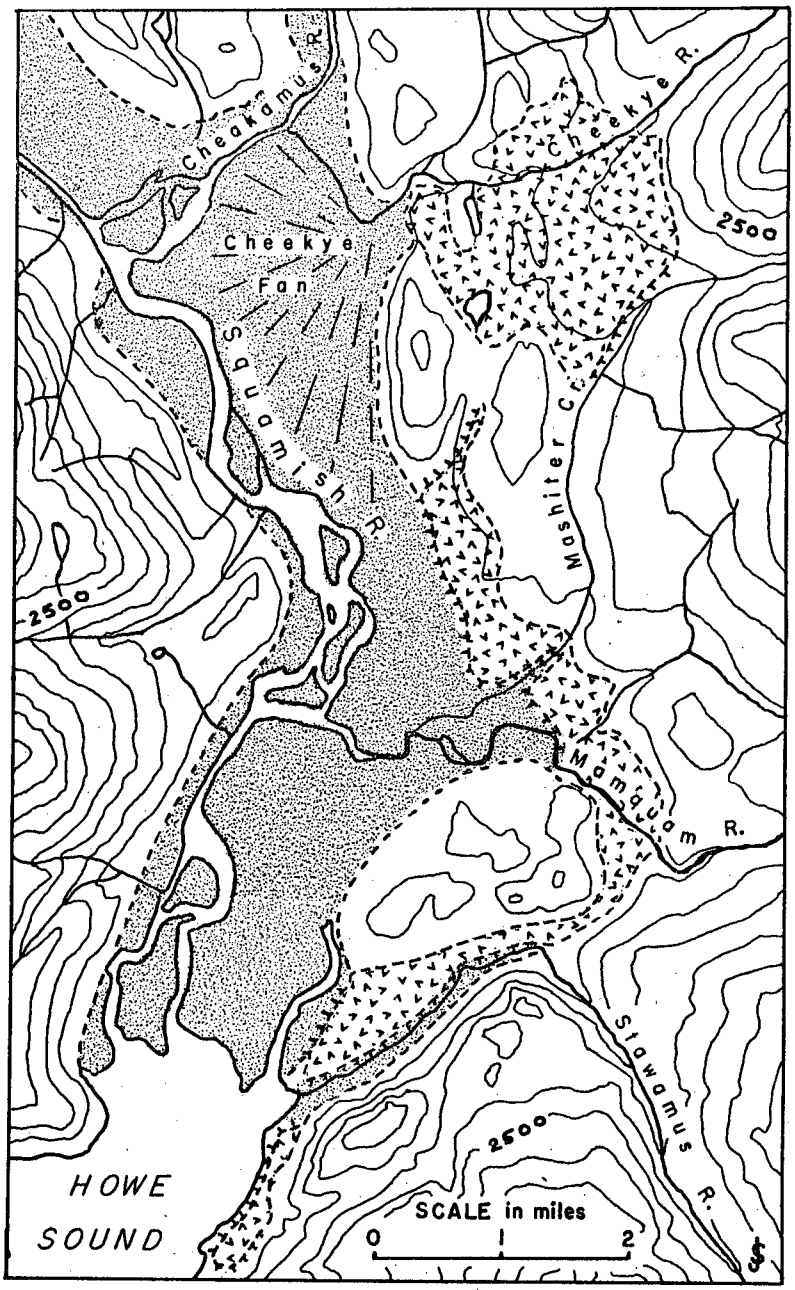
4 Ibid.



LEGEND

Terraced fanglomerates & fluvioglacial debris

Recent alluvium

ALLUVIAL DEPOSITS IN THE

LOWER SQUAMISH VALLEY

MAP 4

by the presence of the retreating ice front. This runoff was consequently forced to flow along the eastern margin of the glacier and the material carried by meltwater was deposited between the ice and the adjoining mountain-side.[5] These deposits remain to the present day and are identified from more recent river alluvium by their coarse nature.

In summary, the major valley and its tributaries are ice-carved and have been partly filled with alluvium deposited since the glacial period. The coarse materials deposited by meltwater during the glacial period differ from the sediments of the river floodplain.

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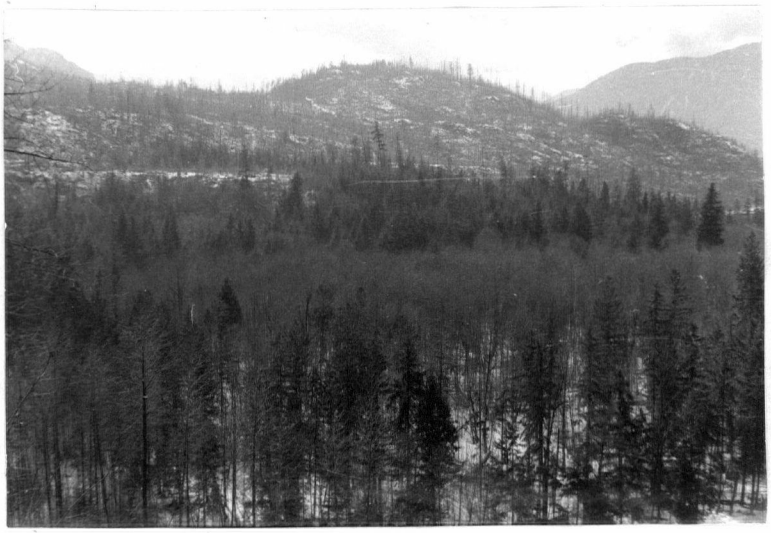
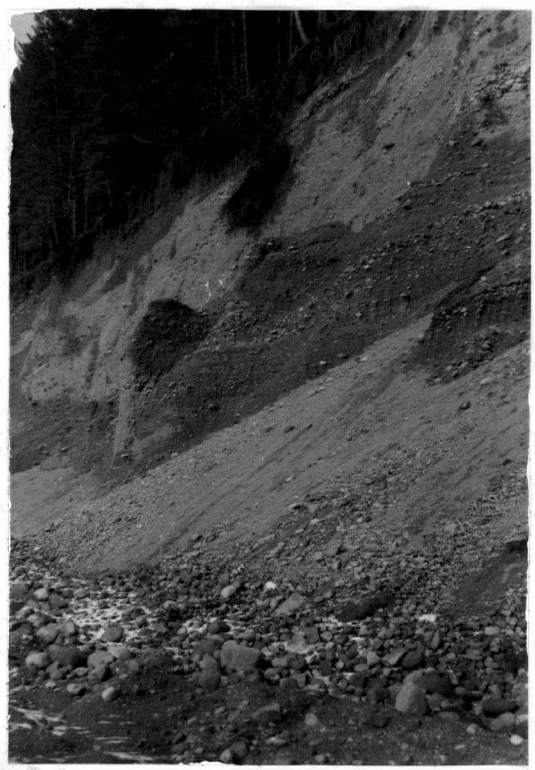
5 Ibid. pp. 95-96.



Photograph No. 4 Gravel Terraces of Glacial Origin (middle distance) on the Eastern Margin of the Lower Squamish Valley.

Photograph No. 5 Deltaic Deposits of the Glacial Period found at Southridge between the Squamish and Stawamus River Valleys.



Photograph No. 6 Glacial Gravels Exposed in a Road Cut above the Mamquam River.

II. CLIMATE

Apart from those observations made by the forest service there are no weather records for the valley. R.A. Baker discusses the climate of the Squamish valley,[6] and to the best knowledge of the writer he arrives at values of the elements which seem to be substantiated by experience. The following values have been paraphrased from Baker's report:[7]

Precipitation - No accurate records kept but the precipitation is believed to average between 60 and 70 inches per year in the valley.

- adequate summer rainfall to ensure against summer drought.

- snowfall rarely under four feet in the upper Squamish valley, but considerably less in the lower valley although snow depths in some years are reputed to reach four feet six inches. Depths of snow in the lower valley are usually less than this, and snow does not normally remain on the ground for lengthy periods of time.

- the first snowfall normally occurs about the end of November or first week of December, while by the end of March or the beginning of April the snow has usually disappeared.

Winds - moist winds of medium velocity blow off Howe Sound and up the valley during the day, while the night breezes

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6 R.A.Baker, Squamish Area Survey, British Columbia Columbia Division of Land Utilization Research and Survey, Lands Service, Department of Lands and Forests, Victoria, 1949. Unpublished report.

7 Ibid., pp. 2-4.

are reversed and blow from the valley to the sound. These breezes aid in maintaining a fairly constant temperature during the summer months, and help to maintain comparatively warm day-time temperatures during the winter months.

- north winds can occur in both the summer and winter months. In summer this wind results in high temperatures and low humidity and in the winter, in low temperatures and heavy snowfall.

Sunshine and Cloudiness - hours of sunshine are short compared to the lower mainland region of the province due to the high mountains and relatively heavy cloud cover even in summer.

- continuous cloudiness, with or without rain, can usually be expected for three or four days at least once every three weeks.

Frost-free Period - according to local inhabitants, the last killing frost comes about the end of March, and the first killing frost about the first of November, giving a frost-free period of about 215 days.

Relative Humidity and Temperature - according to local forestry station records kept from May 1 until September 30 of any year, the relative humidity for this period reaches a high of 100 percent and rarely falls below 65 percent. Humidity is usually recorded between 75 and 87 percent.

- temperatures taken daily over the same period at 8:00 A.M. and 4:00 P.M. showed temperatures as low as 50°F. and as high as 80°F. Values usually fall between 55° and 65°F.

- during this period temperatures are usually low and the relative humidity high.

There is little that can be added to Baker's discussion of climate that is applicable to this study other than a few qualitative statements on selected climatic conditions. Fog, which is not uncommon in the Vancouver area, is very rarely experienced at the head of Howe Sound. When it does occur it is usually not dense and does not remain long enough to cause any significant hazard to either sea or land travel.

The north wind which occasionally blows down the Squamish valley in the winter months sometimes reaches speeds estimated to exceed thirty miles per hour in gusts. These winds, which result from the out-flow of cold air from the interior spilling over the mountainous terrain of Garibaldi Park, at times bring temperatures down sufficiently to threaten normal activity in the area. With high wind velocities the effective temperature is so reduced that it is not uncommon to have the freezing of equipment and machinery so complete as to seriously cripple both the logging and railroad industries. Such occurrences, however, are not frequent and one might expect such adverse conditions to occur only once or perhaps twice each year. The north winter wind on Howe Sound is known to tug boat operators and fishermen as the "Squamish". The name is applied by some of these men to similar winds that occur in other coastal inlets.

Still another aspect of the climate of the Squamish valley is the occurrence of temperature inversions. This phenomenon is readily noticed in the winter when there is an excessive amount of smoke in the atmosphere, at which time the

polluted air tends to settle over the valley at fairly low altitudes. A similar atmospheric condition exists in the summer months if there is a forest fire along Howe Sound or in the valley. The low-lying smoke layer at this time, however, does not result from a temperature inversion, but merely from the fact that the topography of the area will not permit the removal of the polluted air. When this condition exists, the smoke makes a daily cycle of travel down the valley during the night and early part of the day and back up the valley in the afternoon and evening in accordance with the pattern of sea and land breezes. This continues until precipitation or strong winds occur to cleanse the atmosphere or force the polluted air out of the area. Although these conditions do not constitute a serious present threat they may do so in the future if atmospheric pollution in the region is increased to any large degree.

Due to the lack of weather readings in the Squamish region, only qualitative statements regarding the surrounding mountainous areas are justified. Whether or not the eastern side of the valley receives more precipitation than the western side is a conjectural point. Since the local movement of storms is from west or southwest to east or southeast it might seem logical that the western side of the valley would be a rain-shadow area, relatively speaking, and that the eastern side would receive a higher amount of precipitation due to the orographic effect of the mountain barrier. This may be true since it is thought by some residents that more snowfall occurs

on the eastern than on the western side and that the eastern portion of the region has a heavier runoff throughout the year. Map evidence shows that there is a more dense and mature drainage system in the eastern portion of the region than in the west. This, however, may be more a result of geological structure and glacial erosion than climatic differences.

Baker's notes on climate deal largely with the lower valley of the Squamish river and mentions the upper valley only with respect to snowfall. A greater depth of snow in the upper valley is not the only indication of a difference in climate between the two areas. A shorter growing season, as evidenced by a later tree-budding time, longer duration of snow on the ground, fewer hours of sunshine, and generally lower temperatures in the upper valley are well known to long-time residents. A similar climatic change is found along the Cheakamus river although it is not as marked as in the upper Squamish valley.

Snowfall on the mountains of the Squamish region is heavy. At Diamond Head Chalet (altitude 5200 feet) near Mount Garibaldi, it is possible to find snow depths exceeding twenty-five feet during the months from January to April. Some snow remains at this altitude throughout most of the summer and net accumulation begins again in late September. It is reasonable to suppose that similar conditions exist in the remainder of the high mountainous areas of the region.

Since the larger Squamish region, and particularly Garibaldi Park, has a certain potential as a recreational area,

a consideration of the recreational value of the climate is worthwhile. If facilities were to be provided for a winter playground, the climate would in one instance be in its favour by assuring sufficient snow depths, and in the other, a detriment due to high amount of cloud cover, the resultant large amount of precipitation, and the wetness of the snow. Comparing Garibaldi Park as a potential ski resort with the north shore mountains of the Vancouver area, one would find the weather slightly more unfavourable and the snow conditions little different from those on the Vancouver mountains. Snow depths are sufficiently great to provide reasonable assurance of good skiing throughout the year. This perhaps is the greatest factor of importance in the recreational value of the climate.

Regarding the climate for summertime activities, one would find little difference between conditions in the Squamish region and those of the Vancouver area. The only marked significance of the climate for recreational purposes is that of creating a possibility of skiing throughout the year and thereby attracting the sportsman to the area.

In summary, the climate of the Squamish region appears to be little different from that of the Vancouver area. In general it does not have any significant detrimental influence on the present use of the area. However, if development of the region occurs certain aspects of local weather and associated phenomena may detract from the highest use of the area. These would be the strength of the winter north wind, its effect on

shipping and the operation of industry through the winter months, and the possibility of air pollution resulting from constricting topography, temperature inversions, and restricted air movements.

III. DRAINAGE CHARACTERISTICS

Of all aspects of the physical geography of the Squamish region that of drainage and associated characteristics is undoubtedly of greatest importance. The Squamish valley owes its existence to the very fact that rivers have created a usable landscape through deposition of detritus and the creation of floodplains and deltas.

Watersheds and Discharge Characteristics

The combined watersheds of rivers entering the head of Howe Sound through the Squamish valley cover an area of about 990 square miles (see Map 5). The main rivers are the Squamish, Elaho, Cheakamus, Mamquam and Stawamus. Except in the case of the Stawamus river, all runoff in these watersheds enters the Squamish river before it reaches the sea at the western margin of the valley. In other words, runoff from roughly 965 square miles of the combined watersheds enters the Squamish river. The runoff from the remaining 24 square miles comprising the Stawamus river watershed empties into Howe Sound on the eastern side of the valley quite independently from the Squamish river.

Discharge records are available for only two rivers in the region, the Squamish and the Cheakamus. Records for the

Cheakamus river are available for an almost continuous period from the year starting September 30, 1917 to the year ending September 30, 1942. The recording station is at Garibaldi railway station (station number 8 G A_{17}).[8] Records for the Squamish river are available in final form for only a four-year period from the year starting September 30, 1923 to the year ending September 30, 1926.[9] The gauging station in this case was located one mile above the confluence of the Squamish and Cheakamus rivers.

An examination of the yearly records for the Cheakamus river shows a distinct maximum flow between May and August (see Figure 3). During this period the mean monthly flow approaches four thousand cubic feet per second. During the remainder of the year mean monthly flow is in the neighborhood of two thousand cubic feet per second or less. Only on rare occasions is discharge much in excess of four thousand cubic feet per second. Low discharges are more common than excessively high ones. The maximum flow recorded on this river occurred in October, 1921, with a value of twenty-nine thousand cubic feet per second.* The lowest recorded minimum occurred in March, 1928 with a value of 198 cubic feet per second.

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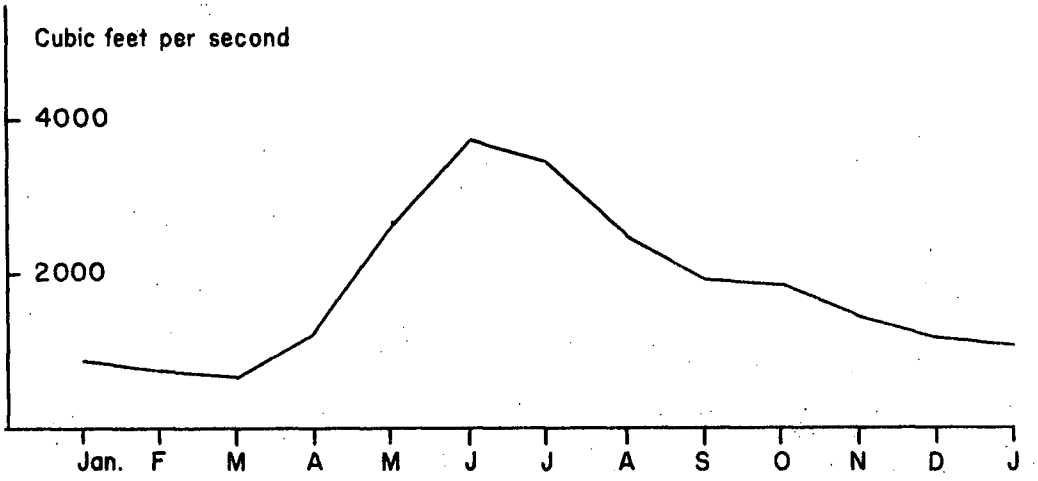
8 Canada, Department of Mines and Resources, Dominion Water Power Bureau, Surface Water Supply of Canada, Pacific Drainage, Climatic Years 1940-41 and 1941-42, Water Resources Paper No. 94, Ottawa, 1946, pp. 34-35.

9 Canada, Department of Northern Affairs and Natural Resources, Water Resources Branch, letter to the writer, Ottawa, January 30, 1957.

* this date corresponds to that when the Mamquam river changed its course to flow into the Squamish river.

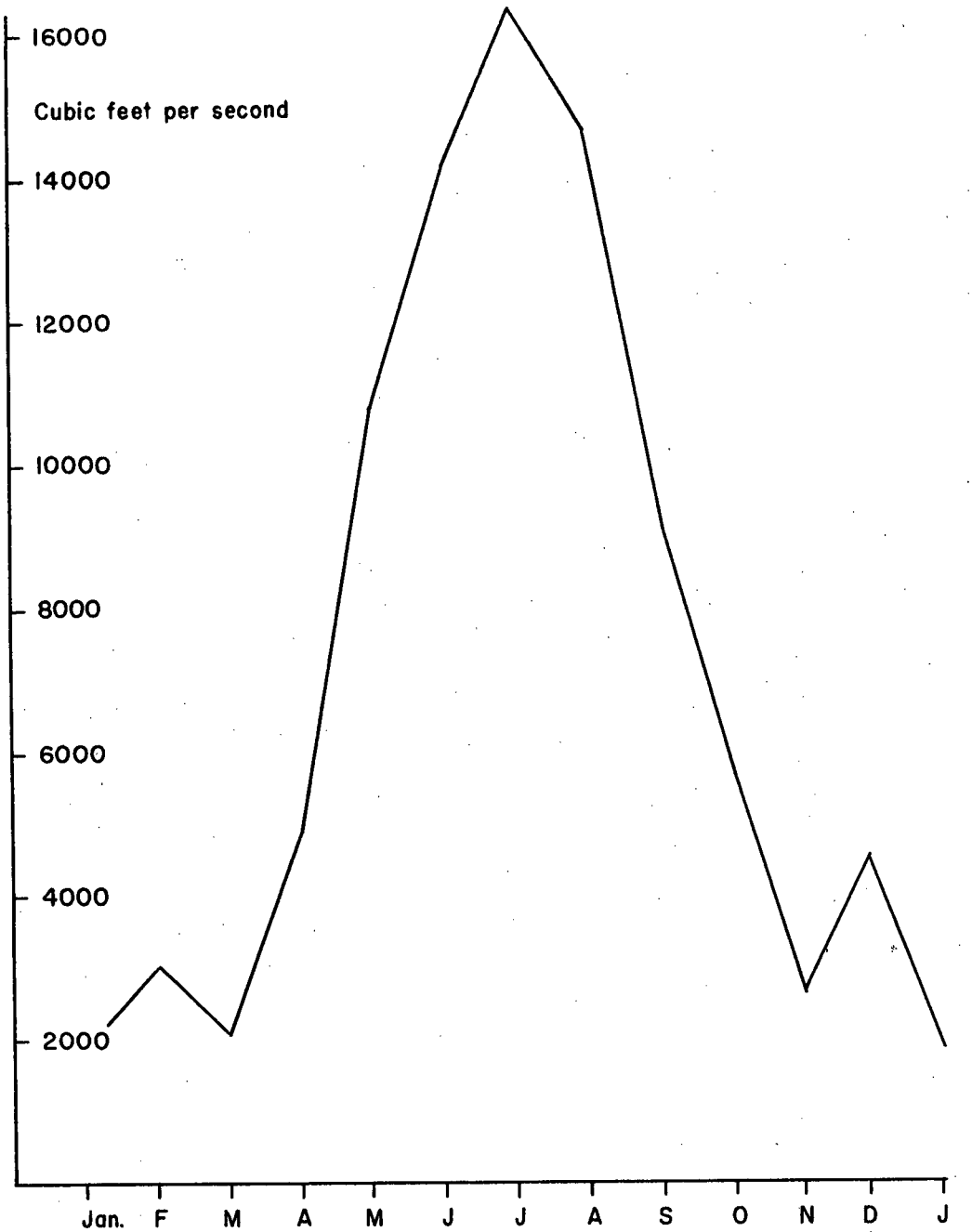


MEAN MONTHLY DISCHARGE FOR THE AVERAGE YEAR (Period Sept. 30, 1917 to Sept. 30, 1942) FOR THE CHEAKAMUS RIVER AT GARIBALDI RAILWAY STATION

FIGURE 3

The records for the Squamish river cover only a four-year period, water years 1923 to 1926 and 1955 to 1956. They should not be accepted as an average since such a short record could not constitute a representative sample. The records, however, do show the general pattern of yearly discharge (see Figure 4). It is evident that there is a distinct maximum flow which occurs from May to August. During this period mean monthly flow ranges from well above ten thousand cubic feet per second to seventeen thousand cubic feet per second. During the remainder of the year, mean monthly flow is less than six thousand cubic feet per second. The maximum recorded value of discharge occurred in October 1925, with a value 32,900 cubic feet per second. The lowest recorded minimum value occurred in January 1923, with a value of 532 cubic feet per second. For comparison, the average rate of discharge of the Fraser river at Hope is 92,300 cubic feet per second.

A comparison of figures 3 and 4 shows that the Squamish river, north of its confluence with the Cheakamus, has a much higher yearly discharge than that of the Cheakamus. This is readily appreciated when one compares the respective drainage basin areas, with 560 square miles in this portion of the Squamish river watershed, and 314 square miles in the Cheakamus river watershed. However, on the basis of existing records, the mean yearly discharge per square mile of drainage basin are vastly different. For this portion of the Squamish river watershed it is 13.8 cubic feet per second per square mile, whereas for the Cheakamus river it is 5.9 cubic feet per second per



MEAN MONTHLY DISCHARGE FOR THE AVERAGE YEAR (Period Sept. 30, 1923 to Sept. 30, 1926) FOR THE SQUAMISH RIVER AT BRACKENDALE

FIGURE 4

square mile. This difference may be explained in part by the fact that the greatest portion of the Squamish river watershed is near the coast and consequently receives more precipitation due to the orographic effect of the mountains immediately adjacent to the coast than the Cheakamus river watershed which is further away from the coast and so receives a smaller amount of precipitation. The difference may also be partially explained by the short length of record for the Squamish river, because the record may have covered a period of years with unusual discharge values. A third factor that may contribute to the higher flow per square mile for the Squamish may be because this watershed contains proportionately more glaciers than that of the Cheakamus. The progressive melting of the glaciers may contribute to the higher ratio of discharge.

No discharge records are available for the Mamquam and Stawamus rivers. However, since the watersheds of these rivers have similar conditions of topography and climate to that of the Squamish and Cheakamus river watersheds, it is reasonable to assume similar characteristics of seasonal pattern of discharge.

River Characteristics

Figure 5 illustrates generalized profiles of the lower portions of major rivers entering Howe Sound through the Squamish valley. The Squamish river, being the main or trunk river, flows at a relatively low gradient. The Cheakamus and Mamquam rivers enter the valley with much steeper gradients. The Cheekye river, in its course across the valley floor, flows

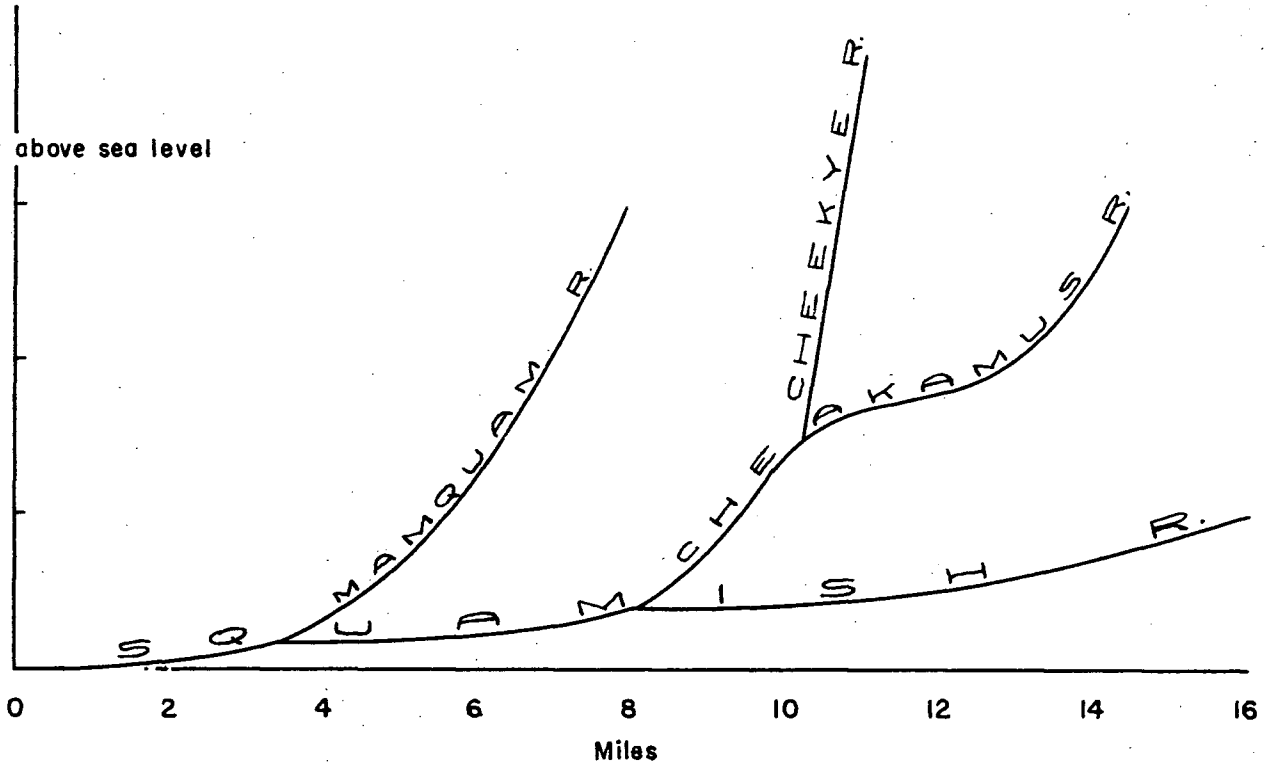


FIGURE 5

GENERALIZED PROFILES OF THE LOWER PORTIONS OF MAJOR RIVERS ENTERING HOWE SOUND THROUGH THE SQUAMISH VALLEY

at an extremely steep gradient. An examination of the gradients and associated characteristics of these rivers offers an explanation of the topography of the valley floor. An understanding of this is necessary to appreciate certain factors such as flooding which affect development potential.

The Squamish river, from its mouth to its confluence with Ashlu creek, approximately 20 miles upstream, flows at an average gradient of 6.2 feet per mile. This gradient is sufficiently low to allow some quiet stretches of river between sections of fast water and near-rapids. Figure 5 shows an irregular profile for this river, with steps in the profile corresponding to the entry of the Cheakamus river in one case, and the Mamquam in the other. The Squamish river is mainly in the stage of late maturity, with a fairly regular profile. The Cheakamus river, flowing at a relatively steep gradient, brings more material to its mouth than the Squamish can carry away. Consequently, there is a damming effect on the Squamish above its confluence with the Cheakamus. This explains the old age characteristics of low velocity, large meanders, oxbow lakes, and broad floodplain, found along this portion of the Squamish river.

Below the mouth of the Cheakmus, the Squamish river flows rather rapidly due to the steepend gradient caused by excessive deposition from the Cheakamus river. This lower section of the Squamish changes its course only slightly and flows between relatively high banks. Further downstream, however, the river again beings to meander, lose velocity and drop material until the mouth of the Mamquam river is reached.

As in the case of the Cheakamus, the Mamquam river has a damming effect on the Squamish. The Mamquam brings down more material than the Squamish can carry away, thereby creating a second step in the profile of the main river. Below the mouth of the Mamquam, the Squamish again flows rather rapidly for about two miles until tidal influence becomes marked. From this point southward the present delta of the Squamish begins (see Map 6), and net deposition becomes the main characteristic of river activity.

The irregular profile of the Cheakamus river is noteworthy (see Figure 5). The change in gradient is caused by the deposits of the Cheekye entering the Cheakamus river. The Cheekye, although only a small river, carries a large amount of detritus due to its steep gradient and the ease of erosion of the topography in its drainage basin. The Cheekye is eroding volcanic debris that slumped from the face of Mount Garibaldi during the glacial period. This material is being deposited on the valley floor in the form of an alluvial fan built by the Cheekye river.[10] The creation of this fan has raised the base level of erosion for the Cheakamus river north of its confluence with the Cheekye and has forced the Squamish river against the western side of the main valley (see Map 4).

The gradient of the lower portion of the Mamquam river

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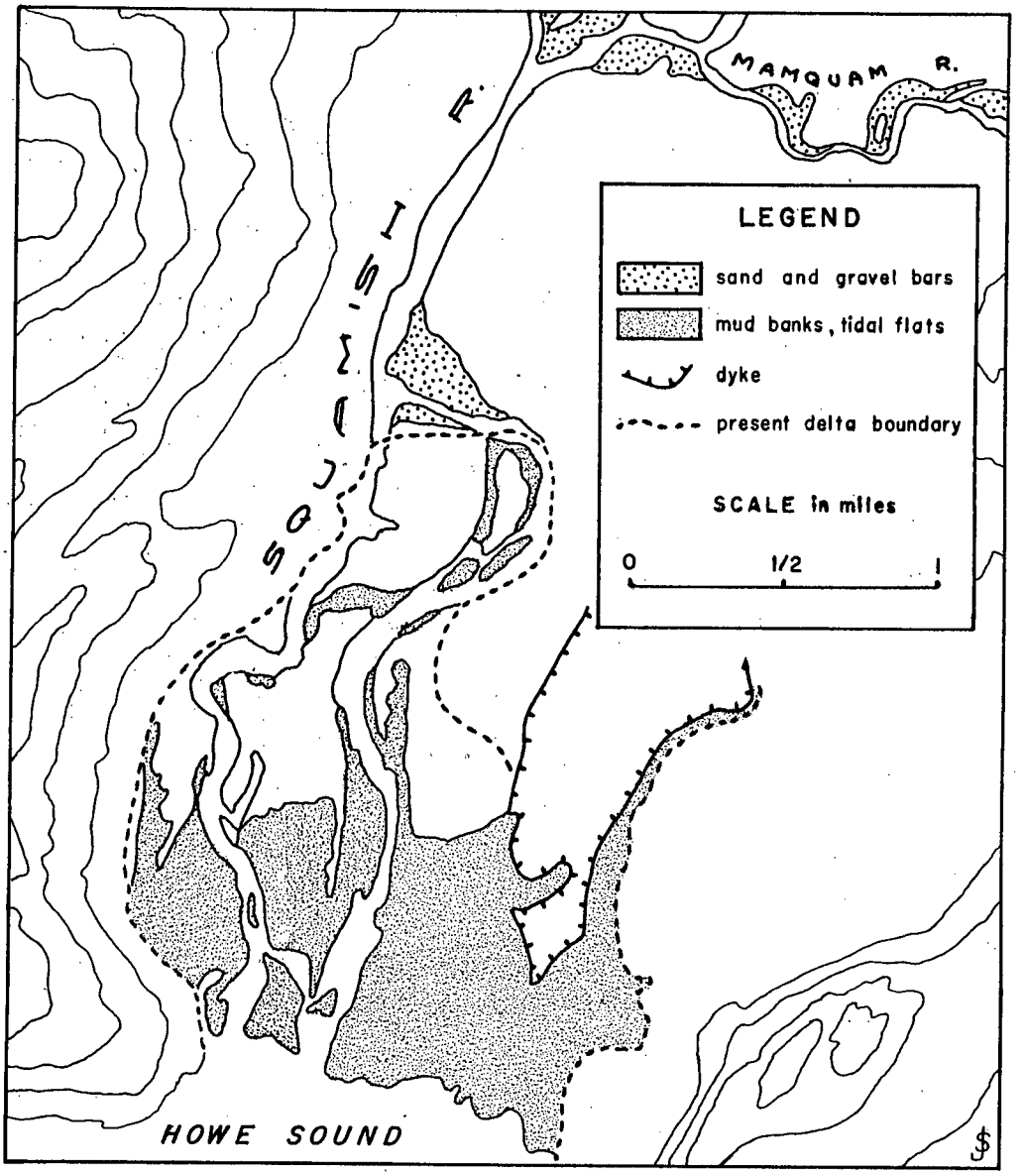
10 Here the author is in disagreement with Mr. R.A. Baker who refers to this feature as an area of glacial till. An examination of it on topographic sheets and on the ground substantiates its classification as an alluvial fan.



THE MODERN DELTA OF THE

SQUAMISH RIVER

MAP 6

as illustrated in Figure 5 is relatively steep. This river enters the Squamish valley after emerging from a canyon whose floor is considerably higher than the floodplain of the Squamish river. Consequently, the Mamquam is forced to flow at a steep gradient from this point to its confluence with the Squamish river. With such a steep gradient one might expect the Mamquam to flow in a well defined channel with few meanders and little deposition. This is not the case, however, because even though the gradient is steep it is not as great as that in the canyon above, and thus large amounts of material are dropped on the valley floor. Because the Mamquam is choked with detritus it often spills over its banks in times of excessive runoff.

The influence of the Cheakamus and Mamquam rivers on the Squamish and the resultant changes in gradient and amounts of deposition are evident through an examination of Map 7. This map shows the smooth and sinuous channel of the Squamish above its confluence with the Cheakamus river. Below the Cheakamus, as explained previously, the gradient of the main river is high initially, but further downstream it branches, loses velocity and deposits material near the mouth of the Mamquam. May 7 illustrates a similar condition of lessening gradient below the mouth of the Mamquam river. This is significant because where the gradient of the Squamish river is relatively high, channel migrations are not excessive, whereas where the gradient is low the river meanders across the valley floor with a continual shifting of channels and resultant erosion of valuable land. This situation is particularly noticeable

in the Brackendale area between the Mamquam river and Brackendale settlement. The excessive meandering and deposition of the Mamquam river are also shown in this illustration.

Flooding

Flooding in the Squamish valley has been a continuous problem since the earliest days of settlement. The threat of flooding occurs every year, particularly from the Mamquam river. Most often this river has risen to a point on the verge of overflowing, but with a rapid change in weather conditions it subsided. Usually there has been little property damage. On occasion, however, roads and bridges were washed out. Major floods have not been too common, but may be expected periodically particularly when the Squamish river is high. The following dates and damage of major floods have been recorded:*

1. October 18, 1921. A severe flood resulting in the P.G.E. railway grade being submerged for several miles up the valley. The Mamquam river changed its course to its present channel.

2. October 27, 1937. Heavy damage to railroad grades and private property. Water to a height of four to five feet in the village stores.

3. October 18, 1940. Property damage was extremely heavy, with railroad grades submerged and eroded.

4. November 26, 1949. Serious flood hazard existed. No major flood occurred, but homes were evacuated within the northern part of the village.

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* Source, confidential.

With three of these major floods, property damage has been extremely heavy. In the Brackendale area, houses were half-filled with water. Throughout the valley, houses had water depths above floor level from several inches to as much as a few feet. Usually there was little warning of the approaching flood. Automobiles and machinery occasionally had to be left where standing resulting in serious damage. Livestock, farm produce, cordwood, wooden sidewalks, barrels, fences, small buildings, boxes, among other things were swept down the river, piled up against buildings and eventually carried out to sea. Needless to say, the hazard of flooding is extremely detrimental to development of the Squamish region.

All major floods have occurred in the month of October. The factors contributing to especially hazardous conditions during this month are many. By October, the previous winter's snow has disappeared from the surrounding mountains and precipitation falling on these mountains drains away rapidly. The presence of snow retains moisture and checks the velocity of runoff. In the autumn, heavy rains are common. Precipitation at this time of the year is accompanied by generally high temperatures, causing rain rather than snow to fall on the mountains. Consequently, runoff is excessive. At this time tides can be extremely high, and when accompanied by high winds, can cause water to back up far into the delta area. When there is the unfortunate combination of high temperatures, heavy autumn rains, high tides, and strong winds, extremely hazardous conditions prevail.

Flooding of the Mamquam river commonly takes place in the autumn at the same time the Squamish river is high or in flood. It can also occur in the spring when pacific storms with heavy rainfall and very high temperatures move over the region. The passage of one of these storms causes the melting of snow in the mountain areas. This, coupled with high precipitation, causes hazardous conditions to exist along the Mamquam river. Due to the large drainage basin of this river and the high gradient associated with excessive amounts of detritus, the river-bed cannot accommodate the amount of runoff being received. Commonly, under these conditions, log jams form in the channel, damming portions of the flow and often providing the triggering action for a flood along this river. Since logging activity has been fairly extensive in the Mamquam river watershed, the danger of flooding is enhanced by unprotected slopes.

The hazard of flooding constitutes a serious threat to further economic development of the Squamish valley. Precipitation in the region is high and drainage from the combined watersheds of major rivers and tributaries is forced to flow to sea through the narrow and constricted Squamish valley. Due to large volumes of runoff so concentrated and the nature of the topography, eroded material has been rapidly deposited in the valley as river floodplain, a feature which can be largely attributed to flooding. Since the origin of this land is at least in part a result of flooding, it is reasonable to suppose that flood waters will always constitute a threat to development

in the valley bottom. Unless considerable effort is expended this hazard will not be overcome. It is a major undertaking to upset the balance existing in and created by nature. Certain activities of man, such as logging the watersheds, have only served to endanger the valley even more. To hold normal runoff within drainage channels would be a large enough task. To hold increased volumes in check may prove to be a task beyond economic feasibility. If logging is to continue in the region and the industry is to expand operations even further in the watersheds, the danger of major floods is bound to increase significantly.

Erosion and Channel Migrations

Map 8 illustrates the former courses of rivers in the lower portion of the valley. The former course of the Squamish river is shown as it existed in the 1889, when most of the original land survey of the area was conducted.[11] The former course of the Mamquam river is also valid for 1889. The Mamquam, at this time, flowed directly to the sea and remained fairly well confined to this channel until the major flood of 1921, when its flow was diverted westward to the point of its present confluence with the Squamish river.

Channel migrations and erosion by the Squamish river have been most excessive in the Brackendale area between the

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11 British Columbia Legal Surveys Division, Surveys and Mapping Branch, Department of Lands and Forests, letter to the writer, Victoria, British Columbia, March 8, 1957.

confluence of the Squamish and Mamquam rivers and the toe of the Cheekye alluvial fan. The channel positions as shown on Map 8 substantiate this statement. Erosion occurs by the migration of meander loops downstream in a wave-like motion. A series of mapped channel positions during the period from 1889 to the present time would illustrate this observation very clearly. A comparison of the former and present positions alone shows that approximately the same number of major meanders in the river which exist at the present were to be found in 1889. The tendency has been merely for them to move downstream.

Because excessive amounts of sediment is being introduced on the eastern side of the valley by the Cheekye and Cheakamus rivers in the north, and by the Mamquam river midway down the valley, the Squamish river is forced to flow against the western side of its flood plain. If the Squamish river alone were responsible for the deposition of all valley sediments, one would expect to find erosion and consequent channel migrations over the entire valley bottom. This is a significant consideration in the evaluation of parcels of land in the lower valley since one can assume that land on the eastern side of the valley, apart from that endangered by the Mamquam river, to be least apt to suffer erosion by the Squamish river. It is also reasonable to suspect that excessive erosion in the future by the Squamish river will be confined roughly to the position of the present meander belt.

In summary, drainage is a major consideration in the analysis of the Squamish region. A large variability in dis-

charge throughout the year, the extremely hazardous conditions of flooding, and the influence of the major rivers on the evolution and modification of the landscape are factors highly pertinent to the evaluation of future possible use of the lower Squamish valley.

IV. VEGETATION

The vegetation in the Squamish region is comparable to that in other parts of the Vancouver Forest District. In the lower Squamish valley, and particularly in the floodplain areas, there is a mixed forest of conifers and deciduous trees. Large spruce and cedar are common to this area. In most places they are interspersed with maple, alder and cottonwood. In general, the growth rate is high, particularly for the deciduous trees. Undergrowth is dense and continuous throughout the area.

Before settlement came to the valley, the river floodplain was covered with a continuous forest, dominantly spruce and cedar which commonly grew to a size of five to six feet in diameter, breast height. The greatest part of this forest was removed by hand-logging methods. A second growth of mixed coniferous and deciduous forest has since grown up. Many of the large stumps of the original forest are still standing. They present an obstacle to clearing since they are deeply rooted and partially covered with sand and silt deposited during recent floods.

On the gravel terraces of the valley's eastern margin is found a mixed forest, dominantly coniferous. This again is

second growth since these areas were also logged during the period of initial settlement. Due to excessive drainage and coarse soil the trees are generally small and not deeply rooted.

CHAPTER IV

SEQUENT DEVELOPMENT

The history of the Squamish region has been little publicized and as a result documented information is obscure.* However, the writer has been able to obtain a few documents from local residents dealing with the period of development between the years 1873 and 1919.** These documents discuss the sequence of development during the period in which the Squamish valley has experienced its initial and subsequently its greatest period of growth.

I. THE PERIOD FROM 1870 TO 1949

Prior to 1873 the Squamish valley was very little known. It was remote from the settled areas bordering Burrard Inlet and the Fraser river.

In 1873 work was begun on a cattle trail from Lillooet to Squamish. In the same year survey parties set out to explore

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* According to Dr. M.A. Ormsby, Professor, Department of History, University of British Columbia, in an interview, April 30, 1957, information on the history of the Squamish area is extremely difficult to obtain. Dr. Ormsby suggested study of the Sessional Papers of the British Columbia Legislative Assembly and Pamphlets dealing with the Pacific Great Eastern Railway as being the best probable, yet even very doubtful source of information. A study of these documents revealed nothing of sufficient value to warrent recording in this thesis.

** These documents have been made available to the writer through the courtesy of the Squamish Centennial Committee.

a route for this trail from Squamish to Burrard Inlet.[12] The purpose of the trail was to bring finished beef from the Lillooet-Clinton district of the interior to market in the Vancouver area.

In 1874, while work continued on the trail, 400 acres were purchased at Squamish to provide pasture for cattle.[13] This is the first reference to acquisition of land in the valley.

By 1875 the cattle trail was completed through to Burrard Inlet. In the following year work progressed to improve the route. Robert Carson of Pavillion in 1877 conducted the first and only cattle drive over the route. Apparently the country was so rugged and the trip so hard on the animals that the idea of bringing cattle to the coast by this route was abandoned.[14]

From 1875 to 1885 there was little interest in the valley. Meadows in the Squamish river delta area were being used as pasture by persons who came to Squamish mainly for the purpose of logging fir and spruce along the banks of the Squamish river.

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12 B.A. McKelvie, "Construction of the Cattle Trail from Lillooet to Squamish," p. 1. (unpublished notes with no date given)

13 Nina Anthony, "An Epic," p. 1. (unpublished poem with no date given)

14 McKelvie, op. cit., p. 2.

The first settlers came to the Squamish valley in 1877. They took up land along the Mamquam river near the present location of the P.G.E. railway shops.[15] The coming of these people marked the beginning of a slow but steady influx of permanent residents. In 1885 a group of Norwegians came to Squamish and in the same year that they arrived a severe flood inundated their homesteads.[16] They became discouraged and subsequently moved to Bella Coola. Regardless of the flood hazard, people continued to move into the valley. By 1889, interest in land was sufficient to warrant a legal survey.[17] The presence of surveyors in the area and the speculation on subdivided land created the beginning of a new and more prosperous era.

By 1892 a post office had been established.[18] The S.S. Saturna was making trips twice weekly from Vancouver to Squamish, navigating the former east branch of the Squamish river to a wharf located near the present commercial section of the village.[19]

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15 Minnie Armstrong, "A Brief Outline of People and Happenings in the Early Days of Squamish". (unpublished notes with no date given).

16 Anthony, loc. cit.

17 British Columbia Legal Surveys Division, op. cit.

18 Anthony, op. cit., p. 2.

19 Anthony, loc. cit.

During the 1900's the Squamish valley was becoming known as a good agricultural area. Interest turned to the growing of hops for sale in Vancouver. Construction of the Bell-Irving hop ranch was started in 1894.[20] Competition from farms in the Chilliwack area soon seriously affected the industry at Squamish. The ranch was not in production many years before it was abandoned.

Much of the interest in land had centered on the area along the banks of the Squamish and Mamquam rivers, the remainder of the valley being considered too heavily timbered or poorly drained to develop as farm land. However, during the early 1900's a portion of the delta was dyked and used for pasture and the growing of hay. These dykes, which still exist and some of which protect the present village, were built by Chinese labour under the direction of local land owners.[21]

During the years that the valley was becoming settled agriculturally, logging by hand methods of small timber stands along the river banks became an increasingly more prominent activity. In 1909 the Howe Sound and Northern Railway Company constructed a line extending about fifteen miles from tidewater northward into the valley of the Cheakamus river.[22] This railroad was built to open up larger timber tracts and to facilitate transport of logs to the booming grounds located at the delta.

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20 Armstrong, op. cit., p. 3.

21 Armstrong, loc. cit.

22 Anthony, op. cit., p. 3.

In 1913 the Howe Sound and Northern Railway Company was forced by the provincial government to sell out to the newly formed Pacific Great Eastern Railway Company.[23] This incident caused a great deal of local ill-feeling. The Howe Sound and Northern Railway Company had taken considerable interest in the development of Squamish. Its management had renamed Squamish to Newport and had envisioned the growth of a great sea port community. In 1907 the company had discovered a route to the interior through the valley of the Cheakamus river. The directors of the P.G.E. had learned of this route and through political pressure enabled acquisition of the rights to construct a rail line over it. By 1919 they had not only acquired this right but had also purchased most of the land in the lower valley that would lend itself to community and port development. Nearly all of the land presently held by the P.G.E. was purchased at this time. In 1918 the provincial government took over control of the P.G.E. and virtually all of the land that it had acquired. The Howe Sound and Northern Railway Company did not regain any of its losses. The name Newport was dropped and the community it had tried so hard to promote continued to be called Squamish.

In 1914 the "Squamish Incorporation Act" was passed for proclamation by the Lieutenant-Governor in Council.[24] The act,

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23 A.McEvoy, "Petition for Incorporation of the City of Squamish," (a letter to the Provincial government) Vancouver, British Columbia, November 15, 1919, p. 1.

24 McEvoy, loc. cit.

however, was not proclaimed and Squamish continued to develop without the benefit of provincial support.

In 1915 the first train ran from Squamish to Lillooet.[25] The opening of the rail link was expected to enable the beginning of tremendous development at Squamish. This, however, was not forthcoming, and as a matter of fact, the rate of growth of the community subsequently declined.

During the depression years of the 1930's, activity in the Squamish valley, as in many other places, declined noticeably. Logging continued at a very reduced production. However, the P.G.E. tended to provide a stabilizing affect on the community. Many employees were out of work, but the weekly train, both passenger and freight, managed to take the time of the men with highest seniority.

The second world war again brought greater prosperity. Business increased for the logging companies and the railroad. Later, the tempo of development was heightened with the return of the war veterans. The favourable lumber market caused a very significant increase in logging, which in turn, bolstered the general level of the local economy. Squamish, as was the case with many other rural areas of the province, was caught in the up-swing of the North American economy.

Prosperity, however, brought problems with it, and the people of Squamish were soon faced with the need to implement

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25 McEvoy, op. cit., p. 3.

some form of local government. On May 18, 1948, in an attempt to cope with local growth, Squamish attained the status of a village. The boundary included only the commercial section and part of the residential area. This boundary is shown on Map 9, as are successive expansions of it to the present.*

II. THE POST 1949 PERIOD

On the instructions of the Premier of British Columbia in May, 1949, the Squamish Valley Development Committee was formed. The purpose of the committee was to "consider the present and future development of the Squamish area in relation to the disposal of crown lands and the requirements of the P.G.E. for terminal purposes, present and future, the proper planning and development of the area and the possible re-subdivision of subdivisions considered outmoded to meet the modern requirements of the present, and to conform to a planned development of the area.**

The committee comprised representatives from the P.G.E., British Columbia Department of Railways, Department of Public Works, Regional Planning Division of the Department of Municipal Affairs, and the Parks and Recreation Division of the British Columbia Forest Service. Other representatives on the committee

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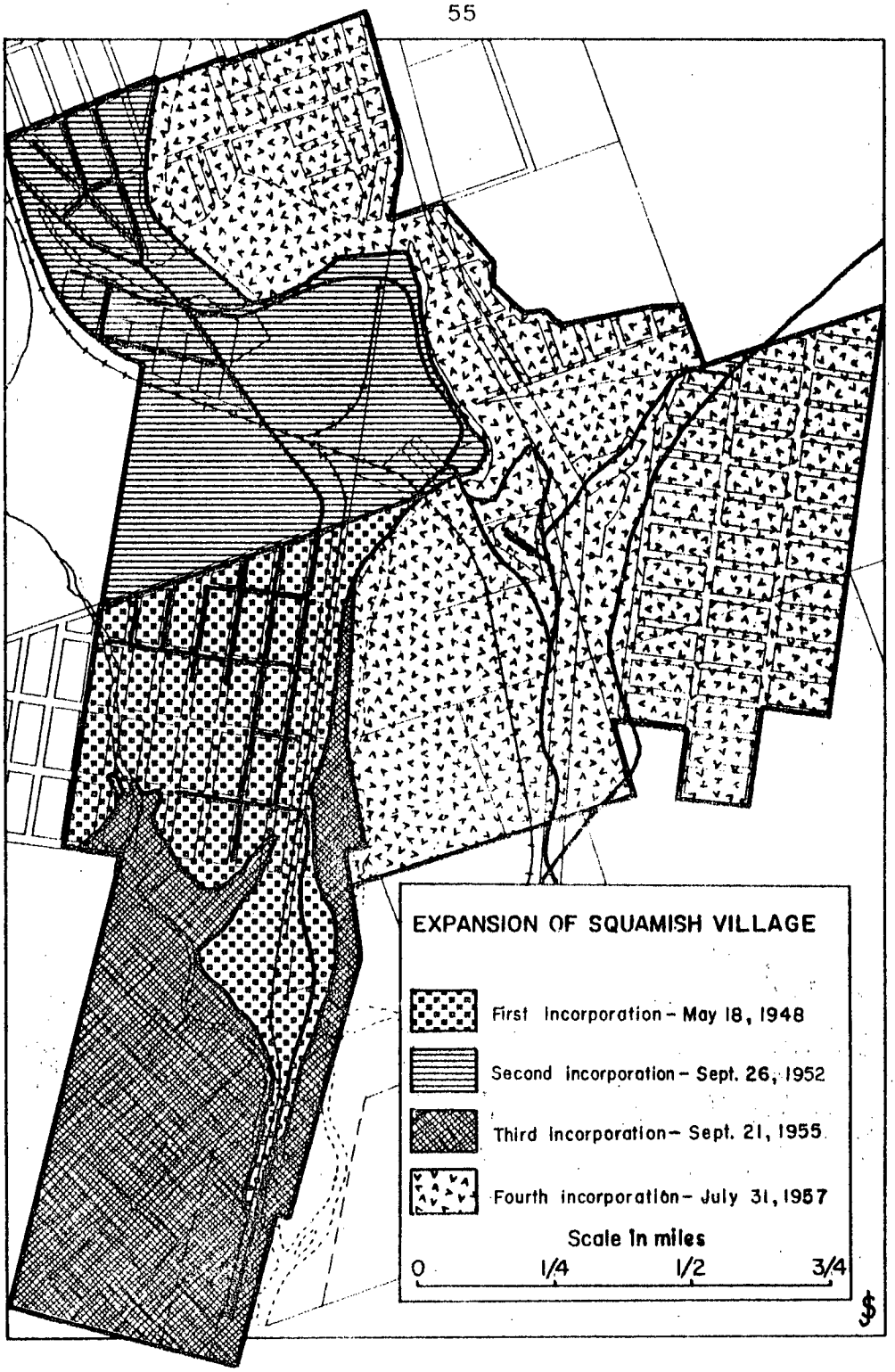
* Some of the maps contained in this thesis were drafted before the boundary of the village was enlarged for a fourth time.

** Information from a confidential source, February 22, 1957.



EXPANSIONS OF THE BOUNDARY OF

SQUAMISH VILLAGE

MAP 9

were the Surveyor General, Chief Land Inspector, Director of Land Utilization Research and Survey Division, Director of Conservation, Superintendent of Lands, and Deputy Minister of Lands, all of the provincial government.* The committee was to meet periodically to discuss all matters pertaining to the area.

The factors that stimulated the formation of this committee were many and varied. In general it can be said that the Squamish valley was a problem area. Numerous requests had come to the Department of Lands for the acquisition of land. Complaints had been received from valley residents, regarding excessive river erosion and flooding. The P.G.E. with its interest in the area due to installations and ownership of large tracts of land and the possibility of greater space requirements for expansion, presented a further problem. The need for highway right-of-ways and the inadequate pattern of subdivision presented still more difficulties. The net effect was such that the area needed consideration as to its potential by the highest authorities of interested groups in the province.

With the formation of the development committee a map reserve was placed over the entire lower valley. This meant that crown land was made unavailable in all parts of the area. P.G.E. land was also frozen. The committee studied each application for land in terms of the proposed use and the location

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* Information from a confidential source.

of the parcel desired. As a result of this "screening process" no additional land was made available for residential development during the period which the committee functioned. Development of the valley was hindered. As the years passed, attendance at the committee meetings decreased. No one appeared to know just what was in store for the area. The Squamish Valley Development Committee was abolished on November 27, 1953.

A reserve on crown lands within the village boundary had been put into effect on February 23, 1949. By November, 1954 no set policy had been formulated for the development of the area and since the demands for land were steadily increasing, it was decided to lift this reserve. The removal of the reserve did not mean that land was available for purchase since every application still had to be cleared with the Land Service in which the prevailing attitude was that land should not be sold. With pressure for land mounting, parcels of P.G.E. and crown land within the village were to be put up for public auction in 1955. The Land Service assessed all P.G.E. and crown land in the village in preparation for the sale.

At this time, the Land Inspector for the New Westminster Land District, in his annual report, suggested the need for an extensive planning study of the valley, and particularly the need for a complete cost analysis of dyking requirements for the prevention of flooding in the village area. As a result of this report, the Provincial Dyking Commissioner was requested to

conduct a dyking requirement study. His visit to the area resulted in the estimate of $16,500 required for adequate dyking protection. This was to involve the clearing of all growth from existing dyke tops, and the raising of all dykes by three feet with a ten foot top and slopes of one to one. The Dyking Commissioner also declared that no land should be sold until this work was completed. The Commissioner's report was issued on February 21, 1956. Immediately following this, on the request of the Minister of Agriculture, the sale of all crown lots in the village was again restricted, and the auction of those parcels of land proposed for sale was prevented.

Currently, no crown land is available in any portion of the lower valley. Government policy has been one of withholding from sale all lands within their jurisdiction, and thereby preventing a pattern of land use from developing that would be incompatible with future plans for the area. The P.G.E. has followed a similar policy, but has withheld land chiefly for its own use.

The significance of the degree of recent government control over the area cannot be underestimated, nor can the policy of the railroad company be considered lightly. Of all factors influencing the extent of development, the land policy resulting from cooperation between the P.G.E., various government departments and the Land Service is of utmost importance.

On March 30, 1957, Premier W.A.C.Bennett of British Columbia announced a government plan to promote the development

of the Squamish area as a sea-port. This is the most important factor yet in its sequence of development. If the plan is carried out as proposed, the valley will be ultimately utilized to its greatest extent, a wonderful climax to an otherwise discouraging process of development.

CHAPTER V

PRESENT STAGE OF DEVELOPMENT

The present stage of development of the Squamish valley is discussed in such a way as to provide an inventory of the pattern and extent of its existing use.

I. LAND USE

Land use in the lower Squamish valley is fully illustrated on Map 10. The various uses of land are classified under five major categories.

1. area used for buildings, townsites and industry
2. cultivated farm land
3. farm land abandoned or reverted to pasture
4. waste land - sand and gravel bars, tidal flats and natural meadow
5. forest - virgin forest, second growth or recently logged.

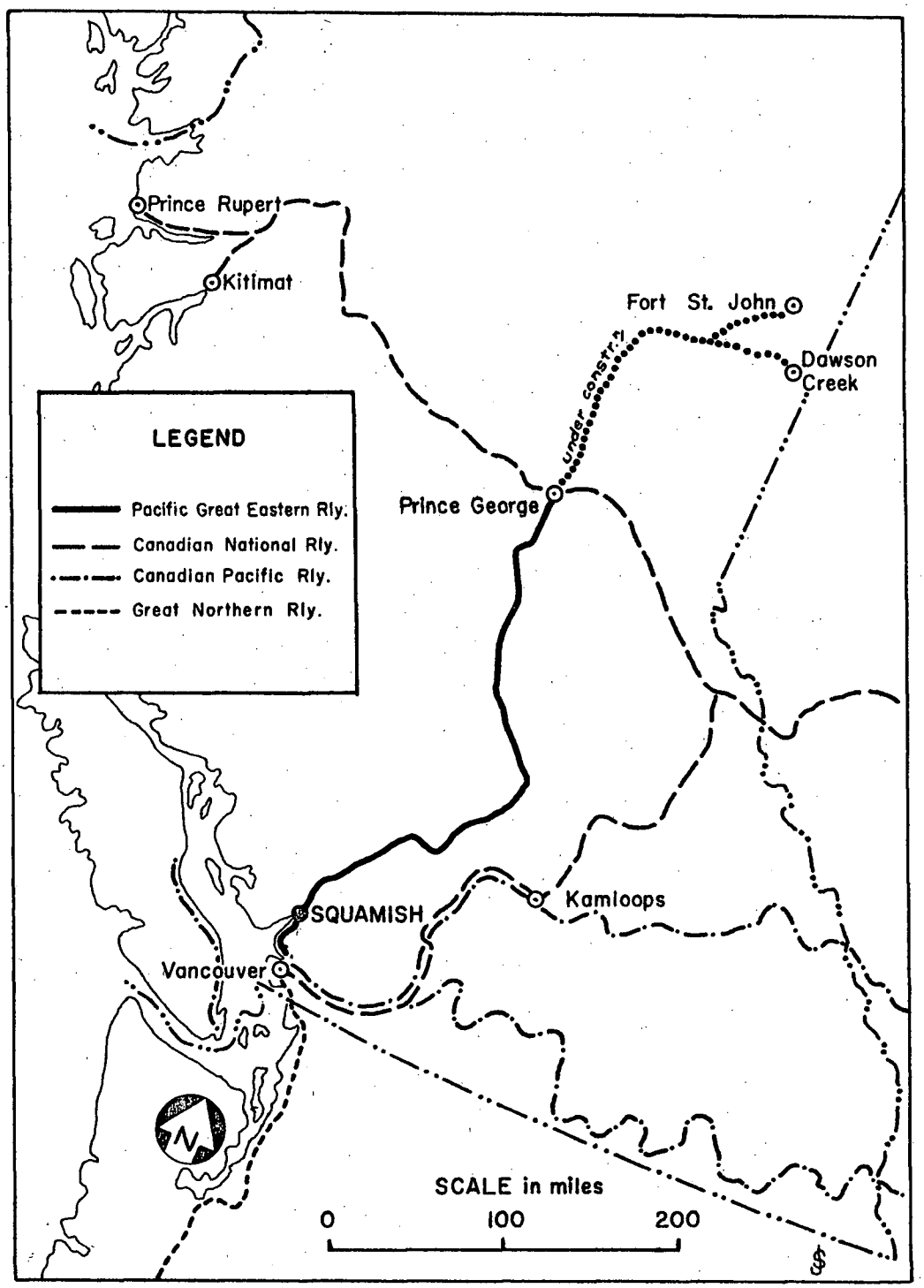
The distribution of used land presents an unusual pattern. As the valley is restricted on both sides by rivers and steep mountains, development has occurred in a linear pattern, for the most part, following the east bank of the Squamish river. The river delta remains largely unused except for that portion within the village that has been reclaimed by dyking and draining. Most agricultural land is found in Brackendale, farming being initially attracted there because land values were relatively low for the valley.

In general only a small portion of the valley is put to intensive use. Many large areas of vacant forest or waste land exist. Regardless of the fact that a great deal of land is potentially available in the area, the present pattern of use will dictate or certainly influence the pattern of future use of remaining areas.

II. TRANSPORTATION FACILITIES

Much of the recent attention directed to the Squamish region has resulted from the improvement of major transportation facilities serving the area. Improved means of transportation has meant the difference between the valley lying economically dormant or showing promise for extensive development.

Map 11 shows the position of Squamish with respect to major rail lines in British Columbia. The completion of the P.G.E. to North Vancouver in 1956 made the entire province a potential hinterland to Squamish. Commodities moved over the Canadian Pacific Railway main line and those handled by the Kettle Valley route as well as Canadian National Railways main line freight and Grand Trunk route traffic can all be directed to Squamish. United States freight from the Great Northern Railway can reach Squamish through the Canadian National Railway interchange. The Milwaukee Railway operates a rail barge service from Squamish south into the State of Washington. It can therefore be seen that Squamish is in a favorable position with respect to rail location. The most significant and highly



SQUAMISH IN RELATION TO MAJOR RAIL LINES

IN BRITISH COLUMBIA

MAP 11

publicized advantage of rail service to Squamish is that of a direct connection with the Peace River country. This may prove to be the most vital rail link serving the Squamish region.

Major highways in the province follow roughly the same routes as those taken by the rail lines (see Map 11). With the completion of the Squamish-Vancouver highway in 1958, Squamish will be accessible by road to all important points in the province.

Transportation facilities within the valley are adequate although somewhat limited. Roads are all gravel except in the village where a few streets have recently been hard-surfaced. One main road serves the valley as a through access route. It is a narrow gravel road rather poorly maintained, and extends northward up the Squamish valley to the British Columbia Electric Company power station at the Squamish river, some twenty miles from the head of Howe Sound. The P.G.E. serves local industrial sites and commercial areas with spur lines. River tugs operate on the Squamish river solely for the movement of logs downstream.

III. LAND OWNERSHIP

Land ownership in the lower valley is illustrated in Map 12.[1] Ownership has been classified as to those lands held

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[1] This map was compiled by the author and the Land Inspector for the New Westminster District directly from the tax assessment rolls. The status is valid for 1956. For the sake of clarity on the scale of the map, ownership has been slightly generalized in three areas: (1) within the central portion of

by: (1) the Crown; (2) the Department of Citizenship and Immigration, Indian Affairs Branch; (3) The P.G.E., and (4) private owners.

Land Ownership within Squamish Village

The village consists of a total area of roughly 1240 acres. Of this, about 210 acres are owned by the Crown and approximately 535 acres by the P.G.E. The remaining 495 acres are in private ownership.

The position and large amount of P.G.E. land is very significant. The large tract of railroad-owned land in the southern portion of the village is within the area zoned for industry. Of this, the water lots are zoned for heavy industry, whereas the remainder of this property is zoned for light industry. (see Map 14).

A second large tract of P.G.E. land within the incorporated area consists of a continuous parcel which effectively divides the village area into two halves. This land is in an area zoned for residential use, and is strategically located for the continuous residential development of the village.

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the village, (2) immediately adjacent to and west of the village by the omission of four private lots, and (3) between the village and the Mamquam river, by the omission of two private lots. The author has possession of a larger scale map with the status correct in every detail, from which Map 14 was drawn.

Most of the crown land is in the Stawamus river valley and is not strategically located so as to seriously affect the pattern of community development for several years hence. The greatest part of the privately held land in the village is presently developed. That which remains is in small units. It may be concluded that the key to the development of the area presently within the village boundary lies in the decision of the P.G.E. as to what land will be sold and in what quantities.

Land Ownership in Unorganized Territory

In the unorganized part of the lower Squamish valley, the ownership of land presents an interesting pattern. The area is held in large tracts by three groups (1) the Crown; (2) the P.G.E., and (3) private owners. Each large parcel generally stands as a separate unit, perhaps capable of controlled development.

In the unorganized area as in the village, the P.G.E. holds one of the most valuable and certainly the most controversial portions of the valley. This area is a continuous block of land comprising the delta of the Squamish river between the village and the mountains on the western side of the valley. Here, the railroad company holds a block of 1024 acres, 925 acres of which are flat alluvial land. Many industrial inquiries concerning the valley have centred on this area. It is evident that the railroad controls the development of the delta by its decisions regarding disposal of this land.

The Crown holds most of the area between the village

and the Mamquam river. Crown ownership of this large area is broken only by one block of land held by a consolidated group of owners. It is conceivable that this area could become a residential district due to its proximity to the present village area. The development of this portion of the valley, however, is improbable in lieu of the government's concern over the flooding hazard of the Mamquam river.

The largest continuous tract of privately held land in the valley bottom is found in the Brackendale area. Much of this land is abandoned farm land (see Map 10). Some of it is available for purchase and could provide land for residential requirements if subdivided. Much of the area, however, is not first class residential land because of poor drainage, likelihood of river erosion, and the flooding hazard.

The Cheekye alluvial fan is almost entirely a continuous block of crown-held land. This area is not liable to flooding, is well-drained, has an excellent view and has longer hours of sunlight than any other part of the valley. It has many attributes of an excellent residential area.

Land ownership in the Stawamus river valley has an unusual pattern. A large portion of the flat valley bottom is still held by the Crown. This block of land comprises most of the area initially subdivided. It is surrounded by land held by one private owner. Part of the entrance to the valley is held by the P.G.E. and the remainder by the Department of Citizenship and Immigration, Indian Affairs Branch as Indian Reserve. This valley has received little attention as a

potential residential site due to its proximity to the steep-rising mountainside and the resultant few hours of sunshine. There is the possibility, however, that it may be considered in the future as an industrial site.

Land held by the Indian Affairs Branch in the form of reserves does not constitute a large acreage. For the most part, these parcels of land are adjacent to the Squamish river in areas highly subject to both river erosion and flooding. They are scattered and not strategically located so as to present an obstacle to the continuous development of the region.

Of all factors pertaining to the development possibilities of the lower Squamish valley the matter of the pattern and extent of land ownership by specific groups is one of the most significant. Fortunately, much of the valley is still held by the Crown and the Crown corporation, the P.G.E., both of which are anxious to see a well-organized development. One can therefore expect land to be more readily available to meet this end, than if private ownership were dominant.

IV. PRESENT AGRICULTURE

Agriculture has less significance in the Squamish valley than one might imagine. However, it is a factor in the present stage of development.

In the period from approximately 1900 to 1940, farming was a major economic activity. Some farm products such as potatoes and raw milk were shipped out of the region, but not in

large quantities. Most farming was either conducted at the subsistence level or concentrated on dairy products for local sale. In recent years, agricultural activity has declined. For various reasons, several farms have been abandoned. Perhaps this is primarily because the younger people have not been willing to take over family farms, preferring to gain more lucrative employment particularly with the railroad and logging companies.

At present, only one farm unit remains in economic production, a small dairy farm operated by a long-time resident. The minor quantity of milk produced here competes with the Fraser valley product for the local market.

Due to the decline in agricultural activity over the past fifteen to twenty years, large abandoned fields remain. These areas are standing unused or are providing a source of natural hay for the few horses and cattle that graze, at most times unattended, in the valley.

Photograph No. 7 Abandoned Farm Land and Buildings at Brackendale.

Photograph No. 8 Abandoned Farm Land of the former Hop Ranch at Brackendale

Photograph No. 9 Abandoned Land and Buildings of a former Dairy Farm in Squamish Village

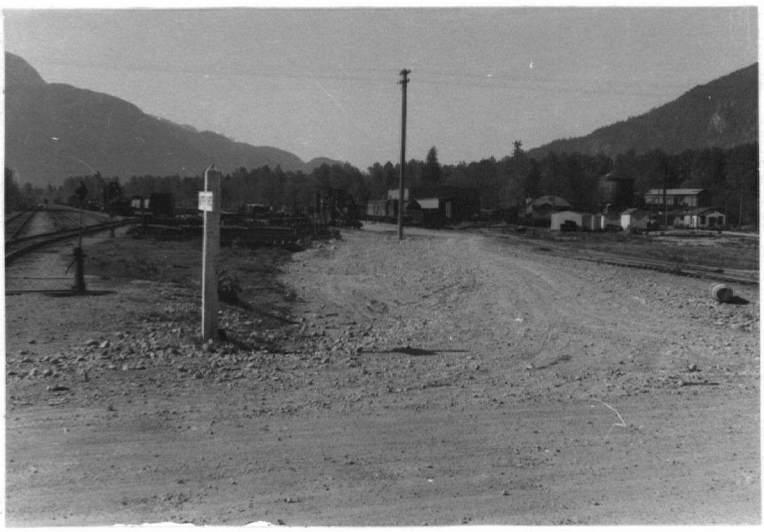
V. PRESENT INDUSTRY

In contrast to agriculture which is on the decline, industry is becoming increasingly dominant as the major economic activity.

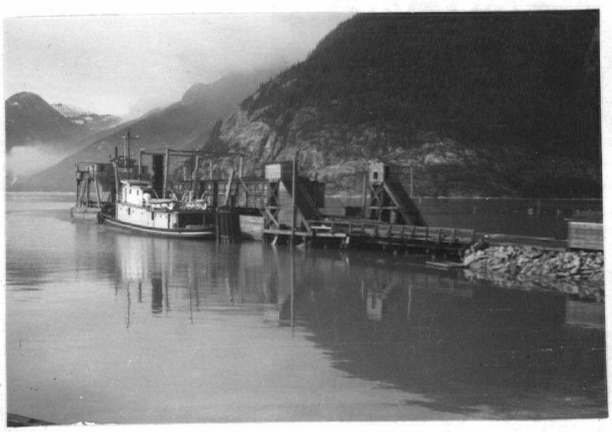
Of the thirteen industrial firms in the valley, eleven are logging or lumbering concerns. The P.G.E. and the British Columbia Electric Company Limited are the only exceptions. (see Appendix C). The firms connected with the logging industry employ a total of 250 to 275 men depending upon the season and the existing market conditions. The P.G.E. employs approximately the same number stationed in Squamish. The British Columbia Electric Company's branch at Squamish has a staff of about six permanent employees.

The significant factor concerning local labour force is its composition. Many industrial workers are transients. This is particularly true with respect to those people employed in the logging industry. Generally speaking, only owners and operators of the logging companies are permanent or semi-permanent residents in the area. Nearly all others come and go regularly. Many railway employees also are transients. Mechanics, permanent staff in the railway shops, and men with high seniority in the operating trades are usually the only railway employees to take up residence in the community. About half of the labour force in all local industry consists of young single men living only temporarily in the valley.

The nature of the labour force presents many problems.



Photograph No. 10 A Portion of the P.G.E. Shops and Classification Yards



Photograph No. 11 P.G.E. Barge Slip at Squamish Dock

Photograph No. 12 Small Shingle Mill

Photograph No. 13 Empire Mills Limited Sawmill

Photograph No. 14 Empire Mills Limited Bunkhouse Shops, Log Dump and Barge Loading Area

Photograph No. 15 P.G.E.Siding and Anglo-Canadian Logging Co. Log Dump.

Its instability creates an unsteady market for those engaged in commerce. Much housing is temporary, thereby contributing to the untidy nature of residential areas. Juvenile delinquency is furthered by the presence of many irresponsible single men. In general, the instability of the labour force is a detrimental factor in the Squamish region at its present level of development.

Since a large portion of the local industry is concerned with the gathering of logs and their bulk shipment out of the valley, few industrial plants have been established. The only industries requiring any large amount of land are Empire Mills Limited and its associated activities, and the P.G.E.

VI. COMMERCIAL CONDITIONS

Since settlement in the Squamish valley is found in four main areas (see Map 13), commercial conditions are discussed as they pertain to each area. Although community and public services and institutions are not commonly associated with commercial activity, they are included in this discussion since they cater to the needs of the local population just as do private commercial enterprises. They are listed and described separately from private enterprise.

Private Enterprise

Brackendale. This small settlement is served, for the most part, by the facilities of Squamish village. However, a

general store and associated gas station, which have been in operation for many years, continue to meet the immediate needs of residents in the Brackendale area. No other private services exist in this small settlement.

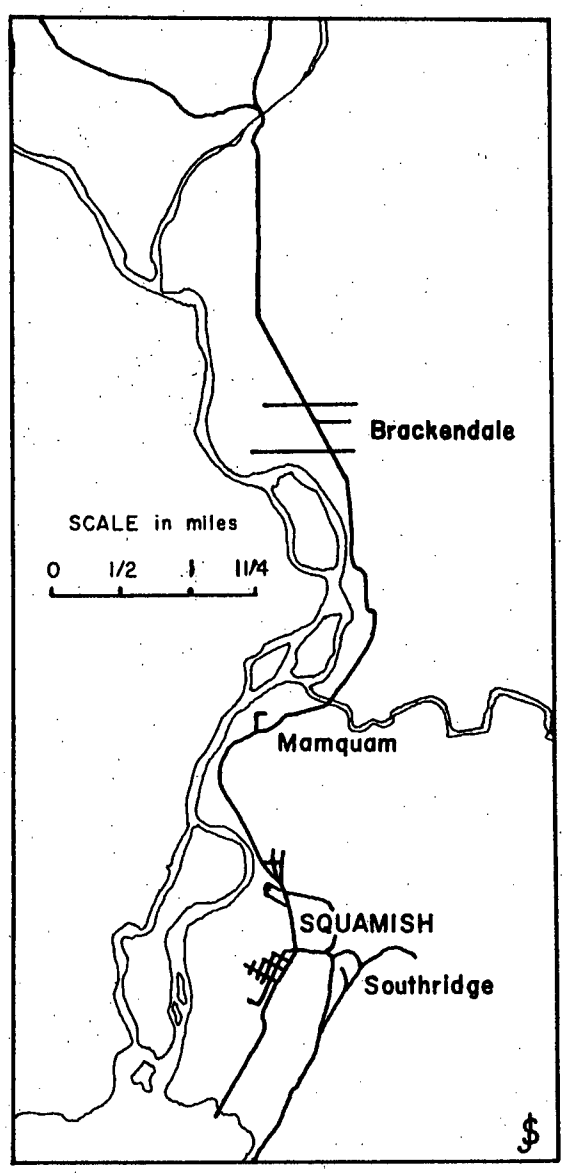
Mamquam. Recent local increase in population has resulted in the further development of a small residential area near the railway shops. This settlement has become known as Mamquam, deriving its name from its proximity to the Mamquam river. The residential district supports no private enterprise other than a small grocery and confectionery store. The residents are almost completely reliant upon the services of Squamish village.

Squamish Village. The village area for many years has had a fairly complete commercial core offering basically essential services and commodities to the local population. In recent years many new businesses have been started. All private enterprise is listed in Appendix D.

Southridge. The new residential district of Southridge has been developed recently. This area, overlooking the main section of the village and Howe Sound, is considered to be the better class housing area in the valley. As yet it supports no private enterprise other than a large trailer park.

Community Services and Institutions

Community services and institutions are listed in



VALLEY SETTLEMENTS

MAP 13

Appendix F. All are located in the village of Squamish except for the Farmer's Institute which meets at Brackendale.

Public Services and Institutions

Public Services and Institutions are listed in Appendix E.

The Character of Commercial Activity

The preceding statements and appendices have provided a factual account of commercial and community activity in the region. A further and equally significant aspect is that of the character of this commercial activity. This discussion of character pertains to the village only since the commercial activity outside the municipal area is negligible.

The commercial area of the village is confined largely to one main street. Many of the buildings are old, having been constructed when settlement first began. Consequently, the main street has a rather shabby appearance. New commercial construction has tended to improve the appearance of the street, but not sufficiently to detract from its generally untidy condition. Logging companies, some of which have left the valley, have blighted the downtown area by leaving discarded machinery on vacant lots. Of all the factors that detract from the appearance of the commercial core, the indifference of these companies is perhaps the most significant.

The attitude of certain businessmen does not enhance the character of the village. Their shops lack the facilities

that one would normally expect to find with their level of business. This results from a lack of competition. The size of the village and the transient nature of the population is such that few services are duplicated. The majority of the businesses that do exist dedicate the absolute minimum of expenditure for shop appearance. Only as recently as 1956 were electric signs installed. Services such as hotels and cafes offer only the bare essentials to the traveller. In brief, the character of commercial activity is detracting rather than adding to the appearance of the village.

Photograph No. 16 View South Down the Main Street of Squamish Village

Photograph No. 17 Small Commercial Area in the "better" part of the Village

Photograph No. 18 New Buildings in the Downtown Business District

VII. VILLAGE ZONING

To date there has been no community planning for the village of Squamish. Zoning restrictions, which are merely a regulatory aspect of planning, have constituted the only action in this respect. These restrictions are set down in By-law No. 29, the purpose of which is "to divide the village of Squamish into districts and to make regulations in relation thereto, regulating the location, use and height of buildings, size of yards and other open spaces; and the use of land pursuant to the provisions of the 'Town Planning Act' and the 'Village Municipalities Act'."[26]

The by-law divides the village into four districts classified as residential districts, commercial districts, light industrial districts, and industrial districts. These are shown as Schedule A of the Zoning By-law, and are illustrated on Map 14.

The four districts have been so designed as to coincide with the present pattern of development and to allow for growth of commercial and industrial activity and its corresponding population increase. Since the zoning does allow for expansion of commerce and industry, there is a high proportion of the village dedicated to this future use of land. Consequently, there is a smaller amount of zoned residential land than would seem necessary to support the potential business and industrial

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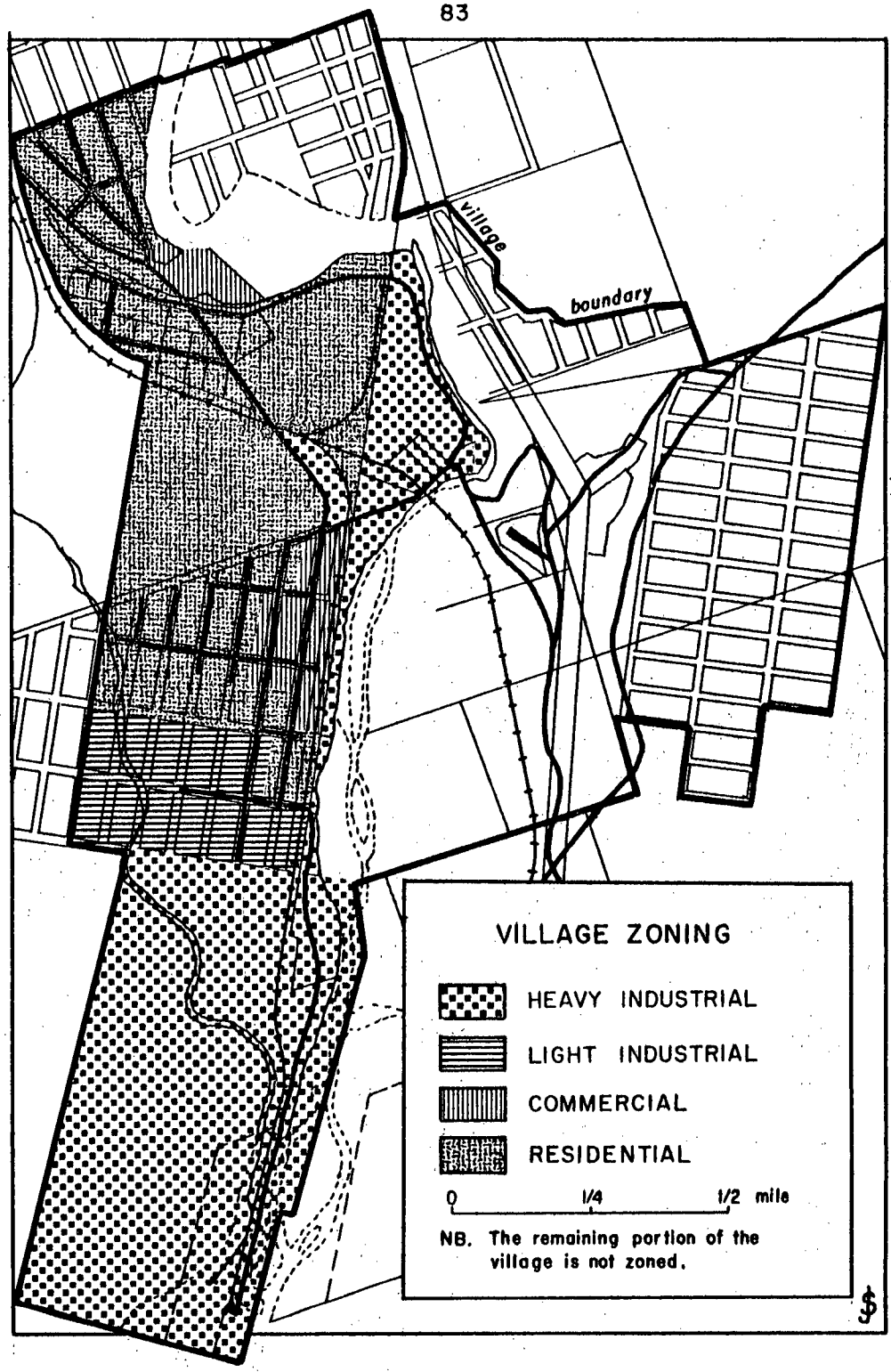
26 The Corporation of the Village of Squamish, "By-law No. 29," 1954.


village
boundary
VILLAGE ZONING
HEAVY INDUSTRIAL
LIGHT INDUSTRIAL
COMMERCIAL
RESIDENTIAL
0
1/4
1/2 mile
NB. The remaining portion of the village is not zoned.

MAP 14

establishments. The zoning, although lacking in certain refinements associated with complete community planning, does present the possibility of readily adapting itself to increase in the size of the village.

VIII. DEVELOPMENT TRENDS

Since the end of World War II the Squamish valley, as with many other small rural areas in the province, has experienced a generally accelerating rate of development. Both the logging and railroad industries have expanded, attracting more workers to the area and creating the need for increased services. Consequently the population of the valley has increased noticeably. For various reasons the pattern or trend of development is rather peculiar.

In this post-war period, about 145 new homes have been built bringing the total number to approximately 390. One would normally expect a high percentage of new home construction to take place within the village since this area has vacant land, provides water and all other necessary services. Figure 6 shows that there are only 67 new homes within the village compared to a total of 78 outside the village.

FIGURE 6

APPROXIMATE NUMBER OF NEW HOMES
BUILT DURING THE POST-WAR PERIOD

Brackendale settlement	30
Mamquam	24
Squamish village	67
Southridge	24
Total	145

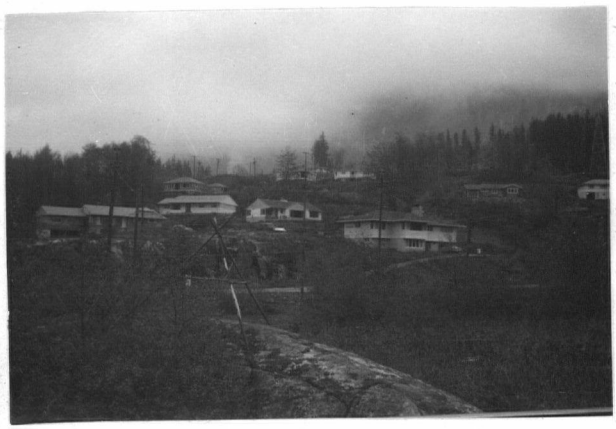
This peculiar development trend largely results from P.G.E. and crown land being withheld from sale in the village and in the area adjacent to the Mamquam river. The privately owned land in these areas either has been developed already or else the owners of vacant property are, for various reasons, unwilling to sell. Consequently, new home construction is forced out of these areas to Brackendale and Southridge. The settlement of Mamquam, although in a flood-danger area which would be withheld from sale if it were crown land, has developed because the land was privately held and available for purchase. The settlement of Southridge has developed on privately owned land which was subdivided and made available in the post-war period.

Because of poor drainage within the dyked portion of the village area (see photographs 19 and 20) many homes are without basements. In both Brackendale and Southridge, with higher ground and resultant good drainage, basements are possible, thus creating a further incentive to live in these areas.

Since land has been more readily available outside the village area than within, and since outlying areas often provide a more pleasant place to live, the recent development in the valley has followed a pattern that at first seems illogical. It is entirely probable that the development of these outlying areas will continue in the future unless land is made available and living conditions are improved within and adjacent to the village area.

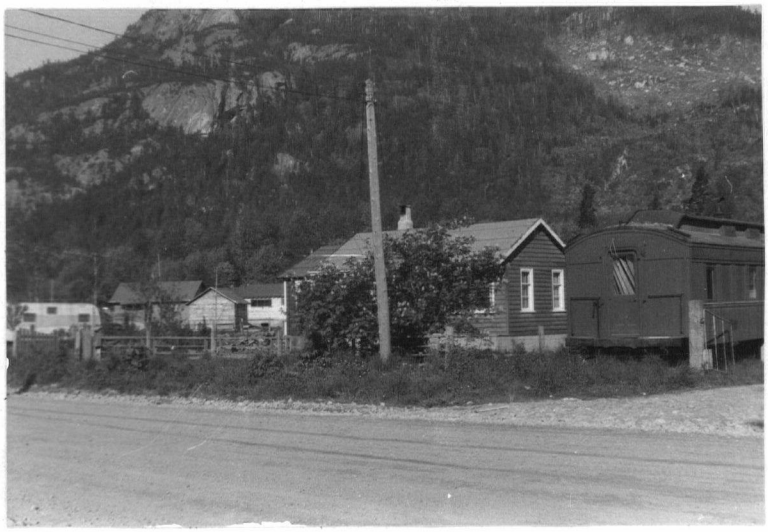
Photograph No. 19 Swing Flood Gate in the Dyke Surrounding Squamish Village

Photograph No. 20 A Portion of the Dyke Surrounding Squamish Village



Photograph No. 21 New Housing at Southridge

Photograph No. 22 Further View of New Housing at Southridge



Photograph No. 23 New Housing at Mamquam Settlement

Photograph No. 24 New Housing in Brackendale

Photograph No. 25 New Housing in Brackendale on the Cheekye Alluvial Fan

Photograph No. 26 Slum Area in Squamish Village

CHAPTER VI

RESOURCES AND RESOURCE USE

This thesis is composed of two major sections, first, the inventory aspect, in which the character and present use of the region are assessed and second, the analysis aspect, the determination of optimum use of land and the subsequent potential for development of specific areas and particular aspects of the economy. The discussion of resources and their use falls somewhat between these basic divisions but should be related to both.

I. FOREST RESOURCES

The forest wealth in the Squamish region is not accurately known. There has been no complete forest inventory to establish either the growth potential or the amount of timber available by species. The fact that the forest resource is great, however, cannot be denied. MacMillan and Bloedel Limited, in its Brief to the Royal Commission on Forestry, discusses the area in terms of the need to construct an access road:

> "This road will make over 1,000,000,000 feet B.M. of Crown timber available to market loggers and to mills in the Strait of Georgia region. This area is most important as a potential Public Working Circle for the very large and important logger and mill population of Vancouver and the Fraser River.

> The valley is also valuable as a source of Douglas Fir. The Forest contains over 300,000,000 feet B.M. of Douglas Fir, all very near the sawmills of the Vancouver and Fraser River milling centers."[27]

This statement tends to summarize the situation fairly well in terms of the advantage of the region from an economic point of view and in terms of the value of the resource itself.

Proposed Forest Management Licences in the region, the development of which would bring the raw material and possibly the finished forest product through the Squamish region are shown in Map 15. These licences are "Applications Advertised". They are not yet granted, awaiting the outcome of the Royal Commission study. The decision as to whether or not these licences will be granted and to whom will have a very direct effect on the development potential of the Squamish region.

Map 15 shows two licences in the area, one applied for by Empire Mills Limited, a firm already operating in the valley, and a second applied for by MacMillan and Bloedel Limited who also conduct logging operations in the region. MacMillan and Bloedel Limited, as indicated in its Brief, presses for the creation of a Public Working Circle in this area rather than a Forest Management Licence as applied for by its opposition, Empire Mills Limited. Yet, a few miles from this proposed licence area, in the upper Pemberton valley, it argues in favour

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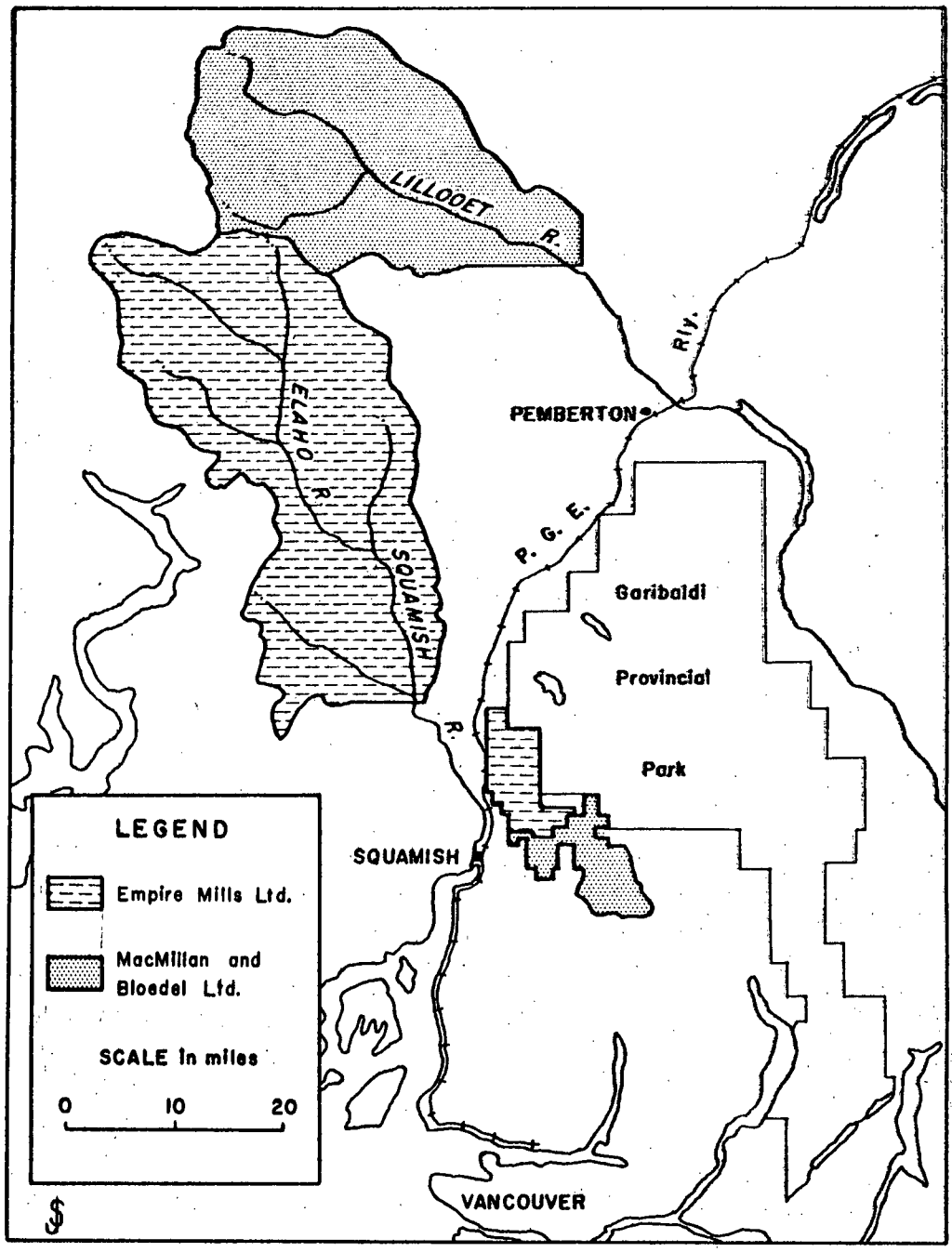
27 MacMillan, H.R., Brief Submitted to Royal Commission on Forestry British Columbia, MacMillan and Bloedel Limited, Vancouver, British Columbia, November, 1955, pp. 14, 16.



Source: Brief submitted to Royal Commisson on Forestry, B.C. by MacMillan and Bloedel Ltd.

FOREST MANAGEMENT LICENCES " APPLICATIONS ADVERTIZED " 1953

MAP 15

of the establishment of a Management Licence for which it has applied. Clearly, if area Number One goes to Empire Mills Limited, MacMillan Bloedel probably will not benefit from it in any way. If it is developed as a Public Working Circle adjacent to their own possible Management Licence they could at least purchase logs to be processed in their integrated forest products plant, which, in all probability, would be located at Squamish. Resulting from this conflict over forest resources there is the possibility of, in one case, one forest products plant being located in the Squamish area, and in the other, if Empire Mills and MacMillan and Bloedel both are granted licences, the possibility of two plants locating in the area. It can therefore be seen that the decision of the Royal Commission on Forestry will have a direct bearing on the manner in which the forest resource of the area is utilized.

A further point to consider regarding forest resources is that of the possibility of tree farming. The upper Squamish valley supports a luxuriant cover of second growth deciduous trees, chiefly alder, maple and cottonwood. According to one authority, this area has the prerequisites for productive tree farming, utilizing chiefly cottonwood because of its excellent pulping quality and extremely high growth rate.[1] Map 16 shows a portion of the upper valley most of which is within the

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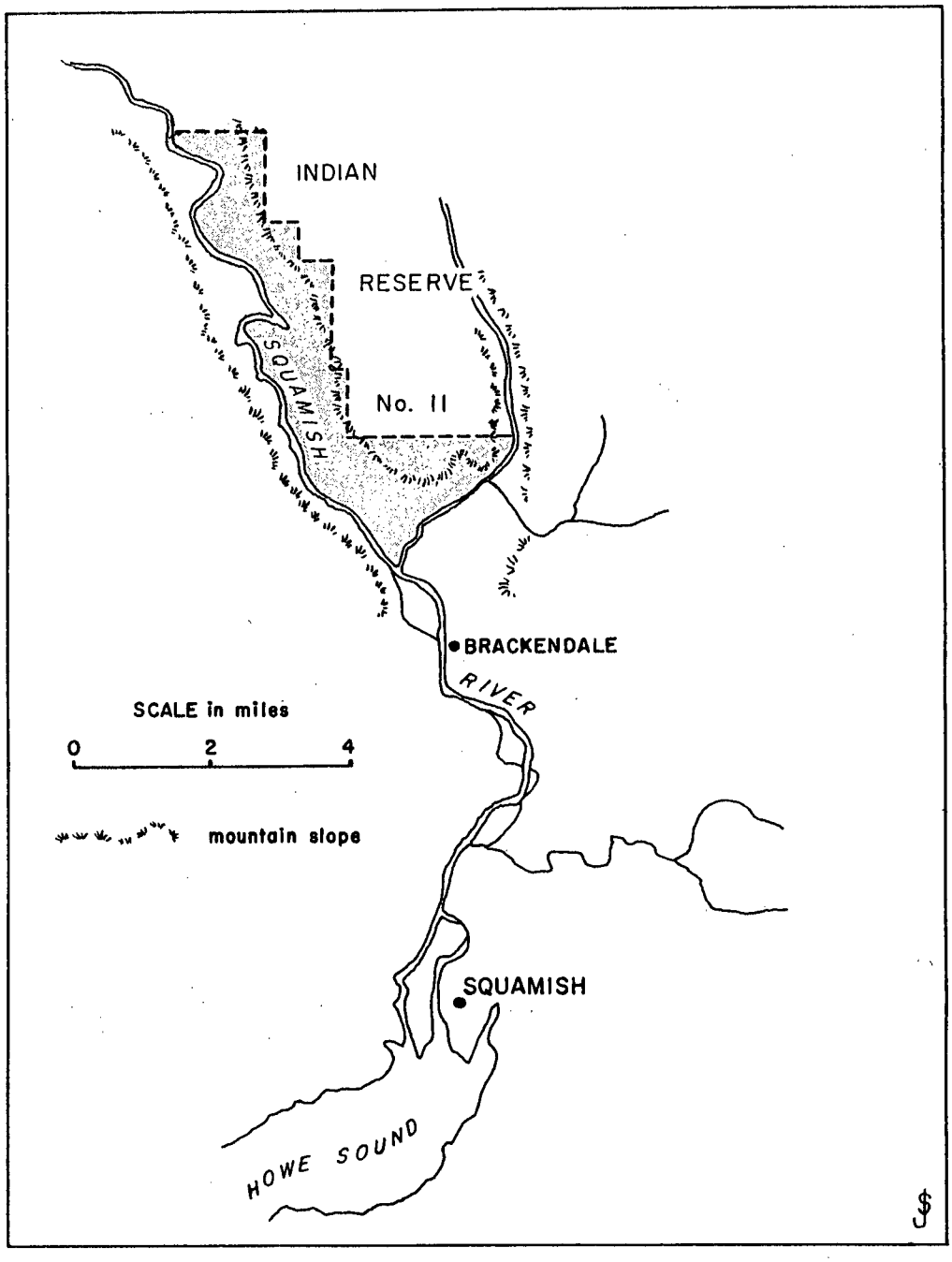
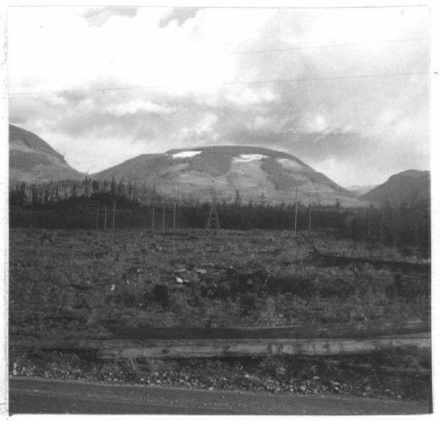
[1] This opinion was obtained from Mr. D.O.L. Schon of the Powell River Company Limited in an interview with the writer, Vancouver, British Columbia, March 4, 1957.

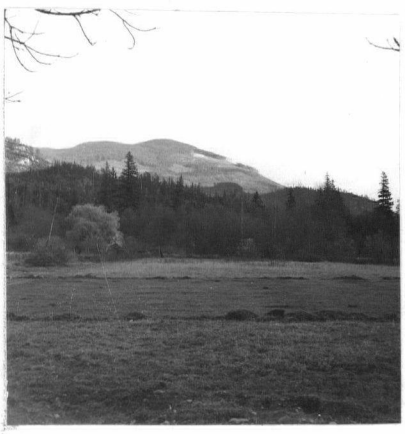


INDIAN RESERVE NUMBER 11

MAP 16

boundaries of Indian Reserve Number 11. This area, consisting mainly of river floodplain is devoid of use at the present time. Since there is little likelihood of its utilization for industrial, residential or agricultural purposes, it could well be put to use as a deciduous tree farm. This is only one portion of the Squamish region that could be devoted to this use. Other areas to the north in the Squamish river valley, and to the east in the Cheakamus river valley, could be equally productive in this respect.





Photographs No. 27, 28, 29 Three General View of Logged Areas in the Squamish Region

II. MINERAL RESOURCES

The mineral resources of the Squamish region are few or have not yet been discovered. Mining has played a very minor part in the development of Squamish. At Britannia, however, a few miles south of Squamish, and just outside the limits of the Squamish region as defined in this thesis, mining has been the only economic activity. Prior to 1930, Britannia rated as the largest copper mine in the British Empire. It operated continuously since about 1911 producing not only copper but the associated minerals, gold, silver, and zinc as well. Due to declining prices of base metals and the rising cost of labour, Britannia has finally been closed. Ore reserves are still sufficient to operate the mine, but only under more favourable economic conditions. Britannia has been almost entirely a "Company town". Whether or not it can prosper as a community independent from mining yet remains to be seen. Complete decay of the community would not have an adverse effect on Squamish to any degree. The two settlements have always been largely economically independent.

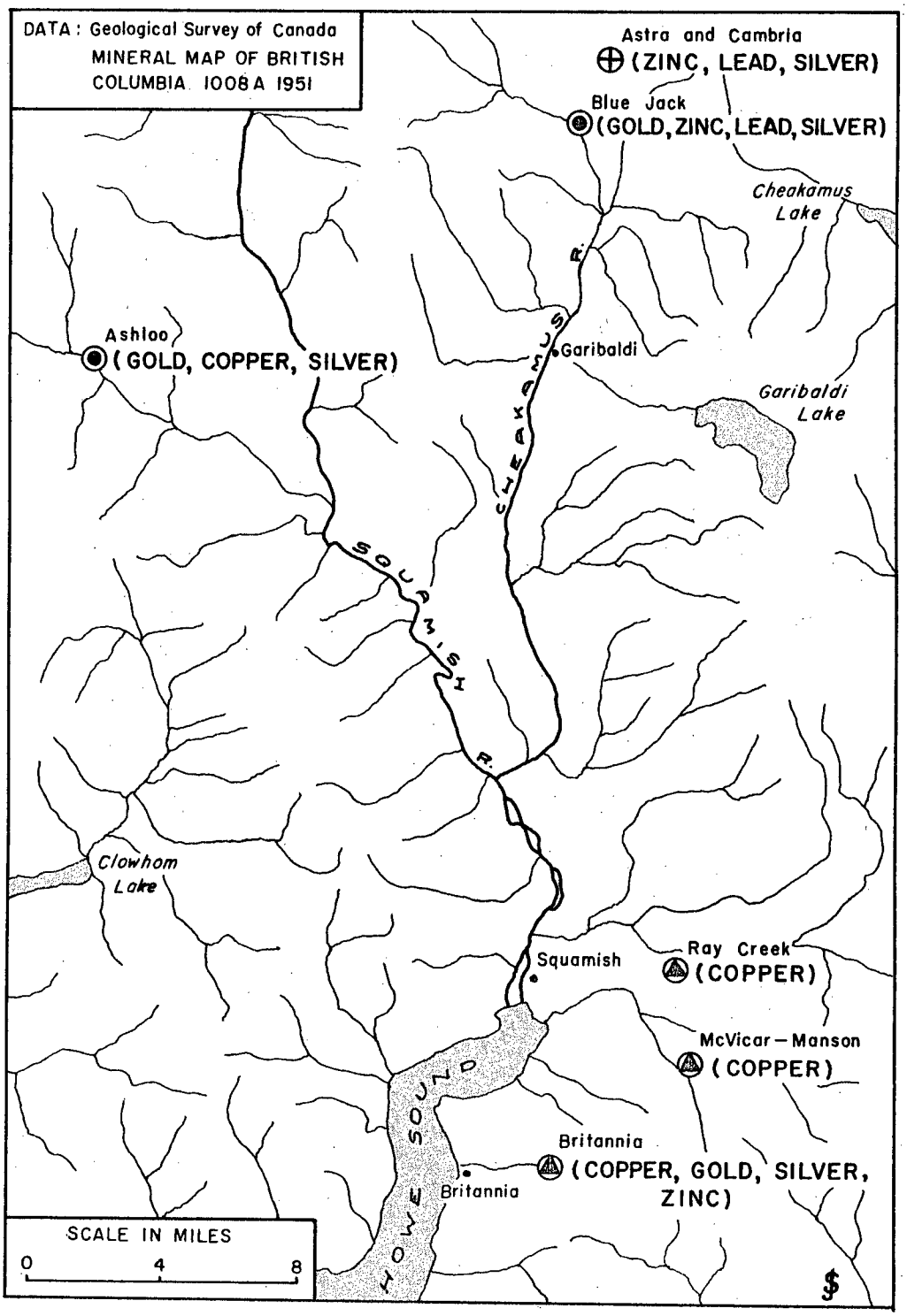
Map 17 shows mineral resources in and adjacent to the Squamish region. The Britannia, Ray Creek, and McVicar-Manson properties are all copper bearing. Their close grouping suggests association one with the other. Perhaps further exploration and a better market for copper at a later date could put these properties into production.

Gold, lead, zinc, and silver mineralization are found

throughout the region. Many of the ores are of high value but are not in workable quantities. Apart from the large amount of gold recovered from Britannia ore, Ashloo was the only major producer of gold in the region; it has not been worked for many years.

Non-metallic minerals have never received any particular attention. Bricking clay of no extraordinary quality and small quantities is found in many parts of the region. During the depression years a small brick plant operated at Darrell Bay, along Howe Sound two miles south of Squamish settlement.

The prospects for further local development of the mining industry are difficult to predict. Probably the past trend will continue, with Squamish becoming increasingly less concerned with mining as a sector of its economy.



REGIONAL MINES AND MINERALS

MAP 17

III. POWER RESOURCES

Water is the only present and potential source of power in the immediate region. Coal and natural gas are neither imported nor found locally and therefore are not available for thermal power.

Hydro power was first developed locally by the P.G.E. The Stawamus river was dammed and a pipeline was constructed about three miles to a powerhouse located near the settlement at tidewater. Squamish lies within the service area of the British Columbia Electric Company and now obtains power from this company through its substation at Britannia.

The recent development of the Cheakamus river as a hydroelectric source has been the only major power development in the region. The waters of the Cheakamus are dammed at Garibaldi and diverted westward through a seven mile tunnel to a powerhouse in the Squamish river valley twenty-seven miles north of Squamish village. The power plant, which in late 1957 rated as the world's largest remotely controlled station, was extremely difficult and costly to construct due to its isolation and the rugged nature of the country. It produces 180,000 horsepower and generates 160,000 kilowatts.[28]

The Elaho, a northerly tributary of the Squamish river, has been surveyed as a potential power source. It also would

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28 W.J.W. McNaughton, ed., "Cheakamus," Electrical News and Engineering, December, 1957, p. 61.

be difficult and costly to utilize. Garibaldi and Cheakamus lakes in Garibaldi Park provide natural storage of glacial waters and could develop much needed power for the growing needs of Greater Vancouver. Their inclusion in the park and their resultant value for recreational purposes, however, preclude their use as sources of hydroelectric power.

Further development of local power sources depends largely on the manner in which power requirements are met on a provincial-wide basis. Greater use of thermal power or the development of large sources such as the Fraser and Columbia rivers would probably mean a trend to utilize fewer small and expensive sites such as those found in the Squamish region.

IV. COMMERCIAL FISHERIES

The lower reaches of the Squamish, Cheakamus, and Mamquam rivers, and some of their tributaries provide excellent spawning grounds for pacific salmon. Sockeye is the only species that does not inhabit these waters. The head of Howe Sound is well known for superior sport fishing during the salmon runs. The commercial fishery, although not large in comparison to that in other coastal waters, provides employment and income to some local fishermen. With increasing governmental control of catches and the implementation of more technology, the value of the resource is improving annually. Further hydroelectric power development in the Squamish region should have little effect on the commercial fishery. Providing adequate water

pollution control is exercised, industrialization should not seriously affect this resource.

In summary, the past trend of resource use should continue, with forestry being by far the most valuable in the local economy. With the eventual implementation of provincial policy to put forests on a perpetual yield basis, the forest resource should become increasingly more valuable. Mining, being based on a non-renewable resource, should relatively decline.

CHAPTER VII

AGRICULTURAL POTENTIAL

I. ECONOMIC FACTORS

With the recent extension of rail facilities to Vancouver and the completion of the Squamish-Vancouver highway, one might expect to find an increased interest in local production of farm commodities. These new transportation facilities should place the Squamish valley in a more competitive position as a food producing region. The increased interest that one might expect has not occurred. There are various reasons for this, one of which is the competition for land. The use of land for agriculture in this area, as in others, must compete with the demand for land for other and perhaps higher uses. As has been previously explained, in the Squamish valley, much of which is unsettled, there is a strong competition for land. In the past few years, even with a moderate amount of development, farm land has already begun to concede to the higher use of residential expansion.

It is reasonable to suppose that if a high degree of commercial and industrial development is to occur, agricultural land may continue to yield to these higher uses. The only circumstances that would deter this would result from an exceedingly high demand for agricultural products from local sources. With the demand for agricultural products presently being met such as it is in western North America, the necessity

of greatly increased local production cannot be immediately forseen. One would conclude, then, that if the Squamish region experiences a significant increase in commercial and industrial activity, agricultural activity will continue to decline.

However, if by chance physical and economic conditions changed so as to be more favorable to agriculture, it is possible that some local production would be warranted. Dairy farming would probably be favored due to physical conditions. If raw milk could be produced at prices competitive with those of the lower Fraser Valley, the greatly improved transportation facilities of the region could conceivably permit Squamish to compete for a portion of Vancouver's raw milk market.

Currently, milk produced in parts of the lower Fraser Valley, as much as sixty miles distant from Vancouver, is brought in by tank truck to distribution centres. The Squamish area is less than forty miles from Vancouver. The new hard-surfaced highway, now under construction, will bring this area into what is now an economic distance for bulk milk transport. It is conceivable then that the costs of shipping milk from Squamish to Vancouver would be competitive with those incurred in the trucking of milk from more distant points. If milk produced in the Squamish region could be marketed, it is probable that other dairy products and perhaps poultry products could also be sold.

The valley could expand the dairying industry through

the demand created within and immediately adjacent to Squamish. If industrial and commercial development occurs and a corresponding population increase is experienced, undoubtedly there would be an increased demand for dairy and poultry products in the area. It is possible then, if quality of the local product is competitive with that produced outside the region, that the local producer would be able to meet the local demand.

The nearby communities of Britannia and Woodfibre together constitute a large market for dairy and poultry products. Unfortunately, however, changing economic conditions have recently forced a temporary closure of the mills in both communities. The market for agricultural products in these towns will probably continue to be unstable until a general upswing in the provincial economy carries the mills back into full production.

The settlements along the P.G.E. presently served by the Vancouver outlets, might be supplied more efficiently by the suggested Squamish dairy and poultry industry. The products, particularly milk, would be fresher and transportation costs less if this were the case.

The question is whether or not products from the Squamish area could compete in terms of quality and production costs with the produce of the Fraser Valley. This question bears much investigation and should warrant research before suitable lands are completely disposed of for other uses. Many factors must be taken into consideration, some of which would be:

1. alternative uses of land
2. availability of land
3. factors of soil
4. costs of land
5. costs of clearing land
6. costs of feed production in the area
7. amount of feed that could be locally produced
8. amount of nutrient available per unit of local feed
9. costs of shipping feed to the area
10. costs of shipping produce out of the area
11. factors of climate

These factors and perhaps more must be considered before one could arrive at a meaningful measure of the agricultural potential of the valley. The first, and perhaps the most significant consideration, is that of alternative uses of land. If land is available in terms of both physical and economic factors, what is the comparative advantage of this area over other dairy and poultry producing regions? This is another research problem and so is not discussed in this thesis.

II. PHYSICAL FACTORS

Map 18 illustrates the land capability rating of the lower Squamish valley. The information shown on this map was prepared by the British Columbia Department of Lands and Forests, Division of Land Utilization Research and Survey, the survey being conducted in 1949 with the capability rating designed to be particularly pertinent to agricultural possibilities. This survey included the upper Squamish valley and the lower Cheakamus valley which are excluded from the present discussion.

The classification uses four main categories; (a)

arable land; (b) limited arable land; (c) non-arable land; and (d) wild land. The first three are shown on Map 18, while the fourth, wild land, is omitted for the sake of clarity. Arable land is divided into two classes, and non-arable land into three. The best land in the valley is second-class arable land, land with moderate permanent limitations, and is found in only two small areas. The next best class of land, that defined as having severe permanent limitations, covers a fairly large area roughly defined by the extent of the recent river sediments south of the Cheekye alluvial fan to as far south as the modern delta of the Squamish river. Class four is limited arable land and is found in very small amounts. The remainder of the lower valley is classed as non-arable.

On the basis of this classification, it is obvious that the possibility of extensive use of land for cropping would be severely limited by physical factors. These are particularly problems associated with drainage and flooding. According to Baker who conducted the survey, the soils are infertile and would require large quantities of fertilizer before stable production could be acquired.[29] Clearing costs in the area are also high. Baker quotes a figure of $400 - $800 per acre for clearing, piling and burning.[30] This estimate is out of date but nevertheless the costs are sufficiently high to discourage clearing on many tracts of land.

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29 Baker, op. cit., p. 24

30 Ibid., p. 16

Because of poor drainage in many parts of the valley bottom, the water table is high throughout the entire year. The excessive dampness of the ground keeps soil temperatures low causing a shortened growing season although air temperatures may be sufficiently high to allow growth. Many valley residents do not plant their vegetable gardens until the end of May because of the probability that seeds will not begin to germinate before that time. Unless drainage conditions are improved this could prove to be a severe limitation to the possibility of successful truck gardening.

The climate of the area as discussed in Chapter III is not too severe to preclude agricultural development. In general, it might be considered as similar to the climate of the lower Fraser Valley with perhaps a tendency to be slightly more extreme in terms of temperatures and precipitation. The limitations of climate, however, cannot be considered as significant as the restrictions caused by the nature of the soil, poor drainage, and flooding hazards.

A further limitation is the danger of river erosion. As previously mentioned, the Squamish river meanders excessively in its course between Brackendale and its confluence with the Mamquam river. The area adjacent to this portion of the river is the most extensive tract of class three arable land. Unless this section of the river is brought under control, it is possible that enough soil would be eroded to render the affected farms uneconomical agricultural units. This is

the only section of the lower valley where this problem is a major consideration as far as farm land is concerned.

The danger of flooding imposes a very severe limitation to agriculture. The probability of future flooding cannot be overlooked since there has been no adequate precaution taken to prevent its recurrence. The valley bottom between Brackendale and Squamish village is most seriously threatened. Since the provincial government recognizes the fact that flooding is a hazard in this area, the sale of endangered crown land has been restricted. One could hardly expect the government to undertake the great expense of preventing flooding to make this small area more suitable for agricultural development, and one would not expect the land to be purchased, if available, when flooding does constitute such a significant hazard.

In summary, the physical limitations to agriculture in the Squamish valley are many. They include infertility of the soil, topographically limited arable land, drainage problems resulting from the high water table, stoniness, flooding hazard of both the Squamish and Mamquam rivers, danger of excessive river erosion, high costs of clearing land, and severity of climate as a minor consideration. A certain demand for agricultural products exists now and potentially in sufficient volume to support dairying, in particular. With residential, commercial and industrial growth and the resulting competition for land, agriculture may tend to be completely forced out of the valley even though certain forms of farming could be conducted economically if land were available.

CHAPTER VIII

INDUSTRIAL POTENTIAL

I. ECONOMIC FACTORS

As evidenced by several inquiries to the P.G.E. by large concerns, the Squamish area is attractive to the industrialist, and may become more so because of certain economic considerations. The area has developable deep-sea access, excellent transportation facilities existing and under construction, land available -- presumably at low cost -- for industrial development, adequate hydroelectric power developed and proposed, direct access to the hinterland of the province, and the advantage of being close to a metropolitan area. These factors combined contribute to a high potential for industrial development.

Potential Deep-sea Access

Attention directed to the Squamish area as an industrial site results from the fact that there is undeveloped land available at low cost adjacent to deep water. Heavy industry requiring deep-sea access is finding it increasingly more difficult to obtain suitable land in the Greater Vancouver area. Practically all available large tracts of land on the waterfront are utilized. The few that remain can be developed only at high costs incurred through the initial price of the land and the heavy expenses involved in the preparation of the

site. On the basis of this consideration, one can expect areas such as Squamish to receive increasingly more attention in the future.

Availability of Land

The map of land use shows large tracts of vacant land adjacent to tide water in the Squamish river delta and at the mouth of the Stawamus river. These parcels of land are strategically located for industrial development, being accessible from the sea. They are available not only because they are presently undeveloped, but also because they are held by the P.G.E. It is reasonable to suppose that industries that are most dependent upon the rail facilities of the P.G.E. would have the best chance of obtaining portions of this industrial land. From an economic point of view, the factor of availability of land is extremely favourable.

Transportation Facilities

Increasing interest in the Squamish area as an industrial site has been stimulated in part by the improved transportation facilities serving the region. There has always been land available at tide-water in Squamish. Its development as an industrial site has been hindered because, until the summer of 1956, Squamish had been relatively isolated. With the completion of the rail extension to Vancouver, the area has been made readily accessible. It will become even more accessible with the final completion of the Squamish-Vancouver highway.

Power Supply

A further point in favour of Squamish as an industrial site is that the area is presently traversed by two major hydro-electric transmission lines, the Bridge River power-line and the recently completed Sechelt Peninsula power-line. If a major industry were to locate in the area, power in sufficient quantity is readily available from existing facilities. Direct line transmission power could be easily brought into the area utilizing power from existing sites or through the development of further sites in the immediate region. The possible development of the Moran power site on the Fraser river would ensure adequate low cost power since Squamish is well within economic transmission distance.

Direct Access to the Hinterland of the Province

Direct access to the hinterland of the province is a further but less significant point in favour of Squamish as an industrial site. Through the existing and proposed rail facilities of the P.G.E. the Peace River and central Rocky Mountain Trench areas are directly accessible via Squamish.

Proximity to a Metropolitan Area

Proximity to a metropolitan area can be considered as a further factor in favour of the Squamish area as a potential industrial site. This factor could be of importance during the construction of a major industrial plant. Labour force would tend to be more stable here than in more remote areas.

Competitive Industrial Areas

The above discussion pertains to the economic advantage of the region from a general point of view. With detailed examination one can bring to light other factors that portray a less optimistic picture.

An important economic consideration is the matter of freight rates. For particular industries, location in Squamish could be a definite advantage. On the other hand, freight charges could constitute a disadvantage for other types of manufacture. For instance, for industries importing large quantities of raw material from the provincial hinterland served by the P.G.E., location at Squamish might be an advantage. Whereas, if the plant were located in the lower mainland region interchange charges and perhaps additional freight charges would be levied. However, if the industry were shipping its finished product by rail to the lower mainland for distribution, the freight charges thus incurred could offset the previous advantage in location.

It can therefore be seen that the entire question of freight rates is exceedingly complex. The question as to whether or not location in Squamish would result in additional costs over competitive locations is one that would only be answered through detailed investigation concerning particular products and raw materials for specified industries. This is a subject quite beyond the scope of this thesis. However, since all major industry must consider this factor in any location,

it may be surmised that, in general, industry should not be adversely affected by locating in the Squamish valley.

It has been stated previously that Squamish has certain gross economic advantages to offer potential industry. However, there are also disadvantages. For many years to come only large industry will be attracted to the Squamish valley. Such industry would probably require large quantities of process water. It is unlikely that this commodity would be supplied in sufficient quantity by the Railway company which presently operates the water system, or by the village if it is to eventually take over this responsibility. Probably industry would have to provide its own supply, incurring costs that it would not be presented with in such magnitude if located within the Greater Vancouver area.

The cost of land is a highly important matter for many small industries. However, for a large industry that would spend many millions of dollars in its development and construction program, the costs of land amortized over the many years it would expect to operate, becomes a relatively insignificant factor. Land in Squamish should not be that less expensive than in competitive areas to be considered a true incentive for location. Further, concerning the matter of land, there is a likelihood that the railway company may not wish to sell land outright but may prefer to lease instead. Most large industries want clear title to land, so if leasing is the policy to be adopted, the potential for industrial development may be lessened considerably.

For a large industry contemplating a new location there are additional important factors to consider such as the costs of transporting the finished product to the market area, availability of services of which water is only one example, community ammenities, and proximity to secondary and allied industries.

The Squamish valley does not have the fundamental advantage of natural gas. Basic industry is becoming increasingly more dependent on natural gas as a source of fuel and a raw material. The advent of natural gas to many industrial areas in eastern Canada and in the United States has resulted in technological achievements very greatly to the advantage of the industrialist and the consumer alike. Competition is becoming sufficiently keen to necessitate the implementation of all major technological achievements. For certain industries this factor alone may rule out the possibility of locating in the Squamish area.

Earlier in the discussion mention was made of the fact that developable deep-sea access property was becoming very difficult to acquire in the Greater Vancouver area. This however, does not imply that all potential property of this type is utilized. The land that remains must be developed in larger parcels, perhaps as industrial estates. Such development would be expensive and only warranted as a long-range investment. However, the Squamish valley is little different in this respect. Its development cannot be considered as a small scale proposition.

In the Greater Vancouver area there remains a small portion of Burrard Inlet in the vicinity of Port Moody that could be made available for deep-sea shipping. The banks of the Fraser river from the mouth upstream to and beyond New Westminster are so far not fully developed. Sturgeon Banks, the vast tidal lands at the mouth of the Fraser river west of Richmond and Delta municipalities are yet undeveloped. Boundary Bay fronting the southern boundary of Delta municipality has yet to be made available for industrial purposes. In these latter three areas development problems are comparable to those in the Squamish river delta area. In all locations river control is involved, land must be filled, wharves constructed, and rail facilities laid out.

During 1957 there was considerable talk of development of the Sturgeon Banks area off the Fraser river mouth. An article in a local newspaper mentions the reclaimation of 10,000 acres.[31] Another article mentions the reclaimation of 13,000 acres in the Boundary Bay-Mud Bay area. In this latter area the large industrial real estate firm of Boultbee Sweet and Co. Ltd., played a major role. Several surveys have already been undertaken.[32] It is obvious from these references that the Squamish area is not the only site that is considered to have a

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31 News item in the Vancouver Sun, Tuesday, July 23, 1957.

32 News item in the Vancouver Sun, Friday, July 14, 1957.

high potential for development as a deep sea shipping port. The government of British Columbia, in its announced intention to develop the Squamish delta area added a further several hundred acres to the amount in southwest British Columbia that was already being considered for similar development.

If the development of all three of these major areas were to become a reality, 20,000 to 30,000 acres would then be available for industrial development. This quantity of land would more than meet the deep-sea industrial site requirements for the entire south-western section of the province for many decades. Obviously there is a high degree of competition involved in the development of these three areas. The question as to which one or other may develop depends on several factors the most important of which may be: (1) fundamental economic factors, (2) political ramifications, (3) the timing of the respective developments, (4) the price of finished land.

Squamish has certain advantages and disadvantages. So have the other areas. Squamish may have an advantage by being a smaller site and therefore more readily developable from the point of view of the amount of initial capital required. However, it may have a disadvantage because its control rests in the hands of the provincial and federal governments. This is a factor that cannot be weighed lightly since government is known to be inflexible at times and also subject to pressures which are not generally experienced by private groups.

This thesis maintains that the Squamish area has a high

overall development potential and a reasonable chance of becoming industrialized. It is the writer's conviction that Squamish will get a share of heavy deep-sea oriented industry due to its obvious general economic advantages. When this development will come, and in what quantity is greatly dependent on the factors mentioned in the immediately preceding remarks.

II. PHYSICAL FACTORS

There are several significant factors pertaining to the physical character of potential heavy industrial sites in the lower Squamish valley region that must be considered before a total evaluation of the industrial potential of the area can be achieved. These factors are flooding hazard and river control, foundation conditions, wharfage requirements, dredging requirements, and water supply.

Flooding Hazard and River Control

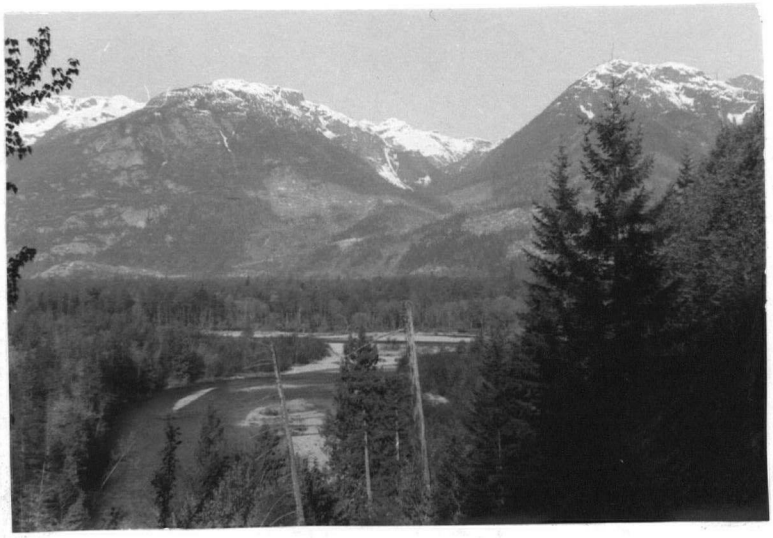
It has been established that industries which most likely will be attracted to the Squamish region will be that requiring deep-sea access. This type of industry will consequently be forced to consider the Squamish river delta as a potential site. As previously mentioned, this area is subject to flooding by both high wind-driven tides and excessively large volumes of runoff carried by the Squamish river.

The problem of flooding is critical to the over-all development of the Squamish region. It is particularly

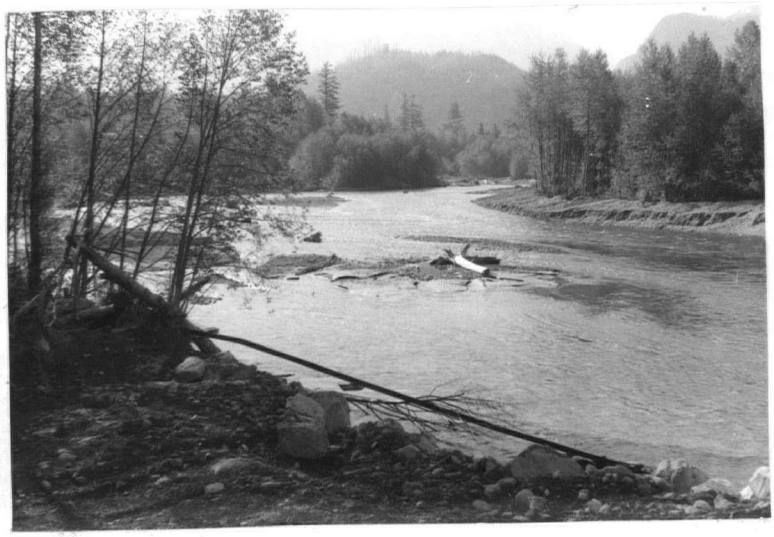
critical in the question of industrial potential of the delta area. Since the protection of the entire valley from flood is a prerequisite for general development, steps taken in this regard in the delta area by any industry would have to be compatible with those undertaken for the rest of the valley. There is also the possibility that flood prevention measures undertaken only in the delta area would not alleviate the flood hazard. In times of major floods, disastrous to the entire valley, flood water covering the complete valley bottom could spill over into the developed industrial site.

In order to remove the danger of flooding from any proposed industry in the delta area, the tidal flats would have to be covered with a considerable depth of fill, sufficient to bring the level of the area above extreme high-water mark for the specific locale. This action would protect the immediate area but if the Squamish region is to achieve coordinated development of industrial, business, residential and recreational areas, as should be expected, flood and river control measures must be taken throughout the entire valley.

Control of the Mamquam River. Concerning the problem of flood and river control, in the writer's opinion the first step that must be taken is the control of the Mamquam river as it is very prone to flood. In its present uncontrolled state it is a detriment to development of the entire region. There are alternative ways in which it might be controlled (see Map 19), each being worthy of consideration.



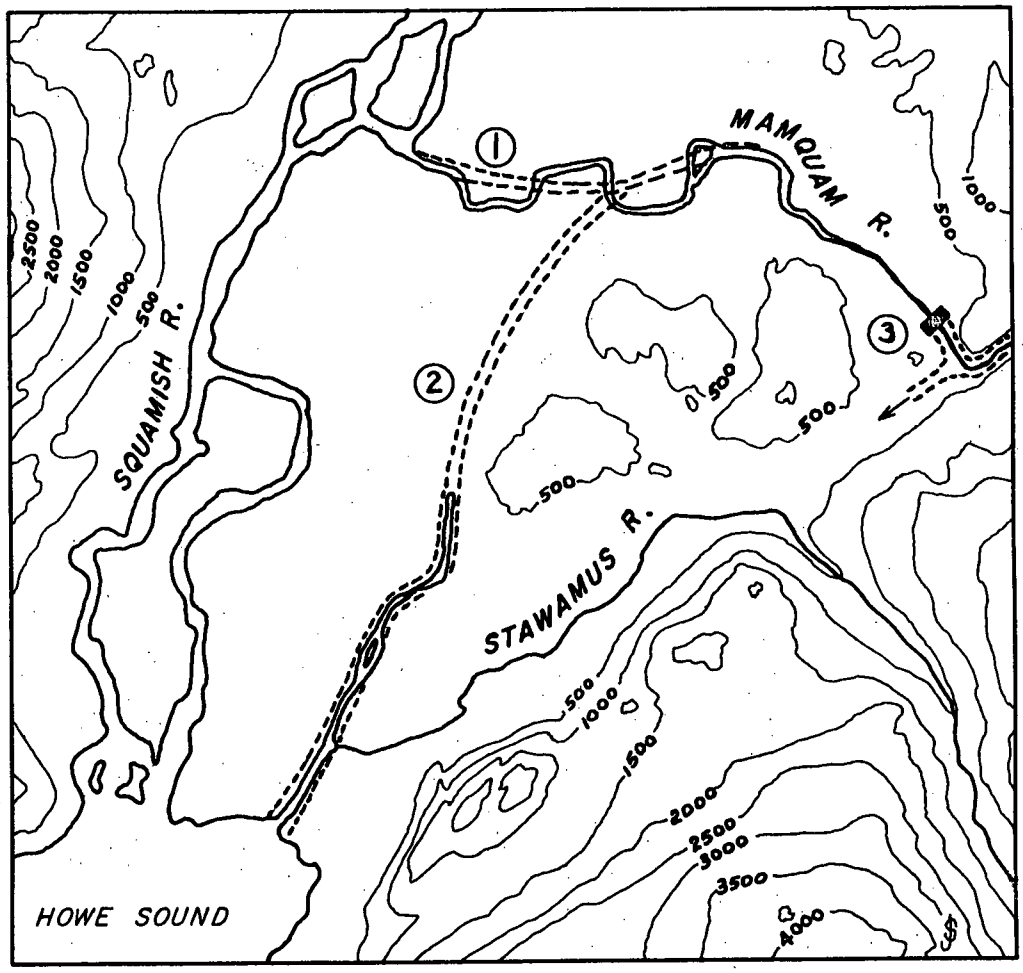
Photograph No. 30 The Mamquam River at its Entrance to the Squamish River Floodplain



Photograph No. 31 The Mamquam River near its Confluence with the Squamish River

Photograph No. 32 The Mamquam River at low water near its Confluence with the Squamish River

Photograph No. 33 The Squamish River south of Brackendale Settlement



SCALE in miles

0 1 2

ALTERNATIVE METHODS FOR CONTROL OF THE MAMQUAM RIVER

(1) Control in its present channel

(2) Diversion into its former channel

(3) Dammed in its canyon and diverted into the Stawamus valley

MAP 19

The first method and one which might seem to provide adequate control, is that of confining the river to its present channel by means of dyking and rip-rap. Although this method might serve to control the river for a short time, it would not in any way solve the problem involved. It would constitute a temporary remedy rather than a cure because this method would not increase the river gradient as is required to overcome the problem of flooding and lateral erosion. To confine the river to a definite channel confluent with that of the Squamish river would only cause the Mamquam to build up its own floodplain within the limits of its confines. Furthermore, this method of river control would not remove the problem of excessive amounts of material being introduced to the channel of the Squamish river which cause it to be dammed, meander and erode its banks.

A second or alternative method of control of this river would be to divert it directly into the head of Howe Sound as it flowed previous to the flood of October, 1921 (see Map 8). The theory supporting this method of control would be that by sending the river directly to sea, the gradient would be increased by approximately four feet per mile. The Mamquam reaches its base level of erosion at its confluence with the Squamish river, at a point roughly ten feet above mean sea level. Diversion directly into Howe Sound would result in the gradient being increased by ten feet over the length of its new channel. This increase in gradient would undoubtedly cause the river to flow much more rapidly and would

allow a constant channel to be maintained. In times of excessively heavy runoff the new course could handle the extra flow more readily due to the unconstricted channel and increased gradient.

There is, however, one problem that could result from the diversion of the Mamquam in this manner. If the gradient were to be increased one could raise the question as to whether or not excessive deposition would occur at the mouth of the river. Presumably, if the gradient were increased, the river would be capable of transporting more material. If this were the case, a large amount of deposition could result. If the amount were excessive, diversion of the river into this area of the delta could conflict with plans to create wharfage in the immediate vicinity. This would be particularly critical to wharfage so located as to serve the potential industrial property at the mouth of the Stawamus valley. However, one might argue that diversion of the river into its former channel would not threaten potential wharfage. The basis for this argument would be the consideration that when the river did flow in this former channel before its natural diversion in 1921 it did not create excess deposits at its mouth. The problem warrants detailed engineering study since it is a situation far too complex to be solved on theory alone.

A third possibility for the control of this river

would be to divert its flow into the Stawamus valley (see Map 19)[1] This would have to be accomplished through the construction of a dam in the Mamquam canyon at the point adjacent to the low pass leading into the Stawamus valley. The advantage of this scheme would be to remove completely the river with its problems from the major valley and, through its diversion, create a water supply sufficient to meet the domestic and industrial needs of the entire region. The Mamquam canyon at this point consists of bedrock walls. Above the canyon rim the topography levels off, the bedrock being covered with a mantle of permeable glacial outwash deposits. It might prove possible to construct a dam in this area sufficiently high to divert the river through a channel cut into the glacial sediments mantling the pass into the Stawamus valley. With this accomplished, the flow would then be free to run uninhibited through the Stawamus valley to sea level.

There are, however, certain complications to a scheme such as this. The diverted flow down the Stawamus valley would travel at a gradient of roughly one hundred feet per mile. If the Stawamus valley floor consisted of bedrock, such a steep gradient would be of little significance. However, the valley

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[1] This tentative proposal has been put forth without detailed study of the area by Minshall, H.H., and Associates, Consulting Engineers for the Area Development Study of Squamish under the jurisdiction of the Pacific Great Eastern Railroad Company.

floor consists of alluvial material throughout the entire length of what would be the new river channel. With such a steep gradient there is no doubt that the river would scour down to bedrock over the Mamquam-Stawamus valley pass, and having accomplished this would remove all alluvial material in its new channel until it created a balance between maximum velocity and amount of material capable of transport, determined by its base level of erosion at tide water. There is little doubt that such a scheme would result in a severe detriment to potential harbour facilities in the entire eastern portion of the Squamish river delta area. The amount of deposition could exceed many times that which would result from the diversion of the Mamquam into its former channel on the eastern side of the Squamish valley.

One manner in which this problem of steepened gradient could theoretically be overcome would be to construct a second dam near the entrance to the Stawamus valley.* Water could be discharged from the bottom of this second dam directly into the sea, thereby removing the problem of excessive deposition. However, it is not likely that a dam could be constructed in this area since the depth of highly permeable mantle in the valley floor, in all probability, is in excess of one hundred feet. Physically, it would be a stupendous task.

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* This also was a tentative suggestion of Minshall, H.H., and Associates, Limited.

A further factor measured against any proposal to utilize the Stawamus valley for either a reservoir or a channel is that such a use would preclude the utilization of the vacant land in the valley bottom for industrial purposes. This is an area of flat land adjacent to developable deep-sea property, and therefore, for this reason alone, is just as valuable for industrial development as is the Squamish river delta.

Diversion of Mamquam river flow directly into Howe Sound in approximately the position of its former channel is, in the writer's opinion, the most satisfactory solution to the problem. This proposal is most sound not only from a physical point of view but also from a consideration of the economic feasibility. It is unlikely that the amount of development to be expected in the region in the immediate future would warrant consideration of a scheme more grandiose than this.

Control of the Squamish River. Control of erosion and flooding by the Squamish river is a problem that needs to be overcome before the highest use of the valley can be assured. The difficulties that would be encountered in this project are few compared to those which have been discussed concerning the Mamquam river. If the Mamquam were diverted such that it no longer flowed into the Squamish river, a great deal of the erosional problems connected with the latter would be removed. The river would then have the opportunity of flowing to sea-level in an unobstructed channel and ultimately, through the

removal of former Mamquam deposits, at a more uniform gradient. The amount of meandering and consequent erosion would thereby be lessened considerably. Having accomplished this initial step, the Squamish river could be held to a straightened channel with relative ease through dyking and protection with rip-rap from the Brackendale area to its mouth.

Excessive runoff of the Squamish river is a hazard that cannot be controlled unless storage reservoirs are constructed on the main river and its large tributaries. Flooding by the river however, could be controlled by the construction of high rip-rap reinforced dykes throughout the length of the flood plain. Flooding by this river has been infrequent but disastrous. The British Columbia Electric Company diversion dam on the Cheakamus river will tend to alleviate the flooding hazard of the Squamish river. However, increased logging activity in the Squamish river watershed, as will certainly occur, will tend to have an adverse effect. In any case, flooding by this river must be prevented and can be accomplished only by protection of the valley by dyking.

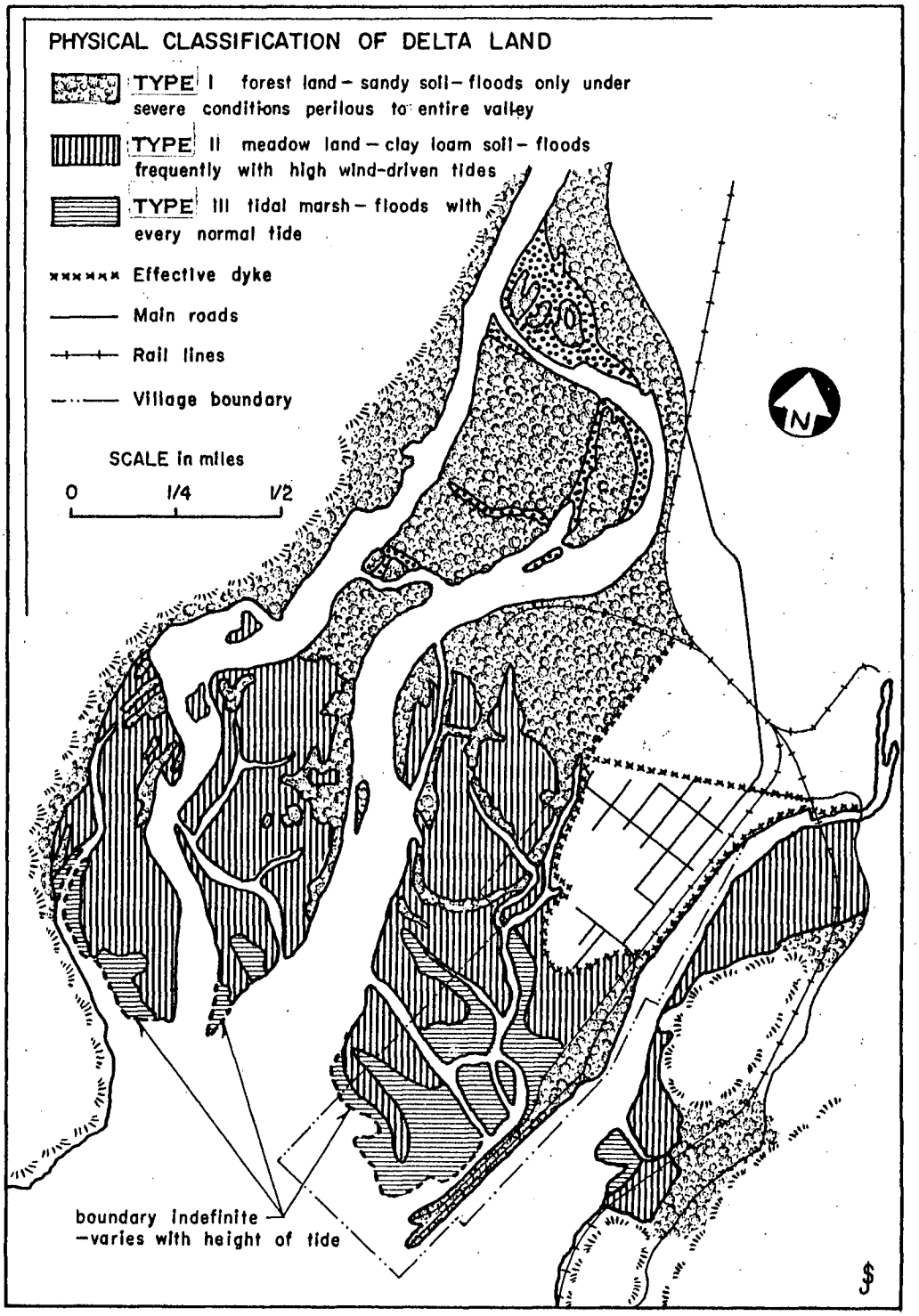
Foundation Conditions

No engineering study has been completed in the Squamish river delta area to determine its physical suitability for industrial plant location. The engineering firm of Minshall, H. H., and Associates are presently conducting such a survey but to date no results have been announced. In order to determine whether or not adverse foundation conditions exist the character

of the delta and its sediments must be examined.

Map 20 shows the physical classification of land in the Squamish river delta area. The classification is primarily based on height of land above mean sea level since all other physical characteristics are associated with this factor. Type I land is that presently under natural forest cover. It tends to be roughly ten feet above mean sea level and is not liable to flooding except under severe conditions perilous to the entire valley. It is therefore the best land in the delta area on the basis of physical characteristics. Type II land is that which is presently natural meadow. The greatest part of this class is flooded with normal high tides. Practically all of the Type II land is flooded with high wind-driven tides. Type III land is tidal marsh and is an area that is flooded with every tide. It is generally at or below mean sea level. On the basis of physical characteristics, this is the least attractive portion of the delta.

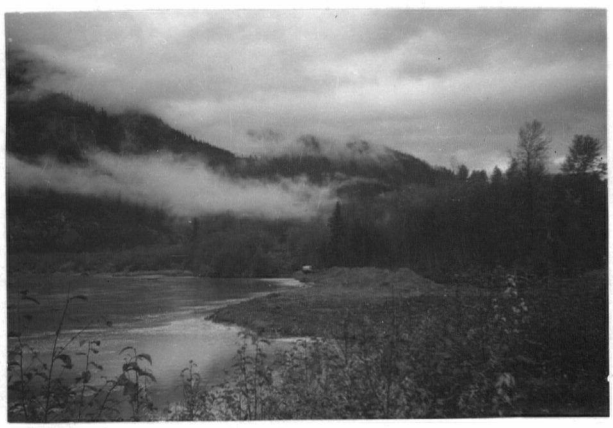
Contributing also to the classification of these delta lands is a consideration of the types of alluvium since this has a fundamental bearing on the subject of foundation conditions. Figure 7 shows an ideal cross-section of surface material and plant transition in the entire delta area. Also included on this diagram is an estimate of height of respective areas above mean sea level. The gradual transition from river floodplain type land to delta front is very striking. Most significant is the gradation of surface material from sand on



PHYSICAL CLASSIFICATION OF DELTA LAND

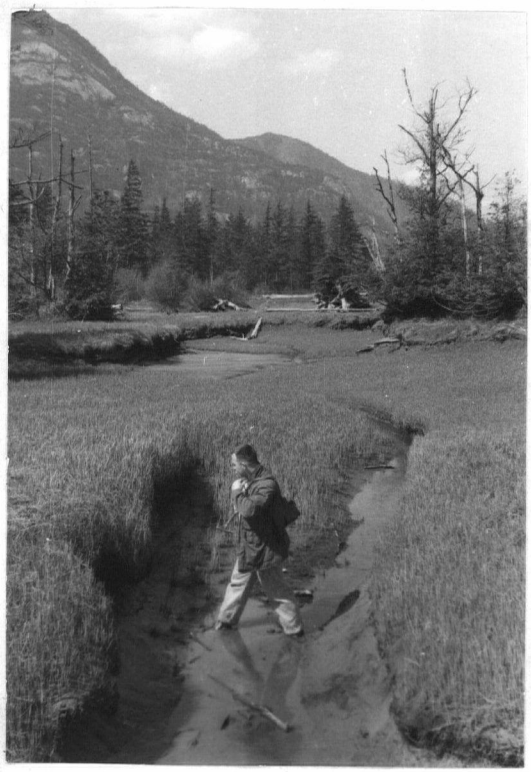
MAP 20

Photograph No. 34 View of the Squamish River Delta showing Transition to Tidal Marsh at the Delta Front



Photograph No. 35 Type I Land along the East Branch of the Squamish River.

Photograph No. 36 A General View of Type II Land in the Squamish River Delta



Photograph No. 37 Transition from Type II to Type I Squamish River Delta Land

Photograph No. 38 Typical Type II
Squamish River Delta
Land at Moderate Tide

Photograph No. 39 Transition from Type II to Type III Land in the Squamish River Delta

Photograph No. 40 Typical Type II Land in the Squamish River Delta

Photograph No. 41 A View West across the Broad Area of Type III Land in the Squamish River Delta

Photograph No. 42 A general view of Type III Land in the Squamish River Delta

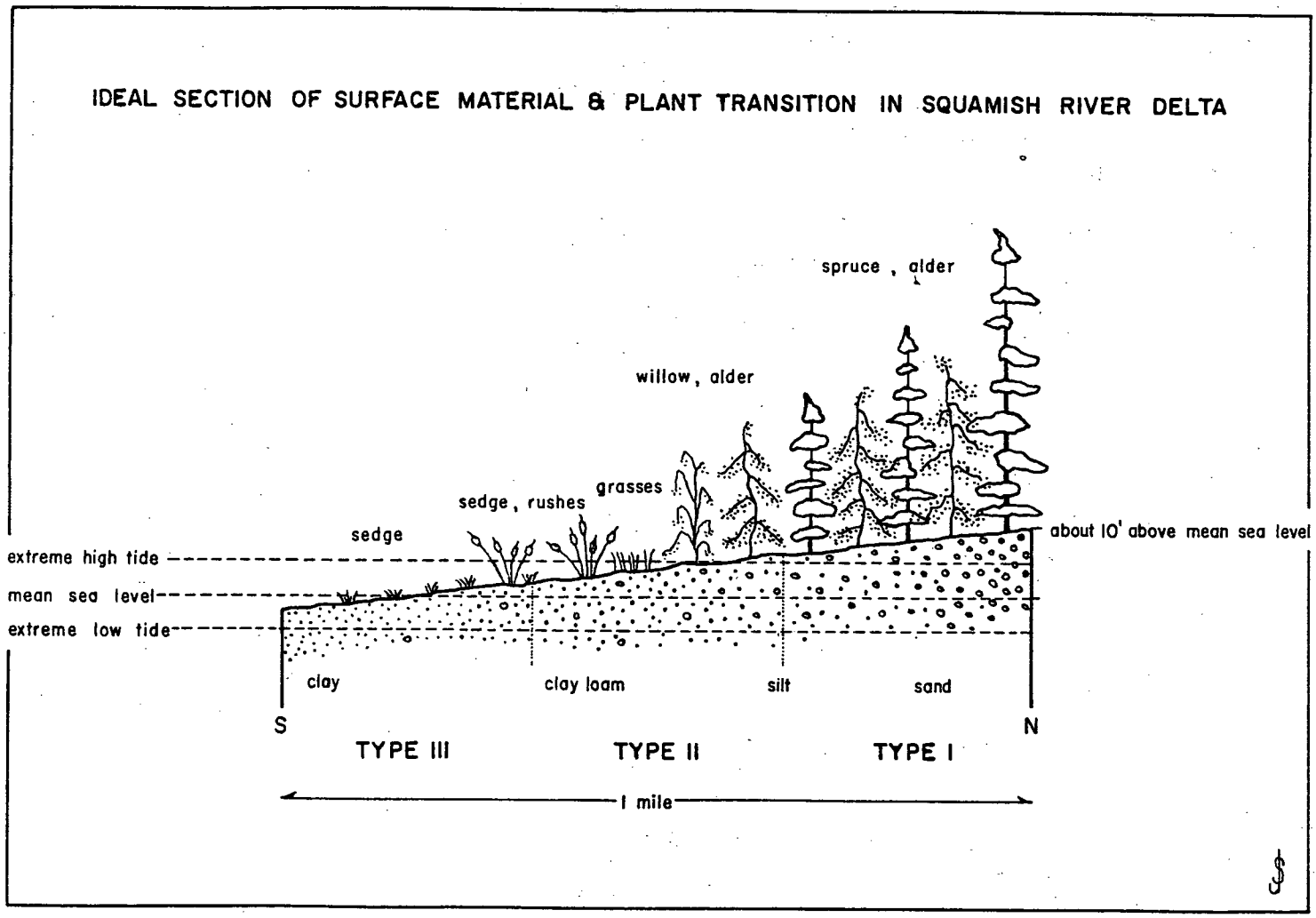
Photograph No. 43 Type III Land at Moderately High Tide

Photograph No. 44 Type III Land at the Very Front of the Squamish River Delta

Photograph No. 45 Fine Gravel Along a Squamish River Channel near the Delta Front

Photograph No. 46 Large Boulders found well above the River River Channel Bottom near the Delta Front

FIGURE 7

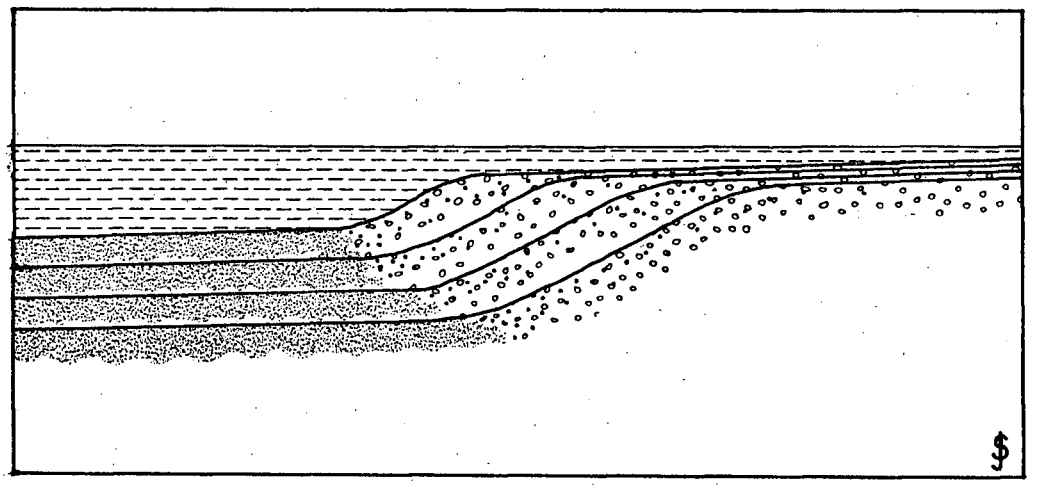

IDEAL SECTION OF SURFACE MATERIAL & PLANT TRANSITION IN SQUAMISH RIVER DELTA
spruce , alder
willow, alder
grasses
sedge, rushes
sedge
about 10' above mean sea level
extreme high tide
mean sea level
extreme low tide
clay
clay loam
silt
sand
S
N
TYPE III
TYPE II
TYPE I
1 mile

the Type I land to silt and clayloam, and on to fine clay on the Type III land at the delta front. These varying surface materials provide a guide to the types of alluvium that may underlie the entire delta area. Since the results of drilling and boring in this area are not known, one must rely on a theoretical estimate of the nature of underlying sediments.

Figure 8 shows stages in the formation of a delta. The heaviest material, that which is carried as the river's bed load remains as topset and foreset beds of the delta. As the sediments build out to sea, this coarser material covers the silts and fine sands that were carried further out and deposited as the bottomset beds of the delta.

Figure 9 is a diagram generalized from Figure 8 and shows a hypothetical longitudinal section of the delta. According to the theory of delta formation, a layer of sand and fine gravel overlies finer material deposited earlier. The uppermost layer is a thin mantle of very fine material or clay that is deposited much later and results from muddy river water being backed up into the delta with high tides. When the tide is high and slack, much of the very fine material that has been carried in suspension is deposited. This thin mantle is so extensive on the Type III and Type II land that one gets the impression that the entire delta must be composed of this material. In actuality it is underlain by coarser alluvium.

With a knowledge of the physical characteristics of the delta, it is possible to arrive at some significant considerations pertaining to the problem of foundation conditions.

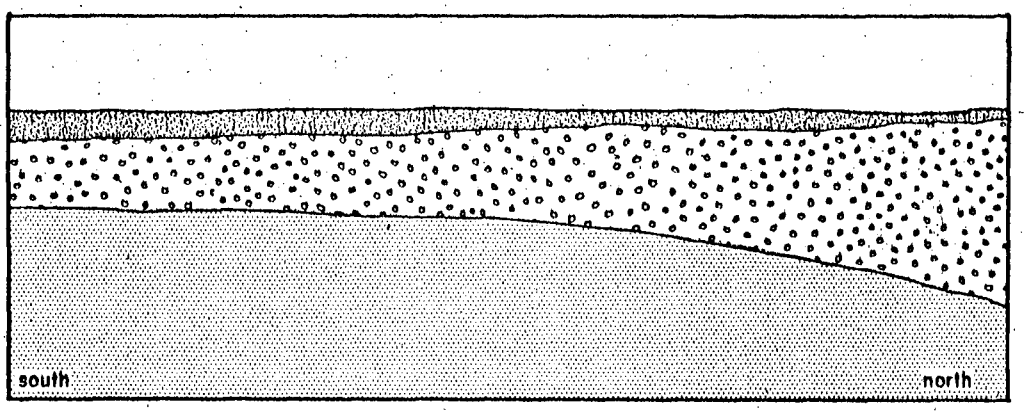


SUCCESSIVE STAGES OF DELTA GROWTH

sand and fine gravel

silt and fine sand

FIGURE 8



LONGITUDINAL SECTION OF DELTA SEDIMENTS
GENERALIZED FROM FIGURE 8

LEGEND

thin mantle of clay
sand and fine gravel
silt and fine sand

FIGURE 9

It should be emphasized that the delta is composed of recent sediments, chiefly sandy in nature, to a depth of many hundreds of feet. The entire area is at or near mean sea level. With similar conditions in other areas, foundation conditions have presented a problem in major building construction.[33] There is therefore the possibility that adverse soil conditions could exist in the Squamish river delta area.

Frequently the problem of total depth of sediments enters into a study of soils particularly when loads to be introduced to an area are large, the theory being that compaction of sediments may occur down to the level of a stable member or to bedrock. In the case of the Squamish river delta area, the sediments may extend to a depth of two thousand feet, and in all probability exceed several hundreds of feet in thickness. This estimate is derived from a study of a transverse section of Howe Sound in this area. Knowing that the Squamish valley and Howe Sound is a glacial fiord, and considering the fact that fiords exhibit a typical U-shaped section and are carved far below present sea level, this estimate of thickness is reasonable. There is the possibility that the floor of the fiord in this locality could be obstructed by a major geological feature, a dyke or morain for example, thereby decreasing the possible depth of sediments. Even if this

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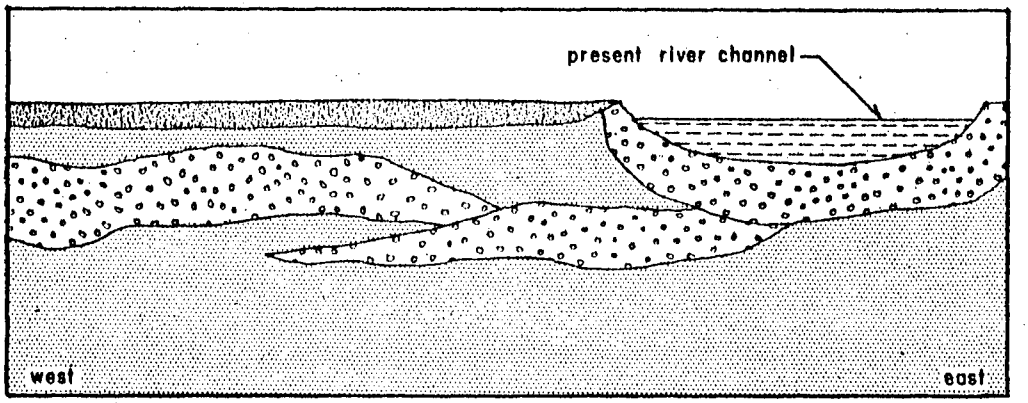
33 R.M. Hardy and C.F. Ripley, "Foundation Investigation for the Kitimat Smelter," The Engineering Journal, Montreal, November, 1954.

were the case, the depth of sediments would probably measure in the hundreds of feet. Figure 11 illustrates the projected profile of the valley walls from which the estimate was made.

It is difficult to estimate the relative thickness of the respective beds of deltaic material. One can be reasonably sure that the top mantle of clay is very thin, perhaps a matter of only a few feet. The layer of fine gravel and sand may be in the order of many tens or even hundreds of feet thick. The lower layer of silt and fine sand would provide the remainder of the fill down to bedrock, except perhaps for a deposit of till or till-like material that may have been deposited directly on the bedrock of the valley floor.

It would be unreasonable to suppose that the three layers or types of material are continuous across the width of the delta. Since the sand and fine gravel is deposited in the bed of the channel and on the delta front, it is most probable that this coarser material forms as lenses in the larger body of finer deltaic sediments. Figure 10, which is a hypothetical transverse section of the delta, illustrates this concept.

Because the deltaic deposits are recent and therefore have not been compacted, the amount of settling might be noticeable. Differential settling due to the lensed nature of the coarser materials could constitute a problem. Various methods of site preparation such as preloading, piling and the use of spread footings might overcome foundation problems in the area.



HYPOTHETICAL TRANSVERSE SECTION OF DELTA SEDIMENTS

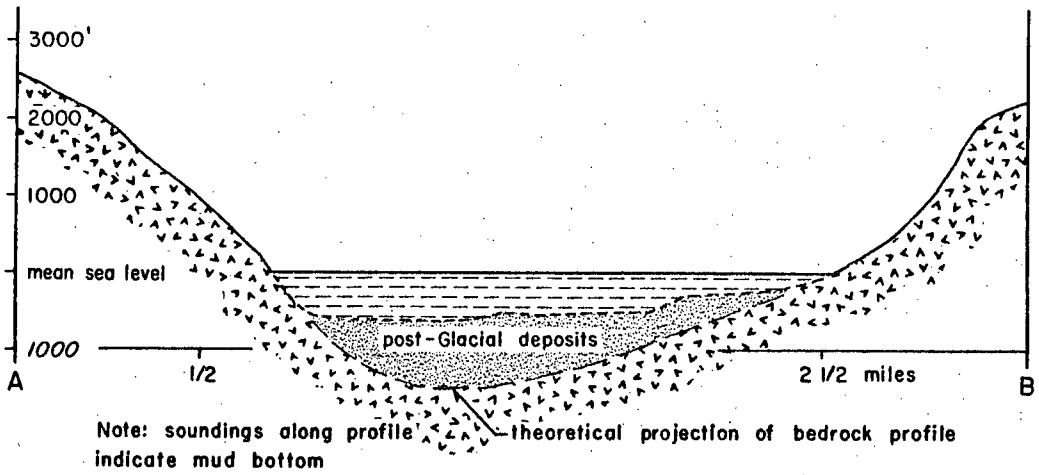
LEGEND

thin mantle of clay

sand and fine gravel

silt and fine sand

FIGURE 10



Note: soundings along profile indicate mud bottom — theoretical projection of bedrock profile

vertical exaggeration 1.32 x

PROFILE ACROSS HOWE SOUND

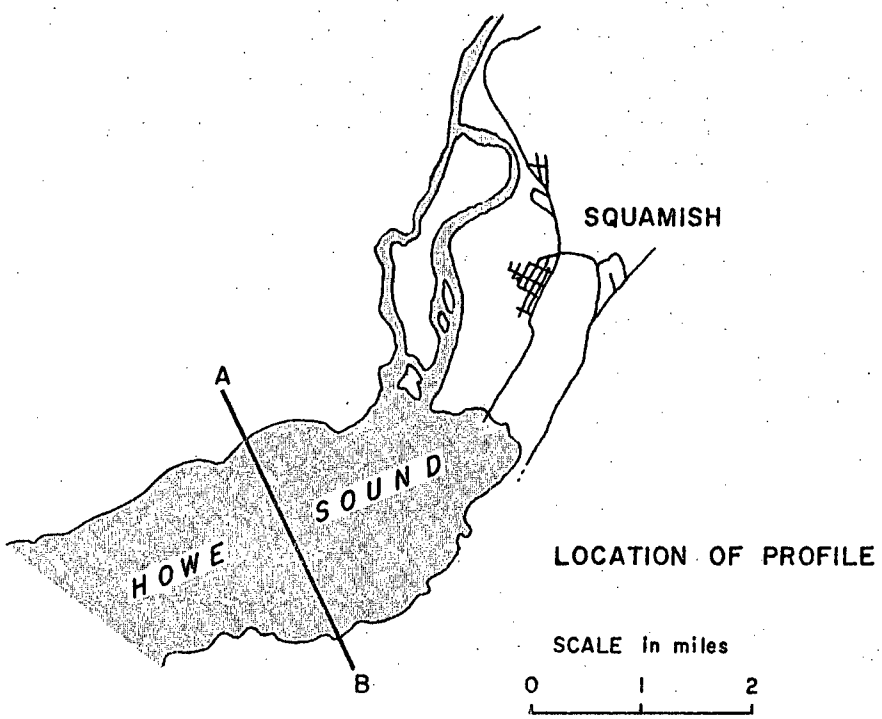


FIGURE 11

According to one authority, foundation settlement problems in British Columbia are most commonly encountered with three broad soil groups; (a) peats and peaty soils, (b) organic silts, and (c) sensitive clays. The organic silts "occur most frequently at the deltas of our coastal rivers and also some of our lakes". Organic silt may "vary in composition from clayey silts with scattered organic matter throughout to a mixture of silty sands and sandy silts containing scattered organic matter and perhaps the occasional thin organic layer".[34]

Organic silt being composed of sandy silts with scattered organic matter and the occasional thin organic layer seems to fairly accurately describe the character of the surface deposits at the Squamish river mouth. The rate of deposition of sediments at the Squamish river delta is unknown although generally considered to be high. In general, a rapid rate of deposition would decrease the proportion of organic constituents.

If development is to take place up to the delta front study may have to be devoted to the problem of stability of the material with respect to slumping. The delta front is steep, lying at an average angle of repose of approximately ten degrees, or roughly twenty percent.*

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34 Earle J. Klohn, "Foundation Settlement Problems, A Discussion of the Situation in British Columbia," The B.C. Professional Engineer, Vol. 8, No. 8, August, 1957, p. 17.

* This angle has been determined through a study of chart of the area, Canada, Plans in the Vicinity of the Strait of Georgia, Survey of 1923-31.

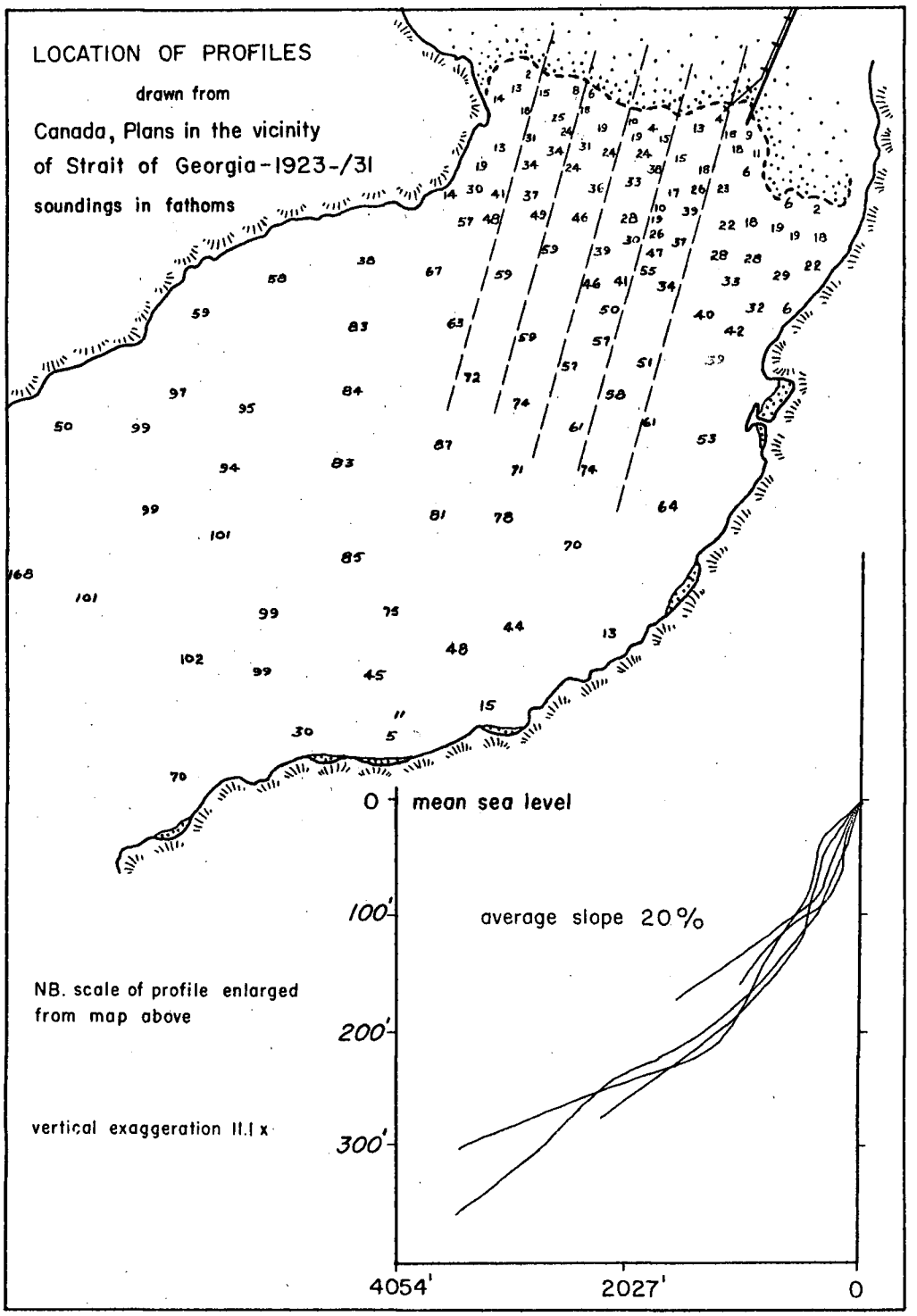

LOCATION OF PROFILES
drawn from
Canada, Plans in the vicinity
of Strait of Georgia - 1923-/31
soundings in fathoms
0
mean sea level
100'
200'
300'
average slope 20%
NB. scale of profile enlarged
from map above
vertical exaggeration 11.1 x
4054'
2027'
0

FIGURE 12

In general it is reasonable to suspect that there will be certain problems concerning foundation conditions with the development of the delta area. Whether or not the adversity of the situation encountered will be a significant detriment to industrialization would depend on the amount of money available for the purpose of site preparation in the development program. If demand for the area as an industrial site is sufficient, there is no doubt that means would be found to overcome almost any adverse condition.

The Squamish river delta area is generally considered to be most valuable as an industrial site. As indicated, there may be problems encountered in the development of this property. The lower Stawamus valley has received less attention as a potential industrial site. There is sufficient acreage here to accommodate a large plant located at the waterfront. This small area seems to have an advantage over the Squamish river delta with respect to foundation problems.

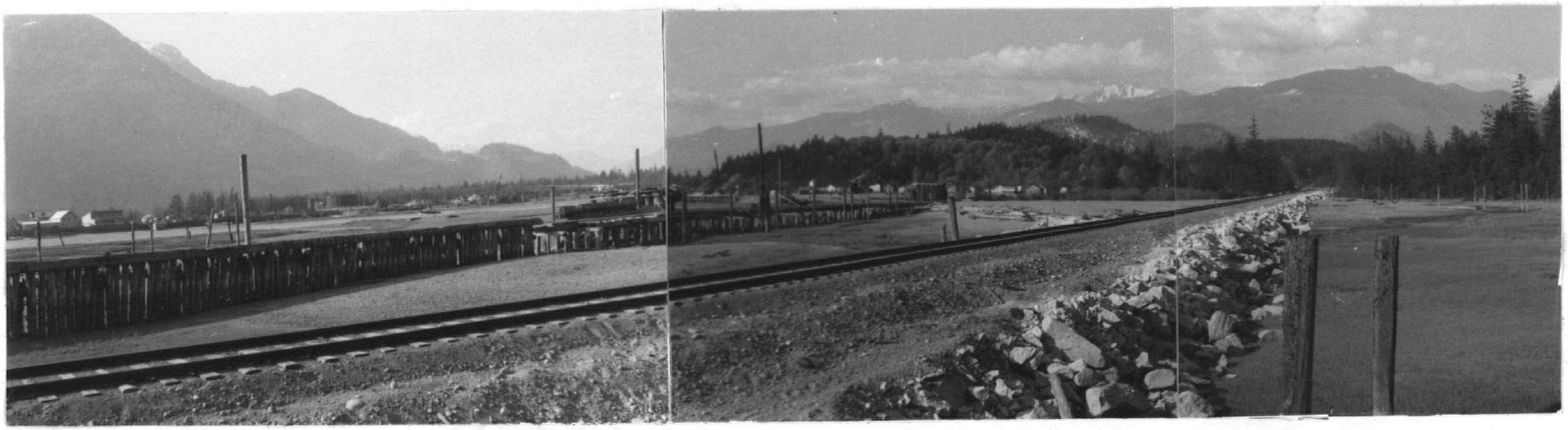
The Stawamus valley is narrow and, in all probability, was not scoured to any great depth by glacial erosion. Depths of sediments here, and specifically at the mouth of the valley, are not likely to exceed several hundred feet. Furthermore, the material constituting the alluvial fill in the valley is all of a very coarse nature, mostly heavy gravel and sand. Light sand and silt is found only at the mouth of the Stawamus river. This comprises only a small proportion of the sediments in the immediate vicinity and results from deposition by silt-laden Squamish river water chiefly at periods of high tide.

During the glacial period, drainage from a large area was diverted down the Stawamus valley. This drainage, chiefly meltwater, carried a large amount of coarse material which was deposited in this valley. Remnants of these deposits are found several hundred feet above mean sea level. Since the time that these extensive glacial sediments were deposited, they have in turn been eroded by the Stawamus river down to a base level created by present sea level. The present fill of the Stawamus valley is the remainder of this glacial debris. It has been preloaded by the previously overlying deposits which have since been removed. This observation combined with the fact that the remaining sediments are coarse leads one to believe that foundation conditions in this area would not constitute a problem. This opinion does not apply to the recent fine alluvium off-shore from the Stawamus delta where soil conditions might be comparable to that of material at the extreme front of the Squamish river delta.

Wharfage Requirements

Of utmost significance to industrial potential is the problem of wharfage requirements. As stated previously, perhaps the greatest single factor contributing to the comparative advantage of the Squamish region as an industrial site is its location with respect to developable deep-seafacilities. One could then expect considerable time and capital to be devoted to the construction of wharfage.

There appears to be two alternative means of creating



Photograph No. 47 A Panorama View of the Stawamus River Delta Area

wharfage in the Squamish delta area. The first is the construction of wharves at the delta front to project out to sea. The second or alternative method is to construct the wharves or wharfage facilities in the river channel, or channels as the case may be.

Looking at the Squamish river delta and perhaps the whole lower valley from a broad point of view, one might be inclined to consider the construction of wharfage out into Howe Sound from the delta front as the immediately obvious choice. Since the delta front drops away rapidly, deep water could be utilized without a large amount of dredging being required. Quite clearly, the immediate delta front would have to be prepared for industry by filling and dyking if wharfage were to extend beyond the delta front. There may be a problem of stability and adverse conditions pertaining to foundation materials may exist in this immediate area. The further an industry can keep away from the delta front and still maintain a proper balance of operating costs, the better. Therefore, if it is possible to create wharfage in the river channels it is worthy of consideration.

Considering overall development requirements for the valley, it is a foregone conclusion that river control must be initiated. This would mean dredging and channelling the Squamish river through the delta area. With this in mind, there is the possibility of building wharves in the channel, taking advantage of development work required for a different purpose.

The use of the river channels for wharves would require dredging to accommodate vessels drawing about thirty feet of water at low tide providing no abnormally large ships were to be handled. Apparently 85% of the world's ships require thirty feet of water or less; and 75% of the world's ports offer 35 feet at high tide or less.*

Dredging to such a depth in the immediate vicinity of wharves would probably require further deep dredging upstream from the site, otherwise the small area of deep water would fill in with material carried as bedload of the river. This seemingly large amount of dredging should not increase total development costs for the area since material must be found to provide fill for the potential industrial land of the delta. The sands of the river bed can be handled by suction dredges. Therefore it should provide low cost fill material of high quality. The straightened channels would have to be heavily rip-rapped and dyked. The installation of a long wharfage area on the straightened channel would not too greatly increase overall costs, and in fact might be less costly than the construction of wharfage out from the delta front.

In an area with a physical character such as that of the Squamish river delta, constant dredging could be expected.

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* These figures were quoted by Captain Jack Dennis of the New Westminster Harbour Commission in an interview with Messrs. E.D. Sutcliffe and J.C. Ingram of Western Development and Power Limited, January 10, 1958.

However, the amount of dredging required to maintain wharfage in the channel might be less than that required to maintain wharfage off the delta front since in the channel there is bound to be a certain amount of scour due to river currents. Also, at all times in the channel there would be a large degree of turbidity, whereas away from the channel there would be more likelihood of still water. Practically all of the fine material deposited by the river occurs as still water deposition. Material carried as bedload in the river constitutes only a part of the total amount deposited. Therefore, there might be an advantage to location of wharves in the channels due to this factor alone.

Concerning the other potential industrial site in the area, the Stawamus river delta, the problem of alternative locations for wharves is not so great. In order to make best use of this site and obtain maximum access to the potential plant site, a ship berth might best be located in a dredged channel in the former river bed, adjacent to the site. If this were not done, the distance between the plant site and the wharf might be too great.

Still another factor worth consideration is that the handling of ships in the channels would probably be no more difficult than at wharves projecting from the delta front. Due to the fact that the head of Howe Sound is narrow it is most probable that ships of any size would have to be handled in the conventional manner by tug boats. With the proviso

that dredged river channels are wide enough, there is little reason to suppose that it would be appreciably more difficult to guide a ship to berth in a channel than at a wharf constructed at the delta front.

Earlier in the discussion reference was made to the north winter winds that occur in the Squamish valley. The severity of this wind combined with the nature of the proposed harbour area should be considered in the location and design of proposed wharves. Immediately off the delta front the floor of Howe Sound drops away to 50 fathoms and gradually deepens to 125 fathoms off Watts Point. According to Captain Simpson depths in excess of thirty fathoms would not permit ships to obtain secure anchorage at any time.* During periods of high winds particularly in the winter, and at times during the summer with strong southerly winds, it would be virtually impossible to obtain anchorage in this portion of the sound. Captain Simpson suggests that ships could obtain secure berth at such times only if they could be guided against the wind into a harbour constructed in a channel protected by breakwaters. Otherwise they would have to stay clear of the head of the sound and find safe mooring elsewhere. These opinions certainly add to the arguments already mentioned in favour of the construction of wharfage facilities in the river channels rather than at the delta front.

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* This opinion was obtained in an interview with Captain Gordon H. Simpson, British Columbia Pilotage Authority, February 23, 1958.

Regardless of whether wharves are constructed in river channels or at the delta front, primary consideration will have to be given to the matter of booming leases. The Squamish river delta has been a major booming ground since logging first began in the region. It also provides an important storage area for booms waiting shipment to the Vancouver area. The logging industry is continually expanding locally, creating an increasing need for booming grounds. If a forest management license is granted tributary to the region, provision will have to be made for foreshore requirements of the company concerned.

In summary, it may be said that due to the character of the delta it may be difficult and impractical to construct wharves on the immediate delta front. And since river channels, in any event, would have to be straightened, dyked and rip-rapped, additional costs incurred through the construction of wharfage on the channel banks would probably be less than costs incurred in the construction of wharfage at the delta front.

Dredging Requirements

The matter of dredging requirements has been discussed in the consideration of other aspects of development of the delta area. To reiterate, extensive dredging would have to be conducted in order to straighten river channels and create adequate depths for wharfage.

In addition to dredging required to meet these demands, it is conceivable that further dredging might be undertaken to provide fill for any proposed industrial site. In order to ensure this potential industrial land to be free of flood hazard, it would be necessary to raise the area several additional feet above mean sea level. To fill an extensive area of the delta, perhaps seven hundred acres, which is not an unreasonable figure, with a depth of fill averaging six feet would require approximately 6,700,000 cubic yards of material. The amount of fill that one could expect to be derived from dredging for river control and creation of wharfage in the immediate vicinity would amount to only approximately 4,000,000 cubic yards. Since this is only a portion of the amount of fill required, and since in this area it should be cheaper to pump fill rather than transport it by other means, extensive dredging in the delta area might ultimately be expected. It is interesting to note that a cost of about fifteen thousand dollars per net acre has been tentatively suggested as that required to fill a similar delta area in British Columbia.*

Water Supply

A further and very significant aspect of industrial potential in the Squamish area is that of water supply. The

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* Information obtained from a local engineering firm, wishing its name to be withheld until official announcement of its study area has been made.

supply system in existence at the present is inadequate to meet any great further demand. In order to supply industry with a sufficient volume of water, an extensive system would have to be developed. Since the supply system could provide a source of domestic as well as industrial water, supply for the whole valley for both purposes should be considered.

The entire developed water supply for the Squamish valley is taken from the Stawamus river through a system constructed and operated by the P.G.E. Stawamus river water is clear and soft, and probably not dissimilar in its proportions of chemical constituents to the Greater Vancouver Water District supply. The Stawamus, although a very small river, is not fully developed for water supply. The construction of a larger dam and the installation of larger pipes would probably increase the amount of usable water to perhaps double that of the present.

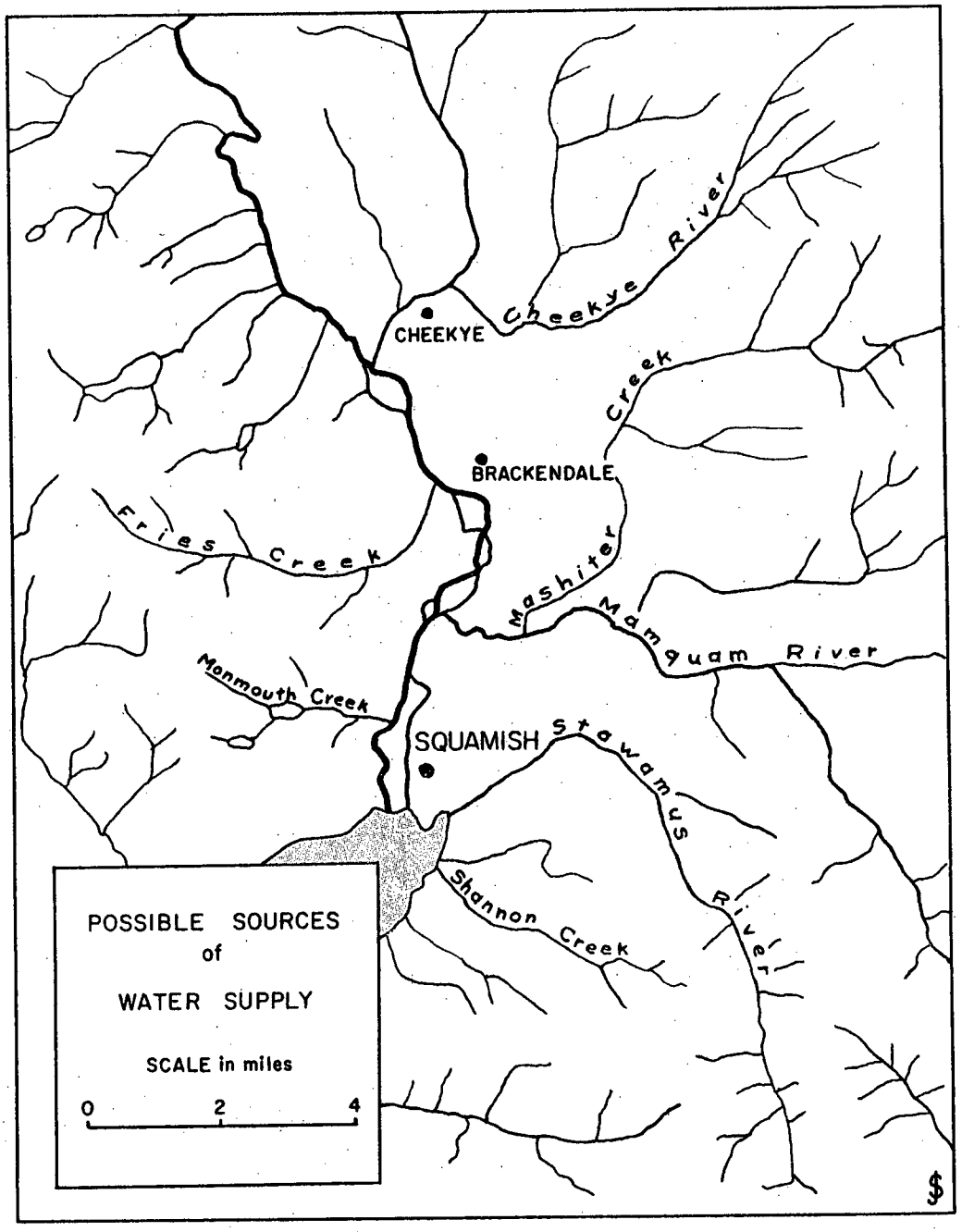
Eventually, with the general development of the Squamish valley, the Stawamus river utilized to its fullest extent will not meet the demands for domestic and industrial water. There is no shortage of water in the area both in the form of large rivers and small tributary streams. (see Map 21). Their utilization depends on their ease of development and the total demand for water. Some of the possible sources, however, even with heavy demands, are not likely to be utilized. These sources would be the major rivers: the Squamish, Cheakamus and Mamquam. They are too large, too

debris-laden, and too subject to flooding to be developed economically.

Shannon, Monmouth, Mashiter, and Fries creeks (see Map 21) are sources that should be considered for the development of an expanded water system. Due to their manageable size and their ability to provide an adequate pressure under gravity flow, they have obvious advantages over the larger rivers.

These creeks are rather small and their individual volumes of flow may not be too large, but combined they could possibly provide an excellent source of water for both domestic and industrial consumption. In each case, the water is clear and soft, having flowed over bedrock or coarse gravel for the most of their courses. They could all be dammed quite readily to provide an even and controlled rate of discharge throughout the year. They have the advantage of being free of pollution problems presently and potentially since they flow from isolated alpine areas.

Following the complete development of the Stawamus river source, Shannon and Mashiter creeks might be the first to attract attention. They are on the eastern side of the valley where pipelines could be laid to the point of demand without excessive costs. Monmouth and Fries creeks are on the western side of the valley, across the Squamish river. They could be economically developed only if a pipe-line crossing were provided over a structure such as a highway bridge. Otherwise,


CHEEKYE
Cheekye River
Creek
BRACKENDALE
Fries Creek
Mashiter
Mamquam River
Monmouth Creek
SQUAMISH
Stawamus River
Shannon Creek
POSSIBLE SOURCES
of
WATER SUPPLY
SCALE in miles
0
2
4

MAP 21

their development would necessitate the construction of a special pipeline crossing either over or under the river. This could possibly involve such costs as to detract from the utilization of these sources.

Cheekye river, previously unmentioned in this discussion, has been considered as a potential water source for the Brackendale area. The residents of this locality have a serious water problem. Currently, they rely upon wells sunk into the unconfined water body of the floodplain. People who live on the Cheekye fan must sink wells to considerable depths in order to be assured of a satisfactory supply. With the sharp increase in the amount of building construction in this area, the problem of obtaining independent water supply from ground water sources will become more acute. Consequently, there has been discussion of utilizing runoff from the Cheekye valley to supply this area.

Interest in this particular source of supply has been stimulated by the fact that no alternative source is closer to the point of demand. Regardless of this fact, it still might not ultimately prove to be the best source since the water is of inferior quality due to its high silt content and peculiar taste. The Cheekye river flows down a valley laden with detritus. The source of the river is at the base of Mount Garibaldi where it is eroding the slope of loose volcanic debris. The water derives its poor taste from this material. This, coupled with the high silt content makes the river a

relatively inferior source. The construction of a settling reservoir might alleviate the situation, but it has obvious disadvantages practically and financially.

Mashiter creek, which is close to the demand point, could provide a better alternative source in all respects, furthermore, it could be developed as a supplementary supply to the delta area.

In general it may be said that there is a fairly abundant supply of high quality water in the lower Squamish valley, and enough to meet the demands of industry, commerce, and residential areas developed to a high degree over a period of many years. The problem of water supply needs immediate attention particularly to accommodate interested industry. The creeks mentioned could be developed as required, culminating in a completely integrated system to serve the entire region.

CHAPTER IX

COMMUNITY DEVELOPMENT

An expansion of community facilities accompanies industrial growth of nearly all communities. Only if residential areas and commercial facilities are properly planned and developed as well as the industrial section will the total area achieve maximum growth. Therefore, the community aspect is as important as the other factors already discussed.

Judging by the very rapid and haphazard residential development in some other British Columbia communities which have experienced sudden economic growth, it is difficult to visualize how the present village of Squamish could adequately accommodate anticipated population growth. At the present, with a relatively large proportion of transient workers, living accommodations are extremely limited. Homes for rent or sale have been rare, and unless a company provides housing for its workers' families, it is almost impossible for an employee on a short-term job to bring his family to the area.

The village of Squamish has many of the elements of a completely undesirable community layout. The principal reason for this is that it was unplanned and its growth largely without regulation. The lack of regulation and control is evidenced in the absence of a properly centralized commercial area. Residential districts are widely separated. Much of the development is located along the major road traversing the

settlement causing great traffic hazards to pedestrians. Children often must cross railroad tracks and walk along the main road to and from school. Most of the village is situated on land that is barely above mean sea level, resulting in poor drainage.

The residential areas are themselves poorly arranged. Lot sizes are frequently too small. There is general absence of lanes and there are many unsightly vacant lots. While there are many well-kept homes and gardens in certain areas, there are an unusual number of shacks and long-unfinished houses.

A program to better the community would include reorganization of the street pattern and installation of proper drainage channels and pumps to drain the low-lying areas. In addition, instigation of regulated community growth would be desirable as would many other and less important improvements. In this way the village could ultimately be brought to a standard by which it could adequately meet modern community requirements. To improve the community in such a way would not be an insurmountable task from a governmental and physical point of view, but it probably would not be economically feasible due to the lack of funds available to undertake such a colossal program.

The present characteristics of the village have been outlined. They render the village largely incapable of adequately accommodating future population growth. There are, however, more important factors stemming from the potential

use of the valley which further detract from the future value of the present village as the residential area of the region.

The present location of Squamish coincides with land which may ultimately be in demand for industry. It is close to deep water, the fundamentally important factor, and also near major developed road and rail facilities. The heavy industry will probably tend to locate close to the delta front, south of the village, and the light industry adjacent to or within the village area. It is mutually disagreeable to have both industry and residential facilities located together, and of course, the highly valuable industrial purpose would receive first consideration by the community.

Air pollution, which frequently accompanies industrialization, would be a major threat to residential areas located in the relatively narrow delta section of the valley. Occasional temperature inversions, occurring mainly in the winter months, would confine the polluted air to lower levels. During the summer season the amount of polluted air would increase daily in travelling up and down the valley because of the pattern of sea and land breezes. The threat of air pollution, however, is not so great in the upper section of the valley where the surrounding mountains have a less constricting effect on the valley.

The factors mentioned so far and considered in total should provide a strong argument against the use of the present village of Squamish as the major residential area of the

region. To encourage and enable the complete development of the region with all land put to its highest use, a new community would have to develop.

After thoroughly investigating the Squamish valley, the writer has come to the conclusion that the Brackendale-Cheekye area would provide the optimum location for such a new community. The gently-sloping alluvial fan at Cheekye and the elevated gravel terraces overlooking the Squamish river at Brackendale are ideal residential sites. A commercial core centrally located at the present settlement of Brackendale and a community park placed on the river floodplain between the commercial core and the river would serve the area well. This scheme is illustrated in Map 22.

The advantages of having the residential community located there are both physical and economic. The valley broadens considerably and divides into three parts, the Mamquam valley to the east, the Cheakamus valley to the north, and the upper Squamish valley to the northwest. Because the valley is not confined there air circulation is at a maximum for the region and the threat of air pollution at a minimum. Also, there are considerably more hours of sunshine than in any other section of the valley.

Homes built on the alluvial fan and terraces could have basements and be provided with adequate sewer systems, both advantages which the present location of Squamish can not offer at reasonable cost. Furthermore, location of the resid-

ential community at Brackendale-Cheekye should not conflict with present or future plans to develop each part of the region to its highest possible use.

Another argument for residential development at Brackendale-Cheekye is the fact that most of the land there is held by the Crown. It would seem logical that if the government wished to encourage the valley residents to develop their community there it would release its property for sale at lower prices than would prevail in other parts of the valley where private ownership predominates.

As illustrated by the maps, no other section in the valley is suitably large and at the same time combines the topographic, climatic and economic advantages for community and particularly residential development as does this area. The manner in which a new community could develop is explained in detail under the heading of Regional Planning.

CHAPTER X

EXTRA-REGIONAL CONSIDERATIONS

In a detailed discussion of an area as small as the Squamish valley it is very easy to consider the possible course of future development as determined by the relative merits of local conditions alone. However, as has been mentioned in the discussion of economic factors affecting industrial potential, development outside the region can play a dominant role in local economic expansion. To evaluate properly the region's potentiality for overall growth one must consider the effect of events and circumstances which take place in other areas.

Perhaps the most important single factor affecting development at Squamish is the continued prosperity and accelerating economic growth of the lower mainland region. Accompanying the growth of this area is an increasing economic and social interaction with adjacent and outlying regions. The lower mainland region is exerting a pressure on its larger surrounding region. Areas do not usually develop independently but in an integrated manner. The increased growth of areas adjacent to Squamish will affect its mode and rate of development. A local example to illustrate this tendency is the recently completed British Columbia Electric Company Cheakamus river hydroelectric power development. The construction of this project has had a noticeable effect on the locality. It has

introduced more payrolls to the area and thereby contributed to an expanding local economy. The need for this power supply has not resulted from demands for electric energy in the immediate vicinity. Energy requirements in the lower mainland region in general has made it necessary, and therefore the beneficial effect on Squamish is truly a consequence of extra-regional circumstances.

The P.G.E. has recently experienced an increase in business. This trend has resulted from economic growth in the hinterland of the province and in the lower mainland region. Squamish has been influenced by the economic forces existing between these two areas. A consequence of this development is the completion of the rail link to Vancouver. Here again is an example of the extra-regional forces that affect the locality.

The potential effect of the Squamish-Vancouver highway and the improvement of Garibaldi Park are two specific examples of developments motivated primarily by extra-regional forces which undoubtedly will alter the nature and economy of the Squamish valley. Since they are eminent they justly deserve detailed discussion.

The completion of the highway link to Vancouver will have a profound and far-reaching effect on the local economy. This effect will become manifest initially in a large number of persons visiting the area merely for the drive. These visitors will spend a certain amount of money in local shops

and thereby bolster the economy slightly. Eventually, conditions permitting, a small portion of these visitors may wish to purchase land in the valley and make it their place of residence. Retired folk in particular may consider this because of a quiet atmosphere, scenic beauty and proximity to the metropolitan area of Vancouver. Other persons may wish to invest in local business, or introduce new enterprise to the economy, for example, gas stations, restaurants, novelty gift shops and other similar forms of business primarily catering to a tourist trade. The foregoing remarks illustrate only some of the economic trends which will result from the improved transportation link to the lower mainland region.

Unfortunately there are no statistics to enable one to calculate the potential highway traffic to and from Squamish. One can assume, however, that traffic will be extremely heavy for a short time after the highway is first opened. Since Squamish is not an important commercial center and is not in a heavily populated district one can expect most traffic to originate in the Greater Vancouver area and to be largely recreational in nature. During the summer months there may be as many as 3000 vehicles per week entering and leaving the Squamish area. This figure is estimated on the basis of Vancouver-Fraser Valley statistics prepared by the Technical Committee on Metropolitan Highway Planning (Vancouver), based on 1955 traffic flows to and from the Burrard Peninsula. The figure used may be somewhat low considering the fact that the

highway to Squamish will open a new recreational area to the population of Vancouver. The drive along Howe Sound will offer scenery superior to that found along other routes leading from the city through congested semi-residential areas. The eventual development of Garibaldi Park will undoubtedly cause traffic flows to increase so markedly that the figure of 3000 vehicles per week would be very conservative.

It is interesting to note the high potential traffic volume that could be expected from Greater Vancouver considering a most conservative estimate of recreational driving for residents of this area. If one family out of ten in Greater Vancouver drove to Squamish only once a year, this would amount to an annual average of approximately 720 vehicles to and from Squamish per week. It is therefore not difficult to appreciate how this volume could increase several times on a fine holiday weekend during the summer months. These high traffic volumes could be expected even though there is little to offer the recreational driver when he reaches Squamish. It must be conceded, also, that the eventual development of Garibaldi Park will create even greater volumes of traffic. During 1958 the British Columbia Department of Recreation and Conservation intends to develop a master plan for the improvement of recreational facilities in the park. Construction is to follow as soon as possible.[35] Therefore, it would seem that the residents of Squamish in the next few years may expect

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35 News item in the Vancouver Sun, January 8, 1958.

visitors amounting to many hundreds per week under ordinary conditions.

CHAPTER XI

REGIONAL PLANNING

The implementation of a well conceived regional plan would very greatly assist development of the area as a pleasant and ammenable community. Map 22 shows a recommended pattern of land use for the valley. Essentially, it depicts seven major points: (1) the preparation of a master plan of land use; (2) the formulation of a plan to relocate the residential community; (3) the control of the Mamquam river; (4) the control of the Squamish river; (5) the preparation of industrial sites at the waterfront; (6) the construction of a water supply system, and (7) the allocation of land suitable for secondary industry.

I. PREPARATION OF A MASTER PLAN OF LAND USE

Industrialization and consequent overall development of the Squamish valley involves many complications that one might not normally expect with the introduction of industry to an area. Rugged topography and fast-flowing rivers create physical obstacles to the location and growth of industrial and residential areas. A further complication exists because the valley is poorly developed as a community and is not yet prepared to receive the impact of industrialization. As a result of these two basic factors there is a desperate need for regional planning and the development of a major land use

plan before industrialization occurs. Proper planning would aid in the harmonous development of all sectors of interest and would enable maximum use of the region with minimum public expenditure.

II. RE-LOCATION OF THE RESIDENTIAL COMMUNITY

One of the first steps that should be taken in a regional development program is the introduction of a scheme to encourage the eventual movement of the main residential community. As the area develops it will become desirable for residents and certain businesses to move away from the industrial district. There is a minor trend at the present for some residential growth in the Brackendale area. This has occurred without the benefit of planning or direction.

A scheme to promote the eventual re-location of the community could probably be implemented fairly readily since the Crown and the P.G.E. jointly control a great deal of land. Manipulation of land sales could act as a method for establishment of a new community. Since the majority of vacant land in the village is held by the Crown and the P.G.E., if this was held from sale residential growth in the village would be restricted. If, at the same time, land under Crown jurisdiction was put on the market at low prices elsewhere, new residential growth could be directed.

For many reasons, previously implied, such as problems of land ownership, flooding and erosion, probability of atmospheric pollution, physical quality of site, and land re-

quirements for industry, the Brackendale-Cheekye area appears to be very desirable as a location for a new community. Map 22 shows land recommended for residential, commercial, and recreational areas.

Residential area A, the Cheekye fan, is the most desirable residential site. It is therefore recommended that this area be the first to provide accommodation for residential expansion. With contour streets, generous lots, and numerous small park areas it could well become a model home site. As residential expansion took place, a commercial nucleus could develop on the river floodplain south of the main residential area between the valley wall and a road allowance ultimately to be utilized for the highway to Lillooet and the interior. The commercial core, situated there, would be close to the main residential area and would be so located as to serve a second residential area which could develop later on the high gravel terraces on the eastern side of the valley north of the Mamquam River. (shown as residential unit B in Map 22).

To meet the recreational needs of the community, a park and golf course with additional features as required could be established between the new community and the rerouted channel of the Squamish river. The recreational requirements of valley residents would be further satisfied through the use of a provincial park at Alice Lake.

III. CONTROL OF THE MAMQUAM RIVER

The problem of Mamquam river control has been discussed previously. It has been shown that it presents an obstacle to the general development of the region. Therefore, it can be seen that one of the first projects undertaken should be control of this river. For various reasons the writer believes that it would best be channelled directly to sea through the construction of a dredged course as indicated in Map 22.

With the possibility of flooding and erosion by the Mamquam river made virtually impossible, the way would be clear to begin the simultaneous control of the Squamish river and the preparation of industrial land at the waterfront, both items prerequisite to an industrialization of the Squamish river delta area. For industry demanding the immediate acquisition of land, after the Mamquam river has been put under control, the development and sale of land in the Stawamus river delta area could begin. (shown as unit G in Map 22)

IV. CONTROL OF THE SQUAMISH RIVER

Control of the Squamish river should be undertaken to insure that industry would not suffer the consequences of a major flood. Therefore, an early start should be made on this aspect of regional development. This project, though costly, would be fairly straightforward since control would consist of consolidating and straightening the channels in

roughly their present location and preventing erosion and flood by the construction of heavily rock-protected dykes. There is no obvious alternative method of preventing flooding by this river.

V. PREPARATION OF INDUSTRIAL SITES

Since material dredged from river channels in the construction of a final course would be required for fill on potential industrial property, it would seem desirable to begin control at the river mouths. This would permit a speedier preparation of industrial property than if river control were begun further upstream, and would thereby allow the government to receive some income from their investment in the earliest stages of the development program. This, of course, is a factor of paramount importance since a project of this magnitude must, as much as possible, prove and pay for itself as development progresses.

VI. THE CONSTRUCTION OF A WATER SUPPLY SYSTEM

In order to attract industry to the Squamish valley and to prepare the area for overall development, the construction of a water supply system is required. The problems involved in this and the possibilities for utilization of various sources have been discussed. At the outset it would not be necessary to construct a system capable of meeting all future needs. However, it would be essential to provide a

supply of domestic water to meet the requirements of the new townsite. This could be achieved by further development of the Stawamus river and by tapping Mashiter creek with new facilities. Other sources could be developed later as required.

VI. ALLOCATION OF AREAS SUITABLE FOR SECONDARY INDUSTRY

Although industrialization of the valley will tend to take the form of that requiring access to the deep sea, there undoubtedly will come a day when industry which is not so dependent will find the area attractive. Therefore, it is wise to consider the land requirements of this type of industry while land is still available for planning purposes. Such land should be capable of becoming fully serviced by rail and highway. Map 22 shows three units of land which would meet this specification. Of the three, unit D would seem logically the first to develop being close to existing facilities. Areas C and E could be developed later. In the intervening period they would provide a pleasant green belt between heavy industrial plants and the new townsite.

Implementation of the seven major points suggested in the development planning of the region would assist in an orderly development of the valley with all land put to its optimum use with the least possible cost to the developer. Well conceived development planning for the valley is a

necessity. In order that Squamish may attract deep-sea oriented industry it must be competitive in quality as a physical site with other proposed areas for development of a similar nature.

CHAPTER XII

LIMITATIONS OF THE STUDY AND CONCLUSIONS

Before discussing conclusions resulting from the research conducted in the preparation of this thesis it is worthwhile to consider some of the important points that have received only passing mention and that deserve further study.

I. LIMITATIONS OF THE STUDY

The basic limitation is that research and study has been confined to the field of geography. A more complete evaluation of the potential for further economic development in the region would be derived from correlated studies from the point of view of the engineer, economist, agriculturalist, planner and others.

There are several specific studies that could be conducted which would aid the theme of the research. Perhaps one of the most important of these would be a study of specific opportunities for industrial expansion in the province, for example, the opportunity for a steel mill to be constructed.

A study of freight rates as they apply to certain commodities in particular areas, and the ability of Squamish to provide sites where transportation costs are minimized, would be of great value. A knowledge of the type of industry that might be expected to find the area attractive would be valuable in land use planning.

A comparative study of potential deep-sea industrial

land that could be competitive with Squamish would provide valuable information to enable more complete examination of the future of Squamish as an industrial area.

The question of foundation problems has been discussed rather academically, but since no engineering study exists to provide more concrete information, even the academic approach is of some value. A complete foundation investigation study would certainly be warranted.

II. CONCLUSIONS

The conclusions that can be drawn from the research indicate a future for Squamish that, although promising, will be fraught with major engineering problems and expenditures in order to prepare the area for further economic development. However, the future will undoubtedly see the valley progress from an undeveloped rural area to a fairly modern community closely integrated with the expansion of the lower mainland region.

The industrial future of the valley seems to be very greatly in the hands of the provincial government. If provincially sponsored industrial development fails, it appears that general development of the region might be hindered. Failure to industrialize the delta land might delay major public works projects such as river control which are essential to the area if maximum growth is to be achieved.

If the provincial government does decide to foster industrial development, the research conducted seems to indicate that industrialization would not take on such major proportions as has been proposed. Detailed economic and engineering study will probably bear out this conclusion.

The industrial future of Squamish seems to be very greatly dependent upon the factor of similar competitive industrial land in other areas. Squamish can undoubtedly offer a site for one or more specific industries over a long period of time, but it will always lack certain qualities that competitive areas could offer. Industrialization at Squamish must be considered with respect to developments in other areas over time. Such consideration tends to discredit the high degree of optimism that has generally been felt for Squamish.

Whereas one large industry would be readily absorbed in the Greater Vancouver industrial complex with little apparent effect on the city and its region, the establishment of the same industry in Squamish would immediately transform the area from a relatively small settlement to a bustling community. It could well be the case that one large industry with its associated growth of all community facilities would be all that the land of the valley could accommodate in the short term and even perhaps for many years hence.

Many municipalities clamour for the establishment of industry in their areas, little realizing that industry, while

sometimes bolstering the general level of the economy, can bring with it many new problems and can increase the former difficulties to the point where no real advantage for the municipality has been gained. Squamish village, to date, has prospered more in spite of itself than because of itself. If greater prosperity, a more stable economy and an improved community is what is desired at the local level, it might be well to improve that which exists in the valley at the present by the implementation of proper community and regional planning. Through this, one could argue, true prosperity will be achieved, and perhaps not through waiting for industry to solve the problems. Squamish will develop gradually because of its location in the province. The sooner this is realized and steps taken to foster orderly growth, the sooner a bright future will be forthcoming.

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Vancouver Sun, March 30, 1957

_____ July 14, 1957

_____ July 23, 1957

_____ January 8, 1958

APPENDIX A

LIST OF INTERVIEWS

The following is a list of major interviews conducted specifically to obtain basic information on the study area.

J.S. Broadbent, General Manager, Pacific Great Eastern Railway Co., Vancouver, November 10, 1956

A.L. Farley, Geographer, Geographic Division, Surveys and Mapping Branch, British Columbia Department of Lands and Forests, Victoria, February 27, 1957.

T. Hislop, Assistant Chief, Land Service, British Columbia Department of Lands and Forests, Victoria, March 5, 1957.

J.F. Jacobsen, Commissioner, Village of Squamish, Squamish, February 9, 1957.

Cyril E. Leonoff, Ripley and Associates Limited, Vancouver, March 15, 1957.

Messrs. W.C. Mearns, R.H. Gram and D.T. Thomson, Western Development and Power Limited, Vancouver, March 23, 1957.

Hannah E.McCormack, Clerk, Village of Squamish, Squamish, February 9, 1957.

H.H. Minshall, H.H. Minshall and Associates Limited, Vancouver, May 13, 1957.

Dr. M.A. Ormsby, Department of History, University of British Columbia, Vancouver, April 30, 1957.

G.L. Ritchie, Right-of-Way and Lease Agent, Pacific Great Eastern Railway Co., Vancouver, October 28, 1956.

Captain Gordon H. Simpson, British Columbia Pilotage Authority, February 23, 1958.

A. Smith, Land Inspector, Land Service, British Columbia Department of Lands and Forests, New Westminster, February 14, 1957.

H.L. Smith, H.H. Minshall and Associates Limited, Vancouver, May 22, 1957.

D. South, Assistant Director, Regional Planning Division, British Columbia Department of Municipal Affairs, Victoria, February 27, 1957.

G.D. Taylor, Research Assistant, Parks and Recreation Division, British Columbia Forest Service, Vancouver, March 2, 1957.

APPENDIX B

LIST OF CORRESPONDENCE

British Columbia Department of Highways, Lillooet, -- October 15, 1957, October 29, 1957.

Canada, Deputy Minister of Public Works, Ottawa, -- April 10, 1957.

Mr. Bill Dennett, The Vancouver Sun, Vancouver, British Columbia -- April 25, 1957.

Geographic Division, Surveys and Mapping Branch, British Columbia Department of Lands and Forests, Victoria -- March 26, 1957, March 29, 1957, April 25, 1957.

Mr. Carles Jennings, The Vancouver Province, Vancouver, British Columbia -- April 25, 1957.

Greater Vancouver Tourist Association, Vancouver, British Columbia -- February 26, 1957, February 27, 1957.

Legal Surveys Division, Surveys and Mapping Branch, British Columbia Department of Lands and Forests, Victoria -- February 19, 1957, February 22, 1957, February 25, 1957, March 8, 1957, March 11, 1957.

National Harbours Board, Canada Department of Transport, Ottawa -- February 27, 1957, March 5, 1957.

Dr. M.A. Ormsby, British Columbia Provincial Archives, Victoria -- February 7, 1958.

Parks and Recreation Division, British Columbia Forest Service, Victoria -- February 26, 1957, February 27, 1957.

Provincial Air Photo Library, Surveys and Mapping Branch, British Columbia Department of Lands and Forests, Victoria -- January 16, 1957, February 18, 1957, February 21, 1957.

Regional Planning Division, British Columbia Department of Municipal Affairs, Victoria -- January 31, 1958, February 5, 1958.

Ripley and Associates Limited, Engineering Consultants, Vancouver British Columbia -- February 27, 1957, March 8, 1957, March 15, 1957.

Mr. B.E. Valde, Chief Engineer, Pacific Great Eastern Railway, Vancouver British Columbia -- February 27, 1957.

Water Resources Branch, Canada Department of Northern Affairs and Natural Resources, Ottawa -- January 18, 1957, January 30, 1957.

APPENDIX C

LOCAL INDUSTRIAL FIRMS
(Valid to January 1, 1958)

1. B. & M. Logging
2. DeBeck Lumber
3. Empire Mills Limited
4. H. & W. Logging Company Limited
5. Squamish Valley Timber Limited
   (recently purchased by the H.R.MacMillan Company)
6. Squamish Mills Limited
7. Wray Mar Limited
8. Howe Sound Timber Company Limited
9. C. R. & B. Logging Company Limited
10. E. Watt Trucking
11. Minanty Bay Lumber Limited
12. Pacific Great Eastern Railway Company Limited
13. British Columbia Electric Company Limited

APPENDIX D

PRIVATE BUSINESSES IN THE VILLAGE OF SQUAMISH
(Valid to January 1, 1958)

1. three service stations
2. three bulk oil distribution agencies
3. general hardware store
4. general gas and electric appliance sales and repair shop
5. electric appliance and record sales store
6. electrical contracting sales and service company
7. television installation, sales and service company
8. heating equipment contracting service and sales company
9. several building contractors
10. plumbing contractor
11. two painting and interior decorating contractors
12. building supplies store
13. laundry and dry cleaning establishment
14. general department store
15. two grocery stores
16. bakery
17. men's shoe store
18. women's clothing store
19. children's clothing store
20. beauty parlor
21. barber shop
22. jewelry store
23. medical clinic

24. general insurance agency
25. Credit Union
26. two banks
27. two taxi companies
28. two transfer companies
29. two wood fuel agencies
30. two hotels
31. motel
32. three restaurants
33. theatre

APPENDIX E

PUBLIC SERVICES AND INSTITUTIONS
(valid to January 1, 1958)

1. four elementary schools; located in Brackendale, Mamquam, Squamish and Southridge
2. Squamish High School
3. general hospital
4. Royal Canadian Mounted Police
5. British Columbia Forest Service
6. Game Warden
7. two post offices; located at Squamish and Brackendale
8. government liquor store

COMMUNITY SERVICES AND INSTITUTIONS
(valid to January 1, 1958)

1. Anglican Church of Canada
2. Roman Catholic Church
3. United Church of Canada and Parish Hall
4. Masonic Order
5. Benevolent and Protective Order of Elks
6. Pacific Great Eastern Railway Company Community Hall, owned and operated by its employees' association
7. Canadian Legion and Legion hall
8. Farmer's Institute and hall