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REPORT ON

GEOTECHNICAL AND ENVIRONMENTAL RECONNAISSANCE STUDY OF THE DISTRICT OF SECHELT OFFICIAL COMMUNITY PLAN AREA

Submitted to:

Corporation of the District of Sechelt

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1.0 INTRODUCTION

1.1 Terms of Reference

This report presents the results of a Geotechnical and Environmental Reconnaissance Study of the District of Sechelt Official Community Plan Area. The request for proposal dated May 20, 1992 and the Scope of Work and Methodology as presented in Golder Associates' proposal for the work dated June, 1992 are included as Appendix I.

Golder Associates received confirmation of the verbal authorization to carry out the study in a fax from the District of Sechelt dated 11 December, 1992. Polster Environmental Services, acting as a sub-consultant to Golder Associates, carried out the environmental and visual aspects of the study.

1.2 Purpose of Study

The purpose of this study is to provide geotechnical and environmental input to the Official Community Plan (OCP) and allow the designation of Development Permit Areas (DPA's) to restrict the use of land that is subject to potentially hazardous conditions or that is environmentally sensitive to development.

Section 945 of the Municipal Act requires that all community plans shall include written statements and maps for those areas of the OCP concerning restrictions on land use due to hazardous conditions or environmental sensitive to development amongst other factors beyond the scope of this report.

Where an Official Community Plan designates areas of restricted land use under Section 945, Section 976 states that the land shall not be subdivided, the lands or existing structures shall not be altered, and new structures or additions or alterations to existing structures shall not be commenced unless the owner first obtains a development permit under this section or is exempted under 945(4.1). As stated in Section 945 (4), the OCP shall, with respect to those areas, describe the special conditions or objectives which justify the designation. However, only general policy statements are needed, especially with respect to the procedural aspects to be undertaken by the District. (Cave, 1992).

The designation of a DPA should include details of the hazardous conditions that prevail and specify guidelines outlining how these conditions can be mitigated when the permit application is made.

In this study, the format of the DPA designation, justification and guidelines has been based on the Halfmoon Bay Official Community Plan dated November, 1990. The geotechnical work required to be undertaken prior to the issuance of building permits and subdivision approval is described in principle for each DPA.

The conditions under which development permits would not be required is also addressed.

For certain of the DPA designations of environmentally sensitive areas, wildlife habitats, vegetation and visual resources are required to be assessed to enable assessment and confirmation of acceptable impact of the proposed land use prior to issuance of a development permit.

1.3 Format of Report

The format of this report is as follows:

The initial section presents a description of the work carried out during the study and the existing development in the area is identified.

The physiography and geology of the area is then described and the biological and visual resources are classified. From this data base, the type of geological hazard and environmental sensitivity are identified.

The DPA's are then defined and the necessary geotechnical and environmental study requirements are provided.

Recommendations are made for zoning bylaws and guidelines for development where they do not already exist. Environmental considerations for future development are described.

The report is accompanied by 1 - 1:20,000 scale forest cover map and 12 - 1:5000 scale topographic/cadastral maps presenting the geotechnical and environmental information collected and the location of the DPA's. Selected photographs are also provided.

1.4 Acknowledgements

Golder Associates would like to acknowledge the assistance of the various ratepayers associations, and the many individuals who provided information and guidance. It is fundamental that studies such as these are based on local knowledge. For this reason, it is necessary that they should be periodically reviewed and updated to take account of new facts and experience.

2.0 WORK CARRIED OUT

2.1 Review of Existing Information

The initial stage of the work involved a detailed review of existing geological and environmental data to determine the portions of the study area which would require special attention. Material collected for review included all relevant geological, hydrological and geotechnical reports and maps and in-house files. Environmental data was obtained through Provincial government sources, including the Ministries of Environment, Forests and Lands, and Federal government sources such as Environment Canada and Fisheries and Oceans. The references obtained are presented at the end of the main text.

2.2 Air Photo Study

Detailed photo-interpretation was carried out to identify geotechnical hazard areas, analyze areas of known geotechnical hazards and establish interim geotechnical hazard maps. Aerial photos interpreted during this study include the following series:

30BCB90113, 30BCB90045, 30BCB90046 and SRS4299

2.3 Field Work

Field work for the geotechnical portion of the study consisted of limited ground reconnaissance and was focussed towards areas of known, or suspected, instability or hazards as identified during review of available data and the photo-interpretation study or during discussions with the DOS staff or local residents. Specific zones examined during the field reconnaissance survey included steep shoreline and upland areas and portions of the major creeks within the District of Sechelt study area.

Field work for the environmental portion of the study was focussed towards the inspection of areas which were known, or suspected, to be environmentally sensitive areas. These included watercourses, estuaries, marshes, shoreline and other areas. In addition, the visual resources of the area were evaluated in a general manner. Areas of environmental significance have been documented photographically. Verification of the presence of significant plant and animal species is beyond the scope of this study. For this reason, further studies of specific sites are recommended to confirm the assessments made in this report of any particular area if development considerations dictate that there is a potential for disturbance.

2.4 Meetings

An introductory meeting was held with Mr. Rob Buchan of the DOS at the start of the work. Further discussions and meetings with DOS personnel were held during the field visits and the later stages of the study.

Meetings were held with representatives of the Ratepayers Association of each neighbourhood during the early stages of the study. These meetings provided insight into community concerns and perceptions regarding geotechnical and environmental issues, and provided valuable historical information of local events such as recent flooding and landslides, forest and construction activities, residential development trends and local flora and fauna.

Discussions were also held with local resource managers, consultants and scientists familiar with the area, natural history group leaders and various local residents.

3.0 EXISTING DEVELOPMENT

3.1 Neighborhoods

The District of Sechelt comprises a number of distinct neighborhoods which are characterized by differences in topography, history, population base and economic diversity. Each of these neighborhoods have their own specific concerns and perceptions regarding future development within their community. Some issues, such as the desire for sound environmental practices and the preservation of viewscapes, are common to all neighborhoods, while other issues such as the rate or form of community development or the desire for municipal services may vary from one neighborhood to another. Discussions with local residents have helped to understand specific neighborhood concerns and to target areas for study. Specific concerns with respect to environmental and geotechnical issues which were expressed by neighborhood representatives and local residents during the course of the study are documented in Appendix II.

3.2 Indian Lands

The OCP area surrounds or adjoins five Indian Land Reserves, the largest of which is located just east of the Village of Sechelt and is self-governed by the Sechelt Indian Band (IR 2). This study does not include a geotechnical or environmental assessment of Indian Band lands. However, coordination with local Indian Band councils and relevant federal agencies may be required if any activity within either Indian Band or lands within the OCP area is perceived to pose a negative geotechnical or environmental impact on the other.

3.3 Forest Harvesting Activity

3.3.1 Past Logging

Much of the OCP area has been logged in the past with logging activities beginning in the area in the late 1800's. A large portion of the watersheds of Gray and Chapman Creeks outside of the OCP area has also been logged. A history of landslide activity within the Chapman Creek watershed related to logging activities, particularly logging road construction, has been documented by Thompson, 1984.

3.3.2 Current Forest Harvesting

The forest industry is the single most important industry on the Sunshine Coast. Some forest harvesting activities are currently being carried out within the OCP area on provincial forest lands. The Sechelt Provincial Forest is crown land which is administered by the B.C. Forest Service.

Most current forest harvesting activities in the region are occurring in the Gray Creek and Chapman Creek watersheds outside of the OCP area.

Other forest related operations in the OCP area include wood processing mills, the Canfor seed orchard and logging companies. Some of the foreshore areas are also used for forestry related activities. Interfor operates an active log dump and booming ground on Lot 1410 on the north side of Gray Creek fan in Tuwanek.

4.0 PHYSIOGRAPHY

4.1 Physiography

The Sechelt OCP area lies in the Georgia Depression physiographic region (Holland, 1976). This area, bounded on the east by the Pacific Ranges of the Coast Mountains and on the west by the Vancouver Island Mountains, contains both the Georgia Lowlands and the Nanaimo Lowlands, on the eastern and western edges, respectively of the Strait of Georgia. The Sechelt OCP area falls in the Georgia Lowland subdivision.

The Georgia Lowland, and the Georgia Depression, was extensively glaciated during the Pleistocene era. Great sheets of glacial ice flowed down from the Coast Mountains, joining with ice sheets originating on Vancouver Island and then flowing southeastward down the Strait of Georgia and eventually westward into the Juan de Fuca Strait. The ice flow followed the structural depression caused by the juncture of the Coast Mountains and the Vancouver Island Mountains, and resulted in a deepening of the Georgia depression. The fijord-like structures found along the mainland coast are a result of the intense glacial scouring action which occurred as the continental glaciation flowed towards the lowlands and sea.

Landforms in the Sechelt OCP area reflect the intensity of glaciation in the area. Sea levels have risen (relative to the depressed land) during glacial advances. Ice sheets up to 2,500 m thick are believed to have covered the area. Advances and retreats of the glacial ice have left a legacy of surficial deposits. These are mixed with marine deposits which developed during retreat of the glaciation and while the land was depressed, so that today, the surficial geology of the Sechelt OCP area is very complex. Marine, glaciomarine, morainal, fluvioglacial and fluvial sediments are found in the area. Bedrock outcrops, although less common than the surficial deposits, may also be found, particularly higher on the slopes in the northern, western portions of the OCP area and at least locally along portions of the shoreline. Organic deposits are found on some sites, where the high rainfall, moderate temperatures and impervious underlying materials have resulted in the development of bogs and wet areas.

4.2 Climate

Climate characteristics of the Sechelt Official Community Plan Area (OCP) will influence general land use patterns, and are therefore of importance in this study. In addition, general climatic patterns influence the vegetation of the area, and consequently the wildlife use, and must be included as a foundation upon which assessments of these components are evaluated. Data on the climatic conditions in the Sechelt OCP have been derived from data collected by Environment Canada, Atmospheric Environment Service. Information contained in the Ministry of Environment (1981) soils mapping has also been used.

The Sechelt OCP area falls within the Pacific Climatic Region (Hare and Thomas, 1979). This area has characteristically wet, mild winters and cool, dry summers. The Sechelt Weather Station receives a total of 1,099.0 mm of precipitation annually (1951 to 1981 normals), with 779.2 mm occurring in the October to March period. July is the driest month, with 41.7 mm of precipitation occurring. Gibsons Gower Point, an adjacent station, records an average annual precipitation of 1,359.3 mm showing the high degree of variability over short distances in this area. Precipitation occurs as warm, moist air moves in from the Pacific Ocean and strikes the Coast Range mountains. Locally, rain shadow effects may be noticed, where the leeward sides of mountains receive less moisture than the windward sides. Precipitation falls in the form of snow at higher elevations in the winter, with large accumulations at elevations above about 1,200 m

ASL. The heavy snowpack results in sustained groundwater and creek flows at lower elevations and significantly affects vegetation patterns.

Thirty year normal temperature records are not available for Sechelt, with Gibsons Gower Point being the nearest station with records. The annual mean daily temperature for this station is 9.9 degrees C, with the warmest mean daily temperatures being recorded in July and August (17.3 degrees C) and the coolest temperatures occurring in January (2.7 degrees C). Extreme minimum temperatures below freezing occur in the October to April period, although the record low temperature for Gibsons Gower Point is -10.5 degrees C. The extreme maximum temperature is recorded for July, when the temperature reached 30.6 degrees C. It is of interest to note that this range of extreme temperatures is far narrower than the range exhibited at stations in the British Columbia interior where the moderating effects of the Pacific Ocean are far less pronounced. The moderating effect of the ocean may be seen on a local level, where snow accumulation near the water is far less than even a few kilometres inland.

Climatic characteristics of the Sechelt OCP area influence land use patterns and potentials. The mild winters, and cool summers make this area an ideal retirement community for people from other, less hospitable places in Canada. This places demands for development of suitable accommodation and recreational activities. Planning activities which enhance the utilization of the naturally occurring mild climate are appropriate, while land uses which cannot be sustained in this climatic area, such as ski development, must be considered as marginal.

4.3 Bedrock Geology

Bedrock within the study area is comprised of strong, massive plutonic rock of quartz diorite and granodiorite composition. These rocks exhibit well developed orthogonal jointing, as well as stress-relief sheeting joints on the steeper slopes.

Rolling bedrock terrain is typical of the upland regions in the West Sechelt, Wilson Creek and Sandy Hook areas. In these areas, bedrock is generally exposed as rounded knolls or localized bluffs, or is present at shallow depths and overlain by a thin pocket or veneer of till, colluvium or organic materials. Areas of steep bedrock terrain also exist within the OCP area, particularly in Tuwanek and Sandy Hook. Rockfalls occur from bedrock cliffs at several locations.

Bedrock also outcrops at beach level or in steep rocky cliffs along the complex shorelines of Sechelt Inlet and Georgia Straight and in the beds and ravine slopes of a number of creeks.

4.4 Surficial Geology

The surficial geology of the OCP area is very complex. The unconsolidated surficial materials are generally of glacial origin which have been modified by marine and fluvial processes. In the areas of shallow bedrock, till veneer and colluvial deposits generally dominate. The till is often overlain by a thin veneer of brownish lag sand and gravel of marine origin below the 180 m elevation.

Thicker ground moraine deposits, mainly sandy till, are exposed within the OCP area and form several steep beach front escarpments along Trail Bay.

Large deposits of fluvial sands and gravels are associated with the fans of Chapman, Angus, Burnet and Gray Creeks. Several of these deposits are being actively worked by sand and gravel extraction operations. Some fine grained glaciomarine deposits are found in the West Sechelt area.

Modern sediments in the study area include channel, floodplain and fan and deltaic deposits associated with the creeks, as well as colluvial and beach deposits. Organic deposits are scattered throughout the region and have developed in poorly drained depressional areas.

The surficial geology is described in more detail by McCammon (1977).

4.5 Soils

Soils in the study area are generally of the Podzolic order and comprise mainly Bose and Sechelt soils which are humo-ferric podzols. Less common occurrences of Capilano, Nicholson, Albion, Heron, Cannel, Sunshine and Summer soils also can be found in the OCP area, particularly in West Sechelt.

Bose soils are common in the West Sechelt and Wilson Creek areas. They occur on variable topography from gently rolling to steeply sloping ground and generally below an elevation of 100 m The parent material for Bose soils consists of moderately to very stony, gravelly marine lag or glaciofluvial deposits overlying moderately coarse textured glacial till or moderately fine textured glaciomarine sediments. Bose soils are moderately well to well drained, being rapidly pervious in the upper gravelly part but slowly pervious in the glacial till underlay. These soiled have poor water retention capacities. Telluric seepage is common along the surface of the till after heavy rains. Up to 10 cm of organic forest litter is common on the surface. These soils provide good bearing capacity for construction but may vary to moderate where glaciomarine deposits occur in the subsoil. The low subsoil permeability limits sewage effluent disposal.

Sechelt soils commonly occur in the eastern, central and northern parts of the OCP area. These soils occur on gently to steeply sloping ground and have developed from deep, coarse textured alluvial fan and delta deposits which sometimes change to gravel below 2 m or more. Sechelt soils are rapid to well drained, have low water holding capability and slow surface runoff. These soils are well suited for urban uses where topography is not excessive. Septic fields generally function well due to the rapid soil permeability, however, high concentrations of septic field may lead to groundwater contamination as a result of generally poor filtration characteristics of these coarse grained soils.

Soils provide a long term indication of conditions at the site. For instance, the presence in the soil profile of the Ae horizon typical of a podzol indicates significant leaching as caused by water movement through a thick carpet of coniferous debris. This would indicate that the site traditionally supported a coniferous forest, although the current forest may be deciduous. Similarly, gleying of the soil profile would indicate moisture, although the soils may at any one time, be relatively dry.

Soils of the Sechelt OCP area have been mapped by the Ministry of Environment (1981).

4.6 Drainage

The study area contains a number of watercourses which drain the upland slopes along Georgia Straight and Sechelt Inlet. The main catchment areas for most creeks lie outside of the study area. Most creeks have relatively small catchments of less than 1500 ha.

however, Gray and Chapman Creeks, the two largest creeks in the study area, have catchments of 5,893 and 6,953 ha. respectively.

Creeks gradients are generally small with the exception of several creeks such as Cairns and Burnet which reach gradients of up to 18 percent and Irvine Creek which flows through a steep gully with a gradient reaching 30 percent.

Most creeks are fed by lakes and snowmelt. The freshet occurs in December and January when rainfall is greatest. A second peak discharge occurs in late spring for creeks fed by snow melt.

Both Gray and Chapman Creeks are used for domestic water supply. Chapman Creek is a main source of domestic water for the District of Sechelt and the Sunshine Coast Regional District.

Some surface runoff is collected in road and boundary ditches and culvert systems and discharges into natural watercourses and the waters of Sechelt Inlet and Georgia Straight. This water may transport fine suspended sediments and pollutants into sensitive watercourse areas.

Blocked ditch culverts may lead to nuisance flooding. For streams and creeks, heavy vegetation, blocked road culverts or construction activities which affect runoff or catchment size may lead to more serious flooding problems, particularly in the low gradient reaches of many of the creeks in the OCP area.

Concerns regarding increased runoff from new developments and associated ditch erosion and watercourse siltation problems were raised by local residents. Many of the problems associated with local drainage, siltation and flooding are avoided through maintenance and proper construction practices.

4.7 Groundwater

The groundwater regime within the study area is complex and controlled by topography and the varying permeability of the various geological units. Generally, groundwater will flow downslope through permeable materials and along the contact between permeable and impermeable materials. This subsurface flow will exit into watercourse channels, the ocean waters of Sechelt Inlet or Georgia Straight or into lakes or swamps in depressional areas.

Shallow groundwater occurs where bedrock or low permeable till units are located at shallow depths. Perched water tables occur in thick layered deposits of impermeable and permeable materials. Within the study area, groundwater discharges from beachfront and creek ravine slopes commonly occur along the top of the bedrock and dense till materials, and is responsible for the occurrence of shallow landslide activity and erosion. In addition, springs and seeps from confined aquifers contribute to erosion and instability problems.

Surface water in the form of lakes, ponds and swamps are found throughout the study area, particularly in areas of hummocky terrain, and occupy low lying areas and depressions which are underlain by impermeable materials.

5.0 BIOLOGICAL AND VISUAL RESOURCES

5.1 Vegetation

Information on the vegetation of the Sechelt OCP area has been derived from forest cover maps, biogeoclimatic zonation, other related studies and site investigations. Vegetation may be used to indicate site conditions (Klinka, et al., 1989). As such, it provides a visual tool for identification of subsurface conditions. Vegetation can be used as a tool in the planning process by providing information on the conditions of the site.

Vegetation patterns reflect the history of the site. Events which occurred hundreds of years previously may be identified by the vegetation growing on the site. Fires, floods, landslides and other such disturbances to the vegetation are reflected in the vegetation growing on the site many years after the occurrence of the event. The successional relationships between vegetation communities provide the clues to site history.

The lower elevations of the Sechelt OCP lie in the Wetter Subzone of the Coastal Douglas Fir Biogeoclimatic Zone, while the higher elevations fall within the Pacific Ranges Variation of the Drier Maritime Coastal Western Hemlock Biogeoclimatic Zone. The Coastal Douglas Fir zone in the Sechelt area is typified by the Douglas Fir - Western

Hemlock - Salal ecosystem association, while the Coastal Western Hemlock zone in the area is typified by the Western Hemlock - Douglas Fir - Feather Moss ecosystem association (Ministry of Forests, 1985).

Logging, which began in the area in the late 1800s and continues today, has resulted in a diversity of early to mid-successional forests. On moist sites, species such as cottonwood and broadleaf maple dominate with salmonberry, thimbleberry, sword ferns and other herbaceous species in the understory. On more mesic sites, young Douglas fir and red alder share dominance, while on drier sites, Douglas fir dominates the tree canopy. Large stumps of the fir, spruce, cedar, hemlock and balsam may be found among the new growth.

Western hemlock occupies a unique position in the forests of the Sechelt OCP. Hemlock is a climax species of many of the moister vegetation assemblages. However, this tree may also provide service as a pioneering conifer on sites where there has been significant wood wastes left after the initial logging. Hemlock may often be found growing on "nurse logs", or other old decaying wood. Western red cedar often occurs with the hemlock on these sites.

Lodgepole pine establishes on sites where a combination of severe fires and coarse gravelly soils result in dry conditions with little organic materials. Lodgepole pine serves as a pioneering conifer on these sites. Lodgepole pine often occurs in a mix with Douglas fir in stands which will eventually be dominated by the fir. Kinnikinnick and other dry site species may occur on the driest of these lodgepole pine sites; although with the closing of the canopy, these understory species will give way to the more typical salal.

Five vegetation cover types have been mapped for the Sechelt OCP. These are:

1) Urban, cleared areas
2) Deciduous forests
3) Coniferous forests
4) Mixed forests, and
5) Shrublands/Marshlands NSR

Urban, cleared areas are, as the name implies, areas which have been cleared for urban development, as pastures and for a variety of purposes. There is a wide variety of vegetation covers in this unit, from the manicured lawns of the housing estates, to the rights-of-way of transmission lines and pipelines.

Deciduous forests are early successional forests composed of red alder, broadleaf maple, and cottonwood or mixtures of these species. There are often conifers growing under the canopy of deciduous species, ready to form the dominant canopy once the work of the pioneering deciduous trees is complete. In some locations, such as along streams in the areas where periodic flooding prevents further succession, stands of deciduous trees will persist.

Coniferous forests would form over the entire Sechelt OCP given sufficient time. These forests, composed of various mixes of Douglas fir, western hemlock, spruce, balsam and cedar have formed the backbone of the forest industry. It is rare to have stands composed of a single conifer species; although a few stands comprising only western hemlock occur, and there are a few places where Douglas fir is the only tree species.

Mixed stands of deciduous and coniferous species dominate much of the Sechelt OCP. These stands are indicative of the relatively early successional stage of most of the forests of the area. Deciduous species aid in preparing the forest sites for healthy conifer growth by adding nitrogen (red alder) and by breaking the cycle of pathogenic organisms which infect conifers.

Shrubland/Marshland NSR vegetation communities encompass openings in the forest cover which are not satisfactorily restocked (NSR) or are naturally vegetated by wetland vegetation. Species such as willows, red-osier dogwood, salmonberry and thimbleberry often form dense stands in logged areas. These stands prevent conifers from becoming established until the species comprising the stand mature. Although this type of cover would appear to restrict forest growth in the short term, the importance of these species for the long term growth of forests cannot be overstated. Shrubland and marshland vegetation provides a diversity of habitats for both plants and animals.

Figure 2 shows the distribution of these vegetation covers in the Sechelt OCP area. The urban, cleared areas dominate the vegetation cover of the mapped areas. Mixed forests most often occur adjacent to these cleared sites, while the coniferous forests occur most frequently in the outlying area. NSR sites are scattered, but are generally found adjacent to coniferous forests. There are very few purely deciduous stands, a reflection on the more advanced state of succession adjacent to the town of Sechelt.

In the opinion of the author, there are no particularly significant botanic features within the Sechelt OCP area. However, Ambrose Lake Ecological Reserve (Number 28), although not located in the Sechelt OCP area, does provide protection for some interesting bog species. Similarly, the Tetrahedron Peak area, located to the north of the Sechelt OCP area has been recognized as being of significance botanically.

A "wildflower" park, known locally as Kinnikinnick Park (Lot 1472), has been established in the West Porpoise Bay area with trails and signs. This is used by local residents for enjoyment of the local flora. In addition, a strip of trees at the north end of Wharf Road has been noted as being of local significance.

5.2 Wildlife

Wildlife distribution in the Sechelt OCP area is closely tied to the vegetation cover for terrestrial animals and the shoreline conditions for marine mammals. Large terrestrial mammals, such as deer, utilize the mixed stands of deciduous and coniferous trees, NSR lands and the edges of the forests surrounding urban, cleared areas. Linear patterns of open areas adjacent to closed forest, such as created by electrical transmission lines, provides an abundance of habitat for ungulates.

Large mammals such as bears and cougars also utilize mixed and open vegetation types. Cougars use these areas because their prey, deer, use them, while bears favour such sites because of the diversity of foods available. Smaller carnivores, such as martins, otters and mink are more specific in their habitat requirements. Martins use coniferous forests almost exclusively, where they prey upon mice, moles, squirrel and rabbits. Otters and mink are associated with aquatic habitats, with otter favouring marine and larger rivers and lakes, and mink being associated with smaller streams, although mink may be found in the same areas as otter. Raccoons are commonly associated with inhabited areas, where they may become pests.

Marine mammals may be found in the waters surrounding the Sechelt OCP area. Whales and dolphins are relatively common in the Straits of Georgia and Juan de Fuca, with the killer whale being the most notable. Males of both Stellar and California sealions may be found during the winter when they feed on herring which come into the Strait of Georgia to spawn. Harbour seals are common year round inhabitants of the water surrounding the Sechelt OCP area.

Birds are found throughout the Sechelt OCP area. Bald eagles, probably the most spectacular bird of the area, are commonly found in areas where salmon spawn. A variety of seagull species are found in the area as are a variety of ducks. Great blue herons may be seen in the marshes and tidal flats, where they prey on small fish. A wide variety of passerine birds are common in the mixed forests and urban areas of the Sechelt OCP area, as are crows. Ravens are more commonly associated with the coniferous forests and areas further from settlement.

Two "duck ponds" figure prominently with local residents. One, near the south end of Sechelt Inlet, adjacent to the north end of Wharf Road, serves as a freshwater extension of the inlet, while the other, located near the arena, in the Rice Subdivision, is home to several dozen ducks, primarily mallards (photo 1).

5.3 Aquatic Resources

The Sechelt OCP area is fortunate in having an abundance of aquatic resources. All of the major salmon species frequent the waters around Sechelt, and most of them spawn in the local streams. In addition, the fresh waters support populations of coastal cutthroat trout, dolly varden char, rainbow trout and a variety of non-sport fish. Steelhead may be found in most of the major creeks. Chapman, Wilson, Burnet, Gray, Angus and Wakefield creeks all support salmon populations, although Chapman and Gray creeks are probably the most significant, supporting populations of chum, pink, coho, chinook and steelhead between them (photo 2). Efforts have been made to enhance the fisheries values of the local creeks through salmonid enhancement projects. Commercial fish farming has been conducted in the Sechelt Inlet, although the lack of a significant market for these fish and problems associated with the low rate of flushing in the inlet has hampered these endeavors.

The abundance of fish relies on the aquatic habitats occurring in the area. Clear flowing streams and good quality ocean waters support the foods of these fish. Maintenance of this resource is contingent upon maintenance of this high quality habitat.

In addition to the fish which frequent the waters of the Sechelt OCP area, there are an abundance of other aquatic organisms which may be found in the area. Clams, oysters and other mollusks may be found in the coastal waters while anemones, starfish and other such species attract divers from around the world.

5.4 Visual Resources

The diversity of the visual resources of the Sechelt OCP area provides enjoyment for visitors and residents alike. The integrity of the visual environment is essential to the enjoyment of the area by residents and visitors. The following paragraphs provide information on the visual resources of the area.

The area has two primary viewscapes; the open Strait of Georgia and the more enclosed Sechelt Inlet. There are few places in the area where one or the other of these viewscapes are not visible, and in some locations, both may be seen.

The Strait of Georgia may be seen from most locations in Central Sechelt and from Wilson Creek, Davis Bay, Selma Park, Wakefield and along the southern part of West Sechelt (photo 3). From these areas, the Strait of Georgia provides an open expanse of water, with the Trail Islands providing a focal point. Activities on the water, such as boats, and the various "moods" of the Strait provide interest for the viewer.

The enclosed views of Sechelt Inlet are visible from Tuwanek, Sandyhook, East and West Porpoise Bay and the north part of Central Sechelt (photo 4). The inlet is enclosed by mountains, which form an important part of the viewscape. In particular, Mount Richardson forms a backdrop to the inlet from most points along the inlet (photo 5). Views of the east side of the inlet are available to residents on the west side, and vis a versa.

The integrity of the vegetation cover is critical to the "value" of the view. Clear-cut logging, mining and gravel extraction cause major visual impacts (photo 6). In addition, housing developments, apartment blocks and other structures may be seen as impacting negatively on view quality. The apartment blocks along the shore of the Strait of Georgia in the central Sechelt area are a case in point. Many residents expressed concern over the extent of logging, mining, gravel extraction and housing developments, particularly when these intrusions fell within their views.

Views from boats, both on the Strait of Georgia and the Sechelt Inlet are critical to the boating public. The large gravel pit, located on Indian lands to the east of Sechelt is by far the largest single visual impact, both from the water and from West Porpoise Bay. Similarly, large cutblocks provide a significant visual intrusion for both the boater and the terrestrial viewer (photo 7). A mine, located on the west side of Sechelt Inlet, near Snake Bay, provides a visual intrusion to boaters in the inlet and to residents of Sandyhook and Tuwanek (photo 7).

6.0 GEOLOGICAL HAZARDS

6.1 Historical Hazard Activity

Historical accounts of geotechnical hazards within the OCP area primarily relate to flooding events along the major creeks and associated soil deposition and erosion activity. Evidence of recent shallow landslides on oversteepened beach front slopes, and areas of rockfall activity can be found within the study area. There is no evidence or accounts of major, deepseated landslide activity.

6.2 Potential Hazards

6.2.1 Hazard Types

The reconnaissance study has identified various types of existing and potential natural hazard which can affect development. In many areas, these hazards have been recognized and been avoided by new development. However, this is not invariably the case and houses have been constructed in areas where the recommended geotechnical guidelines and bylaws would make them non-conforming.

Hazards include the following: landslides, debris flows/debris floods, gully and beach front erosion, flooding, rockfalls and forest harvesting related hazards.

6.2.2 Landslides

Landslides may be developed in the glacial soils and overlying colluvium of the Sechelt area as the result of erosion, oversteepening or overloading of the slopes, changed ground water conditions and/or removal of vegetation, and possibly earthquake activity. The soils vary from dense gravelly tills with thin interbedded sands and gravels, to very thick sequences of fluvial or outwash gravels. Deep-seated slides have not been recognized and the general failure mode in the tills consists of relatively shallow slumping, slide failure or creep in the weakened surface layers where softening and stress-relief jointing has occurred or significant thicknesses of colluvium have accumulated. Caving erosion occurs where sandy layers are eroded due to concentrated groundwater seepage discharge from the ground surface, forming a cave which initiates collapse of the overlying material (photo 8). This process often leads to the formation of a receding scarp and the formation of a gully.

Sliding may also be developed in the granitic rocks of the Sechelt area where discontinuities in the rock dip out of the faces at angles shallower than the slopes. This is usually a localized occurrence developed primarily on steep slopes where stress-relief joints are present sub-parallel to the original ground surface. However, blasting and excavation into such rock for road cuts or lot levelling may also induce local rock slips or failures.

6.2.3 Debris Flows/Debris Floods

Little evidence has been obtained of past debris flows or debris floods. Such events occur in steep drainage courses when appropriate hydrological conditions occur and material is available for transport. The risk of debris flow or flood activity may be adversely affected by activity such as uncontrolled forest harvesting or clear cutting, construction of forest or other roads along or across drainage courses, sidecasting of materials, clearcutting and blockage of drainage channels (Cass, Kenning and Rawlings, 1992).

6.2.4 Gully and Beach Front Erosion

Many of the glacial soils are highly erodible under severe flood or wave activity. This results in rapid removal of material, shift in creek channel alignments, oversteepened slopes, high sediment loads and removal or destabilization of vegetation. The most severe examples in the project area may be seen in Chapman Creek (photo 9) and along Davis and Trail Bays where beach front erosion is a continuing, although intermittent process (photos 10 and 11).

6.2.5 Flooding

All creeks within the study area are considered to be subject to flooding. There are very significant creeks in the project area, some of which have been the subject of reports by others (e.g. Chapman Creek - MOELP -). The hydrological aspects are beyond the scope of this report, but geotechnical evidence of flood-prone areas is provided on the maps. Related aspects of surface water discharge, particularly across steep soil slopes, by individual homeowners and MOTH have been considered.

6.2.6 Rockfalls

Rockfall is the rapid, free fall of a newly detached segment of bedrock from a cliff or steep rock slope. Rockfall areas can often be identified by the presence of talus deposits and recent rockfall activity can be roughly assessed by the presence and distribution of fresh rock fragments.

Rockfall hazards associated with steep bedrock bluffs have been identified at several locations within the study area, and pose a threat to a number of properties. The most serious rockfall hazard has been identified in the area to the south of Sandy Hook (photo 12).

6.2.7 Mining and Forest Harvesting Activity

Soils in certain portions of or adjacent to the study area have been highly disturbed by sand and gravel extraction operations. Steep, unvegetated or partially-vegetated, slopes have been developed and waste soils from the pits have been dumped or moved within the workings. Many of the slopes are oversteepened and potentially unstable, and the fills are loose and uncompacted (photo 13).

Forest harvesting activities have created disturbance of the surficial soils which may locally have created potential geotechnical instability.

6.3 Hazard Mapping

Reconnaissance of the area as described in Section 2 has resulted in the identification of these various types of hazard in the Sechelt region. Details are provided on Figures 3 to 14. This information has been used to define DPA's which are described in detail in Section 9.

7.0 ENVIRONMENTALLY SENSITIVE AREAS

7.1 Terrestrial Sites

Areas of pristine natural quality may be considered as being environmentally sensitive by virtue of their relative rarity in the Sechelt OCP area. These would include sites such as the Trail Islands, Lamb Islets and Poise Island. In addition, stands of mature timber, such as occur in West Sechelt, could be considered sensitive due to the lack of other significant stands in the area.

Marshlands and foreshore and/or tidal areas could be considered environmentally sensitive. These sites are sensitive due to their transitional nature, between terrestrial ecosystems and aquatic habitats. Such sites provide a diversity of organisms and tend to be very biologically productive.

Rocky outcrops, such as occur along the coast in the Wakefield area, could be considered sensitive (photo 14). Plant growth on these sites is restricted and slow, due to the lack of soils and therefore the limited moisture and nutrients. In addition, plant species, such as stonecrop, which are restricted to rock outcrops, may be sensitive to disturbance. Damage to the fragile plant life can take many centuries to repair.

7.2 Aquatic Sites

All streams, creeks, ponds and other water bodies must be considered sensitive due to the diversity of aquatic organisms which rely on these habitats for their existence. In particular, the estuaries of major creeks, such as Chapman Creek (photo 15), Wilson Creek, and Angus Creek (photo 16), are especially sensitive. Stream side vegetation is essential for the protection of the aquatic resources. For this reason, particular care must be taken when work in these areas is contemplated.

The extensive fisheries resources of the Sechelt OCP area are dependent upon the integrity of these aquatic systems. Impacts resulting from measures such as flood control, can have far reaching consequences. Both federal and provincial fisheries departments must be consulted before any changes to aquatic systems are contemplated. In many cases, the timing of proposed works can have a significant effect on the aquatic resources. Scheduling of activities which involve creeks, streams, ponds and other aquatic systems must be developed with the biology of the species involved in mind.

Surface runoff from construction areas may result in silt laden waters entering sensitive watercourses and ocean areas (photo 17). Appropriate construction procedures and scheduling should be carried out to minimize these impacts.

Marshlands, as noted above, are similarly sensitive. Changes in the drainage patterns, as might be caused by development of adjacent lands, can have significant impacts on marshlands. Filling in wetlands for construction purposes can have a detrimental effect on wetland function. The pond in the Rice Subdivision noted above would be sensitive to any changes in the local drainage.

7.3 Marine Sites

All coastal areas may be considered sensitive. Estuaries are of particular importance. These sites serve as important rearing grounds for many salmon species, and provide specific habitats for other biota. Clearing and developments such as currently underway at the Wilson Creek estuary may have a significant negative impact on the fisheries resources and bird life of the area. In addition, major developments in such areas will negatively impact the visual quality of the region generally. Shoreline areas also provide spawning habitat for a variety of non-commercial fish which in turn, provide food for commercial species. Marine vegetation, such as eelgrass, kelp and other such plans are sensitive to factors such as siltation and current changes. Impacts to these species can have significant effects higher in the food chain.

Although not in the DOS, the small islands, such as Trail Islands and White Islets, provide habitat for marine mammals such as sealions. Developments which might encroach on these sensitive areas must be carefully considered. Activities, such as whale watching or sealion watching, may adversely affect these animals.

As with the aquatic sites noted above, the condition of the shoreline and the vegetation adjacent to the coast is critical to the function of the marine ecosystems. Trees may serve as "roosts" for eagles and/or herons. Roots may serve to bind the soils and prevent erosion, while litter from the vegetation may provide an important function in the marine ecosystem.

Developments on the shores can have a significant impact on the marine environment. Paving and other activities which change the natural drainage can impact marine systems adversely. Accidental spills and other sources of pollution can add to the stress placed on marine ecosystems. Particular care must be taken when considering discharge of storm and sanitary sewers, as these often serve as the conduit for many pollutants. Discharge of treated sewage can have a significant impact on the local biota through the addition of nutrients and smothering of smaller organisms. Plans to develop a secondary sewage treatment outfall offshore from the Wilson Creek estuary for the proposed marina and condominium complex on Indian Reserve 1 (Tsawcome) should be studied in detail, as the consequences to Davis Bay may be severe.

Areas identified as being environmentally sensitive require further consideration prior to development.

8.0 DEVELOPMENT PERMIT AREAS

8.1 General

The primary objective of formulating the recommended Development Permit Areas is to direct development away from sites which are susceptible to geotechnical hazards or are environmentally sensitive or to limit such development to that which can be achieved while meeting the objectives of safety to persons and property and maintenance of environmental standards. DPAs will also serve to provide further study of sites which are recognized as being important but which have not been thoroughly documented to permit detailed planning to occur.

A total of 4 environmental DPA's (environment sensitivity category) and 5 geotechnical DPA's (natural hazard category) are recommended. All DPA boundaries are approximate and are subject to detailed site investigations and surveys.

The DPA limits shown are estimates based on the information made available to us at the time of the study and limited visual reconnaissance field checks. If DPA boundaries change as a result of future, more detailed investigation or changed land use conditions, these maps should be updated to reflect the new information.

The development permit areas have been designated using judgement and consideration of existing or potential geotechnical or environmental hazards. This study is not sufficiently accurate for site specific applications for permit approval.

The implementation of DPA recommendations within portions of the OCP area will require liaison with relevant Provincial and Federal Ministries such as the Ministry of Health, Ministry of Environment, Lands and Parks, Ministry of Forests, the Ministry of Transportation and Highways and the Department of Fisheries and Oceans.

It is important to require an applicant for a Development Permit to obtain the permit prior to any work on the land, the only exceptions being survey works which do not entail significant cutting, or works which are undertaken to remedy an immediate environmental problem (e.g. malfunctioning septic systems). Similarly, for those areas identified as potential geotechnical hazards, a suitable site specific investigation should be carried out, submitted to and accepted by the District of Sechelt and other Authorities prior to issuance of a development permit and commencement of work other than that needed to provide protection against immediate risk to persons.

Where both environmental sensitivity and geotechnical hazard considerations apply, the environmental assessment should be carried out first to determine whether the proposed land use is compatible with the environmental constraints and to establish suitable means and methods of carrying the geotechnical investigation within the constraints of the environmentally sensitive conditions.

For the purpose of development permit designations along watercourses, the creek high water is defined as either:

- the limit of the 1:200 year flood as defined by Provincial records; or
- as the natural creek boundary as determined in the field for creeks where the 1:200 flood limits have not been determined.

8.2 Geotechnical

The objectives of geotechnical DPA's are as follows:

- to provide protection to development from hazardous conditions in the form a landslides, rockfalls, storm wave erosion, and flooding and other channelized hazards;
- to require that appropriate measures, such as adequate building setbacks, drainage and cut and fill precautions be taken where potential geotechnical hazards exist.

Areas with similar geotechnical hazards exists, such as rockfall hazard areas, have been grouped into a single DPA designation.

For all geotechnical development permit areas, subdivisions for dwellings and other permanent structures should not be permitted without a geotechnical investigation by a Registered Professional Engineer in the Province of British Columbia, having specific training and experience in geotechnical engineering. The report should confirm the suitability of the proposed development and provide detailed, site specific recommendations and constraints to development meeting the objectives of the Development Permit guidelines and the measures required to ensure the protection of structures.

For the purpose of this study, the setback distance is the defined as horizontal distance from the obvious change in grade which defines the crest or toe of the slope. Detailed site surveys are required to determine the location of the slope crest and setback zone. Setbacks boundaries illustrated on the Figures are approximate and were determined from limited site reconnaissance, airphoto interpretation and estimations of slope crest/toe locations from the 1:5000 topographic maps.

In areas not covered by development permit designations, it is assumed that geotechnical review by MOTH during subdivision application and observations by DOS staff will determine the requirements for geotechnical work for development proposals. It is further assumed that a geotechnical report may be called for by the Building Inspector during the permit application process should a geotechnical problem be perceived.

For the purpose of this study, the probability of hazard occurrence at a particular location has been specified as being either high (red) or moderate to low (yellow). The level of this study did not permit quantification of hazard probability levels. In a very general manner, it may be assumed that a high (red) hazard zone may be associated with a probability of hazard occurrence of greater than about 1:100, a moderate (yellow) hazard zone being associated with a probability of about 1:100 to 1:500 and a low (yellow) hazard zone being associated with a probability of less than about 1:500. Within those areas on the maps which are not coloured, no apparent and relatively widespread geotechnical hazards were identified within the scope of this study. However, it must be recognized that local or more severe hazards may exist at specific locations within larger areas having no or lesser hazard risk.

It is emphasized that these estimates are subjective and approximate and should be used for comparison purposes only. The assigning of probability levels to specific hazard events, or series of events, can only be achieved by carrying out more detailed geotechnical and hydrological studies to determine appropriate hazard probability/magnitude relationships.

8.3 Environmental

The objectives of environmental DPA's are as follows:

- to provide protection for sensitive terrestrial sites and upland areas, including visually sensitive sites;
- to provide protection of the aquatic resources associated with creeks, marshes and wetlands, and the marine resources associated with foreshore areas and islands within the OCP area; and
- to provide protection for unique and/or sensitive sites which may contain elements of both terrestrial and aquatic habitats and which are sensitive to the function of the whole ecosystem.

Development permits should be required prior to any development, including any and all soil disturbances, within the DPAs as shown. The permits may specify where:

1) a development may proceed with suitable environmental protection procedures during the construction and/or development process;

2) further study and planning is required to determine the extent of potential impacts and to define how the development may proceed; and,

3) the nature of the site under consideration and/or the extent of the contemplated development are not compatible with the environmental sensitivity of the site or area and the development may not proceed.

9.0 RECOMMENDED DEVELOPMENT PERMIT AREAS

9.1 AREA: **DEVELOPMENT PERMIT AREA 1: Coniferous Forest Areas,** as shown on Figure 2.

CATEGORY: a) Natural Environment Conditions

EXTENT OF DPA: Development Permit Area 1 comprises all coniferous forests as shown on the forest cover map shown on Figure 2.

JUSTIFICATION: Coniferous Forest Areas contain visually significant vegetation which, if cleared, may take decades or centuries to recover to the pre-clearing state. Stands of mature coniferous forests provide habitat for a wide variety of animals and birds as well as other plant life. Large trees standing near the ocean or watercourses often serve as perches for eagles and other large birds. In addition, mature forests act as a sponge in reducing peak flows and controlling flooding. Mature coniferous forests also provide recreational opportunities which may not exist in successionally younger forests. Hiking and "nature enjoyment" within these forests provides a sense of relief from the stresses of everyday life. The importance of such sites will increase in the future as society recognizes the need for such relief.

GUIDELINES: Development permits should be issued for works in this area only under the following conditions (all conditions should be addressed):

(a) The clearing will not be significantly visible from any other area;

(b) No trees greater than 0.75 m DBH (diameter at breast height) shall be cut; and,

(c) Clearing activities will not endanger standing timber through increased wind throw, disease resulting from damage, or soil compaction.

Developments should be planned to maintain tree cover by appropriate siting and layout. Removal of trees should be limited to those which are in direct conflict with the planned and accepted development. Planning of developments to avoid removal of trees may enhance the value of the development.

Care should be taken that there are no raptor nests in the trees being removed, and that removal of the trees does not result in damage to adjacent trees.

9.2 AREA: **DEVELOPMENT PERMIT AREA 2: Gravel Pit Areas** within the Neighborhoods of Sandy Hook, East Porpoise Bay and West Porpoise Bay as shown on Figures 6,7,9 and 10.

CATEGORY: a) Natural Environment Conditions

EXTENT OF DPA: Development Permit Area 2 comprises all sand and gravel pits within the OCP area as shown on the Figures.

JUSTIFICATION: Gravel pits often contain loose, fine textured materials which, when exposed to the elements, are subject to erosion. Fine sands and silts can enter watercourses and damage aquatic habitats. Single storm events can result in the erosion of large quantities of unconsolidated fine sands, resulting in burial of spawning beds, deterioration of habitats, and filling of swamps and marshes. Erosion of sands may also impact marine habitats in creek estuaries through burial and changes in the course of the stream. Sediment laden streams may have sufficient energy to transport materials to the ocean, where, upon reduced velocities, the sediment load is lost. Biotic habitats may be impacted while reduced water quality may impact recreational diving.

In addition, geotechnical hazards frequently exist in the development of gravel pits. Steep slopes may be prone to local sliding and slipping. As described above, loose and exposed materials within the gravel pits are subject to erosion. These areas, and associated access roads or modifications to natural drainage courses, and may provide significant sources of materials for debris flow or flood activity.

GUIDELINES: Proposed developments within gravel pit areas should address the potential for erosion and slope instability. Measures which will minimize erosion, both in the short term during development and the operation of the gravel pits, and over the long term must be clearly determined in advance. Protective and reclamation measures might include:

(a) Scheduling of initial stripping or excavations during development or expansion of gravel extraction operations to avoid periods when the probability of significant rainfall is high;

(b) Selection and design of interim and final cut or fill slopes within gravel pits to maintain stability and avoid creation of large cuts and fills in unconsolidated materials;

(c) Provision of erosion controlling structures in the design such as settling ponds, siltation traps and avoidance of uncontrolled ponding and drainage;

(d) Minimizing the extent of cleared and grubbed areas prior to the establishment of a suitable vegetation cover; and

(e) Incorporation of a program for rapid revegetation, including temporary revegetation, of all disturbed soils on an ongoing basis throughout the period of gravel pit operations and as part of final reclamation and abandonment.

Development permits in gravel pit areas should not be issued until potential erosion, sediment discharge and stability issues have been thoroughly dealt with and are incorporated within a gravel extraction and reclamation plan, meeting the objectives of the OCP guidelines and those of other appropriate Authorities. Avoidance of erosion problems and unstable slopes is the primary means of dealing with such problems.

9.3 AREA: **DEVELOPMENT PERMIT AREA 3: Watercourses Habitat Areas.**

CATEGORY: a) Natural Environment Conditions

EXTENT OF DPA: All watercourses within the OCP area including creeks, streams, ponds and wetlands and the lands extending 15 meters on either side of the highwater mark and/or ravine crest. Only the major creeks within the OCP area are indicated on the Figures although all watercourses are included in this DPA designation.

JUSTIFICATION: These watercourses and adjacent lands provide habitat for fish, waterfowl and other aquatic organisms. Disturbance of this habitat without specific permission is contrary to provincial and federal legislation. Works adjacent to watercourses may pose the threat of vegetation removal and potential erosion, therefore, a 15 meter setback should be included within DPA 3. The following streams provide habitat for fish populations:

1) Chapman Creek
2) Wilson Creek, East Wilson Creek and Hudson Creek
3) Wakefield Creek
4) Burnet Creek
5) Angus Creek
6) Gray Creek
7) Irvine Creek

while ponds and wetlands in the Sechelt OCP area, including the small pond in the Rice Subdivision, provide habitat for waterfowl and other aquatic organisms. Small drainages, whether natural or constructed, may provide important habitat for young fish, or may discharge into streams with important habitat. Wetlands, swamps and bogs provide important functions in the aquatic ecosystems by buffering the effects of storms, modifying nutrient loadings (acting as a sink) and water chemistry, and by providing habitats for many plants and animals. These areas are included in DPA 3.

GUIDELINES: Developments within the DPA limit should be avoided wherever possible. Development permits for work in or adjacent to these areas must accommodate the appropriate requirements of both federal and provincial legislation. Specifically, development permits should include:

(a) Minimizing all clearing, grubbing or other works within the zone;
(b) Provisions for erosion control for sites adjacent to the zone; and,
(c) Scheduling provisions which avoid sensitive periods.

Buildings and permanent structures should not be allowed within the watercourse zones. Works around and adjacent to the zones, including drainage and septic systems, should be restricted to prevent adverse impact within the DPA zone or not permitted if such adverse impacts can not otherwise be prevented. Septic discharges should not be allowed to enter the zone, while storm water discharges should be treated in such a manner that deposition of sediments and contaminants are prevented from entering the watercourses.

9.4 AREA: **DEVELOPMENT PERMIT AREA 4: All Shoreline and Foreshore Areas** as shown on Figure 2.

CATEGORY: a) Natural Environment Conditions

EXTENT OF DPA: Development Permit Area 4 is defined as all areas within 15 meters of the hightide line and 15 meters below the lowtide line of all shoreline and foreshore areas along Georgia Straight and Sechelt Inlet within the OCP area.

JUSTIFICATION: Shoreline and foreshore areas are important both ecologically and visually. These areas provide habitats for young fish, shorebirds and many marine organisms. The beautiful coastlines of the Sechelt OCP area are an attraction to visitors and residents alike. Developments within these areas may result in damage to fragile ecosystems and may impair the visual quality of the coastline. Shoreline processes, such as erosion by natural wave action, may serve important functions in terms of providing materials for the development of sand bars and beach areas. Works which modify these processes may result in damage to adjacent ecosystems.

Discharge of materials within DPA 4 may damage sensitive ecosystems. Filling of marshy areas (such as at the north end of Wharf Road) may similarly damage fragile ecosystems. Estuary areas serve as important habitats for many aquatic and marine organisms. Estuary areas would include DPA 3 as well as DPA 4.

GUIDELINES: Development within DPA 4 should be avoided where possible. Detailed studies by competent personnel of the potential impacts of proposed developments should be conducted prior to issuance of a Development Permit for theses sites. Key issues include:

(a) the potential effects of the proposed development on the marine ecosystem;

(b) the visual impacts of the proposed development; and,

(c) an assessment of the need for the development or provision of development alternatives to minimize the impacts.

Where possible, developments adjacent to DPA 4, should include provisions for public enjoyment of the coastline. The inclusion of walking trails and viewing points in development proposals should be encouraged. These should be established as a buffer between the proposed development and the shoreline/foreshore area at the 15 meter setback line. Developments which must, by their nature, encroach on DPA 4, such as wharves and docks, should be designed so that they do not impair the enjoyment of the area by other members of the public. Care should be taken to avoid creating structures which could pose a hazard to boaters.

9.5 AREA: **DEVELOPMENT PERMIT AREA 5: Rocky Beach Front and Upland Slopes** as follows:

1) the shoreline area along the Straight of Georgia between the western municipal boundary of the District of Sechelt at Sargeants Bay and the Fiddler Road right-of-way, within the neighborhood of West Sechelt, as shown on Figures 3 and 4.

2) the beach front area to the south of the Sunshine Coast Highway and to the west of Camden Road right-of-way, within the neighborhood of West Sechelt, as shown on Figure 8.

3) the upland areas located between the Sunshine Coast Highway and the northern boundary of the District of Sechelt, within the neighborhoods of West Sechelt and West Porpoise Bay, as shown on Figures 3 and 4.

4) the shoreline area along the Sechelt Inlet extending from the District of Sechelt boundary at Snake Bay, southwards to the District of Sechelt boundary adjacent to Indian Reserve 3 (Swaycalse), including an area between Gale Avenue South and Lookout Avenue in the Sunshine Heights area, within the neighborhood of West Porpoise Bay, as shown on Figures 6 and 7.

5) the shoreline areas along Sechelt Inlet to the west of Sechelt Inlet Road, the upland areas to the east of Sechelt Inlet Road, within the neighborhood of Tuwanek, as shown on Figure 5.

6) the shoreline areas along Sechelt Inlet and upland areas, between Naylor Road in Tillicum Bay and the western boundary of the Indian Reserve 28 (Shannon Creek), within the neighborhood of Sandy Hook, as shown on Figures 5 and 6.

7) a shoreline area along Porpoise Bay to the west of the wharfs, and an upland area partially bounded on the east by Salmon Drive, within the "village" of Central Sechelt, as shown on Figure 7.

8) a shoreline area along the Straight of Georgia south of Browning Road between McCullough Road and the Paul Road right-of-way, within the neighborhood of Wilson Creek, as shown on Figures 12 and 14.

CATEGORY: b) Natural Hazard Conditions

EXTENT OF DPA: Development Permit Area 5 includes the following:

i) for beach front slopes: the slopes, the beach area above the high water level of the Strait of Georgia or Sechelt Inlet, up to a minimum 15 m horizontal setback behind the crest of the slopes.

ii) for upland slopes: as mapped on the Figures.

JUSTIFICATION: The terrain within this Development Permit Area comprises predominantly steep rocky beach front and upland slopes with a discontinuous surficial blanket or veneer of fine grained or granular morainal soils or rubbly colluvium over bedrock. In the Snake Bay area, soils deposits are generally thicker and include a sand and gravel veneer of probable marine origin.

The soils are subject to potential shallow instability, small debris landslides and to minor storm wave erosion where they are exposed along the beach front. Creep and shallow instability in the surficial soils were observed.

On rock slopes, there is a potential for local instability including the possibility of rockfalls from exposed bedrock faces. Three areas of severe rockfall hazards were identified in the Tuwanek and Sandy Hook Neighborhoods and one in the Sunshine Heights area of West Porpoise Bay, and are included in DPA 7. Modifications to existing rock slopes, either as cuts or fills may increase the extent or risk of instability.

Surficial runoff and seepage from perched groundwater tables have contributed to the formation of gullies within the thicker surficial soil deposits in these areas.

Estimated Probability of Hazard Occurrence: It is estimated that a moderate to low (yellow) probability exists for the occurrence of shallow soil instability including debris landslides, rock slope instability and isolated rockfalls from these existing natural slopes. It is estimated that a high (red) probability exists for soil instability including small soil slides on the slopes of the small creek gully located at the north end of Porpoise Drive in the community of Sandy Hook.

GUIDELINES: Prior to issuance of a development permit, the potential for both rock and soil slope instability and the impact of the proposed development should be addressed by a site specific investigation and report prepared by a Registered Professional with specific experience in geotechnical engineering and/or engineering geology.

a) In areas of exposed bedrock, the potential for rockfalls should be addressed. This should be supported by documentation of the extent of anticipated instability with measurements tied to physical features where possible. Accurate field determination of slope crest location or other geological features should be made. Site plans and slope profiles should be provided.

b) The engineering report should address geotechnical considerations of cut and fill slope stability and provide appropriate recommendations and restrictions on excavation, blasting and filling.

c) Building envelopes should be determined with relation to natural or cut slope crests and possible rockfall zones.

d) Possible changes in slope conditions that might indicate an imminent landslide of rockfall hazard should be included for the attention and education of landowners.

e) The engineering report and any associated plans or designs should assess groundwater conditions and the potential slope instability caused by groundwater seepage.

f) The anticipated effects of septic and drainage systems on slope instability should also be considered. The abundance of bedrock or low permeability soils at shallow depth throughout this area will limit the viability of in-ground septic disposal systems.

g) The report and proposed development plans should also address the erosion potential by ocean waves or drainage flows.

h) In general, vegetation should be maintained on the slopes and within the setback zone above the slopes to minimize erosion. In areas of bedrock, the engineer should assess the necessity for selective scaling, rock bolting and tree removal to improve stability conditions, on a site specific basis.

Recommended tree protection, septic field, soil removal and deposition and shoreline protection bylaws should apply.

9.6 AREA: **DEVELOPMENT PERMIT AREA 6: Beach Front Escarpments** along Trail Bay and Davis Bay as follows:

1) the area to the south of the Sunshine Coast Highway from approximately Mason Road to just east of Norwest Bay Road, along Trail Bay in the neighborhood of West Sechelt, as shown on Figure 8;

2) the area west of the Sunshine Coast Highway from just north of Bay Road, northward to the boundary with Indian Reserve 2 (Sechelt), along Davis Bay in the neighborhood of Davis Bay, as shown on Figures 11 and 12.

CATEGORY: b) Natural Hazard Conditions

EXTENT OF DPA: Development Permit Area 6 includes the escarpment slopes, the beach area above the high water level of the Strait of Georgia, and 15 m minimum horizontal setback behind the crest of the escarpments.

JUSTIFICATION: Steep beach front escarpment slopes up to 50 m high comprising predominantly a gravelly to sandy veneer of probable marine origin and colluvium over compact to dense sandy till. Bedrock is exposed near beach level at several locations in the Trail Bay area. There are areas of active landsliding and slumping on the escarpments and soil creep is widespread.

Seepage from the escarpment is common, particularly along the top of the dense till. Local perched groundwater tables can be expected. Gullies have formed on the escarpments and there are many areas of saturated surficial materials. Uncontrolled drainage exists in some areas and is currently directed towards and onto these slopes. Discharge from septic fields may contribute to slope instability and hence limit the extent of development.

The excavation of roads, driveways, footpaths and stairways for beach access is contributing to slope instabilities.

The potential for debris landslides, slumping, creep movements and gullying on the face of the escarpments is high and there is some potential for storm wave erosion.

Estimated Probability of Hazard Occurrence: It is estimated that a very high probability exists for the occurrence of landslides and related soil instability on the escarpment slopes. It is estimated that a high to moderate probability exists for the occurrence of landslides and related soil instability exists within the 15 setback zone behind the slope crest.

GUIDELINES: Prior to issuance of a development permit, the potential for slope instability, landslide activity and creep movements and the impact of the proposed development on or by such natural hazard conditions should be addressed by a site specific investigation and report prepared by a Registered Professional with specific experience in geotechnical engineering and/or engineering geology. This should be supported by documentation of the extent of anticipated instability with measurements tied to physical features where possible. Accurate field determination of slope crest location or other geological features should be made. Site plans and slope profiles should be provided.

a) The report should assess the erosion potential of ocean waves on beach front slopes.

b) Groundwater conditions should be evaluated considering seasonal and local variations in the groundwater regime and the potential for slope instability caused by groundwater seepage.

c) The anticipated effects of septic and drainage systems on slope instability should also be considered. These systems should be designed to avoid surface and groundwater erosion of beach front slopes.

d) The report and the plans and design of the proposed development should address geotechnical considerations of cut and fill slope stability and provide specific recommendations and criteria on design, construction and maintenance. Building envelopes should be determined with relation to natural or cut slope crests with appropriate setbacks or other restrictions within these envelopes to be specified.

e) Possible changes in slope conditions that may indicate an imminent landslide should be included for the attention and education of landowners.

f) In general, vegetation should be maintained on the slopes and within the setback zone above and below the slopes to minimize erosion or instability. The removal or topping of trees from the slopes or crest of slopes for view enhancement purposes must be considered on a site specific basis with resultant stability and environmental impacts taken into consideration (photo 18).

The recommended tree protection, septic field, soil removal and deposition and shoreline protection bylaws should apply.

9.7 AREA: DEVELOPMENT PERMIT AREA 7: Rockfall Hazards

Development Permit Area 7 includes identified rockfall hazard areas within the neighborhoods of Tuwanek as shown on Figure 5, the neighborhood of Sandy Hook both north and south of Four Mile Point as shown on Figure 6, and within the Sunshine Heights area of the neighborhood of West Porpoise Bay as shown on Figure 7.

CATEGORY: b) Natural Hazard Conditions

EXTENT OF DPA: as mapped on Figures 5, 6 and 7.

JUSTIFICATION: These areas comprise steep fractured bedrock slopes or bluffs having a known or perceived high potential for slope instability and rockfalls. Active rockfalls areas are characterized by the presence of blocky colluvial deposits. These areas may present a serious hazard to development, including or in particular those properties downslope of the rockfall area.

Estimated Probability of Hazard Occurrence: It is estimated that a very high probability exists for the occurrence of rockfalls in these areas.

GUIDELINES: Prior to issuance of a development permit, the stability of the natural rock slopes and the potential for rockfalls and the impact of the proposed development on or by such natural hazard conditions should be addressed by a site specific investigation and report prepared by a Registered Professional with specific experience in geotechnical engineering and/or engineering geology. This should be supported by documentation of the extent of potentially unstable slopes and rockfall zones should be defined.

a) The report should address cut and fill slope stability and provide site specific recommendations on the suitability of the proposed development as well as criteria on the design, related construction and long term maintenance.

b) Building envelopes and setbacks or other restrictions to development should be established with reference to natural or cut slope crests and possible rockfall zones should be determined.

c) Consideration should be given to the necessity for stabilization treatment of the rock slopes, including the need for and selective or extensive scaling or rock bolting as well as the maintenance or removal of vegetation from the slope.

9.8 AREA: **DEVELOPMENT PERMIT AREA 8: Watercourse Hazards** as follows:

1) the limits along Cairns and Wakefield Creeks and their tributaries, within the neighborhood of West Sechelt, as shown on Figures 3 and 4.

2) the limits along Irvine, Angus, Burnet and Irgens Creeks and along an unnamed creek between Burnet and Irgens Creeks, within the neighborhoods of Tuwanek, Sandy Hook and East Porpoise Bay, as shown on Figures 5,6,9 and 10.

3) the limits along Wilson, East Wilson and Hudson Creeks, within the neighborhoods of Wilson Creek/Davis Bay, as shown on Figures 11, 12, 13 and 14.

CATEGORY: b) Natural Hazard Conditions

EXTENT OF DPA: The development permit area includes a minimum 15 m horizontal setback from each side of the creek high water or the crest of ravine or eroded slopes of the creeks and their tributaries, or as mapped on the Figures. The DPA limit should also be no lower than 1.5 m above the creek high water. The more restrictive criteria of the above should apply.

JUSTIFICATION: Steep ravine slopes are subject to potential shallow slope instability in granular and fine grained soils. Creep and shallow soil slides on the ravine slopes of Angus and Wakefield Creeks was observed (photo 19). Erosion of creek banks is common along all creeks. Oversteepened and potentially unstable slopes have been developed as a result of gravel pit operations on both sides of Burnet Creek.

All creeks are considered to be subject to a moderate or high water flood hazard, except for Cairns Creek which has been identified as having little or no flood hazard (Dayton & Knight, 1982).

No debris flows or debris floods are anticipated in these creek systems.

Lewis (1989) maps the course of Wilson Creek to the north of the DOS and extending about 200 m into the OCP area as having a moderate instability and very high to high erosion potential.

A number of properties situated adjacent to lower Wakefield and Irvine Creeks and on the flood fans of Angus and Wilson Creeks are subject to a potential flood hazard; some localized bank protection is in place.

Estimated Probability of Hazard Occurrence: It is estimated that a high (red) annual probability of shallow slope instability, erosion or flooding hazard exists south of Anchor Place along Wakefield Creek as shown on Figure 4, along lower Angus Creek as shown on Figures 6 and 9 and along lower Wilson Creek south of Cope Road right-of-way as shown on Figure 12.

It is estimated that a moderate to low (yellow) annual probability of shallow slope instability, erosion, deposition or flooding hazard exists along the creeks as follows:

Hosdon

i) along Cairns, Irvine, Burnet, Irgens, Hudson, and East Wilson Creeks and along the unnamed creek between Burnet and Irgens Creeks as shown on the Figures 3 to 5, and 9 to 14;

ii) to the north of Anchor Place along Wakefield Creek, along its tributaries, and within the 15 m setback from the crest of ravine slopes of Wakefield Creek south of Anchor Place as shown on Figures 3 and 4;

ii) along Wilson Creek as shown on Figures 12, 13 and 14 and within the 15 m setback from the crest of the west creek bank of Wilson Creek as shown on Figure 12.

GUIDELINES: Prior to issuance of a development permit, the stability of the natural slopes and the potential for erosion or flooding and the impact of the proposed development on or by such natural hazard conditions should be addressed by a site specific investigation and report prepared by a Registered Professional with specific experience in geotechnical and/or hydrotechnical engineering.

a) The report should consider the potential for creek erosion, deposition and flooding along the creeks and their tributaries and the potential for slope instability on the ravine slopes.

b) Local bank erosion protection and flood proofing or other measures to provide suitable protection of structures should be addressed. The report and protective measures should take into consideration channel conditions upstream of the site as well as the potential for adverse downstream impact.

c) The influence of tides on flooding should be considered.

d) The proposed development and protective measures should include provision to accommodate stream management and development controls which may become necessary if increased development along the creeks or drainage channels is planned or permitted within the OCP.

e) In general, vegetation should be maintained to minimize erosion along eroding creek banks, creek valley floors and floodplains, on ravine slopes, and within the 15 m setback from the creek high water or crest of ravine slope. In addition, the development should incorporate those requirements for maintenance of vegetation, protection against erosion or sediment discharge and channel modifications which are detrimental or contrary to the environmental guidelines or requirements.

f) The anticipated effects of septic and drainage systems on slope instability and water quality should be considered. Drainage works should avoid erosion of ravine slopes and septic effluent should not discharge onto ravine slopes or into the creeks.

g) The report should consider forest harvesting activities and practices in the watershed at the time of the study in the context of potential related slope and channelized instability.

The recommended tree protection, septic field, soil removal and deposition and shoreline protection bylaws should apply.

9.9 AREA: **DEVELOPMENT PERMIT AREA 9: Watercourse Hazards along Gray and Chapman Creeks** as shown on Figures 5, 11 and 12.

CATEGORY: b) Natural Hazard Conditions

EXTENT OF DPA: The development permit area includes a minimum 30 m horizontal setback from each side of the natural boundary of the creek high water, or a 15 m horizontal setback from the crest of the ravine or eroded slopes of the creeks and their tributaries. The DPA should also be no lower than 3.0 m above the creek high water. The more restrictive criteria of the above should apply.

JUSTIFICATION:

Chapman Creek: There is great potential for riverbank erosion, local overbank inundation and deposition and flooding on the alluvial fan. Channel bars and point bars are common in the stream channel zone and stream bed geometry is subject to frequent change.

Ongoing bank erosion is occurring along Chapman Creek throughout the DOS. This is evident along the west creek bank approximately 100 m upstream of the bridge where erosion has necessitated relocation of portions of the hiking trail (photo 20). Erosion has also produced several large erosional scars up to 30 m in height in unconsolidated materials within the steep ravine slopes. Active undercutting of the sandy ravine slopes which are located on the west side of the creek approximately 200 m upstream of the bridge have resulted in loss of land from the upper terrace (photo 21). Some riprap has been placed along this portion of the creek as a preventative measure but is inadequate for long term bank protection.

There is a history of flooding on the fan of Chapman Creek. A serious flood which occurred in the early 1980s which resulted from a combination of high creek flows, high tide levels and storm waves and caused widespread inundation of the fan.

Steep ravine slopes of Chapman Creek are subject to potential shallow slope instability in granular and fine grained soils. Creep and shallow soil slides on the ravine slopes were observed.

Continued clear-cut forest harvesting and associated logging road construction in the mid and upper basins of Chapman Creek could affect streamflow characteristics such as annual runoff and peak flows, sediment load and water quality.

<u>Gray Creek</u>: There is a potential for local erosion and deposition hazards along lower Gray Creek and flooding on the Gray Creek fan. Old channel scars observed on the fan are evidence of creek instability and volatility. Cobbles and boulders on the bed of Gray Creek are an indication the creek's rapid runoff rate and high load carrying capacity (photo 22).

Steep soil slopes along the margins of Gray Creek fan are subject to shallow slope instability.

There does not appear to be a potential for debris flows or debris floods impacting OCP lands within the Gray Creek or Chapman Creek systems.

Estimated Probability of Hazard Occurrence: It is estimated that a high (red) annual probability of shallow slope instability, erosion or flooding hazard exists on the steep ravine slopes, creek valley bottom and alluvial fan of Chapman Creek as shown on Figures 11 and 12. It is estimated that a high (red) annual probability of flooding and erosion hazard exists on the alluvial fan of Gray Creek as shown on Figure 5.

It is estimated that a moderate to low (yellow) annual probability of shallow slope instability or erosion exists within the 15 setback zone behind the crest of steep ravine slopes of Chapman Creek. It is estimated that a moderate to low (yellow) annual probability of shallow slope instability or erosion exists on the unconsolidated slopes flanking the alluvial fan of Gray Creek and on the steep bedrock slopes to the north of Gray Creek along the eastern boundary of the OCP area.

GUIDELINES: Active alluvial fans do not provide good locations for development due to the potential for sudden shifts of creek channels, flooding and sediment deposition.

Prior to issuance of a development permit, the stability of the natural slopes and the potential for erosion or flooding and the impact of the proposed development on or by such natural hazard conditions should be addressed by a site specific investigation and report prepared by a Registered Professional with specific experience in geotechnical and/or hydrotechnical engineering.

a) The report should consider the potential for creek erosion, deposition and flooding along the creeks and their tributaries and the potential for slope instability on the ravine slopes.

b) A comprehensive hydrological study to determine the 1:200 year flood limits and appropriate bank protection measures should be undertaken if significant development on the fans of Chapman or Gray Creeks is to be carried out.

c) Local bank erosion protection and flood proofing or other measures to provide suitable protection of structures should be addressed. The report and protective measures should take into consideration channel conditions upstream of the site as well as the potential for adverse downstream impact.

d) The influence of tides on flooding should be considered.

e) The proposed development and protective measures should include provision to accommodate stream management and development controls which may become necessary if increased development along the creeks or drainage channels is planned or permitted within the OCP.

f) In general, vegetation should be maintained to minimize erosion along eroding creek banks, creek valley floors and floodplains, on ravine slopes, and within the 30 m setback from the creek high water or 15 m from crest of ravine slope, whichever is greater. In addition, the development should incorporate those requirements for maintenance of vegetation, protection against erosion or sediment discharge and channel modifications which are detrimental or contrary to the environmental guidelines or requirements.

g) The anticipated effects of septic and drainage systems on slope instability and water quality should be considered. Drainage works should avoid erosion of ravine slopes and septic effluent should not discharge onto ravine slopes or into the creeks.

h) The report should consider forest harvesting activities and practices in the watershed at the time of the study in the context of potential related slope and channelized instability.

The existing local bank protection is considered inadequate for the long term conditions. Consideration should be given to improving creek bank protection to minimize erosion of ravine slopes, prevent further destruction of the hiking trail and ensure protection of the highway bridge. Appropriate river hydraulic studies should be conducted prior to the placement of any bank protection measures to avoid `shifting' the erosion problem to a different section of the creek bank.

The recommended tree cutting, septic field, excavation/dumping and shoreline setback bylaws should apply.

10.0 ENVIRONMENTAL CONSIDERATIONS FOR FUTURE DEVELOPMENT

Recognition of the importance of the natural and visual environment to the residents, both present and future, of the Sechelt OCP area will serve to guide the implementation of effective planning. The objectives stated in Section 9.1.2 must be viewed as being of importance now, and hopefully well into the future. However, it is recognized that values may change in the future, and that the objectives of the DPAs will have to change as well to accommodate the changing values.

All developments will have some impact on the natural environment. However, the magnitude of the impact, and whether the natural systems can sustain them will determine the extent of the effects. Development must be considered in terms of the associated impacts.

Developments which will impact on the visual quality of the Sechelt OCP area must be carefully considered. In some cases, it may be wise to avoid the impacts by restricting the development while in other cases, effective mitigative techniques are available. Consideration of the visual effects of activities such as logging, mining and gravel extraction must take into account both the views from other land areas as well as from the water.

Logging as currently practiced, poses the greatest potential for adverse visual impacts. However, methods are available for timber harvesting which do not require clear-cuts (Hammond, 1991). Selective, sustainable forest management should be required in the Sechelt OCP area. The ever increasing value of the visual resources dictates that forest harvesting techniques which do not impact on the scenic quality of the area should be followed (photo 23).

Housing developments can adversely impact both the visual quality of the area and the environmental quality. Visually, housing developments intrude on the natural quality of the views while, environmentally, housing developments can, if done improperly, result in adverse changes in drainage, increased erosion, changes in nutrient loadings and other such impacts. As with logging however, there are ways of minimizing such impacts. These should be sought.

The Sechelt OCP area is a unique area which is attractive to an increasing number of people. Demand for housing and services could adversely effect the very environment which these people are seeking. However, with careful consideration of all of the factors involved, protection of the environment which people treasure need not preclude development.

11.0 RECOMMENDED ZONING BYLAWS AND GUIDELINES FOR DEVELOPMENT

11.1 Current ByLaw

Review of the District of Sechelt Zoning Bylaw No. 25, 1987 and revised February 19, 1993 indicates that Section 320 of the current Bylaw establishes development constraints and setback requirements for Flood Control purposes. However, at present, the Bylaw does not appear to establish comparable criteria or constraints for the various geotechnical hazards and environmentally sensitive areas.

11.2 Authority for Official Community Plan and Zoning Bylaws

As described previously, the Official Community Plan may, for the purposes of Section 976 of the Municipal Act, designate areas for the protection of the natural environment and for protection of development from hazardous conditions, by means of development permit requirements.

In accordance with Section 734 of the Municipal Act, the District of Sechelt may, for the health, safety and protection of persons and property, and subject to the Health Act and the Fire Services Act, institute Bylaw(s) which require the preparation of a report certified by a professional engineer with experience in geotechnical engineering that the land can be used safely for intended purpose. Such Bylaw requirements can include both the construction of new buildings, or the structural alteration of or addition to an existing building or structure.

As described in Section 734 (4),

"Where a professional engineer with experience in geotechnical engineering determines and certifies that the land may be used safely for the use intended, subject to conditions contained in his report with respect to:

a) the siting, structural design and maintenance of buildings, structures and works

b) the maintenance or planting of vegetation

c) the placement and maintenance of land fill

d) other conditions respecting the safe use of the land, buildings, structures and works.

a building inspector may issue a building permit on the condition that:

e) the owner of the land covenants with the municipality or regional district to use the land only in the manner determined and certified by the engineering as enabling the safe use of the land for the use intended,

f) the covenant contains conditions respecting reimbursement by the covenantor for any expenses that may be incurred by the covenantee as a result of a breach of the covenant under paragraph (e) and

g) the covenant be registered under Section 215 of the Land Title Act."

Based on our previous experience in the preparation of reports, designs and monitoring of developments as well as reviews of problems associated with prior development, where certain limitations or restrictions are required to permit suitable and safe development, it is our opinion that a permanent and accessible record of such limitations or restrictions to development is essential to enable long term enforcement of the conditions. It is recommended that the Bylaw(s) be enacted requiring the establishment and registration of covenants under Section 215 of the Land Title Act, including plans identifying the areas or locations of constraints and limitations to development, prepared and certified by a B.C. Land Surveyor.

In addition to the above, Bill 77 - 1992 the Municipal Amendment Act (No.2), 1992 provides authority in addition to that of Section 978 for the establishment of Bylaw(s) to prohibit and regulate tree cutting, removal or damage and to maintain or replace damaged or removed tree growth.

11.3 Recommended Bylaws

In addition to the Flood Protection Bylaw presently incorporated as Section 320 of the current Zoning Bylaw 25, it is recommended that the following Bylaws be enacted to support the objectives and guidelines for protection against geotechnical hazards and of environmentally sensitive areas with respect to development.

Shoreline Protection Bylaw

It is recommended that DOS adopt a bylaw which restricts or controls all development or other activities located within a zone extending from 15 m horizontal distance inland from the marine high water mark or high tide level to 15 m offshore from the low tide level. The bylaw should apply to all shoreline areas within recommended DPA 2.

Tree Protection Bylaw

It is recommended that DOS enact a bylaw which prohibits or requires an approved permit supported by the results of a report and plans prepared by a Registered Professional, with experience in geotechnical engineering or hydrotechnical engineering prior to cutting, removal or damage to trees and other significant vegetation within DPA zones having potential soil or rock slope instability, erosion or flooding.

In addition, the bylaw should incorporate the requirement for a site specific environmental assessment of the impact of modification or removal of tree and vegetation cover within all DPA areas identifying environmental sensitivity or combined natural hazard risk and environmental sensitivity. Environmental assessment and reporting in support of development should be considered of paramount importance along water courses, areas of known or probable fisheries habitat and features of specific importance to the community.

Soil Removal and Deposition Bylaw

It is recommended that DOS adopt a bylaw prohibiting any excavation, removal or other disturbance of soil or rock and dumping or deposit of waste soil, rock, wood, yard waste, garbage or other materials on any slope, within any tree and vegetation protection zone, watercourse or other environmental protection DPA prior to issuance of a permit supported by a report prepared by a geotechnical engineer and/or qualified environmental scientist.

Septic Disposal Fields

The siting and approval of property as suitable for installation of in ground septic disposal field is generally carried out under the authority of the Health Act by the local Health Unit inspector who may, at his discretion require a geotechnical investigation and report in support of the application.

Irrespective of the capability or suitability of a local site to meet the percolation criteria for in ground disposal, septic effluent should not "daylight" at ground surface, discharge on ravine or shoreline slopes nor enter into water courses or bodies of water. It is recommended that the DOS use the "Design Guidelines for Wastewater Systems in B.C. Region", 1987 or latest edition, prepared on behalf of Indian and Northern Affairs as indicated in the attached Appendix III. These guidelines will promote preservation of ground and surface water quality.

Septic disposal fields should be located at least 15 m offset from the crest of natural or man made slopes. No disposal field should be closer than 30 m from springs, lakes, streams, ponds or impoundments not used as potable water sources. The siting of septic disposal fields adjacent to surface water sources or springs used for potable water should be prohibited unless supported by site specific investigation and design by a qualified professional engineer.

11.4 Guidelines

It is recommended that the Official Community Plan incorporate guidelines for development within the DPA areas identified in this report as indicated in the attached

Appendix IV for geotechnical hazard areas. These guidelines were developed and implemented within the District of Coquitlam from about 1981 onward as a means of directing the planning and controlling the development of suitable and safe land uses on or adjacent to sloping terrain subject to natural hazards.

As indicated, the degree of investigation and limitation or restriction on development increases with increasing steepness of the sloping terrain.

Appendix V presents a draft guideline or covenant for Tree and Vegetation Protection with respect to development in areas of environmental sensitivity. The criteria set out in the suggested covenant also relate to the guidelines for development presented in Appendix IV.

Yours very truly,

GOLDER ASSOCIATES LTD.

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GER/MGG/RCB/gc

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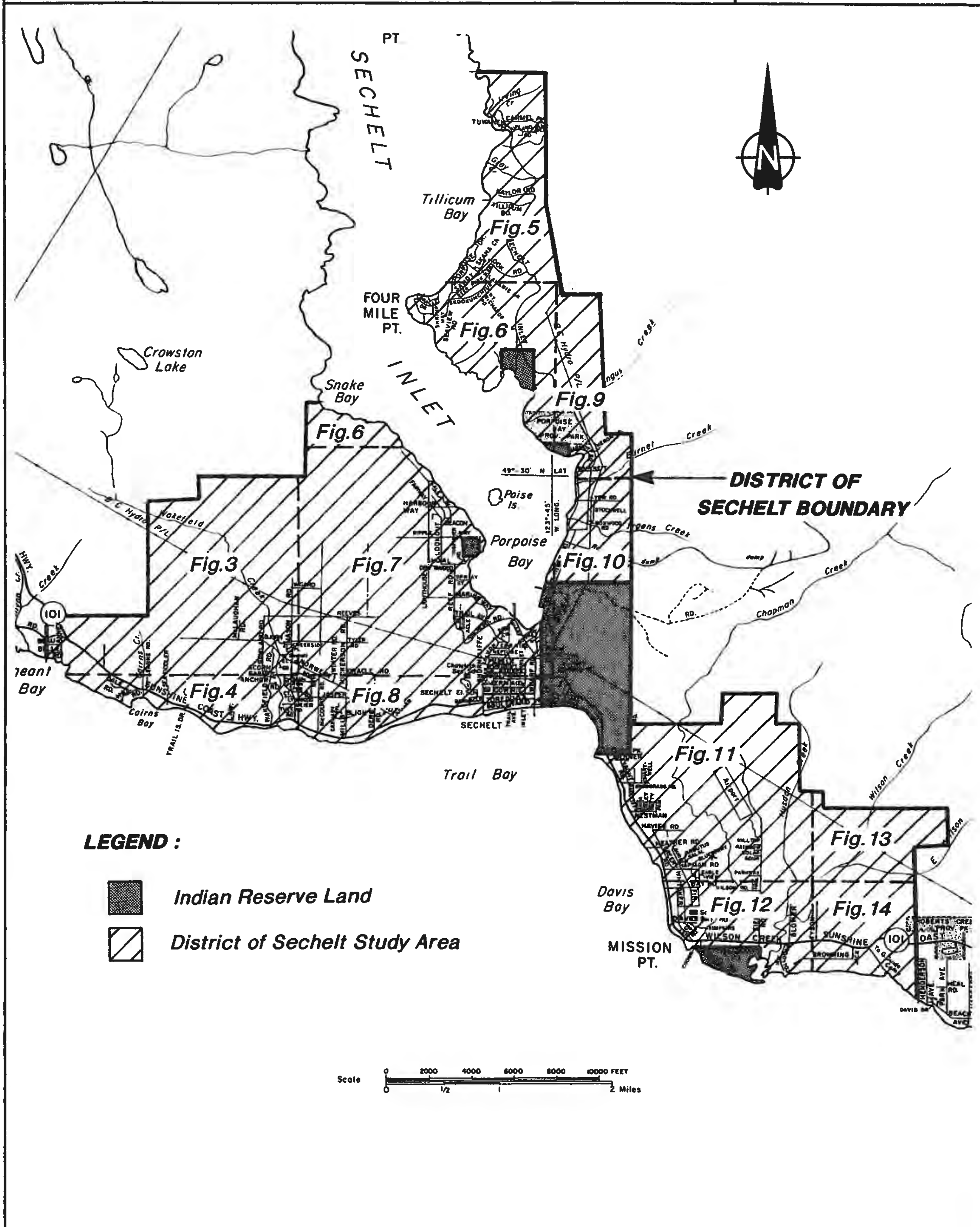
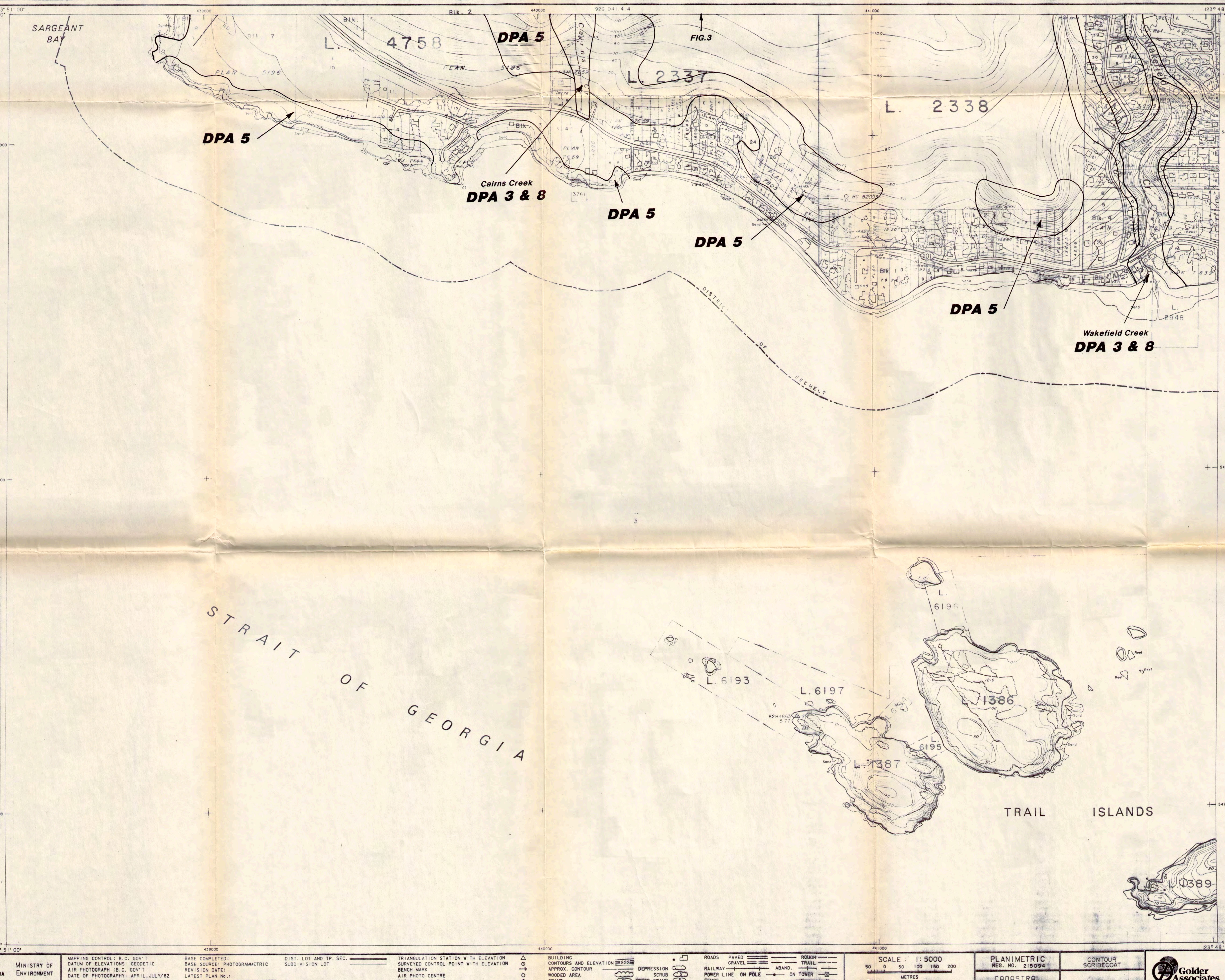
SITE PLAN
THE DISTRICT OF SECHELT STUDY AREA

Figure **1**



PROJECT NO. 922-1172 DRAWN ✓ REVIEWED DATE March '93

NOTES
1) For the purpose of this study, airphoto analysis was carried out supported by limited ground reconnaissance and review of previous work. The development permit areas have been designated using judgement and consideration of existing or potential geotechnical hazards. This study is not sufficiently accurate for site specific applications for permit approval.
2) All DPA boundaries are approximate and are subject to detailed site investigations and surveys.
3) The DPA limits shown are estimates based on the best information made available at the time of the study. If DPA boundaries change with later, more detailed investigation or changed land use conditions, these maps should be updated to reflect the new information.
DPA 5
DPA 5
DPA 5
DPA 5
DPA 5
DPA 5
DPA 5
DPA 5
Wakefield Creek
DPA 3 & 8
Cairns Creek
DPA 3 & 8
DPA 3 & 8
FIG.7
FIG.4
SECHELT
PROVINCIAL
FOREST
Wakefield
BRITISH COLUMBIA HYDRO & POWER AUTHORITY
L.4662
L.2224
L.2225
L.1734
L.3824
L.4756
L.4757
L.2371
L.4758
L.2406
L.5267
L.4832
L.4313
L.4314
L.4312
L.4311
L.4309
L.4310
L.4308
L.6761
SARGEANTS BAY
PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT
SCALE: 1:5000
CONTOUR INTERVAL 2 METRES
PLANIMETRIC
CONTOUR
SCRIBECOAT
CADASTRAL
Golder Associates
Figure 3



NOTES

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PROVINCE OF BRITISH COLUMBIA — MINISTRY OF ENVIRONMENT

MAPPING CONTROL: B.C. GOV'T
DATUM OF ELEVATIONS: GEODETIC
AIR PHOTOGRAPH: B.C. GOV'T
DATE OF PHOTOGRAPHY: APRIL, JULY/82
U.T.M. GRID: ZONE 10 (1975)
SHORELINE: HIGH WATER MARK

BASE COMPLETED:
BASE SOURCE: PHOTOGRAMMETRIC
REVISION DATE:
LATEST PLAN No.:
LAND DISTRICTS: NEW WESTMINSTER
LAND TITLE DIST.: VANCOUVER

DIST. LOT AND TP. SEC.
SUBDIVISION LOT

TRIANGULATION STATION WITH ELEVATION
SURVEYED CONTROL POINT WITH ELEVATION
BENCH MARK
AIR PHOTO CENTRE
SURVEYED LOT TIE

BUILDING
CONTOURS AND ELEVATION
APPROX. CONTOUR
WOODED AREA
SWAMP
CULTIVATED
DEPRESSION
SCRUB
TREED SWAMP
ORCHARD

ROADS PAVED / GRAVEL / ROUGH / TRAIL
RAILWAY / ABAND.
POWER LINE ON POLE / ON TOWER
FENCE
FLUME

SCALE: 1:5000
METRES
CONTOUR INTERVAL 2 METRES

PLANIMETRIC NEG. NO. 215094
CONTOUR SCRIBECOAT
CADASTRAL

Golder Associates

Figure 4

NOTES

1) For the purpose of this study, airphoto analysis was carried out supported by limited ground reconnaissance and review of previous work. The development permit areas have been designated using judgement and consideration of existing or potential geotechnical hazards. This study is not sufficiently accurate for site specific applications for permit approval.

2) All DPA boundaries are approximate and are subject to detailed site investigations and surveys.

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FIG.5
Rockfall Hazard
DPA 7
FOUR MILE PT.
Four Mile Point
DPA 5
Rockfall hazard
DPA 7
SECHELT PROVINCIAL FOREST
L.1556
L.4681
L.4680
L.4682
L.4683
Hammond Brook
L.4690
L.4689
L.4688
L.4687
DPA 5
P O R P O I S E
PORPOISE
BAY
B A Y
Snake Bay
L.5201 M.C.
BC 86078
DPA 2
FIG.9
L.1557
PORPOISE BAY
Angus Cr.
Angus Creek
DPA 3 & 8
PROVINCIAL
DPA 5
L.1716 M.C.
S E C H E L T
P E N I N S U L A
NURSERY
SCRD 1008
1008
NOTES
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PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT
SCALE 1:5000
METRES
PLANIMETRIC SCRIBECOAT
CONTOUR SCRIBECOAT
Golder Associates

Figure 6

NOTES

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PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT

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DATUM OF ELEVATIONS: GEODETIC
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DATE OF PHOTOGRAPHY: APRIL, JULY/82
U.T.M. GRID: ZONE 10 (1975)
SHORELINE: HIGH WATER MARK

BASE COMPLETED:
BASE SOURCE: PHOTOGRAMMETRIC
REVISION DATE:
LATEST PLAN No.:
LAND DISTRICTS: NEW WESTMINSTER
LAND TITLE DIST.: VANCOUVER

DIST. LOT AND TP. SEC.
SUBDIVISION LOT

TRIANGULATION STATION WITH ELEVATION
SURVEYED CONTROL POINT WITH ELEVATION
BENCH MARK
AIR PHOTO CENTRE
SURVEYED LOT TIE

BUILDING
CONTOURS AND ELEVATION 500
APPROX. CONTOUR
WOODED AREA
SWAMP
CULTIVATED
DEPRESSION
SCRUB
TREED SWAMP
ORCHARD

ROADS PAVED
GRAVEL
ROUGH
TRAIL
RAILWAY
ABAND.
POWER LINE ON POLE
ON TOWER
FENCE
FLUME

SCALE: 1:5000
50 0 50 100 150 200
METRES
CONTOUR INTERVAL 2 METRES

PLANIMETRIC
NEG. NO. 215093

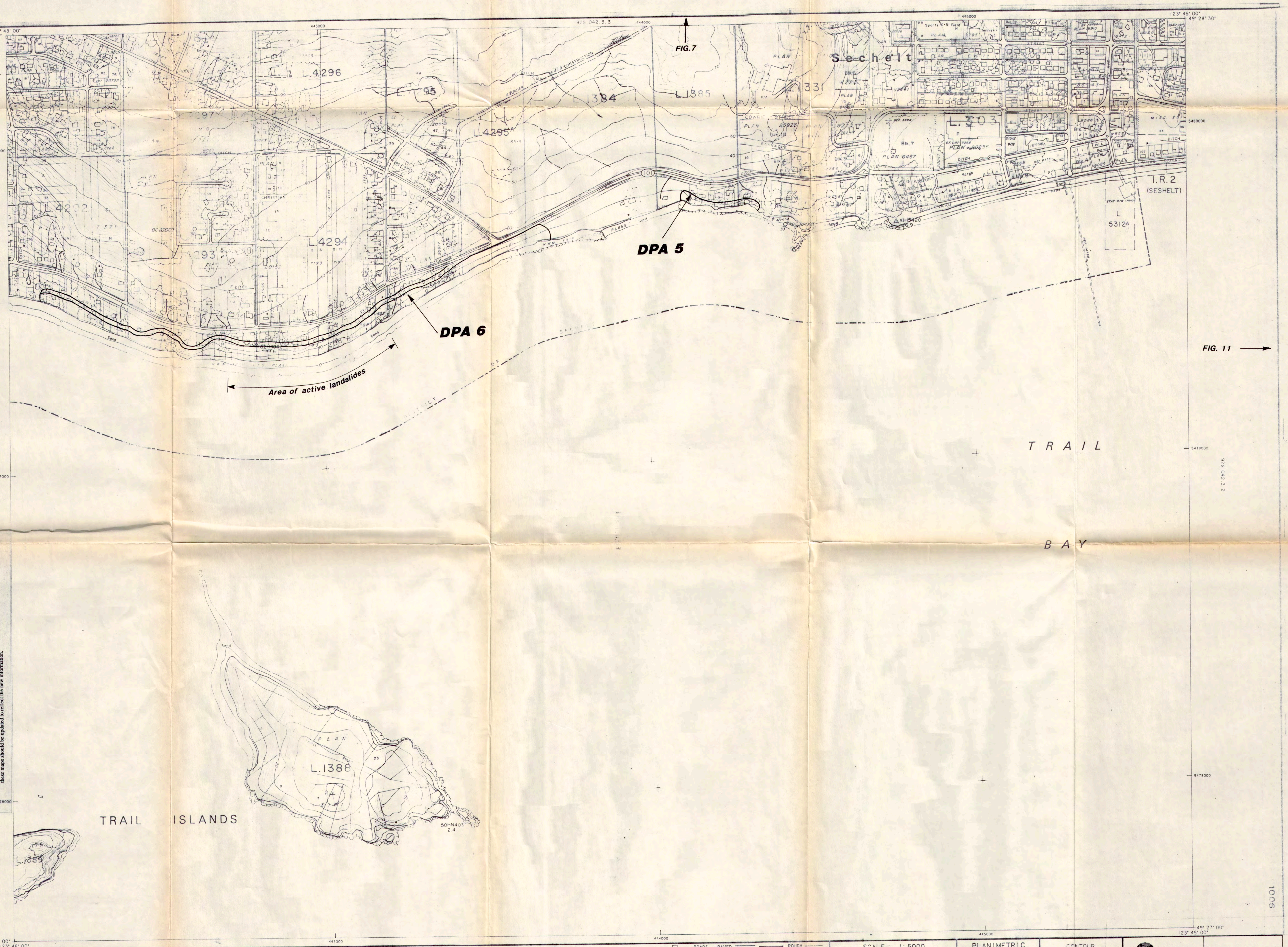
CADA
NEG. No. 4088

CONTOUR
SCRIBECOAT

Golder Associates

Figure 7

1007



NOTES

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Province of British Columbia — Ministry of Environment

MAPPING CONTROL: B.C. GOV'T
DATUM OF ELEVATIONS: GEODETIC
AIR PHOTOGRAPH: B.C. GOV'T
DATE OF PHOTOGRAPHY: APRIL, JULY/82

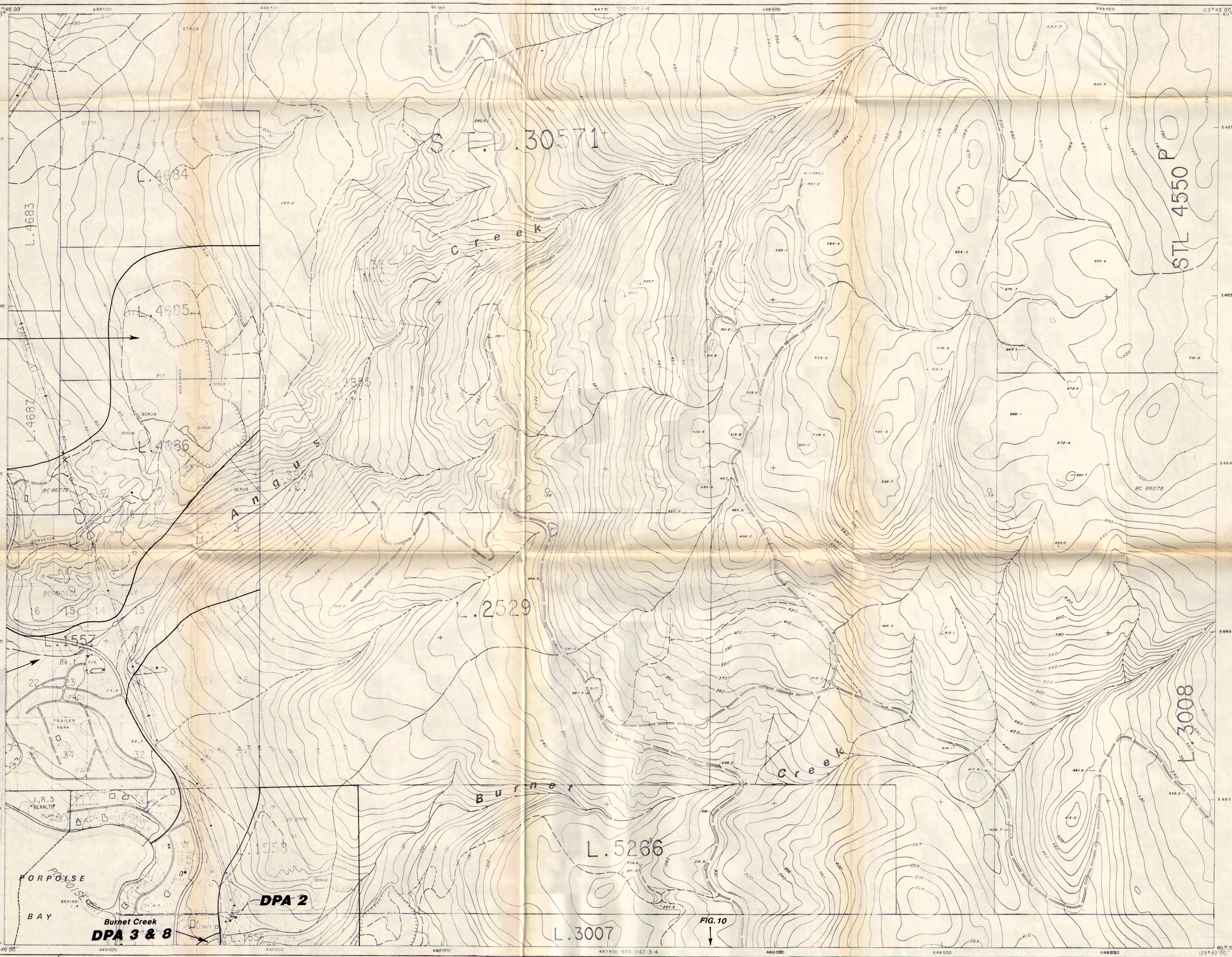
BASE COMPLETED:
BASE SOURCE: PHOTOGRAMMETRIC
REVISION DATE:
LATEST PLAN No.:

SCALE: 1:5000
50 0 50 100 150 200
METRES
CONTOUR INTERVAL 2 METRES

PLANIMETRIC NEG. NO. 215092
CADASTRAL NEG. No. 264078
CONTOUR SCRIBECOAT

Golder Associates

Figure 8



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PROVINCE OF BRITISH COLUMBIA — MINISTRY OF ENVIRONMENT

MAPPING CONTROL: B.C. GOV'T
DATUM OF ELEVATION: GEODETIC
AIR PHOTOGRAPHY: B.C. GOV'T
DATE OF PHOTOGRAPHY: 1986
U.T.M. GRID: ZONE 10
SHORELINE: APPARENT HIGH WATER MARK

BASE COMPLETED: 1986
BASE SOURCE: PHOTOGRAMMETRIC
REVISION DATE:
LAND DISTRICTS:
LAND TITLE DIST.:
LATEST PLAN No.:

DIST. LOT AND TP. SEC.
SUBDIVISION LOT

HORIZONTAL CONTROL POINT - MARKED
HORIZONTAL CONTROL POINT - UNMARKED
VERTICAL CONTROL POINT
AIR PHOTO CENTRE
SURVEYED CADASTRAL TIE

BUILDING
CONTOURS AND ELEVATION 500
APPROX CONTOUR
WOODED AREA
SWAMP
DEPRESSION
SCRUB
ORCHARD

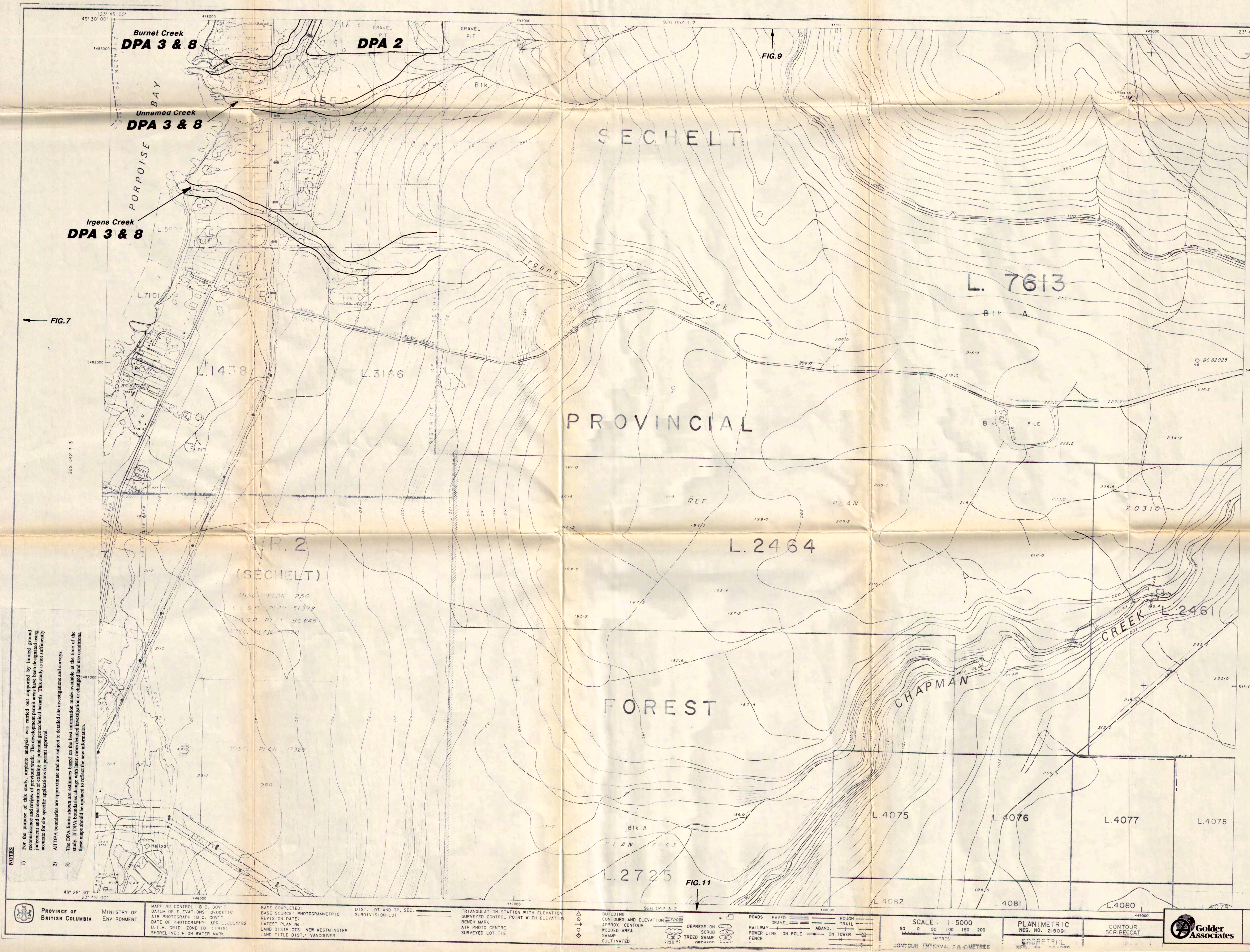
ROADS PAVED, GRAVEL, ROUGH, TRAIL
RAILWAY, ABAND.
POWER LINE ON POLES, ON TOWERS
FENCE, FLUME

SCALE: 1:5000
50 0 50 100 150 200
METRES
CONTOUR INTERVAL 2 & 10 METRES

PLANIMETRIC SCRIBECOAT	CONTOUR SCRIBECOAT	AVAILABLE LAYERS
		PLANIMETRIC CONTOUR CADASTRAL ORTHOPHOTO

Golder Associates

Figure 9



Burnet Creek
DPA 3 & 8
DPA 2
Unnamed Creek
DPA 3 & 8
Irgens Creek
DPA 3 & 8
FIG.9
FIG.7
FIG.11
PORPOISE BAY
SECHELT
PROVINCIAL
FOREST
L. 7613
L. 2464
L. 2461
L.1438
L.3166
L.7101
I.R. 2 (SECHELT)
L.4075
L.4076
L.4077
L.4078
L.4082
L.4081
L.4080
L.2725
Irgens Creek
CHAPMAN CREEK
GRAVEL PIT
Hallport
NOTES
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PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT
SCALE: 1:5000
PLANIMETRIC
CONTOUR SCRIBECOAT
Golder Associates

Figure 10

NOTES

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PROVINCE OF BRITISH COLUMBIA — MINISTRY OF ENVIRONMENT

MAPPING CONTROL: B.C. GOV'T
DATUM OF ELEVATIONS: GEODETIC
AIR PHOTOGRAPH: B.C. GOV'T
DATE OF PHOTOGRAPHY: APRIL, JULY/82
U.T.M. GRID: ZONE 10 (1975)
SHORELINE: HIGH WATER MARK

BASE COMPLETED:
BASE SOURCE: PHOTOGRAMMETRIC
REVISION DATE:
LATEST PLAN No.:
LAND DISTRICTS: NEW WESTMINSTER
LAND TITLE DIST.: VANCOUVER

SCALE 1:5000 — METRES

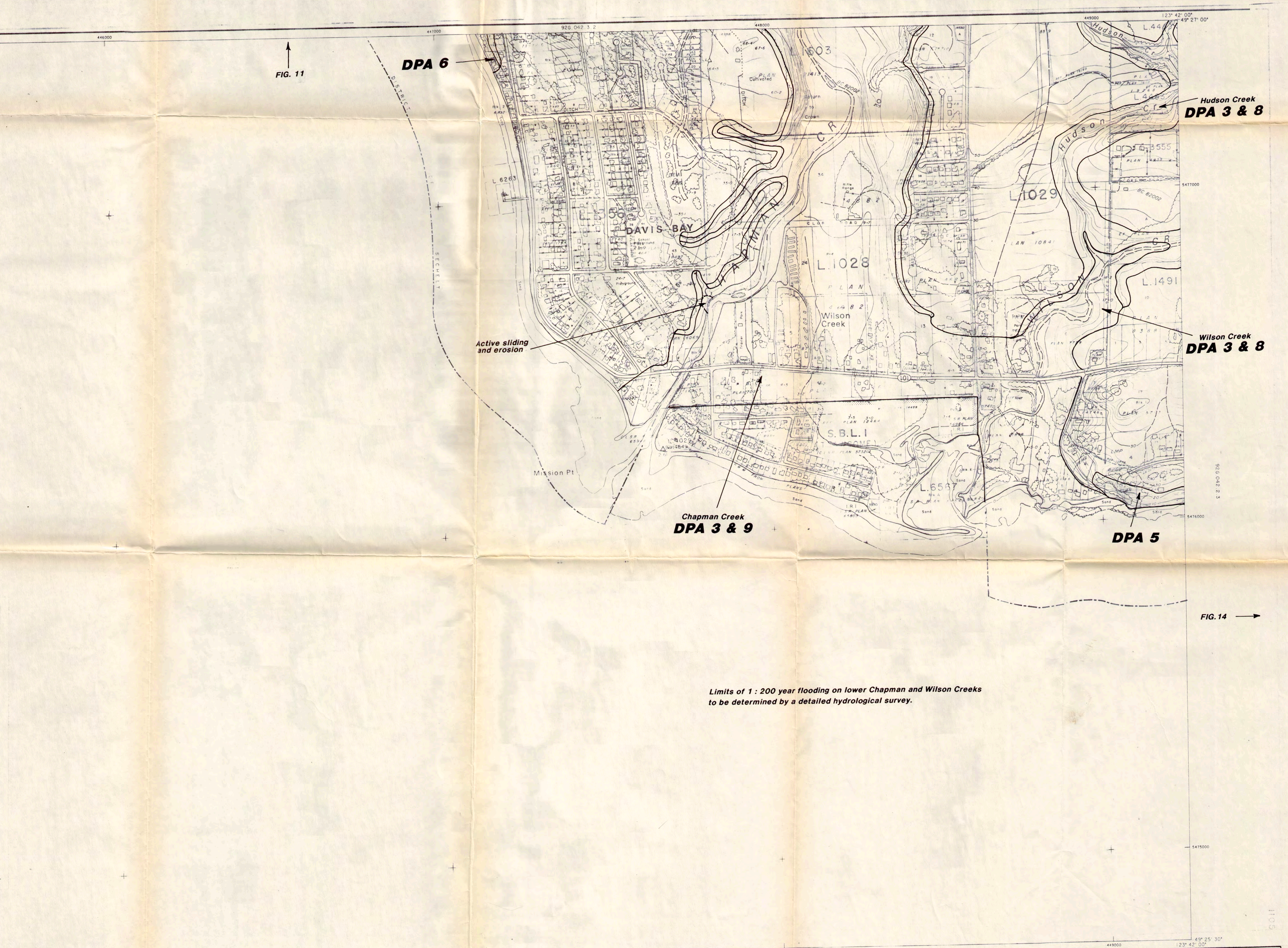
PLANIMETRIC — NEG. NO. 215090

CONTOUR — SCRIBECOAT

CADASTRAL

Golder Associates

Figure 11



NOTES

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Golder Associates

Figure 12

NOTES

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Figure 13


Hudson Creek
DPA 3 & 8
FIG. 13
East Wilson Creek
DPA 3 & 8
Wilson Creek
DPA 3 & 8
FIG. 12
DPA 5
SECHELT
PROVINCIAL
FOREST
ROBERTS CREEK PROVINCIAL PARK
STRAIT OF GEORGIA
L. 2142
L. 3312
L. 2618
L. 1491
L. 6213
L. 1541
L. 1319
L. 1321
L. 2631
L. 1317
NOTES
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PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT
SCALE 1:5000
PLANIMETRIC
CONTOUR SCRIBECOAT
CADASTRAL
Golder Associates
Figure 14

APPENDIX I

TERMS OF REFERENCE

- Request for Proposal
- Study Objectives and Methodology from Golder Associates Ltd. Proposal

The Corporation of the District of Sechelt

"Heart of the Sunshine Coast"

May 20, 1992

G.E. Rawlings, P. Eng.
Golder Associates Ltd.
Consulting Engineers
224 West 8th Avenue
Vancouver, B.C.
V5Y 1N5

RE: Geotechnical and Environmental Reconnaissance Study of the District of Sechelt Official Community Plan Area

Dear Mr. Rawlings:

In the process of amending the Official Community Plan, the District of Sechelt is inviting submissions for undertaking a geotechnical and environmental reconnaissance study for the Official Community Plan Area. The terms of reference and maps of the area are available for your information on request.

If your firm is interested in undertaking this project, please submit a proposal to the undersigned by June 15, 1992, indicating the following:

(a) Details regarding proposed study approach, including:

- information to be used;
- an activity schedule describing the various activities and subactivities offered;
- the extent of field work to be undertaken.

(b) Details regarding professional services and associated costs, including:

- the individuals in your firm responsible for the work, together with a resume indicating the details of each individual's background and an organizational chart clearly defining staff responsibilities;
- charge out rates, the hours each individual will devote to the various activities and the costs of disbursements;
- details regarding the format and content of the final written submission to accompany the 1:5,000 mapping and the proposed time frame for completing the work for each community plan area.

P.O. Box 129, 5545 INLET AVENUE, SECHELT, B.C. V0N 3A0 Telephone: (604) 885-1986 Fax: (604) 885-7591

More detailed background information and 1:5,000 cadastral and topographical mapping can be inspected at the offices of the District of Sechelt located at 5545 Inlet Avenue, Sechelt. This information will be made available in print form free of charge to the firm selected to undertake the study.

The award of the study will be on the basis of what the District of Sechelt considers to be the best, most appropriate and cost effective proposal.

Please do not hesitate to phone me if you have any questions or require additional information.

Yours truly,

THE DISTRICT OF SECHELT

for

Rob Buchan
Municipal Planner and
Approving Officer

RB:sw

OBJECTIVES

The objectives of the study are as follows:

a. To map land areas that pose potential hazards to development within the area shown on Figure 1; to identify the type of hazards within each of the mapped areas; and to assess the relative probability of hazard occurrence with respect to the proposed land uses for each of the mapped areas.

b. To specify the relevant precautions and guidelines for development of the potentially hazardous lands and issues to be addressed as part of the development permit process through detailed geotechnical assessments which would be required prior to issuance of building permits or subdivision approval; and to specify the types of analysis and documentation required in the more detailed geotechnical assessments.

c. To identify conditions and situations under which development precautions and therefore development permits would not be required.

d. To identify existing wildlife and vegetation habitats together with the visual resources of the area, and to discuss planning and development implications.

e. To identify and categorize environmentally sensitive areas, and provide a general evaluation of their sensitivity to development.

METHODOLOGY

The Sechelt Plan Area encompasses some 4500 Ha surrounding the town of Sechelt. It is estimated that the potential development permit zones could encompass some 15 km of coastline and 15 km of foreshore along Sechelt Inlet, as well as some 20 km along 10 significant creeks.

To meet the objectives of the study for this community plan area, our scope of work would be structured as follows:

Geotechnical Study

The geotechnical study would comprise the following components:

- Data review to determine primary hazard areas.

- Air photo study to produce an interim hazard zoning map.
- Ground truthing fieldwork to check air photo interpretation.
- Hazard zoning map production and establishment of development permit zone boundaries.
- Final report.

The details of the proposed work are as follows:

Data Review

At the start of the study, we intend to perform a thorough review of the existing data to determine the parts of the study area which will require special attention. This review will include published maps and reports as well as data held in District of Sechelt and Golder Associates files.

Air Photo Study

Following the data review, we propose to carry out an air photo study using the recently flown 1991 photo series. This air photo study will be used to establish an interim hazard zoning map, subdividing the community plan area into zones of varying type and degree of geotechnical hazard. The results of the data review will be useful in "calibrating" the air photo interpretation. Areas of known geotechnical concern will be identified on the air photos, ensuring that other areas with similar characteristics are also identified.

A review of historical air photos would be useful in determining the extent of time-dependent hazards, such as the retreat of shore lines. We understand that the earliest photographs available date from 1936. We propose to review all available historical air photos.

Ground Truthing Fieldwork

The interim hazard zoning map, produced from the air photo study, will be checked in the field to provide more detail on boundaries between adjacent hazard zones, and to check on the severity of the potential concerns. However, before commencing any significant fieldwork we would liaise with District of Sechelt personnel, utilizing their previous experience in the area to critique the interim hazard zoning map. We envisage an informal round-table discussion which may take several hours. The hazard areas would be rated by importance to ensure that greater attention would be directed to areas of greater potential concern.

Hazard Zoning Map

Using the results of the data review, airphoto interpretation and ground truthing, development permit zone boundaries would be established. Following their designation, the boundaries would be verified in the field where they may be contentious or of major economic significance.

On completion of the fieldwork, the geotechnical hazards and Development Permit Area boundaries would be plotted onto the 1:5,000 base maps.

Permit Zone Guidelines

Guidelines for Development Permit Areas would be established and further studies required at subsequent stages of permitting and approval would be specified.

- Identification of wildlife and vegetation habitats and the visual resources of the area, together with planning and development implications.
- Identification and categorization of environmentally sensitive areas and a general evaluation of their sensitivity to development.
- Recommendations for the designation of Development Permit Areas.
- Specification of precautions and guidelines necessary for the Development Permit Areas.
- Specification of geotechnical and environmental studies, analyses and documentation needed for the various stages of permitting and approval, and not covered by current regulations.
- Indications of conditions and situations under which development permits would not be required.

The report would be accompanied by 1:5,000 topographic maps showing identified hazards, recommended Development Permit Area boundaries and environmental zoning.

The report is intended to be a practical working document. We intend to structure the report to distinguish between the various communities within the District. We recognize that each community will have their own particular needs and concerns regarding geotechnical and environmental issues. We consider it important that the document recognizes this individuality and highlights the specific concerns of each community.

We would issue the report to the District of Sechelt in draft format for review. After a presentation to District of Sechelt and the public, a final report would be produced with modifications as agreed.

APPENDIX II

ENVIRONMENTAL AND GEOTECHNICAL CONCERNS EXPRESSED BY LOCAL RESIDENTS DURING MEETINGS

ENVIRONMENTAL AND GEOTECHNICAL CONCERNS EXPRESSED BY LOCAL RESIDENTS DURING MEETINGS

Community Considerations

The following provides details of the environmental and geotechnical concerns expressed by residents/rate payers associations during interviews held in December, 1992. Although many of the issues raised during the interviews have been discussed in a more general manner in the main text, specific concerns raised by residents warrant consideration.

It was clear from the interviews conducted with local people that there is a high degree of concern for the local environment in the Sechelt OCP area. People have come to live in the area in part because of the nature of the environmental conditions and the rural character of the area. Activities which appear to impact on the quality of the area will be opposed. The concern for environmental quality was expressed in many of the issues detailed below:

Selma Park/Wilson Creek/Davis Bay

The integrity of Chapman and Wilson Creeks is of prime importance to the residents of this neighborhood. The use of these streams by a variety of salmon species as well as resident trout populations as noted above was echoed by the residents. In addition, the use of the Chapman, Wilson and Hudson Creeks as domestic water supplies was noted. The estuaries of these streams was noted for their abilities to support not only the fisheries, but also an abundance of bird life, including eagles and herons. Proposals for development of the estuary areas were seen as a threat to the integrity of these fragile areas.

A hiking trail along the west side of Chapman Creek is viewed as a major attraction for local residents. Portions of the trail are being damaged by river erosion upstream of the highway bridge and there was a desire to re-establish this trail. Another trail is located along the top of the ravine slopes on the west side of the creek. This trail extends from the end of Chapman Road to north of the OCP area and goes through tall forest with some old growth present. A desire was expressed to preserve this trail along with a buffer behind the ravine crest to preserve the trees and vegetation along the trail.

A waterfall and canyon near the confluence of East Wilson Creek and Wilson Creek is considered as an important location to the local residents. Selective logging in the upper Wilson Creek area is seen as a positive step in protecting these resources while enjoying the economic benefits of the forest.

Flooding along Chapman Creek was raised as a concern by the residents. Although there is a desire to control flooding, concerns over the installation of protective structures were expressed. Flooding was also noted on Wilson Creek with the "flashy" nature of the flooding being attributed by residents to upstream logging.

Concerns over the "strip developments" along the highway were expressed by residents of this area. The industrial area along Field Road was noted as detracting from the residential quality of the area, although it was recognized that there needed to be some place for accommodating such activities.

Housing developments between Chapman Road and Snodgrass Road were reported to be the cause of loss of local flora. Orchids and other wildflowers which were valued by residents were lost during developments. This was of concern to local residents interested in the botany of the area. Similarly, the loss of cougars, which were reported to once frequent the area was seen as a negative impact of development to some residents.

Maintenance of the Agricultural Land Reserve classification of much of the land in the area is seen as essential to maintaining the quality of the community. In particular, farms along Tyson Road are viewed as important. The Canfor seed orchard, located on Lot 1603 as well as the "wet" nature of Blocks "B" and "C" of Lot 2307 were noted as part of the character of the area.

The shoreline in the Wilson Creek/Davis Bay area is of concern to local residents. A potential sewage outfall located near the Chapman Creek estuary was of concern to residents. Erosion of the beach just north of Chapman Creek is of concern to the local residents, although certain measures to protect the shore, such as installation or rip rap is viewed as unacceptable to some residents.

East Porpoise Bay and Sandy Hook

Gravel extraction activities in the East Porpoise Bay area are of major concern to local residents. The pit now operated as B & A Blacktop has been noted as detracting from the environmental quality of the area through deposition of sediments into the bay. The pits on Burnet and Angus Creeks are also credited with environmental and visual degradation of these areas. The potential for development of a gravel reserve located near Sandy Hook Road was viewed with concern by local residents. Although not within the OCP area, the Construction Aggregates Ltd. pit were noted by residents as detracting from the environmental quality of the area generally.

Logging in the Angus Creek watershed is reported by residents to have caused logjams, periodic flooding and degradation of salmon spawning habitat in the lower reaches of Angus Creek. Although not visible from these communities, this logging provides a negative impact on the West Porpoise Bay viewshed.

Local marshes and wetlands are credited with collecting sediments generated by upstream activities, including logging and gravel pit developments. Concern over the loss of wetland function was expressed by residents in the area. These areas are recognized as being particularly sensitive to environmental degradation.

The viewshed of these neighborhoods includes the neighborhood of West Porpoise Bay and the relatively undeveloped areas north of West Porpoise Bay. Logging, mining and housing developments in these areas are seen as detracting from the visual quality of the area. Mining activities across the inlet from Sandy Hook were noted as being of particular concern to residents.

The need to reduce, and eventually phase out, industrial developments along the Sechelt Inlet was expressed by local residents. However, the need for a boat refuelling facility was noted. Much of the industrial activity occurs on Indian Reserve lands. The lack of "flushing" in the inlet was seen as a concern, both in terms of sewage and industrial developments. Abandoned fish farms were viewed as both an environmental hazard and a boating hazard and there was a desire to revert these areas back to public use. Establishment of an "environmental hotline" for reporting of environmental problems along the inlet was suggested by residents.

As with other neighborhoods, a desire to maintain the rural quality of the area was expressed by local residents. The need for a "tree protection bylaw" was noted. Developments north of Sandy Hook, in the Tillicum Bay area are seen as lacking environmental planning. In addition, fill placement adjacent to a minor drainage in a steep ravine just north of Sandy Hook was noted as a concern by residents.

Tuwanek

Tuwanek occupies a unique position among the Sechelt OCP area neighborhoods, at the northern extent of development on Sechelt Inlet. As such, the residents view activities and developments along the inlet as "in their area". Resident's concerns centre on protection of the natural terrestrial environment, the views and the local creeks. Concerns expressed by Tuwanek residents ranged from the protection of the Tetrahedron area and Salmon Inlet (sites well removed from the community) to concerns over the Gray Creek estuary and the Lamb Islets.

Specific concerns were expressed over the log dump and booming grounds in the Gray Creek estuary. Gray Creek, with it's attendant fish hatchery, is viewed as an important fisheries site, with the estuary providing important rearing areas. The development of the booming grounds on Lot 1410 was contested prior to establishment in 1978. Logging in the watershed during the 1940s, 70s and 80s has been credited with burial of kelp beds which were said to have supported an otter population. Concern was expressed with the high coliform content of Gray Creek waters which is attributed to upstream logging. Gray Creek is presently used as a domestic water supply, however there was some desire expressed to use Irvine Creek for domestic water.

Mount Richardson, which forms the "backdrop" to Tuwanek was seen as being important for obvious visual reasons, because of local recreational use (hiking trails and beaches), because of wildlife use (deer habitat), and because it figures prominently in native mythology. Similarly, the Irvine Creek watershed, which is located on the face of Mount Richardson and flows through the community, is considered by residents as important. Some old growth forests are said to occur on the slopes of Mount Richardson as well.

The Lamb Islets, which are privately owned and contained within the Islands Reserve, serve as a local diving area. The islets form a dominant part of the viewshed for many Tuwanek residents. They provide diversity both for the divers and for the viewer. An informal diving area has been along the beach, while waterfowl are reported to use the sheltered bays around the islets.

There is a history of flooding along the lower end of Irvine Creek. Recent flooding on lower Gray Creek has required the reconstruction of the highway bridge on Sechelt Inlet Road. A desire was expressed for restrictions on development to control flooding on lower Gray Creek.

Developments along Carmel Place are reported to have sewage and stability concerns. The shallow soils and exposed bedrock are cited as being responsible for these problems.

Access to the Tetrahedron area, which is classified as an important area for study by the Ministry of Environment, Lands and Parks, is gained from Tuwanek. This area is reported to be used extensively for hiking and cross country skiing and has cabins and lakes as local features. In addition, some old growth forests are reported to occur in this area. Efforts to preserve this area by local residents attests to the fact that the residents view this area as part of their neighborhood.

Central Sechelt (the "village")

Central Sechelt encompasses the downtown area with beach areas both north and south of the town centre. Waterfront areas are considered important by local residents for recreational purposes. The ability to gently stroll along the Strait of Georgia beach is considered important to many of the older residents. Similarly, developments near the southern extent of Porpoise Bay are of concern to residents.

A small strip of trees lining the street at the north end of Wharf Road provides residents an enjoyable experience. This is complemented by a shallow marshy area and "duck pond" adjacent to the trees. Again, the ability of residents to walk down to this pond from the downtown area was noted as being important.

Some concerns of Central Sechelt residents are related to the lot by lot developments. Establishment of townhouses and other such developments adjacent to the marshy duck pond area are of concern. This concern may relate as much to the increased population density which is inherent with the developments as with the potential for significant impacts on the pond itself. As with other neighborhoods, the desire to maintain the current lifestyle without intrusions from over-development was a common thread in the discussions, although the need to provide the shops and services associated with the downtown area is recognized.

West Porpoise Bay

West Porpoise Bay residents look out on the gravel pits on the east side of the Sechelt Inlet. These are perceived as detracting from the visual quality of the views by area residents. The "skyline" view of areas stripped for gravel extraction from West Porpoise Bay heightens this visual impact.

The noise from float planes using Porpoise Bay was seen as detracting from the quality of life in the neighborhood. Under certain weather conditions, the planes fly low, and the noise from the engines can be disruptive, especially to many of the elderly residents.

Poise Island, which is said to have gotten it's name from a cartographical error in transcribing Porpoise, is reported to be a native burial ground. There was a suggestion that this area could be used as a municipal cemetery. In any case, Poise Island provides an important visual feature for the residents of West Porpoise Bay. The growth of trees and/or the development of large buildings (apartment blocks) adversely impacts the views of the bay for residents. This includes views of Poise Island as well as the adjacent parts of Sechelt Inlet.

West Porpoise Bay residents are concerned with maintenance and enhancement of areas for walking and nature observation. Kinnikinnik Park (Lot 1472) was established to provide a natural area which could be enjoyed by residents. Similarly, a need for further development of the foreshore esplanade was expressed by residents. Trails and walkways which may be navigated by the older members of West Porpoise Bay are important to the residents.

Drainage concerns, both for storm water and for septic and sewer systems were mentioned by West Porpoise Bay residents as being of concern. On steep sites, areas where drainage occurs are subjected to erosion. Storm water runoff is eccentuated by development, and this, in the opinion of residents, has not been adequately addressed in the development of the area, and some downslope residents are being impacted.

West Sechelt

West Sechelt may be divided into two areas; the areas along the sea front and the upland areas above the shoreline. Visual features which include the Strait of Georgia are important to the latter, while such features are less important to residents on the uplands. The visual integrity of the Trail Islands is important to the lower West Sechelt residents. There is a recognition by residents of the importance of these islands to bird and animal life on the coast. Views along the beach, which is used recreationally, are similarly important to residents of this part of the neighborhood.

Sewage problems (lack of suitable drainfields) tend to be of greater importance to residents on the uplands of West Sechelt. Concerns by these residents over the potential impacts of the golf course which is currently under construction were expressed. Much of this land swampy and development concerns related to groundwater flows and changes in flow patterns exist. High coliform levels found in Wakefield Creek and in the estuary were reported by residents. This is reportedly due to the sewage problems and the lack of drainage. In addition, Canada Geese are said to winter in some of the low lying areas and in some of the local fields.

Sargent Bay, which is largely west of the Sechelt OCP area, is reported to be an important wildlife area. Recognition of the importance of this area by West Sechelt residents is a reflection of their concern for such sites. As with other communities, the need to preserve the essential character of the West Sechelt neighborhood, with its agricultural lands and stands of timber, is recognized by residents.

Wakefield Creek flows down through the centre of West Sechelt. Although there is no trail along the creek as there is along Chapman Creek, Wakefield Creek provides a focal point for residents whose properties front the creek. There is concern over reported proposals by local logging interests to drain the lakes which form the headwaters of the creek. This is viewed as having potential negative consequences for the creek and the adjacent residents.

APPENDIX III

SUGGESTED GUIDELINES FOR SEPTIC DISPOSAL FIELDS

DESIGN GUIDELINES FOR WASTEWATER SYSTEMS

IN B.C. REGION

FIRST EDITION

MAY 1987

DESIGN GUIDELINES FOR WASTEWATER SYSTEMS

IN B.C. REGION

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SEWAGE TREATMENT

4.1 General

Design Guidelines have not yet been prepared for the unit processes noted below. The engineer shall refer to state-of-the-art science and engineering texts and standards for guidelines for the treatment processes listed in this section. The investigation and design methodology shall be thoroughly, technically substantiated and include a bibliography of technical references used.

Effluent quality shall meet Federal guidelines unless a Provincial Waste Management Permit is applied for and obtained, in which case, the effluent quality can meet the B.C. Provincial objectives.

It is expected that Design Guidelines for the following specific processes will be developed in the future and this part revised and distributed to users of this publication.

4.2 Screening, Grit Removal and Flow Equalization

4.3 Settling

4.4 Sludge Handling and Disposal

4.5 Mechanical Biological Treatment Plants

4.6 Lagoons

4.7 Wetlands

4.8 Sand Filters

4.8.1 Subsurface Sand Filters
4.8.2 Recirculating Sand Filters

4.9 Disinfection and Evaluation of Effectiveness

4.10 Dechlorination

4.11 Exfiltration Basins

The following ground disposal systems require pre-acceptance by the reviewing authority if they are to be considered as an option.

a) Seepage Pits
b) Built-up Mounds

5.2 SITE EVALUATION

Information concerning soil and site conditions is needed for proper design of liquid waste treatment and disposal facilities.

5.2.1 Evaluation of Soil and Hydrogeological Factors

Hydrogeological factors shall be evaluated by soil profiles, groundwater observations and percolation tests and soil analyses data.

For a single isolated residence or a single residence to be filled in amongst other existing houses, the soil evaluation and site investigation shall be carried out by a specialist. If, in the case of the fill-in residence, the existing systems are experiencing ground disposal system failures, an investigation, including an hydrogeological assessment of the area shall be conducted before the house is constructed.

Where a proposed single residence will be one of several future additions amongst other existing housing with ground disposal systems, and a hydrogeological investigation for the housing area as a whole has not been undertaken, one shall be undertaken before construction of the proposed new house.

For multiple single housing, group housing, or community systems, a specialist shall be involved in the soil evaluation and site investigation to characterize the hydrogeological features and identify hydrogeological and soil restraints.

5.2.2 Soil Profile and Site Observations

The number of soil profile and groundwater testholes and percolation test holes will be dependent on site conditions and should be determined by a specialist. The minimum number of test holes shall be three and the minimum number of percolation test holes shall be three. Normally perc tests should be averaged; however, where test values vary significantly, consider using a geometric mean value or the second slowest perc rate. A topographic map showing location and elevations of all test holes and percolation holes must be prepared to accompany data submitted to the reviewing authority.

4. Exposure to sunshine (i.e. non-shaded area)
5. Lot size and amount of suitable area: Sufficient suitable soil must be available for the initial absorption area while maintaining the proper or adequate horizontal isolation or set-back distances required to protect water supply, surface waters, property lines, and structures. Sufficient suitable area must be dedicated for replacement absorption systems.

5.2.3 Flood Elevation Restraints For Ground Disposal Units

Unless specified elsewhere in these guidelines, the bottom of the ground disposal trench absorption bed, seepage pit, etc., for individual households shall be a minimum of 1.0 meters above the ground water mound created by wastewater disposal for the following flood conditions :

	Flood Return Frequency
Single Individual household system	1/20-year
Multiple " " systems	1/20-year
Group Housing Unit systems	1/20-year
Community Systems (greater than 10 houses)	1/100-year

5.2.4 Percolation Tests

Soil percolation tests should be conducted at the optimal depth based on soil profile textures indicating permeable conditions. They shall be conducted at the depth where wastewater will be introduced and/or absorbed by the soils. Additional percolation tests may be needed to identify the existence of a limiting layer. The following is the falling head test procedure which is to be used.

a) Dig or bore a hole, 100-300 mm square or diameter, with vertical walls.
b) Scarify side wall and bottom, remove loose material.
c) Place 25 mm of coarse sand or gravel on bottom. In Sandy and Gravelly Soils - Place 300 mm of water in hole and determine time to seep away, repeat, and if second filling seeps away in ten minutes or less, proceed with test.

   1. Establish a fixed reference point, add water to 150 mm above gravel and measure water level drops every ten minutes for one hour.
   2. Use a shorter time interval if first 150 mm seeps away in ten minutes or less. Refill when necessary, do not exceed 150 mm of water; use final water level drop to calculate.

5.3.2.3 House sewers should be installed with as straight an alignment as possible. Where bends of 45 degrees or greater are necessary, a cleanout fitting, the same size as the sewer, extending to the ground surface shall be provided.

5.3.2.4 There shall be access to every house sewer through a cleanout fitting in the house drain or sewer. The location and number of cleanouts shall be installed in accordance with the Canadian Plumbing Code.

5.3.2.5 A minimum horizontal separation of 3.0 meters (10 ft) be provided between a house sewer and any water line. Suction lines from wells shall not cross the house sewer.

5.4 TREATMENT TANKS

5.4.1 Septic Tanks

5.4.1.1 General

a) Influent

All liquid waste and washwater shall discharge into the septic tank. Roof, footing, garage, and surface water drainage, and cooling water shall be excluded.

b) Location

The septic tank shall be located where it is readily accessible for emptying and inspection.
The following are minimum horizontal separation distances that must be provided between the septic tank and the features indicated. The actual design horizontal separation distances will be dependent upon the site conditions and shall be specified through the assessment by the specialist.

* Buildings and structures	1.0 m	(3 ft.)
Water Wells and suction lines	30.5 m	(100 ft.)
Property lines	3.0 m	(10 ft.)
Water supply lines under pressure	3.0 m	(10 ft.)
Lakes and streams	30.5 m	(100 ft.)

* In determining the design horizontal separation to buildings and structures, the structural aspects of foundation stability and the protection of the septic tank from freezing and excessive heat loss during winter should be considered. The maximum separation should be no more than 1.5 meters (5 ft.).

Note that volume requirements are largely dependent upon sludge storage considerations, such as quantity and type of influent solids, and septage removal frequencies; these factors should be considered when sizing the tanks.

c) Dimensions

The depth from the invert of the outlet to the floor of the tank (liquid depth) of any septic tank or compartment thereof shall not be less than 1.2 m (4 feet) and a liquid depth greater than 2 m (6.5 feet) shall not be considered in determining tank capacity. The length of a septic tank should not be less than 1.5 m (5 feet) and should be approximately two to three times the width; but no tank or compartment thereof shall have an inside horizontal dimension less than 0.6 m (2 feet). The minimum inside diameter of a vertical cylindrical septic tank shall be 1.5 m (5 feet).

d) Inlets

The inlet connection to the septic tank shall not be less than 100 mm (4 in.) inside diameter and enter the tank at least 75 mm (3 in.) above the liquid level. The inlet connection of the septic tank and each compartment thereof shall be submerged by means of a vented tee or baffled so as to obtain effective retention of scum and sludge. The inlet tee or baffle shall extend above the liquid level to a point not less than 25 mm (1 in.) from the underside of the top of the tank to assure system venting. The inlet baffle or tee shall extend below the liquid level at least 150 mm (6 in.), but not more than 20 percent of the total liquid depth. Baffles shall be located a minimum of 150 mm (6 in.) from the inlet pipe.

e) Outlets

The outlet connection to the septic tank shall not be less than 100 mm (4 in.) inside diameter. The outlet connection of the septic tank and each compartment thereof shall be submerged by means of a vented tee or baffled so as to obtain effective retention of scum and sludge. The outlet tee or baffle shall extend above the liquid level not less than 20 percent of the liquid depth in tanks with straight vertical sides and 15 percent of the liquid depth in horizontal cylindrical tanks. The outlet tee or baffle shall extend below the liquid level a distance equal to 40 percent of the liquid depth for tanks with straight which the inspection pipe passes through the cover shall be so located that a downward projection of the pipe clears the inlet and outlet device by not less than 50 mm (2 in.). The top of the inspection pipe shall be provided with a readily removable water-tight cap or plug and its location shall be marked at the ground surface. The inlet and outlet devices shall be made accessible by removable covers, manholes, or by properly located inspection ports.

Consideration should be given to covering the access lids with 150 mm (6 in.) of top soil to reduce the potential of nuisance odours within the community.

5.4.1.3 Community and Multiple Dwelling Septic Tanks

Community and multiple dwelling septic tanks must be custom designed to address adequate access for sludge measurement and desludging, and to enhance settleable and floatable solids removal through optimum inlet and outlet design (eg. reduction of hydraulic short circuiting, use of gas/solids deflection baffles etc.)

For large community septic tanks, sludge characteristics and quantities must be considered when designing access for desludging. From limited experience with some of these systems in Indian communities, the scum and sludge quantities have been such that tanks require desludging every three to twelve months. The scum in the larger community tanks is very dense, with considerable grease content, and requires access across a significant portion of the surface area in the first compartment to remove sludge efficiently.

A flow measurement system shall be installed on communal tanks. If a V-knotch weir is used, the system shall be designed to allow expedient visual readings of instantaneous flows and to allow for installation of portable continous-flow measurement and recording equipment

5.4.2 Maintenance

The depth of sludge and scum in the individual household septic tanks should be measured at least once per year and at least once every 4 months in the larger communal tanks. When, as a result of such measurement, the top of the sludge layer in the tank or any compartment of the tank is found to be less than 300 mm (12 in.) below the bottom of the outlet baffle or submerged pipe, the tank shall be pumped and the contents disposed in a sanitary and approved manner. Annual pumping for individual household systems and quarterly pumping for larger systems may be substituted for measurement. A maximum pumping frequency shall be two years.

5.5.3 Methods of Wastewater Application

5.5.3.1 RECOMMENDED METHODS OF WASTEWATER APPLICATION FOR VARIOUS SYSTEM DESIGNS AND SOIL PERMEABILITIES (*)

Soil Permeability (Percolation Rate)	Trenches or Beds On Level Site	Trenches On Sloping Site Greater than 5%
Very Rapid (less than 1 min/25mm)	Uniform Application ** Dosing	Gravity Dosing
Rapid Gravity (1-10 min/25mm)	Uniform Application Dosing Gravity	Dosing
Moderate *** (11-60 min/25mm)	Dosing Gravity Uniform Application	Gravity Dosing

* Methods of application are listed in order of preference.

** Should be used in alternating field systems to ensure adequate treatment.

*** In the fine grain soils, intermittent loading is recommended to promote short periods of saturation and a pulsing action that will force both water and air into the fine soil matrix.

Gravity Flow: Wastewater flows from treatment unit directly into the absorption system. A header or distribution box is used.

Dosing: Wastewater is dosed by pumping or siphon to ensure intermittent aeration. A header or a distribution box (with each distribution line connected to the distribution box) is used.

Uniform Application: Wastewater is applied through a pressure distribution system.

5.5.3.2 Dosing may be accomplished by either pumps or siphons. Each side of the system should be dosed not more than four (4) times per day. The volume of each dose should be the greater of the daily sewage volume divided by approximately 3/4 of the internal volume of the distribution lines being dosed (approximately 1.89 L (0.42 gal.) per lineal 300 mm (1 foot) of 100 mm (4 in.) pipe).

5.5.3.3 In a system using pressure distribution, the field should be dosed not more than two (2) times per day. The size of the dosing pumps and siphons shall be selected to maintain a minimum pressure of 703 kN/sq. meter (2.3 feet of head or 1.0 psi) at the end of each distribution line.

5.6 ABSORPTION SYSTEMS

The common design of absorption systems is one using absorption trenches, each separate from the other and each containing a distribution pipe. This type of system should be used whenever practical. Other types of absorption systems may be used as alternatives where the site conditions warrant and meet the specific design requirements of such alternative systems.

5.6.1 Absorption Trenches

5.6.1.1 General

The absorption trench gives additional treatment to the sewage from the treatment tank. Regardless of its appearance of clarity or transparency, the outflow or effluent from a treatment tank is a dangerous source of contamination. The satisfactory operation of the sewage disposal system is largely dependent upon the proper site selection, design, and construction of the absorption trench.

5.6.1.2 Location

a) The horizontal separation distances noted below are minimum values, but greater distances will often be required depending on engineering and hydrogeological data such as topography, hydraulic conductivity, soil chemistry, geology, ground water gradient, type of water supply, potential for contaminating potable water sources, etc. Engineering and hydrogeological data must be submitted to the reviewing authority to substantiate the proposed separation distances.

Minimum Distances from:

Potable water well or suction line (except as noted below)	30 meters	(100 ft.)
Well with a sealed and water tight casing to a depth of 6 meters	15 meters	(50 ft.)
Water supply line under pressure	3 meters	(10 ft.)
A spring not used as potable water source, or a lake, stream, pond or impoundment	15 meters	(100 ft.)
Building or structure	5 meters	(16 ft.)
Property line or boundary	3 meters	(10 ft.)
Escarpment or manmade cut	6 meters	(20 ft.)
Curtain drain	3 meters	(10 ft.)

5.6.1.3 Design

a) Each absorption trench system shall have a minimum of two trenches. The minimum length of pipe for any installation shall not be less than 45 m.

b) The minimum flows for the ground disposal systems shall be based on the sewage flows of 230 L per person per day and in accordance with the table noted below. For communal systems, infiltration flows must be added. Allowances should be made when higher flows are expected

ESTIMATED MINIMUM DAILY SEWAGE FLOWS FOR GROUND DISPOSAL SYSTEMS

Type of facility	Estimated Minimum Daily Sewage in Liters
Apartments & condominiums (having one common entrance)	805 for 1 bedroom unit 1035 for 2 bedroom unit 1150 for 3 bedroom unit
Houses, duplexes (all other residential units)	1150 for 1 and 2 bedrooms 1265 for 3 bedrooms 1725 for 4 bedrooms 2070 for 5 bedrooms 2530 for 6 bedrooms
Mobile home parks	1150 per space
Hospitals with laundry	1150 per bed
Hospitals without laundry	690 per bed
Institutions, work camps, rest homes, residential schools	230 per bed
Nursing homes	690 per bed
Motels/hotels	345 per unit 460 per housekeeping unit
Campsites	460 per unit 690 per unit (year round operation)
Theatre/drive-in (food service is limited to single service containers)	20 per auditorium seat/car space
Fixed seat assembly (theatres, churches)	10 per seat

i) Gravity fed absorption field distribution lines should be at least 100 mm (4 in.) in diameter. If 300 mm long (1 foot) tiles are laid, they shall each be separated by a 6.4 mm (1/4 inch) space and the joint covered by a strip of untreated building paper, geotextile material, or other material accepted by the reviewing authority.

5.6.1.4 Slope

a) Gravity fed absorption field distribution lines and trenches shall slope at the rate of 50 to 100 mm (2-4 in.) per 30.5m (100 ft). Dosed absorption field distribution lines and trenches shall be level.

b) On rolling or sloping land, each absorption trench shall approximate the land surface contour.

c) It is preferred that absorption trenches not be installed on land with a slope greater than 12 percent. However, under certain soils and hydrogeological conditions trenches can be installed on slopes up to 30 percent. For slopes greater than 20%, the disposal field must be designed based on the specialist's investigation results and designed to allow for equipment access on the steep slopes, to ensure even distribution of effluent, and to avoid water hammer damage to pipes & anchorages.

5.6.1.5 Lot Sizes

a) Minimum sizes of residential lots for which ground disposal fields are proposed, should be determined as follows:

Lot sizes for residential dwellings.

Site Slope	Minimum Lot Size
Less than 5% (community water supply)	1300 m2
Less than 5% (on-site well)	2000 m2
5% to 10%	* 3000 m2
10% to 20%	* 4000 m2

Note that the above are minimum sizes and, depending on the hydrogeological conditions of the site and adjacent area, larger sizes may be required to allow for set-back distances and replacement fields.

* b) If the domestic water supply is from private wells on each individual lot, consideration must be given to

Adequate provisions shall be taken to assure stability and provide easy location (eg. use marker posts) and access for inspection of the distribution box.

c) Each distribution line shall connect individually to the distribution box.

d) The pipe connecting the distribution box to the distribution line shall be of a tight joint construction laid on undisturbed earth or properly bedded throughout its length.

e) If a header is used, the header shall be of water-tight construction and there should be an equal number of distribution lines spaced evenly on both sides of the junction of the leader to the header.

f) Each distribution line should be equal in length.

g) When the trenches have been excavated, the sides and bottom shall be raked to scarify any smeared soil surfaces. The soil material raked from the sides shall be removed from the bottom of the trench. Over excavated trenches shall be back-filled with coarse clean sand, gravel or crushed stone. Construction equipment not needed to construct the system should be kept off the area to be utilized for the absorption trench system to prevent undesirable compaction of the soils. Construction shall not be initiated when the soil moisture content is high. (Note: If a fragment of soil occurring approximately 230 mm (9 in.) below the surface can easily be rolled into a wire, the soil moisture content is too high for construction purposes.)

h) At least 50 mm (2 in.) of coarse clean sand shall be placed in the bottom of the trench.

i) At least 175 mm (7 in.) of gravel or crushed stone (as defined in Section 5.6.1.6. d) shall be placed in the bottom of the trench on top of the 50 mm (2 in.) of coarse sand.

j) The distribution line shall be carefully placed on the bedding at a uniform slope and covered with at least 50 mm (2 in.) of gravel or crushed stone (as defined in Section 5.6.1.6. d).

k) The ends of distribution lines shall be capped or plugged or, when they are at equal elevations, they should be connected.

e) The coefficient of permeability (defined as K3) of the soil mantles into which the deep trench is penetrating, shall be such that the perc rate is faster than 30 min/25 mm.

f) K1 shall be greater than K2 and K2 shall be greater than K3.

g) The length and width of the distribution pipe trench (not the deep trench) shall must be based on the K1 permeability.

h) Trench design features shall be similar to those of the conventional absorption trench.

5.6.3 <u>Absorption Beds</u>

5.6.3.1 <u>General</u>

The absorption bed is similar in operation to the absorption field (trench system). It is generally installed when the lot size limitations preclude the installation of an absorption trench system. Since the operation of the absorption bed is primarily dependent upon the absorptive capability of the bed bottom, meticulous care must be given to proper design and construction. Since the sidewall area is significantly reduced in comparison to the trench system, the bottom area is increased by a factor of two (See Section 5.6.3.3 b).

5.6.3.2 <u>Location</u>

a) Absorption beds shall be located in accordance with Section 5.6.1.2.

b) Absorption beds shall not be constructed in soils having a percolation rate slower than 30 minutes per 25 mm, or where rapid percolation may result in contamination of water-bearing formations or surface waters.

c) Careful attention must be given to the hydraulic conductivity of the insitu soil and the imported fill soil for the bed.

d) The absorption bed shall be located on the property to maximize the vertical separation distance from the bottom of the absorption bed to the seasonal high groundwater level, highest ground water mound, bedrock, or other limiting layer, but under no circumstances shall this vertical separation be less than 1.0 m (3 feet). Where water-bearing formations are in danger of contamination, greater vertical separation may be required.

c) Absorption beds shall not be installed on land with a natural land slope greater than eight (8) percent.

5.6.3.5. Materials

a) If perforated distribution lines are used, the perforations shall be at least 12.7 mm (0.5 in.) and no more than 19 mm (0.75 in.) in diameter and spaced to provide at least the equivalent total opening of comparable diameter 300 mm long (foot-long) tile laid with 6.4 mm (0.25 in.) open joints.

b) Coiled perforated plastic pipe shall not be used when installing absorption bed systems. Straight lengths of pipe shall be used instead.

c) Pipe used for distribution lines shall meet the appropriate CSA or ASTM standards or those of an equivalent testing laboratory. Fittings used shall be compatible with the materials used in the distribution lines.

d) Gravel or crushed stone shall be washed and shall range in size from 19 to 64 mm (0.75 - 2.5 in.).

e) The material used to cover the top of the stone shall be untreated building paper or a 50 mm (2 in.) layer of straw. Other material must be accepted by the reviewing authority. Plastic or treated building paper shall not be used.

5.6.3.5 Construction

a) A distribution box or header shall be installed between the septic tank and the absorption bed. The header shall be of watertight construction.

b) The distribution box or header shall be set level and arranged so that effluent is evenly distributed to each distribution line. Adequate provisions shall be taken to assure the stability and to provide for easy locating and accessing to inspect the distribution boxes.

c) Each distribution line shall connect individually to the box when a distribution box is used.

d) The pipe connecting the distribution box or header to the distribution lines shall be of tight joint construction laid on undisturbed earth and properly bedded throughout its length.

e) If a header is used, there should be an equal number of distribution lines spaced evenly on both sides of the leader to the header.

b) The effective depth of a seepage pit shall be measured from the bottom of the inlet pipe to the pit bottom, with the thickness of strata of soils having percolation rates slower than 30 minutes per 25 mm deducted. The effective diameter of seepage pits shall be the mean diameter of the excavation below the inlet pipe.

c) The effective area of a seepage pit shall be the vertical wall area of the pit excavation. No allowance shall be made for bottom area.

d) The flows shall be in accordance with Section 5.6.1.3.

e) The minimum area in any seepage pit shall be based on flows in Section 5.6.1.3 and in accordance with the table below.

Weighted Average Perc Rate (min/in)	Absorption Sq. Meters	Area/Bedroom Sq. Ft.	Loading Litre/Sq. Meters	Rate/Day Gal/Sq.Ft.
0-5*	12	125	49	1.2
6-10*	15	165	37	0.9

*Sec. 5.6.4.2 b)

f) The minimum inside dimension of the lining of any seepage pit shall be 0.6 m (2 ft.).

g) When more than one seepage pit is used, they shall be separated by undisturbed soil at least equal to twice the pit depth or 1.5 m (5 ft.), whichever is greater.

h) The top of the seepage pit shall be within 300 mm (12 in.) of final grade.

i) When more than one seepage pit is used, a distribution box shall be installed between the septic tank and all seepage pits.

j) The distribution box shall be set level with adjustable v-knotch weirs so that the effluent is evenly distributed to each seepage pit.

k) The distribution box shall be connected individually to each seepage pit with pipe of water-tight construction at least 100 mm (4 in.) in diameter, and sloped at least one percent.

l) When more than one seepage pit is used, each pit shall have an equal effective area.

b) Built-up mounds shall not be utilized on soils where the high groundwater level, bedrock, or other strata having a percolation rate slower than 120 minutes per 25 mm occurs within 600 mm (24 in.) of natural grade. Where rapid percolation may result in contamination of water-bearing formations or surface waters, built-up mounds shall not be utilized unless it can be demonstrated to the reviewing authority that risk of contamination is remote. Built-up mounds shall be constructed only upon undisturbed, naturally occurring soils.

c) Minimum setback distances from the outer edge of the built-up mounds shall be located as per Section 5.6.1.2 a), except that setback distances to property lines, buildings, driveways, or any other subsurface obstructions which are on the down gradient side of the mound shall be a minimum of 15 m (50 ft.). No future construction activity is to take place in the effluent dispersal area described in this section as long as the mound is in use.

5.6.5.3 <u>Fill Material</u>

a) The fill material should generally be less permeable than the underlying natural soil, so that the effluent can spread out over the built-up mound basal area before either being evapotranspired at the surface or seeping into the ground. If the natural soil under the built-up mound is not capable of transmitting the effluent, then seepage could develop at the soil-fill interface. A water budget calculation should be attempted, as illustrated in the Figure in Appendix III, to ensure that the effluent discharge at the soil fill interface will pass into the soil at all times of the year. Important criteria are (refer to Appendix III):

1) $Q_2 = 0$
2) $(Q_5 + Q_3)$ not to exceed potential Q_4

It is emphasized that conducting percolation tests in loosely compacted soil soon after construction can cause misleading results resulting in excessive hydraulic loading of the fill. Hence, either correction factors must be incorporated into the design, or the fill should be compacted as it is placed.

Pressure dosing shall be required for the built-up mound system and shall be designed and constructed in accordance with the publications noted above.

5.6.6 Fencing

All multiple housing ground disposal systems, including tanks, distribution boxes etc. should be fenced with a lockable gate in a manner which is acceptable to the reviewing authority. Community systems shall be fenced with lockable gates in a manner which is acceptable to the reviewing authority.

APPENDIX IV

GUIDELINES FOR DEVELOPMENT
(As used in the District of Coquitlam)

TABLE IV
GUIDELINES FOR DEVELOPMENT (Cont'd)

Group	Slope Angle (3)	General Development Requirements	Construction on Crest (1) (4)	Construction on Slope (2)	Construction at Toe (4)	Drainage Control
C	20°-30°	All development to be reviewed and construction supervised by an experienced geotechnical engineer.	Minimum setback for structures and fill is 8 m from crest. Minimum setback for clearing is 3 m. No fill in excess of 1 m within 25 m of crest.	All clearing, structures or road design excavations or fills greater than 0.5 m to be reviewed and approved by geotechnical engineer.	All clearing, structures or roads within 10 m of toe to be designed and approved by geotechnical engineer. No excavation within 10 m of toe without design and approval of geotechnical engineer.	Site to be graded to prevent concentrated flow downslope. All drainage to be contained within closed hydraulically designed structures and carried down full slope. All major flows to be collected and carried out to municipal drainage system.
D	> 30°	No development permitted except with approval of District Engineer. All site preparation, road and structural foundations to be designed and construction supervised by an experienced geotechnical engineer.	Minimum setback for structures is 15 m from crest. Minimum setback for clearing is 8 m. No filling in excess of 1 m within 25 m of crest. Minimum setback for any fill is 8 m from crest. All excavations in excess of 1.5 m should be carried out until the supervision of a geotechnical engineer.	No clearing, development or disturbance on slopes.	All clearing, structures or roads within 15 m of toe to be designed and supervised by geotechnical engineer. No excavation within 15 m of toe without design and supervision by geotechnical engineer.	Site to be graded to intercept and direct all surface flow or near surface seepage to suitably designed drains and into municipal drainage system or suitable closed hydraulically designed structures extending down the full slope. Drainage to be designed and supervised by professional engineer.

Notes:
(1) Height of fill is maximum height from existing ground level.
(2) Maximum depth of cut is maximum upslope vertical depth.
(3) Slope angles refer to the top 6 m of the slope or the average slope inclination, whichever is greater.
(4) The setback distance is the horizontal distance from the obvious change in grade which defines the crest or toe of the slope.

APPENDIX IV
PROVISIONS FOR PREPARATION OF DESIGNS REQUIRING DEPOSIT OR REMOVAL OF SOIL DISTRICT OF COQUITLAM, BYLAW NO. 1199, SCHEDULE C

1. Except as permitted in this bylaw, no design shall propose that a person install drainage works or install, construct, improve, extend or alter works for maintaining the flow of water in a ditch on sensitive lands unless

   (a) the works are designed and installed in accordance with the requirements of the Municipal Engineer,

   (b) the natural environment of all streams on or adjacent to the land on which the works are located is protected in accordance with the requirements of the Municipal Engineer.

2. (1) Lots containing or adjacent to the crest of a slope of an angle of 15 to less than 20 degrees shall be drained by a gravity storm drainage system or a pumped drainage system connected to the municipal drainage system.

   (2) If the municipal drainage system as required in Subsection (1) is not available, then

   (a) hydraulic structures extending down the full height of the slope, or

   (b) drainage to a tile field evenly distributed across the slope

   shall be used, subject to approval by both the Municipal Engineer and Chief Building Inspector.

   (3) Soakage pits are prohibited on the lots referred to in Subsection (1).

3. (1) Lots containing or adjacent to the crest of a slope of an angle of 20 to 30 degrees shall be graded to prevent a concentrated flow of water down

the slope and be drained by a gravity storm drainage system or a pumped drainage system connected to the municipal drainage system.

(2) If the municipal drainage system as required in Subsection (1) is not available, then, subject to both the approval of the Municipal Engineer and Chief Building Inspector, drainage shall be contained within closed hydraulically designed structures extending down the full height of the slope.

(3) Soakage pits are prohibited on the lots referred to in Subsection (1).

4. (1) Lots containing or adjacent to the crest of a slope of an angle greater than 30 degrees shall be graded to intercept and direct all surface flow and seepage near the surface to a gravity storm draining system or a pumped drainage system connected to the municipal drainage system.

(2) If the municipal drainage system as required in Subsection One (1) is not available, drainage shall be contained within closed hydraulically designed structures extending down the full height of the slope.

(3) All drainage systems in this section shall be designed and their construction inspected by a Professional Engineer.

(4) Soakage pits are prohibited on the lots referred to in Subsection (1).

5. On sensitive lands containing or adjacent to a slope of an angle of less than 15 degrees, no person shall remove soil adjacent to the toe of the slope in such a manner as to steepen the slope to an angle of 20 degrees or more, unless the requirements in Sections 32 and 33 of this bylaw are met.

6. On sensitive lands containing or adjacent to a slope of an angle of 15 to less than 20 degrees, no person shall

(a) deposit soil on the slope or adjacent to the toe of the slope to a depth greater than one metre,

(b) deposit soil adjacent to the crest of the slope to a depth greater than 1.5 metres,

(c) remove soil from the slope or adjacent to the crest or toe of the slope to a depth greater than 1.5 metres,

(d) construct a retaining structure on the slope or adjacent to the crest of the toe of the slope greater than 1.5 metres in height unless the structure is designed and its construction inspected by a Geotechnical Engineer and the plans for the structure are approved by the Municipal Engineer.

7. On sensitive lands containing or adjacent to a slope of an angle of 20 to 30 degrees, no person shall

(a) deposit soil on the slope or within 8 metres above the crest at the slope,

(b) deposit soil of a depth greater than 1 metre in the area from 8 to 25 metres above the crest of the slope,

(c) construct structures within 8 metres of the crest of the slope,

(d) construct structures or remove soil for earthworks on the slope unless the structures or earthworks are designed and inspected by a Geotechnical Engineer, and the plans for the structure or removal are approved by the Municipal Engineer.

(e) construct structures or roads or remove soil within 10 metres of the toe of the slope unless the construction or removal is designed and inspected by a Geotechnical Engineer, and the plans for the structure or removal are approved by the Municipal Engineer.

8. On sensitive lands containing or adjacent to slopes of greater than 30 degrees, no person shall

(a) deposit soil on the slope or within 15 metres of the crest of the slope,

(b) deposit soil of a depth greater than 1 metre in the area within 25 metres above the crest of the slope,

(c) remove soil to a depth greater than 1.5 metres above the crest of the slope unless the removal is designed and inspected by a Geotechnical Engineer, and the plans for the removal are approved by the Municipal Engineer,

(d) construct structures within 15 metres of the crest of the slope,

(e) remove or deposit soil or construct structures on the slope,

(f) construct structures or road or remove soil within 15 metres of the toe of the slope unless the construction or removal is designed and inspected by a Geotechnical Engineer, and the plans for the construction or removal are approved by the Municipal Engineer.

9. In any case where a design proposes to remove or deposit soil or construct structures, roads or earthworks on sensitive lands containing or adjacent to slopes of not less than 15 degrees, the Municipal Engineer may request a report from a Geotechnical Engineer, the cost of which shall be borne by the applicant to assist him in his consideration of the application.

TABLE IV
GUIDELINES FOR DEVELOPMENT

Group	Slope Angle (3)	General Development Requirements	Construction on Crest (1) (4)	Construction on Slope (2)	Construction at Toe (4)	Drainage Control
A	< 15°	Normal municipal development guidelines and good engineering practice.	Normal procedures apply. No minimum setback.	Normal procedures apply.	Normal procedures apply unless excavation steepens slope to 20° or more. If so, see below.	Normal procedures apply.
B	15°-20°	Normal development guidelines and good engineering practice. Design to be reviewed by professional engineer.	No minimum setback. Maximum fill thickness 1.5 m, fill side slopes at 20° (2.5:1) or less. Retaining structures greater than 1.5 m to be designed or reviewed by a geotechnical engineer.	Maximum cut height 1.5 m, cut slope 25° (2:1) or less. No fill greater than 1 m depth. Cuts or retaining structures greater than 1.5 m to be reviewed by geotechnical engineer.	Similar conditions to construction on slope.	Preferred method of draining lots to be properly designed and constructed gravity drainage system. No sump drains or soakage pits. If gravity storm drainage system is not available, the following may be used subject to approval by professional engineer and chief building inspector. a) suitably designed hydraulic structures extending down full height of slope; b) drainage to tile field to be evenly distributed across slope on property.

APPENDIX V

SUGGESTED COVENANT FOR TREE AND VEGETATION PROTECTION

APPENDIX V
SUGGESTED COVENANT IN RESPECT OF VEGETATION

1. Definitions

(a) CUT or CUTTING means the cutting down, limbing, pruning or cutting so as to permanently damage any tree; or the damage causing death of any tree including, but not limited to, damage inflicted upon the trunk, stem, or root system by machinery, storage of materials, the removal or compaction of soil, changing the natural grade above the root system or around the trunk; damage inflicted on the tree permitting infection or pest infestation; excessive pruning; but shall not include beneficial pruning or limbing of trees to permit corridors for scenic viewing provided that the health of trees or vegetation is not affected.

2. Control

Subject to this agreement and the covenants therein contained, no cutting or removal shall take place on the lots within criteria set out in Table V unless the following circumstances can be avoided:

(a) endangering the stability of any soil or unreasonably allowing such soil to become susceptible to any erosion, slippage, landslides, slumping, settling, or other removal on, about, or adjacent to the said lots.

(b) unreasonably disturbing, damaging, or destroying the vegetation in the Development Permit Area or the adjacent escarpment.

(c) injuriously affecting the established amenities of adjoining or adjacent properties to the lots.

And provided:

(d) prior written approval of the Municipality has been applied for and obtained; all such applications shall be submitted together with a written opinion, supplied by the applicant, of a landscape architect or arborist and shall be in a form acceptable to the Municipality;

(e) any deterioration or damage resulting directly or indirectly from cutting or removal shall be immediately remedied by the applicant under the direction and supervision of a landscape architect.

3. <u>Covenant</u>

The applicant covenants with the Municipality that it shall not:

(a) cut or cause or permit any tree or vegetation to be cut from that part of the lots within the area which is in the specified Management Zone during and after any construction which takes place on the lots, unless:

- the applicant has first sought and obtained the advice and report of a qualified geotechnical engineer as to the effect on the stability of the slope occasioned by any proposed activities set forth in sub-paragraphs a, b, c, or d of this paragraph,

and

- the applicant has deposited the report of the qualified geotechnical engineer in writing with the Engineering Department of the Municipality, or such other person or persons as the Municipality may from time to time designate, for the approval of the Municipality;

and

- the applicant shall have received approval by the Municipality in writing to any or all proposed activities falling within sub-paragraphs a, b, c or d of this paragraph.

TABLE V
GUIDELINES FOR DEVELOPMENT

Group	Slope Angle (3)	General Development Requirements	Construction on Crest (1) (4)	Construction on Slope (2)	Construction at Toe (4)	Drainage Control
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B	15°-20°	Normal development guidelines and good engineering practice. Design to be reviewed by professional engineer.	No minimum setback. Maximum fill thickness 1.5 m, fill side slopes at 20° (2.5:1) or less. Retaining structures greater than 1.5 m to be designed or reviewed by a geotechnical engineer.	Maximum cut height 1.5 m, cut slope 25° (2:1) or less. No fill greater than 1 m depth. Cuts or retaining structures greater than 1.5 m to be reviewed by geotechnical engineer.	Similar conditions to construction on slope.	Preferred method of draining lots to be properly designed and constructed gravity drainage system. No sump drains or soakage pits. If gravity storm drainage system is not available, the following may be used subject to approval by professional engineer and chief building inspector. a) suitably designed hydraulic structures extending down full height of slope; b) drainage to tile field to be evenly distributed across slope on property.

TABLE V
GUIDELINES FOR DEVELOPMENT (Cont'd)

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Notes:
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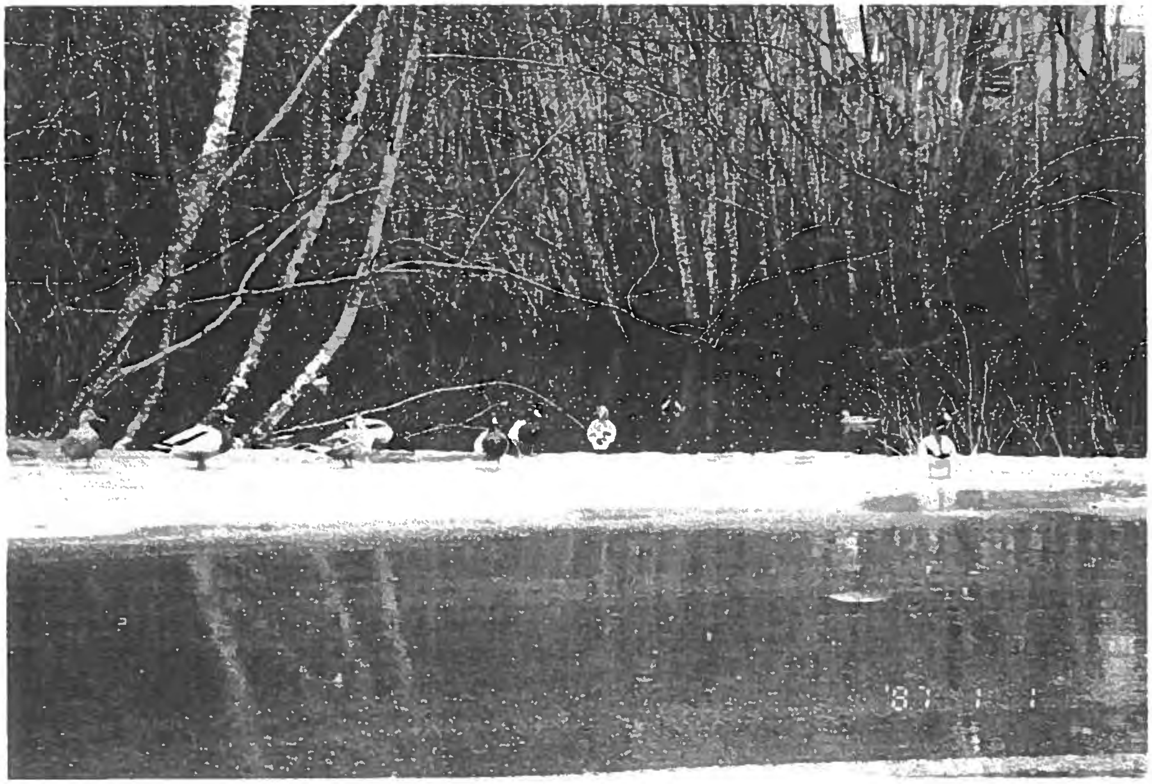
(3) Slope angles refer to the top 6 m of the slope or the average slope inclination, whichever is greater.
(4) The setback distance is the horizontal distance from the obvious change in grade which defines the crest or toe of the slope.

APPENDIX VI

SELECTED PHOTOGRAPHS



PHOTOGRAPH 1

Duck pond in Rice Subdivision.

PHOTOGRAPH 2

Chapman Creek from Sunshine Coast Highway bridge showing important fisheries area.

PHOTOGRAPH 3

View of Straight of Georgia along rocky coastline in West Sechelt showing importance of maintaining conifer cover in screening houses. Also shows one of the Trail Islands.

PHOTOGRAPH 4

View up inlet from West Porpoise Bay. Viewshed is important to residents.

PHOTOGRAPH 5

View of Tuwanek from log dump, showing Mount Richardson and screening afforded by maintaining conifer cover.

PHOTOGRAPH 6

Visual impact of East Porpoise Bay gravel pits from West Porpoise Bay.

PHOTOGRAPH 7

View from West Porpoise Bay of Mine site and clear-cut areas across from Sandy Hook. The mine constitutes a visual impact for the residents living across the inlet.

PHOTOGRAPH 8

Caving erosion in interbedded sands and silts on south slope of small creek gully at north end of Porpoise Bay road in Sandy Hook.

PHOTOGRAPH 9

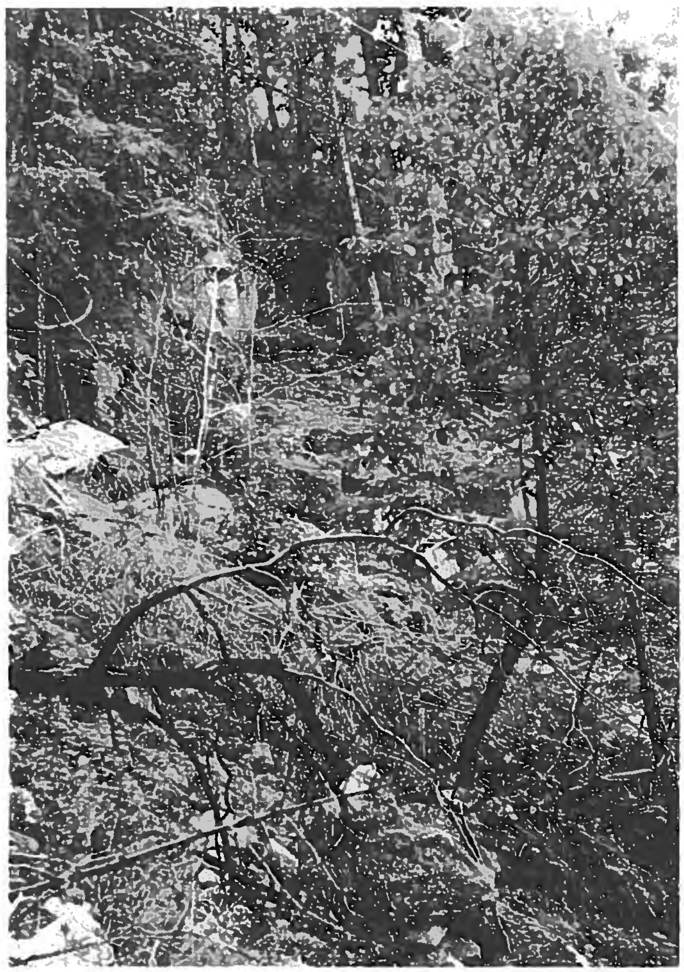
Landsliding along ravine slopes of Chapman Creek due to erosion at toe of slope.

PHOTOGRAPH 10

Shallow landsliding on beachfront escarpment in Selma Park.

PHOTOGRAPH 11

Shallow landslide from beachfront escarpment below Sunshine Coast Highway in West Sechelt.



PHOTOGRAPH 12

Rockfall hazard from rockbluff south of Sandy Hook road.

PHOTOGRAPH 13

Gravel Pit in East Porpoise Bay showing steep unstable slopes and loose exposed sediments with high erosion potential.

PHOTOGRAPH 14

Steep rocky beachfront slopes between Sargeant Bay and Wakefield Creek.

PHOTOGRAPH 15

View of Chapman Creek estuary and adjacent beach area. This is an important recreational area as well as being biologically important.

PHOTOGRAPH 16

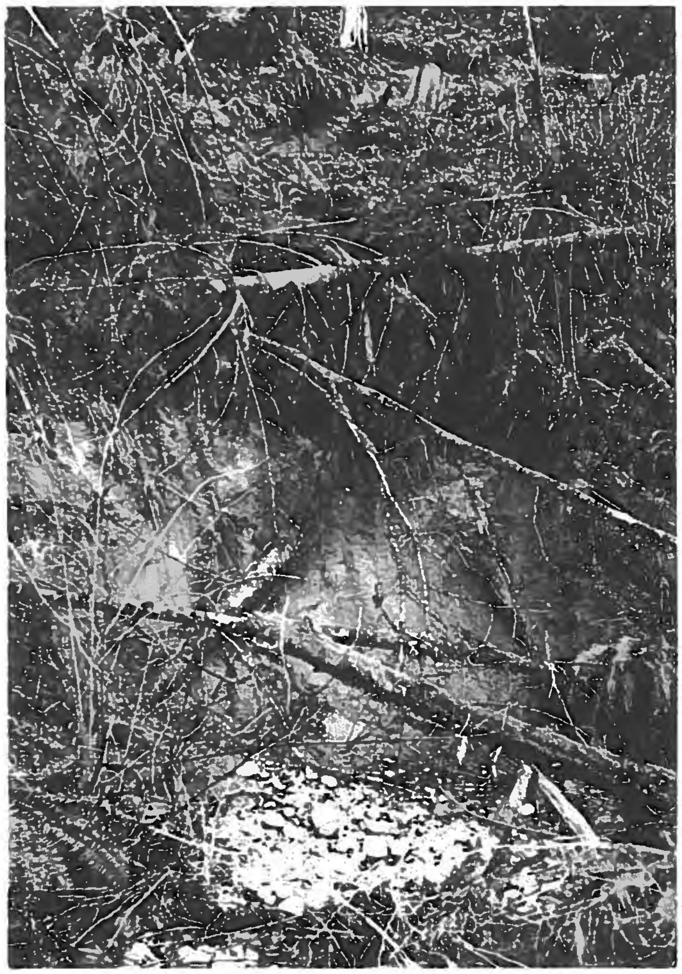
Angus Creek estuary looking north to B & A Blacktop sand and gravel operations.

PHOTOGRAPH 17

Golf course area showing problems of leaving soils exposed. Silt laden waters will enter sensitive watercourse or ocean areas.

PHOTOGRAPH 18

Removal of large coniferous trees from escarpment slope to provide oceanview for house at crest in Selma Park.



PHOTOGRAPH 19

Active sliding on south ravine slope of Angus Creek, approximately 300 m upstream of Sechelt Inlet road bridge.

PHOTOGRAPH 20

Bank erosion along Chapman Creek upstream of highway bridge is destroying sections of the hiking trail.

PHOTOGRAPH 21

Severe retrogression of ravine slope comprising bedded sands and gravel, due to erosion at toe by Chapman Creek. Some riprap along creek bank at this location is inadequate for the long-term.

PHOTOGRAPH 22

Gray Creek channel on fan downstream of Sechelt Inlet Road bridge showing cobbles and boulders in creek bed.

PHOTOGRAPH 23

View of the confluence of East Wilson Creek and Wilson Creek, just upstream of the canyon and waterfalls. This is located in a forest which is being selectively cut by MacMillan Bloedel.