# Physical Shore-Zone Mapping System for British Columbia

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The Resources Inventory Committee consists of representatives from various ministries and agencies of the Canadian and the British Columbia governments as well as from First Nations peoples. RIC objectives are to develop a common set of standards and procedures for the provincial resources inventories, as recommended by the Forest Resources Commission in its report “The Future of our Forests”.

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# PREFACE

This report is submitted to the Resources Inventory Committee (RIC) by the Coastal Task Force.

The Resource Inventory Committee members are resources inventory specialists from a wide variety of professional disciplines and representing provincial, federal, aboriginal and private sector agencies and other resource interests. RIC's objective is to develop a common set of standards and procedures for provincial resource inventories.

The Coastal Task Force has identified a number of projects to develop a common set of inventory mapping standards for the coast of British Columbia. This manual provides documentation of the Physical Shoreline-Mapping System which is a scheme designed and developed in the early 1980's for mapping the physical character of the coastal zone of British Columbia. The system has been tested and used to map the British Columbia coast for a number of years by Provincial and Federal agencies despite the lack of a formal documentation.

Funding of the Resources Inventory Committee work, including preparation of this report, is provided by the Canada-British Columbia Partnership Agreement on Forest Resources Development: FRDA II. This is a five-year (1991-1996) $200 million program cost-shared equally by the federal and provincial governments.

Funding from FRDA II does not imply acceptance or approval of any statements or information contained herein by either government. This document is not official policy of Forestry Canada or any British Columbia government ministry or agency.
For additional copies and/or further information about the Committee and its task forces, please contact the Secretariat, Resources Inventory Committee, 840 Cormorant St, Victoria, B.C. V8W 1R1, phone (604)-381-5661 or fax (604) 384-1841.

## ABSTRACT

This manual provides standards for Physical Shore-zone Mapping in British Columbia. The manual provides an overview of the mapping system, details of the mapping methodology, instructions for completion of the database and an example of the system.

The approach was developed in the late 1970's and provides for the systematic recording of shore morphology, shore-zone substrate and wave exposure characteristics. The system involves the subdivision of the shore zone into alongshore units and across-shore components. The Shore Units are usually represented by line segments on a map and identified with a unique identifier; alternatively, shore units may be represented as polygons or points. Additional information on the unit and on the components are recorded in an associated Shore-Zone Database.

The system has been used at mapping scales ranging from 1:10,000 to 1:50,000. However, because the information contained within the Shore-Zone Database is more detailed than information portrayed on the map, the effective mapping scale of the system is usually about 1:10,000 to 1:15,000; that is, a map of at least 1:10,000 scale would be required to display all the information recorded within the database. Information is recorded at three levels:

**Project Information** - administrative information on the project such as the project name, the responsible agency, the mapper, the scale of mapping, etc.

**Unit Information** - information that pertains to the entire Shore Unit such as wave exposure, alongshore length, tidal range, data sources and location.

**Component Information** - data on the morphology, material (bedrock or sediment character) and width of each across-shore component.

Each Shore Unit is characterized by a Shoreline Type which is a summary indicator of the morphology and sediment within the unit. Some of the Shoreline Types include: rock cliffs, rock platforms, rock platforms with beaches, gravel beaches, sand beaches, sand flats, man-made shores and estuaries. Thirty-four standard Shoreline Types have been defined by a systematic consideration of substrate, sediment, width and slope. The Shoreline Type for each unit is typically shown on a map by a pattern or colouring scheme to indicate the general nature of the shore unit geomorphology.

## ACKNOWLEDGEMENTS

Since its introduction, this mapping scheme has been used extensively by various Provincial and Federal Government agencies in and outside of British Columbia. Other mappers beside the authors that have applied the British Columbia system include: P.D. Reimer, P. Lewis, M.J. Miles, D.L. Forbes, N. McFadden and M.Dunn. The authors would like to acknowledge these mappers for contributing their ideas and comments to improve this system and to improve its application for multiple types of land use and resource mapping.

Financial assistance to produce this report was provided by the Government of British Columbia's Corporate Resources Inventory Initiative (CRII). CRII is a multi-ministry initiative to integrate and improve provincial resources inventories in support of land use allocation processes, socioeconomic mitigation strategies and integrated resource management. Credible and comprehensive information on all resource values is essential as British Columbia moves toward the overall goal of sustainable development.

Contents of this report are presented for discussion purpose only. Funding from CRII does not imply endorsement of any statements or information contained herein by the Government of B.C.

# 1.0 INTRODUCTION

## 1.1 Purpose

The purpose of this manual is to provide documentation of the Physical Shore- Zone Mapping System developed by the British Columbia Ministry of Environment in 1979. The manual has been prepared to ensure that an empirically supported, qualitative, standard physical shore-zone mapping system for multiple resource interpretations is available for the Province of British Columbia. It provides the information on the concept of the shore-zone mapping system, mapping procedures, the terms and their definitions used to describe a shore unit and the classification of shore units into shore types. It also recommends the type of professional qualifications required for shore- zone mapping.

## 1.2 History of Development

The conceptual framework and coding system of the Physical Shore-Zone Mapping System was developed in 1979 by E. Owens of Woodward- Clyde Consultants and D. Howes of the Ministry of Environment. The definition of terms and codes were originally developed by D. Howes in 1979, and subsequently revised by Howes and P. Lewis (Ministry of Environment) in 1982. The codes and definitions have been reviewed and modified by the authors and incorporated into this document. The system was originally tested on the shoreline of Saanich Peninsula and Saltspring Island in the summer of 1979 (see Owens 1980a; Howes and Harper 1984). It was during these pilot projects that Howes and Owens tested the use of oblique video imagery for mapping the shoreline. This technique has become an integral component in the process of physical shore-zone mapping.

## 1.3 Format

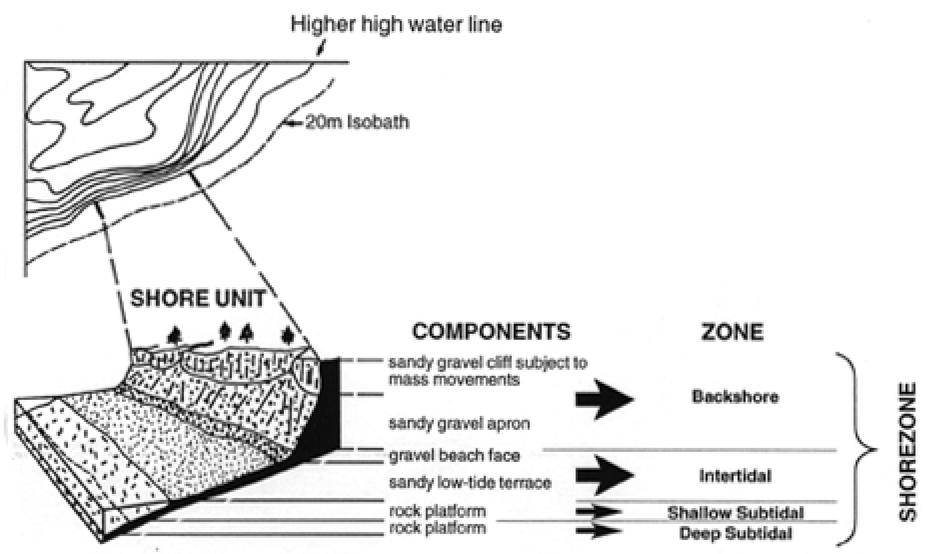
The Physical Shore-Zone Mapping System presented in this manual is a scheme designed for the classification of the materials, forms and processes that occur or operate along the coast of British Columbia. It has been specifically developed to provide an inventory of the physical character of the shore-zone and to show their distribution, extent ad location. The system is scale independent and provides base data applicable for a wide range of natural resource applications including planning, management, impact assessment and oil spill response. The data is conveyed in map and database forms, and is conducive to computer digital storage, management and processing.

# 2.0 THE SHORE-ZONE MAPPING CONCEPT

## 2.1 The Mapping Concept

The basic concept underlying this mapping system is that the shore zone can be subdivided and described in terms of systematic collection of physical entities. That is, a shoreline can be subdivided into smaller pieces, and the characteristics of each piece described and recorded. The subdivision hierarchy that is used is to first subdivide the shoreline into alongshore units, subdivide the shore units into across-shore components and categorize each of the components into zones. The subdivision hierarchy is illustrated in Figure 1.

**FIGURE 1:** Schematic example of a shore unit showing the subdivision into across-shore components and shore zones (after Howes and Harper 1984)




Each across-shore component can be systematically described in terms of physical characteristics such as morphology, texture and dominant processes. As such, the mapping approach is descriptive in nature where the mapper describes what can be seen of the components; there are no functional relationships incorporated into the classification system. The descriptive nature of the system allows non- technical users of the information to grasp a basic picture of the shoreline. For example, this system might classify an eroding cliff cut into glacial till (a genetic term indicating a glacial origin of the sediment) as a cliff, comprised of sand and gravel and erosional as opposed to a "feeder bluff" (Bauer 1980), which implies a functional relationship to "down-drift" beaches.

## 2.2 Definitions

Definitions of these mapping building blocks are:

**Unit** - an association of one or more across-shore components or processes that are continuous alongshore within the unit.

**Component** - a geomorphic feature, with unique form and texture, that is uniform alongshore the shore. Components are polygons, with length usually exceeding length by several times.

**Zones** - a vertical reference frame to categorize components in the supratidal, intertidal or subtidal elevation levels. The zones provide an indirect indication of the dominant process affecting the component. For example the transition from supratidal to intertidal implies a transition from a zone of terrestrially- dominated processes to a zone of marine-dominated processes.

This approach allows for the systematic description of the shoreline. By subdividing into smaller pieces, the major characteristics of the shore-zone can be recorded in tabular or database formats that facilitate recording of large amount of information.

## 2.3 The Concept of a Shore Unit

The concept of a shore unit is fundamental to understanding and using the mapping system. Although the across-shore component is the primary building block of the mapping system, the shore unit is the primary feature portrayed on the maps. The shore unit identifies areas of morpho-dynamic homogeneity. That is, within a unit, the morphology, sediment texture and dynamic physical processes do not vary in the alongshore direction.

As a general rule, a change in one or more across-shore components (i.e., a change in either form or texture) or a significant change in processes operating on the shore zone will define a new unit.

**FIGURE 2:** Identifies a simple series of shore units; the units are represented by two shore types: rock cliffs and pebble pocket beaches. In this case, morphology and texture are used to delineate the unit boundaries.

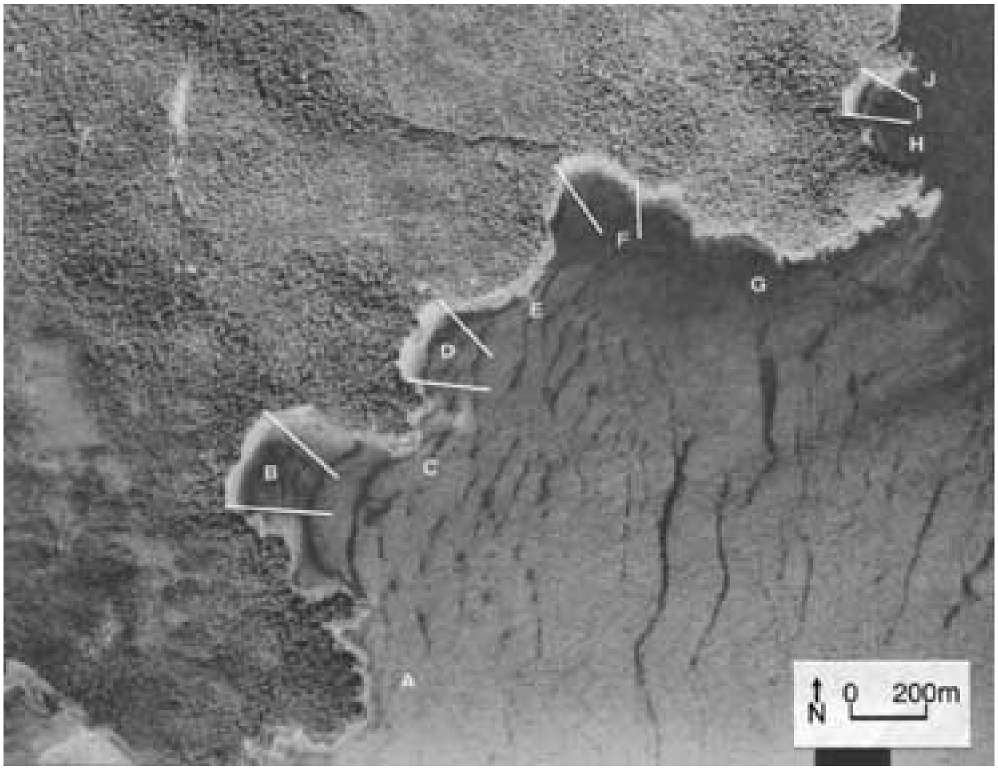
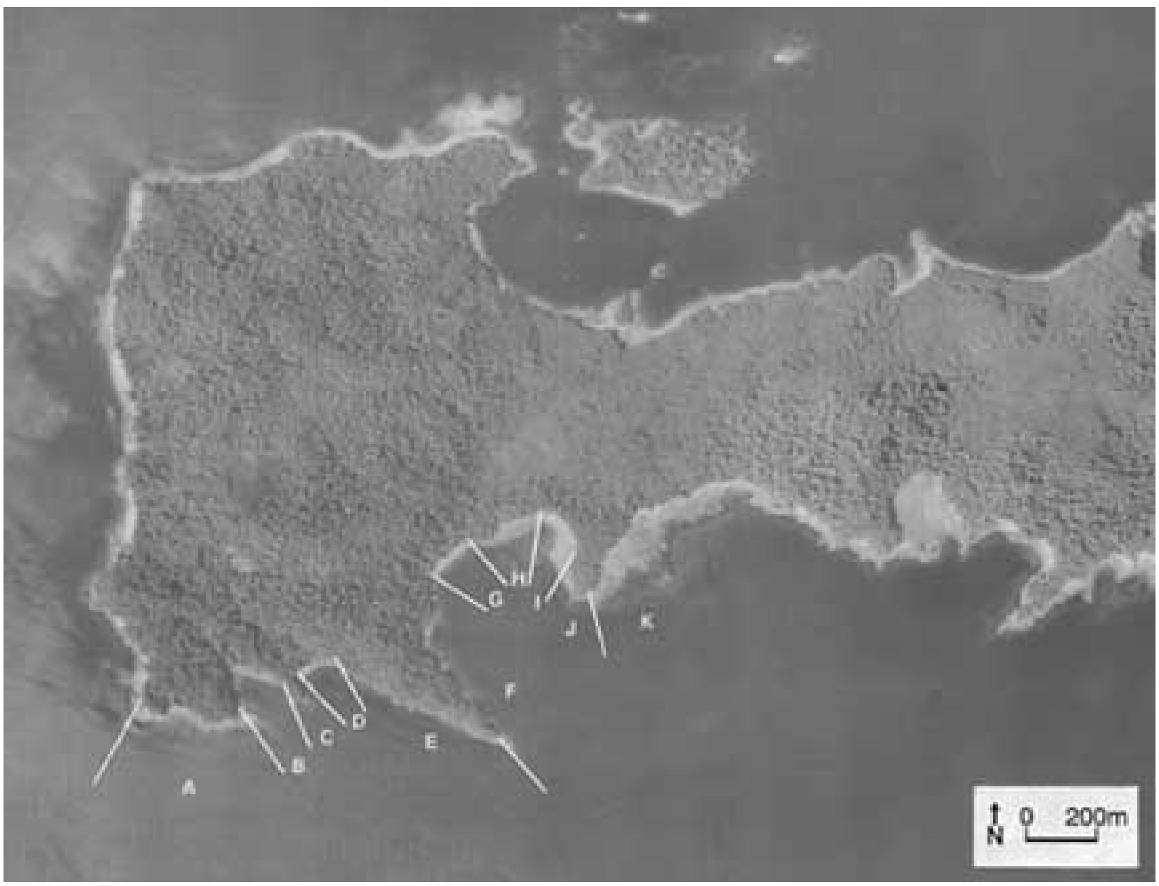



**FIGURE 3:** A vertical air photo of Whiffin Spit at the entrance to Sooke Harbour. Some portions of the spit include both a gravel beach and a sand & gravel flat (Units B,D) whereas other portions are just gravel beaches (Units C,E).

Figure 3 illustrates a more subtle change between two units. In this case, one of the across-shore components, a beach terrace, narrows to the east and eventually disappears. Units B&D have three across-shore components: a beach berm, a beach face and a beach terrace; Units C&E have only a beach berm and a beach face. Figure 4 Illustrates units with similar morphology and texture but differing wave exposure levels (Units E&F); the east-facing unit (Unit F) is exposed to large fetches across Hecate Strait (120km) where large storm waves can be generated whereas west-facing unit is exposed to maximum fetches of less than 15km, a relatively protected environment. Because the wave exposures are significantly different, the shoreline is subdivided where the wave exposure changes significantly.

**FIGURE 4:** A segment of shoreline from Murchison Island (Queen Charlotte Islands) with similar morphology but with substantially different wave exposures, hence separate shore units (Units E,F). The east-facing shore unit (Unit F) is exposed to maximum wave fetch distances of 120km. The west-facing shore unit (Unit E) is significantly less exposed with maximum wave fetches less than 15km.



## 2.4 Mapping Scale Considerations

It should be noted that the units and components are dependent of the mapping scale and on the scale of the data. The same units or components might not necessarily be defined at a 1:50,000 mapping scale as at a 1:10,000 scale. Similarly, shorelines mapped during a ground survey are likely to have significantly different units than one using 1:20,000 scale vertical air photos.

Units and components are polygons that represent an area. At detailed mapping scales such as 1:2,000 or 1:5,000, it may be possible to illustrate the components as polygons. More often, components are not illustrated on maps and only the unit is indicated. At mapping scales of 1:50,000 even units are seldom illustrated as polygons because the shore zone is so narrow (a 50m-wide shore unit would be 1mm wide); shore units are most often illustrated with a coloured or patterned line segment.

Figure 5 illustrates a map with shore units shown as polygons (Harper 1981). The mapping scale is 1:10,000 and the use of vertical aerial photos flown at a "zero tide" allowed the entire intertidal zone to be mapped. Figure 6 illustrates a shore zone map with units illustrated as line segments and polygons (mapping scale 1:50,000); some of the units were sufficiently large to be shown as polygons.

An important feature of the mapping approach is that the scale of the data, which is mostly recorded in a tabular/database format, is somewhat independent ofthe map presentation scale. For example, much of the coastal mapping that has been done within British Columbia has been at a map presentation scale of 1:40,000 or 1:50,000. However, the information contained within the associated database is more related to the raw data used to make the original interpretation. In that oblique aerial video imagery (AVI) was used in most of the mapping, the "data scale" is closer to 1:5,000. Thus the data scale is almost always of much greater detail than the presentation mapping scale.

**FIGURE 5:** A map which illustrates shore units as polygons with the shore type indicated by different patterns. The relationship between the vertical air photo of the site and the map is also indicated. Mapping scale, 1:10,000.

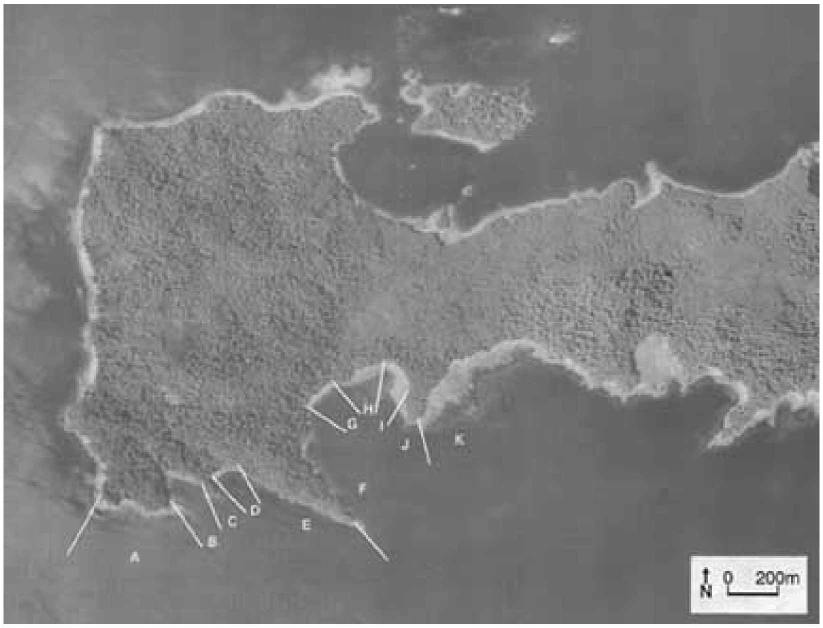
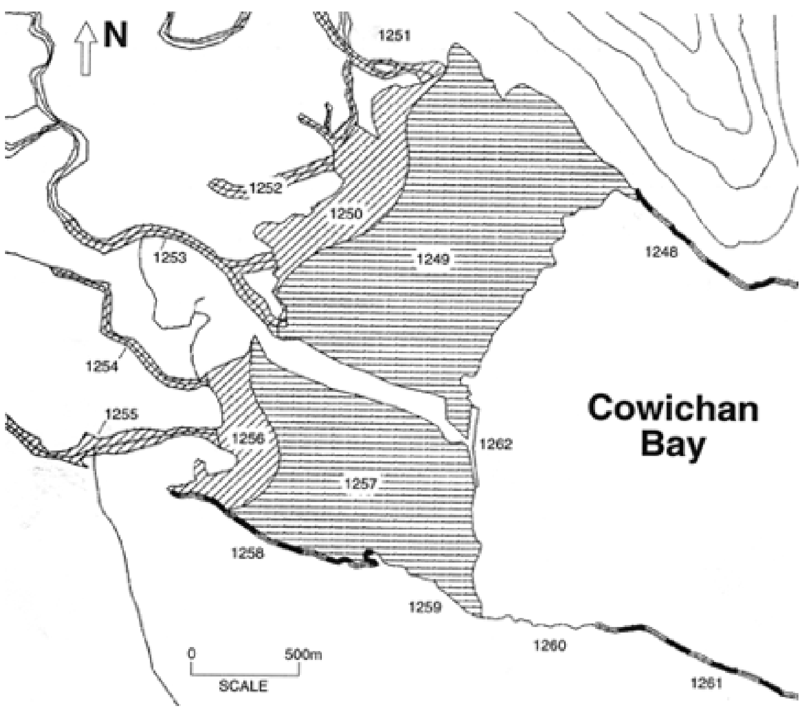



**FIGURE 6:** A map of Cowichan Bay and the associated estuary illustrating a GIS-produced shore-unit map (from Howes et al 1994). The map includes both linear shore units (1248, 1258-1262) and polygonal shore-units (1249-1257). The unit numbers are identifiers that tie the geographic or spatial data to a database. Map scale, 1:40,000.



## 2.5 Mapper Qualifications

It should be emphasized, however, that a shoreline is seldom represented as discrete physical features but more often shows a gradation from one geomorphic feature to the next. As such, the application of the system requires professional interpretation, and a minimum level of professional experience is suggested for mappers (see below). The following provisions are intended to ensure a consistent and professional treatment of the physical shoreline mapping outlined in this manual. These requirements should be applied to all persons responsible for conducting, coordinating, directing or reporting on physical shore-zone mapping projects. Mapper requirements include:

- Registered member of the Association of Professional Engineers and Geoscientists of British Columbia.
- Master of Science degree in geology or physical geography with a specialty in geomorphology, or a Bachelor of Science with an equivalent combination of training and experience.

Demonstrated knowledge and experience related to:
- coastal geomorphology and processes
- mapping procedures and techniques
- designing and conducting mapping projects
- shoreline and coastal processes pertinent to the B.C. coast.

# 3.0 MAPPING PROCEDURES

This section provides a description of the materials required for mapping and the general procedures used in the mapping process. The sections outline the general scope of the shore-zone database and the associated steps taken to complete the mapping.

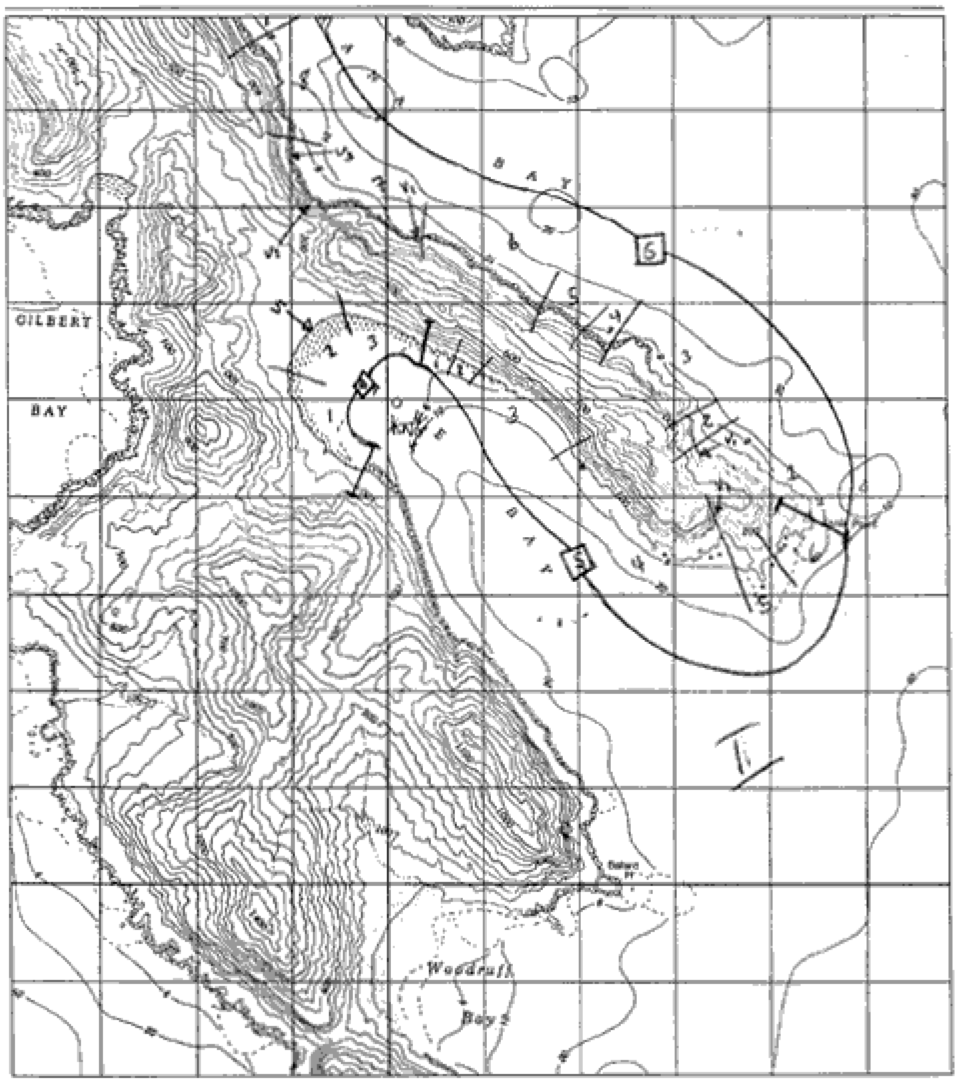
## 3.1 Resource Materials

A wide-range of information may be required to compile coastal maps. Some of the more important types of information include:

**Base Map** - a base map is required for marking the location of shore unit boundaries and locations of variants (Figure 7 illustrates a chart used as a base map with unit boundaries, unit identifiers and variants). The base map should be of suitable scale for the project requirements. If a large-scale, regional overview is required, base maps in the range of 1:100,000 may be adequate; for detailed mapping to complement a community plan, base maps in the range of 1:10,000 may be required. Ideally the base map should be a stable base (non-stretchable mylar for example; paper charts are adequate if not handled too much). If digitizing of the base map is contemplated, the base map should be the same scale of the digital base map to facilitate transfer of data. An uncluttered base map will facilitate interpretation by drafting or digitizing personnel but there must be sufficient information on the map so that unit boundaries and variants are accurately located.

**Air Photos** - air photos provide key information on shore-zone characteristics. Even if more detailed information sources are used, such as aerial video imagery (AVI), air photos are often extremely helpful in relating the AVI to the map. Air photos at a scale of 1:20,000 or better are required. Colour air photos, if available, normally provide a better delineation of across-shore components. Low-tide air photos should be utilized where possible (the Canadian Hydrographic Service can provide tidal elevation data if the date and time of the air photo are known). Figure 2 illustrates a typical, 1:20,000 scale black and white air photo, which are widely available for most of the B.C. coast. Figures 3 and 5 illustrate a 1:10,000 scale air photos that were shot at a "zero tide" thereby imaging the entire intertidal zone.

**FIGURE 7:** Example of an annotated based map showing the method used to delineate wave exposure units (indicated by boxed numbers), shore units (unboxed numbers along the shore) and variants (arrows with numbers) along the southeast coast of Kunghit Island (Queen Charlotte Islands). For example, Exposure Unit "4", contains Shore Units "1", "2" and "3". Shore Unit 4/2 contains variant "v1", a point feature indicating a stream mouth.



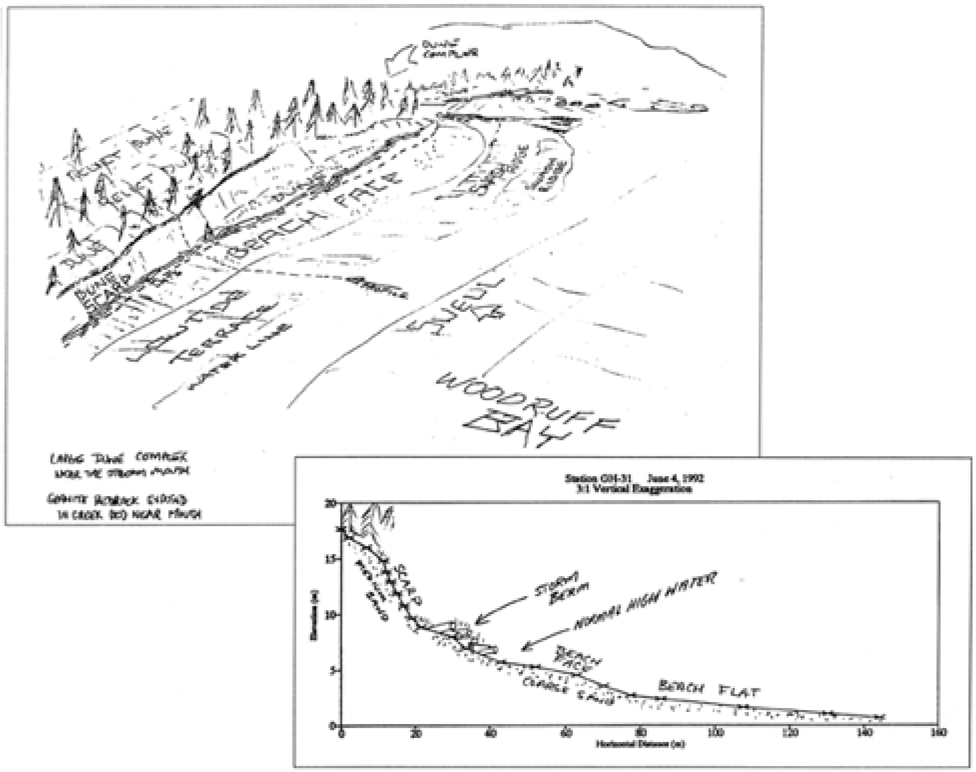

**Aerial Video Imagery (AVI)** - aerial video imagery has been widely used for shore-zone mapping, especially in British Columbia. The oblique imagery is collected from low altitude overflights using a high-quality video system. The AVI normally includes a synchronous narration on the shore-zone morphology and/or intertidal biota. It is possible to routinely resolve features the size of boulders on the imagery and under optimum conditions, may be possible to resolve objects the size of a sea urchin. The effective mapping scale is probably 1:2,500 to 1:5,000 although the map presentation scale may be much larger (e.g., 1:40,000).

**Aerial Slide Imagery** - the AVI is frequently accompanied by oblique 35mm slide imagery of the shore zone. Although this medium is non-continuous, the resolution is much higher and particularly useful for resolving sediment sizes. Figure 8 provides a good example of the high resolution of the slide imagery.

**FIGURE 8:** Oblique aerial photo of Nitnat Narrows at the mouth of Nitnat Lake. The photo shows the vertical rock cliffs to the north (left) of the entrance, the inlet during ebb tide and the pebble/sand beaches to the south (right) of the entrance. Photo taken from a fixed-wing aircraft at about 150m (500ft) altitude.

**Ground Survey Data** - there may be ground survey available for the area being mapped and this data is often useful for interpreting sediment textures. Figure 9 illustrates a field sketch and an across-shore profile that was collected as part of a large coastal mapping project.

**FIGURE 9:** Ground-survey data: (a) sketch of Woodruff Bay, Kunghit Is (Queen Charlotte Islands) and (b) associated across-shore beach profile at the same location.




**Published Reports** - published reports may be available that include incidental information of relevance to coastal mapping. These may include: land-use studies, geological reports, engineering site investigations, research studies, habitat mapping data, etc.

The mapping program may define a need to implement a ground survey program to improve confidence in mapping interpretations. For example, the mapper may have difficulty in interpreting sediment textures, such as pebble beaches from sand and gravel beaches; a ground survey can be focused on the beaches in question to improve mapping confidence.

## 3.2 The Physical Shore-zone Database

The previous section of this report (Section 2) described the basic approach to the mapping. A key feature of the mapping system is the Shore-Zone Database that provides additional information that cannot be illustrated on the maps. Early versions of this database were in hard-copy, tabular formats (e.g., Owens 1980a) whereas recent versions are in electronic database files that are fully integrated with GIS systems (Howes et al 1994).

The database records a much greater level of detail than can be recorded on the shore-zone maps. As such the effective mapping scale is typically in the range of 1:5,000 to 1:10,000; that is, features that would ordinarily be shown on this scale of map are recorded within the database even though the base maps are at a scale of 1:40,000. The organization of the database (1993) is illustrated in terms of a data entry form (Table 1) with associated data fields. There are four general levels of information recorded: Project Information - information that relates to the entire project and is primarily of an administrative nature. Exposure Information is information on wave exposure and tides, usually applicable to several shore units. Unit Information is information that relates to the entire shore unit, such as shore unit length, shore-unit width, wave exposure, etc. Component Information - information relating to the across-shore components; each component is documented in a separate data record. Fields are included for component form and material, widths and any anomalies within the component. Details on these four levels of information are described in the following sections.

**TABLE 1:** Shore-zone database data entry

| **PROJECT INFORMATION** | | | |
|---|---|---|---|
| Project Name: | | | |
| Project Agency: | | Date of Mapping: | |
| Name of Mapper: | | Scale of Mapping: | |
| Editor: | | | |

| **WAVE EXPOSURE INFORMATION** | | | | | |
|---|---|---|---|---|---|
| **Exposure Unit I.D.** | | **Associated Shore Units:** | | | |
| **Waves —** | Maximum Fetch Direction (°): | | | | |
| | Maximum Fetch Distance (km): | | | | |
| | Shore Normal (°): | | | | |
| | Fetch Distances (km): | | | | |
| | | (left 45°) | (90°) | (left 45°) | |
| | Effective Fetch (km): | | Exposure Category: | | |
| **Tides—** | Range (large): | | Range (mean): | | |

| SHORE UNIT INFORMATION | | | | | | |
|---|---|---|---|---|---|---|
| **Unit I.D.—** | Region: | | **Unit Type:** | | | |
| | Area: | | **Shoreline Type:** | | | |
| | Unit: | | **Note No.:** | | | |
| | Sub Unit: | | | | | |
| **Associated Exposure Unit:** | | | | | | |
| **Unit Location—** | Start (lat/long): | | End (lat/long): | | | |
| **Unit Length:** | | | Intertidal Width: | | | |
| **Sediment Transport** | Source: | | Abundance: | | Direction: | |
| **Shoreline Change—** | Type (A/S/E): | | Rate (m/yr): | | | |
| **Data Sources—** | Air Photo No.: | | Ground Truthing: | | | |
| | NTS Map Sheet No.: | | Chart No.: | | | |
| | Videotape No: | | Tape Time: | | | |

| SHORE COMPONENT INFORMATION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Component** | **Zone** | **Component** | **Form*** | | | **Material*** | | | **Width (m)** | |
| **I.D.** | | **Number** | **1** | **2** | **3** | **1** | **2** | **3** | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| **Distribution Code of each Primary/Secondary/Tertiary* (See Appendix A for entry codes) | | | | | | | | | | |

**Distribution Code of each Primary/Secondary/Tertiary*

(See Appendix A for entry codes)

## 3.3 Project Information

### 3.3.1 Recording Project Information

Table 2 shows a data record form for project information; that is, information that relates to the project as a whole rather to specific mapping areas or to specific mapping units.

**TABLE 2:** Shore-zone data entry fields - project information

| PROJECT INFORMATION | | | |
|---|---|---|---|
| Project Name: | Southern Strait of Georgia | | |
| Project Agency: | Ministry of Environment | Date of Mapping: | July 1996 |
| Name of Mapper: | J Smith | Scale of Mapping: | 1:40,000 |
| Editor: | J Jones | | |

### 3.3.2 Explanation of Project Data Fields

**Project Name:** the commonly used name for the project, usually an abbreviation of the associated report title and usually indicating the general geographic coverage of the mapping (e.g., Oil Spill Response Atlas of the Southwest Coast of Vancouver Island - SW Vancouver Island).

**Project Agency:** the government agency or private company responsible for providing the funding for the project.

**Date of Mapping:** the date when the mapping was conducted and data entry forms completed; usually the date of the final report.

**Name of Mapper:** the name of the primary mapper or mappers who directed the inventory and made the professional mapping interpretations.

**Scale of Mapping:** the scale of the base map onto which the shore-unit boundaries are transferred.

**Editor:** the name of the person responsible for editing the maps prior to release.

## 3.4 Exposure Units

Wave action is the primary process controlling morphology and biota in the shore zone, and indirect measurements are used to characterize the wave energy and wave exposure of the Exposure Unit (Appendix C contains a complete explanation and "how to" of the wave exposure measurements). Tidal information is also included within the Exposure Unit component of the database; tides are important in controlling intertidal morphology by distributing wave energy across the intertidal zone and are of critical importance in determining across-shore intertidal biological community zonation. Exposure Units are a collection of Shore Units with similar wave exposure and tidal characteristics. Morphology or substrate may vary from unit to unit but the coastal orientation and fetch windows are similar enough to be in the same Exposure Unit. Data included in the exposure database are indicated in Table 3. In practice, a mapper would delineate Shore Units first, then cross-reference which Shore Units would be included in a particular Exposure Unit. Figure 7 provides an indication of Shore Units nested within Exposure Units.

**TABLE 3:** Shore-zone data entry fields - wave exposure information

| **WAVE EXPOSURE INFORMATION** | | | | | |
|---|---|---|---|---|---|
| **Exposure Unit I.D.** | | **Associated Shore Units:** | | | |
| **Waves—** | Maximum Fetch Direction (°): | | | | |
| | Maximum Fetch Distance (km): | | | | |
| | Shore Normal (°): | | | | |
| | Fetch Distances (km): | | | | |
| | | (left 45°) | (90°) | (left 45°) | |
| | Effective Fetch (km): | | Exposure Category: | | |
| **Tides—** | Range (large): | | Range (mean): | | |
| (See Appendix A for entry codes) | | | | | |

### 3.4.1 Explanation of exposure information fields

**Exposure Unit I.D.** - the unique identifier of the Exposure Unit, usually a hierarchal number related to the region and area (e.g., 08/03/002, indicates Region 8, Area 3, Exposure Unit 2).

**Associated Shore Units** - a cross-reference list of shore units that are nested within the Exposure Unit, usually a hierarchial number related to the region and area (e.g., 08/03/002/001 to 08/03/002/004, indicates Region 8, Area 3, Exposure Unit 2, Shore Units 1 to 4).

**Maximum Fetch Direction** - the azimuth (in degrees from true north) of the direction of the maximum fetch.

**Maximum Fetch Distance** - the distance in kilometres of the maximum fetch as measured along the Maximum Fetch Direction.

**Shore Normal Direction** - the azimuth (in degrees from true north) of the normal to the general orientation of the shore unit. That is, if the general trend of the shoreline is from northwest to southeast with open water to the east), then the Shore Normal Direction would be about 45°.

**Fetch Distances** - the distances in kilometres as measured along a line 45° to the left of the Shore Normal, along the Shore Normal and along a line 45° to the right of the Shore Normal.

**Modified Effective Fetch** - the distance in kilometres as computed from the Fetch Distance Measurements. The Modified Effective Fetch represents a simplification of standard engineering procedures for estimating effective fetch (see CERC 1977; Harper et al 1991).

**Exposure Category** - the exposure category provides a summary indicator of wave exposure for the unit (see Table C.1, Appendix C). The following classes of wave exposure have been utilized and are derived from knowledge of Maximum Fetch and Modified Effective Fetch:

*Very Protected - maximum wave fetch less than one kilometre; usually the location of all-weather anchorages, marinas and harbours.

*Protected - maximum wave fetch less than 10 km; usually areas of provisional anchorages and low wave exposure except in extreme winds.

*Semi-protected - maximum wave fetch distances in the range of 10 to 50 km. Waves are low most of the time except during high winds.

*Semi-exposed - maximum wave fetch distances between 50 and 500 km. Swells, generated in areas distant from the shore unit create relatively high wave conditions. During storms, extremely large waves may occur.

*Exposed - maximum wave fetch distances greater than 500 km. High ambient wave conditions usually prevail within this exposure category, which is typical of open-Pacific ocean-wave conditions.

**Range (large/mean)** - the range of large and mean tides as taken from the nearest reference station to the shore unit from the Canadian Tide and Current Tables, published by the Canadian Hydrographic Service.

## 3.5 The Shore Unit

### 3.5.1 Identification of Unit Boundaries

Once the materials are assembled, the first step for the coastal mapper is to review a section of coast and define the shore unit boundaries. Fig. 7 illustrates an example of a base map with the units delineated. Criteria used to define these units are discussed on page 10 but the basic guideline for delineating a unit boundary is a change in one or more across-shore components (i.e., a change in either form or texture) or a significant change in processes operating on the shore zone will define a new unit.

### 3.5.2 Recording Shore-Unit Data

Once the unit boundaries are defined, information pertaining to the unit can be recorded into the data base. Table 4 indicates the typical information recorded for a shore unit. In general, all the shore unit items should be completed as most are essential for making derivative interpretations; the one exception is the rate of change of the shoreline, which usually requires published information rather than a professional interpretation. The actual codes that are entered are described in Appendix A.

**TABLE 4:** Shore-zone data entry fields - shore unit information

| **SHORE UNIT INFORMATION** | | | | | | |
|---|---|---|---|---|---|---|
| **Unit I.D.—** | Region: | | **Unit Type:** | | | |
| | Area: | | **Shoreline Type:** | | | |
| | Unit: | | **Note No.:** | | | |
| | Sub Unit: | | | | | |
| **Associated Exposure Unit:** | | | | | | |
| **Unit Location—** | Start (latlong): | | End (latlong): | | | |
| **Unit Length:** | | | Intertidal Width: | | | |
| **Sediment Transport—** | Source: | | Abundance: | | Direction: | |
| **Shoreline Change—** | Type (A/S/E): | | Rate (m/yr): | | | |
| **Data Sources—** | Air Photo No.: | | Ground Truthing: | | | |
| | NTS Map Sheet No.: | | Chart No.: | | | |
| | Videotape No: | | Tape Time: | | | |
| | | | | | | |
| (See Appendix A for entry codes) | | | | | | |

### 3.5.3 Explanation of Shore Unit Data Fields

**Unit I.D**. - the Unit I.D. is a hierarchical set of numbers that provides an approximate geographic region for the shore unit. Appendix D includes a map of the regions that have been used to summarize information on the British Columbia coast (see page 71).

**Unit Type** - an indication of the map portrayal format of the unit, either as a polygon, a line segment or a point.

**Shoreline Type** - the shoreline is a code that provides a summary of the coastal geomorphology and sediment type that occurs within the unit. The shoreline type is chosen after the shoreline component data has been mapped and is selected from the 34 shoreline types listed in Table 6 (see page 27).

**Note No.** - the mapper may chose to provide a text description of the unit or to include comments on any anomalies that occur within the unit; these notes are incorporated into a separate database and cross-referenced by the Note Number.

**Unit Location** - the geographic latitude and longitude of the two end points of the unit. Normally these values are computed during the digitizing process and automatically entered into the electronic database. They can, however, be manually entered during the initial mapping process.

**Associated Exposure Unit** - a cross-reference to the Exposure Unit in which the Shore Unit is nested.

**Unit Length** - the alongshore length of the unit in kilometres as measured along the high-water line at the original scale of mapping. The unit length is usually computed and entered into the database automatically during the digitizing process. The Unit Length can be measured manually, however, during the initial mapping process.

**Intertidal Width** - the estimated distance in metres between the high water line (usually taken as the storm log line) and the low water line. This is an interpreted estimate made by the mapper from the aerial video imagery. In the case where there is a significant range of width within the unit, a range may be specified (e.g., 20-50m). The Intertidal Width should agree with the sum of the component widths (see page 24).

**Sediment Transport** - sediment transport represents a dynamic component of the Shore Unit information. The three Sediment Transport descriptors are provided by the mapper based on geomorphological indicators and/or published information from the general area.

**Source** - the probable internal or external sources of unconsolidated material in the shore unit.

**Abundance** - a relative index of sediment abundance within the shore unit.

**Direction** - dominant alongshore direction of sediment transport expressed as one of eight Cardinal compass points (i.e., N, NE, E, SE, S, SW, W, NW) and indicating direction towards which sediment is transported.

**Shoreline Change** - an interpretive index of the shoreline stability based on an interpretation of geomorphology within the unit.

**Type** - type of shoreline change such as accretional, stable or erosional.

**Rate** - long-term rate of change in metres per year. Rates usually must be determined from historical air photo analysis or from long-term beach surveys. As such, published information is usually required to complete this entry.

**Data Sources** - data sources provide the user with an indirect indication of the confidence of interpretation in that the type and date of information used by mapper is clearly identified.

**Air Photo Number** - a unique identifier of the air photo used in the shore unit mapping; usually this consists of the flightline and frame number of the air photo.

**Ground Truthing** - a code indicating the intensity of ground surveys conducted within the shore unit.

**NTS Map Number** - the National Topographic System map number.

**Chart No.** - the Canadian Hydrographic Service (CHS) chart number.

**Videotape Number** - the unique identifier of the aerial videotape used in the mapping.

**Tape Time** - the tape time, taken directly from the video image, for the start of the shore unit. Entry of the time greatly simplifies the relocation of shore unit for updating or other mapping (e.g., shore access).

## 3.6 Components

The across-shore component represents the basic building block of the shore-zone mapping system and essentially the finest map entity. The across-shore components represent different morphological features, recorded as if walking from the land to the sea. Variants represent anomalies within the shore unit, usually features that have only a short alongshore length and as such represent "point" features (they are indicated as "point" types in the shore unit database).

### 3.6.1 Recording Component Information

Component information is identified in Table 5. Usually, this information is recorded in an electronic database so that the recording format may differ from that shown in Table 5; however, the table shows the minimum amount of data that should be recorded for each component.

**TABLE 5:** Shore-zone data entry fields - shore component information

| SHORE COMPONENT INFORMATION | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Component** | **Zone** | **Component** | **Form*** | | | **Material*** | | | **Width (m)** |
| **I.D.** | | **Number** | **1** | **2** | **3** | **1** | **2** | **3** | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| **Distribution*\(See Appendix A for entry codes) | | | | | | | | | |

## 3.6.2 Explanation of Component Terms

**Zone** - portion of the shore zone indicating relative elevation within the intertidal zone (e.g, supratidal, intertidal, subtidal).

**Component Number** - components within each zone are identified in sequence from land to sea (e.g., component A1, A2, B1, B2, B3 ...).

**Form** - a summary indicator of the dominant or secondary forms associated with the shore component. A wide range of codes are used to describe primary and secondary geomorphic forms (see Appendix A).

**Material** - a summary indicator of the materials that occur within the component, such as bedrock, sand and gravel, logs, etc. The codes may indicate relative position, such as logs over a beach berm or a gravel veneer over a bedrock platform. A wide range of primary and secondary material descriptors are used to record materials (see Appendix A).

**Width** - estimated across-shore width of the component.

# 4.0 CLASSIFICATION OF SHORE UNITS

## 4.1 Classification of Shore Units

The shore-zone mapping system records considerable detail on the morphology and sediments of the shore zone within the database. As previously mentioned, the "effective" mapping scale is in the range of 1:5,000 to 1:10,000, independent of the map portrayal scale. There is, however, too much detail to be portrayed on the maps and a summary indicator of morphology and texture is used to indicate the general morphology and substrate that occurs within the shore unit.

This summary indicator is termed the Shoreline Type and represents a generalization of the detailed mapping data. Shoreline Type - represents a repetitive collection of across-shore components.

**EXAMPLES OF SHORELINE TYPES**

**Across-shore Components Shoreline Type**

1. Gravel beach berm Platform with gravel beach
   Gravel beach face
   Rock platform
2. Sand and Gravel beach berm Sand flat
   Sand beach face
   Sand flat
3. Sand and Gravel beach face Rock ramp with Sand and Gravel beach
   Gravel veneer over a rock ramp

In each case some information is lost between the across-shore component description of the unit and the Shoreline Type. However, the generalization is necessary to simplify the information to an extent that it can be clearly displayed on the maps, usually by a distinct colour or pattern (Fig. 5,6).

As such, each Shore Unit is represented by a single Shoreline Type. This shoreline type provides a summary indication of the morphology and substrate that occurs within the unit and sufficient information for most resource applications (e.g., oil spill sensitivity assessments, recreational planning). The higher level of detail is not lost, but rather stored in the database.

## 4.2 Classification Rationale

Early in the evolution of this coastal mapping system, Shoreline Types were defined on an ad hoc basis for each project. However, as the complexity of mapping and number of mapping projects increased, a system of Shoreline Types was developed to assure standardization between various projects.

The following parameters were used to define a rationale for a Shoreline Type classification:

**Classification**
Criteria Categories

**Substrate** - Rock
Rock + Sediment
Sediment
Anthropogenic

**Sediment** - Gravel Sand & Gravel (S&G)
Sand
Man-made

**Width** - Narrow (<<30m)
Wide (>30m)

**Slope**- Steep (>20°)
Inclined (5-20°)
Flat (<<5°)

A systematic application of the criteria is shown in Table 6 and was used to define 34 repetitive Shoreline Types. These Shoreline Types cover the vast majority of component combinations that have been encountered on the British Columbia coast; exceptions are categorized in terms of the most representative Shoreline Type.

Shoreline Type Class codes are entered into the database under the Unit Data category. Although there are 34 potential codes, in practice, usually only about 10 Shoreline Types occur within a project area so that a manageable legend can be developed for the maps.

**TABLE 6:** Rationale for the classification of shoreline types

| Substrate | Sediment | Width | Slope | Shoreline type (class) |
|---|---|---|---|---|
| **ROCK** | n/a | Wide (>30m) | Steep(>20°) | n/a |
| | | | Inclined(5-20°) | Rock Ramp, wide (1) |
| | | | Flat (<5°) | Rock Platform, wide (2) |
| | | Narrow (<30m) | Steep(>20°) | Rock Cliff (3) |
| | | | Inclined(5-20°) | Rock Ramp, narrow (4) |
| | | | Flat(<5°) | Rock Platform, narrow (5) |
| **ROCK** | GRAVEL | Wide (>30m) | Steep(>20°) | n/a |
| **+** | | | Inclined(5-20°) | Ramp w gravel beach, wide (6) |

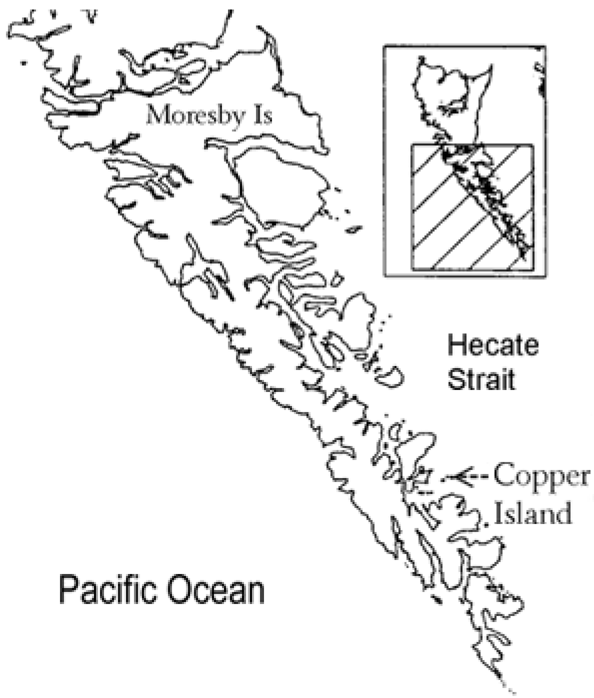
| | | | | |
|---|---|---|---|---|
| **SEDIMENT** | | | Flat(<5°) | Platform w gravel beach, wide (7) |
| | | Narrow (<30m) | Steep(>20°) | Cliff w gravel beach (8) |
| | | | Inclined(5-20°) | Ramp w gravel beach (9) |
| | | | Flat(<5°) | Platform with gravel beach (10) |
| | SAND | Wide (>30m) | Steep(>20°) | n/a |
| | & | | Inclined(5-20°) | Ramp w gravel & sand beach, wide (11) |
| | GRAVEL | | Flat(<5°) | Platform w G&S beach, wide (12) |
| | | Narrow (<30m) | Steep(>20°) | Cliff w gravel/sand beach (13) |
| | | | Inclined(5-20°) | Ramp w gravel/sand beach (14) |
| | | | Flat(<5°) | Platform with gravel/sand beach (15) |
| | SAND | Wide (>30m) | Steep(>20°) | n/a |
| | | | Inclined(5-20°) | Ramp w sand beach, wide (16) |
| | | | Flat(<5°) | Platform w sand beach, wide (17) |
| | | Narrow (<30m) | Steep(>20°) | Cliff w sand beach (18) |
| | | | Inclined(5-20°) | Ramp w sand beach, narrow (19) |
| | | | Flat(<5°) | Platform w sand beach, narrow (20) |
| **SEDIMENT** | GRAVEL | Wide (>30m) | Flat(<5°) | Gravel flat, wide (21) |
| | | Narrow (<30m) | Steep(>20°) | n/a |
| | | | Inclined(5-20°) | Gravel beach, narrow (22) |
| | | | Flat(<5°) | Gravel flat or fan (23) |
| | SAND | Wide (>30m) | Steep(>20°) | n/a |
| | & | | Inclined(5-20°) | n/a |
| | GRAVEL | | Flat(<5°) | Sand & gravel flat or fan (24) |
| | | Narrow | Steep(>20°) | n/a |

| | | | | |
|---|---|---|---|---|
| | | (<30m) | | |
| | | | Inclined(5-20°) | Sand & gravel beach, narrow (25) |
| | | | Flat(<5°) | Sand & gravel flat or fan (26) |
| | SAND/MUD | Wide (>30m) | Steep(>20°) | n/a |
| | | | Inclined(5-20°) | Sand beach (27) |
| | | | Flat(<5°) | Sand flat (28) |
| | | | | Mudflat (29) |
| | | Narrow (<30m) | Steep(>20°) | n/a |
| | | | Inclined(5-20°) | Sand beach (30) |
| | | | n/a | |
| | ORGANICS/ FINES | n/a | n/a | Estuaries (31) |
| **ANTHRO-POGENIC** | MAN-MADE | n/a | n/a | Man-made, permeable (32)<br>Man-made, impermeable (33) |
| **CURRENT-DOMINATED** | | | | Channel (34) |

# 5.0 MAPPING EXAMPLE

The following example shows the mapping and coding procedures along with appropriate reference within the text. The example is taken from the recently completed coastal mapping project of Gwaii Haanas National Marine Park in the southern Queen Charlotte Islands (Harper et al, 1992; Harper et al 1994). The example shows East Copper and Jeffery Island from the Skincuttle Inlet area, bordering on Hecate Strait (Fig. 10).

**FIGURE 10:** Location of the Queen Charlotte Islands (inset) and the Copper Islands




## 5.1 Project Data

Information related to the entire project is included in the Project Data Fields

**TABLE 7:** Data entry fields - project information

PROJECT INFORMATION

| | |
|---|---|
| Project Name: GWAII HAANAS COASTAL INVENTORY | |
| Project Agency: PARKS CANADA | Date of Mapping: 92-2-28 |
| Name of Mapper: HARPER/REIMER | Scale of Mapping: 1:50,000 |
| Editor: HARPER | |

## 5.2 Exposure Information

Once the resource materials are collected (in this project this included: aerial video imagery, vertical air photos, topographic maps, charts and oblique aerial photos), the Exposure Units were defined (Fig. 11). Three Exposure Units were defined in this case:

***Exposure Unit 7/7** - a general southerly orientation with limited fetches to the south within Skincuttle Inlet but with maximum fetches exposed to the open Hecate Strait

***Exposure Unit 7/8** - mostly east-facing shore units and exposed to the extensive fetch window of Hecate Strait

***Exposure Unit 7/9** - generally north-facing shoreline with a fetch window open to northern Hecate Strait

Although there are small indentations and islets along the coast that have slightly different wave exposures, these exposure units provide a reasonable first approximation of the wave climate around the Copper Islands.

More detailed fetch measurements are then made for each exposure unit. The measurements made for Exposure Unit 7/7 are schematically shown in Figure 12 and summarized in Table 8.

**TABLE 8:** Shore-zone data entry fields - wave exposure information

**WAVE EXPOSURE INFORMATION**

**Exposure Unit I.D.:** 7/7 **Associated Shore Units:** 7/7/1 TO 7/7/4

**Waves —** Maximum Fetch Direction (°): 110°

Maximum Fetch Distance (km): 219 KM

Shore Normal (°): 192°

Fetch Distances (km): 5 (left 45°) 4.5 (90°) 1.4 (left 45°)

Effective Fetch (km): 3.8 Exposure Category: SE

**Tides —** Range (large): 5.4 Range (mean): 4.7

**TABLE 9:** Shore-zone data entry fields - shore unit information

**WAVE EXPOSURE INFORMATION**

**Exposure Unit I.D.:** 7/7 **Associated Shore Units:** 7/7/1 TO 7/7/4

**Waves —** Maximum Fetch Direction (°): 110°

Maximum Fetch Distance (km): 219 KM

Shore Normal (°): 192°

Fetch Distances (km): 5 (left 45°) 4.5 (90°) 1.4 (left 45°)

Effective Fetch (km): 3.8 Exposure Category: SE

**Tides —** Range (large): 5.4 Range (mean): 4.7

**FIGURE 11:** Wave Exposure Units of East Copper and Jeffrey Islands.

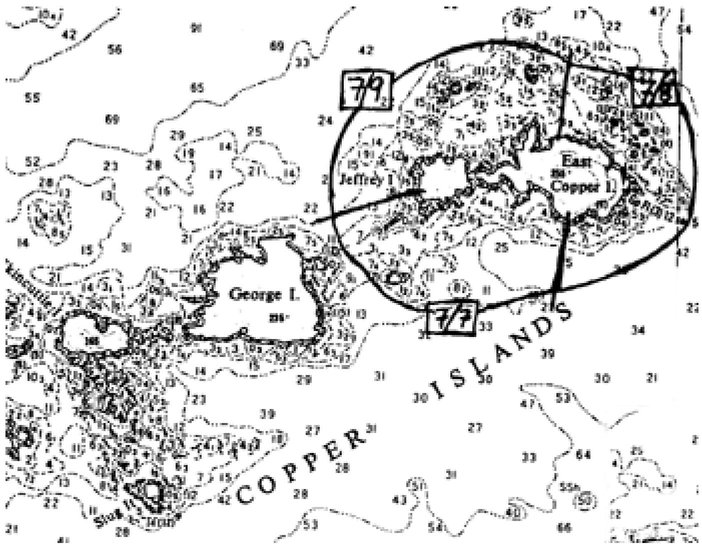



**FIGURE 12:** Wave fetch measurements for Exposure Unit 7/7 showing direction of Maximum Wave Fetch (110 degrees at 219km) and the Shore Normal (192 degrees) with associated fetch measurements. Refer to Appendix Cfor details on measurement procedures.

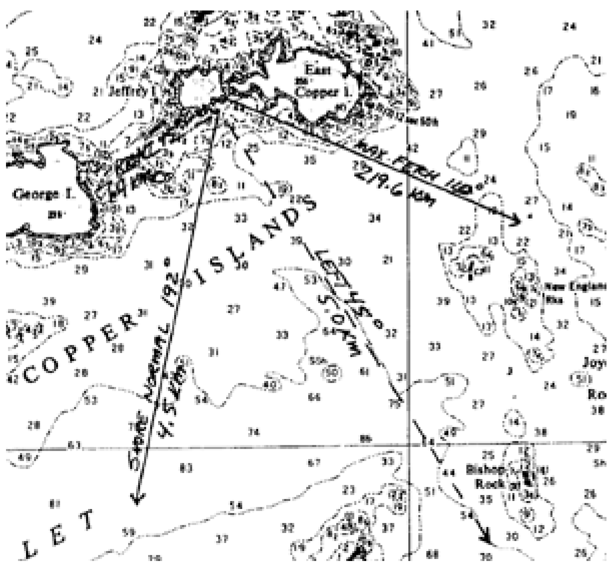
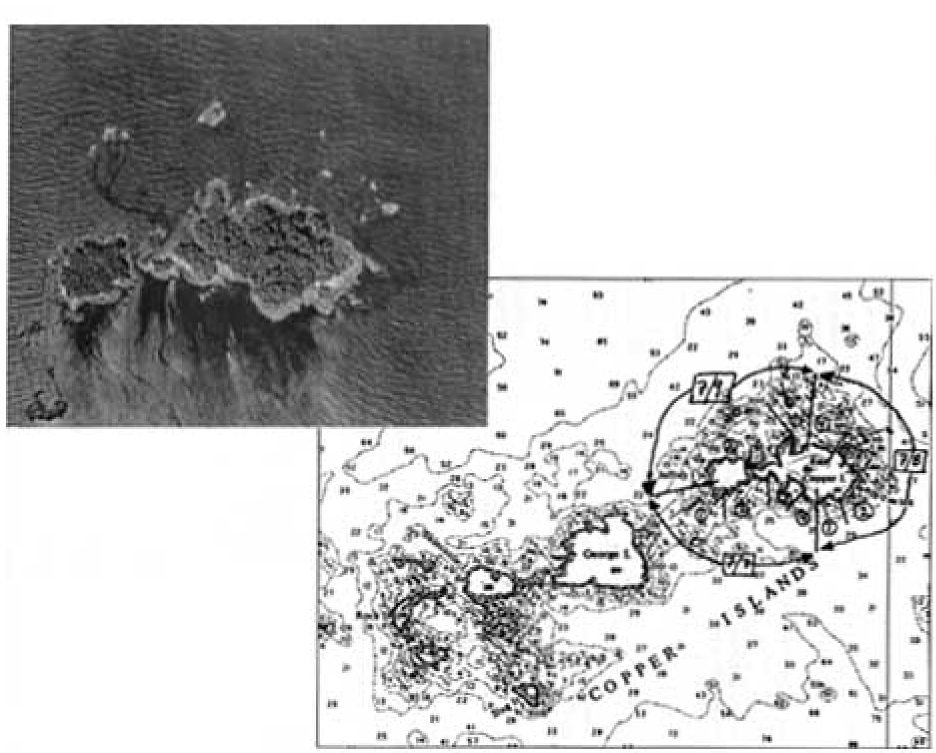


**FIGURE 13:** Vertical aerial photo of the Copper Islands and the working copy of associated Shore Units (indicated by circled numbers) on East Copper Island. Note that Shore Units are nested within Exposure Units. Variants, which are point features within the Shore Units, are indicated by "v1" (indicating Variant 1).




## 5.3 Across-shore Component Information

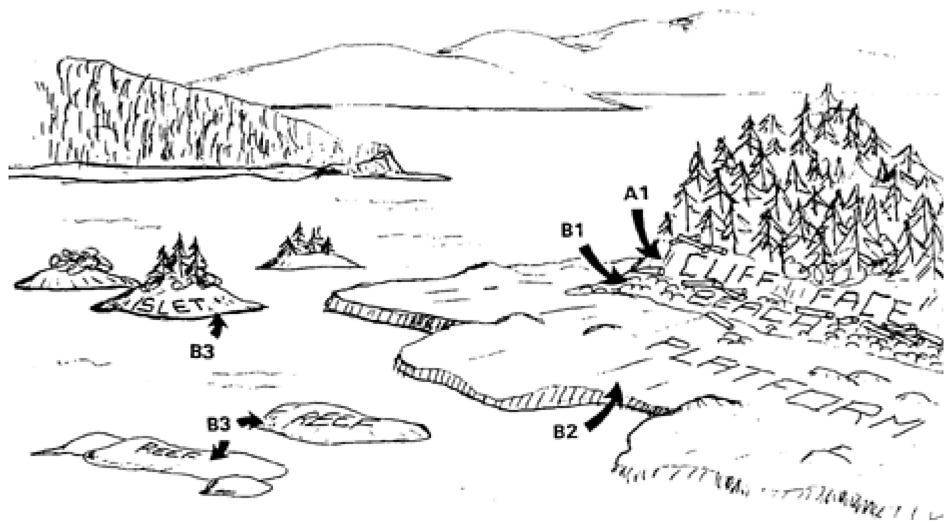
Each Shore Unit has associated across-shore components that provide a detailed characterization of morphology within the unit in an onshore to offshore progression. The Across-shore Component data are summarized in Table 10 and schematically represented in a sketch (Fig. 14).

**TABLE 10:** Shore-zone data entry fields - shore component information

**SHORE COMPONENT INFORMATION**

| Component I.D. | Zone | Component Number | Form* 1 | Form* 2 | Form* 3 | Material* 1 | Material* 2 | Material* 3 | Width (m) |
|---|---|---|---|---|---|---|---|---|---|
| 7/7/1 | A | 1 | Cli | | | Ac/Rs | | | |
| | B | 1 | Bi | | | Ac/Ce | Rs | | 10 |
| | B | 2 | Phi | | | Rs | | | 70 |
| | B | 3 | Oc | Fi | | Rs | | | ~ |

**FIGURE 14:** Sketch of Shore Unit 7/7/01 illustrating across-shore components of the Shore Unit. See Table 10 for detailed coding of across-shore components.




The first Zone characterized is the supra-tidal zone (indicated by A). There is only one component (A1), a low ("l" indicates less than 5m high), inclined ("i" indicates a slope of 20-35o cliff (C); the cliff includes anthropogenic or cut logs (At) over rock, sedimentary (Rs).

The next component (B1), located in the upper intertidal zone, is a beach, inclined (Bi) comprised of logs (At) over clastic cobbles (Cc) over rock, sedimentary (Rs); this beach is approximately 10m in width.

The second component (B2) lies seaward of the beach and consists of rock platform (P) which is a high-tide platform ("h") and has an irregular ("i") surface; it is comprised of sedimentary bedrock and is estimated at 70m in width.

The third component (B3) lies seaward of the platform and consists of two types of morphologies: offshore islet chains (Oc) and detached reefs with an irregular surface (Fi). Both the reefs and islets are comprised of sedimentary bedrock.

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## A.1 Project Data

**TABLE A.1:** Project data fields

| PROJECT INFORMATION | | | |
|---|---|---|---|
| Project Name: | | | |
| Project Agency: | | Date of Mapping: | |
| Name of Mapper: | | Scale of Mapping: | |
| Editor: | | | |

Table A.1 indicates the fields included within the Shore-zone database.

**Project Name** - Enter project name. As a general rule, use a geographic name that provides a general reference to where the study is located (e.g. Salt Spring Island or Southern Strait of Georgia).

**Project Agency** - Enter the name of the agency for whom the mapping is being conducted.

**Date of Mapping** - Enter the date of mapping (Year/Month/Day).

**Name of Mapper** - Enter the name of the person undertaking the mapping.

**Scale of Mapping** - Enter the scale of the maps that the shoreline unit boundaries are being defined (e.g., 1:20,000, 1:50,000, 1:250,000).

**Editor** - Enter the name of the person responsible for editing the maps prior to release.

## A.2 Exposure Data

Fields Table A.2 indicates the information typically contained in the Exposure database.

**TABLE A.2:** Exposure data fields

| WAVE EXPOSURE INFORMATION | | | | | |
|---|---|---|---|---|---|
| **Exposure Unit I.D.** | | **Associated Shore Units:** | | | |
| **Waves—** | Maximum Fetch Direction (°): | | | | |
| | Maximum Fetch Distance (km): | | | | |
| | Shore Normal (°): | | | | |
| | Fetch Distances (km): | | | | |
| | | (left 45°) | (90°) | (left 45°) | |
| | Effective Fetch (km): | | Exposure Category: | | |
| **Tides—** | Range (large): | | Range (mean): | | |

**Waves** - wave action is the primary process controlling morphology and biota in the shore zone and the following indirect measurements are used to characterize the wave energy and wave exposure of the unit. Appendix C contains a complete explanation and "how to" of the wave exposure measurements.

**Maximum Fetch Direction** - the azimuth (in degrees from true north) of the direction of the maximum fetch.

**Maximum Fetch Distance** - the distance in kilometres of the maximum fetch as measured along the Maximum Fetch Direction.

**Shore Normal Direction** - the azimuth (in degrees from true north) of the normal to the general orientation of the shore unit. That is, if the general trend of the shoreline is from northwest to southeast with open water to the east), then the Shore Normal Direction would be about 45°.

**Fetch Distances** - the distances in kilometres as measured along a line 45° to the left of the Shore Normal, along the Shore Normal and along a line 45° to the right of the Shore Normal. Modified Effective Fetch - the distance in kilometres as computed from the Fetch Distance Measurements.

**The Modified Effective Fetch** represents a simplification of standard engineering procedures for estimating effective fetch (see CERC 1977; Harper et al 1991).

**Exposure Category** - the exposure category provides a summary indicator of wave exposure for the unit (see Table C.1, Appendix C). The following classes of wave exposure have been utilized and are derived from knowledge of Maximum Fetch and Modified Effective Fetch:

**CodeTerm Definition**

VP very protected very protected wave exposure with modified
effective fetch less than 1 km.
P protected protected wave exposure, as per Table C.1.
SP semi-protected semi-protected wave exposure as per Table C.1.
SE semi-exposed semi-exposed wave exposure as per Table C.1.
E exposed exposed wave exposure as per Table C.1.

**Tides** - tides are important in controlling intertidal morphology by distributing wave energy across the intertidal zone. The tides are also of critical importance in determining across-shore biological zonation.

**Range (large / mean)** - enter the numerical value in metres for large tides and mean tides as taken from the nearest reference station to the shore unit from the Canadian Tide and Current Tables, published by the Canadian Hydrographic Service (see CHS 1993)

## A.3 Shore Unit Data

**Table A.3:** Unit data fields from the data entry form

| **SHORE UNIT INFORMATION** | | | | | | |
|---|---|---|---|---|---|---|
| **Unit I.D.—** | Region: | | **Unit Type:** | | | |
| | Area: | | **Shoreline Type:** | | | |
| | Unit: | | **Note No.:** | | | |
| | Sub Unit: | | | | | |
| **Associated Exposure Unit:** | | | | | | |
| **Unit Location—** | Start (lat, long): | | End (lat, long): | | | |
| **Unit Length:** | | | Intertidal Width: | | | |
| **Sediment Transport—** | Source: | | Abundance: | | Direction: | |

| | | | | |
|---|---|---|---|---|
| **Shoreline Change—** | Type (A/S/E): | | Rate (m/yr): | |
| **Data Sources—** | Air Photo No.: | | Ground Truthing: | |
| | NTS Map Sheet No.: | | Chart No.: | |
| | Videotape No: | | Tape Time: | |

**Unit I.D**. - A hierarchy of Coastal Regions and Coastal Areas has been defined to assist in recording mapping data (Appendix D). The appropriate Coastal Region and Coastal Area should be entered. Units should be numbered sequentially starting at "1", unless there has been previous mapping within the area, in which case, unit number should follow the highest number of the previous mapping program. The main unit has the subunit code of "00" whereas variants or other subunits are numbered sequentially from "1".

**Unit Type** - an indication of the map portrayal format of the unit, either as a polygon, a line segment or a point.

**CodeTermDefinition**
A Area coastal units represented as a polygon on the map (see Fig. 5&6 for examples).
L Line coastal units which are mapped as line segments on the map due to the difficulty of portraying narrow across-shore widths (see Fig. 6).
P Point coastal units or variants within a unit which are too small to portray on a map due to short alongshore lengths and narrow across-shore widths of the feature (see Fig. 7).

**Shoreline Type** - a summary geomorphic descriptor of the unit that describes a repetitive collection of across-shore components (e.g., rock platform with gravel beach; cliff with sand beach; mudflat). Shoreline type is entered as a number based on Table 6 (see Section 4 for discussion of the Shoreline Type).

**Note No.** - relevant notes should be indexed by a number and included in either a memo field of the database or linked database.

**Unit Location** - enter the start and end locations of the unit at the high water line as latitude and longitude. Latitude and longitude are expressed in degrees, minutes and decimal minutes with appropriate hemisphere indicator (N,S,E,W) included (e.g., N48o 37.25', W123o 46.9).

**Unit Length (km)** - the alongshore length of the unit in kilometres as measured along the high-water line at the original scale of mapping.

**Unit Width (m)** - the estimated distance in metres between the storm high water line (usually taken as the storm log line) and the low water line. This is an interpreted estimate made by the mapper from the aerial video imagery. In the case where there is a significant range of width within the unit, a range may be specified (e.g., 20-50m). The Unit Width should agree with the sum of the component widths (see page 41).

**Sediment Transport** - sediment transport represents a dynamic component of the Shore Unit information. The three Sediment Transport descriptors are provided by the mapper based on geomorphological indicators and/or published information from the general area.

**Source** - the probable internal or external sources of unconsolidated material in the shore unit.

**Code Term Definition**

A alongshore material derived from adjacent units and transported by alongshore drift in to the shore unit.
B backshore- material derived from onshore sources derived by processes such as mass-wasting and slope wash but excluding fluvial sources.
F fluvial material contributed from onshore fluvial processes.
O offshore material derived from offshore sources by processes such as waves or currents.

**Abundance** - a qualitative index of sediment abundance within the shore unit.

**Code Term Definition**
A abundant abundant amount of mobile sediment within the shore unit (e.g., a beach with a well-developed berm and dune system).
M moderate moderate amount of mobile sediment within the unit (e.g., a small inclined beach at the base of a rock cliff).
S sparse sparse amount of mobile sediment within the shore unit (e.g., a thin sediment veneer over a rock platform).

**Direction** - dominant alongshore direction of sediment transport expressed as one of eight Cardinal compass points (i.e., N, NE, E, SE, S, SW, W, NW) and indicating direction towards which sediment is transported.

**Shoreline Change** - an interpretive index of the shoreline stability based on an interpretation of geomorphology within the unit.

**Type** - type of shoreline change

**Code Term Definition**
A accretional shore unit shows a net accumulation of sediment over time.
E erosional shore unit shows net loss of sediment over time,

usually manifested as an erosional scarp or cliff.
S stable no net accretion or retreat of the shoreline within the unit.

**Rate** - rate of change in metres per year. Rates usually must be determined from historical air photo analysis or from long-term beach surveys. As such, published information is usually required to complete this entry.

**Data Sources** - data sources provide the user with an indirect indication of the confidence of interpretation in that the type and date of information used by mapper is clearly identified.

**Air Photo Number** - a unique identifier of the air photo used in the shore unit mapping; enter the Flightline and Frame number of the airphoto.

**Ground Truthing** - a code indicating the intensity of ground surveys conducted within the shore unit.

**CodeTermDefinition**

- 0 - no field checkingno field reconnaissance hasbeen conducted at the time of the mapping.
- 1 - reconnaissance survey of the unit by boat.
  boat survey
- 2 - reconnaissance survey of some parts of the unit by foot.
  foot survey
- 3 - intensive foot entire unit surveyed by foot at low tide
  survey
- 4 - intensive beach profiles, transects and/or sediment
  surveys samples collected.

**NTS Map Sheet** - enter the number of the National Topographic Map Sheet (NTS).

**Chart No.** - enter the number(s) of any CHS chart used for mapping the unit.

**Videotape Number** - enter the unique identifier of the aerial videotape used in the mapping.

**Tape Time** - enter the tape time, taken directly from the video image, for the start of the shore unit. Entry of the time greatly simplifies the relocation of shore unit for updating or other mapping (e.g., shore access).

## A.4 Component Data

Codes and definitions used in the component fields refer only to those features which are mapped as components, not to project or unit information. A component is a geomorphic feature that has alongshore length and across-shore width; length is usually much greater than width and components may be visualized as line segments with length but no width.

Data Fields included in the Component Level of the Shore-Zone Database are indicated in Table A.4.

**TABLE A.4:** Across-shore component data information

| SHORE COMPONENT INFORMATION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Component** | **Zone** | **Component** | **Form*** | | | **Material*** | | | **Width (m)** | |
| | **I.D.** | | **Number** | **1** | **2** | **3** | **1** | **2** | **3** | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| **Distribution Code of each Primary/Secondary/Tertiary* (See Appendix A for entry codes) | | | | | | | | | | | |

**Zone** — a qualitative indicator of the relative elevation of the component with respect to the intertidal zone.

| **Code** | **Term** | **Definition** |
|---|---|---|
| A | backshore or supratidal | the zone that extends landward from thehigher high water line(large tides); thelandward limit is variable and may be (a) the top of a coastal cliff or (b) the landward limit of marine process (i.e., storm surge limit). |
| B | intertidal | the zone between the higher high water line (large tides) and the lower low water line(large tides). |
| C | shallow sub- | the zone that extends tidal from the lower low-water line (large tides) seaward to the -10m isobath. |
| D | deep sub- tidal | the zone that lies between the -10m and -20m isobaths. |

Tide Notes:

1. Higher high and lower low water for large tides represent heights for the nearest Reference or Secondary Port to the study area as listed in Canadian Tide & Current Tables. The published values are derived from a complex formula involving tidal constituents and are not, therefore, directly related to any simple statistic. Normally, though, they can be expected to fall within 30

cm of the long term arithmetic mean of highest and lowest monthly tides. Nor can the line defined by height or on the ground by any consistent physical and/or biological criteria. (Pers. comm. F. Stephenson, Canadian Hydrographic Service, Sept. 1983.)

2. The definition of tidal zones, therefore will usually be quite subjective: the criteria used will vary from area to area and their application will vary from mapper to mapper. Commonly the boundary locations will be relative to the published water level at the time of videotaping/aerial photography or of field checking.

**Component Number** — within each zone, each across-shore component is identified by an integer number, sequenced from landward to seaward (e.g., A1, A2, A3, B1, B2, C1, C2).

### A.4.1 Forms

**Form** — descriptors of the morphological character (form) or surface expression within a component is described by 12 primary form descriptors. Additional information on each of theses primary form types can be presented through the use of secondary form modifiers.

| **Primary Form Descriptors** | |
|---|---|
| **Code** | **Term** |
| A | Anthropogenic |
| B | Beach |
| C | Cliff |
| D | Delta |
| E | Dune |
| F | Reef |
| L | Lagoon |
| M | Marsh |
| O | Offshore Island |
| P | Platform |
| R | River Channel |
| T | Tidal Flat |

| **Code** | **Term** | **Definition** |
|---|---|---|
| A | Anthro-pogenic | man-made or man- modified features (see Fig. B.18); includes those constructed by man for purposes of moorage (e.g., docks, marinas) or for protected anchorage (e.g., breakwater) or commercial activities, and features in which material is deposited for backshore protection (e.g., seawalls) or shore land extension (e.g., fill) or excavated, commonly by dredging (e.g., gravel extraction sites). |
| B | Beach | an accumulation of unconsolidated material formed by |

waves and wave-induced currents in the zone that extends landward from the lower low water line to a place where there is a marked change in material or physiographic form usually the effective limit of storm waves. The character of materials and forms associated with beaches is variable (see Fig. B.8-B.12). Beach materials may consist of any combination of sand, gravel and angular fragments. Common beach forms include beach faces, low-tide-terraces, bars and troughs.

C Cliff — a sloping face that is steeper than 20° usually formed by erosional processes and composed of either bedrock or unconsolidated materials or both (see Fig. A.1, B.2, B.3, B.10). Also includes material deposited at the base of cliffs as talus or fans by mass movement processes (e.g., rockfall, mud flows, slumping).

D Delta — an accumulation of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea (Fig. A.2). Deltaic forms are initiated as submerged features and are dependant in their development on the interaction of fluvial and marine processes.

In overall plan, deltas, range from arcuate- form (fan-shaped) to lobate-form (bird-foot shaped). Their surfaces are less than 20° and crossed by either single or multiple channels. Landforms typically associated with deltas include tide channel(s), bar(s), and levee(s).

**FIGURE A.1:** Oblique aerial photo of the eroding cliffs at Cape Lazo near Comox (Denman Island in background).The cliffs are cut into unconsolidated marine sediments and include a discontinuous talus apron. The beach is gravel, primarily pebble/cobble and a wide beach terrace with a boulder/cobble armour lies seaward of the beach.

**FIGURE A.2:** An oblique aerial photo of the delta complex near the mouth of Oyster River. The large, shore-parallel swash ridge has formed due to wave action at the delta front. Several shore-perpendicular gravel bars are probably relict natural levees from the river. The main channel evident in the photo is dredged to the Oyster River marina.

| | | |
|---|---|---|
| E | Dune | a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt; see Fig. B.12); common dune forms include crescentic, transverse, longitudinal, parabolic attached and irregular. |
| F | Reef | a rock outcrop, detached from the shore, with maximum elevations below the high-water line (outcrops with areas above the higher-high water line are classified as "Offshore Islands"). |
| L | Lagoon | usually a shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier or barriers such as a spit (Fig. A.3). The barrier provides protection from wave action although overwash may occur during storms.<br><br>Lagoons may be open, that is connected to the open sea by an inlet or closed (no surface connection to the sea). Sediments in lagoons are commonly fine textured, usually mud or muddy sand except near inlets where sand tends to dominate. |
| M | Marsh | a coastal wetland area which is periodically inundated by tidal brackish or salt water and which supports significant (15% cover) non-woody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year (Fig. B.16, B.17). Marshes are characterized by a surface accumulation of organic matter deposited in water but the substratum normally is dominated by mineral material. Tidal channels |

and/or ponds may be present.

| | | |
|---|---|---|
| O | Offshore Islands | a piece of land made up of either rock or unconsolidated material or both, that projects above and is completely surrounded by water at higher high water for large (spring) tide. Islands vary in shape from narrow, steep-sided pillar forms (sea stacks) to smooth, elongate hillocks. |
| P | Platform | a relatively level or inclined surface with a slope of 20o or less formed by erosional processes (see Fig. 5, B.6). Platforms are usually composed of bedrock but may be made up of unconsolidated materials. Their surface topography is variable; they may be smooth, irregular, or step-like, and pitted with tidepools. |
| R | River Channel | a natural passageway of perceptible extent which continuously or periodically contains a stream. |
| T | Tidal Flat | a level or gently sloping (less than 5°) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without organic detritus, and resulting from tidal processes (see Fig. B.14, B.15). |

**Figure A.3:** A vertical aerial photo of the Esquimalt Lagoon area of Victoria. The lagoon is enclosed by a long barrier spit (a) that has prograded from the south. A flood-tidal delta (b), formed due to flood currents in the tidal channel is inside the lagoon, and an ebb-tidal delta flat (c) is present on the seaward side of the tidal channel to the lagoon.

**Secondary Form Modifiers**

Additional information can be provided for these primary forms. The following is a list of the additional codes and terms that can be used with each of these primary forms.

**Anthropogenic (A) Secondary Form Descriptors**

| **Code** | **Term** |
|---|---|
| a | dolphin |
| b | breakwater |
| c | log dump |
| f | float bulkhead, revetment |
| h | shell midden |
| j | jetty |
| k | dyke |
| m | marina |
| n | ferry terminal |
| p | port facility |
| s | seawall |
| w | wharf |
| x | outfall or intake |

| **Code** | **Term** | **Definition** |
|---|---|---|
| a | dolphin | a piling or group of pilings usually used for mooring log booms, barges or ships. |
| b | breakwater | a structure extending into the sea for any of the following uses: (1) to direct and channelize stream or tidal flows; (2) to prevent channel shoaling by longshore drift; (3) to trap littoral drift or retard shore erosion and; (4) to provide protection for a harbour, anchorage or basin. |
| c | log dump | log handling structure(s) and/or terrain modified for the purposes of log handling or storage; includes log dumps and haulout areas. |
| f | float | a float platform, often associated with a wharf; several |

| | | |
|---|---|---|
| | | linked floats that are primarily used for berthage are classified as "Marinas". |
| h | shell midden | accumulations of waste shells and shell fragments; includes refuse heaps and shell middens. |
| j | jetty | a structure used to provide protection from wave exposure for a port or harbour (see Fig. B.18). |
| k | dyke | a wall or mound built around a low-lying area to prevent flooding by the sea; the surfaces of some dykes may be used as a road. |
| m | marina | a series of floats, usually in a protected location that provides secure moorings for boats, as well as offering supplies, repairs and other facilities (see Fig. B.18) |
| n | ferry terminal | a landing facility for ferries, usually consisting of a complex of bulkheads, dolphins and ramps. |
| p | port facility | a terminal and related structures extending from the backshore to subtidal waters for loading/unloading cargo and/or passengers from large ships; includes docks, storage yards, parking lots; includes ferry terminals. |
| s | seawall, bulkhead, revetment | a wall, embankment, or facing of stone, bulkheads, concrete etc. bulkheads, constructed parallel to the shoreline to protect revetments, scarps or shore structures against erosion by wave action or currents or to prevent sliding of land. |
| w | wharf | a structure used for the mooring or tying of vessels while loading or discharging cargo and/or passengers; includes wharves, quays, and piers. |
| x | outfall | structures in which water and effluent is discharged into the sea. |
| y | intake | structures in which water is captured from the sea. |

**Beach (B) Secondary Form Descriptors**

| **Code** | **Term** |
|---|---|
| b | berm |
| n | relic ridges |
| c | washover channel |
| r | single ridge/bar |

| | |
|---|---|
| f | face |
| s | storm ridge |
| i | inclined |
| t | low tide terrace |
| m | multiple bars and troughs |
| w | washover fan |
| v | veneer |

| **Code** | **Term** | **Definition** |
|---|---|---|
| b | berm | a horizontal or landward sloping bench of a beach, formed of material deposited by receding storm waves; some beaches have no berms, others have one or several (see Fig. 9; B.9). |
| c | washover channel | a channel formed by storm waves through the berm or dunes. |
| f | face | the sloping section of a beach, below the beach berm, normally exposed to the action of wave uprush (see Fig. 9, B.9). |
| i | inclined | a thin deposit of material with a seaward sloping face (use this term instead of "face" when no berm is present or beach is poorly organized). |
| m | multiple bars and troughs | elongate embankments or ridges that usually trends parallel to the shoreline in the intertidal and/or subtidal zones. Ridges are separated by troughs characterized by gently to moderately sloping sides. |
| n | relic ridges | multiple beach ridges in the backshore marking the former location of active foredune ridges. |
| r | single ridge/bar | an elongate embankment or ridge that usually trends parallel to the shoreline in the intertidal and/or subtidal zones (see Fig. B.11). |
| s | storm ridge | a backshore ridge formed by storm waves.or floating ice pressure. |
| t | low tide terrace | a horizontal to gently sloping surface, less than 3° slope, that extends from the lower low water line for spring tides to the break in slope marked by the beach face. |
| w | washover | a fan-shaped accumulation of sediment that can be likened |

| | | |
|---|---|---|
| | fan | to a segment of a low-angled cone deposited on the landward side of an overwash channel by storm waves |
| v | veneer | a very thin ( a few clasts thick) layer of unconsolidated sediment usually in the upper part of the intertidal zone with a slight seaward slope; thinner and less organized than an inclined beach. |

**Cliff (C) Secondary Form Descriptors**

| Code | Term |
|---|---|
| a | eroding |
| p | passive (inactive) |
| c | cave |
| f | fan, apron |
| t | terraced |
| | **Slope** |
| i | inclined (20-35°) |
| s | steep (>35°) |
| | **Height** |
| l | low (<5m) |
| m | moderate (5-10m) |
| h | high (>10m) |

| Code | Term | Definition |
|---|---|---|
| a | eroding | a cliff showing evidence of active erosion such as slumping, lack of vegetation, talus cones at base, etc. |
| p | passive (inactive) | a cliff which shows no signs of active erosion or mass-wasting such as indicated by a vegetated cliff face. |
| c | cave | a cleft or cavity in a cliff formed by the action of waves or weathering; caves may occur at present sea level or at higher elevations in the cliff |

| | | |
|---|---|---|
| f | fan, apron | an accumulation of unconsolidated materials (sand, gravel, rubble, blocks) along the base of the cliff that is fan-shaped surface or has an unidirectional (planar) surface; the sediments are formed by mass movement processes operating on the cliff face above. |
| t | terraced | an inclined or steep cliff that is characterized by alternating horizontal or gently sloping surfaces and scarps. |
| | **Slope** | |
| i | inclined (20-35°) | a cliff with a slope between 20° and 35°. |
| s | steep (35°) | a cliff with a slope greater than 35°. |
| | **Height** | |
| l | low (<5m) | a cliff with a vertical rise of less than 5 metres. |
| m | moderate (5-10m) | a cliff with a vertical rise between 5 and 10 metres. |
| h | high (>10m) | a cliff with a vertical rise greater than 10 metres. |

**Delta (D) Secondary Form Descriptors**

| Code | Term |
|---|---|
| b | bars |
| m | multiple channels |
| f | fan (5-20°) |
| s | single channel |
| l | levee |

| Code | Term | Definition |
|---|---|---|
| b | bars | an elongate embankment or ridge that usually trends parallel to the shoreline in the intertidal and/or subtidal zones (see Fig. A.2). |

| | | |
|---|---|---|
| f | fan (5-20°) | the steeper portion of the delta as it emerges onto the shore zone. |
| l | levee | ridges parallel to channels and formed by deposition of river materials as overbank deposits (see Fig. A.2). |
| m | multiple channels | more than one channel on the delta; typical of braided deltas. |
| s | single channel | a single channel on the delta (see Fig. A.2). |

**Dune (E) Secondary Form Descriptors**

| Code | Term |
|---|---|
| b | blowouts |
| p | parabolic/ cresentric |
| i | irregular |
| n | relic |
| v | veneer |
| o | ponds |
| w | vegetated |
| r | ridge/ swale |

| Code | Term | Definition |
|---|---|---|
| b | blowouts | a saucer- or trough-shaped depression formed by wind erosion on a pre-existing dune (see Fig. A.4). |
| i | irregular | a dune with multi-directional slopes that in plan has a chaotic form. |
| n | relic | a dune which is no longer actively aggrading or degrading; usually indicated by heavy vegetation (see Fig. A.4). |
| o | ponds | a natural body of permanent standing fresh water usually less than 2 hectares in surface area (see Fig A.4). |
| r | ridge/ swale | an asymmetrical sand dune elongated perpendicular to the direction of the prevailing winds or a long, narrow sand |

| | | |
|---|---|---|
| | | dune, usually symmetrical in cross profile, orientated parallel with the direction of the prevailing wind (longitudinal dune; see Fig. A.4). |
| p | parabolic/ crescentic | a crescent-shaped dune lying transverse to the direction of the prevailing wind with the horns of the crescent pointing downwind (syn. with barchan) or a dune with long, scooped-shaped form, convex in the downwind direction so that its horns point upwind. |
| v | veneer | thin veneer of eolian-deposited sand less than 1-m thick. |
| w | vegetated | a dune feature covered by vegetation. |

**Reef (F) Secondary Form Descriptors**

| Code | Term |
|---|---|
| f | horizontal |
| i | irregular |
| r | ramp |
| s | smooth |

| Code | Term | Definition |
|---|---|---|
| f | horizonal | a horizontal or gently sloping surface less than 5°. |
| i | irregular | a horizontal or ramped platform that is characterized by undulating or hummocky surface topography; local relief is greater than 1 metre. |
| r | ramp | an inclined surface with a slope between 5° and 20°. |
| s | smooth | a horizontal or ramped platform that is characterized by an even surface topography; local relief is less than 1 metre. |

**Lagoon (L) Secondary Form Descriptors**

| Code | Term |
|---|---|
| o | open |

| | |
|---|---|
| c | closed |

| Code | Term | Definition |
|---|---|---|
| o | open | a lagoon connected to the open sea by an inlet (see Fig A.3). |
| c | closed | a lagoon in which there is no visible connection to the open sea (see Fig A.4). |

**Marsh (M) Secondary Form Descriptors**

| Code | Term |
|---|---|
| h | high |
| e | levee |
| l | low |
| o | pond |
| c | tidal creek |

| Code | Term | Definition |
|---|---|---|
| | Elevation | |
| h | high | a marsh covered by most high tides; some soil development and organic buildup is obvious; exhibit a high diversity of plant species dominated by grasses and shrubs. |
| l | low | a marsh covered by all moderate and high tides; characterized by little soil development, low species diversity, hydrophillic and often halophytic pioneer species (sedges, glasswort, sea-milkwort), and discontinuous cover. |
| c | tidal creek | a creek with a definite bed and banks that is formed and maintained by fluvial processes (Fig. B.16). |
| e | levee | a slightly elevated area usually elongate and parallel to a creek bank. |
| o | pond | a natural body of permanent standing fresh water usually less than 2 hectares in surface area. |

**FIGURE A.4:** A vertical aerial photo of the Rose Spit area of Graham Island, Queen Charlotte Islands shows two stages of relict, east-west trending dune ridges (a,b) along the north-facing coast, blow-out dunes (c) along the east- facing coast, and an enclosed lagoon (d).

**Offshore Island (O) Secondary Form Descriptors**

| Code | Term |
|---|---|
| b | barrier |
| c | chain of islets |
| t | table shaped |
| p | pillar/ stack |
| w | whaleback |
| | **Elevation** |
| l | low (<5m) |
| m | moderate (5-10m) |
| h | high (>10m) |

| Code | Term | Definition |
|---|---|---|
| b | barrier | an island made up of unconsolidated materials that usually trends parallel to the shore and "protects" other features, such as lagoons and marshes, from direct wave attack of the open ocean. |
| c | chain of islets | a chain of offshore islands, often linear in distribution and sub-parallel to shore. |
| t | table-shaped | an island with a horizontal or irregular surface bounded by a cliff, in cross-sectional profile the shape of a table. |
| p | pillar/ stack | an isolated, pinnacle- shaped island that is characterized by steep to vertical sides; also referred to as sea stacks, chimney rocks. |
| w | whaleback | a smooth, elongate island having the shape of a whale's back. |
| | **Elevation** | |
| l | low (<5m) | indicates that the surface elevation of the island is less than 5m above the higher high water line for large spring tide. |
| m | moderate (5-10m) | indicates that the surface elevation of the island is between 5 to 10m above the higher high water line for large spring tide. |
| h | high (>10m) | indicates that the surface elevation of the island is greater than 10m above higher high water line for large spring tide. |

**Platform (P) Secondary Form Descriptors**

| Code | Term |
|---|---|
| f | horizontal |
| r | ramp |
| h | high tide platform |
| t | terraced |
| i | irregular |
| s | smooth |
| l | low tide pool |
| p | tidepool |

| Code | Term | Definition |
|---|---|---|
| f | horizontal | a horizontal or gently sloping surface less than 5° (see Fig. B.6). |
| h | high tide platform | a platform extending from mean water line to the higher high water line for large (spring) tide. |
| i | irregular | a flat or ramped platform that is characterized by undulating or hummocky surface topography; local is greater than 1m. |
| l | low tide platform | a platform extending from mean waterline to the lower low water line for large (spring) tide. |
| r | ramp | an inclined surface with a slope between 5° and 20°. |
| t | terraced | stepped or bench-like topography; a flat or ramped platform that is characterized by alternating horizontal or gently sloping surfaces and scarps. |
| s | smooth | a horizontal or ramped platform that is characterized by an even surface topography; local is less than 1m. |
| p | tidepool | a closed, more or less circular depression filled with sea water when the sea is standing at the lower low water line for large (spring) tide. |

**River (R) Secondary Form Descriptors**

| Code | Term |
|---|---|
| a | perennial |
| m | multiple channels |
| t | intermittent |
| a | single channel |

| Code | Term | Definition |
|---|---|---|
| a | perennial | a stream that flows continuously throughout the year. |
| t | intermittent | a stream that only flows at certain times of the year. |
| m | multiple channels | the channel zone is characterized by many diverging and converging channels separated by bars; vegetation is either absent or limited on bars; many channels are dry at low flow. |
| s | single channel | the channel zone characterized by a single channel. |

**Tidal Flats (T) Secondary Form Descriptors**

| Code | Term |
|---|---|
| b | bar, ridge |
| c | tidal channel |
| e | ebb tidal delta |
| f | flood tidal delta |
| l | levee |
| s | multiple tidal channels |
| t | flats |
| p | tidepool |

| Code | Term | Definition |
|---|---|---|
| b | bar, ridge | an elongate embankment that usually trends parallel to the shoreline (see Fig. B.13). |
| c | tidal channel | a channel that dissects the tidal flat surface that is formed and maintained by tidal currents (see Fig. B.15). |
| e | ebb-tidal delta | an delta created by ebb-tidal currents, usually associated with an inlet to a lagoon or harbour (see Fig A.3). |
| f | flood-tidal delta | an delta created by flood-tidal currents, usually associated with an inlet to a lagoon or harbour (see Fig A.3). |
| l | levee | a bank of unconsolidated sediment formed adjacent to a tidal channel that is elevated above the general level of the tidal flat surface. |
| s | multiple tidal channels | tidal flat surface dissected by several channels that are formed and maintained by tidal currents. |
| t | flats | a unidirectional, horizontal or gently sloping surface less than 5°. |
| p | tidepool | a closed, more or less circular depression filled with sea water when the sea is standing at the lower low water line for large (spring) tide. |

### Application Of Form Terms

The form of a component is described using a primary form descriptor (e.g., A,B,R) with or without secondary form modifiers (e.g., Ap, Bfxbu, Rs). Up to 3 secondary form modifiers may be used with each primary form descriptor. Their order has no significance.

A maximum of 3 primary form descriptors may be used to characterize the surface morphology of a component. They may be the same primary descriptor or a mix of descriptors. They are written in order of decreasing importance and separated by colons (e.g., Bt:Plfi:Plfs).

The use of only one primary form descriptor indicates that it comprises 75% of the surface area of the component; if two primary descriptors are used, the first covers 50-75% and the second 25-50% of the component; when three primary form descriptors are used, each covers 25% or more of the component being described. For example:

- Bft — Beach comprises 75% of the component form

- Bt;Br — 50 -75% of the component form consists of a beach low tide terrace and 25- 50% is a beach ridge (bar).
- Bt;Br;Bf — The component form consists of a beach low tide terrace, ridge and face each of which covers at least 25% of the component form; there is however, more low tide beach terrace than beach ridge and more beach ridge than beach face in the component.

Where stratigraphic information is available, additional primary form descriptors and secondary modifiers may be used. Up to 3 stratigraphic layers may be described. One form overlying another is indicated by a slash line. For example:

- Bv/Phindicates that a thin veneer of beach sediment overlies a horizontal platform.
- Bv/Ph;Phindicates that a thin veneer of beach sediment overlies a horizontal platform for 50-75% of the component form and 25 -50% of the component form is made up of a horizontal platform.
- Bv/B/P;Phindicates that a thin veneer of beach sediment overlies different beach sediments that in turn rest on a horizontal platform for 50-75% of the component form and 25 -50% of the component form is made up of a horizontal platform.

### A.4.2 Materials

**Materials** — Descriptors of the physical materials (e.g., sediments or bedrock) within the component is described by five primary material descriptors. Additional information on each of these primary materials can be presented through the use of secondary material modifiers.

**Material Primary Descriptors**

| **Code** | **Term** |
|---|---|
| A | Anthropogenic |
| B | Biogenic |
| C | Clastic |
| I | Ice |
| R | Bedrock |

| **Code** | **Term** | **Definition** |
|---|---|---|
| A | Anthro-pogenic | materials made or modified by man; includes concrete, metal and wood |

| | | |
|---|---|---|
| B | Biogenic | materials produced by living organisms excluding man |
| C | Clastic | materials made up of fragments of rock; these can be any size and shape; texture of clastic sediments is the size, roundness and sorting of particles. |
| I | Ice | water in the solid state; includes a variety of ground ice types, sea and freshwater ice |
| R | Bedrock | aggregates of mineral grains, sometimes a simple mineral but more often of several minerals, that are coherent under ordinary conditions |

**Anthropogenic (A) Material Secondary Descriptors**

| Code | Term |
|---|---|
| a | metal |
| r | rubble |
| c | concrete |
| t | logs |
| d | debris |
| w | wood |

**Secondary Form Modifiers** — additional information can be provided for these primary forms. The following is a list of the additional codes and terms that can be used with each of these primary forms.

| Code | Term | Definition |
|---|---|---|
| a | metal | any class of substance that is typically fusible and opaque, good conductors of electricity and have a peculiar metallic lustre |
| d | debris | a man-made mixture of refuse such as old building materials, concrete and metal; may include some unconsolidated materials (gravel, earth) |
| c | concrete | building material made up of mineral aggregate (sand, gravel) and a cementing agent |
| r | rubble | angular-shaped clots of rock, greater than 64mm, produced |

| | | |
|---|---|---|
| | | by blasting or ripping bedrock |
| t | logs | a length of tree trunk sawed by man; usually logs from log booms. |
| w | wood | structural lumber, such as boards and pilings. |

**Biogenic (B) Material Secondary Descriptors**

| Code | Term |
|---|---|
| c | coarse shell |
| l | trees |
| f | fine shell hash |
| o | organic litter |
| p | peat, organic sediment |

| Code | Term | Definition |
|---|---|---|
| c | coarse shell | shell material greater than 4mm in size; also hash includes shell material modified by man such as middens and shell heaps |
| f | fine shell hash | shell material less than 4mm in size; also includes shell material modified by man such as middens and shell heaps |
| l | trees | applies to trees that are no longer living and accumulate along the shoreline by natural processes; for example, mass movements or wave action |
| o | organic litter | vegetative matter, excluding trees; includes wood debris (bark) and kelp accumulations |
| p | peat, organic sediment, | material that results from accumulation of decaying vegetative matter; for example, peat |

**Clastic (C) Secondary Material Descriptors**

| Code | Term |
|---|---|
| a | blocks |
| b | boulders |
| c | cobbles |
| d | diamicton |
| f | fines |
| g | gravel |
| k | clay |
| p | pebbles |
| r | rubble |
| s | sand |
| $ | silt |
| x | angular fragments |

| Code | Term | Definition |
|---|---|---|
| a | blocks | angular particles >256mm |
| b | boulders | rounded and subrounded particles >256mm |
| c | cobbles | rounded and subrounded particles between 65- 256mm |
| d | diamicton | a non-sorted to poorly sorted mixture of sand and larger rounded and angular particles in a matrix of silt and clay |
| f | fines, mud | a mixture of silt and clay; may include a minor fraction of sand |
| g | gravel | a mixture of pebble, cobble and boulders (>2 mm); may include some interstitial sand |
| k | clay | particles < .0195 mm |
| p | pebbles | rounded and subrounded particles between 2.1 — 64 mm |
| r | rubble | large boulders > 1m in diameter; usually angular. |
| s | sand | particles with a size range of .0626 — 2 mm |

| | | |
|---|---|---|
| $ | silt | particles with a size range of .0195 — .0625 mm |
| x | angular fragments | a mixture of blocks and rubble; may include some interstitial sand |

**Rock (R) Secondary Material Descriptors**

| **Code** | **Term** |
|---|---|
| | Rock Type |
| i | igneous |
| m | metamorphic |
| s | sedimentary |
| v | volcanic |
| | Rock Structure |
| 1 | bedding |
| 2 | jointing |
| 3 | massive |

| **Code** | **Term** | **Definition** |
|---|---|---|
| | **Rock Type** | |
| i | igneous, intrusive | rock formed below the surface of the earth by the crystallization of magma |
| m | meta-morphic | rocks that have been modified from its original nature (texture or composition) by heat, pressure or chemical action. |
| s | sedi-mentary | a rock resulting from the consolidation of loose sediment and formed at or near the surface of the earth. |
| v | volcanic | rocks of volcanic origin, usually extrusive, and including: andesites, trachytes, rhyolites, dacites, basalts, agglomerates, breccias and tuffs. |
| | **Rock Structure** | |
| 1 | bedding | layers of rock usually related to discrete sedimentation units |

| | | |
|---|---|---|
| | | of sedimentary bedrock, but layering can occur in metamorphic or volcanic rocks. |
| 2 | jointing | a fracture or parting in rock without displacement; the surface is usually plane and often occurs with parallel joints to form part of a joint set |
| 3 | massive | bedrock that has a homogeneous structure; no bedding or joints present |

**Use of material codes**

A material descriptor consists of a primary term (A,B,C) with a maximum of one modifier (e.g., Ad, Cs).

A single form will be composed of one or more layers of differing materials. A maximum of 3 material descriptors, written in order of increasing importance, may be used to describe each layer. If only one descriptor is used, that material type comprises 75% of the volume of the layer (e.g., Cs); if two, the first comprises 50-75% and the second 25-50% (e.g., Cs Bc); if three, each covers 25% or more (e.g., Cs Bc An).

Where two or more descriptors with the same primary term follow one after the other, the primary term need only be coded once (e.g., Cskb rather than Cs Ck Cb).

When a surface layer is less than 1m thick, the prefix "v" (veneer) is added to its material code (e.g., vCsk).

Where a form has more than one layer or where more than one form descriptor is used to describe a component, both form and material descriptors must be ordered and separated so that there is no ambiguity about which material codes apply to which forms. For example; logs over a pebble beach berm would be coded as At/Cp or where primary and secondary form descriptors exist:

- Form: Bi;Ph
- Materials: At/Cps;Rs

The system is adaptable for other mapping applications outside of B.C., for example ice substrates found in Arctic Canada could be classified in the following manner:

**Ice (I) Secondary Material Descriptors**

| Code | Term |
|---|---|
| c | pore ice |
| p | pingo ice |

| | |
|---|---|
| f | freshwater ice |
| s | sea ice |
| g | ground ice |
| v | segregated ice |
| i | ice-wedge |

| **Code** | **Term** | **Definition** |
|---|---|---|
| c | pore ice | ground ice that fills or partially fills pore spaces between clastic particles or in rocks |
| f | freshwater ice | ice originating from the freezing of fresh water in lakes and streams; also includes ice formed by emerging ground water (i.e., aufeis) |
| g | glacier ice | ground ice that is part of a glacier; ice that is flowing or that shows evidence of having flowed |
| i | ice-wedge ice | massive ground ice that is V-shaped with its apex pointing downward; usually composed of foliated or layered white ice |
| p | pingo ice | ground ice that forms the core of hill-like, conical features that rise above the surrounding terrain (pingos) |
| s | sea ice | ice originating from the freezing of seawater |
| v | segregated ice | ground ice that forms discrete lenses, layers or seams ranging in thickness from hairline to than 10m; bands of sediment may occur within the ice; includes vein ice and lens ice |

## APPENDIX B - Description of Shoreline Types

The following parameters were used to define a rationale for a Shoreline Type classification:

**Classification Classification**
Criteria Categories

**Substrate** Rock
Rock + Sediment
Sediment
Anthropogenic

**Sediment** Gravel
Sand & Gravel (S&G)
Sand
Man-made

**Width** Narrow (<<30m)
Wide (>30m)

**Slope** Steep (>20°)
Inclined (5-20°)
Flat (<<5°)

Table 6 summarizes the application of these categories. Brief descriptions of the Shoreline Types are provided below.

**Rock substrates**

Rock substrates are those which are devoid of sediment or where sediment is extremely scarce, such as a veneer over a bedrock platform.

**Rock Ramps, wide (>30m) [Class 1]** - rock shorelines with an intertidal width >30m and intertidal slopes in the range of 5° to 20° (Fig. B.1). Ramps are frequently hummocky with a fractured or jointed surface. A thin sediment veneer may be associated with the ramps but the veneer is typically patchy and there are no organized beach features.

**FIGURE B.1:** Oblique aerial photo of rock shoreline near Pachena Point, Strait of Juan de Fuca, categorized as a wide rocky ramp (Class 1). This segment includes small platform sections (near waterfall) and a sea cave (right) that could be mapped as variants.

**Rock Platforms, wide (>30m) [Class 2]** - near horizontal rocky intertidal areas >30m in width. A thin sediment veneer may be associated with the ramps but the veneer is typically patchy and there are no organized beach features. Most commonly associated with sedimentary bedrock outcrops.

**Rock Cliff, narrow (<<30m) [Class 3]** - steep-sloped (20°) rock coasts (Fig. B.2, B.3). Small pockets of sediment may occur sporadically within indentations along the upper intertidal.

**FIGURE B.2:** Oblique aerial photo of vertical rock cliffs on Texada Island (Class 3)

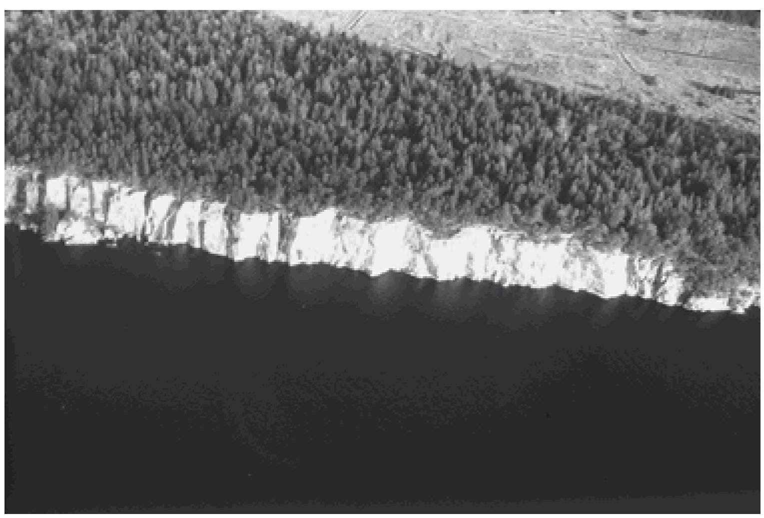


**FIGURE B.3:** Oblique aerial photo of a rock cliff near Pachena Point, Strait of Juan de Fuca. The unvegetated cliff is estimated to be 25m high.

**Rock Ramp, narrow (<<30m) [Class 4]** - rock shorelines with an intertidal width <<30m and intertidal slopes in the range of 5° to 20°

**FIGURE B.4:** An oblique aerial photo of a narrow (est. 15m wide) rock ramp shoreline in Gwaii Haanas (Queen Charlotte Islands). Wave exposure is relatively low as indicated by the overhand of the tree canopy over the high water line. The narrow black band is lichen growing just above the high water line.

**Rock Platforms, narrow (<<30m) [Class 5]** - near horizontal rocky intertidal areas <<30m in width. A thin sediment veneer may be associated with the platforms but the veneer is typically patchy and there are no organized beach features. Most commonly associated with sedimentary bedrock outcrops.

## Rock and sediment substrates

Rock and pockets of clastic sediments are common in the British Columbia coastal zone. Sediments may occur as well developed beach forms, such as berms or beach terraces, or as large patches of sediment in an otherwise rocky shoreline.

Sediments were considered in terms of three major sediment textures: (1) gravels (materials >2mm diameter), (2) sands and muds (<<2mm in diameter) and (3) sand & gravel combinations. Substrate, sediment texture and intertidal zone width were used to assign coastal types as follows:

**Gravel Textures (>2mm)**

**Ramp w Gravel Beach, wide (>30m) [Class 6]** - this coastal type has similar characteristics to the Rock Ramp (Class 1) defined above but with addition of a rubble, boulder, cobble or pebble beach (<<10% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Platform w Gravel Beach, wide (>30m) [Class 7]** - this coastal type has similar characteristics to the Rock Platform (Class 2) defined above but with addition of a rubble, boulder, cobble or pebble beach (<<10% sand content). The beaches typically occur in the middle to upper intertidal zones (fig. B.5) and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**FIGURE B.5: G**round photo of wide rock platform with gravel (boulder beach) along the southern portion of the West Coast Trail, Strait of Juan de Fuca. The rock platform (to the right) is over 100m in width near this location; the boulder beach (left) is located in the upper intertidal zone and is capped by a large log-debris pile.

**Cliff w Gravel Beach (<<30m) [Class 8]** - this coastal type has similar characteristics to the Rock Cliff (Class 3) defined above but with addition of a rubble, boulder, cobble or pebble beach (<<10% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Ramp w Gravel Beach, narrow (<<30m) [Class 9]** - this coastal type has similar characteristics to the Rock Ramp (Class 4) defined above but with addition of a rubble, boulder, cobble or pebble beach (<<10% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Platform w Gravel Beach, narrow (<<30m) [Class 10]** - this coastal type has similar characteristics to the Rock Platform (class 5) defined above but with addition of a rubble, boulder, cobble or pebble beach (<<10% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

## Sand and Gravel Textures

**Ramp w Sand and Gravel Beach, wide (>30m) [Class 11]** - this coastal type has similar characteristics to the Rock Ramp (Class 1) defined above but with the addition of a rubble, boulder, cobble, pebble and sand beach (>10% sand content and >10% gravel content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. The gravel in the lower and middle intertidal zones frequently occurs as an armour over the sand gravel mixture. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Platform w Sand and Gravel Beach, wide (>30m) [Class 12]** - this coastal type has similar characteristics to the Rock Platform (Class 2) defined above but with addition of a rubble, boulder, cobble, pebble and sand beach (>10% sand content and >10% gravel content). The beaches typically occur in the middle to upper intertidal zones (Fig. B.6) and often include log deposits in the supra-tidal zone. The gravel in the lower and middle intertidal zones frequently occurs as an armour over a sand/gravel mixture. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**FIGURE B.6:** Ground photo of rock platform with a sand and gravel beach on the West Coast Trail. The beach (to the right) is comprised of a sand and pebble mixture; the platform is cut into the sedimentary Carmanah sandstone.

**Cliff w Sand and Gravel Beach, (<<30m) [Class 13]** - this coastal type has similar characteristics to the Rock Cliff (Class 3) defined above but with addition of a rubble, boulder, cobble, pebble and sand beach (>10% sand content and >10% gravel content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone.

**Ramp w Sand and Gravel Beach, narrow (<<30m) [Class 14]** - this coastal type has similar characteristics to the Rock Ramp (Class 1) defined above but with the addition of a rubble, boulder, cobble, pebble and sand beach (>10% sand content and >10% gravel content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. The gravel in the lower and middle intertidal zones frequently occurs as an armour over the sand gravel mixture. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Platform w Sand and Gravel Beach, narrow (<<30m) [Class 15]** - this coastal type has similar characteristics to the Rock Platform (Class 2) defined above but with addition of a rubble, boulder, cobble, pebble and sand beach (>10% sand content and >10% gravel content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. The gravel in the lower and middle intertidal zones frequently occurs as an armour over a sand/gravel mixture. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**<u>Sand Textures (<<2mm)</u>**

**Ramp w Sand Beach, wide (>30m) [Class 16]** - this coastal type has similar characteristics to the Rock Ramp (Class 1) defined above but with sand beach (>90% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Platform w Sand Beach, wide (>30m) [Class 17]** - this coastal type has similar characteristics to the Rock Platform (Class 2) defined above but with addition of a sand beach (>90% sand content). The beaches typically occur in the middle to upper intertidal zones (Fig. B.7) and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**FIGURE B.7:** Oblique aerial photo of the Tsusiat Falls area of the West Coast Trail illustrating a sand beach over a wide rock platform. Sand is contributed from the stream and from weathering of the sandstone bedrock.

**Cliff w Sand Beach, (<<30m) [Class 18]** - this coastal type has similar characteristics to the Rock Cliff (Class3) defined above but with addition of a sand beach (>90% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Ramp w Sand Beach, narrow (<<30m) [Class 19]** - this coastal type has similar characteristics to the Rock Ramp (Class 1) defined above but with the addition of a sand beach (>90% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations.

**Platform w Sand Beach, narrow (<<30m) [Class 20]** - this coastal type has similar characteristics to the Rock Platform (Class 2) defined above but with addition of a sand beach (>90% sand content). The beaches typically occur in the middle to upper intertidal zones and often include log deposits in the supra-tidal zone. Distributions may be patchy, occurring intermittently along the coast within small indentations. Sediment substrates Sediment substrates are those units with little or no bedrock cropping out within the intertidal zone. Sediments may range from boulders to mud. As with the above-defined Coastal Types, units are classified with respect to sediment texture, intertidal zone width and intertidal zone slope.

## Gravel Textures (>2mm)

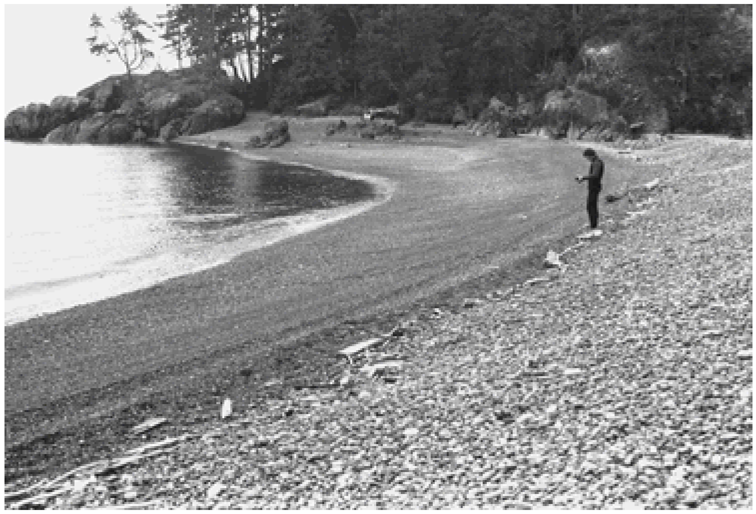
**Gravel Flat (>30m intertidal zone width) [Class 21]** - surface sediments are usually comprised of a boulder, cobble, pebble mixture (<<10% sand content). Beach slopes are in the range of 5° to 20° with the berm being the steepest part of the intertidal zone. Lower to middle intertidal zones are commonly armoured. The width of flat (>30m) usually indicates that the immediate subsurface is sand eventhough the surface is gravel armour; the surface layer may be permeable but the subsurface is usually of much lower permeability.

**Gravel Beach (<<30m) [Class 22]** - sediments are usually comprised of a boulder (Fig. B.8), cobble, pebble (Fig. B.9) mixture (<<10% sand content). Beach slopes are in the range of 5° to 20° with the berm the steepest part of the intertidal zone. Lower to middle intertidal zones are commonly armoured. Because of the low sand content, these beaches are highly permeable.

**Gravel Flat or Fan, narrow (<<30m ) [Class 23]** - sediments are usually comprised of a boulder, cobble, pebble mixture (<<10% sand content). Beach slopes are low, <<5° with the berm the steepest part of the intertidal zone. Lower to middle intertidal zones are commonly armoured. Because of the low sand content, these beaches are highly permeable.

**FIGURE B.8:** Ground photo of a boulder beach located along the northern shore of Esperanza Inlet on Western Vancouver Island. The beach is approximately 40m in width with a well-sorted boulder/cobble surface.

**FIGURE B.9:** Ground photo of a well-sorted pebble beach(Class 22), southeast of Otter Point, on Sooke Bay. A small swash ridge is evident at the last high-water mark.



__Sand and Gravel Textures__

**Sand and Gravel Flat or Fan (>30m) [Class 24]** - sediments are a mixture of boulders, cobbles, pebbles and sand (>10% sand content and >10% gravel content). Beach slopes are low, <<5° with the berm the steepest part of the intertidal zone (Fig. B.10; B.11). Lower to middle intertidal zones are commonly armoured by cobbles with the sand layer in the subsurface. These beaches usually have similar permeabilities to sand beaches.

**FIGURE B.10:** Aerial oblique photo of Cape Lazo with Goose Spit in the background illustrating a sand and gravel beach (wide). Much of the beach face and berm are comprised of pebble/cobble sediment but the beach flats have a mixture of sand, cobble and boulder.

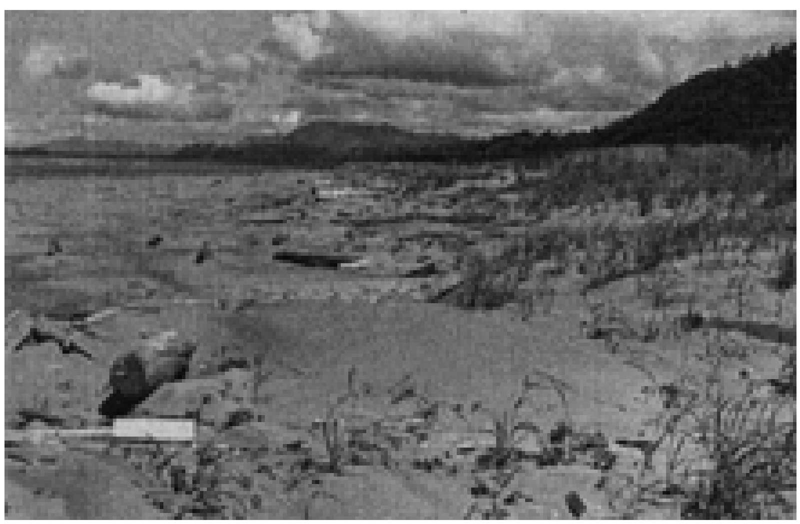
**FIGURE B.11:** Ground photo of a sand and gravel beach (Mount Douglas Park, Cordova Bay). The boulder/cobble sediment has been eroded from the till cliff (not visible to the left). The beach face is comprised of sand/pebble and the swash ridge (right-centre) is comprised of sand.

**Sand and Gravel Beach (<<30m) [Class 25]** - sediments are a mixture of boulders, cobbles, pebbles and sand (>10% sand content and >10% gravel content). Beach slopes are in the range of 5° to 20° with the berm the steepest part of the intertidal zone. Lower to middle intertidal zones are commonly armoured by cobbles with the sand layer in the subsurface. These beaches usually have similar permeabilities to sand beaches.

**Sand and Gravel Flat or Fan (<<30m) [Class 26]** - sediments are a mixture of boulders, cobbles, pebbles and sand (>10% sand content and >10% gravel content). Beach slopes are low, <<5° with the berm the steepest part of the intertidal zone. Lower to middle intertidal zones are commonly armoured by cobbles with the sand layer in the subsurface. These beaches usually have similar permeabilities to sand beaches.

**Sand/Mud Textures Sand Beach (>30m) [Class 27]** - sediments are <<10% gravel and >50% sand. Beach slopes are in the range of 5° to 20° with the berm the steepest part of the intertidal zone. Sediments are highly mobile in moderate to high energy exposure areas (Fig. B.12). Beach permeability may range from high to low depending on the mud content of the beach. Ridge and runnels or swash bars may occur in the lower or middle intertidal zones (Fig. B.11 shows a sand ridge or swash bar on a S&G beach).

**FIGURE B.12:** Ground photo of the supra-tidal zone area of the wide sand beach at Long Beach. The storm log debris pile has been buried by wind-blown sand, transported by summer northwesterlies, and has been colonized by some seasonal vegetation.



**Sand Flat (>30m) [Class 28]** - sediments are <<10% gravel and >50% sand. Beach slopes are low, <<5° with the berm the steepest part of the intertidal zone. Beach permeabilities may range from high to low depending on the mud content of the beach. Multiple ridge and runnels or swash bars are common in the lower or middle intertidal zones (Fig. B.13, B.14).

**FIGURE B.13:** Oblique aerial photo of a wide sand flat north of Parksville. The sand flat is nearly 1km in width and shows a series multiple ridge and runnel "bars" (Class 28).

**FIGURE B.14:** Ground photo of the wide, featureless sand flat just east of Tow Hill with Rose Spit in the background (Queen Charlotte Islands). The sand flat is comprised of medium sand and has a high water retention (Class 28).

**Mud Flat (>30m) [Class 29]** - sediments are <<10% gravel and >50% mud (Fig. B.15). Beach slopes are low, <<5°, with the berm the steepest part of the intertidal zone. Berm sediments located near the high-tide mark are usually coarser than those of the beach flat. Beach permeability is low due to the high mud content.

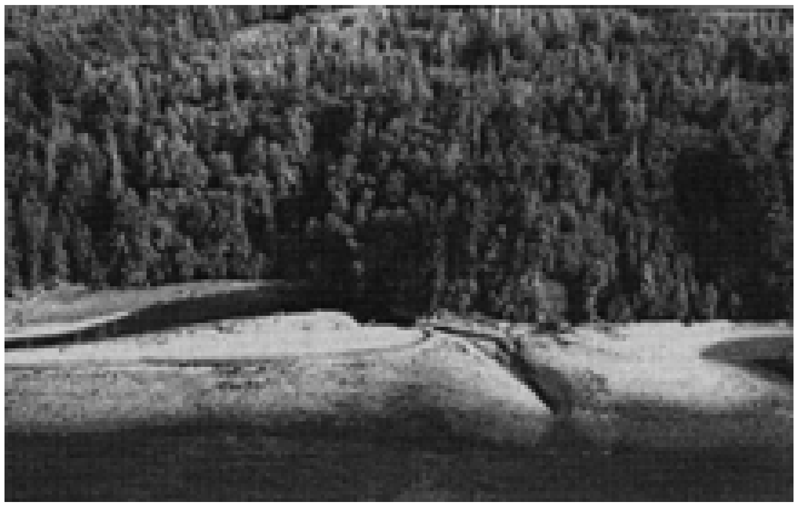
**FIGURE B.15: O**blique aerial photo of the Grice Bay mud flats, located to the southeast of Tofino (Class 29). Water retention within the mud sediments is high. Wave exposure at this location is very low.

**Sand Beach (<<30m) [Class 30] -**- sediments are <<10% gravel and >50% sand. Beach slopes are in the range of 5° to 20° with the berm the steepest part of the intertidal zone. Sediments are highly mobile in moderate to high energy exposure areas. Beach permeability may range from high to low depending on the mud content of the beach.

**Estuaries [Class 31]** -- estuaries are characterized by high variable distribution in texture although muds and organics are common (Fig. B.16, B.17). Wetland greasses frequently rim the estuary at the high water mark. Brackish water conditions are common due freshwater input to the estuary from stream runoff. Exclusively confined to low wave-exposure environments.

**FIGURE B.16:** Oblique aerial photo of the Ladner Marsh area of the Fraser River estuary (Class 31)

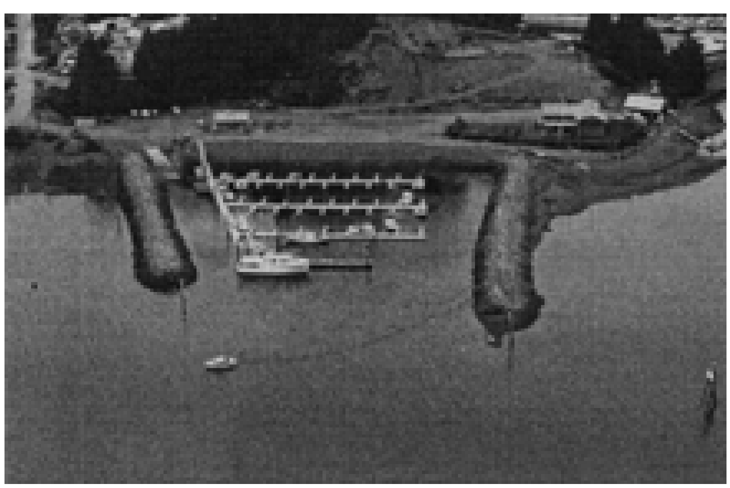
**FIGURE B.17:** Oblique aerial photo of the a very small estuary near the mouth of Kirby Creek near Jordan River on the Strait of Juan de Fuca (Class 31). The photo shows the marsh/wetland within the estuary, the stream channel, a spit enclosing the estuary and a small delta at the mouth of the stream. There is a very sharp transition from high wave exposure on the seaward side of the spit to low wave exposure inside the estuary.



Anthropogenic or man-made substrates

Anthropogenic materials are man-made shorelines that often predominate in urban areas. These types of shorelines may include seawalls, bulkheads, rip-rap, landfill, crib-work and pilings. Current-Dominated Forms Man-made, permeable (Class 32) - these are man-made structures or features within the intertidal zone such as wharfs, seawalls, breakwaters, jetties, log dumps, piers, etc. (Fig. B.18). Common construction materials are: concrete, timer, pilings, rubble and rock. Intertidal zone widths are often narrow.

**FIGURE B.18:** Oblique aerial photo of a small boat harbour in Ucluelet illustrating several anthropogenic features including: a permeable rubble breakwater (Class 32), floats and a boat ramp.



**Man-made, impermeable (Class 33)** - these are man-made structures or features within the intertidal zone such as wharves, bulkheads or seawalls. Common construction materials are: concrete, timber or sheet pile. Intertidal zone widths are often narrow due to the vertical nature of most structures.

**Current-dominated forms**

**Channels [Class 34]** - channels are current- dominated features that may be fixed by rock substrates or may be formed in unconsolidated materials (Fig. B.19, B.20). Strong tidal currents that occur in channels may be capable of transporting large sediment and often there are unique biological communities are associated with these features.

**FIGURE B.19:** Oblique aerial photo of Nitinat Narrows at the entrance to Nitinat Lake on the Strait of Juan de Fuca. The currents in the channel can exceed 8 knots, creating a unique, current-dominated intertidal habitat (Class 34).

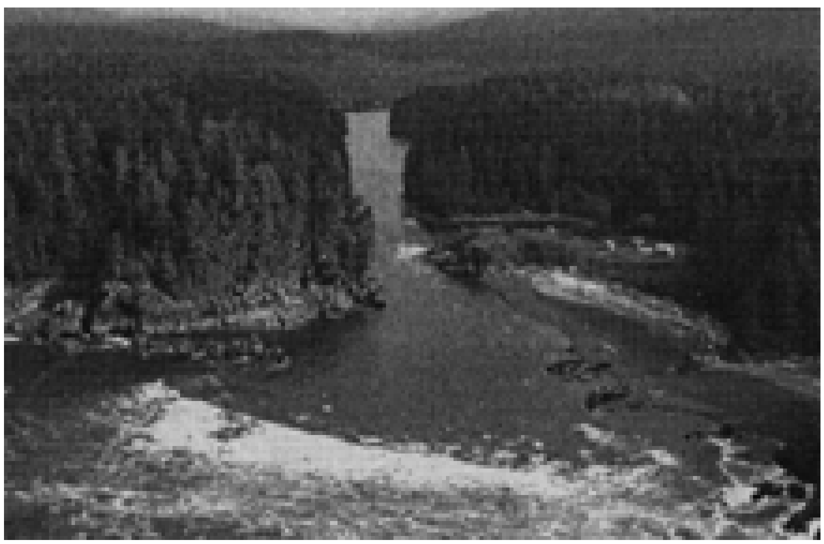


**FIGURE B.20:** Oblique aerial photo of Dolomite Narrows (also known as Burnaby Narrows) between Moresby and Burnaby Islands, Queen Charlotte Islands. The combination of strong currents and shallow water depths result in a unique intertidal habitat with very high biomass(Class 34).

# APPENDIX C - Wave Exposure Calculations

## Introduction

Wave processes provide the dominant controlling process for shore morphology and sediment redistribution and are probably the dominant control of biota that use the shore zone. Wave exposure indirectly controls the persistence of oil stranded in the shore zone. As such, it is important to have an index of wave exposure for each Shore Unit.

Ideally wave exposure estimates would be based on the consideration of wave energy units; however, the calculation of wave energy for a particular shore unit would involve the use of complex wave climate models that use wave fetch characteristics, historical wind climate measurements from shore stations with over-the-water corrections for the area under consideration, wind-wave generation routines, and wave refraction and shoaling routines. The application of these routines would be required for each shore unit!

The following method for estimating wave exposure is based on some standard engineering practices for estimating wave heights for a particular wind speed and direction.

The method involves the consideration of the wave fetch window; that is, the open-water area offshore from the Shore Unit over which waves can be generated by winds - **the larger the fetch window, the greater the wave exposure.**

Estimation of wave exposure involves the consideration of two fetch indices: effective fetch and maximum fetch. The wave exposure estimates provided by this technique represent a first approximation of wave exposure. Important controls such as the associated local wind climate and wave refraction are ignored for the sake of simplifying the estimate. As such, the Wave Exposure estimates provide a first-order estimate of wave energy expended within the Shore Unit.

Intertidal biotic assemblages have been used as an index of wave exposure categories (see Harper et al 1994) and have been found to agree reasonably well with the Wave Exposure estimates defined from the "fetch model". Analysis of detailed ground survey stations of intertidal biota showed about 75% agreement with the fetch model and about 85% agreement with video-imagery revisions of the "fetch model". In other words, the Wave Exposure categories defined as part of the fetch model agree well with community assemblages observed in the field.

## Effective Fetch

Effective fetch calculation involves the measurement of the fetch distance along several directions from a given point from the shore (Fig. C.1) and is a standard engineering measurement for shore protection studies (CERC 1977). To simplify the large number of measurements required for a mapping area (for example there are over 1,800 Shore Units in the Southern Strait of Georgia Shore-zone Database), a "modified effective fetch" measurement was developed. The "modified effective fetch" technique involves the measurement of three fetch distances: the shore-normal or perpendicular to the general trend of the shore unit, 45° to the left of the shore-normal and 45° to the right of the shore normal (Figure C.1).

**TABLE C.1:** Wave fetch measurement values and exposure calculations

| Unit | Shore Normal Azimuth ° | Shore Normal Fetch (km) | Left 45° (km) | Right 45° (km) | Max Fetch Azimuth° | Max. Fetch (km) | Effective Fetch (km) | Exposure Category |
|---|---|---|---|---|---|---|---|---|
| A | 135 | 15.7 | 8.2 | 19.5 | 131 | 29 | 14.6 | SP |
| B | 066 | 19.0 | 13.0 | 11.0 | 073 | 40 | 14.9 | SP |
| C | 035 | 13.5 | 11.5 | 50 | 082 | 75 | 23.6 | SE |

These three measurements are used to compute a modified effective fetch for the Shore Unit based on the fetch equations:

**Effective Fetch Calculation (after CERC 1977)**

INSERT EQUATION

Fe = S(cosai).Fi/S(cosai) (Equation C.1)

where Fe = effective fetch in kilometres

ai = the angle between the shore normal and the direction I

Fi = the fetch distance in kilometres along direction i

**Modified Effective Fetch Calculation (after Harper *et al* 1991)**

INSERT EQUATION

Fm = [cos(45°).F45L + cos(90°).F090 + cos(45°).F45R]/[cos45°+cos90°+cos45°] (Equation C.2)

= [(0.707).F45L + (1.0).F090 + (0.707).F45R]/[2.414] (Equation C.3)

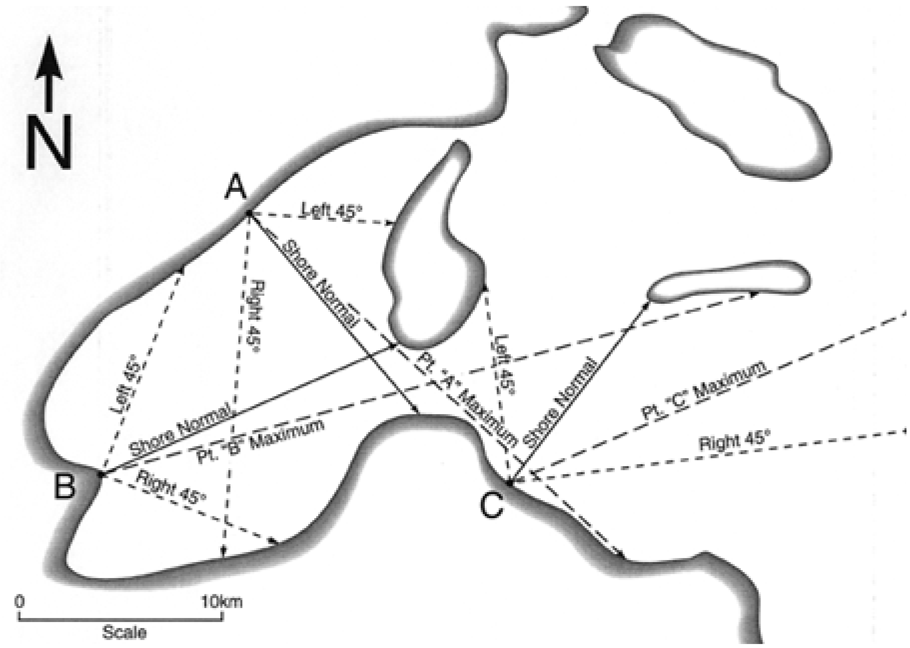
where F = modified effective fetch in kilometres

F45L = the fetch distance in kilometres along direction 45° left of the shore normal

F090 = the fetch distance in kilometres along direction the shore normal

F45R = the fetch distance in kilometres along direction 45° right of the shore normal

**FIGURE C.1:** Examples of "modified effective fetch" measurements. Refer to Table C.1 for actual measurement values.




Maximum Fetch

The wave climate of a particular point cannot be characterized by effective fetch alone because waves may be generated in an area remote from the shore unit and propagate into the area of the shore unit. These waves are commonly refereed to as swell. A good B.C. example is that of Juan de Fuca Strait where locally- generated waves (indexed by effective fetch) are relatively small but large swell, generated in the open Pacific, can penetrate into the Strait. The maximum fetch of a Shore Unit is intended to provide an index of the swell waves and, to a lesser extent, refraction effects.

The Maximum Fetch is the maximum fetch distance in kilometres that can be measured from a centre point of the Shore Unit. An example is provided in Figure C.1

Wave Climate Fields Of The Shore Zone Database

There are several wave climate data fields within the Shore Unit section of the Shore-zone Database. The fields and associated definitions are:

**Shore Normal Direction** -the azimuth (in degrees from true north) of the normal to the general orientation of the shore unit. That is, if the general trend of the shoreline is from northwest to southeast with open water to the east), then the Shore Normal Direction would be 45°.

**Fetch Distances** - the distances in kilometres as measured along a line 45° to theleft of the Shore Normal, along the Shore Normal and along a line 45° to the right of the Shore Normal.

**Maximum Fetch Direction** - the azimuth (in degrees from true north) of the direction of the maximum fetch (refer to Fig. C.1).

**Maximum Fetch Distance** - the distance in kilometres of the maximum fetch as measured along the Maximum Fetch Direction (refer to Fig. C.1).

**Modified Effective Fetch** - the distance in kilometres as calculated from the Fetch Distance Measurements (see Equation C.2).

**Exposure Category** - the exposure category provides a summary indicator of wave exposure for the unit. The following class of wave exposure have been utilized and are derived from knowledge of Maximum Fetch and Modified Effective Fetch (Table C.2):

**Very Protected (VP)** - maximum wave fetch less than one kilometre; usually the location of all-weather anchorages, marinas and harbours.

**Protected (P)** - maximum wave fetch less than 10 km; usually areas of provisional anchorages and low wave exposure except in extreme winds.

**Semi-protected (SP)** - maximum wave fetch distances in the range of 10 to 50 km. Waves are low most of the time except during high winds.

**Semi-exposed (SE)** - maximum wave fetch distances between 50 and 500 km. Swells, generated in areas distant from the shore unit create relatively high wave conditions. During storms, extremely large waves create high wave exposures.

**Exposed (E)** - maximum wave fetch distances 500 to 1,000 km. High ambient wave conditions usually prevail within this exposure category.

**Very Exposed (VE)** - maximum wave fetch distances > 1,000 km. Large swell (>1m) almost always present. Typical of open-Pacific conditions.

This procedure, although preliminary and subject to refinement, offers an objective, repeatable basis for estimating wave exposure. Wave exposure, in turn, is of critical importance in determining species distribution, sediment mobility and a variety of other shore processes.

**TABLE C.2:** Effective and maximum fetch wave exposure matrix

| | | | | | |
|---|---|---|---|---|---|
| **Maximum Fetch** | **Modified Effective Fetch (km)** | | | | |
| **(km)** | **<1** | **1-10** | **10-50** | **50-500** | **>500** |
| <1 | very protected | n/a | n/a | n/a | n/a |
| <10 | protected | protected | n/a | n/a | n/a |
| 10-50 | n/a | semi-protected | semi-protected | n/a | n/a |
| 50-500 | n/a | semi-exposed | semi-exposed | semi-exposed | n/a |
| 500-1000 | n/a | n/a | semi-exposed | exposed | exposed |
| <1000 | n/a | n/a | n/a | very exposed | very exposed |
| | | | | | |

## APPENDIX D - Coastal Mapping Regions Of B.C.

**FIGURE D.1:** Regions used to summarize coastal mapping data