

## AGGREGATE POTENTIAL PROJECT FOR THE NANAIMO AREA, VANCOUVER ISLAND (NTS 92B, C, F and G)

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### INTRODUCTION

The Nanaimo Area Aggregate Potential Project was initiated in 1998 by the Geological Survey Branch of the Ministry of Energy and Mines as part of an ongoing government effort to assist municipal planners and local developers in their management of aggregate resources. This particular study represents a direct response to the regional needs of the Nanaimo Regional District which currently recognizes the importance of assessing aggregate inventory data and aggregate potential data in future land use deci-

sions. The 1998 Nanaimo project as well as the previous 1997 Okanagan Aggregate Potential Mapping Project (Matheson *et al.*, 1997, 1998) and 1996 Prince George Aggregate Potential Mapping Project (Bobrowsky *et al.*, 1996a) all reflect efforts by local government to respond positively to the provincial Growth Management Strategies Act which encourages local governments to manage their own aggregate resources.

The primary project objective was to examine existing aggregate resources and known occurrences, and define potential aggregate resources for the Nanaimo Regional District following the methodology of Bobrowsky *et al.* (1996b). It is reasonable to assume that increased demand for gravel resources in this area has been brought about

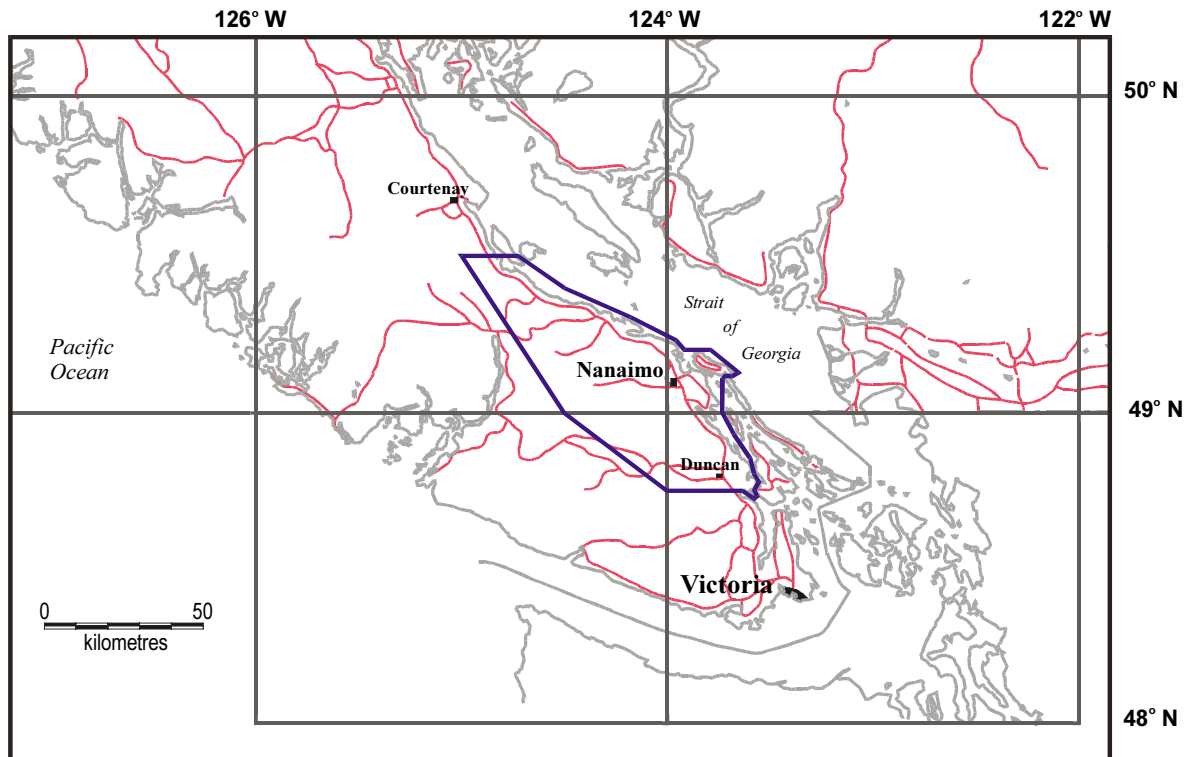


Figure 1. location of the study area on Vancouver Island.

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by the pressures resulting from the construction of the Island Highway, coupled with continuing urban development and population growth. More specifically, the aim of the 1998 study was to evaluate the aggregate potential of the region as defined by parts of nine 1:50 000 scale map sheets: NTS sheets 92B12, 92B13, 92C09, 92C16, 92F01, 92F02, 92F07, 92F08 and 92G04. The exact boundaries are georeferenced in our digital product but roughly corresponds to the coastal areas beginning directly south of Duncan and continuing northwestwards to about Qualicum Beach (Figure 1). The field work was completed over a two week period, and a total of 117 pits were examined along this coastal strip of Vancouver Island.

## PREVIOUS STUDIES

A number of studies relevant to aggregate resources have been completed in this area during the past few decades. One of the earliest mapping projects in the northern part of the study area was that of Fyles (1963) who detailed surficial deposits and evaluated the economic potential of the aggregate resources in the coastal areas from Parksville north to Denman

Island. Later a study by Leaming (1968) provided the most complete assessment on the status of sand and gravel bordering the Strait of Georgia. The detail of this work has yet to be repeated, and although the stratigraphic interpretations remain valid, the pit descriptions and reserve estimates have long since passed their usefulness. More recently, casual observations by Galbraith and Beswick (1982) have further confirmed the need for better aggregate information in this area and academic studies by Manson (1995) have provided an update of Ministry of Transportation and Highways aggregate activity in the region. Finally, the region was inventoried using Notice of Work files managed by the Ministry of Energy and Mines in Victoria and published by Matheson *et al.* (1996a).

## FIELD ACTIVITIES

The first stage of this project was to identify and evaluate all active and inactive aggregate operations still evident in the district. The existing aggregate inventory database of Matheson *et al.* (1996a) was further supplemented by relying upon and verifying features denoted on NTS maps, current Notice of Work applications and



Photo 1. Gravel sizing operations - 800 meter conveyor built from jaw to crushers (Cassidy Pit).

pits discovered during field work through the region. Each known sand and gravel pit was visited by staff of the Geological Survey Branch. Pits identified in the study area were first photographed (Photo 1), and described according to the following parameters: name of pit, unique identity number and license, licensee or operator, and development status. Additional technical data included stratigraphic descriptions, measurements of exposed sections that allowed for the interpretation of facies, depositional history and quarry type, including these parameters: activity, (producing, reclaimed or abandoned) landform type, environment of deposition, stratigraphic units, structures, and thickness, pit lithology, clast size and roundness, etc. A hand held global positioning system (GPS) unit and 1:50 000 NTS maps were used to accurately define the pit location which was then plotted using UTM coordinates on the NTS maps and terrain maps used in the field.

## METHODOLOGY

A field derived database using an Excel spreadsheet was first compiled consisting of the licensing information, all field observations, air-photo interpretations, as well as delineation and identification of the involved landforms. In the office, a digital database for use in ArcView was generated when individual aggregate pits were digitized as points on the nine map sheets.

Additional data were collected and compiled including water well records from the Ministry of Environment, Lands and Parks (location and stratigraphic data), isolated geotechnical records from the Ministry of Transportation and Highways, airphotographic interpretation of surficial geology, digitization of landform polygons and sediment thickness.

The primary element used in aggregate potential maps relies on “polygons” (areas containing similar surficial deposit type and landform genesis) as defined by the surficial geology. Within the Nanaimo Regional District study area, 1394 individual terrestrial polygons were assessed for hosting potential natural aggregate resources. An additional 50 aquatic (lakes, rivers, etc.) polygons were not included in this analysis. Manipulation of other layers of data

was accomplished by reference to these surficial polygons. The data were managed and manipulated in a PC-based GIS environment using ArcView and dBase software. In the Nanaimo study, which comprises nine 1:50 000 scale NTS map sheets, the following variables (mostly geological) were compiled for each polygon:

- ♦ Landform type.
- ♦ Texture of surficial material.
- ♦ Area of landform polygon.
- ♦ Presence/absence of aggregate pits.
- ♦ Overburden and aggregate thickness (from 4625 water well records).
- ♦ Aggregate resource volume (estimated from pits).

All 1394 polygons were then ranked for aggregate potential following the methodology of Bobrowsky *et al.* (1996b). We applied a weighted algorithm defined as follows to the terrestrial polygons:

$$\text{Total Rank} = \{3 \times \text{Landform1}\} + \{3 \text{ landform2}\} \\ + \{3 \times \text{Thickness(well)}\} + \{2 \times \text{Overburden(well)}\} \\ + \{3 \times \text{Pit}\} + \text{Area}$$

where Landform1 = primary landform present in the polygon, Landform2 = secondary landform in the polygon, Thickness(well) = gravel thickness in the polygon as estimated from water well records, Overburden(well) = overburden thickness in the polygon as estimated from water well records, Pit = presence or absence of an aggregate pit in the polygon, and Area = total area in hectares of the polygon. Details regarding algorithm generation, weighting and application appear in detail elsewhere (Bobrowsky *et al.*, 1996b; Bobrowsky *et al.*, 1998b; Massey *et al.*, 1998a)

Briefly, individual parameters were independently categorized and assigned a rank score. A two-step process was used to determine a final aggregate potential ranking. First, unfavorable polygons were screened based on the rankings considered most important for indicating resource potential (e.g. landform type, thickness of overburden, etc.). Eliminated polygons (those with virtually no possibility of aggregate) were designated ‘unclassified’. For the remaining polygons, the individual parameter rankings were ‘weighted’ according to significance in

assessing aggregate potential and then summed to determine an overall ranking. This weighting method and the reasoning behind the schema is discussed at length in Bobrowsky *et al.* (1996b). Finally, the significance of a polygon for aggregate resources was assigned. All polygons containing active or historical (inactive pits) were removed from the tally (48 in total) and classified as “H” for historic producers. These represent 7.04% of the total area or 3.44% of the total number of polygons. In the study, the following sub-groups were designated:

- H. Areas of present or recent aggregate production
- U. Unclassified or eliminated polygons.
  - 1. Areas of primary potential
  - 2. Areas of secondary potential, and
  - 3. Areas of tertiary potential.

## RESULTS

From the original 1394 polygons the following distribution of categories resulted:

- H - 48 polygons, 6.75% of the total area and 3.44% of the total number,
- U - 395 polygons, 23.26% of the total area and 28.34% of the total number,
- 1 - 75 polygons, 7.31% of the total area or 5.38% of the total number,
- 2 - 229 polygons, 12.84% of the total area or 16.43% of the total number,
- 3 - 647 polygons, 49.85% of the total area or 46.41% of the total number.

The final aggregate potential map for the Nanaimo study has now been released, at no cost to users, in digital format, including the full parameter and ranking-score database, and is available from the Branch’s website: Open File 1998-12, <http://www.ei.gov.bc.ca/geosmin/mapinv/surfical/aggmap.htm> (Massey *et al.*, 1998b).

## CONCLUSIONS - DISCUSSION

### Locating Future Deposits

Exploration for future deposits should be focused in the low lying coastal areas where various glaciofluvial deposits tend to be common



Photo 2. Fan-delta outwash (Cassidy Pit).

(Photo 2). This area corresponds to the historic distribution of aggregate pits recorded as part of the inventory field work. When urban development and expansion have limited the aggregate potential for these areas, smaller but similar deposits located adjacent to the large valleys should be examined. Such landforms may be first recognized on the aggregate potential maps produced here, and with further ground truthing and additional detailed air photo interpretation, will allow accurate identification of aggregate resources for future use. Proportionately, just over 8% of the total number of polygons or 14% of the total area has favorable aggregate potential. Large parts of the H category polygons have yet to be mined for sand and gravel and these areas should be protected and explored first before land use sterilization occurs. Category 1 polygons also have very good potential to host suitable sources of sand and gravel, but polygons in this category do not yet support any operations. These polygon areas should also be given significant attention for protection against competing land use options.

The ranking of polygons will enable prospective producers and operators to target



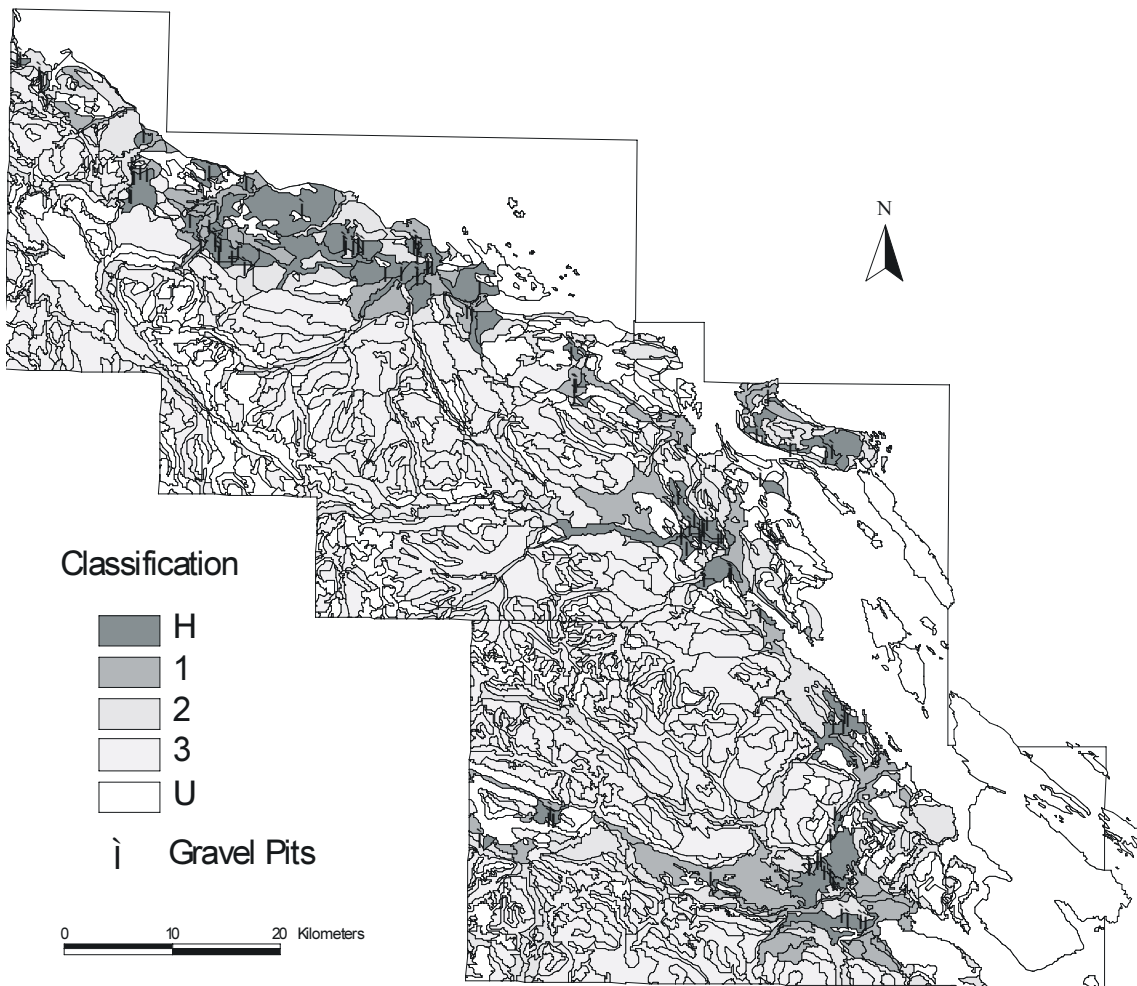


Figure 2. Nanaimo Aggregate Potential Map. Legend: H are historical or proven aggregate resources; 1 are primary or high potential polygons; 2 are secondary or medium potential polygons; 3 are tertiary or low potential polygons and U are unclassified or least favorable polygons for aggregate resources.

areas of greatest potential for future development. Equally important, such information can be used by planners to ensure that long term land use strategies take into account limited or high potential aggregate resources and thus minimize the opportunity for sterilization of the nonrenewable resources (Figure 2). Moreover, the digital data are ideally suited for importation into GIS systems, thus enabling the user groups to further integrate, compare and analyze aggregate data relative to other geographic and socioeconomic data sets.

### Value of Aggregate Program

It is axiomatic that there will always be a demand for aggregate and consequently it is essential to have a well documented inventory and evaluation for future use in general develop-

ment planning, for construction purposes and the consequent infrastructure of transportation networks (Bobrowsky 1998). In short, an inventory and an evaluation of potential aggregate resources should be completed in areas of British Columbia where aggregate consumption is increasing rapidly or where present supplies are now exhausted.

The current series of nine partial 1:50 000 scale maps illustrating aggregate potential for the Nanaimo Regional District (Massey *et al.*, 1998b) can now be added to the five Prince George digital maps (Bobrowsky *et al.*, 1996a) and the 16 Okanagan digital maps (Bobrowsky *et al.*, 1998a). Collectively, these data provide an excellent information source for multi-client user groups interested in sand and gravel, surficial geologic and geotechnical information.

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