

DETAILED AGGREGATE MAPPING RELATED TO CONCRETE PLATFORM CONSTRUCTION

M.J. Ricketts
Quaternary Geology Section

ABSTRACT

This report describes an aggregate resource study in the Placentia Bay area, where large quantities of aggregate material will be in demand during the construction of offshore concrete platform structures. The study was designed to map areas of greatest aggregate potential. Results, to date, indicate that there are adequate shoreline deposits from which barges can provide a cheap means of transportation. The Swift Current deposit is possibly the largest and most suitable shoreline deposit for production of a high quality, fine aggregate for use in concrete.

INTRODUCTION

During the 1985 field season, detailed aggregate resource mapping was conducted in the Placentia Bay area (Figure 1) to support developments related to concrete platform construction. Large quantities of sand and gravel will be required on a continuous basis during the construction periods. An estimated volume of 140,000 to 150,000 m³ of sand will be required in the platform structure. Another 1,000,000 m³ of crushed rocks, gravel, silt and clay will be needed for the structure and related activity, e.g., cell fill for the service dock, access roads, and a causeway (Kristiansin, 1985 and Clark, 1985). For this reason, detailed aggregate studies were undertaken in potential resource areas, concentrating on the Arnold's Cove to Swift Current area at the head of Placentia

Bay. These areas are within a reasonable distance to the proposed construction site at Adams Head (see also Bragg, *this volume*). Since construction will take place in a coastal area, and will require barging once the concrete base is floated out of the dry dock, most sampling was conducted in shoreline deposits.

The objectives of the project were to determine the quantity and quality of aggregate material in deposits within a reasonable haulage distance of Adams Head. Aggregates used in concrete platforms must have a high strength and a non-reactive chemical content. For these reasons, detailed sampling was conducted to provide material for petrographic analysis, grain size analysis and alkali reactivity testing. The testing will be done under the Canada-Newfoundland Mineral Development Agreement, 1984-1989; the alkali reactivity testing will be done by CANMET.

The height of shoreline exposures and the estimated depth of deposits in areas of hand dug test pits were recorded. These, together with the lateral extent of the deposits as determined from airphoto and/or field observations, were used to calculate available volumes of aggregate material.

Physiography

The climatic conditions of the study area consist of late springs and cool summers. Winters are cold but less severe than most areas of the province. The climate is also influenced by the cold Labrador Current which flows along the east coast of Newfoundland. Situated near the isthmus of the Avalon Peninsula, the area is subject to heavy and prolonged fogs that come off the waters of Placentia Bay and Trinity Bay. The prevalent wind direction is westerly.

The area was covered during the Late Wisconsin by glaciers that converged on Placentia Bay, generally from northwesterly and northeasterly directions. Generally there is a less than 3 m thick till veneer (composed of compacted silty materials) with numerous rock outcrops interspersed throughout. Large glacial erratics are common on hill tops. Major deposition resulted from glaciofluvial action in rounded

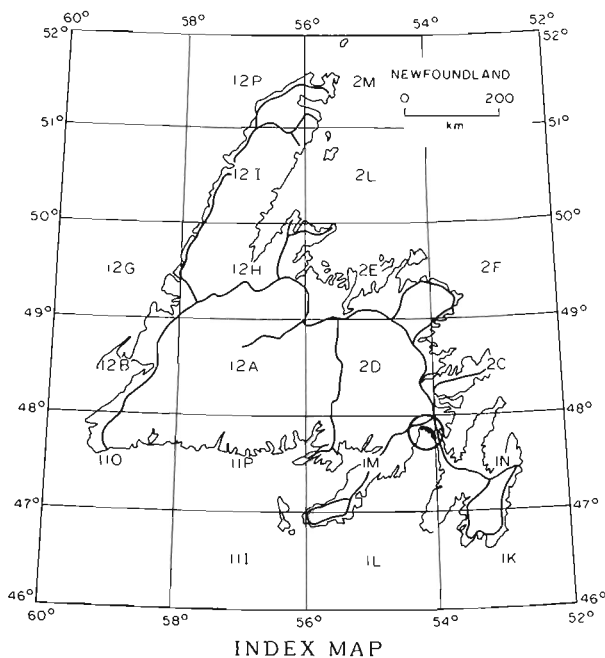


Figure 1: Location of study area.

U-shaped valleys, such as in the valleys at Pipers Hole, North Harbour and Come-By-Chance. Glacial retreat resulted in small to large glaciofluvial deposits along valley floors and near the mouths of rivers entering the ocean. Wave-cut benches within glacial sediments and wave-built terraces are well developed in many places along the coast. They occur at various elevations from the present sea level to 18 m above it (Rose, 1947).

A jagged shoreline with steep to near vertical cliffs is common around most parts of Placentia Bay. With the exception of local shore ice, Placentia Bay is relatively ice free throughout the year.

FIELD PROGRAM

Field sampling was conducted on a number of deposits using a 200 m sample interval. Where possible, samples free of plant debris and topsoil were taken from natural exposures such as stream cuts, coastal sections or gullied areas. Where natural exposures were not present, samples were collected from hand-dug test pits that extended well into the C horizon (usually greater than a 2 m depth) in order to provide a fresh sample.

Data Analyses

An important objective of the field program was to obtain lithological, petrographic (Canadian Standards Association, 1973) and grain-size analyses. Field sieve analyses were conducted on samples containing material greater than 8 mm in diameter and laboratory grain-size analyses (Kirby *et al.*, 1983) were conducted on the minus 8 mm sample fractions. From the accumulated sieve data, the percentages of gravel, sand and silt/clay content of individual samples were determined.

A database management system (Scientific Information Retrieval System) designed for storage and retrieval of aggregate and surficial geology data (Atkinson, 1984) is used to record all field and laboratory data.

AGGREGATE RESOURCE AREAS

Ten deposits of aggregate resource potential were sampled in the most northern areas of Placentia Bay. The sampled deposits have individual estimated volumes that range from 16,000 m³ to 8,360,000 m³. The three largest deposits are located near Swift Current, Pipers Hole and North Harbour, with less extensive deposits at Black River Point and Woody Island. Deposits of low potential were sampled from: (a) two eskers 3 km west of Pipers Hole Provincial Park, (b) glaciofluvial terraces at Jack's Pond Provincial Park and Bittern Cove, and (c) small deposits at Baker Cove and Muddy Hole.

Swift Current Deposit

The Swift Current deposit is situated on the southwest shore of Swift Current and extends for 2.8 km in a northwest direction from Clay Cove (Figure 2). Its upper surface ranges in elevation from 4 to 15 m a.s.l. and is dissected by three small intermittent streams. It is overlain by dense forest growth and bog cover (30 to 40 percent). The combined A and B soil horizons reach thickness of 1 m in several localities.

The Swift Current deposit is the largest known deposit of high quality aggregate in the northern part of Placentia Bay. It is dominantly a sandy pebble gravel, with boulders and large cobbles occurring at some localities. Typical grain-size curves show less than one percent silt/clay content with a few samples showing greater than ten percent. Samples with the higher percentages were usually collected near the fringe of the deposit, or near its surface. An average petrographic value of 134 (Table 1) is based on analyses of 62 samples that gave values ranging from 100 to 300, of which only 7 were above 150.

A large deposit of stratified clay and fine sand is situated at the southeast end of the Swift Current deposit at Clay Cove (Figure 2). The clay deposit can provide a source of impervious material for use as seals in cofferdams.

The water channel flanking the Swift Current deposit is approximately 3.5 m deep at low tide. It is thus probable that mined aggregate material can easily be transported by barge to the proposed Adams Head construction site. It is expected that very little dredging (except for wharf facilities) will be needed.

Pipers Hole

The Pipers Hole deposit was originally sampled in 1978 (Kirby, *et al.*, 1983) under the Inventory of Aggregate Resource program. The deposit is located northwest of Mooring Rock Cove (Figure 2). It reaches an elevation of approximately 11 m a.s.l., tapering off gently toward the southeast where it has a thickness of less than 1 m a.s.l. The main part of this deposit is covered by barrens, including 1 to 1.5 m of peat (Tucker, 1979) and stunted tree growth. The lower region near the coast is bog covered and, because the deposit is thin above the water table, it has little potential for mining of sand and gravel.

The Pipers Hole deposit has 60 percent sand content and is overlain by 1 to 2 m of pebble gravel in many areas. An average petrographic value of 128 is based on 7 samples (collected in 1978 and 1985) that ranged in value from 100 to 180.

If the Pipers Hole deposit is used in concrete platform construction, with barging as the mode of transportation, dredging would be required along a 2 km stretch of shallow water (0.5 m at low tide) from Cape Pine to Mooring Rock Cove in the upper part of the Swift Current channel. This deposit has been quarried since 1974 and is approximately 20 percent depleted. It is presently being used by two operators. The Department of Transportation extracts sand for use in ice control, and Atlantic Concrete (formerly Lundrigan's East) mines the deposit as a source of blending sand for use in high strength concrete and cement blocks.

North Harbour

The North Harbour deposit is situated at the north end of North Harbour in the Caplin Cove area, and near the mouth of the North Harbour River (Figure 3). It is composed of a glaciofluvial terrace, dissected by several small streams. The deposit, which is separated into two areas by the North Harbour River, a designated salmon river, is covered by dense forest growth.

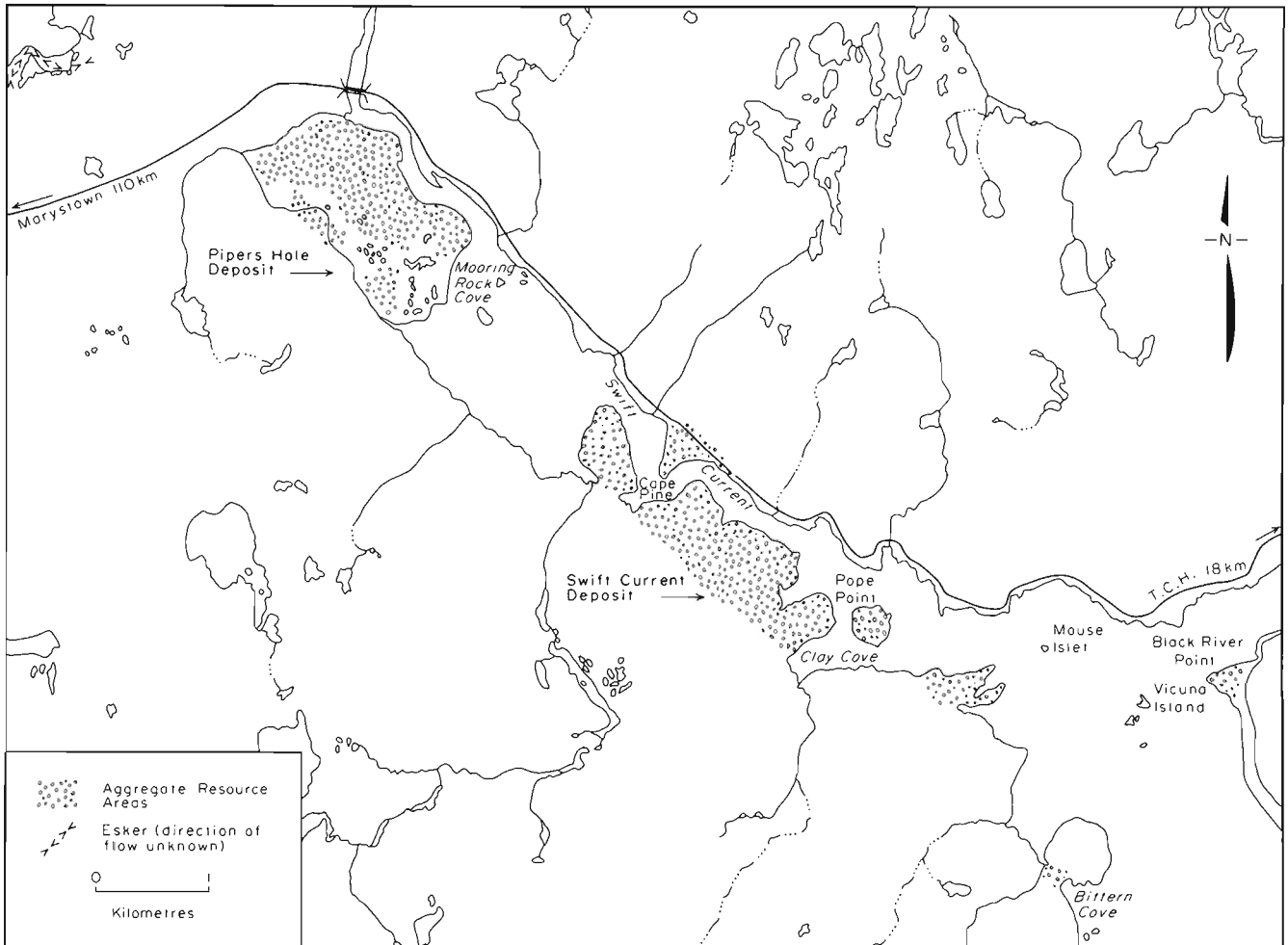


Figure 2: Aggregate resource areas at Pipers Hole, Swift Current, Black River Point and Bittern Cove.

Analyses of 33 samples in this area (Table 1) indicate a higher sand and silt/clay content than deposits at Swift Current and Pipers Hole. Petrographic values are also much higher, with an average of 223 based on 14 samples that had values ranging from 130 to 390. Although certain sections of this deposit could be used to produce a good quality concrete, it is generally of substandard quality and not suited for a massive concrete construction project.

Woody Island

The Woody Island deposit, situated on the northeastern side of Woody Island (Figure 4), is surrounded by deep water and is closer to the Adams Head construction site than any other deposit. It is partly forested, and has some barrens and a few cleared areas.

An average petrographic value of 127 is based on analyses from six samples, ranging from 110 to 150. The average silt/clay content is 1 percent which is lower than any of the larger deposits listed. The 77 percent average for sand content (Table 1) is 7 percent lower if the values from 5 sand samples taken in the northeastern part of the deposit are excluded. This would increase the gravel content from 22 percent to 30 percent.

Black River Point

The Black River Point deposit is located on the southern shoreline at the entrance to Black River Harbour (Figure 2). It has a maximum height of 8 to 12 m a.s.l. and, except for a few cleared areas, is covered by tree growth. An average petrographic value of 103 was calculated from analyses of ten samples with values ranging from 100 to 120. The Black River Pond deposit has the best petrographic qualities of all shoreline deposits sampled.

The deeper water along this shoreline will provide easy access if aggregate material is transported by barge from the Black River Point deposit. A road from Garden Cove to the Burin Peninsula Highway runs along the eastern side of the deposit.

Esker Deposits

Two eskers were located 3 km west of Pipers Hole Provincial Park near the Burin Peninsula Highway. These are not potential source areas of aggregate material for concrete platform construction, but would provide a high quality aggregate for local use such as road upgrading. The eskers are 1 to 1.5 km from the highway and are situated in an area of

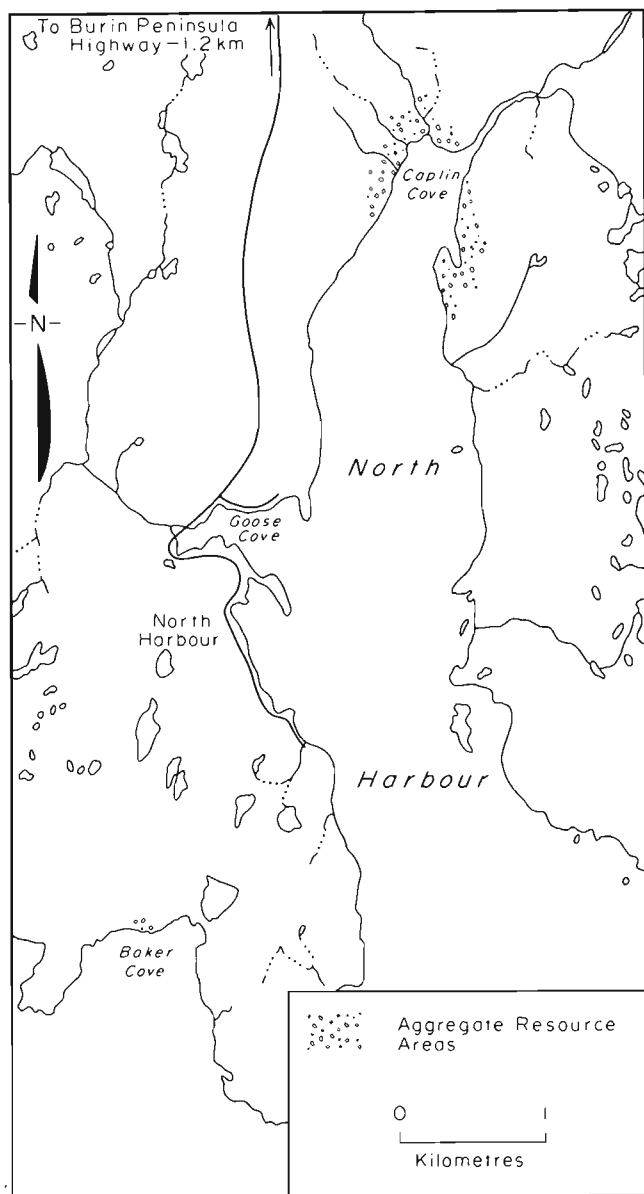


Figure 3: Aggregate resource area at North Harbour and Baker Cove.

bogland and barrens; thick tree growth occurs near the highway. The eskers are approximately 1100 m long and range from 5 to 13 m in height above the surrounding area.

An average petrographic value of 102 was calculated from analyses of five samples, of which four had values of 100.

Jack's Pond Provincial Park

The Jack's Pond Provincial Park deposit is situated near Great Southern Harbour, within the boundaries of Jack's Pond Provincial Park in the Sunnyside map area (1 N/13). The vegetation in this area consists of thick tree growth.

An average petrographic value of 187 was obtained from four samples with values ranging from 120 to 280. These high values indicate the material is of poor quality and not useable

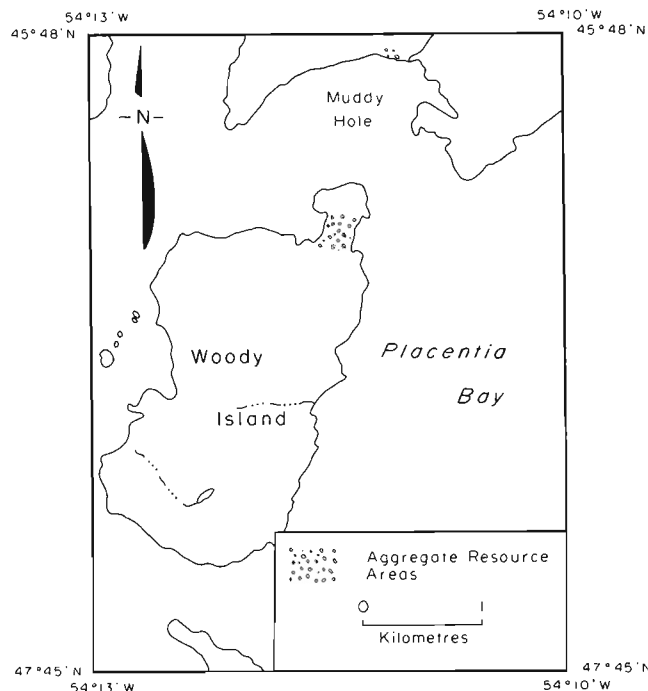


Figure 4: Aggregate resource area at Woody Island and Muddy Hole.

in most concrete projects. Deposits of compacted silty tills were sampled adjoining this shoreline, glaciofluvial, gravel deposit. These tills have 30.5 percent gravel, 40.3 percent sand and 29.2 percent silt/clay content.

Bittern Cove

The Bittern Cove deposit is situated in a sheltered cove 2 km southeast of the Swift Current deposit (Figure 2). Thick tree growth covers most of the deposit.

The 73 percent sand content shown in Table 1 is the second-highest sand concentration of all deposits sampled. Petrographic analyses have been conducted on only two samples, with respective values of 100 and 110. This is a high quality material but is of insufficient quantity for the required project.

Baker Cove

Located in a cleared area south of North Harbour, the Baker Cove deposit (Figure 3) is predominantly comprised of a sandy gravel. Its isolation, small size and high petrographic values (170 to 240), based on analyses of two samples, make it a very poor deposit for use in any construction project.

Muddy Hole

The Muddy Hole deposit is situated in a forested area 1 km north of Woody Island (Figure 4). Similar to the Baker Cove deposit, its isolation, small size, high silt/clay content and poor quality reduces its potential for use in offshore construction projects.

Table 1: Summary and comparisons of aggregate deposits sampled in the northern part of Placentia Bay.

Deposit	Cubic Meters	Number of Samples Collected	Average Petro-graphic Number	% Gravel (+ 2 mm)	% Sand (+0.074 mm to - 2 mm)	% Silt (-0.074 mm)	Comments
Swift Current							
a) Sand/Gravel	8,160,000	87	132	40	57.35	2.65	Predominantly medium to fine grained sand with the highest percentage of particles occurring between the 0.5 to 1.0 mm range. A clay deposit is situated at the southeast end of the Swift Current deposit
b) Clay (Clay Cove)	200,000	5		0	29.14	70.86	
Pipers Hole	5,250,000	15	128	38	60	2	Cross-bedded, ripple-laminated sands and pebble gravels exposed in an active quarry. Dominant particle size occurs between the 0.25 to 0.5 mm range. The deposit is overlain by 1 to 1.5 m of peat
North Harbour	2,048,000	33	223	28	64	8	Glaciofluvial terrace dissected by several small streams. Dominant particle size occurs between the 0.25 to 0.5 mm range
Woody Island	825,000	17	127	22	77	1	Fine to medium sands with dominant particle size occurring between the 0.25 to 0.5 mm range
Black River Point	600,000	14	103	37	61	2	Predominantly sands and sandy gravel with minor cobble gravel near the surface. The dominant particle size occurs between the 0.5 to 1.0 mm range
Eskers (3 km west of Pipers Pond Provincial Park)	330,000	5	102	67	32.50	0.50	Pebble, cobble gravel with dominant particle size occurring between the 16 to 31.5 mm range
Jack's Pond Provincial Park	240,000	5	187	42	54	4	Coarse to medium sandy gravel with dominant particle size occurring between 2.0 to 4.0 mm range
Bittern Cove	202,300	5	105	26	73	1	Coarse to fine sand and pebble gravel with the dominant particle size occurring between the 2.0 to 4.0 mm range
Baker Cove	22,400	2	210	53.55	46.20	0.25	Medium to coarse sandy pebble gravel with the dominant particle size occurring between 0.5 to 2.0 mm range
Muddy Hole	16,000	3	120	25	54	21	Medium sandy gravel and silt with silt/clay being the dominant particle size

Note: Estimated quantities given in table are based on airphoto analysis and field investigation of extent and depth of shoreline deposits. Percentages are based on a compilation of individual samples and do not take into account extent and depth of deposits at any one locality.

CONCLUSIONS

Several deposits of sand and gravel sampled in the Placentia Bay area are large enough to supply the quantity of aggregate material required in the construction of offshore concrete platforms. Additional testing will be required on these deposits to determine their compressive strength and their chemical reactivity under strenuous environmental conditions. Sixteen samples have been arbitrarily selected for alkali reactivity testing, sponsored under the Canada-Newfoundland Mineral Development Agreement, 1984-1989, using the resources of CANMET.

The extent and depth of underlying layers in deposits sampled during the 1985 field season could not be determined from exposures in shallow hand dug pits. For this reason further sampling (including drilling) will have to be conducted on any selected deposit for continued geotechnical testing.

Many deposits sampled are too small and/or have poor aggregate qualities, i.e., unacceptable petrographic values and/or too high silt/clay content, rendering them unsatisfactory for use in quality concrete. These deposits should be ignored for use in concrete platforms.

The Woody Island and Black River Point deposits may lack sufficient quantities to establish a major quarry operation, despite their good petrographic values and low silt/clay content. These may, however, generate interest if the larger deposits were proven unsuitable.

The three largest deposits at North Harbour, Pipers Hole and Swift Current individually have the quantity of material required, but quality and access are variable. The North Harbour deposit may not be developed because of the poor petrographic qualities and/or high silt content in most sections of the deposit. However good petrographic numbers, and samples with low silt/clay contents were obtained in some sections.

Analyses of aggregate samples collected from the Pipers Hole deposit indicate it is a good quality concrete aggregate in most localities. However, it is situated in an area where dredging will be required to allow barges to navigate the upper part of Swift Current. Otherwise, trucks will have to be used to transport the aggregate material to the construction site or to an area where barges could be loaded. Whichever method is used, a cost increase will occur as opposed to other shoreline deposits closer to Adams Head. In addition, this deposit is presently used to meet land use requirements for ice control and high strength concrete, and consideration must be made to ensure this deposit is not depleted for these uses.

Sand and gravel in the Swift Current deposit are in a suitable location and, in most sections, have good petrographic qualities and low silt/clay content. It is also the largest known deposit in the Placentia Bay area and therefore the most likely to be developed during construction of concrete platforms.

ACKNOWLEDGEMENTS

The author wishes to thank Jim Rodgers for his cheerful and capable assistance and his lengthy conversations during the long days of summer. Baxter Beck, the park ranger at Pipers Hole Provincial Park, is thanked for his friendly discussions and helpful advice on the terrain of the Swift Current and Pipers Hole areas.

A critical review by Fred Kirby, Martin Batterson and Doug Vanderveer resulted in substantial improvements to this manuscript.

REFERENCES

- Atkinson, J.
1984: Aggregate resource inventory system. *In* Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-1, page 290.
- Bragg, D.
This volume: Reconnaissance study of bedrock aggregate potential for offshore and industrial use.
- Canadian Standards Association
1983: CSA Standards A23.1, A23.2, A23.4, Rexdale, Ontario.
- Clark, P.
1985: Excavation summary for concrete platform construction. Unpublished report, North Atlantic Contractors, St. John's, Newfoundland.
- Kirby, F.T., Ricketts, R.J. and Vanderveer, D.G.
1983: Inventory of aggregate resources in Newfoundland and Labrador, information report and index maps. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-2.
- Kristiansin, K.O.
1985: Construction of concrete platforms, industrial and regional benefits - government policy. Paper presented by the Royal Norwegian Ministry of Petroleum and Energy, March 21, 1985, St. John's, Newfoundland.
- Rose, E.R.
1947: Summary report of geological field work from Come-By-Chance to Swift Current. Unpublished report, Geological Survey of Newfoundland. [1M(4)]
- Tucker, C.M.
1979: Late Quaternary events on the Burin Peninsula, Newfoundland. Ph.D. thesis, McMaster University, Hamilton, 282 pages.

Note: Mineral Development Division file numbers are included in square brackets.