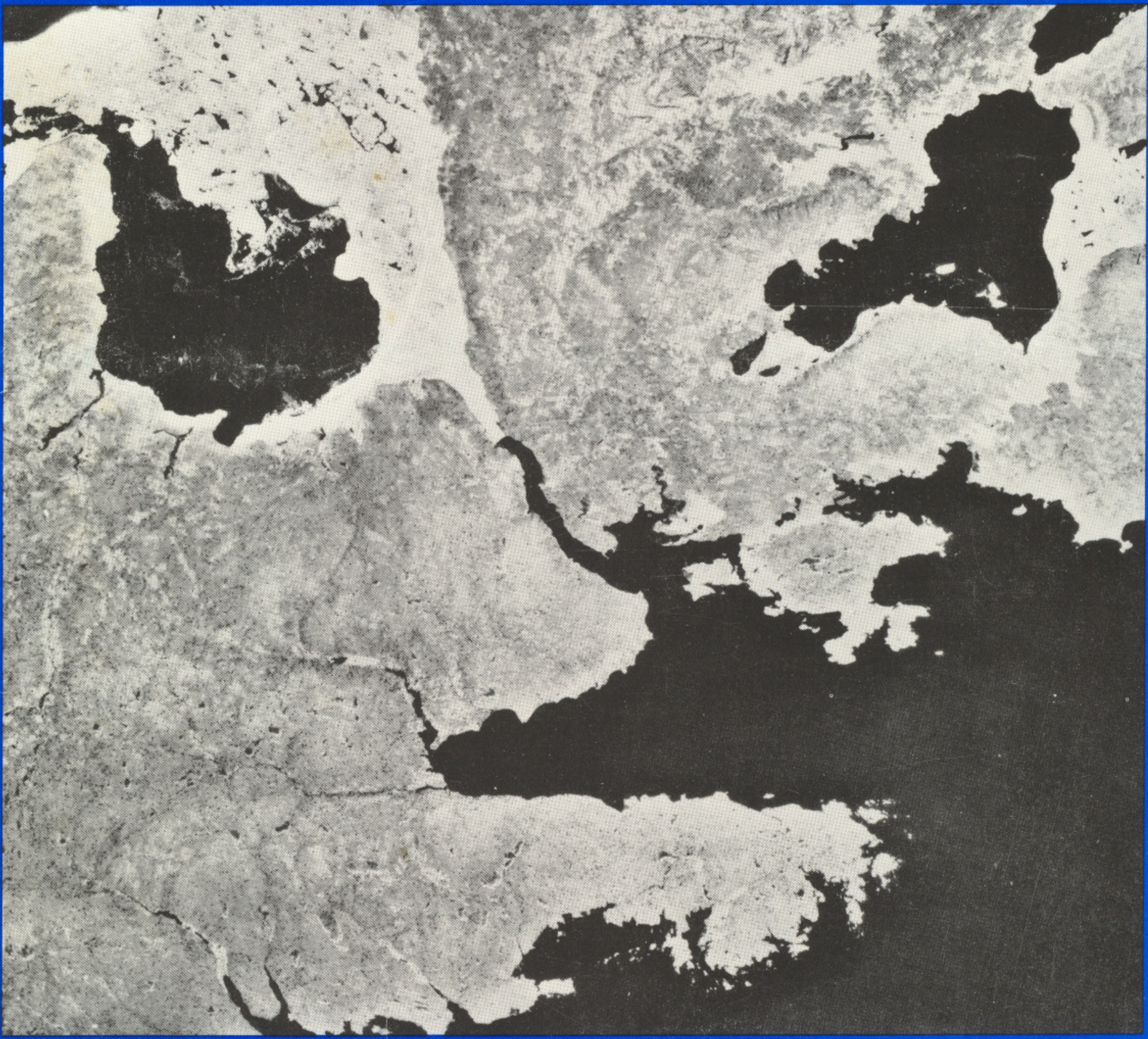
Water Resources



Strait of Canso Natural Environment Inventory

commissioned by
The Canada-Nova Scotia Strait of Canso Environment Committee
1975

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FOREWORD

An exchange of letters in 1973 between the Ministers of the Environment for Nova Scotia and for Canada identified the need for an environmental assessment of the Strait of Canso region and established the Canada-Nova Scotia Strait of Canso Environment Committee. The Committee is composed of representatives of the Department of Regional Economic Expansion, Environment Canada and Transport Canada, and of the Department of the Environment, Department of Development and Department of Municipal Affairs of the Province of Nova Scotia.

The Strait of Canso Environment Committee has as its first objective the development of an environmental management strategy proposal for the Strait of Canso area. Regional environmental assessment and environmental management programs must necessarily be based upon a comprehensive and integrated knowledge of the physical, social and economic resource base of the region.

Toward this end, the Committee arranged for an initial program, funded under a Federal-Provincial agreement, comprising an inventory of existing information on the natural environment of the Strait of Canso region. The inventory of natural resources and resource uses commenced the summer of 1974, leading to the presentation of the information in a series of special maps and accompanying reports for publication and distribution in late 1975 and early 1976.

This task would not have been possible without the enthusiastic support and assistance of the many individuals, agencies and departments mentioned in greater detail in the acknowledgements which follow.

J. S. Mactavish, Chairman,
Strait of Canso Environment Committee.

ACKNOWLEDGEMENTS

The cooperation of many government agencies and individuals in the diverse field of water resources research, planning and development has been of invaluable assistance in the preparation of the water resources map and report for the Strait of Canso region.

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Gratitude is also expressed to P. Talbot and C. Oldreive of the Nova Scotia Department of the Environment for information on water supply and use, and F. Shea and J. Fowler of the Nova Scotia Department of Mines for compilation of information on bedrock geology. Contributions by other agencies and individuals are also gratefully acknowledged.

Prepared by the
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INTRODUCTION

Mainland Nova Scotia and Cape Breton Island were linked in 1954 upon completion of the Strait of Canso causeway. The Strait is relatively narrow, varying in width from 800 m to 2,000 m (2,600 to 6,600 ft.), although it is most commonly 1,600 m (1 mile) wide throughout the 27 km (17 mi.) length. The section south of the causeway is 15 km (9 mi.) long, with a depth usually varying between 38 m and 64 m (125 to 210 ft.).

Although the primary objective of the causeway was to facilitate road and rail traffic, an additional benefit was the creation of one of the best year-round, deep-water harbours found along the eastern seaboard of North America. This stimulated the development of the Strait of Canso area. Port facilities were established, industries located in the area, communities expanded rapidly, and further developments are anticipated. Considerable attention is focusing on this area.

The map and report are part of a series commissioned by the Canada-Nova Scotia Strait of Canso Environment Committee. The inventory is intended to provide basic information on natural resources and resource use in a format useful to all concerned with the development of the Strait area and the coastal and inland zones of the surrounding region. The map covers a land area of approximately 4,350 km ^{2} (1,680 sq. mi.) and a total area, including George Bay, Bras d'Or Lake, Chedabucto Bay and the waters off the southern shore, of approximately 8,630 km ^{2} (3,300 sq. mi.).

The water resources map and report provide information, available mainly as of November 1974, on surface water resources, groundwater resources and marine waters. Groundwater resources are directly dependent on the bedrock and surficial geology, which forms the background content of the map. The map should be used in conjunction with the accompanying report and is largely intended as a tool to assist planners and potential developers in the assessment of freshwater resources available in the Strait of Canso region.

PHYSIOGRAPHY

The Strait of Canso and the surrounding region have a complex history. This is reflected in the geology and soils, which influence the development of surface drainage patterns and have a bearing upon groundwater resources.

Although the region is a relatively small part of the province, 17 of the 24 geological formations of Nova Scotia have been mapped in the area. These range from the province's oldest rocks of the George River group, 800 to 900 million years old, to the second youngest, the Annapolis group, formed about 200 million years ago. Tectonic movements have complicated the geological structure. A major fault line extending from Minas Basin past the south shore of Chedabucto Bay separates the Nova Scotia Uplands in the south from the Lowlands to the north. The Lowlands are bordered in the northwest by the Antigonish Highlands and in the east by the Mabou Highlands and the hills around Bras d'Or Lake, formed by smaller, usually tilted blocks of older bedrock. During the past 1.5 to 2 million years, four major glacial periods, separated by long-term interglacial intervals, have occurred. During the last period, the entire region was covered by glaciers, which disappeared 12,000 to 10,000 years ago. The turbulent past is also reflected in the soils. Most of the 23 major soil types of the province are represented, and in most instances they exhibit characteristics derived from the underlying bedrock.

FRESHWATER RESOURCES

HYDROMETEOROLOGY

The ultimate source of all freshwater supplies is water arriving in the area in the form of precipitation. Some of this water is stored temporarily as snow, surface water and groundwater, but in the end it is removed by stream flow, evapotranspiration and in a very minor way by groundwater flow directly to the sea.

Eleven climatological stations have been in operation within the region, and several others are located nearby, as indicated on the 1:125,000 map and in Table 1 and Figure 1. Hydrometric stations in and near the study region are listed in Table 2, and the locations are also shown on the 1:125,000 map and in Figure 1. Selected data for these stations are summarized in graph form in Figures 2, 3, 4 and 5. In addition, standard climatological graphs for several stations are provided in the Appendix.

Mean annual precipitation varies from 105 cm (41.3 in.) at Antigonish to 151 cm (59.4 in.) at Dickie Brook. Precipitation in the form of snow arrives in October and peaks in January and February to about half the total precipitation, gradually diminishing in ratio to its disappearance in May. The annual precipitation pattern is rather uniform for all stations. These and other characteristics are shown in Figure 2.

Due to temperatures, stream flow may not immediately reflect the precipitation pattern. Snow accumulation, snowmelt and evapotranspiration are influenced by variations in temperatures, shown in Figure 3. The mean temperature range for the 8 stations is very small. Larger deviations, due to local conditions, are observed in the extreme maximum and minimum temperatures.

The difference between the mean annual precipitation of 105-150 cm (41-59 in.) and the mean annual river discharge of 95-120 cm (37-47 in.) leaves an amount of 10-30 cm (4-12 in.) accountable to actual evapotranspiration. Means and extremes of annual precipitation and stream flow for some of the climatological and hydrometric stations in or near the area are indicated in Figures 4 and 5.

TABLE 1
CLIMATOLOGICAL STATIONS IN AND NEAR THE STRAIT OF CANSO REGION

Figure and Map No.	Station Name	Agency Station No.	Latitude	Longitude	UTM Grid	Period of Operation	Temperature	Precipitation
C1	Barrie Brook	8200400	45.39	61.26	PF219557	1950 —		X
C2	Port Hastings	8204480	45.39	61.22	PF254552	1882 — 1913	X	X
			45.38	61.23		1959 —	X	X
C3	Birchtown	8200581	45.27	61.29	PF189329	1958 —		X
C4	Dickie Brook	8201500	45.21	61.30	PF172227	1950 —		X
C5	Canso	8200640	45.19	60.58	PF592202	1963 — 1971	X	X
C6	Eddy Point	8201716	45.31	61.15	PF364413	1971 —	X	X
C7	River Denys	8204565	45.48	61.12	PF393737	1966 —	X	X
C8	Collegeville	8201000	45.29	62.01	NF768377	1916 —	X	X
C9	Deming	8201410	45.13	61.11	PF432082	1956 —	X	X
C10A	White Head	8206300	45.12	61.08	PF463064	1885 — 1925	X	X
C10B		8206300	45.13	61.11	PF429085	1926 — 1960	X	X
C11	Antigonish	8200150	45.38	61.58	NF783520	1911 — 1947	X	X
C12	Copper Lake	8201100	45.23	61.58	NF815250	1945 — 1974	X	X
C13	Stillwater	8205600	45.10	61.59	NF804028	1915 — 1967	X	X
C13A	Stillwater-Sherbrooke	8205601	45.08	61.59	NE804995	1967 —	X	X
C14	Port Hood	8204500	46.01	61.34	PF115967	1961 —	X	X
C15	Baddeck	8200300	46.06	60.44	PG737071	1935 —	X	X
C16	Loch Lomond	8203150	45.44	60.37	PF870664	1958 —		X
C17	Ecum Secum	8201700	44.58	62.09	NE671794	1940 —	X	X

Source: Atmospheric Environment Service, Environment Canada.
Note: Stations C1 to C11 are located within the study region. UTM — Universal Transverse Mercator Grid Locations.

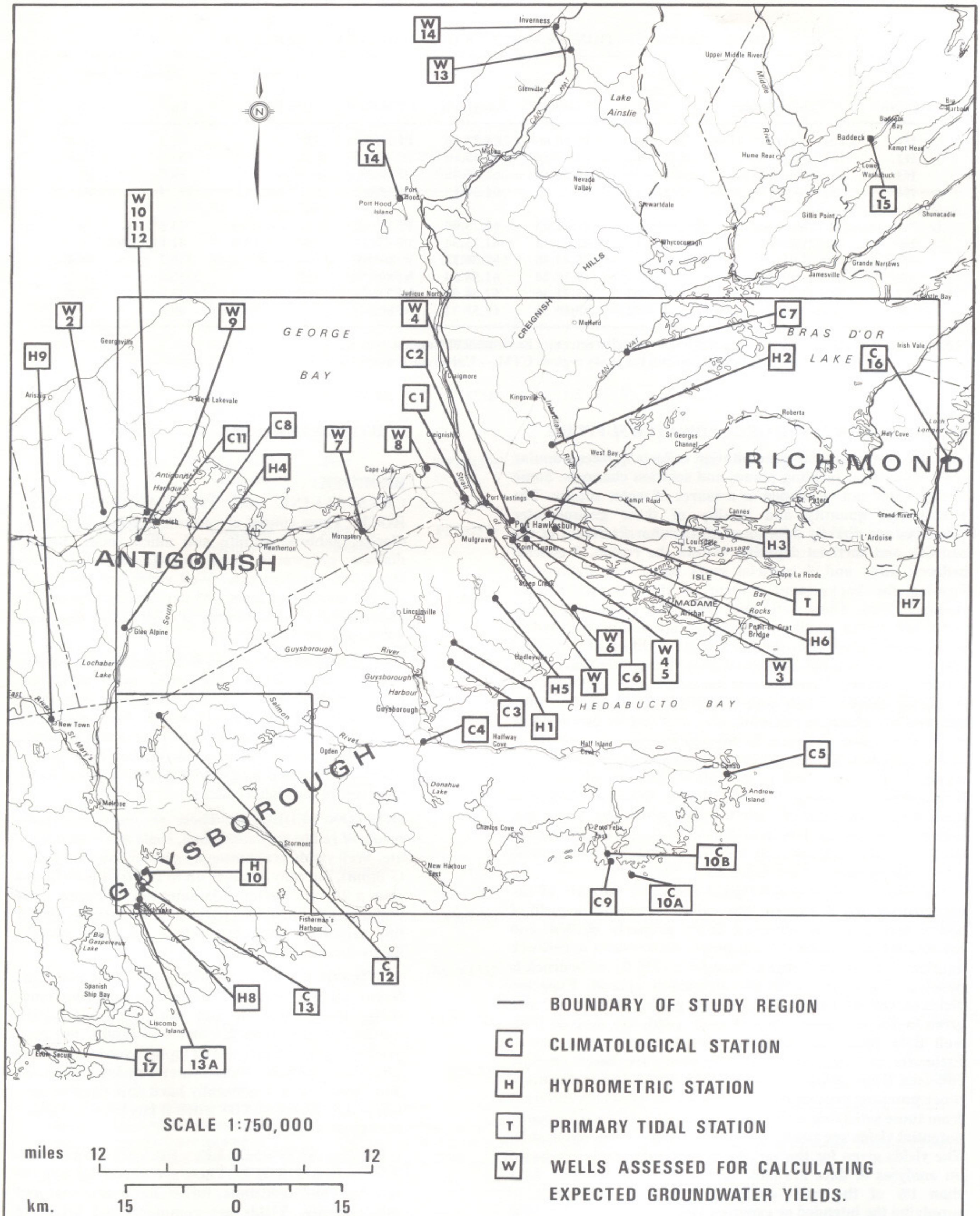


FIGURE 1– LOCATION OF CLIMATOLOGICAL STATIONS, HYDROMETRIC STATIONS, PRIMARY TIDAL STATION, AND WELLS IN AND NEAR THE STRAIT OF CANSO REGION.

TABLE 2
HYDROMETRIC STATIONS IN AND NEAR THE STRAIT OF CANSO REGION

Figure and Map No.	Station Name	Agency Station No.	Latitude	Longitude	UTM Grid	Period of Operation	Watershed Area km^2	Watershed Area sq. mi.
H1	Clam Harbour River	01ER001	45.28.06	61.27.36	PF203360	1958 —	45.1	17.4
H2	Inhabitants River	01FA001	45.43.15	61.17.10	PF333641	1965 —	193.0	74.5
H3	North Little River	01FA003	45.37.50	61.17.05	PF336541	1969 —	26.7	10.3
H4	South River	01DR001	45.33.35	61.54.15	NF855455	1917 — 1933 1965 —	177.4	68.5
H5	St. Francis River	01ER002	45.32.03	61.25.00	PF237433	1958 — 1960	23.8	9.2
H6	Little River	01FA002	45.36.12	61.15.34	PF358512	1967 — 1968	41.0	16.0
H7	Grand River	01FH001	45.43.48	60.36.12	PF865665	1920 —	120.2	46.4
H8	St. Mary's River	01E0001	45.10.24	61.58.54	NF801795	1915 —	1355.0	523.0
H9	East R. St. Mary's	01E0003	45.21.36	62.08.08	NF236231	1965 —	282.0	109.0
H10	Archibald Brook	01E0002	45.10.33	61.58.33	NF805029	1915 — 1926	49.0	19.0

Source: Water Survey of Canada, Inland Waters Directorate, Environment Canada.
Note: Stations H1 to H6 are located within the study region. UTM — Universal Transverse Mercator Grid Locations.

HYDROGEOLOGY AND GROUNDWATER SUPPLIES

Water resulting from precipitation collects in intergranular voids, fractures, bedding planes and solution channels. Some of this water can be tapped as a source of water supply. The availability, quantity and quality of these groundwater resources are directly dependent on the characteristics of the bedrock and surficial deposits. Within the region, 5 general bedrock units and 5 surficial units have been delineated, forming the background content of the 1:125,000 water resources map. These units have particular characteristics of yield and water quality, depending upon inherent hydrostratigraphic properties. Bedrock units of different geological age but with similar hydrogeological properties have been grouped together. Groundwater moves because of intergranular permeability through sands and gravels, through fractures and bedding planes in consolidated rocks and by distinct flow through solution channels in limestone, gypsum and other soluble deposits. Favourable sites of groundwater sources are major fault zones, which are often present within rock formations and along the boundaries between geological formations. The type of rock through which the water has been flowing and the length of time of such contact affects the quality of water, expressed in the TDS (total dissolved solids) and hardness values of groundwater.

For each of the hydrogeological units, an estimate of the expected well yield is given. The values represent the yield of water that may be obtained from properly drilled and constructed wells in the various units. With respect to bedrock aquifers, it is assumed that at least 50 m (150 ft.) of bedrock is penetrated and that wells are adequately spaced. Expected yields of wells constructed in different geological units are also given in Table 3. Short-term (1 year) yields are derived from well data based on pumping tests lasting 1 to 3 hours. Estimates of long-term (20 years) yields are based on data collected from pumping tests of at least 72 hours duration. Since pumping procedures for domestic demands are different from those satisfying industrial and commercial requirements, potential yields are given for both categories where applicable. The yields given for the various stratigraphic units are based on analyses of data available for 14 different districts. Less than 1% of the wells drilled proved to be incapable of supplying the intended or expected yield required for domestic purposes.

HYDROSTRATIGRAPHIC UNITS

BEDROCK:

CRYSTALLINE and METAMORPHIC BEDROCK. These consist of volcanic breccia, tuff, lava, diorite, gabbro, granite and allied rocks, basalt, diabase, greywacke, shale, schist, quartzite, sandstone and conglomerate. Well yields are commonly 0.2-0.4 litre/s (3-5 Igpm). Water quality is generally excellent, with a low degree of TDS (total dissolved solids) and hardness.

HALIFAX and GOLDENVILLE BEDROCK. These include slate, schist, quartzite, greywacke and gneiss. Well yields are commonly 0.1-0.4 litre/s (1-5 Igpm) and generally of good quality. The water has a low degree of TDS and is slightly hard and alkaline. The manganese content is sometimes high in the Goldenville, while iron and manganese tend to be excessive in the Halifax slates.

HORTON BEDROCK. These are terrestrial sediments of red to grey sandstone, shale and conglomerate. Well yields are commonly greater than 0.4 litre/s (5 Igpm), but may produce up to 10 litre/s (150 Igpm) over a 20 year period, assuming no recharge. This unit generally provides water of good quality, with a low degree of TDS, but with a tendency towards hardness and alkalinity.

WINDSOR BEDROCK. This group comprises different kinds of marine sediments, including limestone, shale, gypsum and salt. Well yields are commonly more than 0.4 litre/s (5 Igpm), but may produce up to 7.5 litre/s (100 Igpm) over an extended (20 year) period from water-bearing zones in limestone. Water is generally hard and alkaline, and has a high degree of TDS when it has been in contact with gypsum deposits.

CANSO, RIVERSDALE, PICTOU and ANNAPOLIS BEDROCK. These are terrestrial, grey to red shale and sandstone, limestone, minor coal and conglomerate. Yields are commonly 0.2 litre/s (2 Igpm), but may produce as high as 15 litres/s (200

TABLE 3
EXPECTED GROUNDWATER YIELDS
Representative Wells in and near the Strait of Canso Region

Well No.	Geological Group	Material	Location	UTM Grid	Static Level Below Surface		Depth of Pumping		Expected Safe Pumping Rate and sustainable period (for a properly sized and constructed well)			
									1 yr.		20 yrs.	
					m	ft.	m	ft.	litre/s	I gpm	litre/s	I gpm
1	Horton	Sandstone Shales	Mulgrave	PF253525	41	134	122	400	14	190	12	155
2	Windsor	Sandstone Siltstone Grit	Antigonish	NF747539	1.5	5	78	255	2	24	1.5	19
3	Riversdale	Sandstone Siltstone Shales	Port Hawkesbury	PF294528	3.5	12	91	300	16	210	13	170
4	Riversdale	Sandstone Siltstone Shales	Port Hawkesbury	PF282526	3	9	118	388	2.3	30	1.9	25
5	Riversdale	Sandstone Siltstone Shales	Port Hawkesbury	PF284522	5.5	18	91	300	3.3	43	2.7	35
6	Riversdale	Shales Siltstone	Point Tupper	PF287493	3.5	12	61	200	1.5	20	1.2	16
7	Canso	Sandstone Shales	Monastery	PF061523	7	23	158	520	7	90	5	70
8	Canso	Sandstone Shales	Havre Boucher	PF167599	30	99	110	360	4	50	2.7	35
9	Glacio-fluvial	Sand Gravel	Antigonish	NF778497	3	11	14	45	9.5	125	7.5	100
10	Glacio-fluvial	Sand Gravel	Antigonish	NF781532	2	6	14	45	21	280	17	230
11	Glacio-fluvial	Sand Gravel	Antigonish	NF781532	1.5	5	12	40	39	520	35	460
12	Glacio-fluvial	Sand Gravel	Antigonish	NF781532	3	10	12	40	31	410	28	370
13	Glacio-fluvial	Sand Gravel	Inverness County	PF320158	1	3	30	100	37	490	33	430
14	Glacio-fluvial	Sand Gravel	Inverness County	PF301201	2	7	30	100	129	1700	114	1500

Source: Unpublished records, Water Management Division, Nova Scotia Department of the Environment.
Note: The wells are located on the 1:125,000 map and in Figure 1, with numbers corresponding to those used in the table. Wells 2, 13 and 14 are located beyond the study limits. The UTM (Universal Transverse Mercator) Grid locations are also given.

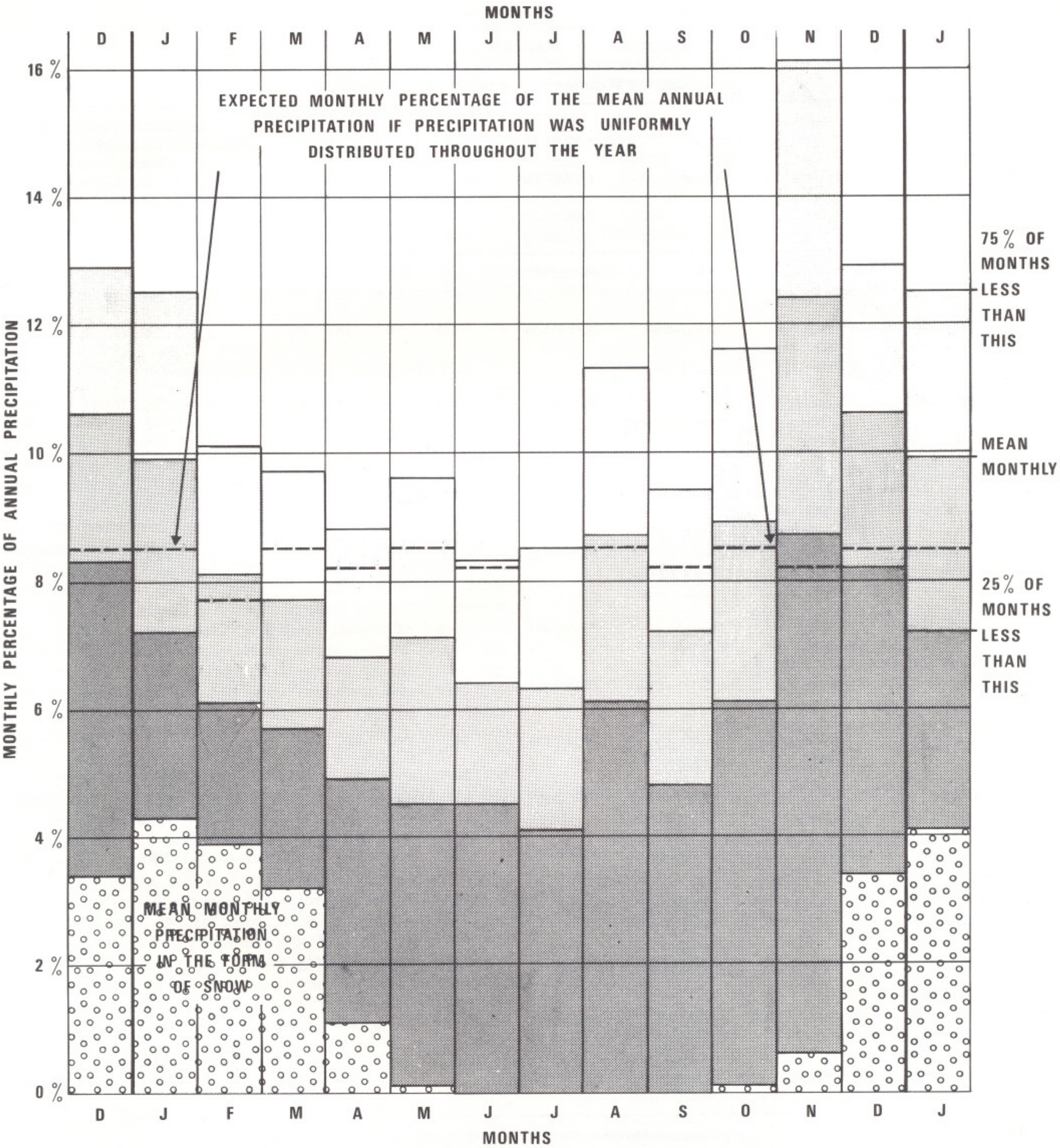


FIGURE 2 – MEAN MONTHLY PRECIPITATION PATTERN OF 14 CLIMATOLOGICAL STATIONS IN AND NEAR THE STRAIT OF CANSO REGION, BASED ON VARYING PERIODS OF RECORDS BETWEEN 1941 AND 1970.

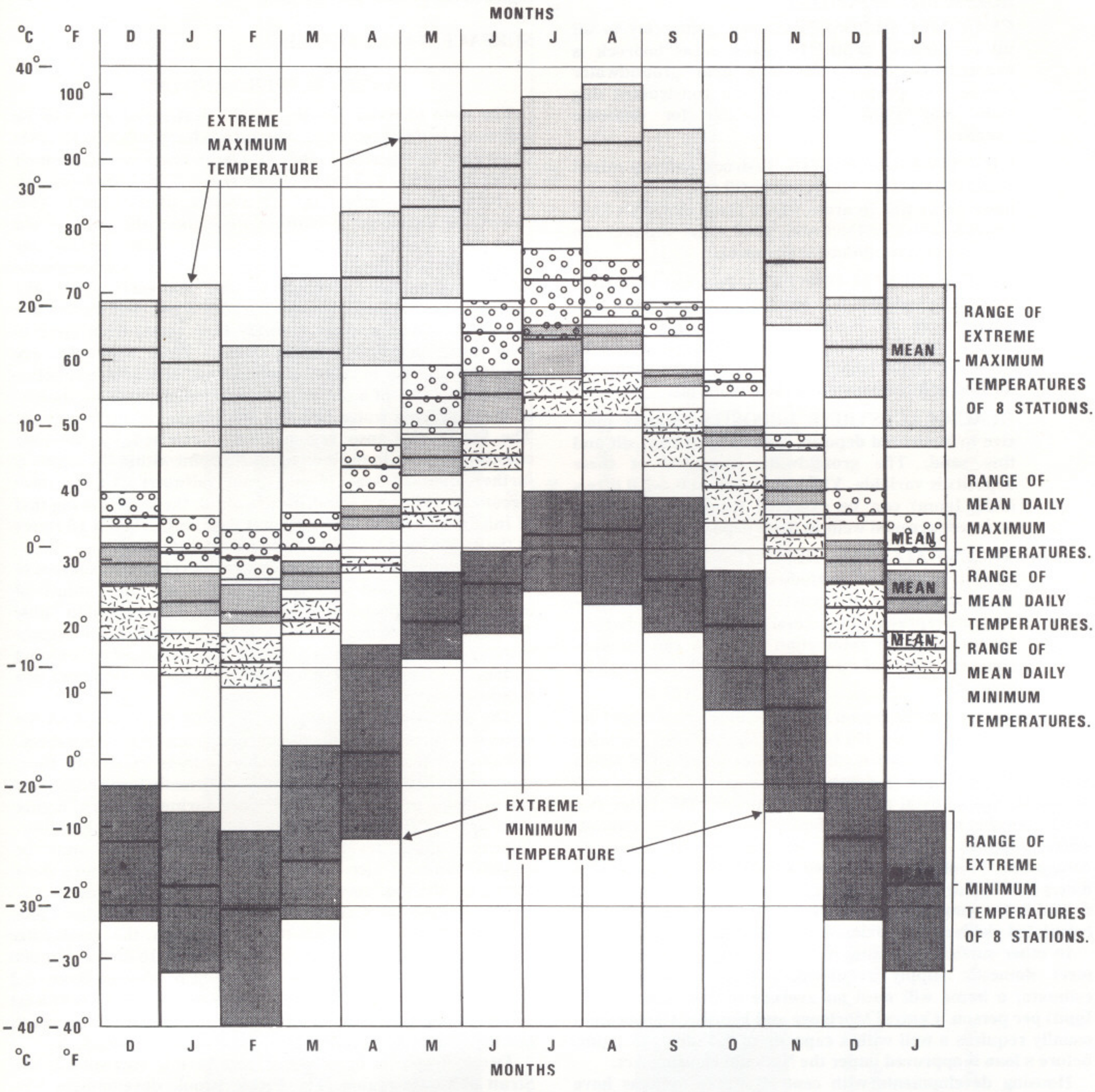


FIGURE 3 - MEAN AND RANGE OF TEMPERATURES OF 8 CLIMATOLOGICAL STATIONS IN THE STRAIT OF CANSO REGION.

Igpm) over an extended (20 year) period. Water quality is good, with a low degree of TDS, but a tendency towards hardness.

The surficial geology of the region is also variable. The map provides information on 5 surficial units and related groundwater potential.

SURFICIAL DEPOSITS:

CLAY TILL DEPOSITS. Stoney, gritty clay to silt till of variable depth. In many areas bedrock is exposed. Generally, this is a poor groundwater source, but properly located and constructed dug wells may yield sufficient water for domestic supplies.

SANDY TILL DEPOSITS. Bedrock outcrop mixed with either a thin stoney, sandy till over bedrock or a loose sandy till. In areas where these materials have enough saturated thickness, good water supplies can be developed for domestic purposes.

GLACIOFLUVIAL DEPOSITS. Poor to well-sorted, stratified sands and gravels. These deposits have high potential as an excellent source of groundwater. Yields from 20-100 litre/s (250-1500 Igpm) can be expected from shallow screened wells properly located and constructed in these materials.

GLACIOLACUSTRINE DEPOSITS. Mainly massive to laminated deposits consisting of clay, silt and fine sand. The groundwater potential of these deposits is variable. Yields from about 0.4-2.0 litre/s (5-25 Igpm) can be expected from properly constructed screened wells in these deposits.

RECENT ALLUVIAL DEPOSITS. Alluvial deposits consist mainly of periodically inundated bottom lands and stream bed gravels, sands and silts. These deposits represent a potential source of groundwater. In areas where infiltration galleries can be constructed, yields of up to 15 litre/s (200 Igpm) can be expected.

The major part of the region has a thin cover (less than 1 m, or 3 ft.) of glacial till over the bedrock. Most of the remaining area has a layer of ablation till over basal till, both of which may vary considerably in depth. Small areas are covered with drumlins, glaciofluvial and alluvial deposits. The latter two are favourable sources for developing large-capacity groundwater supplies. Wells drilled in glaciofluvial sands in Antigonish County have indicated a continuous yield of 17.5 litre/s (230 Igpm) over an extended (20 year) period, and those drilled in the same type of materials in Inverness County have calculated yields of approximately 115 litre/s (1500 Igpm).

In other surficial deposits, well yields may be sufficient to meet domestic supply requirements. As a conservative estimate, a home will need an average of 350 litre/day (75 Igpd) per person. Central Mortgage and Housing Corporation usually requires a well with a capacity of 0.4 litre/s (5 Igpm) before a loan is approved under the National Housing Act.

Housing developments with central supply systems have tapped groundwater sources with a mean potential yield of 1 litre/s (13 Igpm), the range being 0.3 to 1.9 litre/s (4-25 Igpm). During the past 10 years, numerous industrial and commercial establishments have developed groundwater sources. The potential yields average 1.5 litre/s (20 Igpm) and range from 0.1 to 6 litre/s (1-75 Igpm).

In summary, the groundwater potential is generally good with respect to developing small and medium sized groundwater supplies associated with the various bedrock units and the glaciofluvial sands and gravels. Many settlements, however, are situated in the coastal zone, where proximity to the saltwater-freshwater interface can result in saltwater intrusion and consequent well contamination. Wells developed in these areas should be rather shallow and designed, considering expected pumping stresses, to minimize disturbance of the ground flow pattern.

SURFACE WATER SUPPLIES.

WATER SUPPLIES AND USE

The yield of water flowing from a watershed area can be expressed in different ways. Annual discharge of some rivers is illustrated in Figures 4 and 5. The average annual runoff varies from 95 to 120 cm (37-47 inches = 2.75-3.45 cfs/sq. mi. = 1028-1300 Igpm/sq. mi. = 30-38.2 litre/s / km^2). This amount of discharge, if uniform throughout the year, would meet the requirements of approximately 16,000 persons per square mile of utilized watershed. However, the discharges are lower than normal during the summer and early fall. In the average lowest month, the discharge is 3 cm, but during dry years, the lowest average monthly flow varies from river to river from practically nil to 1 cm. Thus reservoirs are required in order to ensure a continuous, dependable supply.

The reliability of a surface water system depends on the size of the supplying watershed and the volume of the reservoir. The Strait of Canso region is characterized by the long coastline relative to the land area. No point within the region is farther than 24 km (15 mi.) from saltwater. Under these circumstances, the watersheds are small, the largest being that of Inhabitants River (355 km^2 or 137 sq. mi.). About 10 rivers in the region have watersheds larger than 100 km^2.

Some watersheds have already been developed as sources of water supply, and the major users are the industrial establishments, particularly at the Strait, as indicated in Table 4. These requirements are met by surface water supply systems located on both sides of the Strait. The existing systems and some that have potential for development are listed in Table 5.

The approximate yields given in Table 5 are based on the estimated mean annual discharges from the watersheds. Because of seasonal and annual variations in stream flow, these yields can only be relied on if sufficiently large reservoirs are available to store the excess water during periods of higher than average flow, to be utilized during periods of low flow. Figure 5 illustrates that a below average flow may be experienced for 5 successive months, and Figures 4 and 5 show the variability that may be expected in river discharges.

The industry at Canso obtains water from Wilkins Lake, 6.4 km (4 mi.) west of town. Although the freshwater demand of the fish plant at Petit-de-Grat is 10 litre/s 220,000 US gpd, the only existing source is a well producing about 0.2 litre/s 50,000 US gpd. A small lake (Freezer Lake) northeast of the plant provided water, which was piped to the plant, but the system proved unreliable and was abandoned.

Two hydropower installations have been in operation in the Strait of Canso region. The Dickie Brook development was put into operation in 1948 and has a maximum output capacity of 2,480 kw. The watershed is 42 km^2 (16.3 sq. mi.) and the reservoirs are Donahue and Tom lakes with a combined storage area of 3,400 ha (8,410 acres). The Barrie Brook power development was completed in 1940 and had a maximum power output of 360 kw ; however, operation has ceased. The water supply was collected in the Barrie (Mill) Brook watershed and was supplemented from the Grant Lake

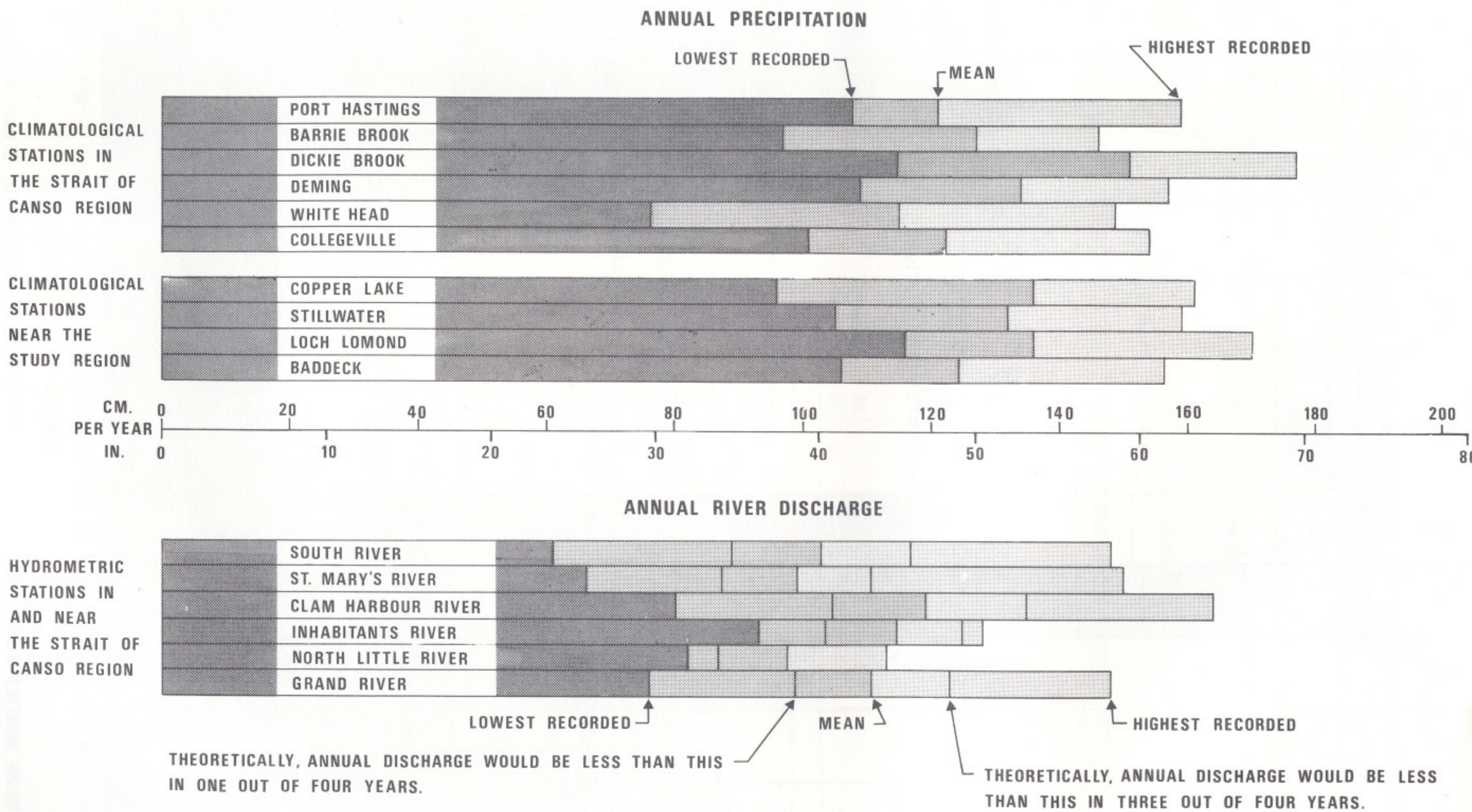


FIGURE 4 – MEAN AND EXTREME ANNUAL PRECIPITATION AND RIVER DISCHARGE AT SELECTED STATIONS IN AND NEAR THE STRAIT OF CANSO REGION.

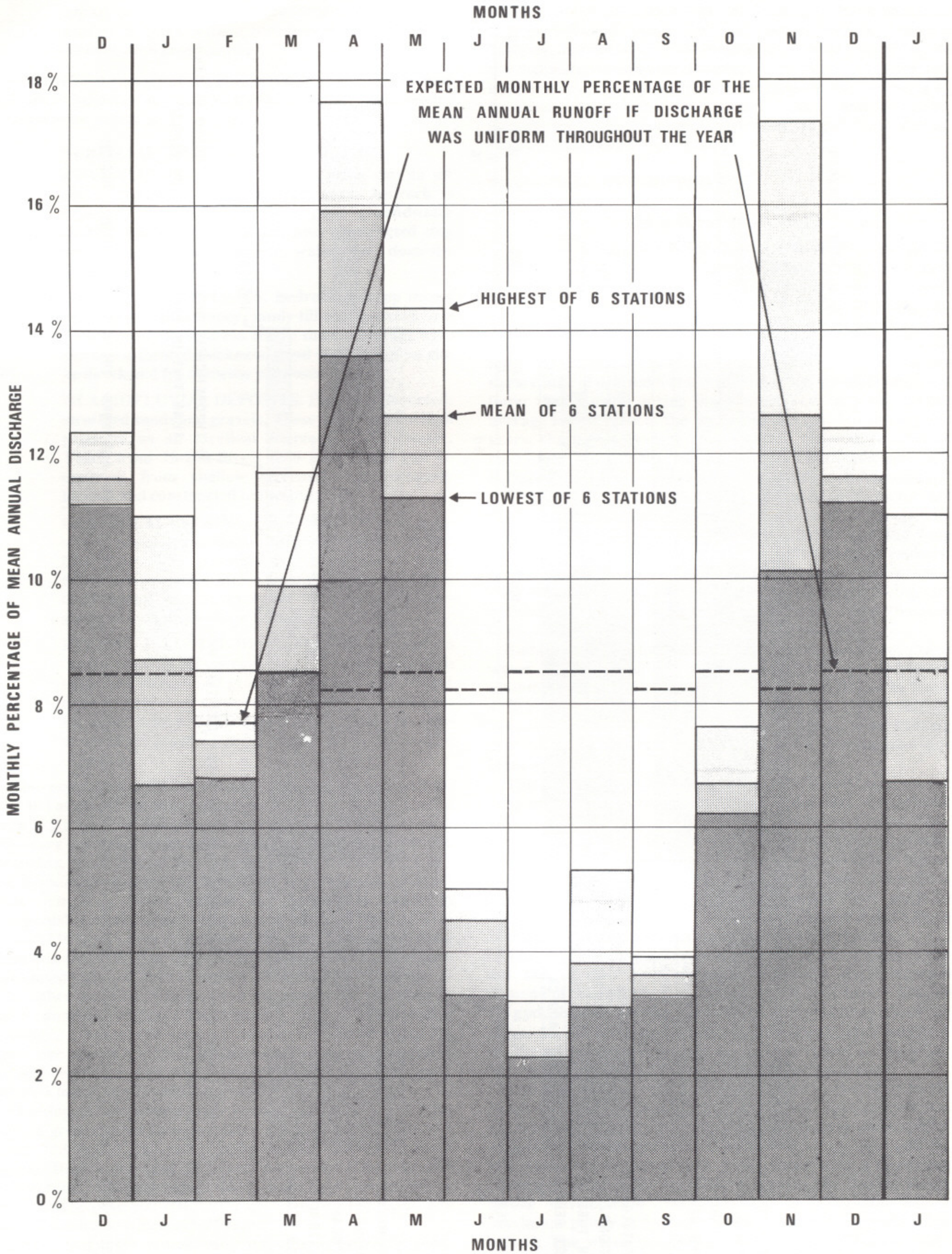


FIGURE 5 – MEAN MONTHLY RIVER DISCHARGE OF 6 HYDROMETRIC STATIONS IN THE STRAIT OF CANSO REGION.

TABLE 4
INDUSTRIAL WATER REQUIREMENTS

Industry		Water Demand litre/s	gpd	Product
Atomic Energy of Canada Ltd., Point Tupper		630	14,400,000 US	Heavy water
Gulf Oil, Point Tupper		30	700,000 US	Refinery Products
Nova Scotia Power Corporation, Point Tupper		13	250,000 I	Electric Power Steam for Atomic Energy of Canada Ltd
Nova Scotia Forest Industries, Point Tupper		1200	27,000,000 US	Pulp and Paper
Canso Seafoods Ltd.,	(fresh)	30	720,000 US	
Canso	(salt)	125	2,880,000 US	Fish Products
Richmond Fisheries,	(fresh)	10	220,000 US	
Petit-de-Grat	(salt)	65	1,482,000 US	Fish Products

Source: Nova Scotia Department of the Environment.

TABLE 5
EXISTING AND POTENTIAL SOURCES OF SURFACE WATER SUPPLIES
SELECTED SYSTEMS

Map Code	Name of System	Watershed Area km²	sq. mi.	Approximate Yield litre/s	Millions of Igpd	State of Development
S1	Grant and Summer Lakes	19.9	7.7	475	9.0	Existing
S2	Goose Harbour Lake	23.0	8.9	580	11.0	Existing
S3	Landrie Lake System	24.0	9.3	1180	22.5	Existing
	a) Landrie Lake	(10.9)	(4.2)			
	b) Little River Beaver Dam Lake McIntyre Lake	(13.1)	(5.1)			
S4	Melford Lake	16.6	6.4	440	8.3	Existing
S5	West Brook	3.5	1.4	110	2.1	Potential
S6	North Tracadie Lake	13.0	5.0	395	7.5	Potential
S7	Clam Harbour River and Lake	41.8	16.1	1168	22.2	Potential
S8	Horton Lake	5.9	2.3	180	3.4	Potential
S9	Mill Brook	12.1	4.7	285	5.4	Potential
S10	Inhabitants River	246.0	95.0	2420	46.0	Potential
S11	Halfway Cove System			3160	60.0	Potential
S12	Northwest Arm Brook	24.9	9.6	750	14.3	Potential

Source: Information prepared for the Nova Scotia Water Resources Commission by the Montreal Engineering Company, provided by the Water Management Division of the Nova Scotia Department of the Environment.

TABLE 6
SUMMARY OF WATER QUALITY DATA OF SAMPLED SURFACE AND GROUNDWATER SUPPLIES

	CANADIAN DRINKING WATER STANDARDS AND OBJECTIVES Analyses in mg/litre			SURFACE WATER SUPPLIES — HYDROMETRIC STATIONS — Analyses in mg/litre						GROUNDWATER SUPPLIES* — HYDROSTRATIGRAPHIC UNITS — Analyses in mg/litre				
	Objective	Acceptable	Maximum Per-missible	Clam Harbour River	Inhabitants River	South River	Grand River	St. Mary's River	Rivers-dale	Canso	Windsor	Horton	Meguma Golden-ville	Crystalline Meta-morphic
Total Hardness as $CaCo_3$	< 120			9.6	38.4	34.5	14	6.5	137	146.1	1621.0	128.8	230.3	47.6
pH		6.5-8.3		6.2	6.9	6.7	6.5	6.0	7.0	7.2	7.4	7.6	7.1	6.5
Alkalinity ($CaCO_3$)									106	90	126	128	87.1	33
Turbidity JTU	< 1	5		0.6	2.4	1.0	0.7	1.0						
Colour, relative				30	33	15	20	30						
Calcium as Ca	< 75	200		2.3	11.7	10.0	4.2	1.5	40.2	38.0	257.0	36.7	48.9	13.8
Magnesium as Mg	< 50	150		0.9	1.6	1.5	0.8	0.6	7.7	14.1	21.9	9.0	25.4	3.0
Sodium as Na				3.3	29.0	42.5	3.4	2.8	22.0	22.8	29.4	37.6	190.4	26.2
Iron as Fe	< 0.05	0.3		.150	.260	.090	.070	.160	1.1	.37	.15	.25	0.08	4.9
Manganese as Mn	< 0.01	0.05		.03	< .03	.02	.03	< .04	.05	.03	.27	.04	.33	.02
Sulphate as SO_4	< 250	500		4.2	20.5	18.9	8.6	3.3	55	16	595	26	54	6.3
Chloride as Cl	< 250	250		5.5	43	65	5.3	4.3	26.9	35.4	139	54.3	351	46.5
Nitrate and Nitrite as N	< 10	< 10	10	.027	.030	.095	.020	0.18	0.07	.68	.45	.45	.50	.45
Ammonia as N	.01	.5		.2	.2	.1	.2	.2	—	—	—	—	—	—
Phosphorous, dissolved in-organic PO_4, as P	.007	.07		< .01	.015	< .01	.01	< .01	—	—	—	—	—	—
Cadmium as Cd	ND	< .01	.01	< .001	< .001	< .001	< .001	< .001	—	—	—	—	—	—
Copper as Cu	< .01	1.0		< .01	0.02	< .01	.002	.03	.0260	.0112	.0628	.083	.0179	.1807
Lead as Pb	ND	< .05	.05	0.004	0.004	.002	.002	.005	.0250	.0227	.0183	.015	.0126	.0260
Zinc as Zn	< 1.0	5.0		.010	0.014	< .01	.019	.01	.0705	.1168	.0368	.0938	.1088	.1605
Total Dissolved Solids	< 500	1000		21	122	150	27	17	279	347	1861	269	< 600	< 200

Sources: Guidelines for Water Quality Objectives and Standards, Technical Bulletin No. 72, Inland Waters Branch, Environment Canada, 1972.
Water Quality Summary Computer Printouts, Water Quality Branch, Inland Waters Directorate, Environment Canada, 1974.
Water Management Division, Nova Scotia Department of the Environment.

Note: Except for pH, Turbidity and Colour, all given median values are in mg/litre. Mg/litre is also expressed as ppm.
*Values for cadmium, ammonia and phosphorus are not available for groundwater since chemical analysis does not include these parameters. Water quality data given for groundwater are based on a limited number of samples and should not be regarded as completely representative of the hydrostratigraphic units.
ND — Not Detectable
JTU — Jackson Turbidity Unit

storage reservoir. The principal watershed is 9 km² (3.5 sq. mi.). The Nova Scotia Power Corporation is presently negotiating with the Nova Scotia Department of the Environment as to its future ownership and the management of the existing dams and other installations.

FLOODING

A sudden snowmelt during winter or spring combined with a heavy rainfall can cause flooding. Inundations can also occur during the passage of hurricanes and other tropical weather systems in late summer and during the fall. In August 1968 and August 1971, heavy precipitation caused severe flood damages in flood-prone areas of the region, and potential users of low-lying land should be aware of possible future problems due to flood occurrences. It is known that such problems may arise in the Antigonish area and along the Inhabitants River. Areas covered with recent alluvial and glaciofluvial deposits may be susceptible to flooding.

WATER QUALITY

Water quality data are available for groundwater derived from bedrock sources and for surface water sampled at 5 hydrometric stations. A summary of these data is provided in Table 6. As a basis of comparison, the Canadian Drinking Water Quality Objectives and Standards for some chemical and physical components are included. As can be noted, most of the sources provide better-than-standard quality water. The industrial water quality requirements can be met by most sources. The deuterium content (150 ppm) of the water is relatively high, which is one reason why the Canadian General Electric (now Atomic Energy of Canada Ltd.) heavy water plant was located in the region. Large quantities of water and steam are available from the power plant of the Nova Scotia Power Corporation.

Suspended sediment and bedload survey stations have not been maintained in the region, but the records of two stations nearby (Middle River near New Glasgow and April Brook near Inverness) show that the mean concentrations of suspended sediment (20-24 mg/litre) are close to the mean values measured in Maritime rivers, which in turn are very low when compared to national averages.

MARINE WATERS

There are three saltwater bodies in the area, each with distinct characteristics. In the northwest is the Northumberland Strait with George Bay, while in the northeast is the inland sea, Bras d'Or Lake, with West Bay as its southernmost extremity. To the south is the Atlantic Ocean with Chedabucto Bay, the region's main shipping lane. The draft of the present tankers is nearly 25 m (82 ft.). The assumed practical upper limit of superships, 1 million deadweight tons, would require a water depth of a little more than 30 m (100 ft.), the ships increasing in length from the present maximum of 345 m (1,133 ft.) to 472 m (1,550 ft.). The hydrographic charts indicate controlling depth of 27.4 m (15 fathoms) in the approach lane and the width of the Strait sufficient for the turning of ships.

WIND AND WAVES

Winds prevailing in the area can generate waves and currents. In general, there is a shortage of data on winds of the region. Wind data recorded at the Canso climatological station, which is in an exposed location, formed the basis for Figure 6. The prevailing winds come from the southwest during the months of May to September and from the northeast between December and March; they shift through the west during the remaining months. The wind patterns for Halifax, Sydney and Charlottetown are very similar. The entrance to the Strait of Canso and Chedabucto Bay is in the lee of the land, giving wind little chance to generate waves. Waves generated by storms on the North Atlantic may, however, be transmitted into Chedabucto Bay. Such waves, approaching from the south and southeast, may be refracted by the Canso ledge, so that they appear to arrive from an easterly direction. Based on 1970 and 1971 data, the extreme sea states in Chedabucto Bay can be judged from the estimated frequency that certain wave heights will be exceeded, as indicated in Table 7.

TABLE 7
ESTIMATED FREQUENCY OF EXCEEDANCE OF WAVE HEIGHTS IN THE CENTRAL PART OF CHEDABUCTO BAY

Significant Wave Height (mean of highest 33%)	Maximum Wave Height	Number of 6-hour Periods per Year
3 m (10 ft.)	5.5 m (18 ft.)	48.0
4 m (13 ft.)	7.0 m (23 ft.)	16.5
5 m (17 ft.)	9.0 m (30 ft.)	5.5
6 m (20 ft.)	11.0 m (36 ft.)	1.0

Source: Unpublished report, H. J. A. Neu, Atlantic Oceanographic Laboratory, Bedford Institute.

Between May 31, 1972 and February 15, 1973 a total of 1,980 observations were carried out with a waverider buoy about half a mile offshore of Eddy Point. The significant wave height reached magnitudes from 1.5-1.8 m (5-6 ft.) on four occasions, the wave periods being 5 and 6 seconds. The maximum wave height under the same conditions was estimated to be a little over 2.4 m (8 ft.).

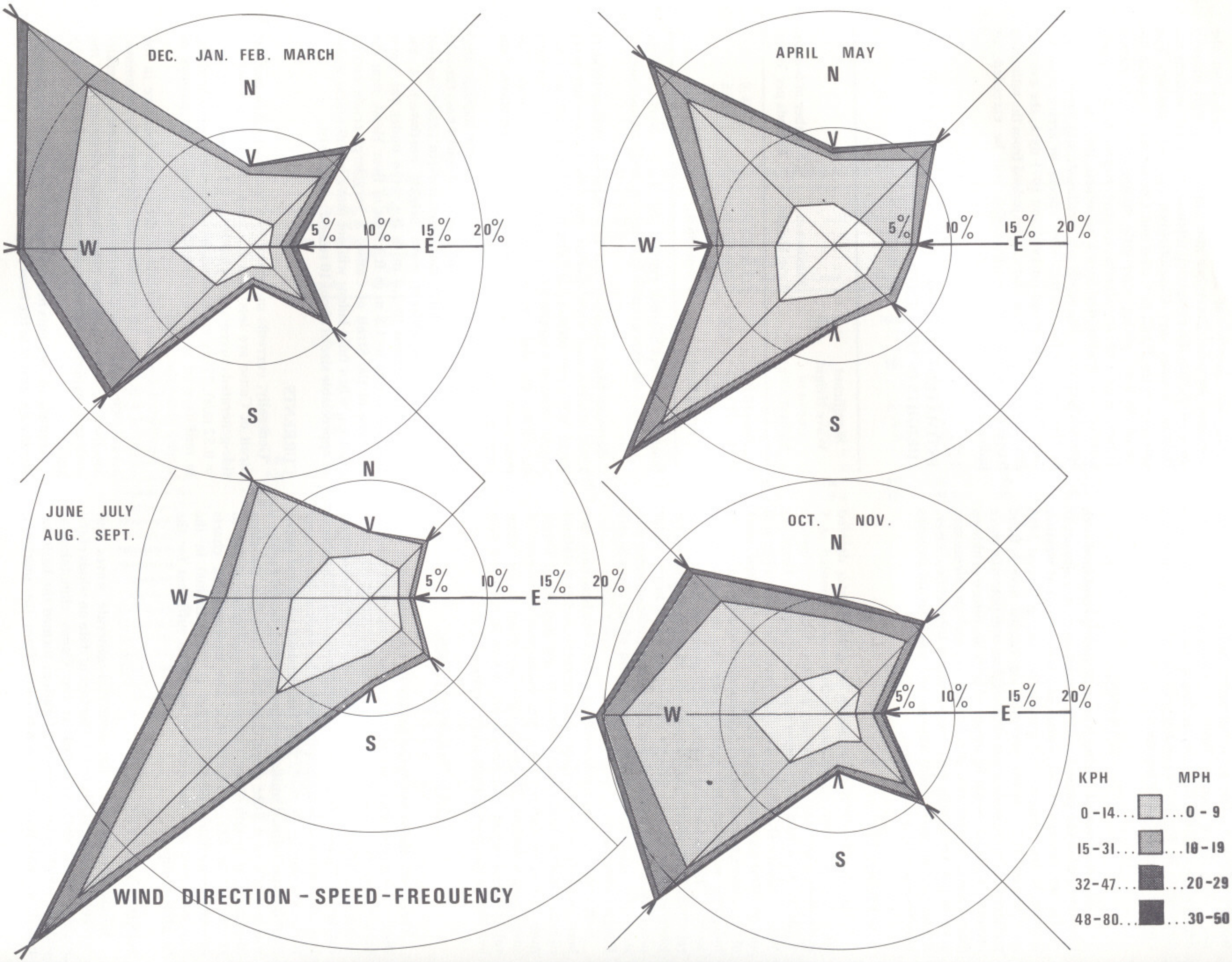
Computer studies of the waves' refraction indicate that waves with a period longer than 6 seconds cannot pass through the channel between Eddy Point and Janvrin Island, so that the maximum significant wave heights northwest of the channel are limited to 2.4 m (8 ft.), even under the worst conditions, and to 1.8 m (6 ft.) west of Bear Head, near the entrance of the Strait of Canso. A very large crude carrier (VLCC), when fully laden, will not move in roll unless waves of appreciable size of about 10 second period exist.

CURRENTS

Generally, currents measured in Chedabucto Bay and the Strait of Canso are less than 0.3 knot, the amplitude of the tide-generated currents analyzed being 0.1 knot or less (1 knot = 0.52 m/s). There are indications of internal waves, resulting in multilayered water movements, related to the passage of storms along the coast.

Predicted extreme currents in the Canso area are in the order of 1 knot, to be exceeded once in every three-summer period (500 days). Near Cerberus Rock, currents are generally less than 0.5 knot, with the most frequent direction from the southeast; expected extremes are estimated to be 1.27 ± 0.25 knot.

Examples of currents in the Strait of Canso and Chedabucto Bay are illustrated in the inset diagram on the 1:125,000 map.


DEC. JAN. FEB. MARCH
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OCT. NOV.
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15%
20%
KPH MPH
0-14... ...0 - 9
15-31... ...10-19
32-47... ...20-29
48-80... ...30-50
WIND DIRECTION - SPEED - FREQUENCY

TIDES

Within the study area, tides along the Atlantic seaboard have the same magnitude everywhere and are predominantly semi-diurnal. They are represented in the inset diagram showing the tidal movements at Port Hawkesbury during March 1966. During an average tide, water at Point Tupper rises 0.7 m (2.3 ft.) above Mean Water Level (MWL) and falls 0.6 m (2.2 ft.) below it. The High Water for a large tide is 1.1 m + MWL and the Low Water 0.9 m (2.9ft.) - MWL. Under extreme conditions, the water level has risen to 1.6 m (5.2 ft.) + MWL.

Along the Northumberland Strait section, the tides are also uniform. Although the vertical range is less than along the Atlantic shoreline, the tidal movements are more complex. During the course of most days, a Higher High Water is followed by a succession of Lower Low Water, a Lower High Water and a Higher Low Water. At times, the Lower High Water and the Higher Low Water differ so little in elevation that it appears that only one High and one Low Water occur during a day. This type of tide, for March 1966 at Auld Cove, is also illustrated in the inset diagram on the map. During an average tide High Water rises to 0.4 m (1.4 ft.) + MWL and falls to 0.5 m (1.7 ft.) − MWL and during large tides High Water reaches 0.7 m (2.4 ft.) + MWL and during Low Water 0.8 m (2.5 ft.) − MWL.

The tidal range is insignificant in the southern part of Bras d'Or Lake.

Wind-driven surface currents can be 1/40 of the wind speed measured 10 m (33 ft.) above the water surface. A wind of 40 knots can generate a surface current of 0.5 m/s, much larger than local tide-generated currents.

WATER QUALITY

Prior to the construction of the causeway, the narrow deep channel of the Strait of Canso was flushed by tidal currents reversing 4 times a day. This was caused by the tidal regimes at both ends of the Strait, which differ in tidal range and are about 1.5 hours out of phase. Tidal currents of 2-2.5 m/s (4-5 knots) were observed. After the causeway was constructed, this flushing action ceased. The result is that, north of Ship Point and Peebles Point, a body of relatively stagnant water has developed, which, during the summer, has a significantly lower temperature and a higher salinity at levels below 15 m (50 ft.) than waters of Chedabucto Bay.

More mixing takes place north of the causeway, because the prevailing winds, from a westerly direction, cause water to pile up against the eastern shore of George Bay and thus in the adjacent part of the Strait. A counter current of deep water, in a seaward direction, brings about a mixing action which results in lower salinity and higher temperatures in upper water levels.

Industrial development has resulted in millions of gallons of waste water discharged daily into the southern part of the Strait, most of it heated to 74°C (165°F) and containing 4,500 kg (10,000 lbs.) of mostly organic, suspended solids. At the present rates of discharge, this could cover an acre with 60 to 100 feet of water in a day and a square mile with 34-60 feet in a year. Since the area of the Strait between the causeway and Melford Point is approximately 26 km² (10 sq. mi.), the annual discharged waste water would amount to a layer 3.4 to 6.0 feet thick, or about 1-2 m deep.

ICE

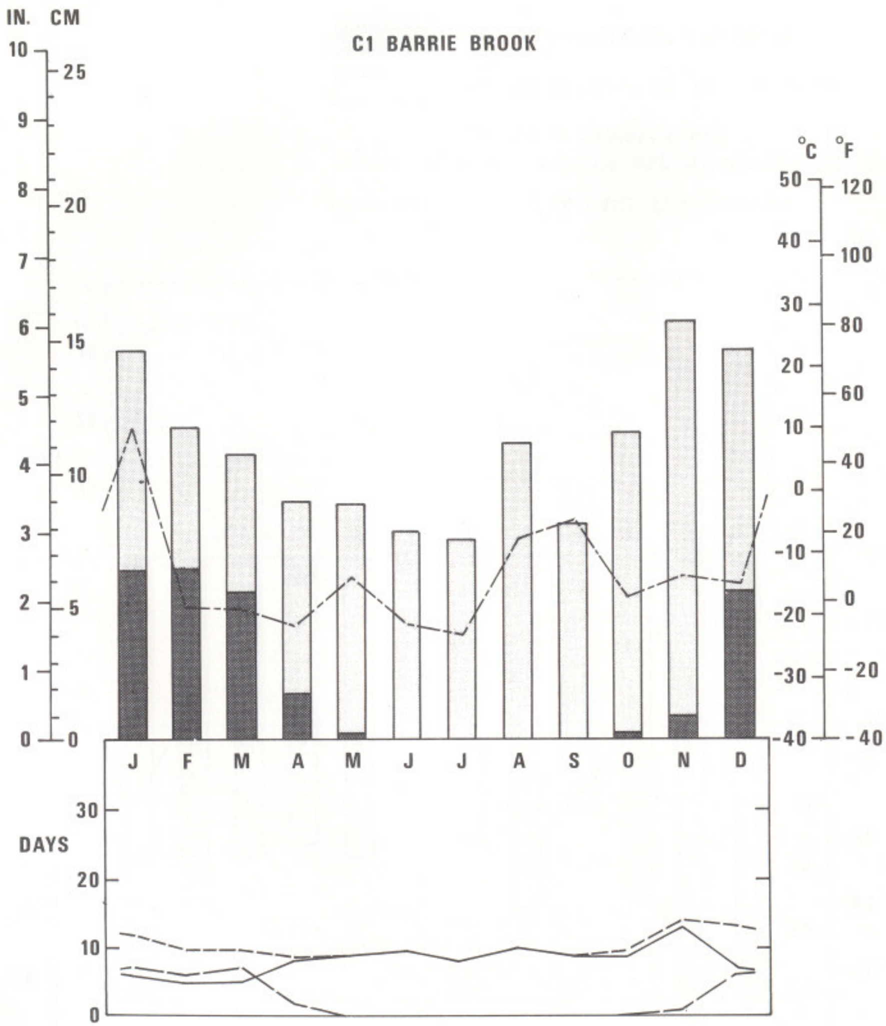
There is a striking difference between ice conditions north and south of the causeway. In Northumberland Strait and George Bay, ice conditions vary considerably from year to year, in accordance with variable temperatures and wind conditions during the winter months. In some years, the northern approaches to the Strait of Canso remain ice-free, however the general situation is that surface waters start to freeze in bays and inlets at about −1.7°C (29°F). Shorefast ice will cover George Bay. Wave and tidal action in the Strait will cause ice sheets to fracture and slip on top of each other. Drifting results in pressure ridges which account for 70-90% of the ice surface off the Cape Breton Island coast. These ridges, 1.5-2 m (5-7 ft.) high, and occasionally 15 m (50 ft.) high, extend 4 to 5 times this distance below the surface of the water. The concentration of ice reaches a peak in February and March. The break-up and clearing of ice begins in March and continues through April. The final clearing sometimes occurs in March, although generally in April, but may extend into May.

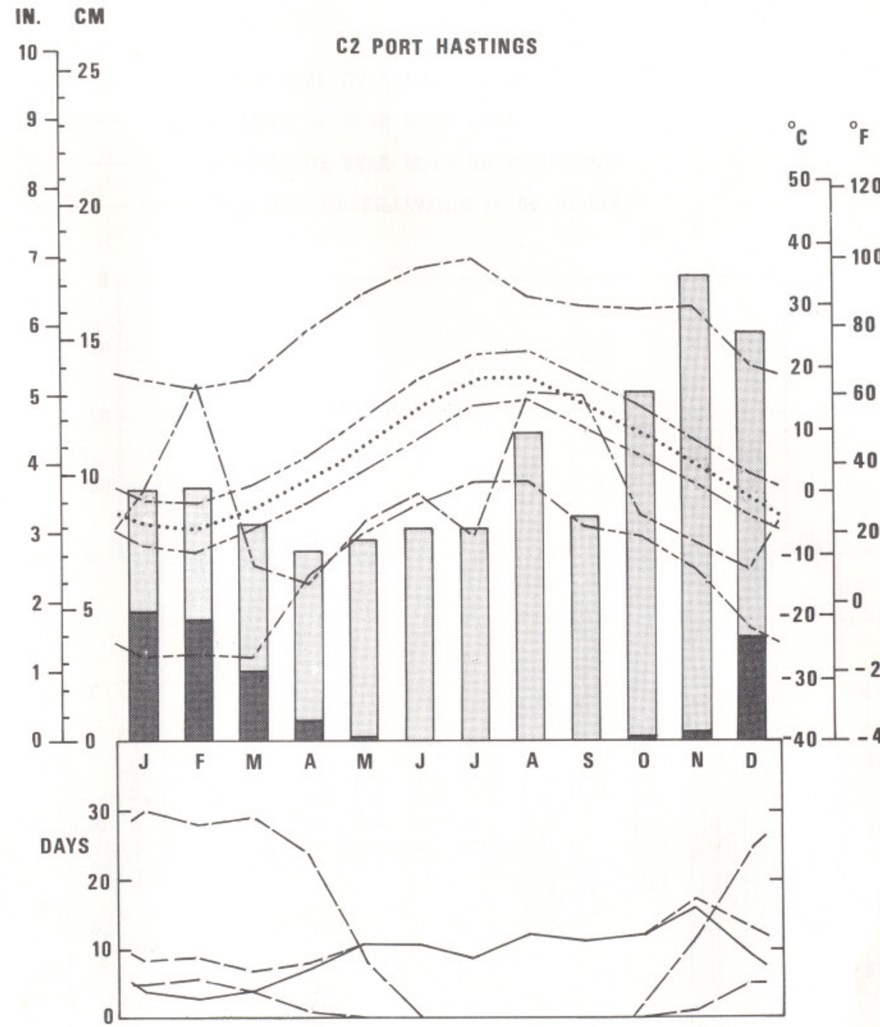
The Strait of Canso south of the causeway usually remains free of ice, since the causeway prevents drift ice from passing through. However, in 1957, for example, a 6-inch sheet of ice formed completely across the Strait during a long period of calm, cold weather. It was easily broken by a fishing vessel within a short period of time. Occasionally, as in March and May of 1962, ice accumulates in extensive fields to the east of Cape Breton Island and may temporarily block the southern approaches to the Strait of Canso.

APPENDIX

CLIMATE GRAPHS,

STRAIT OF CANSO REGION





MEAN DAILY TEMPERATURE

MAXIMUM AND MINIMUM MEAN DAILY TEMPERATURE

EXTREME MAXIMUM AND MINIMUM TEMPERATURE

MEAN MONTHLY PRECIPITATION

MEAN MONTHLY SNOWFALL

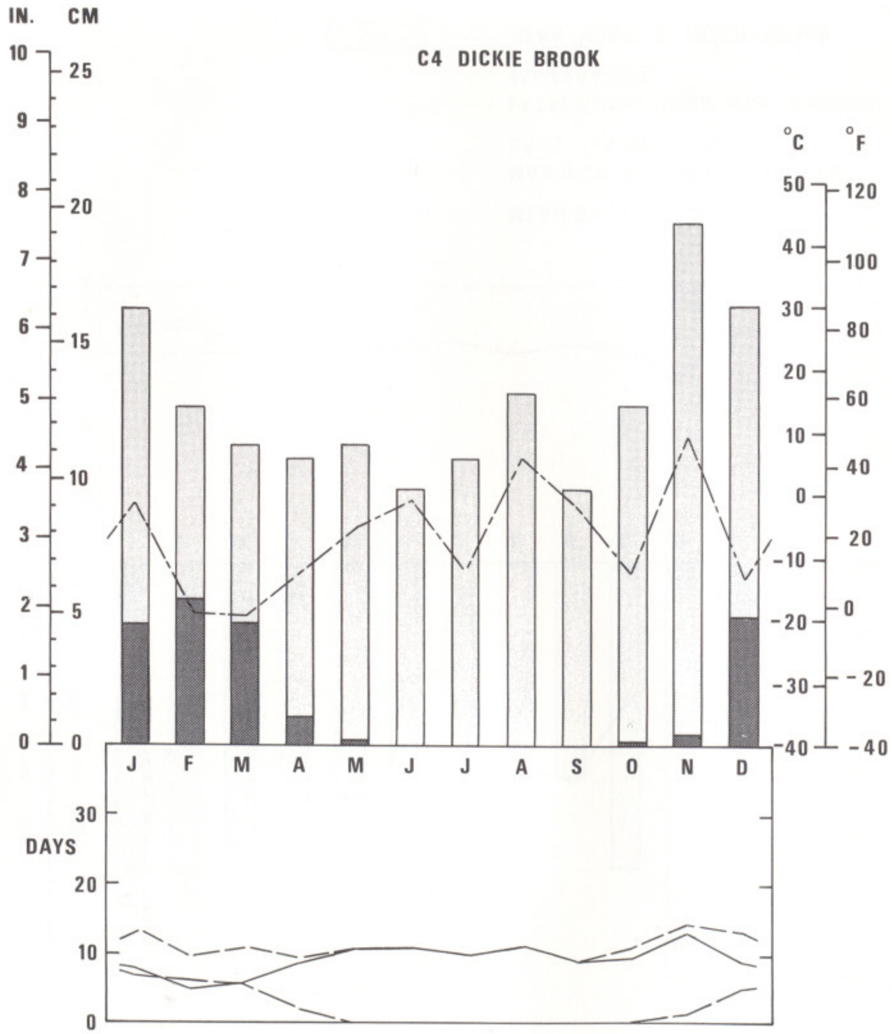
GREATEST PRECIPITATION IN 24 HOURS

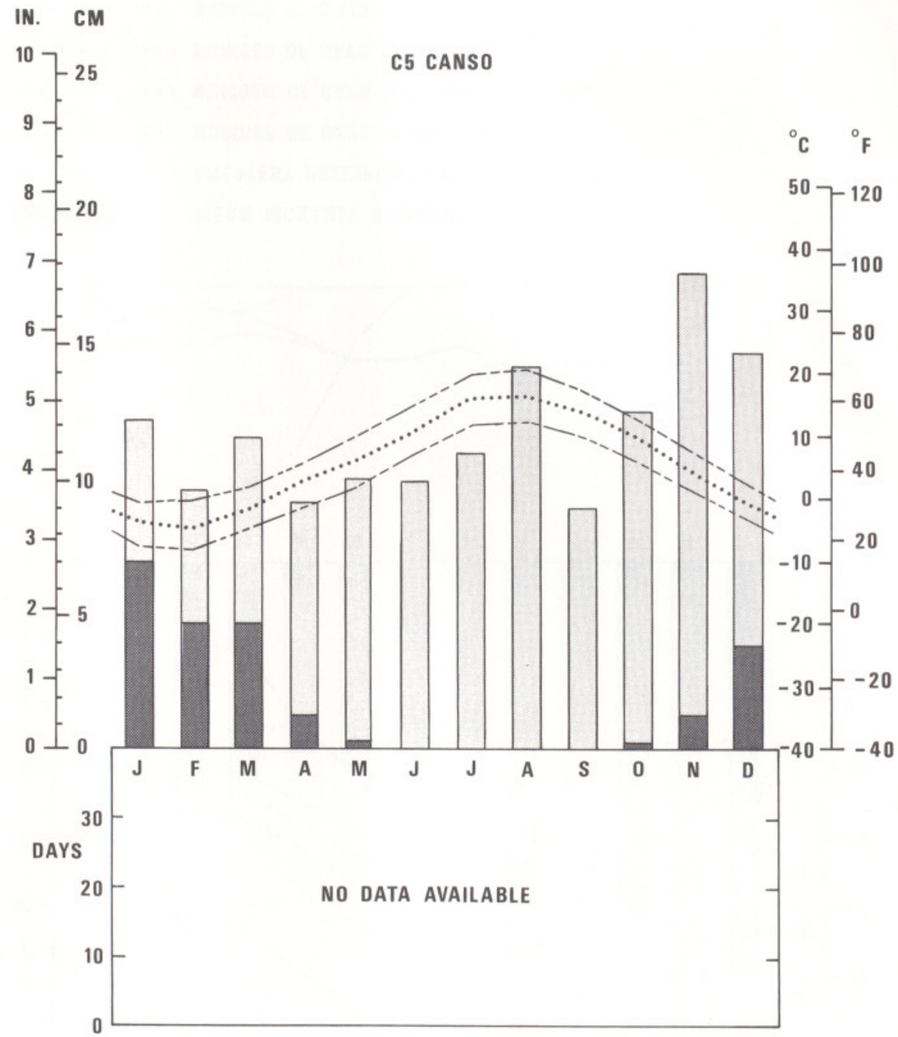
NUMBER OF DAYS WITH FROST

NUMBER OF DAYS WITH PRECIPITATION

NUMBER OF DAYS WITH RAIN

NUMBER OF DAYS WITH SNOW





---- MEAN DAILY TEMPERATURE

---- MAXIMUM AND MINIMUM MEAN DAILY TEMPERATURE

---- MEAN MONTHLY PRECIPITATION

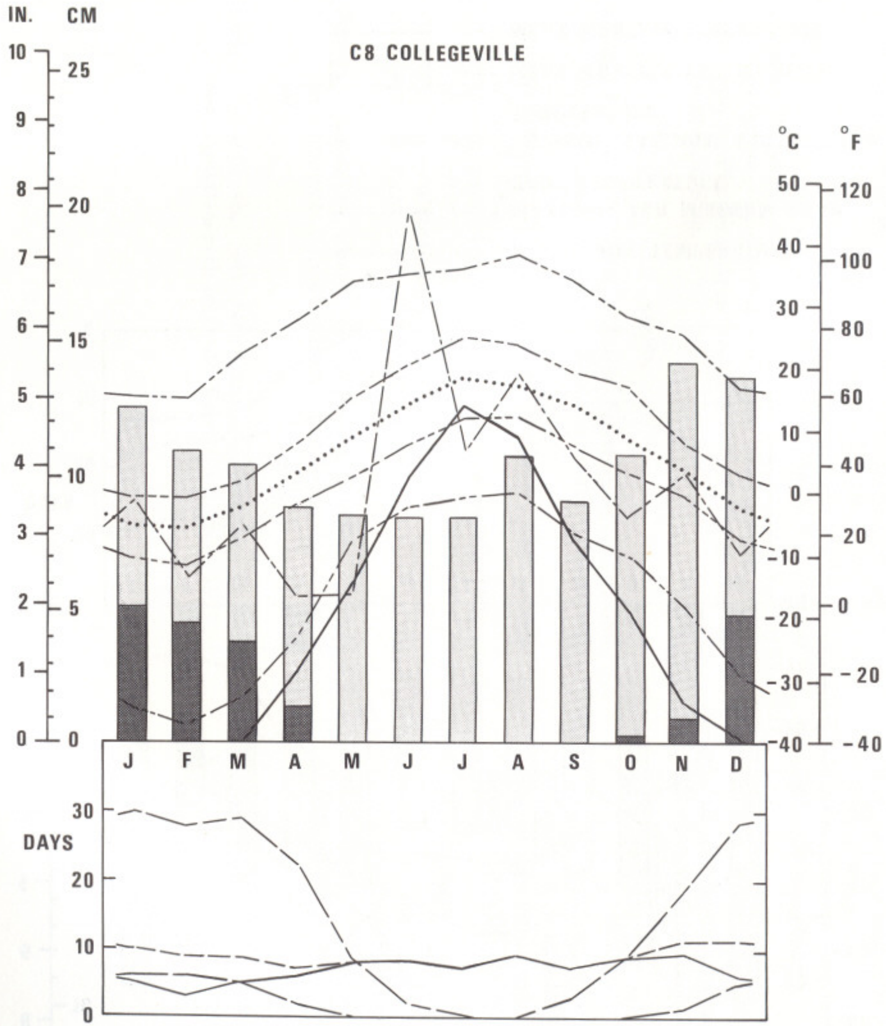
---- MEAN MONTHLY SNOWFALL

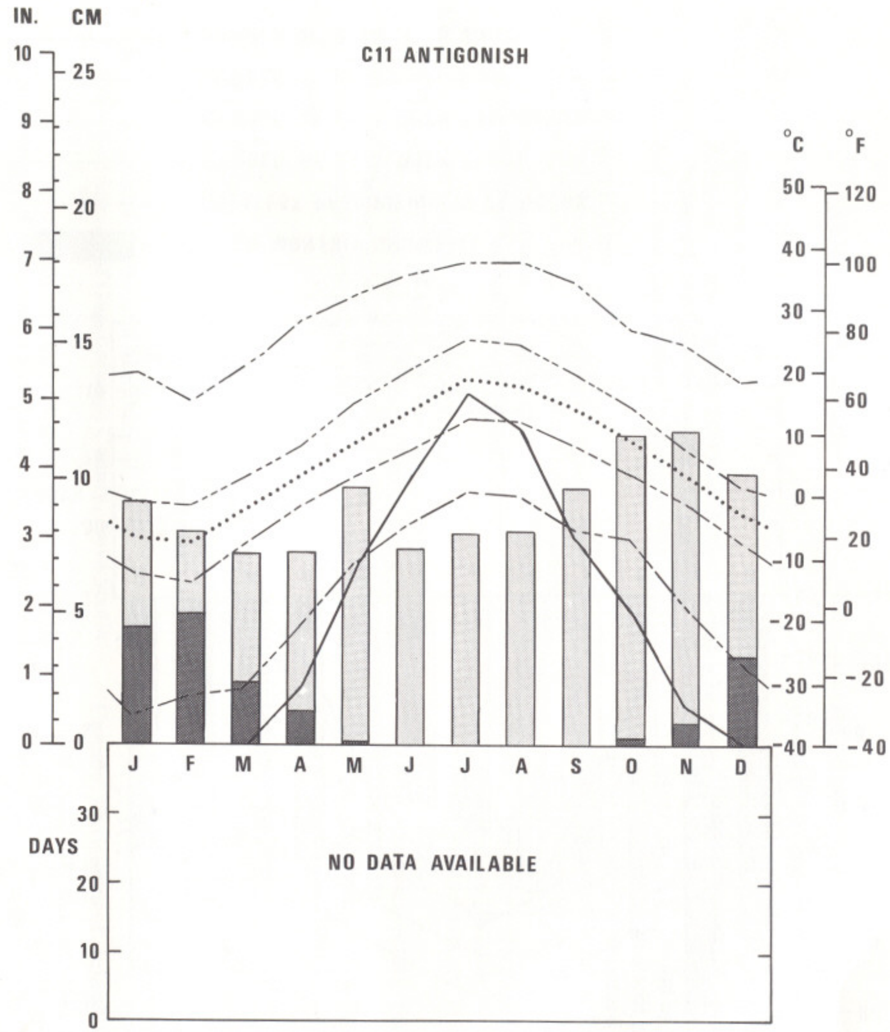
---- GREATEST PRECIPITATION IN 24 HOURS

---- NUMBER OF DAYS WITH PRECIPITATION

---- NUMBER OF DAYS WITH RAIN

---- NUMBER OF DAYS WITH SNOW





···· MEAN DAILY TEMPERATURE

···· MAXIMUM AND MINIMUM MEAN DAILY TEMPERATURE

···· EXTREME MAXIMUM AND MINIMUM TEMPERATURE

···· MEAN MONTHLY PRECIPITATION

···· MEAN MONTHLY EVAPORATION

···· MEAN MONTHLY SNOWFALL

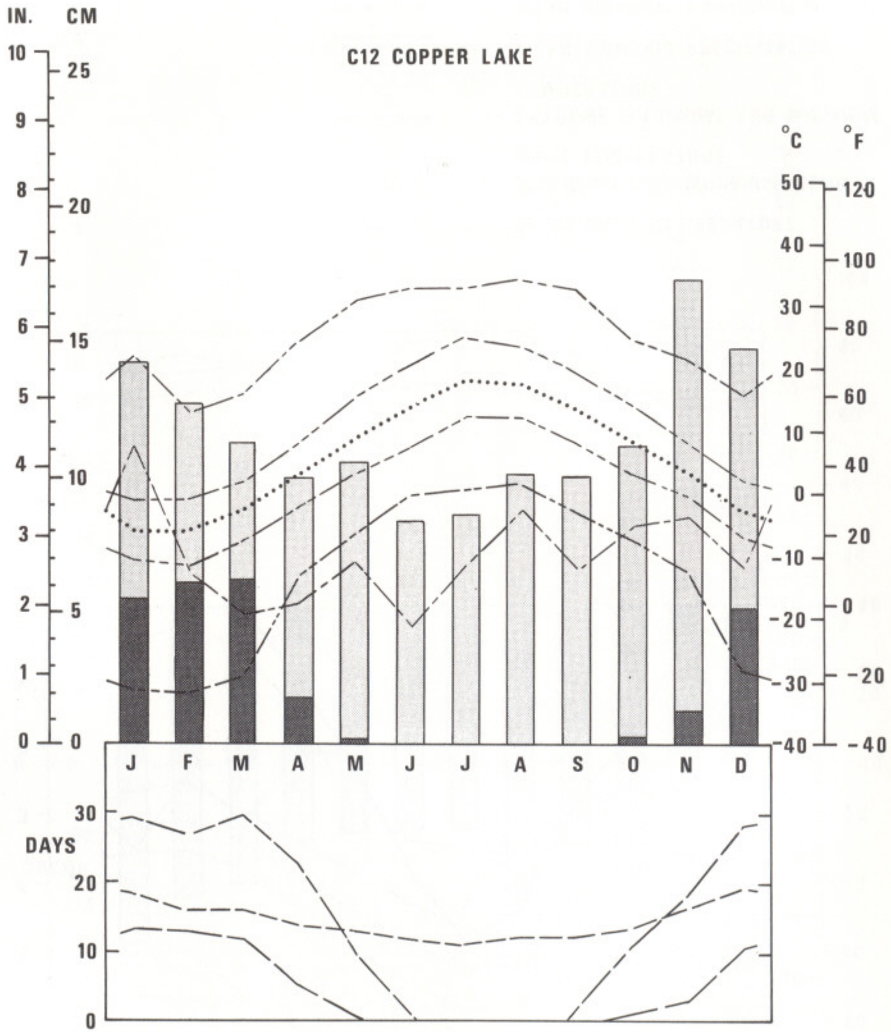
···· GREATEST PRECIPITATION IN 24 HOURS

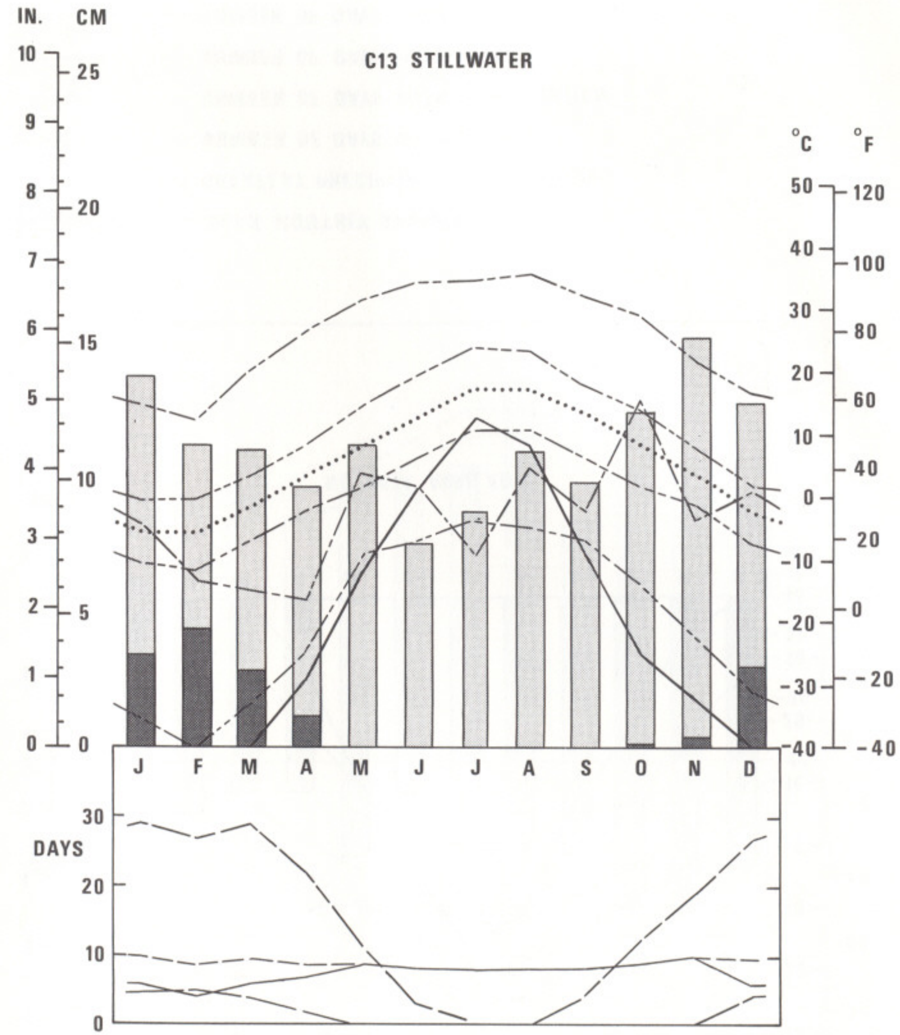
···· NUMBER OF DAYS WITH FROST

···· NUMBER OF DAYS WITH PRECIPITATION

···· NUMBER OF DAYS WITH RAIN

···· NUMBER OF DAYS WITH SNOW





---- MEAN DAILY TEMPERATURE

---- MAXIMUM AND MINIMUM MEAN DAILY TEMPERATURE

---- EXTREME MAXIMUM AND MINIMUM TEMPERATURE

---- MEAN MONTHLY PRECIPITATION

---- MEAN MONTHLY EVAPORATION

---- MEAN MONTHLY SNOWFALL

---- GREATEST PRECIPITION IN 24 HOURS

---- NUMBER OF DAYS WITH FROST

---- NUMBER OF DAYS WITH PRECIPITATION

---- NUMBER OF DAYS WITH RAIN

---- NUMBER OF DAYS WITH SNOW

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Map Scale 1:125,000

Fish and Wildlife Resources
Water Resources
Geological Resources
Socio-Economic Environment

Map Scale 1:25,000

Natural Environment Development Considerations
Socio-Economic Features

Cover Photo
Earth Resources Technology Satellite, 26 March 1974, Band 5.
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