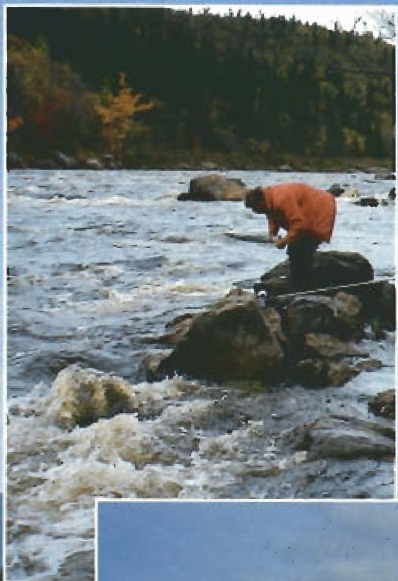
Water Resources Study of the Burin Peninsula and Fortune Bay Area



GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

DEPARTMENT OF ENVIRONMENT AND LANDS
WATER RESOURCES DIVISION

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Water Resources Study of the Burin Peninsula and Fortune Bay Area
Volume 1

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Acres International Limited
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Executive Summary

The Regional Water Resources Study of the Burin Peninsula and Fortune Bay area is the sixth in a series of studies of the water resources of the Province of Newfoundland. Its purpose is to provide information to assist the Water Resources Division of the Department of Environment and Lands in its water planning and management activities.

The objectives of the study were to

- assess the availability of water using existing data;
- examine present and future uses of water;
- assess water quality;
- rank areas according to their supply-demand situation and water resource potential;
- make recommendations to government on future priorities and directions;
- prepare a detailed inventory of the water supply systems in the study area.

The study area covers all of the Burin Peninsula, up to and including Piper's Hole River. It extends to the west to include all the land draining into the northern part of Fortune Bay, as well as the Connaigre Peninsula. It also includes all the drainage area of the Bay d'Espoir hydroelectric development. The total area is over 15,000 km^2, of which nearly 6,000 km^2 is the Bay d'Espoir area. The total population of the region is about 35,000. The largest communities are Marystown, Burin and Grand Bank.

The detailed survey of water supply systems is provided in the **Inventory of Water Supply Infrastructure**, presented as Volume 2 of this report.

The findings and recommendations for each of the major study items are summarized below.

Availability

Surface Water: The region has abundant water, with an average annual runoff of 1100 mm relatively evenly distributed through the year. Hydrometric data collection is improving, particularly with the introduction of the Provincial Hydrometric Network. There is still a complete lack of data in the Fortune Bay north area, however. Data required to develop precipitation/runoff relationships along the south coast where orographic effects can be significant are also not available.

This report recommends that

- the federal and/or provincial governments put a high priority on maintaining high quality continuous flow records;

- the provincial government monitor selected community water supply systems to provide additional flow data at coastal locations;

- the federal and/or provincial governments establish at least one or two streamflow and climate stations in the Fortune Bay north area;

- the federal and/or provincial governments, possibly in association with Memorial University of Newfoundland, undertake a data collection and analysis program to investigate precipitation/runoff relationships in coastal regions along the south coast.

Groundwater

Prediction of well yields is difficult, because the yield depends on local discontinuities rather than regional stratigraphy. Groundwater can be a good water supply source for small demands (e.g., a few homes), but in general cannot be expected to be a major water resource.

Water Quality

The natural quality of both surface water and groundwater in the region is generally good. Iron, manganese and colour are the parameters whose levels most frequently exceed guidelines. These parameters are an aesthetic rather than a health concern. Concentrations of fluoride exceed guidelines at St. Lawrence, Parkers Cove and English Harbour East.

Other than local point sources of pollution, the main future water quality concern is atmospheric deposition of pollutants (acid rain), because there is little buffering capacity in the natural soils and water.

This report recommends some additional monitoring particularly where fluoride concentrations are high, as well as analysis of water quality at the end of distribution systems (not just at source). Government should also regularly test for trihalomethanes where chlorine is used in an organic rich environment.

Instream Uses

The major instream uses are hydroelectric generation, recreation and tourism, and fisheries conservation. At present there are no major conflicts because of the low population density, the relative abundance of the resource, and the static economic base. These factors are not expected to change significantly in the foreseeable future.

Withdrawal Uses

Despite the general abundance of water, small coastal communities are often located at uneconomic distances from large sources. As a consequence, although most communities have adequate supplies, few have surpluses. About one third of the communities served by groundwater occasionally experience shortages.

Some of the communities with surface systems have supply/demand ratios less than one, and can be expected to experience shortages in dry periods. In some of these communities, improvements are underway. The supply/demand ratios estimated in this study assume that the improvements are in place; even so, the supply/demand ratios indicate shortfalls. The communities which may experience shortages are as follows.

Baine Harbour
Bay L'Argent
Fox Cove
Grand LePierre
Little Bay East
Milltown
Pool's Cove
Rencontre East
Winterland

The recommendations of this report are that

- the provincial government should immediately review the water supply systems in the communities listed above. This is particularly important where improvements are underway, and shortages are nevertheless anticipated.

- the Water Resources Division of the provincial Department of Environment and Lands should work with the Department of Municipal and Provincial Affairs to ensure that proposed water supply systems have sufficient capacity.

1 - Introduction

1 Introduction

This report, on the regional water resources of the Burin Peninsula and Fortune Bay area, is the sixth in a series which will eventually cover the whole province. The previous reports covered the Eastern and Western Avalon Peninsula,[1-1, 1-2] Bonavista Bay Area,[1-3] Northern Peninsula and Humber Valley,[1-4] and Notre Dame Bay Area and Central Newfoundland Region.[1-5]

1.1 Study Objectives

The Water Resources Division (WRD) of the Department of Environment and Lands (DOEL), Government of Newfoundland and Labrador, is responsible for the management of the water resources of the province. The purpose of the regional water resources studies is to provide information for the planning and management of these resources. The specific objectives of this study were to

(i) assess the availability of water using existing data;
(ii) examine present and future uses of water;
(iii) assess water quality;
(iv) rank areas according to their supply-demand situation and water resource potential;
(v) make recommendations to government on future priorities and directions;
(vi) prepare a detailed inventory of the water supply systems in the study area.

Chapters 2 and 3 of this study describe surface and groundwater availability. Chapter 4 presents water quality data, Chapter 5 discusses instream uses, and Chapter 6 analyses supply and demand for the water supply systems in the study area. Chapter 7 presents an overall assessment, and Chapter 8 provides conclusions and recommendations.

An important component of this study is the detailed **Inventory of Water Supply Infrastructure**. The inventory describes the water supply systems in the study area in detail and is presented as Volume 2 of this report.

1.2 Study Area

The location of the study area is shown in Figure 1.1. It covers all of the Burin Peninsula, up to and including Piper's Hole River. It extends to the west to include all the land draining into the northern part of Fortune Bay, as well as the Connaigre Peninsula. It also includes all the drainage area of the Bay d'Espoir hydroelectric development. The total area is over 15,000 km^2, of which nearly 6,000 km^2 is the Bay d'Espoir area.

The climate on the Burin Peninsula and coastal areas is characterized by mild winters and cool summers. Winter thaws are frequent, and the driest periods tend to be in the summer (e.g., August). The interior areas, particularly the upper reaches of the Bay d'Espoir basin, are slightly drier, with colder winters. The area is directly exposed to the dominant cyclonic weather systems coming from the southwest.

The Burin Peninsula is characterized by relatively low relief with numerous small ponds and brooks. The drainage pattern was originally developed by the erosion of valleys along the lines of weakness produced by tectonic folding and faulting. This pattern has been extensively modified by glaciation. A thin layer of surficial sediment with sparse vegetation overlies bedrock. Much of the region is barren and bog-covered. Forested areas are rare.

The north part of Fortune Bay and the Bay d'Espoir area have a similar geologic history and are similarly barren. Much of this region is a plateau with elevations ranging from 200 - 300 m, behind steep coastal cliffs.

The principal economic activities are related to the fishery, with small pockets of agriculture in the southern part of the Burin Peninsula. There is some potential for tourism.

The population of the region is about 35,000. The largest communities are Marystown, Burin and Grand Bank.

FIG. 1.1

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Study Area

ACRES

1.3 Sources of Data

The reports and other sources used to obtain data for this study are documented in the List of References at the end of this report. In addition, staff from various levels of government, as well as other agencies, were most helpful in supplying information and comments. These agencies include

- Government of Newfoundland and Labrador
  - Department of Environment and Lands (DOEL)
  - Department of Industry, Trade and Technology
  - Department of Fisheries
  - Department of Municipal and Provincial Affairs (DMPA)
  - Department of Tourism and Culture
  - Department of Health
  - Executive Council, Newfoundland Statistics Agency
  - Executive Council, Economic Research and Analysis
  - Department of Forestry and Agriculture
  - Department of Mines and Energy

- Government of Canada
  - Agriculture Canada
  - Fisheries and Oceans Canada (DFO)
  - Statistics Canada
  - Environment Canada
    - Water Survey of Canada (WSC)
    - Atmospheric Environment Service (AES)

- Newfoundland and Labrador Hydro

The sources of information for the **Inventory** are listed in Volume 2.

2 - Availability of Surface Water

2 Availability of Surface Water

2.1 Introduction

The first step in assessing the water resources of the study area was to estimate the amount of surface water available. For this study, meteorological and hydrologic data were analyzed to provide estimates of

- mean annual runoff
- low flows, and
- reliable yield from community water supply systems with storage ponds.

Mean annual runoff is a commonly used hydrological characteristic. It expresses the average annual discharge over an area as a depth. Mean annual runoff has a continuous distribution over an area, and can thus be conveniently represented on a map using isolines. Streamflow and precipitation data as well as topography were used to prepare such a map for this study.

To provide more information on availability of water, estimates of mean annual runoff are supplemented by analyses of the variability of flow. Low flows and flow duration curves were examined, and estimates were made of the improvement in yield that results from controlled storage.

In summary, the hydrological studies included the analysis of

- mean annual runoff
- flow variability (low flows, flow duration curves)
- improvement in yield from increased storage
- water balance.

Based on these analyses, the natural water availability was then estimated and tabulated for all basins in the study area.

2.1.1 Available Data

The principal sources of streamflow data are the records from the hydrometric stations operated by Water Survey of Canada (WSC), and those operated by DOEL as part of the Provincial Network (PN). Precipitation data are also available for the PN stations. In addition, precipitation data are recorded by Atmospheric Environment Services (AES) at its climate stations in the study area.

Newfoundland and Labrador Hydro (NLH) is a major water user in the study area, and records from their generating stations in the Bay d'Espoir system and at Paradise River were also used. Inflows to the reservoirs are not measured directly, but are calculated by backrouting. Other minor sources of information (e.g., previously published reports) are noted in the text as appropriate.

Figure 2.1 shows the locations of the WSC and PN stations, and Figure 2.2 shows the locations of the NLH basins. Figure 2.3 shows the locations of the AES climate stations. Tables 2.1 (a) to (c) present the flow records, and Table 2.2 gives the annual precipitation data.

2.2 Mean Annual Runoff

Mean annual runoff (MAR) is the average annual discharge over an area expressed as a depth in millimetres or inches. The purpose of this part of the study was to prepare a runoff map of the study area, showing the variation in average annual runoff. This map can conveniently be used to estimate the mean annual flow at an ungauged site.

The runoff estimates were based on analysis of streamflow data, supplemented by precipitation data.

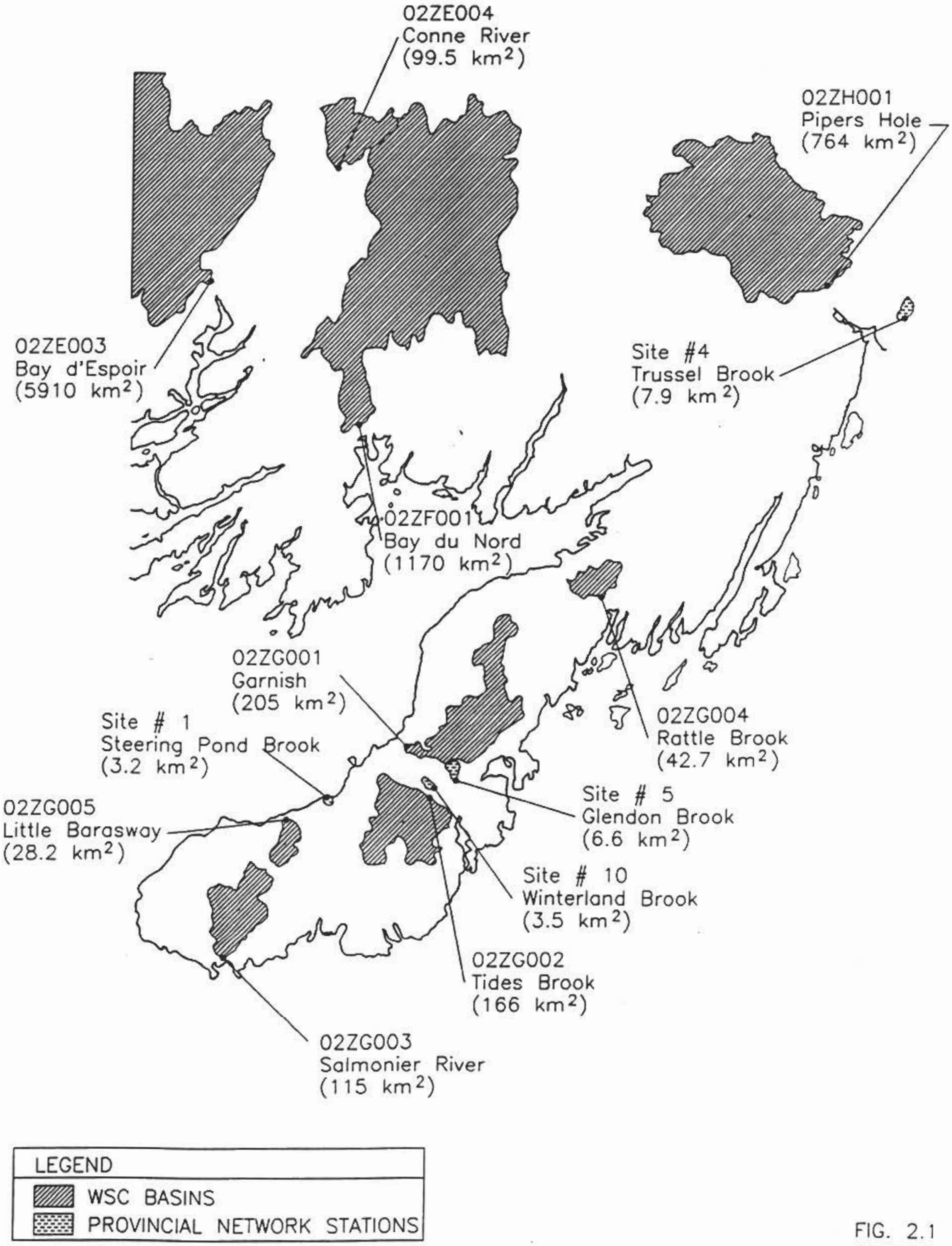

FIG. 2.1

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Locations of Gauged Basins

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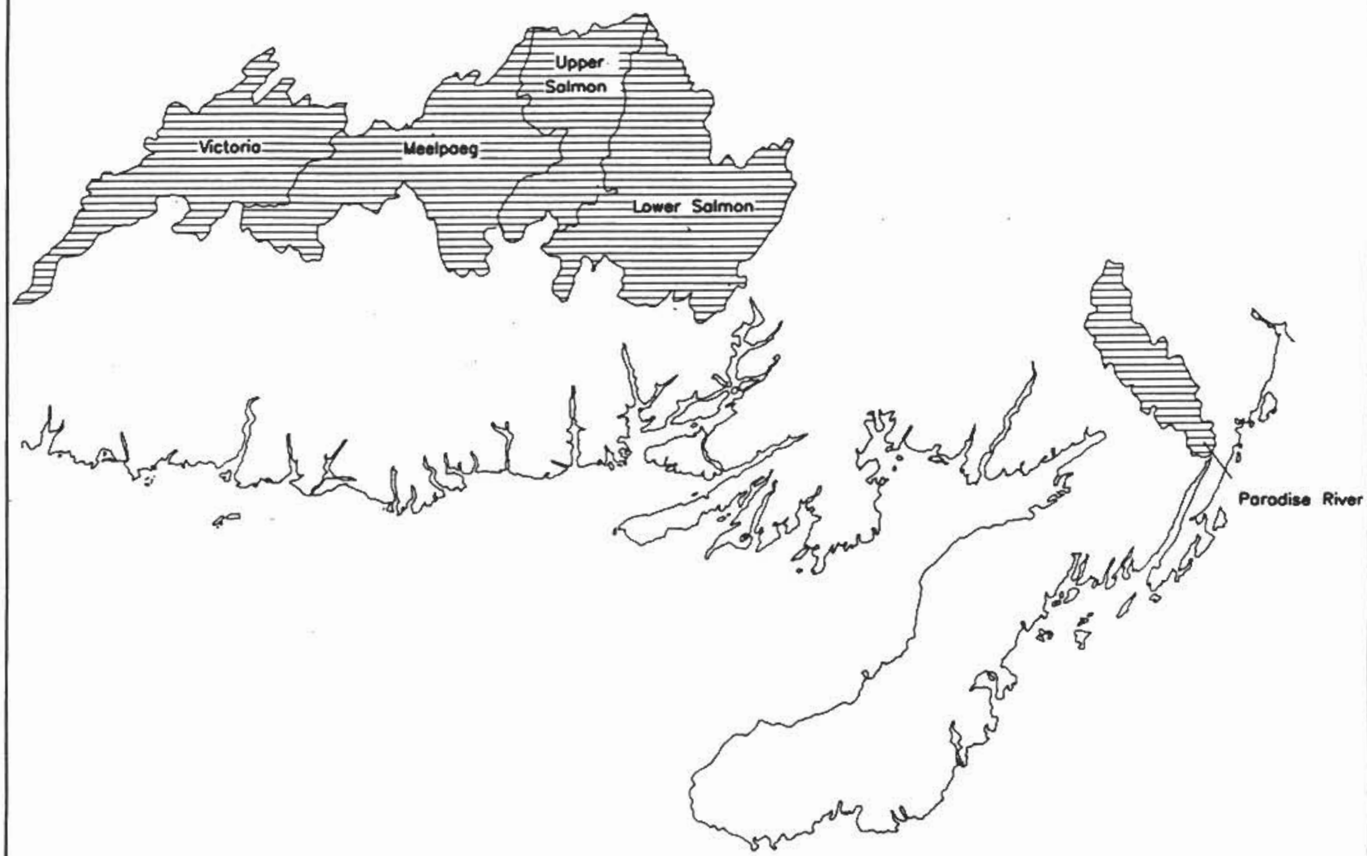

FIG. 2.2

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Locations of N & L Hydro Basins

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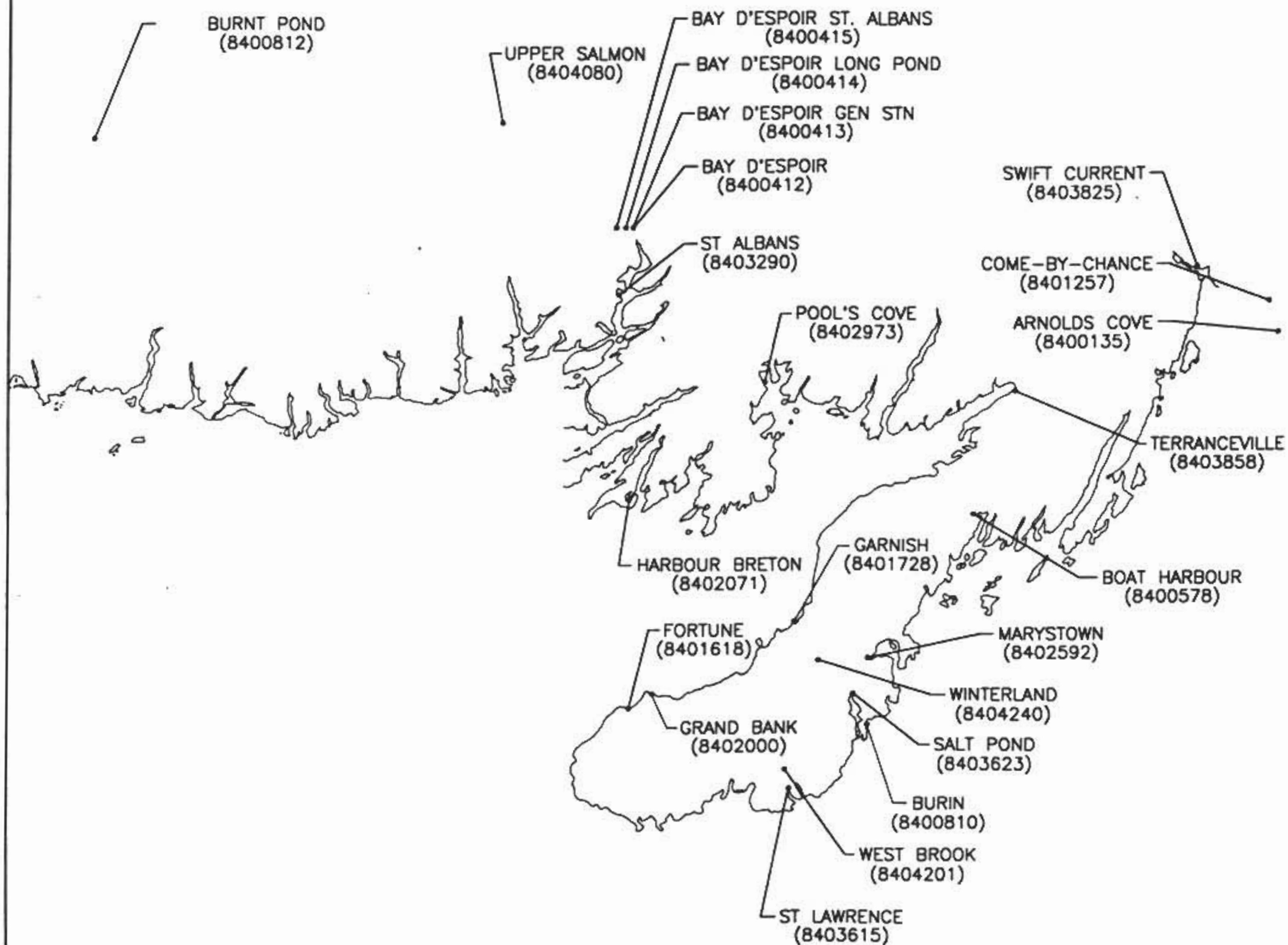

FIG. 2.3

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Locations of Climate Stations

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Table 2.1
Mean Annual Flows (m^3/s)
A: WSC Basins

D.A. (km^2)	Bay du Nord 1170	Garnish 205	Pipers Hole 764	Salmon River Long Pond 2640	Conne River 99.5	Tides Brook 166	Salmonier River 115	Rattle Brook 42.7	Little Barasway 28.2	Come By Chance 43.3
Station No.	02ZF001	02ZG001	02ZH00	02ZE001	02ZE004	02ZG002	02ZG003	02ZG004	02ZG005	02ZH002
1944				141.00						
1945				128.00						
1946				93.10						
1947				63.70						
1948				114.00						
1949				77.80						
1950				56.10						
1951				82.40						
1952	44.70			89.70						
1953	39.50		24.00	79.10						
1954	44.70		26.30	94.20						
1955	37.10		27.40	73.50						
1956	46.30		28.00	88.80						
1957	35.50		23.30	70.80						
1958	35.90		22.10	82.00						
1959	37.10	8.34	21.60	63.50						
1960	25.60	5.19	18.30	57.40						
1961	24.10	6.76	16.30	54.40						1.04
1962	43.90	8.07	30.80	101.00						
1963	45.60	9.45	29.70	102.00						
1964	40.00	8.66	24.50	88.70						
1965	39.30	7.79	22.20							
1966	31.40	7.61	21.90							
1967	39.30	7.58	24.00							
1968	46.60	9.62	27.50							
1969	44.90	9.93	27.60							
1970	42.20	9.88	28.30							2.58
1971	45.50	8.64	27.00							2.09
1972	44.70	8.37	22.50							1.80
1973	47.90	10.00	28.60							2.10
1974	35.40	9.39	21.80							1.87
1975	34.80	8.57	20.80							1.53
1976	47.20	8.41	24.00							1.76
1977	42.20	7.97	22.60							1.57
1978	37.20	8.55	21.50			6.72				1.70
1979	34.30	9.16	21.90			7.19				1.66
1980		10.70	32.80			8.80	5.68			2.35
1981	50.20	10.40	31.90			8.82	5.42	2.28		2.22
1982	37.20	10.40	25.10			9.15	6.23	2.17		1.77
1983	51.80	10.40	28.40			9.17	5.54	2.24		1.96
1984	48.20	9.06	29.90			8.06	4.60	1.99		2.04
1985	28.50	7.52	18.50			6.53	4.40	1.89		1.61
1986	37.20	9.99	24.60			9.21	4.41	2.41		1.82
1987	33.90	7.95	20.80			6.68	3.43	2.06	0.83	1.67
1988	44.30	11.30	31.20			9.89	5.10	2.21	1.28	2.20
1989	31.10	8.30	17.00			6.63	4.91	1.74	1.06	1.31
1990	44.40	9.24	26.50		3.43	7.75	4.97	2.40	1.16	2.26
1991	36.80	8.16	25.10		3.66	7.36	4.04	1.82	0.78	1.90
Average	39.91	8.83	24.78	85.77	3.55	8.00	4.89	2.11	1.02	1.86
Standard Deviation	6.55	1.24	4.07	22.30	0.11	1.12	0.74	0.22	0.19	0.34

Table 2.1 (con't)
Mean Annual Flows (m³/s)
B: Provincial Hydrometric Basins

D.A. (km²)	Steering Pond Brook 3.2	Trussel Brook 7.9	Glendon Brook 6.6	Winterland Brook 3.5
Station No.	Site #1	Site #4	Site #5	Site #10
1944				
1945				
1946				
1947				
1948				
1949				
1950				
1951				
1952				
1953				
1954				
1955				
1956				
1957				
1958				
1959				
1960				
1961				
1962				
1963				
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1966				
1967				
1968				
1969				
1970				
1971				
1972				
1973				
1974				
1975				
1976				
1977				
1978				
1979				
1980				
1981	0.09			
1982	0.10			
1983				
1984				
1985				
1986				
1987				
1988	0.11	0.32	0.20	
1989	0.06	0.22	0.18	
1990	0.09	0.36	0.21	
1991	0.08	0.31	0.19	0.08
Average	0.09	0.30	0.19	0.08

Table 2.1 (con't)
Mean Annual Flows (m^3/s)
C: N & L Hydro Basins

	Paradise River	Meelpaeg	Victoria	Upper Salmon	Lower Salmon
D.A. (km^2)	477	2151	1057	920	1786
Station No.					
1944					
1945					
1946					
1947					
1948					
1949					
1950		53.99	33.76	19.33	38.37
1951		70.28	36.61	28.13	55.86
1952		73.07	33.93	30.76	61.01
1953	16.46	67.76	33.50	27.03	53.60
1954	18.06	78.25	38.09	32.16	63.79
1955	18.79	61.28	31.62	25.10	49.86
1956	19.20	73.48	34.50	30.38	60.33
1957	15.98	64.55	37.72	24.14	47.94
1958	15.30	74.57	40.63	28.02	55.58
1959	14.78	55.76	30.65	21.66	43.18
1960	12.53	50.17	28.87	19.65	38.94
1961	11.20	49.83	27.60	18.57	36.85
1962	21.01	79.62	36.81	34.32	68.20
1963	20.39	81.05	38.29	34.96	69.39
1964	16.79	71.30	34.13	30.35	60.28
1965	15.18	67.62	30.11	28.19	56.03
1966	14.98	56.51	30.05	23.06	45.79
1967	16.46	72.46	35.14	28.63	56.88
1968	18.85	78.25	40.33	29.01	57.56
1969	18.91	86.91	43.14	31.87	63.22
1970	19.41	52.01	33.90	30.29	60.16
1971	18.44	83.57	47.56	30.73	61.01
1972	15.42	92.77	46.49	27.52	54.67
1973	19.58	88.14	37.28	24.40	48.45
1974	15.06	85.89	34.17	22.51	44.77
1975	14.25	72.39	33.76	26.09	51.79
1976	16.46	96.66	40.53	30.00	59.60
1977	15.45	110.77	50.31	25.54	50.71
1978	14.75	77.37	33.30	22.25	44.20
1979	15.01	75.39	39.22	23.27	46.13
1980	22.54	80.09	39.53	28.66	56.88
1981	21.98	101.57	48.03	29.13	57.79
1982	17.17	80.30	35.54	24.37	48.39
1983	19.53	98.98	46.49	28.57	66.50
1984	20.77	85.34	39.96	29.68	62.88
1985	12.77	57.80	24.95	25.95	42.00
1986	16.88	69.32	31.62	23.82	48.00
1987	14.28	65.23	35.10	23.18	47.88
1988	21.30	72.66	37.42	34.11	51.56
1989	12.18	56.44	28.20	26.09	39.05
1990	19.45	78.19	40.43	33.99	59.54
1991	14.16	68.64	33.90	31.87	49.41
Average	16.97	74.20	36.50	27.32	53.19

Note : These inflows were calculated by backrouting using reservoir levels and outflows through structures.

Table 2.2
Annual Precipitation at AES Climate Stations (mm)

	Bay D'Espoir 2	Bay D'Espoir Gen Stn	Bay D'Espoir Long Pond	Bay D'Espoir St Albans	Burnt Pond	Harbour Breton	Pools Cove Fortune Bay	Boat Harbour	Fortune	Garnish	Salt Pond	Swift Current
	8400412	8400413	8400414	8400415	8400812	8402071	8402973	8400578	8401618	8401728	8403623	8403625
1909	.	.	.	.	.	.	.	.	.	.	.	.
1910	.	.	.	.	.	.	.	.	.	.	.	.
1911	.	.	.	.	.	.	.	.	.	.	.	.
1912	.	.	.	.	.	.	.	.	.	.	.	.
1913	.	.	.	.	.	.	.	.	.	.	.	.
1914	.	.	.	.	.	.	.	.	.	.	.	.
1915	.	.	.	.	.	.	.	.	.	.	.	.
1916	.	.	.	.	.	.	.	.	.	.	.	.
1917	.	.	.	.	.	.	.	.	.	.	.	.
1918	.	.	.	.	.	.	.	.	.	.	.	.
1920	.	.	.	.	.	.	.	.	.	.	.	.
1921	.	.	.	.	.	.	.	.	.	.	.	.
1922	.	.	.	.	.	.	.	.	.	.	.	.
1925	.	.	.	.	.	.	.	.	.	.	.	.
1926	.	.	.	.	.	.	.	.	.	.	.	.
1927	.	.	.	.	.	.	.	.	.	.	.	.
1928	.	.	.	.	.	.	.	.	.	.	.	.
1929	.	.	.	.	.	.	.	.	.	.	.	.
1930	.	.	.	.	.	.	.	.	.	.	.	.
1931	.	.	.	.	.	.	.	.	.	.	.	.
1932	.	.	.	.	.	.	.	.	.	.	.	.
1933	.	.	.	.	.	.	.	.	.	.	.	.
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1962	.	.	.	.	.	.	.	.	.	.	.	.
1963	.	.	.	.	.	.	.	.	.	.	.	.
1964	.	.	.	.	.	.	.	.	.	.	.	.
1965	.	.	.	.	.	.	.	.	.	.	.	.
1966	1323.1	.	.	.	.	.	.	.	.	.	.	.
1967	.	.	.	1674.5	.	.	.	.	.	.	.	.
1968	.	.	.	.	.	.	.	.	.	.	.	.
1969	.	1563.5	.	.	.	.	.	.	.	.	.	.
1970	.	.	.	.	.	.	.	.	.	.	.	.
1971	.	1714.6	.	.	.	.	.	.	.	.	.	.
1972	.	1695.5	.	.	.	.	.	.	.	.	.	.
1973	.	1651.0	.	.	1327.9	.	.	.	.	.	.	.
1974	.	1482.1	.	.	1278.1	.	.	.	.	.	.	.
1975	.	1452.4	.	.	1299.8	.	.	.	.	.	.	.
1976	.	1830.2	.	.	1461.5	.	.	.	.	.	.	.
1977	.	1622.2	.	.	1622.1	.	.	.	.	.	1181.1	.
1978	.	1392.9	.	.	1286.4	.	.	.	.	.	1254.3	.
1979	.	1350.4	.	.	1455.3	.	.	.	.	.	.	.
1980	.	1656.4	.	.	1508.5	.	1913.4	.	.	.	.	.
1981	.	1850.1	.	.	1797.4	.	2134.8	.	1635.0	.	.	.
1982	.	1275.1	.	.	1374.2	.	1282.8	.	1277.9	.	1866.0	.
1983	.	1868.6	1709.2	.	1724.8	.	2252.8	.	1592.0	1552.9	2186.9	.
1984	.	1672.1	1591.2	.	1531.3	1769.2	1652.2	1669.4	1413.8	1488.4	1805.5	.
1985	.	1380.4	1335.3	.	1191.5	1425.3	1455.4	1627.2	1265.0	.	.	1322.1
1986	.	1484.1	1393.8	.	1265.0	1564.0	1757.2	1710.1	1556.4	.	.	1478.0
1987	.	1377.7	1324.8	.	1363.3	.	1621.8	1650.1	1370.2	1576.1	.	1429.2
1988	.	1504.3	1561.3	.	1417.9	1495.0	1627.2	1909.8	2034.8	1242.7	2071.1	1688.6
1989	.	1372.4	1399.6	.	1219.2	.	1698.8	1183.2	.	.	1359.4	1162.8
1990	.	1611.6	1661.6	.	1424.8	1663.6	2175.5	1578.2	.	.	1715.6	1529.8
Average	1323.1	1562.3	1497.1	1674.5	1420.5	1583.4	1797.4	1618.3	1518.1	1465.0	1660.0	1435.1

Table 2.2 (con't)

	Westbrook St Lawrence	Winter-Land	Arnolds Cove	Come By Chance	Grand Bank	Marystown	St Lawrence	Upper Salmon	Burin	St Albans	Terrence-ville
	8404201	8404240	8400135	8401257	8402000	8402592	8403615	8404080	8400810	8403290	8403858
1909	.	.	.	.	.	.	.	.	.	.	.
1910	.	.	.	.	.	.	.	.	.	.	.
1911	.	.	.	.	.	.	.	.	.	.	.
1912	.	.	.	.	.	.	.	.	1976.5	.	.
1913	.	.	.	.	.	.	.	.	.	.	.
1914	.	.	.	.	.	.	.	.	1933.1	.	.
1915	.	.	.	.	.	.	.	.	2076.4	.	.
1916	.	.	.	.	.	.	.	.	1873.4	.	.
1917	.	.	.	.	.	.	.	.	1775.9	.	.
1918	.	.	.	.	.	.	.	.	.	.	.
1920	.	.	.	.	.	.	.	.	1615.4	.	.
1921	.	.	.	.	.	.	.	.	2069.9	.	.
1922	.	.	.	.	.	.	.	.	.	.	.
1925	.	.	.	.	.	.	.	.	.	.	.
1926	.	.	.	.	.	.	.	.	1139.2	.	.
1927	.	.	.	.	.	.	.	.	.	.	.
1928	.	.	.	.	.	.	.	.	861.3	.	.
1929	.	.	.	.	.	.	.	.	1351.3	.	.
1930	.	.	.	.	.	.	.	.	1116.9	.	.
1931	.	.	.	.	.	.	.	.	.	.	.
1932	.	.	.	.	.	.	.	.	.	.	.
1933	.	.	.	.	.	.	.	.	.	.	.
1934	.	.	.	.	.	.	.	.	.	.	.
1935	.	.	.	.	1339.9	.	.	.	.	.	.
1936	.	.	.	.	1558.4	.	.	.	.	.	.
1937	.	.	.	.	1367.8	.	.	.	.	.	.
1938	.	.	.	.	1266.1	.	.	.	.	.	.
1939	.	.	.	.	1541.0	.	.	.	.	.	.
1940	.	.	.	.	1086.8	.	.	.	.	.	.
1941	.	.	.	.	1234.4	.	.	.	.	.	.
1942	.	.	.	.	1252.4	.	.	.	.	.	.
1943	.	.	.	.	1586.2	.	.	.	.	.	.
1944	.	.	.	.	1697.0	.	.	.	.	.	.
1945	.	.	.	.	1597.9	.	.	.	.	.	.
1946	.	.	.	.	1222.0	.	.	.	.	.	.
1947	.	.	.	.	927.0	.	.	.	.	.	.
1948	.	.	.	.	1330.5	.	.	.	.	.	.
1949	.	.	.	.	.	.	.	.	.	.	.
1950	.	.	.	.	.	.	.	.	.	.	.
1951	.	.	.	.	.	.	.	.	.	.	.
1952	.	.	.	.	1421.9	.	.	.	.	.	.
1953	.	.	.	.	1402.5	.	.	.	.	.	.
1954	.	.	.	.	1524.6	.	.	.	.	.	.
1955	.	.	.	.	1428.1	.	.	.	.	.	.
1956	.	.	.	.	1472.8	.	.	.	.	.	.
1957	.	.	.	.	1121.7	.	.	.	.	.	.
1958	.	.	.	.	1224.2	.	.	.	.	.	.
1959	.	.	.	.	997.2	.	.	.	.	.	.
1960	.	.	.	.	953.6	.	.	.	.	.	.
1961	.	.	.	.	831.9	.	.	.	.	.	.
1962	.	.	.	.	1298.4	.	.	.	.	.	.
1963	.	.	.	.	1353.9	.	.	.	.	.	.
1964	.	.	.	.	1394.9	.	.	.	.	.	.
1965	.	.	.	.	1332.3	.	.	.	.	.	.
1966	1447.4	.	.	.	.	.	.	.	.	.	.
1967	1311.7	.	.	.	.	.	1225.4	.	.	.	.
1968	1547.6	.	.	.	.	.	1404.4	.	.	.	.
1969	1699.9	.	.	.	.	.	1547.6	.	.	1735.9	.
1970	1828.6	.	.	.	.	.	1699.8	.	.	1707.9	.
1971		.	.	.	.	.	1309.9	.	.	1692.2	.
1972	1494.2	.	1154.2	.	.	.	1467.2	.	.	1816.9	.
1973		.	1258.5	.	.	.	1507.2	.	.	1984.9	.
1974	1805.9	.	1366.2	.	.	.	1636.4	.	.	1559.4	.
1975	1498.2	.	.	.	.	.	1526.7	.	.	1416.6	.
1976		.	1351.3	1049.9	.	.	1434.8	.	.	1931.2	.
1977	1005.6	.	.	720.0	.	.	1184.6	.	.	1920.5	.
1978	1244.1	.	1128.1	914.2	.	.	1351.3	.	.	1724.0	.
1979	.	.	1217.9		.	.	1547.4	.	.	1633.0	.
1980	.	.	1580.3	1549.0	.	.	1601.7	.	.	1857.2	.
1981	.	.	1501.1	1479.2	.	.	1682.0	.	.	1962.1	.
1982	1664.7	1369.9	.	1244.5	.	.	1857.7	1252.9	.	1439.0	.
1983	.	.	.	1439.8	.	.	1940.8	.	.	.	.
1984	.	.	.	1454.3	.	.	1669.4	.	.	.	.
1985	.	.	1274.9	.	.	.	1471.8	.	.	.	.
1986	.	.	.	1347.7	.	.	1752.0	.	.	.	.
1987	.	.	1275.1	.	.	.	1501.2	.	.	.	.
1988	.	1536.8	1558.8	1431.3	.	.	.	.	.	.	.
1989	1405.9	998.4	996.0	1066.8	.	.	1448.2	.	.	.	.
1990		1488.9	1375.5	1532.6	.	.	1751.6	.	.	.	1414.8
Average	1496.2	1348.5	1310.6	1269.1	1313.1	N/A	1543.4	1252.9	1617.2	1741.5	1414.8

The analysis proceeded as follows.

- establish the best estimates of long-term MAR for all gauged basins;
- relate the MAR from the gauged basins to physiographic characteristics, if possible;
- plot isolines using the MAR from the gauged basins and the relationship derived from the physiographic characteristics.

2.2.1 Estimates of Long-Term MAR from Gauged Basins

There are 11 basins gauged by WSC in the study area, plus one (Come-by-Chance) just outside the study area. Of these, two of the records, Salmon River at Round Pond (02ZE002) and Bay d'Espoir Power (02ZE003) could not be used, since their drainage areas changed twice during the period of record, when NLH constructed diversions in the Bay d'Espoir system. In addition, there are records from four PN stations, and from four sub-basins in the Bay d'Espoir system, as well as from NLH's station on Paradise River.

The records were first adjusted to the same period of record, which was then taken to be representative of the long-term MAR. Although the MAR for the period of record could simply be used directly, it could misrepresent the MAR if the gauge had only been operating during a period either wetter or drier than average.

The records were therefore adjusted using the gauges with the longest data sets. The longest record is from the Bay du Nord River (gauged since 1952), followed by Piper's Hole (since 1953). Garnish is the next longest, gauged since 1959. These are the only three stations still operating with records covering the dry period in the early 1960's.

The average flows in Bay du Nord River and Piper's Hole River before 1959 were very close to the overall average, so for the purposes of the MAR analysis, the records were assumed to start at 1959. This provided three records of 32 years which could be used as predictor gauges for basins with shorter records.

Some consideration was given to the question of stationarity of the records, i.e., whether there might be a trend upward or downward in long-term runoff. A previous study for DOEL examined the longest records on the island, for Humber River and Gander River, and detected no significant trend.[1-5]. Figure 2.4, showing the seven year moving average for Bay du Nord, Garnish and Salmon River at Long Pond, tends to confirm this result. Salmon River was included because it is the only station in the study area with records before 1950; it was closed when the hydroelectric station was built at Bay d'Espoir in the mid-1960's. The three rivers generally show the same patterns of wet and dry years, and there is no evidence of a long term persistent trend since the early 1950's.

The very wet period in the mid-1940's suggested by the Salmon River data seems to be part of normal cycles, not a long-term trend. The precipitation record at Grand Bank (Table 2.2) also shows this wet period; the wettest year on record at Grand Bank was 1944, 29.2 percent above the mean, with 1943 and 1945 also very wet, at 20.8 percent and 21.7 percent above the mean. Prior to this period precipitation records suggest a climate similar to the last 30 or 40 years, with a mix of wet, average and dry years. The Burin climate station, for example, shows a very dry year in 1928 comparable to 1961, the driest year of record for most currently operating precipitation and stream flow stations on the island.

Having selected three gauges to represent the long-term average, the next task was to estimate the 32 year mean for gauges with shorter records. The three gauges with 32 years or more of data were used as the predictor gauges for the shorter-record gauges.

The annual runoff value for the overlapping periods of record for the short and long-record gauges were correlated using ordinary least squares linear regression. The preferred predictor for each shorter record gauge was the one with the

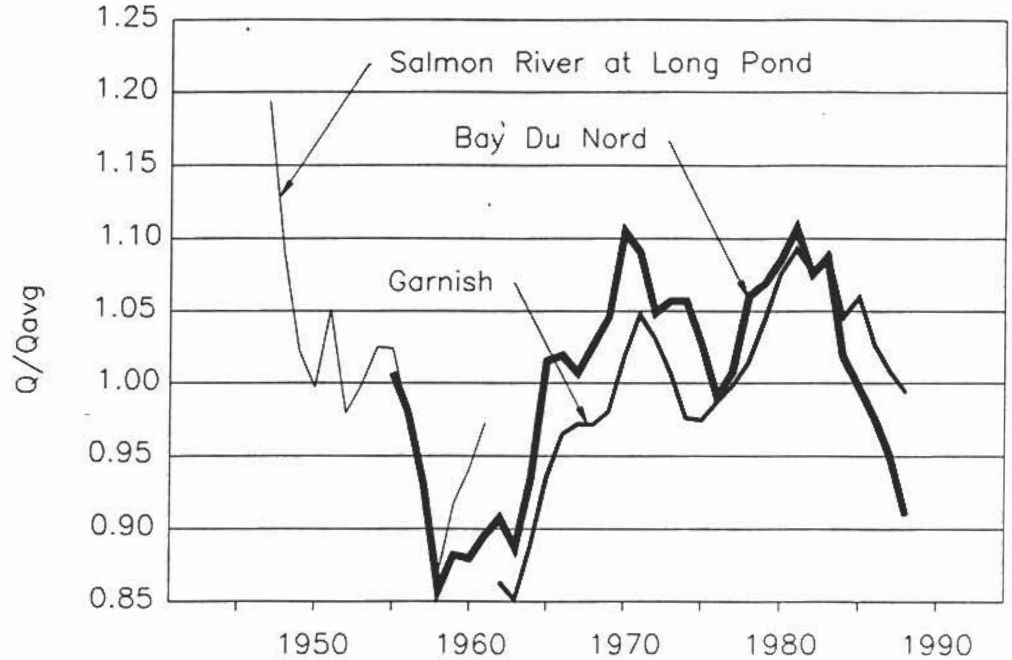


FIG. 2.4

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area

Annual Flows: 7-Year Moving Average

ACRES

highest correlation coefficient. Table 2.3, showing the correlation matrix, is provided to give an indication of how the annual flows for gauged rivers compare with longer term gauges in three different parts of the study region; Bay du Nord draining from the north into Fortune Bay, Garnish draining from the Burin Peninsula into Fortune Bay, and Pipers Hole draining from the northern part of the Burin Peninsula into Placentia Bay. The correlation coefficients are not all statistically significant, especially for short records. The regression equations were not used directly for prediction; the purpose of the analysis was simply to identify the preferred longer term gauge.

The long-term MAR was then estimated for each of the shorter records by proration, i.e., $MAR_{L2} = (MAR_{S2}/MAR_{S1}) * MAR_{L1}$, where

MAR_{L2} - long-term (32 year) MAR for short record gauge
MAR_{S2} - MAR for period of record of short gauge
MAR_{S1} - MAR for predictor gauge, for overlapping period
MAR_{L1} - long-term (32 year) MAR for predictor gauge.

Table 2.4 (a) to (c) shows the 32 year averages for the predictor gauges, and the estimated long-term (32 year) MAR for the remaining gauges.

2.2.2 Relationship of MAR to Physiographic Characteristics

Once the long-term MAR at the gauge locations was estimated, an exhaustive stepwise multiple regression analysis was used to identify the physiographic characteristics which best explain the variation in MAR. The variables used in the regression analysis are given in Table 2.5, and the correlation matrix of physiographic variables in Table 2.6.

The results indicated that the two most important explanatory variables are elevation of the basin centroid and distance from the sea in a southwesterly direction. When the distance is taken in a broader sense, to mean the shortest distance in a generally southwesterly direction, within an arc from 180 degrees to

Table 2.3
Correlation Matrix of Mean Annual Runoff

Gauged Basins		Bay du Nord		Garnish		Pipers Hole
	N	Correlation Coefficient r	N	Correlation Coefficient r	N	Correlation Coefficient r
Bay du Nord		1.00				
Garnish	32	0.66	32	1.00	32	
Pipers Hole	38	0.85	38	0.73	38	1.00
Salmon River,Long Pond	13	0.91	13	0.75	13	0.88
Tides Brook	14	0.68	14	0.94	14	0.79
Salmonier River	12	0.52	12	0.73	12	0.48
Rattle Brook	11	0.56	11	0.70	11	0.57
Little Barasway	5	0.64	5	0.85	5	0.49
Come By Chance	22	0.68	22	0.64	22	0.87
Steering Pond Brook	6	0.50	6	0.86	6	0.74
Trussel Brook	4	0.92	4	0.44	4	0.81
Glendon Brook	4	0.88	4	0.41	4	0.63
Paradise River	3	0.98	3	0.93	3	0.80
Meelpaeg	22	0.66	22	0.13	22	0.32
Victoria	20	0.77	20	0.25	20	0.51
Upper Salmon	8	0.67	8	0.47	8	0.69
Lower Salmon	24	0.83	24	0.36	24	0.70

Note: Relationships were not statistically significant for n<=12, nor for Meelpaeg.

Table 2.4
Estimated Long Term Mean Annual Runoff (mm)
A: WSC Basins

	Predictor Gauges									
	Bay du Nord	Garnish	Pipers Hole	Salmon River Long Pond	Conne River	Tides Brook	Salmonier River	Rattle Brook	Little Barasway	Come By Chance
D.A. (km²)	1170	205	764	2640	99.5	166	115	42.7	28.2	43.3
Station No.	02ZF001	02ZG001	02ZH001	02ZE001	02ZE004	02ZG002	02ZG003	02ZG004	02ZG005	02ZH002
Gauge for Prediction				Bay du Nord	Bay du Nord	Garnish	Garnish	Garnish	Garnish	Pipers Hole
1959	1001	1284	892	759						
1960	690	799	756	686						
1961	650	1041	673	650						758
1962	1184	1242	1272	1207						
1963	1230	1455	1227	1219						
1964	1079	1333	1012	1060						
1965	1060	1199	917							
1966	847	1171	905							
1967	1060	1167	991							
1968	1257	1481	1136							
1969	1211	1529	1140							
1970	1138	1521	1169							1880
1971	1227	1330	1115							1523
1972	1206	1288	929							1312
1973	1292	1539	1181							1530
1974	955	1445	900							1363
1975	939	1319	859							1115
1976	1273	1295	991							1283
1977	1138	1227	933							1144
1978	1003	1316	888			1277				1239
1979	925	1410	905			1367				1210
1980	1293	1647	1355			1673	1559			1713
1981	1354	1601	1318			1677	1487	1685		1618
1982	1003	1601	1037			1739	1709	1604		1290
1983	1397	1601	1173			1743	1520	1655		1428
1984	1300	1395	1235			1532	1262	1471		1487
1985	769	1158	764			1241	1207	1397		1173
1986	1003	1538	1016			1751	1210	1781		1326
1987	914	1224	859			1270	941	1522	932	1217
1988	1195	1739	1289			1880	1399	1633	1432	1603
1989	839	1278	702			1260	1347	1286	1186	955
1990	1197	1422	1095		1088	1473	1364	1774	1298	1647
1991	993	1256	1037		1161	1399	1109	1345	873	1385
Average of period of record	1073	1359	1020	930	1124	1520	1343	1559	1144	1356
32 yr MAR	1079	1359	1020	1033	1108	1433	1254	1474	1124	1359

Table 2.4 (con't)
Estimated Long Term Mean Annual Runoff (mm)
B: Provincial Hydrometric Basins

	Predictor Gauges					
	Bay du Nord	Garnish	Steering Pond Brook	Trussel Brook	Glendon Brook	Winterland Brook
D.A. (km²)	1170	205	3.2	7.9	6.6	3.5
Station No.	02ZF001	02ZG001	Site # 1	Site # 4	Site # 5	Site # 10
Gauge for Prediction			Garnish	Bay du Nord	Bay du Nord	Garnish
1959	1001	1284				
1960	690	799				
1961	650	1041				
1962	1184	1242				
1963	1230	1455				
1964	1079	1333				
1965	1060	1199				
1966	847	1171				
1967	1060	1167				
1968	1257	1481				
1969	1211	1529				
1970	1138	1521				
1971	1227	1330				
1972	1206	1288				
1973	1292	1539				
1974	955	1445				
1975	939	1319				
1976	1273	1295				
1977	1138	1227				
1978	1003	1316				
1979	925	1410				
1980	1293	1647				
1981	1354	1601	858			
1982	1003	1601	996			
1983	1397	1601				
1984	1300	1395				
1985	769	1158				
1986	1003	1538				
1987	914	1224				
1988	1195	1739	1065	1286	937	
1989	839	1278	631	883	851	
1990	1197	1422	848	1454	1018	
1991	993	1256	809	1222	894	721
Average of period of record	1079	1359	868	1211	925	721
32 yr MAR	1079	1359	795	1238	945	780

Table 2.4 (con't)
Estimated Long Term Mean Annual Runoff (mm)
C: N & L Hydro Basins

	Predictor Gauges							
	Bay du Nord	Garnish	Pipers Hole	Paradise River	Meelpaeg	Victoria	Upper Salmon	Lower Salmon
D.A. (km²)	1170	205	764	477	2151	1057	920	1786
Station No.	02ZF001	02ZG001	02ZH001					
Gauge for Prediction				Bay du Nord	Bay du Nord	Bay du Nord	Pipers Hole	Bay du Nord
1959	1001	1284	892					
1960	690	799	756					
1961	650	1041	673					
1962	1184	1242	1272					
1963	1230	1455	1227					
1964	1079	1333	1012					
1965	1060	1199	917					
1966	847	1171	905					
1967	1060	1167	991					
1968	1257	1481	1136					1017
1969	1211	1529	1140					1117
1970	1138	1521	1169		763			1063
1971	1227	1330	1115		1226			1078
1972	1206	1288	929		1361	1388		966
1973	1292	1539	1181		1293	1113		856
1974	955	1445	900		1260	1020		791
1975	939	1319	859		1062	1008		915
1976	1273	1295	991		1418	1210		1053
1977	1138	1227	933		1625	1502		896
1978	1003	1316	888		1135	994		781
1979	925	1410	905		1106	1171		815
1980	1293	1647	1355		1175	1180		1005
1981	1354	1601	1318		1490	1434		1021
1982	1003	1601	1037		1178	1061		855
1983	1397	1601	1173		1452	1388		1175
1984	1300	1395	1235		1252	1193	1018	1111
1985	769	1158	764		848	745	890	742
1986	1003	1538	1016		1017	944	817	848
1987	914	1224	859		957	1048	795	846
1988	1195	1739	1289		1066	1117	1170	911
1989	839	1278	702	806	828	842	895	690
1990	1197	1422	1095	1287	1147	1207	1166	1052
1991	993	1256	1037	937	1007	1012	1093	873
Average of period of record	1079	1359	1020	1010	1167	1129	981	937
32 yr MAR	1079	1359	1020	1080	1138	1108	1001	905

Table 2.5
MAR Regression Analysis

Station	MAR	Elevation (m)	SW Distance to Coastline (km)	Alternate Distance (km)	Azimuth (degrees)	Longitude (degrees)
Winterland Brook	780	31	44	15	214	55.30
Steering Pond Brook	795	31	38	2	249	55.52
Glendon Brook	945	122	47	18	215	55.20
Pipers Hole	1020	213	68	55	209	54.46
Bay du Nord	1079	152	76	38	190	55.27
Conne River	1108	213	88	77	206	55.43
Little Barasway	1124	91	27	18	260	55.62
Trussel Brook	1238	122	8	8	219	54.10
Salmonier River	1254	91	13	9	218	55.73
Garnish	1359	152	66	12	211	55.16
Tides Brook	1433	213	33	20	214	55.33
Rattle Brook	1474	122	97	11	237	54.87
Paradise River	1080	168	25	18	212	54.60
Meelpaeg	1138	284	96	74	195	56.77
Victoria	1108	338	88	68	197	57.45
Upper Salmon	1001	320	117	78	180	56.32
Lower Salmon	905	183	95	49	189	56.03

Note: Alternate Distance refers to the shortest distance to the coastline in the SW quadrant

Table 2.6
Correlation Matrix of Physiographic Variables

Correlation Coeffient r

	MAR	Azimuth	Longitude	SW Distance	Alternate Distance	Elevation
MAR	1.000					
Azimuth	0.038	1.000				
Longitude	0.142	0.246	1.000			
SW Distance	0.126	0.265	0.027	1.000		
Alternate Distance	0.097	0.480	0.027	0.559	1.000	
Elevation	0.477	0.546	0.328	0.354	0.674	1.000

270 degrees (true), the results are better than if the direction is strictly defined as SW (225 degrees).

Several transformations (e.g., logarithmic) were tried, and none of the resulting equations was better than a linear regression equation.

A second model was also proposed, which excluded the four sub-basins in the Bay d'Espoir system (Lower Salmon, Upper Salmon, Meelpaeg and Victoria).

This was done for several reasons. First, the inflows are calculated by backrouting through large storage reservoirs. (Although the same procedure is used at Paradise River, the station is run of river, and the levels and outflows can be carefully monitored.) Secondly, the Bay d'Espoir area is quite far from the Fortune Bay/Burin Peninsula area; the centroids of the sub-basins range from 50 km to over 150 km from Bay du Nord River, the nearest long-term gauge in the study area. Also, the NLH basins drain into Bay d'Espoir Bay, not Fortune Bay. Thirdly, there is no real advantage to including these basins in an equation which may be used for prediction, because the ungauged basins for which prediction is required are not located in this region.

The two models (with and without the Bay d'Espoir sub-basins) were compared, using the predicted residual sum of squares technique (PRESS). The more usual procedure for evaluating equations intended for prediction is data splitting, in which a portion of the data set is not used in the regression analysis. This portion can be used to test the equations. Since the data set in this study was small, and precluded data splitting, the PRESS technique was selected. It is similar in concept, but withholds observations one at a time, recalculating the coefficients of the equation. Two or more models can be evaluated by comparing what is called the PRESS statistic, i.e., the sum of the squares of the PRESS residuals.

The two predictive models, i.e., with and without the Bay d'Espoir sub-basins, were compared in this way (Table 2.7). As expected, the PRESS statistic was lower using the second model, without the Bay d'Espoir sub-basins.

Table 2.7
Press Analysis

Model 1 – All gauges (Bay d'Espoir & Burin Peninsula)

Gauge omitted from analysis	MAR = a x Elev – b x Alt.Dist + c Constants a	b	c	MAR from equation w.o. gauge	MAR from equation	Estimated MAR	PRESS Resid. (m)	Ord. Resid. (m)	(PRESS Resid.)²	(Ord. Resid.)²
No gauges removed	1.87	-6.73	1033.4							
Winterland Brook	1.14	-5.04	1111.7	1071	990	780	0.291	0.210	0.085	0.044
Steering Pond Brook	1.43	-6.36	1112.4	1143	1077	795	0.348	0.282	0.121	0.080
Glendon Brook	1.92	-7.14	1052.2	1158	1141	945	0.213	0.196	0.045	0.038
Pipers Hole	1.86	-6.60	1034.2	1068	1063	1020	0.048	0.043	0.002	0.002
Bay du Nord	1.89	-6.77	1031.8	1063	1063	1079	-0.016	-0.016	0.000	0.000
Conne River	2.66	-10.19	1004.5	788	915	1108	-0.320	-0.193	0.103	0.037
Little Barasway	1.91	-6.77	1031.8	1085	1084	1124	-0.039	-0.040	0.002	0.002
Trussel Brook	1.83	-6.53	1031.4	1203	1208	1238	-0.035	-0.030	0.001	0.001
Salmonier River	1.86	-6.44	1018.2	1130	1144	1254	-0.124	-0.110	0.015	0.012
Garnish	1.60	-5.65	1032.9	1212	1242	1359	-0.147	-0.117	0.022	0.014
Tides Brook	2.27	-7.43	969.2	1305	1070	1433	-0.128	-0.363	0.016	0.132
Rattle Brook	1.58	-5.25	1011.9	1147	1188	1474	-0.327	-0.286	0.107	0.082
Paradise River	2.18	-7.86	1032.1	1256	1226	1080	0.176	0.146	0.031	0.021
Meelpaeg	1.86	-6.98	1039.2	1050	1067	1138	-0.088	-0.071	0.008	0.005
Victoria	2.28	-7.46	1001.6	1266	1210	1108	0.158	0.102	0.025	0.010
Upper Salmon	2.02	-6.61	1014.8	1146	1108	1001	0.145	0.107	0.021	0.011
Lower Salmon	1.76	-6.18	1043.1	1062	1046	905	0.157	0.141	0.025	0.020
							Press Statistic		0.050	0.037
							Standard Error		0.058	0.049

Model 2 – All gauges except Bay d'Espoir subbasins

Gauge omitted from analysis	MAR = a x Elev – b x Alt.Dist + c Constants a	b	c	MAR from equation w.o. gauge	MAR from equation	Estimated MAR	PRESS Resid. (m)	Ord. Resid. (m)	(PRESS Resid.)²	(Ord. Resid.)²
No gauges removed	3.51	-7.88	847.4							
Winterland Brook	3.20	-7.41	884.5	871	836	780	0.091	0.056	0.008	0.003
Steering Pond Brook	3.01	-7.71	924.9	1001	939	795	0.206	0.144	0.043	0.021
Glendon Brook	3.50	-8.06	868.0	1150	1133	945	0.205	0.188	0.042	0.035
Pipers Hole	3.65	-7.01	823.3	1217	1163	1020	0.197	0.143	0.039	0.020
Bay du Nord	3.51	-7.86	847.5	1084	1083	1079	0.005	0.004	0.000	0.000
Conne River	3.83	-11.70	868.8	785	989	1108	-0.323	-0.119	0.104	0.014
Little Barasway	3.64	-8.04	824.5	1012	1026	1124	-0.112	-0.098	0.012	0.010
Trussel Brook	3.49	-7.75	845.1	1209	1212	1238	-0.029	-0.026	0.001	0.001
Salmonier River	3.60	-7.60	814.7	1075	1097	1254	-0.179	-0.157	0.032	0.025
Garnish	3.37	-7.43	849.1	1277	1291	1359	-0.082	-0.068	0.007	0.005
Tides Brook	3.54	-7.94	845.6	1442	1438	1433	0.009	0.005	0.000	0.000
Rattle Brook	3.34	-6.84	820.8	1153	1188	1474	-0.321	-0.286	0.103	0.082
Paradise River	2.18	-7.86	1032.1	1256	1226	1080	0.176	0.146	0.031	0.021
							Press Statistic		0.029	0.010
							Standard Error		0.051	0.030

The equation for MAR from the second model, for the study area excluding the Bay d'Espoir area, is

$$MAR = 847 + 3.51 \text{ (Elev)} - 7.88 \text{ (Alt-SW)}$$

where MAR is mean annual runoff in millimetres, Elev is the elevation of the basin centroid in metres, and Alt-SW is the distance in kilometres of the centroid from the sea in a generally southwesterly direction (180 to 270 degrees true).

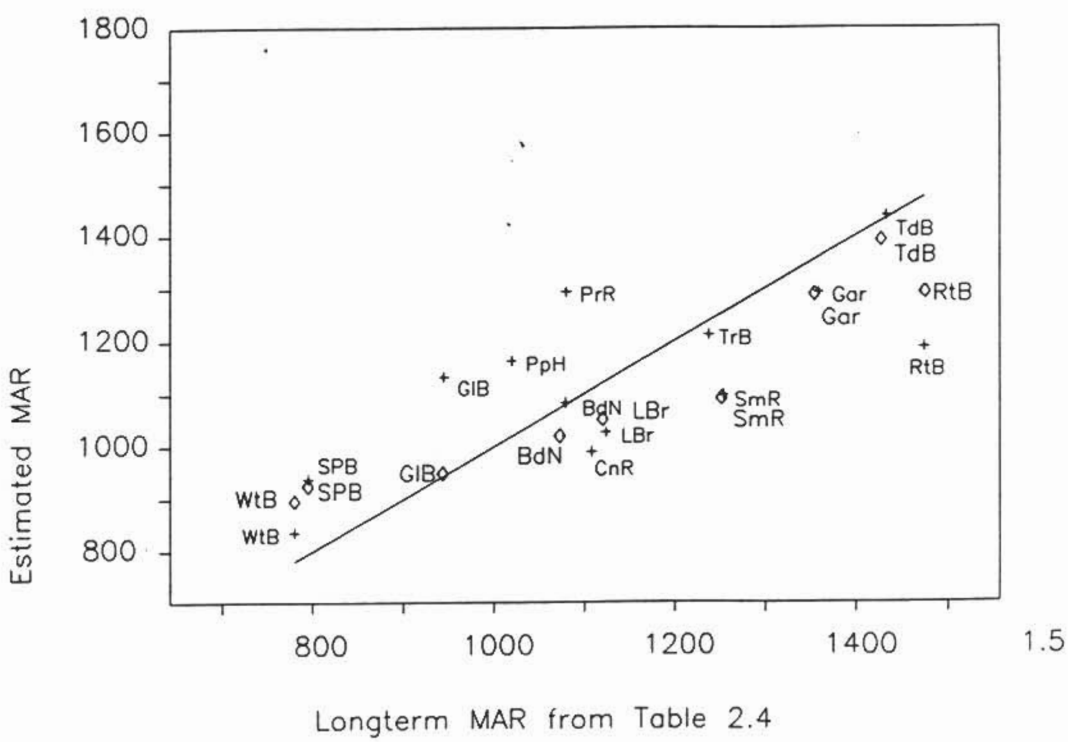
The coefficient of determination (r^2) is 0.548, indicating that just over half of the variance in MAR is explained by the regression equation. The variance inflation factor was checked to ensure that the relationship between DA and Alt-SW did not cause problems of multi-collinearity.

The equation makes sense hydrologically, in that runoff increases with elevation and decreases as distance from the sea increases in the direction of the incoming storm systems. The standard error was quite high, however, at 161 mm (about half the standard deviation). Because of the high standard error, the equation was not used directly to prepare the isolines; rather, when shaping the isolines, the elevation and distance from the sea were taken into account.

Figure 2.5 shows the results of the regression analysis.

2.2.3 Map of Isolines of MAR

The estimates of long term mean annual runoff, the AES data, and the results of the regression analysis were used to draw the map of isolines of MAR. The long-term estimates of MAR from Table 2.4 were first plotted at the centroids of the basins, as shown in Figure 2.6. Precipitation data points were also included on this figure, taken from Table 2.2. There were too many missing values in the precipitation records to be able to estimate long term average annual precipitation, so the average for the period of record for each station is indicated



\+ Predicted MAR from Equation

◇ Estimated from Map Fig. 2.7

FIG. 2.5

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Mean Annual Runoff Predictions

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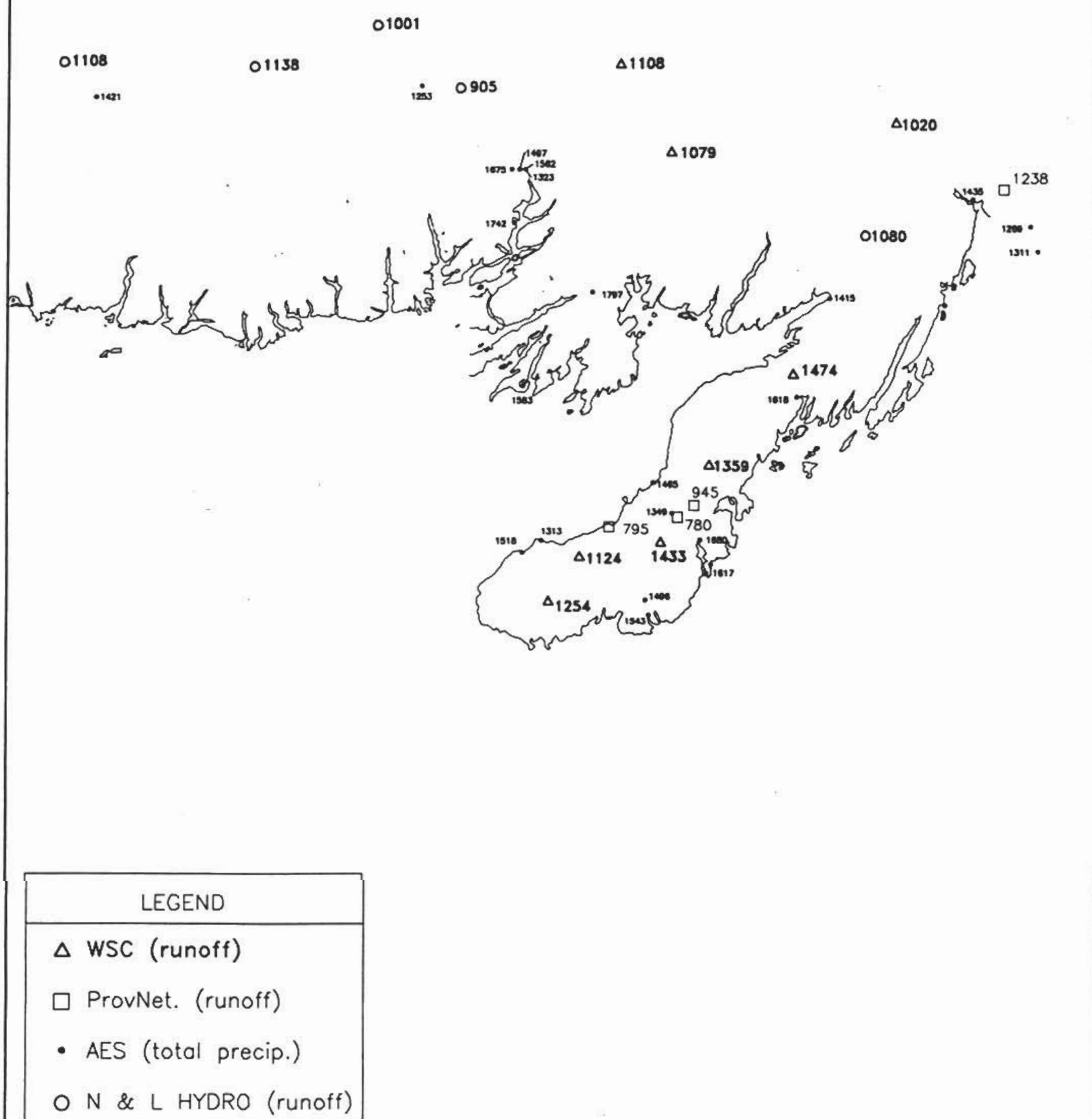

Note: MAR values are estimated long-term(30yrs). Precipitation values are for period of record.

FIG. 2.6

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area

Mean Annual Runoff and Precipitation Points

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on the plot. Precipitation data for the PN stations are not shown on this figure because they are located at approximately the same points as the runoff values, and the runoff information is more important. The isolines of MAR were then drawn taking into account the mean annual runoff from gauged basins, elevation, distance from the sea in a generally southwesterly direction, and precipitation. The lack of precipitation and flow data in the Fortune Bay North region and along the south coast in general precluded any better definition of runoff in that area.

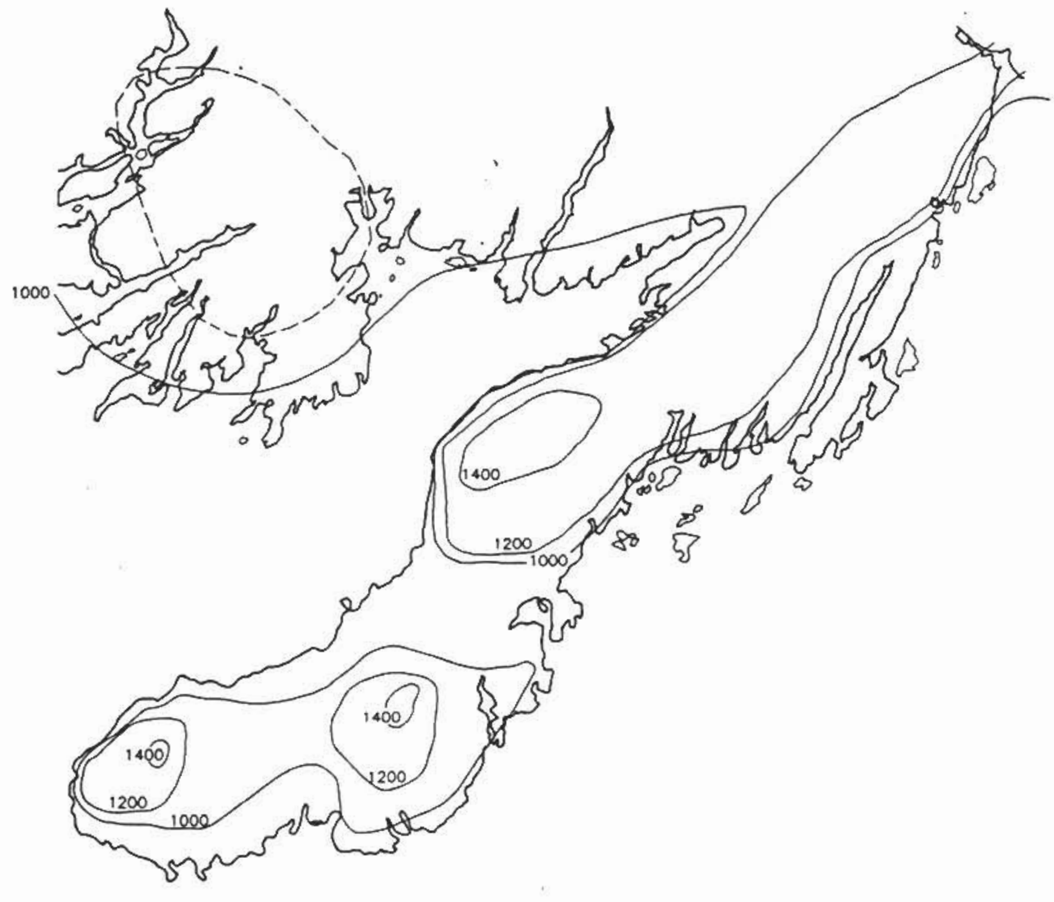
The resulting map is shown in Figure 2.7. In estimating the MAR at ungauged basins (Section 2.7), this map was used taking into account data points from Figure 2.6, rather than the equation. It may be noted that the area of lower runoff between Grand Bank and Marystown corresponds to the lowlands area shown on the map of physiographic regions in Chapter 3 (Figure 3.1).

2.3 Seasonal Distribution of Precipitation and Runoff

Having estimated the mean annual runoff in the study area, the next step was to consider flow variation through the year.

The pattern is similar to that observed on the rest of the island, but winter lows are lower and spring peaks are higher. This difference is evident in Figure 2.8, which shows a plot of the normalized mean monthly flows at gauge locations in different parts of the island of Newfoundland. The basin with the highest peak of the three is Torrent River (02YC001), on the Northern Peninsula. The middle one is in central Newfoundland, Gander River at Big Chute (024Q001). The third, showing the least variation, is Garnish River, in the study area.

A single annual cycle is dominant in all three regions of the island, but flows are more evenly distributed through the year in the Garnish basin. Throughout the study area, the trend is similar; the bottom part of Figure 2.8 shows the average variation through the year for the three gauges with the longest records. Piper's Hole River has slightly higher spring runoff flows and lower summer flows than either Bay du Nord or Garnish River; all three show about the same winter régime.



------- High Elevation suggests MAR>1200; no data available

MAR in mm

FIG. 2.7

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Isolines of Mean Annual Runoff

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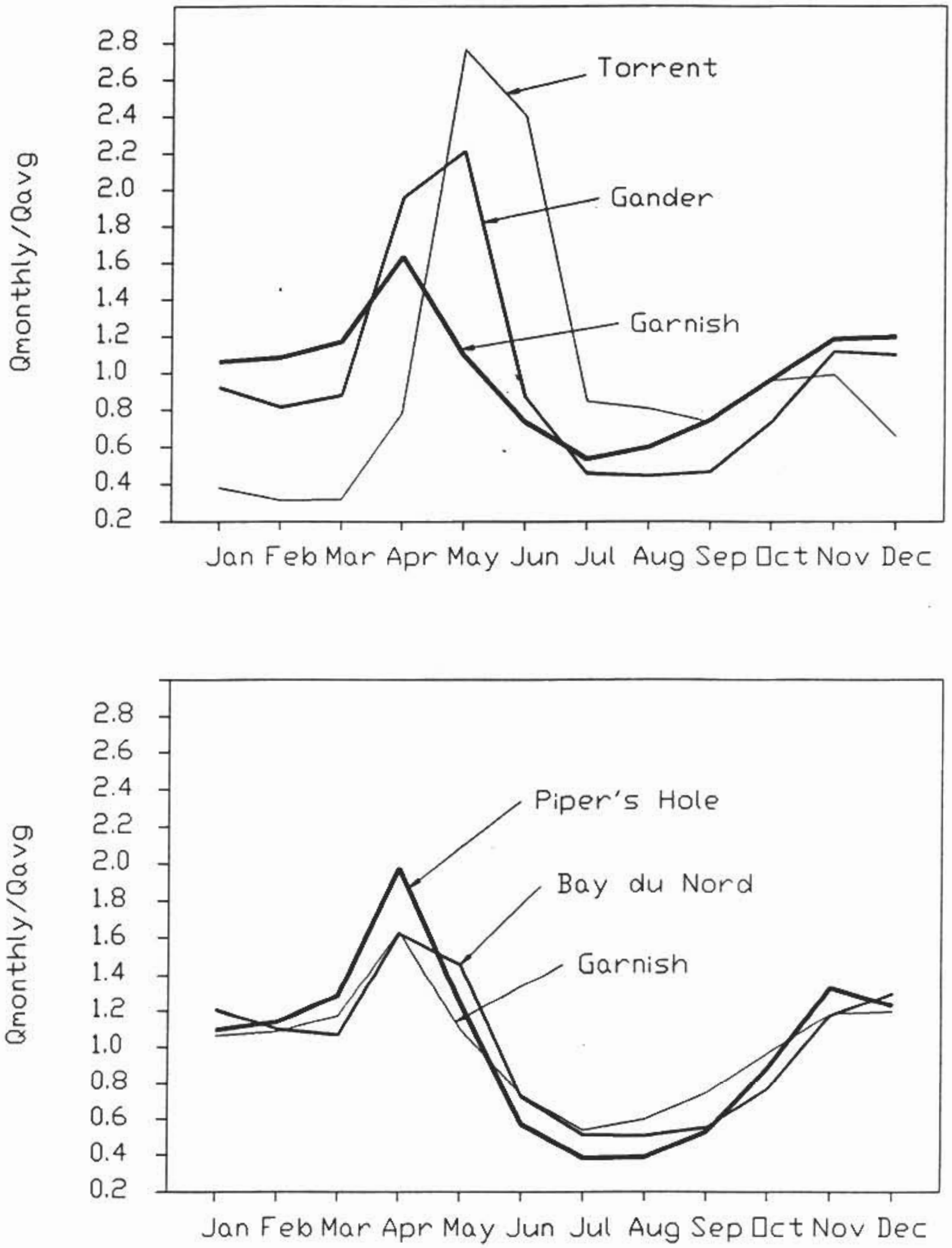

FIG. 2.8

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Mean Monthly Flow

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The Burin Peninsula/Fortune Bay region has higher winter flows and lower spring runoff flows compared to more northerly areas because the winter climate is milder. As Figure 2.9 shows, winter precipitation can be either rain or snow. Low flows in the study area generally occur during the summer (usually August, although the lowest flows on record occurred in September). Occasionally a cold winter will result in a low flowin January or February. On the average, over 85 percent of the minimum daily flows in the gauged basins occur in summer (June to October).

2.3.1 Flow Duration Curves

Flow duration curves are another way to show the proportion of high and low flows in a basin. The flow duration curves for all the stations in the study area are given in Appendix A. These were prepared by ranking all the daily flows from highest to lowest, and non-dimensionalizing them by dividing by the mean annual flow for the period of record.

Flow duration curves give a good indication of the extent to which a basin is regulated, either naturally or by a control structure. They are used to estimate the proportion of time the flow exceeds a given value. Figure 2.10 gives an example of this for two basins in the study area, Tides Brook and Salmonier River. Both are in the same general area, near the boot of the peninsula, both have about the same length of record, and both are about the same size (Salmonier River is 115 km^2, Tides Brook 166 km^2). But Tides Brook shows quite a bit more regulation, probably due to the natural regulation of Freshwater Pond. As an example of the use of flow duration curves, assume that there is a requirement to have a flow of half the average annual discharge (0.5 Q_{avg}). At Tides Brook, this requirement would be met over 70 percent of the time, whereas at Salmonier River, it would only be met about 55 percent of the time.

2.4 Low Flow Analysis

Low flows in Newfoundland have been discussed in a previous report by DOEL.[2-1]. They are important for such uses as water supply and maintenance of water quality

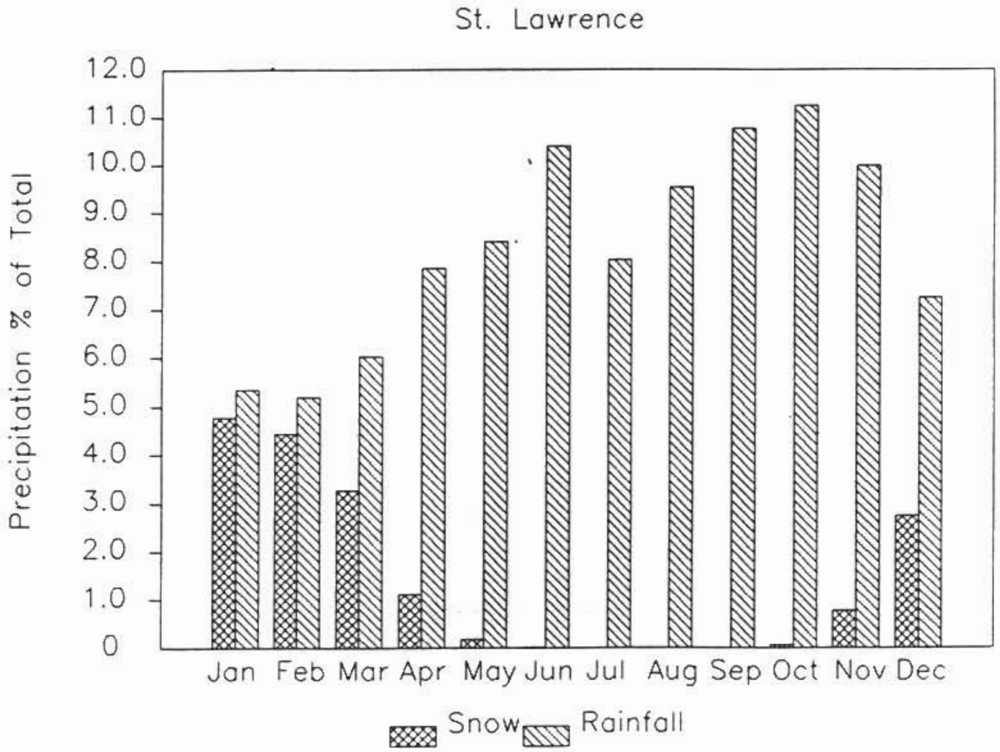

FIG. 2.9

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Average Monthly Pattern of Snow and Rain

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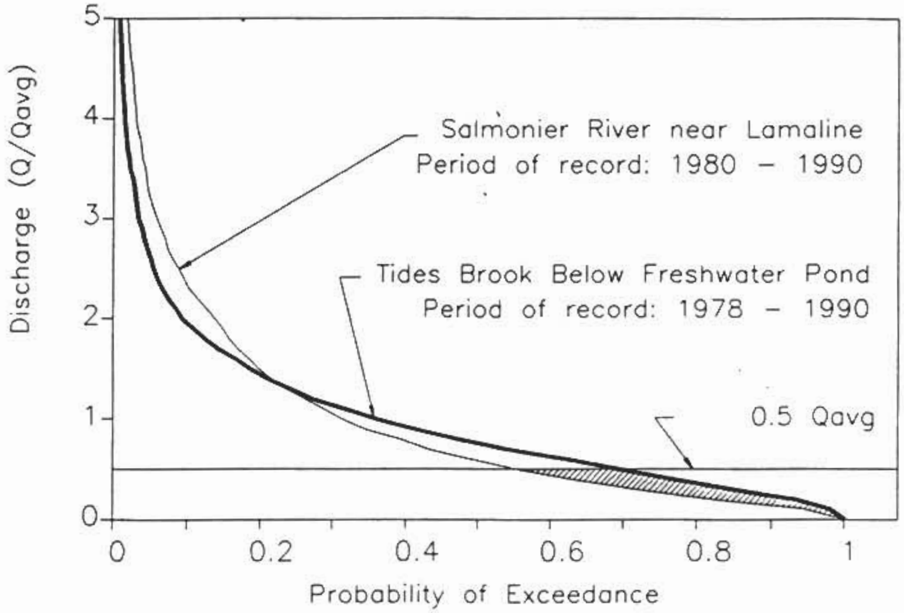

FIG. 2.10

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Typical Flow Duration Curves

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and fisheries. Two approaches are available for most low flow analyses - flow duration, as discussed above, and frequency. Frequency analysis is more useful where the length of a low flow event is important (e.g., whether it lasts one day, seven days, or ten days) and is discussed below.

2.4.1 Frequency Method

The frequency-based methodology follows that developed by DOEL in its island-wide low flow analysis.[2-1]

The stations and physiographic parameters used in the analysis for the region are given in Table 2.8, and frequency estimates for selected return periods for the stations in the study area are given in Table 2.9. The basins used in the analysis are relatively large, with more barrens than forest. The drainage areas used in the analysis range from 42.7 km^2 to 1,170 km^2, the percentage of barren area ranges from 23 percent to 72 percent and the percentage of forested area ranges from ten percent to 38 percent. If a basin has characteristics outside these ranges, results should be used with caution.

Precipitation is not included in the data set, nor as one of the predictive equations in the regression equations because

1. precipitation data are scarce at high elevations and there can be significant differences in precipitation amounts even between closely-related stations;

2. it is a difficult parameter to estimate at sites with no precipitation data; and

3. the error in estimating precipitation can be as large as the range of precipitation.

The DOEL report notes that the accuracy of the low flow estimates is dependent upon the accuracy of the low flow measurements themselves. While the latter

Table 2.8
Low Flow Analysis - Stations and Physiographic Data

Station Number	D.A. (km^2)	Forest (%)	Barren (%)	Lakes & Swamps (%)	% ACLS	Drainage Density (1/km)	Shape Factor	Slope (%)	Length of Main Stream (km)	Elevation Difference (m)	Record Length (yrs)
02ZG004	42.7	35.0	47.0	18.0	92	1.62	1.53	1.1	10.0	107	81-91
02ZG003	115.0	15.8	72.0	12.0	92	1.55	1.62	0.34	24.5	136	80-91
02ZG002	166.0	38.0	48.6	13.3	92	1.35	1.84	1.35	26.7	221	78-91
02ZG001	205.0	26.5	64.0	10.1	96	0.55	2.45	0.6	44.7	370	59-91
02ZH001	764.0	10.7	23.4	65.9	91	0.71	1.67	0.35	51.0	207	59-91
02ZF001	1170.0	32.2	44.1	23.6	96	0.61	2.15	0.29	68.1	282	59-91

Table 2.9
Results of Low Flow Frequency Analysis

		Bay du Nord	Pipers Hole	Garnish	Tides Brook	Salmonier River	Rattle Brook
D.A.(km^2)		1170	764	205	166	115	42.7
Station No.		02ZF001	02ZH001	02ZG001	2ZG00	02ZG003	2ZG004
2 Year	1 day	9.26	2.33	1.32	1.02	0.37	0.144
	7 day	9.94	2.63	1.47	1.21	0.48	0.196
	15 day	10.84	2.99	1.75	1.43	0.63	0.260
	30 day	12.49	3.69	2.28	1.82	1.11	0.436
10 Year	1 day	4.46	0.67	0.49	0.44	0.14	0.058
	7 day	4.83	0.76	0.52	0.53	0.20	0.081
	15 day	5.20	0.81	0.60	0.63	0.28	0.107
	30 day	6.01	0.93	0.86	0.77	0.42	0.165
20 Year	1 day	3.31	0.41	0.31	0.36	0.09	0.032
	7 day	3.61	0.48	0.33	0.41	0.13	0.043
	15 day	3.84	0.51	0.37	0.48	0.17	0.059
	30 day	4.34	0.58	0.53	0.57	0.25	0.064

depends upon many parameters, including the absolute magnitude of the flows, a rule-of-thumb worst-case of typical data quality is ± 50 percent.

As noted in the discussion on seasonal variation of flow, the summer case is more severe, so the frequency analysis was based on these extremes. The frequency estimates were made using the Gumbel Type III probability distribution function. Details are provided in the DOEL report.

The DOEL analysis provides equations for estimating the 30 day beta parameter of the Gumbel probability function. Once this parameter has been estimated, low flows for various frequencies and durations can be obtained from additional equations. These results are then generalized by regression using the variables listed in Table 2.8.

The records from the PN stations are too short for frequency analysis, but they were used to demonstrate the application of these equations, as well as to provide data on low flows in small basins.

The Burin Peninsula falls in Low Flow Region A. The Fortune Bay area west of Terrenceville was not identified as a low flow region because of insufficient hydrologic data. The PN gauges at Steering Pond Brook, Trussel Brook, Glendon Brook and Winterland Brook all fall in Region A.

The equation for estimating the 30 day beta parameter for Region A uses both drainage area and percentage of area covered by forests. (Of the two, drainage area is identified as a much more important explanatory variable than percentage of forests.) The beta parameter and resulting low flows were estimated for the PN gauges, with the note that the drainage areas were outside the range used in the analysis. Table 2.10 presents the observed low flows at the PN gauged sites for various durations, together with the estimated 1:2 year low flows for those basins. The probability that the 1:2 year low flow will be equalled or exceeded in a four-year period is over 90 percent. Table 2.10 shows that even though the drainage areas were outside the range, the results of using the predictive equations are quite good at Steering Pond Brook and Glendon Brook. At Trussel Brook, the

Table 2.10
Low Flows, Provincial Hydrometric Stations

D.A. (km²)	Steering Pond Brook 3.2	Trussel Brook 7.9	Glendon Brook 6.6	Winterland Brook 3.5
Station No.	Site #1	Site #4	Site #5	Site #10
1 - Day				
1988	0.020	0.014	0.018	
1989	0.013	0.018	0.015	
1990	0.006	0.012	0.015	
1991	0.005	0.012	0.016	0.004
Estimated 2 yr	0.007	0.021	0.015	0.012
7 - Day				
1988	0.021	0.022	0.025	
1989	0.014	0.020	0.018	
1990	0.007	0.013	0.019	
1991	0.006	0.015	0.018	0.005
Estimated 2 yr	0.009	0.026	0.019	0.015
15 - Day				
1988	0.023	0.025	0.027	
1989	0.015	0.024	0.023	
1990	0.008	0.014	0.024	
1991	0.006	0.024	0.022	0.005
Estimated 2 yr	0.011	0.033	0.023	0.019
30 - Day				
1988	0.025	0.033	0.028	
1989	0.016	0.029	0.030	
1990	0.012	0.022	0.026	
1991	0.009	0.033	0.029	0.008
Estimated 2 yr	0.016	0.048	0.034	0.027

Note: 2 year estimates are based upon equations from WRD Low Flow Analysis equations tend to overpredict. At Winterland Brook, the record is too short to evaluate the results, but equations appear to overpredict.

DOEL will be incorporating the low flows from these small basins into the update of the low flow analysis when the records are sufficiently long; this should improve prediction of low flows in small basins.

2.5 Storage/Yield Analysis

Major water uses such as water supply or hydroelectric generation require an estimate of the effect of storage. The low flow equations are not appropriate for estimating yield when dams and control structures have been built.

The reliable yield for a water supply or hydroelectric station is the amount of water that can safely be withdrawn over a specified period of time. If the source is a natural stream, without dams or control structures to provide storage, the reliable yield is the lowest dry weather flow of the stream during the period. For this report, the reliable yield for systems without storage is taken as the one in ten year seven day low flow as estimated using the DOEL equations.

For a water supply system with storage (usually a dammed pond), the reliable yield is the maximum constant rate of withdrawal which will not deplete the reservoir during the specified period. Calculating this rate usually requires a site specific analysis. A daily or monthly series of inflows is obtained, from a station with a long record if possible. The characteristics of the project are defined, in particular the demand rate on the reservoir, the spillway (or other) outflows and the volume/elevation relationship for the reservoir. The operation of the system is then simulated on a daily or monthly basis over the period of the streamflow sequence.

For this study, a regional curve was developed which could be applied to any basin to estimate the reliable yield for the existing system and for increased storage if required.

Detailed analyses were carried out for all the gauged rivers, assuming that they were being used for water supply. Each of the gauged basins was analyzed for various live storage volumes. For each volume of storage, daily operation of the storage reservoir was simulated for several different withdrawal rates. For each withdrawal rate, the amount of storage required in order to avoid failure was determined.

The results were then combined to produce a regional storage/yield curve. This curve gives an estimate of the constant rate at which water can be withdrawn with shortfalls occurring less frequently than about once every ten years on the average.

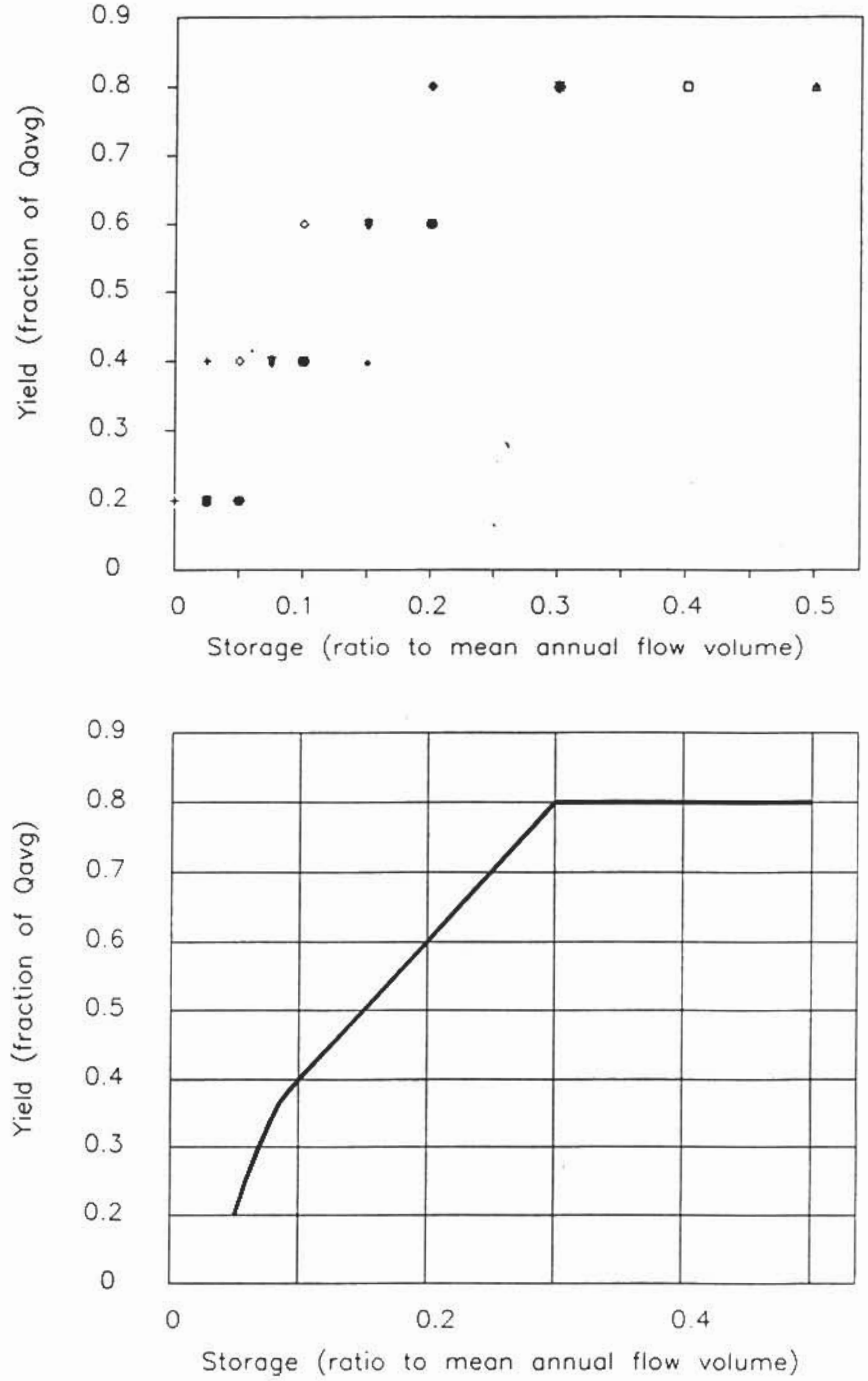
The results were made non-dimensional by expressing the volumes of storage and the withdrawal rates as fractions of mean annual flow. By examining the yields from each basin, a regional non-dimensional curve was prepared. The results are presented in Figure 2.11, and summarized as follows.

Yield/Storage Relationship

Yield (Fraction of Average Flow)	Storage (Fraction of Average Annual Volume)
0.2	0.05
0.4	0.10
0.6	0.20
0.8	0.30

The top part of Figure 2.11 shows the storage required to guarantee yields ranging from 20 percent to 80 percent of the average annual flow throughout the period of record for all the gauges in the study area. The bottom part of the figure shows the lower envelope curve, which can be used to estimate the increase in yield with storage at an ungauged site. A sample calculation using a similar curve is given in a previous DOEL report.[1-4].

The curve in Figure 2.11 does not replace detailed analysis at a particular site, but it does give a good indication of required storage and is used in the supply demand analysis in Chapter 6. If the storage ratio at a proposed water supply site is less than 0.2, then either the low flow frequency equations should be used, as discussed in



Note: Below a storage ratio of 0.05, use low flow equations

FIG. 2.11

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Storage/Yield Curve

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Section 2.4, or a detailed yield analysis should be carried out, as described in Section 2.5.1 below.

2.5.1 Detailed Yield Analysis - Example

A detailed yield analysis at a given site is often carried out by daily simulation using a reference streamflow sequence. The reference streamflow sequence is usually obtained by proration from an adjacent gauged basin. The proration factor is obtained by estimating the mean annual flow at the ungauged site (using the method outlined in Section 2.2), and dividing it by the mean annual flow at the gauged site. This proration factor accounts for differences in both drainage area and mean annual runoff. The simulation is repeated, constantly increasing the demand, until the reservoir is depleted. This will occur in the driest period in the reference sequence, so the results are sensitive to the basin used for proration, to the length of record, and to the amount of storage. Depending on the importance of the project, many streamflow sequences may be generated using stochastic techniques, as discussed in Reference 2-2, for example.

A basin near Grand Beach water supply was used to illustrate the application of this analytical procedure. The example basin has a drainage area of 8.4 km^2, and a mean annual runoff of 950 mm, so the mean annual flow is 0.25 m^3/s. There are three gauged basins nearby, Steering Pond (3.2 km^2), Little Barasway (28.2 km^2) and Garnish (205 km^2). Little Barasway and Steering Pond Brook have only been gauged since 1987; Garnish River has been gauged since 1959. All three rivers therefore include the dry period in 1987, but only Garnish includes the dry period in 1961.

Four cases were examined, the first three with proration from all three gauges for the same period of record, the fourth from the longest record only.

Case A No Storage - Proration from

1. Steering Pond
2. Little Barasway
3. Garnish

Case B Storage = 1.25 percent of average annual flow volume (about 1 m on a pond of 0.10 km^2). Proration from all three gauges.

Case C Storage = 2.5 percent of average annual flow volume (about 2 m on a pond of 0.10 km^2). Proration from all three gauges.

Case D Storage = 1.25 percent Q_{avg} (as Case B), but using the longest record for proration (Garnish since 1959).

The results are presented in Tables 2.11 to 2.14. (Although the time step in the simulation is one day, the results are summarized by month for convenience.) The interesting result is that using the basin with the smallest drainage area for proration (Steering Pond) does not give the lowest yield, even when there is no storage. This is probably explained by the fact that there is a large pond in the watershed providing natural regulation, which confirms that factors other than drainage area alone influence reliable yield. As Table 2.11 (Case A) shows, a yield of 0.018 m^3/s (over 1,500 m^3/day) would be estimated using a four-year sequence based on Steering Pond Brook. This demand would lead to numerous failures (shaded) if Little Barasway had been used for proration, and occasional failures if Garnish River had been used.

If some storage is added (Case B), the yield improves considerably, to 0.058 m^3/s (over 5,000 m^3/day) based on Steering Pond Brook. Again, however, this demand could not be met if the inflows followed the pattern of either Little Barasway or Garnish basins.

If the storage is doubled (Case C), the reliable yield improves to 0.076 m^3/s (over 6,500 m^3/day), but even this large amount of storage is not sufficient to prevent failures if the inflow sequence is based on Little Barasway or Garnish.

Table 2.11
Case A: Storage Ratio (vol/Qavg)=0

1) Prorated from Steering Pond

Demand (m³/s) No Storage

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1988	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1989	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1990	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Mean	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Failure	No	No	No	No	No	No	No	No	No	No	No	No

2) Prorated from Little Barasway

Demand (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.018	0.018	0.017	0.018	0.018	0.018	0.013	0.009	0.017	0.018	0.018	0.018	0.017
1988	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1989	0.018	0.018	0.018	0.018	0.018	0.018	0.017	0.017	0.018	0.018	0.018	0.018	0.018
1990	0.018	0.018	0.018	0.018	0.018	0.018	0.017	0.016	0.018	0.018	0.018	0.018	0.018
Mean	0.018	0.018	0.018	0.018	0.018	0.018	0.016	0.015	0.018	0.018	0.018	0.018	0.018

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0	0	9	0	0	0	21	29	8	0	0	0
1988	4	0	0	0	0	0	0	4	0	0	0	0
1989	0	0	0	0	0	3	4	5	0	0	0	0
1990	0	0	0	0	0	0	6	12	6	0	0	0
Failure	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	No	No	No

3) Prorated from Garnish

Demand (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.009	0.018	0.018	0.018	0.018	0.017
1988	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1989	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
1990	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Mean	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.016	0.018	0.018	0.018	0.018	0.018

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0	0	0	0	0	0	4	28	1	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
Failure	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No

Table 2.12
Case B: Storage Ratio (vol/Qavg)=0.0125

1) Prorated from Steering Pond

Required Yield (m³/s) Storage (99,800m³)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1988	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1989	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1990	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Mean	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Failure	No	No	No	No	No	No	No	No	No	No	No	No

2) Prorated from Little Barasway

Required Yield (m³/s) Storage (99,800m³)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.058	0.058	0.058	0.058	0.058	0.058	0.051	0.009	0.042	0.058	0.058	0.058	0.052
1988	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1989	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1990	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.050	0.038	0.058	0.058	0.058	0.056
Mean	0.058	0.058	0.058	0.058	0.058	0.058	0.056	0.044	0.049	0.058	0.058	0.058	0.056

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0	0	0	0	0	0	5	31	13	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	7	19	0	0	0
Failure	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No

3) Prorated from Garnish

Required Yield (m³/s) Storage (99,800m³)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.025	0.048	0.058	0.058	0.058	0.054
1988	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1989	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1990	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Mean	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.050	0.056	0.058	0.058	0.058	0.057

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0	0	0	0	0	0	0	20	14	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
Failure	No	No	No	No	No	No	No	Yes	Yes	No	No	No

Table 2.13
Case C: Storage Ratio (vol/Qavg)=0.0250

1) Prorated from Steering Pond

Required Yield (m^3/s) Storage (199,600m^3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
1988	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
1989	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
1990	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
Mean	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
Failure	No	No	No	No	No	No	No	No	No	No	No	No

2) Prorated from Little Barasway

Required Yield (m^3/s) Storage (199,600m^3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.016	0.051	0.076	0.076	0.076	0.069
1988	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
1989	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
1990	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.071	0.043	0.076	0.076	0.076	0.073
Mean	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.060	0.062	0.076	0.076	0.076	0.074

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.0	14.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	23.0	0.0	0.0	0.0
Failure	No	No	No	No	No	No	No	Yes	Yes	No	No	No

3) Prorated from Garnish

Required Yield (m^3/s) Storage (199,600m^3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1987	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.035	0.057	0.076	0.076	0.076	0.071
1988	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
1989	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
1990	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
Mean	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.066	0.071	0.076	0.076	0.076	0.075

Number of days that demand is not met

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987	0	0	0	0	0	0	0	18	14	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
Failure	No	No	No	No	No	No	No	Yes	Yes	No	No	No

Table 2.14
Case D: Longer Record
Prorated from Garnish

Required Yield (m^3/s) Storage Ratio (vol/Qavg)=0.0125 Storage (99,800m^3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1960	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.039	0.020	0.056	0.058	0.058	0.053
1961	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.014	0.003	0.026	0.058	0.058	0.047
1962	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1963	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1964	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1965	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1966	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1967	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1968	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1969	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1970	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1971	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1972	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1973	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1974	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1975	0.058	0.058	0.058	0.058	0.058	0.058	0.049	0.044	0.058	0.058	0.058	0.058	0.056
1976	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1977	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1978	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1979	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1980	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1981	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1982	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1983	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1984	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1985	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1986	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1987	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.025	0.048	0.058	0.058	0.058	0.054
1988	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1989	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
1990	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Mean	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.055	0.055	0.057	0.058	0.058	0.057

Table 2.14 (cont'd)

Number of days that demand is not met

Storage Ratio (vol/Qavg)=0.0125 Storage (99,800m³)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	30.0	7.0	0.0	0.0
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0	30.0	21.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1973	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	0.0	0.0	0.0	0.0	0.0	0.0	8.0	18.0	0.0	0.0	0.0	0.0
1976	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	14.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Failure	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No

The effect of using a longer record is shown in Case D (Table 2.14). Assuming the Case B storage (1.25 percent Q_{avg}), the same failures occur in 1987. In addition, at this demand rate, failures would have occurred in 1960, 1961 and 1975, i.e., in four years out of 21, and for prolonged periods in some cases.

2.6 Water Balance

A water balance for a basin requires that the runoff (the output) be equal to the precipitation (the input) minus the losses through evapotranspiration. Water balance calculations are useful in estimating expected losses, or in assessing the reliability of runoff estimates made from precipitation data. Although streamflow measurements are values averaged over the basin area, not point values, it can be assumed for the purpose of these calculations that the mean runoff value at the basin centroid is approximately equal to the mean real value.

Two approaches were used to estimate the expected losses in the water balance equation

1. direct rainfall-runoff comparison;
2. Thornthwaite evapotranspiration method.

Rainfall - Runoff Comparison

A comparison of the locations of the climate stations and the basin centroids presented previously shows that there are no AES climate stations located near basin centroids. At all the PN stations, however, both precipitation and runoff data are available, though the precipitation stations are not located at the centroids of the basins. The recorded precipitation and runoff data are presented below, with the calculated losses. Clearly there is wide variation, and additional precipitation data from stations in the basins is required to improve the estimates.

	Period of Record	Mean Annual Precipitation P (mm)	Mean Annual Runoff R (mm)	Estimated Evapotransp P-R (mm)	Ratio R/P
Steering Pond	1981-82, 1988-91	1,680	868	812	52%
Glendon Brook	1988-91	1,382	925	457	67%
Trussel Brook	1988-91	1,365	1,211	154	89%
Winterland Brook	1991	1,171	721	450	62%

Thornthwaite Method

Another approach is to estimate evaporation from temperature data by the Thornthwaite method. This method is based on an extensive set of experiments to establish the correlation between temperature and evapotranspiration; it was specifically developed for an area with close-set vegetation and adequate water supply in the latitudes of the United States. The original calculation was modified by AES to improve the snow storage and snowmelt runoff component.

The results, based on precipitation data for Grand Bank, the only station in the study area for which a water balance has been calculated by AES, are as follows.

	Precipitation P (mm)	Runoff R (mm)	Estimated Evapotransp E (mm)	Ratio R/P
Grand Bank	1,305	779	526	60%

2.7 Natural Surface Water Availability

To estimate the total natural surface water availability, the study area was divided into 105 natural drainage basins. The natural drainage basins were grouped into two major regions, according to whether they drain into Placentia Bay or Fortune Bay. The NLH Bay d'Espoir sub-basins form a separate group. For each of these natural basins, the drainage area was measured and the average flow was calculated.

The procedure was as follows

- identify all the rivers and streams, except minor coastal brooks;
- mark their watershed boundaries;
- measure drainage area;
- locate the centroid of each basin;
- select appropriate mean annual runoff from Figure 2.7;
- calculate mean annual flow, using mean annual runoff and the drainage basin area.

Figure 2.12 shows the locations of the identified watersheds, and Table 2.15 lists all the basins identified in the study area, together with their drainage areas and average flow.

The total mean annual flow volume for the major basins is 10,440 x 10^6 m^3 in the study area. The average annual runoff is 1,070 mm.

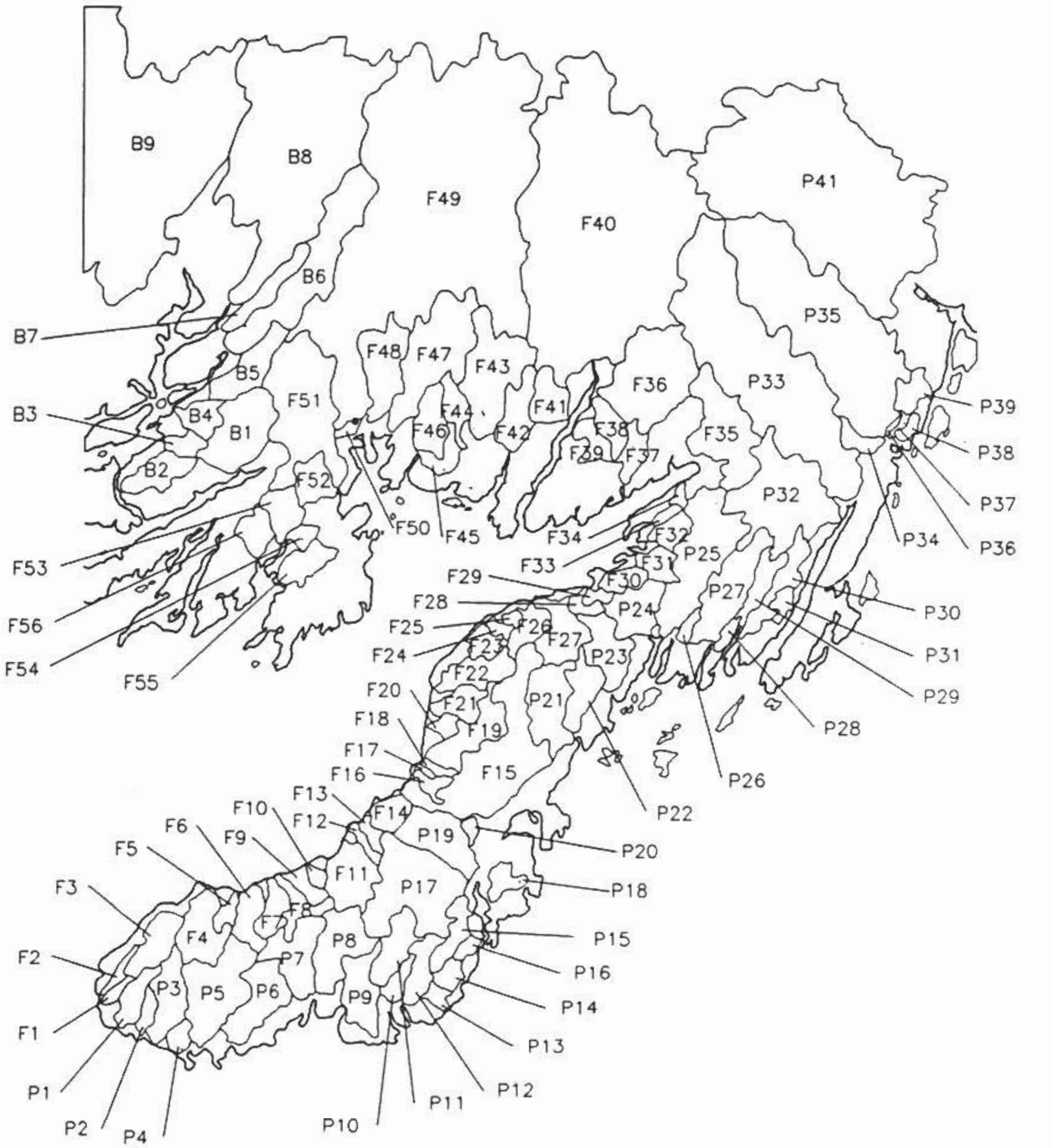

FIG. 2.12

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area

Location of Drainage Basins in Study Area

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Table 2.15
Drainage Basins in Study Area with Drainage Area and MAR

Basin	Name	Drainage Area (km²)	MAR	Qavg	Basin	Name	Drainage Area (km²)	MAR	Qavg
F1	Snooks Brook	8.8	1250	0.35	F54	Bottom Brook	13.1	1200	0.50
F2	Little Dantzic Cove	10.5	1250	0.42	F55	Salmonier Pond	37.2	1150	1.36
F3	Fortune	47.6	1300	1.96	F56	Great Bay de l'Eau	30.9	1200	1.17
F4	Grand Bank Brook	65.7	1200	2.50	P1	Lories Brook	30.8	1250	1.22
F5	L'anse-a-Loup	13.8	1000	0.44	P2	High Beach	14.2	1200	0.54
F6	L'anse-a-Loup Barasway	35.4	1000	1.12	P3	Piercey Brook	57.2	1200	2.18
F7	Gull Pond	30.8	1000	0.98	P4	Kenedy Hill	14.8	900	0.42
F8	Famine Brook	29.7	1000	0.94	P5	Salmonier River	116.5	1100	4.06
F9	Famine Back Cove	18.4	900	0.52	P6	Taylor's Bay	72.4	1000	2.29
F10	Grouse Point	8.4	850	0.23	P7	Lawn	72.1	1000	2.28
F11	Clanceys Pond	66.4	1000	2.10	P8	Great Lawn Harbour	79.6	1150	2.90
F12	White Point	10.3	900	0.29	P9	Lawn River	59.8	1100	2.08
F13	Horseshoe Hill	11.4	900	0.33	P10	Mt. Anne Pond	17.9	1200	0.68
F14	Great Garnish Barasway	27.6	850	0.74	P11	Burnt Woods Pond	49.8	1300	2.05
F15	Garnish River	209.0	1200	7.95	P12	Waterfall Brook	36.1	1200	1.37
F16	Doughball Cove	14.2	900	0.40	P13	Bass Point	11.2	1000	0.35
F17	Devil Brook Head	3.3	950	0.10	P14	Corbin	16.6	1050	0.55
F18	Brown Harbour	7.5	1000	0.24	P15	Salmonier Pond	34.2	1100	1.19
F19	Devil Brook	63.2	1300	2.60	P16	Wandsworth	9.7	1050	0.32
F20	Bluff Point	12.1	1200	0.46	P17	Freshwater Pond	163.9	1200	6.23
F21	Brown Lookout	30.9	1400	1.37	P18	Little Salmonier	20.5	1000	0.65
F22	Hare Hill	46.8	1400	2.08	P19	Southwest Arm	76.1	900	2.17
F23	Peltry Barasway	21.7	1300	0.89	P20	Creston North	7.3	850	0.20
F24	Grand Jersey Head	8.4	1200	0.32	P21	Red Harbour	78.0	1300	3.21
F25	Grand Jersey Cove	6.2	1200	0.24	P22	Red Harbour Head	44.4	1300	1.83
F26	Miller Head	30.2	1400	1.34	P23	Rushoon River	59.0	1300	2.43
F27	Grand John Point	58.3	1400	2.59	P24	Boat Harbour	57.3	1250	2.27
F28	Western Harbour	13.3	1300	0.55	P25	Brookside	150.8	1200	5.73
F29	Langue de Cenf Cove	9.0	1250	0.36	P26	Bay de l'Eau	9.8	1200	0.37
F30	Jacques Fontaine	22.3	1200	0.85	P27	Cape Roger Brook	92.7	1200	3.53
F31	Sugarloaf Hill	26.1	1200	0.99	P28	Burnt Islands	9.7	1200	0.37
F32	Salmonier Brook	24.7	1200	0.94	P29	NE Nonsuch Arm North	32.2	1200	1.22
F33	Bottom Brook	7.6	1000	0.24	P30	NE Nonsuch Arm East	44.8	1100	1.56
F34	Terrenceville	6.6	950	0.20	P31	Paradise Sound North	12.9	1050	0.43
F35	Terrenceville Brook	120.5	1100	4.20	P32	Paradise Sound South	178.5	1200	6.79
F36	Gisborne Lake	163.2	1000	5.17	P33	Paradise River	480.0	1150	17.49
F37	English Harbour East	27.4	1000	0.87	P34	Monkstown Road	19.2	1200	0.73
F38	Billy's Pond	29.9	1000	0.95	P35	Sandy Harbour River	433.2	1050	14.41
F39	Snooks Tolt	25.1	1000	0.80	P36	Great Sandy Hb West	2.9	1200	0.11
F40	Long Harbour River	978.6	1000	31.01	P37	Great Sandy Hb East	4.7	1200	0.18
F41	Schooner Brook	39.9	1000	1.26	P38	Gulch Head	8.7	1100	0.30
F42	Mat Bay Brook	49.1	1000	1.56	P39	Haddock Cove	25.7	1200	0.98
F43	Rencontre Brook	130.5	1000	4.14	P40	Whitehead Pond	807.5	1000	25.59
F44	Little Blue Hill Pond	28.1	1000	0.89	B1	Salmonier Cove	99.2	1200	3.77
F45	Isle à Glu Pond	23.6	1000	0.75	B2	Little Passage	42.9	1100	1.50
F46	Belle Harbour	45.6	1000	1.45	B3	Garrison Hills Brook	18.7	1200	0.71
F47	North East Brook	147.2	1000	4.66	B4	Morgan Arm	30.6	1200	1.16
F48	North West River	81.5	1000	2.58	B5	Collins Brook	59.6	1200	2.27
F49	Bay du Nord River	1188.3	1000	37.66	B6	Little River	173.6	1000	5.50
F50	North Bay	6.5	1200	0.25	B7	Reuben Point	41.3	1000	1.31
F51	Salmon River	196.2	1200	7.46	B8	Conne River	608.7	1000	19.29
F52	Simmons Brook	36.8	1200	1.40	B9	Long Pond Reservoir	722.9	1000	22.91
F53	Old Brook	38.1	1200	1.45					
						Total DA	9753.63		
						Total Q	330.86		

3 - Groundwater Availability

3 Groundwater Availability

The hydrogeology of the region has been reviewed in Water Resources Report (WRR) 2-7 of the provincial groundwater series.[3-1]. This section is a synopsis of the above report and attempts to highlight hydrogeological features of concern to water resource utilization. Wherever possible, recent information is included to improve the analysis. As an example, water well data is updated to October 1992.

3.1 Physiography

The Burin Peninsula study area contains two distinct physiographic zones consisting of the Burin Peninsula and the area north of Fortune Bay, including Bay d'Espoir. These zones are identified in Figure 3.1. The terrain in both zones is generally rugged with exposed or thinly covered bedrock and surficial geology consisting of bog, till, and sand and gravel. The coastal bays and inland ridges generally trend northwest - southeast over the entire study area.

The northern section has a rocky coastline which rises 50 m to 150 m above sea level. The highest elevations are encountered in the west, inland of Hermitage Bay, where bedrock elevations range from 300 to 375 m above sea level. To the east, the less rugged inland rolling topography varies in elevation from 150 m to 280 m above sea level.

The Burin Peninsula section of the study area extends approximately 140 km southwest and varies in width between 15 and 25 km along its length. The terrain is similar to the northern section of the study area with rugged, northeast/southwest trending bedrock ridges ranging in elevation from 50 m to 375 m above sea level. Highlands to the north and south of the peninsula are separated by a lowland extending from Burin/Marystown to Frenchman's Cove/Garnish. It may be noted that this lowland corresponds to an area of lower runoff (Figure 2.7) The highest elevations occur in the north highland from the Garnish Blue Hills to Terrenceville where ridges reach 300 to 375 m above sea level. The elevation in the lowlands is

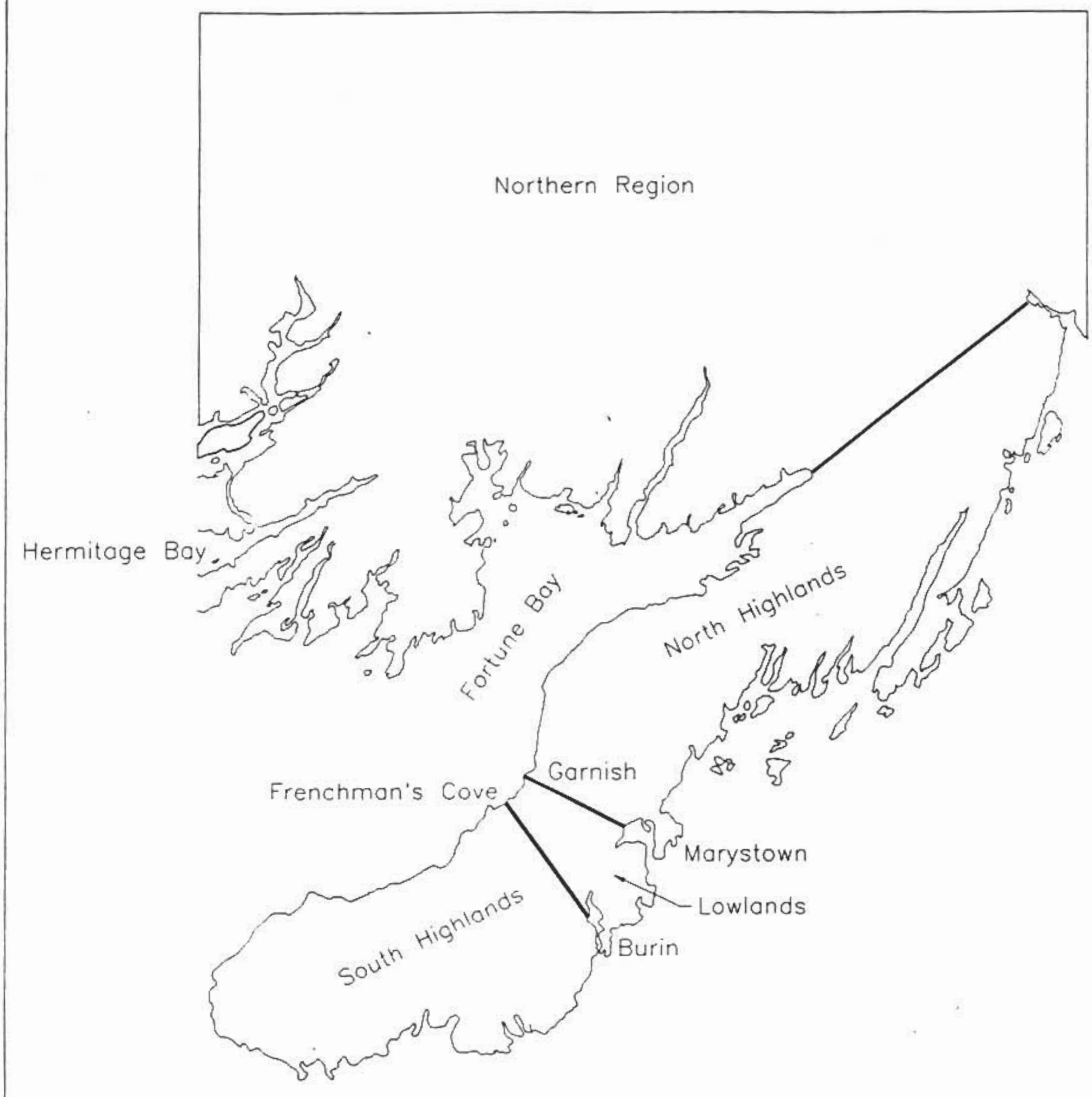

FIG. 3.1

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Physiographic Regions of Study Area

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generally less than 75 m above sea level. Some sheltered valleys and much of the lowland are forested with spruce and alder.

The Burin Peninsula is drained by generally small rivers with small drainage basins, as described in Section 2. The largest system is the Garnish River with a drainage basin of 205 km^2. The northern section of the study area is also drained by small rivers, but contains several large river basins including the Conne River (618 km^2), Piper's Hole River (764 km^2), Bay du Nord River (1,176 km^2) and Long Harbour River (1,010 km^2).

3.2 Surficial Hydrogeology

The surficial geology is comprised of four units. Two of the units, exposed bedrock and bog, are not considered hydrogeologically significant. The other two units are broadly grouped together as Unit S1, glacial till, and Unit S2, outwash sand and gravel deposits. The yield rates quoted for Unit S1 and Unit S2 in the following section are the same as those quoted in WRR 2-7 and are listed in Table 3.1. These values are reasonable and are considered appropriate for the study area.

3.2.1 Unit S1 - Glacial Till

The till has a fine sandy to silty composition giving it a moderate to low permeability. It is deposited as a thin veneer over much of the study area, but there are local thick moraine deposits in the south of the Burin Peninsula.

Most wells are domestic dug types with a generally low yield. An adequate supply of water is usually dependent upon sufficient volume storage in the well itself. A yield rate of 0 to 45 L/min can be expected with an average yield of 9 L/min. These rates are estimates based on known rates from similar soil types in other parts of the province since there are no published rates for the study area. The presence of local deposits with higher proportions of sand and gravel or sand and gravel lenses would likely produce a higher well yield.

TABLE 3.1

Surficial Hydrostratigraphic Units, Burin Peninsula Area

Surficial Hydrostratigraphic Units	Well Yield L/min , (gpm)			Well Depth m , (feet)		
	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
Unit S1 Glacial Till Low Yield	0 - 45 (0 - 10)	9 (2)		5 - 46 (15 - 150)		
Unit S2 Sand & Gravel Moderate-High Yield	55 - 270 (12 - 60)	25 (5.4)	23 (5.0)	8 - 27 (25 - 90)	14 (46)	
	4 - 340 (1 - 70)	100 (22)	45 (10)	10 - 15 (32 - 50)	13.1 (43)	14 (45)
	5.7 - 182 (1.2 - 40)	40.6 (8.9)		8.5 - 65.5 (28 - 215)	20.9 (68.7)	

Note: The data presented in this table was taken from WRR 2-7. Since Yield rates were not available for the study area, WRR 2-7 used other data from similar surficial geology [Notre Dame Bay, S1 and S2(top); Humber Valley, S2(middle); and Avalon Peninsula, S2(bottom)].

3.2.2 Unit S2 - Sand and Gravel Deposits

Isolated sand and gravel deposits occur in the southern Burin Peninsula, but are not extensive over the study area. As with Unit S1, yield rates for the sand and gravel are estimated from other studies performed in the province. This data suggests expected yield rates of 25 to 100 L/min. These units represent potential local sources of water. Each unit occurrence should be individually investigated since yield is dependent on soil gradation and recharge ability.

3.3 Bedrock Hydrogeology

The underlying bedrock in the study area ranges from Late Proterozoic and Devonian to Carboniferous granitoidal intrusions to Cambrian, Ordovician, and Devonian sedimentary and volcanic rock. Except for the Devonian sedimentary and volcanic rock, all units have undergone low grade metamorphism.

Six significant hydrostratigraphic units are grouped together on the basis of rock type, structure, and expected well yield. These units are listed in Table 3.2 along with well yield and depth characteristics reported by the water well drillers. The occurrence of groundwater in the bedrock is almost entirely dependent upon secondary permeability resulting from joints, faults, bedding and fracture zones. High well yield rates in Unit B-4 have also been attributed, at least in part, to primary permeability of the non-metamorphosed rock resulting from natural intergranular porosity.

The different hydrostratigraphic units are discussed below and presented in Figure 3.2. The metasediments of Unit B2 and granitoid intrusions of Unit B5 are further grouped on the basis of similar well-yield characteristics which allows for better zone discrimination. These units are discussed separately, however, and the zones are graphically separated in WRR 2-7.

Table 3.2
Bedrock Hydrostratigraphic units, Burin Peninsula Area

Hydrostratigraphic Unit	Lithology	Total No. of Wells	Well Yield Characteristics			Well Depth Characteristics		
			No. of Wells	Range L/min (gpm)	Mean L/min (gpm)	No. of Wells	Range m (feet)	Mean m (feet)
Unit B1 Late Proterozoic Volcanic Rock	Felsic to mafic volcanic flows and pyroclastics.	113	113	0-227 (0-50)	23.1 (5.1)	113	12.0-182.9 (39-600)	34.56 (113.4)
Unit B2 Late Proterozoic and Cambrian Sedimentary Rock.	Sandstone, siltstone, shale, slate, minor unseparated limestone.	80	80	0-270 (0-59.4)	24.2 (5.3)	80	14.0-109.7 (46-360)	53.82 (176.5)
Unit B3 Cambrian to Middle Ordivician Sedimentary Rock.	Shale, siltstone, slate, sandstone, minor schist and gneiss.	31	31	0-205 (0-45.1)	13.7 (3.0)	31	9.1-152.4 (30-500)	57.47 (188.5)
Unit B4 Devonian and Carboniferous Sedimentary Rocks.	Conglomerate, sandstone, siliciclastic and carbonate rocks.	73	73	1.0-545 (0.2-120)	42.4 (9.3)	73	12.2-97.5 (40-320)	34.63 (113.6)
Unit B5 Late Proterozoic and Devonian Granitoid and Granite Rock.	Diorite, granodiorite, granite, gabbro, orhto and paragenesis.	18	18	0-136 (0.-30)	26.3 (5.8)	18	9.2-207.2 (30-680)	57.26 (187.8)
Unit B6 Carboniferous St. Lawrence Granite	Alaskite granite, rhyolite porphyry.	22	22	4 - 568 (0.9-125)	29.0 (6.4)	22	19.8-114.3 (65-375)	49.55 (159.4)

NOTE: The data presented is updated to Oct. 26, 1992. The information was supplied by WRD of the DOEL and was recorded by water well drillers as required under the "Well Drilling Regulations," 1982, and amendments.

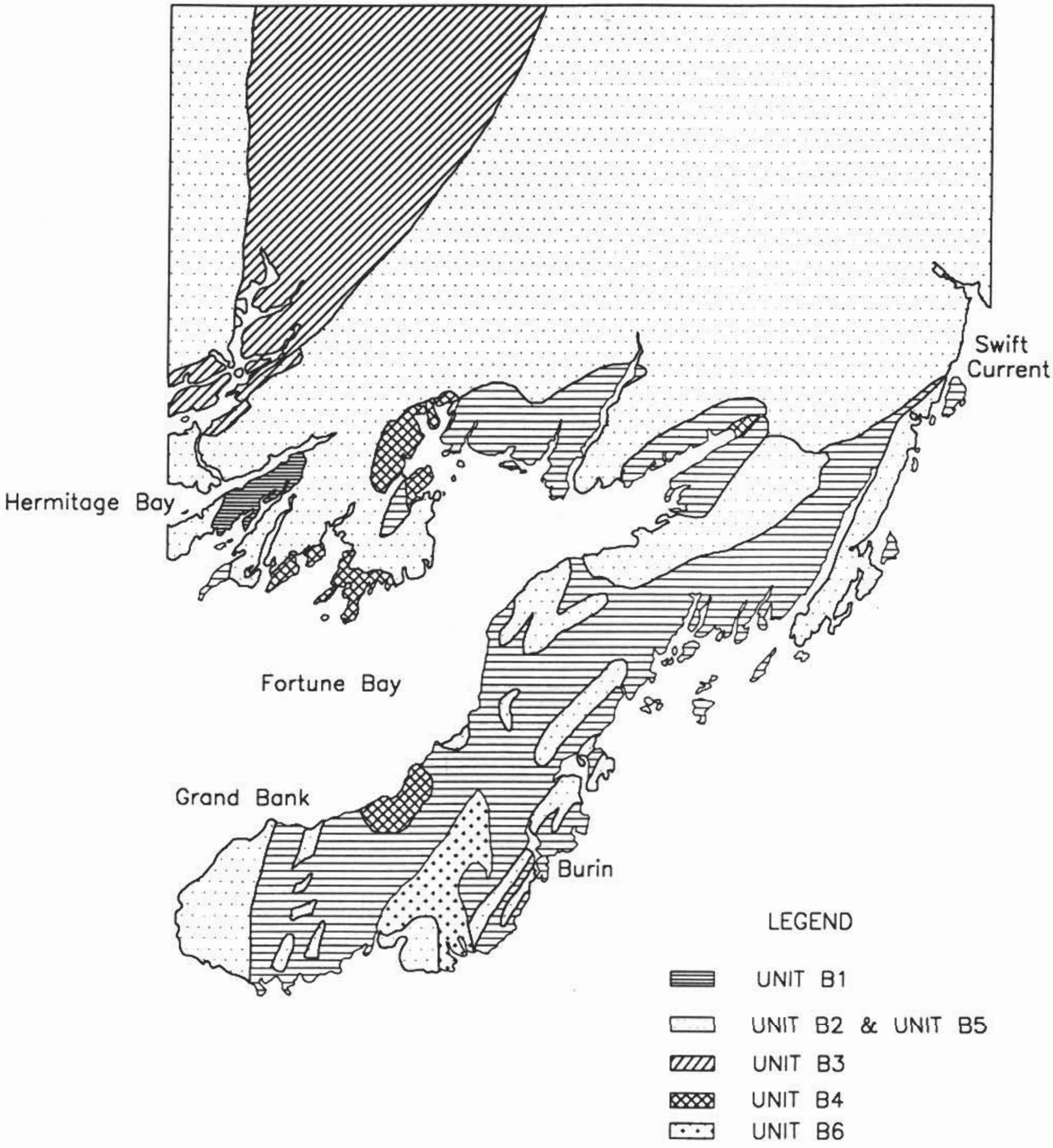

FIG. 3.2

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Bedrock Hydrostratigraphy of Study Area

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3.3.1 Unit B1 - Late Proterozoic Volcanic Rocks

This unit consists of Bimodal, submarine to subaerial volcanic rock with minor siliciclastic sedimentary rock. It underlies much of the Burin Peninsula and Fortune Bay area. There were a total of 113 wells in the area, with well yields varying from 0 to 227 L/min at depths of 12 m to 182.9 m. Generally, well yields are near the average of 23.1 L/min and are well suited for domestic purposes. There are wells with yield rates as high as 227 L/min at Rushoon and 136 L/min at Marystown which could provide moderately high production wells. These high yields are likely due to fractures in the rock and are impossible to predict accurately.

3.3.2 Unit B2 - Late Proterozoic and Cambrian Sedimentary Rocks

This unit consists of shallow marine siliciclastic sedimentary rock with minor limestone and bimodal volcanic rock. Occurrences are not as frequent as Unit B1 and are generally sporadic. There are records for 80 wells in this unit with well yields varying from 0 to 270 L/min at depths of 14 m to 109.7 m. The average yield of 24.2 L/min indicates a low to moderate yield rate.

Close inspection of individual areas indicates yield rates are generally low. Swift Current, in the northeast of the study area, exhibits the highest percentage of wells with moderate to good yield with seven of 16 wells having a yield greater than 50 L/min. A further six wells in the area had yields less than 5 L/min, however, suggesting the high yields are isolated occurrences related to faulting. Generally, Unit B2 should be sufficient for domestic use with two or three households per well.

3.3.3 Unit B3 - Cambrian to Middle Ordovician Sedimentary Rocks

This unit consists of marine siliciclastic sedimentary rocks, including argillite, siltstone, conglomerate and volcanic and intrusive rocks. The unit is located in the northwestern section of the area, north of Hermitage. Yield rates are generally low to poor. One well in St. Albans has a yield of 205 L/min; otherwise, all are generally around or below 10 L/min. The St. Albans well is located in a slate bedrock overlain by 41 m of sand and gravel. This well indicates local geology may be important to well site selection but the important parameters to identify are not evident. This unit does not represent a good source for domestic use due to the uncertainty of yields.

3.3.4 Unit B4 - Devonian and Carboniferous Sedimentary Rocks

This unit is comprised of fluviatile and lacustrine siliciclastic and carbonate rocks with subaerial, bimodal volcanic rocks. Occurrences are isolated, but yields are generally high for wells in this unit. The occurrences can be seen in Figure 3.2.

Most information on yield rates comes from English Harbour West and Bay du Nord where well yields range from 0 to 545 L/min with an average rate of 42.4 L/min. Unlike the other units, Unit B4 yield rates do not deviate much from the mean. The one extreme yield of 545 L/min was at English Harbour West; otherwise, all yields were less than 100 L/min.

There is no well yield information on the Grand Beach porphyry complex on the Burin Peninsula. Exploratory diamond drilling in the area, however, has indicated artesian conditions in the unit. A small occurrence near Terrenceville has produced small yields, but with data from only three wells, there is insufficient information to draw conclusions.

In general, Unit B4 can be considered to have moderate to high well yield potential. In this respect, a water well could be used for either domestic or municipal use.

3.3.5 Unit B5 - Late Proterozoic and Devonian Granitoid and Granite Rocks

This unit consists primarily of Silurian granitoid suites and Devonian granite in the north and at St. Lawrence and Late Proterozoic granitoid intrusions in the northern Burin Peninsula and Hermitage area. The yield rates are low for wells at Hermitage and on the Burin Peninsula. All these wells are drilled in the Mafic volcanic intrusive associated with this unit. Yield rates vary from 0 to 25 L/min. An occurrence at St. Jacques yielded much higher yield rates with a maximum of 136 L/min and an average rate of 45.5 L/min. This high yield is likely a result of faulting in the rock. In general, the mafic volcanics in Unit B5 are poor producers for water wells while the granitoid suites can produce high yield wells if the rock is fractured.

3.3.6 Unit B6 - Carboniferous St. Lawrence Granite

The St. Lawrence intrusive granite is the host rock for the abandoned fluorspar mine at St. Lawrence. The mine was known for having dewatering troubles during operation and needed a pump rate of about 9,500 L/min to keep the mine workings dewatered. Also, the town of St. Lawrence's municipal water supply came from a drilled well with a yield of 568 L/min. High levels of fluorine and radon gas in the St. Lawrence municipal water well caused it to be abandoned in 1971. The existence of these gases is a concern in the area, as discussed further in Section 4.

Twenty-two wells were identified in the unit with yield rates ranging from 4.0 to 568 L/min from depths of 19.8 m to 114.3 m. The mean yield was 29.0 L/min when the abandoned well at St. Lawrence was excluded. It was excluded because the excessively high flow would skew the mean for the unit to a non-representative value. The St. Lawrence granite can yield high flow rates suitable for both domestic and municipal use. The primary concern in the unit is fluorine concentrations and radon gas related to uranium and fluorspar mineralization in the host granite.

3.4 Municipal Usage of Groundwater

Many communities and individual households within the study area rely on groundwater for their domestic water supply. The most recent water well data indicates 337 drilled wells in the area. Most bedrock wells have been drilled in the past decade with limited success in most cases. Flow rates in many wells can accommodate a maximum of five to ten households per well, but are not sufficient for municipal use.

The municipality of St. Albans is the largest in the region with a drilled well water supply. The system consists of six drilled wells, four in use and two in reserve, with typical yields of 205 L/min. The aquifer is located in a broad valley containing Swanger's Brook and consists stratigraphically of 41.0 m of sand and gravel overlying a slate formation. Typical well depths are 92 m and each is cased into the slate. Since the supply was developed in 1973, several wells have been abandoned and replaced by new wells with equivalent yields.

It is noteworthy that Conne River, which is on the other side of Bay d'Espoir and within the same hydrostratigraphic unit as St. Albans, has also attempted to meet water demands with drilled wells, but with little success. In 1985, the Council of the Conne River Micmacs implemented a program to switch to a surface water source. As of September 1992, 80 percent of the population was being serviced by the new system.

Historically, the area has depended on dug wells for supply. While this is changing, smaller municipalities such as Beau Bois and Grand Beach still rely on dug wells. Still other municipalities rely on a combination of dug wells and drilled wells. Municipalities such as Swift Current, Winterland, and Baine Harbour use both dug and drilled wells to meet demands. This practice will help alleviate demand on the dug wells during summer when many of these wells tend to dry up.

3.5 Groundwater Experience

The primary use for wells in the area is for domestic water supply. The yield in bedrock does not seem to be sufficient for commercial or municipal purposes except in Unit B4 and Unit B6. Unit B6 has a proven record of high yield through experience at the Director Fluorspar Mine and the water supply for the Town of St. Lawrence. The quality is poor, however, due to high levels of radon and fluorine gases.

Unit B4 seems to be the best water well producing stratigraphy in the region with an average yield 40 percent to 50 percent higher than the other units, except Unit B6.

Nonetheless, experiences at St. Albans indicate that the productivity of an aquifer is dependent on local geologic features rather than regional trends. The principal geologic control contributing to high yield wells is probably faulting and jointing of the rock mass. In general, individuals and municipalities which have tapped into high yield aquifers have encountered few difficulties.

Many of the surface wells rely on storage volume and frequent surface resupply to ensure an adequate supply of water. The surficial soils are not sufficient to accommodate a commercial or municipal well.

4 - Water Quality

4 Water Quality

The quality of water within a drainage area has a major effect on potential uses for that water. By studying the quality of both surface water and groundwater, long term optimized water usage can be achieved. Also, through water quality monitoring, the effect of anthropogenic and natural actions on water resources can be determined.

4.1 Available Data

The principal source of data for surface water is the National Water Quality Data Base (NAQUADAT). NAQUADAT is a joint venture of the WRD of the DOEL.[4-1, 4-2, 4-3] NAQUADAT contains data from regularly monitored rivers and from spot samples by DFO. The information on community surface water supplies was also obtained from a toxic chemical survey of municipal water sources conducted by Environment Canada and DOEL from 1985 to 1988.[4-4] DOEL also collects groundwater records of all water wells drilled for domestic and commercial uses throughout Newfoundland. This information is recorded by the water well drillers as required by law. The water chemistry of most of these wells, however, is not determined.

The locations of surface water quality information are contained in Tables 4.1 and 4.2. Six NAQUADAT stations were selected as most representative of the water quality in the area based on availability of recent data supplied by DOEL. The most recent NAQUADAT publication is for the years 1981 - 85, but water quality data were supplied up to 1991 for these rivers by DOEL.

4.2 Characteristics of Surface Water Quality in the Area

The range of values for different water quality parameters is recorded in Table 4.3 and a more detailed description of river stations is provided in Table 4.4. The maximum acceptable concentrations (MAC) for various uses, given in the columns on the right in Table 4.3, were taken from the Canadian Water Quality Guidelines

Table 4.1

NAQUADAT Stations Identified in the Area*

No.	Site No.	No.	Site No.
1	01NF02ZE0004	10	01NF02ZF0012
2	01NF02ZE0018	11	01NF02ZF0013
3	01NF02ZF0003	12	01NF02ZF0014
4	01NF02ZF0004	13	01NF02ZF0015
5	01NF02ZF0005	14	01NF02ZG0001/0024
6	01NF02ZF0006	15	01NF02ZG0002/0025
7	01NF02ZF0007	16	01NF02ZG0016
8	01NF02ZF0009/0020	17	01NF02ZH0001
9	01NF02ZF0011	18	01NF02ZH0002

[shaded] - Indicates Stations which contained most extensive and recent data.
/ - Indicates the extension number of the station has been changed to th
* See Figure 4.1 for Map of Study Area

Table 4.2

Municipal Water Supplies Analysed in the Area**

No.	Community Name	No.	Community Name
1	Burin (Big Pond)	11	Gaultois
2	Burin (Long Pond)	12	Harbour Breton
3	Fortune	13	Head Bay D'Espoir
4	Garnish	14	Hermitage
5	Grand Le Pierre	15	Hermitage/Sandyville
6	Parkers Cove	16	Milltown
7	Rushoon	17	Morrisville
8	Belleoram	18	Marystown
9	Conne River	19	Grand Bank
10	Coomb's Cove- St. J.	20	St. Lawrence

[shaded] - Indicates Community water supplies sampled under the Survey of Toxic Chemicals in municipal water supplies, 1989.
** See Figure 6.1 for Map of Study Area

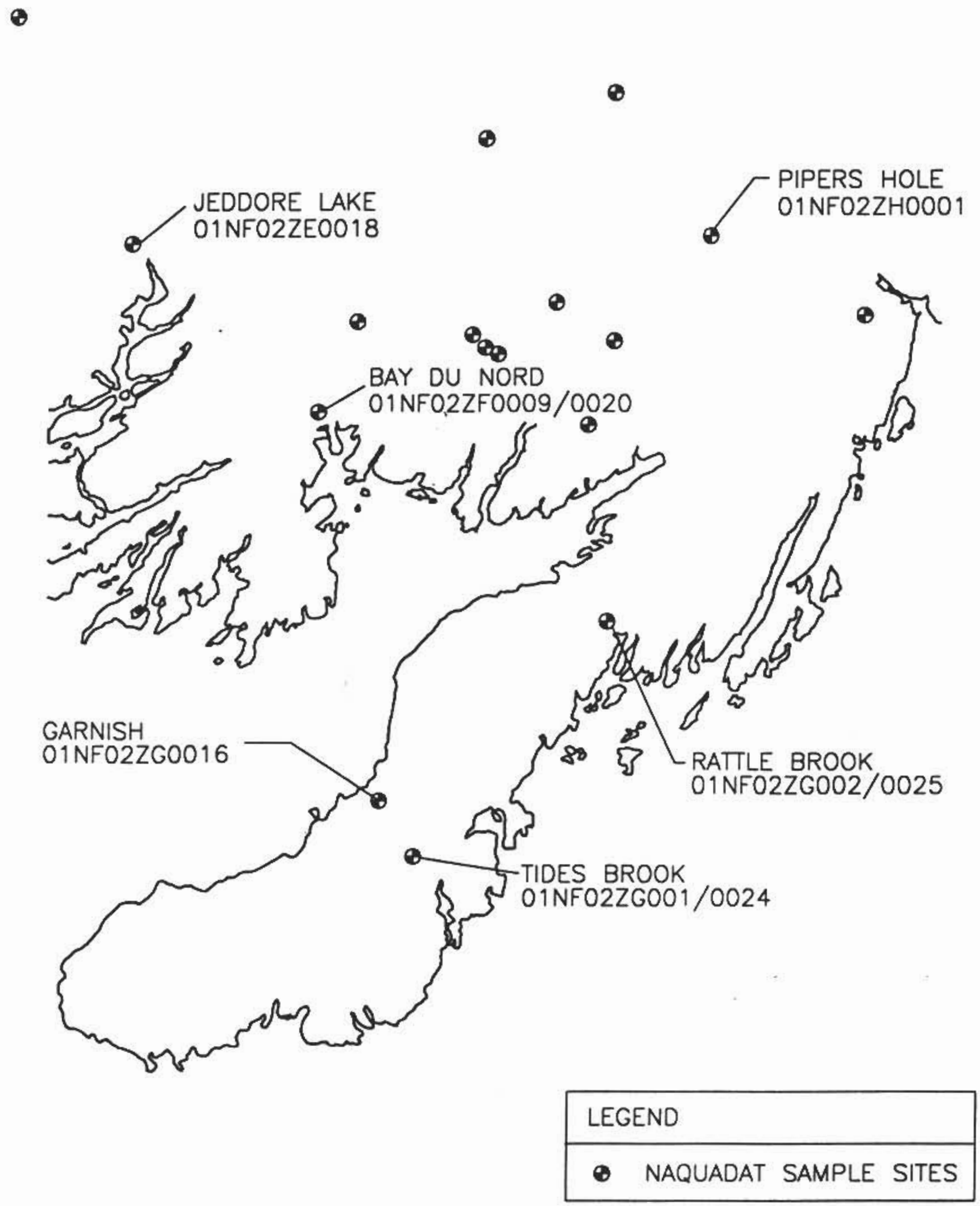

FIG. 4.1

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
NAQUADAT Sample Sites

(CWQG).[4-5] To date, there are still many parameters for which MAC's have not been established. The MAC's for freshwater/aquatic life appear to be the most stringent, when they are applicable, followed by those for drinking water, irrigation, and livestock.

The following sections present a review of the most recent surface water data available from NAQUADAT and from municipal water supplies.

4.2.1 Physical Parameters

With the exception of colour, all physical parameters are within CWQG limits. For both water supply and river station samples, colour is generally above the CWQG of 15 TCU. Also, the temperature recorded at NAQUADAT stations sometimes exceeded CWQG of 15°C, but the mean temperature for each of the stations was well below CWQG.

High values for colour are generally associated with high values of Dissolved Organic Compounds (DOC) or high iron and manganese concentrations. While colour is a problem in drinking water, it is generally more of an aesthetic concern than a health concern. It has been suggested that chlorine treatment of organic rich waters can cause the formation of trihalomethanes (THM) in the water, which are toxic substances.[4-6]. Since many of the community water supplies treated with chlorine may also have high colour, chlorine doses and residuals should be closely monitored.

Organic concentrations can be controlled by coagulation and filtration treatment while iron and manganese are usually treated through precipitation. These processes are expensive and may be out of the range of many small municipalities. The proximity of bogs to the water supply intake will influence the

Table 4.3

Water Quality Parameters Observed at Selected Water Quality Stations

Water Quality Parameter*	Range of Values				CWQG Concentration Levels			
	Observed from Surfacial water sample sites		Observed from Groundwater Water Wells		Drinking Water	Aquatic Life	Irrigation	Livestock
	From	To	From	To				
Temp (C)	0.00	24.00			15			
Oxygen	0.70	16.00						
pH (Field)	5.00	7.40	6.07	7.82	6.5-8.5			
Alk (eq/l)	-3.30	9.20						
Cond (uS)	14.00	89.10	84.40	2070.00				
Turb (NTU)	0.13	3.10			5			
Colour (TCU)	0.00	120.00	0.00	250.00	15			
Sodium	1.20	9.90	3.48	327.00				
Calcium	0.17	3.50	5.40	78.00				1000
Magnesium	0.17	1.52	1.10	40.00				
Potassium	0.10	0.75	0.18	13.12				
Chloride	1.53	10.10	3.00	610.00	250		100-700	
Sulphate	0.60	5.31	3.50	64.00	500			1000
Fluoride			0.00	5.16	1.5		1	2
DOC	0.00	15.60						
Phosphorous	0.00	0.03						
Nitrogen	0.00	0.99			10			100
Nitrate	0.00	0.36	0.00	0.01	10			
Silicate	0.00	3.80						
Aluminum	0.02	0.91				0.005-0.1	5	5
Barium	0.0008	0.0140			1			
Beryllium	0.0000	0.0500					0.1	0.1
Cadmium	0.0000	0.0100			0.005	0.002	0.01	0.02
Chromium	0.0000	0.0033			0.05	0.002	0.1	1
Cobalt	0.0000	0.0004					0.05	1
Copper	0.0000	0.0200			1	0.02	0.2	0.5
Iron	0.0400	1.0200	0.0000	5.6000	0.3	0.3	5	
Lead	0.0000	0.0025			0.05	0.001	0.2	0.5
Lithium	0.0000	0.0019					2.5	
Manganese	0.0000	0.1450	0.0000	0.9400	0.05		0.2	
Mercury(ug/L)	0.0000	0.0200			0.0001	0.0001		0.03
Molybdenum	0.0000	0.0009					0.01	0.5
Nickel	0.0000	0.0032				0.025	0.2	1
Selenium	0.0000	0.0003						
Strontium	0.0032	0.0171						
Vanadium	0.0000	0.0011					0.1	0.1
Zinc	0.0000	0.6500	0.0000	0.6500	5	0.03	1	50

* All units in mg/L unless otherwise indicated

Table 4.4
Summary of Water Parameters for Selected NAQUADAT Sites.

		TEMP °C	COND µS/cm	COLOR T.C.U.	TURB J.T.U.	O2 D mg/L	PH F	ALK mg/L	Ca D mg/L	Na D mg/L	Mg D mg/L	K D mg/L	SO4 IC mg/L	Cl D mg/L	DOC mg/L	P T mg/L	NO3-NO2 mg/L	N T mg/L	SI D mg/L
01NF02ZE0018	#Analysis	13	13	13	13	13	13	13	13	12	13	12	12	12	13	13	12	13	12
Sample Period:	Min Value	0.1	16.5	10.0	0.1	8.3	5.8	1.1	8.00E-01	1.24E+00	3.40E-01	1.70E-01	9.10E-01	1.54E+00	3.40E+00	3.10E-03	0.00E+00	1.38E-01	6.90E-01
05-89 to 09-91	Max Value	15.4	18.5	40.0	0.8	12.5	6.3	2.2	1.06E+00	1.48E+00	3.80E-01	2.40E-01	1.96E+00	2.65E+00	5.00E+00	1.00E-02	7.00E-02	2.30E-01	1.21E+00
Jeddore Lake	Average	7.8	17.2	25.4	0.4	10.0	6.1	1.5	1.01E+00	1.37E+00	3.60E-01	1.96E-01	1.18E+00	1.92E+00	4.50E+00	6.18E-03	3.83E-02	1.74E-01	1.03E+00
	Variance	36.4	0.3	86.4	0.0	1.8	0.0	0.1	4.17E-03	3.60E-03	1.69E-04	3.24E-04	6.61E-02	8.53E-02	2.00E-01	9.31E-06	5.64E-04	5.54E-04	1.84E-02
01NF02ZF0020	#Analysis	16.0	16.0	16.0	16.0	14.0	16.0	16.0	16	15	16	15	15	15	16	16	15	16	15
Sample Period:	Min Value	0.1	16.1	10.0	0.2	8.1	5.8	1.0	8.70E-01	1.38E+00	3.30E-01	1.80E-01	7.60E-01	1.58E+00	4.40E+00	2.80E-03	0.00E+00	1.16E-01	1.20E-01
05-89 to 09-91	Max Value	18.4	22.9	60.0	0.8	13.9	6.4	2.2	1.27E+00	2.07E+00	4.80E-01	3.00E-01	1.90E+00	3.25E+00	7.80E+00	1.00E-02	5.00E-02	2.20E-01	1.63E+00
Bay Du Nord	Average	7.7	19.6	36.3	0.4	11.1	6.1	1.5	1.10E+00	1.70E+00	4.06E-01	2.28E-01	1.21E+00	2.38E+00	5.70E+00	6.27E-03	1.87E-02	1.64E-01	9.72E-01
	Variance	46.7	5.1	123.4	0.0	3.3	0.0	0.1	1.81E-02	5.11E-02	2.42E-03	7.76E-04	7.61E-02	3.10E-01	6.48E-01	8.71E-06	3.45E-04	1.06E-03	2.22E-01
01NF02ZG0016	#Analysis	50.0	51.0	51.0	51.0	25.0	50.0	48.0	51	51	51	51	51	51	51	48	51	51	39
Sample Period:	Min Value	0.0	28.9	10.0	0.2	8.7	5.3	-3.3	1.10E+00	3.00E+00	3.80E-01	1.50E-01	1.10E+00	3.50E+00	3.20E+00	1.00E-03	0.00E+00	0.00E+00	5.03E-01
10-86 to 10-91	Max Value	22.0	89.1	100.0	1.0	14.3	7.0	7.1	3.29E+00	9.90E+00	1.52E+00	7.50E-01	3.80E+00	2.08E+01	1.20E+01	2.00E-02	3.60E-01	4.70E-01	3.27E+00
Garnish River	Average	8.1	43.8	51.1	0.5	11.3	6.1	2.9	1.96E+00	4.99E+00	6.59E-01	2.68E-01	2.19E+00	8.21E+00	6.53E+00	7.89E-03	2.12E-02	1.43E-01	1.68E+00
	Variance	48.3	128.0	468.0	0.0	3.3	0.1	3.1	2.34E-01	1.69E+00	4.50E-02	1.12E-02	2.53E-01	9.64E+00	5.30E+00	1.32E-05	2.63E-03	8.15E-03	4.88E-01
01NF02ZG0024	#Analysis	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59	59	59	59	59	59	59	56	59	59	50
Sample Period:	Min Value	0.1	32.4	5.0	0.2	8.7	5.7	-2.2	1.18E+00	4.90E+00	6.00E-01	3.00E-01	1.66E+00	7.14E+00	3.30E+00	2.30E-03	0.00E+00	6.00E-02	1.01E+00
10-86 to 10-91	Max Value	21.1	61.5	80.0	3.1	14.5	7.1	5.0	1.98E+00	7.50E+00	1.00E+00	6.00E-01	2.68E+00	1.62E+01	9.10E+00	3.00E-02	6.00E-02	6.59E-01	3.00E+00
Tides Brook	Average	8.7	48.3	35.1	0.6	11.6	6.3	1.6	1.50E+00	5.89E+00	7.32E-01	3.51E-01	2.21E+00	1.01E+01	4.79E+00	6.63E-03	2.31E-02	1.56E-01	1.74E+00
	Variance	48.5	27.9	168.0	0.2	3.0	0.1	1.2	2.86E-02	3.71E-01	7.83E-03	1.79E-03	5.11E-02	2.62E+00	9.75E-01	2.11E-05	2.20E-04	5.81E-03	1.04E-01
01NF02ZG0025	#Analysis	59.0	59.0	59.0	59.0	58.0	59.0	59.0	59	59	59	59	59	59	59	56	59	59	50
Sample Period:	Min Value	0.1	21.9	5.0	0.1	7.7	5.0	-0.8	6.00E-01	2.22E+00	2.80E-01	1.20E-01	1.18E+00	3.17E+00	2.20E+00	1.40E-03	0.00E+00	6.50E-02	4.00E-02
10-86 to 10-91	Max Value	23.6	43.0	120.0	1.1	15.4	6.3	2.7	1.70E+00	4.73E+00	6.90E-01	2.50E-01	5.31E+00	9.48E+00	1.56E+01	2.00E-02	2.80E-01	9.90E-01	1.50E+00
Rattle Brook	Average	8.6	29.8	41.3	0.4	11.8	5.6	0.6	9.28E-01	3.26E+00	4.30E-01	1.69E-01	1.84E+00	5.24E+00	5.51E+00	5.06E-03	2.20E-02	1.72E-01	9.22E-01
	Variance	55.8	22.6	399.9	0.0	4.5	0.1	0.2	3.66E-02	1.65E-01	5.79E-03	7.13E-04	3.01E-01	1.42E+00	5.50E+00	1.31E-05	1.42E-03	1.48E-02	1.46E-01
01NF02ZH0001	#Analysis	72.0	73.0	73.0	73.0	43.0	71.0	73.0	73	73	73	73	73	73	73	61	73	73	58
Sample Period:	Min Value	0.0	14.0	0.0	0.1	6.2	5.0	-0.6	1.70E-01	1.20E+00	1.70E-01	1.00E-01	6.00E-01	1.53E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10-86 to 10-91	Max Value	24.0	44.0	75.0	0.9	16.0	7.4	9.2	3.50E+00	4.50E+00	7.10E-01	5.30E-01	2.56E+00	1.01E+01	8.30E+00	1.00E-02	2.10E-01	7.20E-01	3.80E+00
Pipers Hole	Average	8.3	25.2	34.0	0.5	12.2	6.2	3.9	1.75E+00	2.27E+00	3.98E-01	2.03E-01	1.36E+00	3.09E+00	4.70E+00	4.79E-03	2.61E-02	1.53E-01	2.11E+00
River	Variance	55.6	38.7	181.4	0.0	4.4	0.2	3.3	2.82E-01	3.83E-01	1.09E-02	5.45E-03	1.58E-01	1.50E+00	1.76E+00	1.06E-05	1.11E-03	9.51E-03	6.52E-01

[shaded box] - Indicates parameter concentrations exceed recommended guidelines.

Al T mg/L	As T mg/L	Ba T mg/L	Be T µg/L	Cd T mg/L	Co T mg/L	Cr T mg/L	Cu T mg/L	Fe T mg/L	Hg T µg/L	Li T mg/L	Mn T mg/L	Mo T mg/L	Ni T mg/L	Pb T mg/L	Se T mg/L	Sr T mg/L	V T mg/L	Zn T mg/L
13	7	13	13	13	13	13	13	13	12	13	13	13	13	13	7	13	13	13
6.10E-02	2.00E-04	9.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.69E-02	0.00E+00	2.00E-04	4.60E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E-03	0.00E+00	2.00E-04
1.09E-01	3.00E-04	1.60E-03	0.00E+00	0.00E+00	2.00E-04	7.00E-04	1.30E-03	9.93E-01	1.00E-02	5.00E-04	2.07E-02	0.00E+00	6.00E-04	6.00E-04	1.00E-04	4.90E-03	2.00E-04	1.40E-03
7.66E-02	2.71E-04	1.30E-03	0.00E+00	0.00E+00	1.54E-05	1.15E-04	3.38E-04	1.66E-01	8.33E-04	2.92E-04	8.82E-03	0.00E+00	1.92E-04	1.15E-04	8.57E-05	4.74E-03	6.92E-05	7.31E-04
1.46E-04	2.04E-09	2.46E-08	0.00E+00	0.00E+00	2.84E-09	3.67E-08	1.15E-07	5.72E-02	7.64E-06	6.66E-09	1.86E-05	0.00E+00	3.15E-08	3.51E-08	1.22E-09	1.47E-06	6.75E-09	1.07E-07
16	9	16	16	16	16	16	16	16	16	16	16	16	16	16	9	16	16	16
5.70E-02	2.00E-04	1.40E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.20E-02	0.00E+00	0.00E+00	8.60E-03	0.00E+00	0.00E+00	0.00E+00	1.00E-04	4.40E-03	0.00E+00	3.00E-04
1.33E-01	1.00E-03	2.60E-03	0.00E+00	1.00E-04	2.00E-04	1.50E-03	5.00E-04	1.91E-01	1.00E-02	8.00E-04	2.54E-02	9.00E-04	3.20E-03	1.10E-03	2.00E-04	6.20E-03	2.00E-04	2.80E-03
9.29E-02	3.76E-04	1.78E-03	0.00E+00	6.25E-06	3.75E-05	2.94E-04	1.88E-04	1.46E-01	1.25E-03	5.25E-04	1.52E-02	8.75E-05	3.25E-04	1.94E-04	1.22E-04	5.54E-03	8.75E-05	7.81E-04
3.56E-04	5.06E-08	8.53E-08	0.00E+00	5.86E-10	3.59E-09	1.74E-07	3.23E-08	1.62E-03	1.09E-05	3.31E-08	2.12E-05	4.86E-08	5.74E-07	1.22E-07	1.73E-09	3.19E-07	4.84E-09	3.78E-07
49	10	24	26	52	24	24	45	49	41	21	52	27	25	49	0	27	23	48
3.00E-02	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E-02	0.00E+00	2.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.70E-03	0.00E+00	0.00E+00
3.00E-01	0.00E+00	1.00E-02	0.00E+00	1.00E-03	2.00E-04	6.00E-04	1.00E-02	3.10E-01	0.00E+00	9.00E-04	8.00E-02	4.00E-04	3.00E-04	1.20E-03	0.00E+00	1.71E-02	4.00E-04	2.00E-02
1.68E-01	0.00E+00	5.47E-03	0.00E+00	4.62E-05	4.86E-05	1.15E-04	1.19E-03	1.85E-01	0.00E+00	3.89E-04	2.53E-02	1.48E-05	2.80E-05	1.16E-04	0.00E+00	8.71E-03	1.97E-04	1.19E-03
4.13E-03	0.00E+00	3.97E-06	0.00E+00	3.94E-08	4.91E-09	2.73E-08	4.92E-06	4.51E-03	0.00E+00	3.52E-08	2.63E-04	5.71E-09	6.02E-09	7.90E-08	0.00E+00	5.48E-06	1.93E-08	9.89E-06
60	18	60	59	60	57	57	54	60	42	54	60	59	58	55	18	60	56	54
5.30E-02	0.00E+00	1.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.30E-02	0.00E+00	7.00E-04	8.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.90E-03	0.00E+00	4.00E-04
4.52E-01	3.00E-04	1.40E-02	5.00E-02	1.00E-04	4.00E-04	8.00E-04	3.60E-03	1.02E+00	1.00E-02	1.90E-03	1.45E-01	3.00E-04	4.00E-04	2.50E-03	2.00E-04	1.67E-02	1.10E-03	5.20E-03
1.18E-01	1.11E-04	1.20E-02	8.47E-04	5.00E-06	3.39E-05	6.96E-05	4.90E-04	1.99E-01	4.76E-04	1.12E-03	2.58E-02	2.09E-05	4.43E-05	3.04E-04	1.15E-04	1.21E-02	1.48E-04	1.42E-03
2.60E-03	7.65E-09	1.20E-06	4.17E-05	4.75E-10	5.01E-09	2.58E-08	3.45E-07	2.91E-02	4.54E-06	6.25E-08	3.46E-04	3.91E-09	1.09E-08	2.52E-07	5.58E-09	2.30E-06	3.19E-08	4.75E-07
60	18	55	59	60	57	57	55	60	60	55	59	59	58	56	18	57	56	55
4.00E-02	0.00E+00	1.50E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-02	0.00E+00	0.00E+00	4.63E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.20E-03	0.00E+00	0.00E+00
2.75E-01	2.00E-04	4.60E-03	0.00E+00	1.00E-04	3.00E-04	3.30E-03	3.30E-03	3.35E-01	2.00E-02	4.00E-04	4.00E-02	2.00E-04	2.60E-03	1.40E-03	3.00E-04	1.00E-02	4.00E-04	2.40E-03
1.46E-01	7.22E-05	2.33E-03	0.00E+00	1.67E-06	5.15E-05	1.73E-04	6.55E-04	1.17E-01	8.33E-04	1.96E-04	1.40E-02	1.13E-05	1.05E-04	3.31E-04	1.28E-04	4.96E-03	1.49E-04	1.15E-03
1.43E-03	4.23E-09	3.12E-07	0.00E+00	1.64E-10	5.81E-09	2.58E-07	3.48E-07	3.12E-03	1.10E-05	1.17E-08	5.14E-05	1.30E-09	1.27E-07	1.62E-07	7.56E-09	1.62E-06	1.17E-08	2.53E-07
68	18	20	27	74	25	25	63	68	52	20	74	26	26	72	0	27	22	69
2.00E-02	0.00E+00	8.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-02	0.00E+00	2.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.30E-03	0.00E+00	0.00E+00
9.90E-01	0.00E+00	2.20E-03	0.00E+00	1.00E-02	2.00E-04	3.30E-03	2.00E-02	4.70E-01	2.00E-02	1.00E-03	7.00E-02	5.00E-04	4.00E-04	1.60E-03	0.00E+00	1.14E-02	9.00E-04	4.00E-02
6.84E-02	0.00E+00	1.54E-03	0.00E+00	1.77E-04	5.20E-05	3.09E-04	1.68E-03	2.05E-01	3.85E-04	4.87E-04	1.44E-02	3.97E-05	5.77E-05	9.35E-05	0.00E+00	8.41E-03	1.62E-04	1.95E-03
1.32E-02	0.00E+00	1.34E-07	0.00E+00	1.39E-06	5.70E-09	5.16E-07	1.50E-05	5.41E-03	7.54E-06	3.47E-08	1.25E-04	1.31E-06	1.47E-06	9.24E-08	0.00E+00	3.68E-06	4.56E-08	4.28E-05

[shaded box] - Indicates parameter concentrations exceed recommended guidelines.

concentrations of organic compounds in the water. Thus, the most practical option for small communities is to try and locate the intake as far away from bog areas as possible. This will not, however, reduce the concentration of iron in water, and treatment may still be necessary, although to a lesser degree.

4.2.2 pH

The water in the study region is generally acidic. This is indicated by low mean pH values for all the rivers and community water supplies tested. Low pH values will have adverse affects on freshwater biota and human health when waters become excessively acidic.

Tests on salmonoids by DFO indicate a high tolerance to low pH waters. Studies have indicated minimum pH levels of 5.0 for salmon and some trout and as low as 4.5 for brook trout.[4-7] Low pH levels in drinking water can easily be treated to bring them within CWQG limits. Thus, low pH is not an inhibitor of the practical usage of water in the study area.

4.2.3 Anions

The concentration of negative ions is generally low over the entire study region. The ions tested were chloride, sulphate, fluoride and bicarbonate. Bicarbonate was measured only for community water supplies. Fluoride was detected in only a couple of rivers and municipal supplies and the concentrations were ≥ 0.01 mg/L, well below the MAC of 1.5 mg/L.

Low concentrations are favourable for both health and economic concerns. Anions tend to accelerate leaching of mineral constituents and toxic chemicals from soil or rock, causing potential problems further downstream. Higher anion concentrations also increase the corrosive action of water in the distribution system. This could generate economic concerns when pipes and other metal components are used in the distribution system.

4.2.4 Cations

Most concentrations of cations were below the MAC specified by CWQG. Those cations with concentrations above MAC were mercury, aluminum, iron, manganese, lead and cadmium. These are briefly discussed below.

Mercury

Because mercury is highly toxic, it causes concern even in small concentrations. Although mercury was detected in a couple of samples at both river stations and water supply sampling sites, the maximum detected concentration was .020 μg/L, far below MAC of 1 μg/L. Regular monitoring should continue in water bodies where any mercury has been detected.

Aluminum

The MAC for aluminum is dependent on pH. The CWQG for freshwater/aquatic life of 5 μg/L for pH < 6.5 generally applies in this area. The toxicity of aluminum can be diminished by high concentrations of calcium and dissolved organic compounds (DOC). Thus, although aluminum concentrations frequently exceed the MAC, the effect on fish cannot be determined. Aluminum levels as well as DOC and calcium should be closely monitored to assess the effect on fish.

Iron and Manganese

Concentrations frequently exceed MAC for both iron and manganese at both river and water supply locations. These limits for drinking water are derived mostly for aesthetic reasons rather than health concerns. Also, while MAC's for freshwater/aquatic life are occasionally exceeded, the incidents are not frequent. As noted previously, iron and manganese concentrations can be reduced through treatment.

Both iron and manganese enter surface waters through geochemical weathering of native soils and rock. Their concentrations are generally high in Newfoundland due to the large presence of bog and slightly acidic waters. Bog naturally contains high iron concentrations and iron is also more soluble in acidic waters.

Lead and Cadmium

Concentrations were generally low with one occurrence of cadmium above MAC and isolated incidents of lead concentrations in municipal water supplies above MAC. These parameters should continue to be monitored, but do not pose a significant threat in their present concentrations.

4.2.5 Municipal Surface Water Supplies

The majority of the communities in the study area either have an existing surface water supply or have plans to develop a supply from a nearby pond. The quality of the water varies from good to poor, as documented in Appendix B. While most supplies only require simple chlorination to disinfect against bacteria, others are plagued by high colour, high sediment loading, low pH, and high iron and organic contents. Appendix B lists communities in the study area and their main water source along with comments on the overall water quality.

In general, "boil orders" are issued by the Department of Health (DOH) if coliform counts become excessive. There are currently five communities, Grand Le Pierre, Harbour Breton, Morrisville, Swift Current and Jean De Baie with boil orders in force. All these except Grand Le Pierre are a result of either no chlorination facilities or inefficient facilities. Grand Le Pierre has a poor water source. Otherwise the water is typical with high colour and organic content. The water also tends to be slightly acidic causing some corrosion.

4.2.6 Conclusions

The overall quality of surface water in the study area is good. Ion chemistry results indicate that anion concentrations are well below MAC for drinking water and freshwater/aquatic life. Some cation concentrations were sufficiently high to cause concern, particularly in iron and manganese. Iron and manganese are more of an aesthetic concern than a health concern, but excessively high concentrations can seriously degrade water quality. Other cations detected include mercury, lead, cadmium and aluminum. While all concentrations were below MAC, the toxicity of these ions warrants continued monitoring.

The high iron and manganese concentrations combined with DOC cause problems with colour. The colour value for most sites was above CWQG limits, and while this is primarily an aesthetic concern, there are health concerns as well. It has been indicated that organics in water that are treated with chlorine can cause the formation of THM's, which are toxic.

The pH levels of the surface waters are generally low. While this is undesirable, there is no health threat. Also, pH levels can be easily raised through treating.

4.3 Groundwater Quality

Water quality information was available for 21 drilled wells in the study area. The data were supplied by the WRD of DOEL. Table 4.5 illustrates the parameters identified in the water quality analysis. The locations of the communities can be seen in Figure 6.1. Parameters affecting water quality are identified below.

4.3.1 Physical Parameters

The colour of the water was a problem in four of the 21 communities. All of these, with values greater than 130 TCU, had associated high concentrations of iron and manganese. The MAC for colour is 15 TCU.

Table 4.5
Groundwater Quality from Water Well Reports

Well #	Community Name	ALK mg/L	APP. Colour TCU	Hard-ness mg/L	Nitrate + Nitrate mg/L	pH	Total K Mg/L	Spec. Con.	Ca mg/L	Mg mg/L	Mn mg/L
11112	English Hbr East	90.6	5	90.6	1.200	7.82	<0.010	389.0	33.00	2.00	0.00
11543	Bay L'Argent	37.8	5	53.2	0.990	6.86	<0.010	279.0	18.00	2.00	0.02
11544	Little Bay East	73.8	5	73.0	0.042	6.84	<0.010	190.6	27.00	1.35	0.02
12070	Swift Current	51.3	130	47.3	<0.004	6.88	<0.010	109.5	14.00	3.00	0.12
12524	Mortier	99.1	5	95.9	<0.004	7.68	0.050	281.0	30.00	5.10	0.06
12273	Wreck Cove	27.8	5	64.0	0.066	6.36	<0.010	168.0	23.00	1.60	0.26
11107	Bay L'Argent	30.9	5	39.5	<0.004	7.30	0.110	84.4	14.00	1.10	0.02
12920	Wreck Cove	89.2	10	101.0	0.250	6.33	<0.010	226.0	34.00	4.00	0.00
13912	Conne River	104.0	5	131.0	<0.004	6.69	<0.010	268.0	39.00	8.10	0.05
12914	English Hbr West	291.4	39	60.6	0.055	6.07	<0.010	204.0	20.00	2.58	0.33
10817	Swift Current	60.0	140	75.1	<0.004	6.42	<0.010	201.0	23.00	4.30	0.94
11455	Head, B D'Espoir	44.9	0	43.5	0.004	6.82	0.007	124.0	13.00	2.70	0.19
10625	Parker's Cove	84.7	10	62.6	0.004	0.00	0.015	0.0	22.00	1.86	0.22
11109	Boxey	59.5	0	64.3	1.400	7.39	0.008	214.0	23.00	1.66	0.00
11855	Harbour Breton	43.5	0	47.8	0.007	7.34	0.000	164.0	15.00	2.50	0.81
10199	Lewin's Cove	47.0	5	31.6	0.102	0.00	0.000	0.0	10.00	1.61	0.09
12178	Epworth	37.6	5	214.0	0.186	6.58	<0.010	1499.0	78.00	4.60	0.02
10635	English Hbr East	93.4	5	35.3	0.005	0.00	0.007	0.0	12.00	1.29	0.00
10201	St. Lawrence	17.7	10	20.9	0.530	0.00	0.015	0.0	6.50	1.81	0.00
10385	Monkstown	91.3	5	51.2	0.005	0.00	0.000	0.0	18.00	1.52	0.00
13095	Harbour Mille	132.0	250	217.2	<0.050	7.00	<0.010	2078.0	21.00	40.00	0.35

Well #	Community Name	Fe mg/L	Zn mg/L	Cl mg/L	Na mg/L	K mg/L	Fl mg/L	NO3 mg/L	SO4 mg/L	TDS mg/L	INVES/ PI/SAM mg/L
11112	English Hbr East	0.01	0.00	64.0	44.00	0.86	0.56	<0.001	9.70	233	S
11543	Bay L'Argent	0.11	0.03	61.0	44.00	2.13	0.08	0.003	5.30	193	S
11544	Little Bay East	0.00	0.00	11.0	17.00	0.95	0.12	<0.001	12.00	134	S
12070	Swift Current	3.30	0.05	5.3	7.30	0.49	0.09	<0.001	6.60	84	S
12524	Mortier	0.21	0.00	30.0	22.00	0.58	0.09	<0.001	13.00	172	S
12273	Wreck Cove	0.15	0.02	30.0	11.00	0.77	1.00	<0.001	6.10	171	S
11107	Bay L'Argent	0.01	0.00	5.4	3.58	0.18	0.09	<0.001	8.90	59	S
12920	Wreck Cove	0.00	0.02	8.6	8.50	0.86	0.09	<0.001	11.00	132	S
13912	Conne River	0.04	0.03	5.0	5.20	1.03	0.07	<0.001	19.00	295	S
12914	English Hbr West	1.07	0.65	20.0	16.00	0.74	0.09	<0.001	8.80	119	S
10817	Swift Current	5.60	0.04	31.0	12.00	0.79	0.09	0.001	3.50	144	S
11455	Head, B D'Espoir	0.98	0.00	3.0	3.46	1.41	0.05		6.80	64	S
10625	Parker's Cove	0.22	0.01	8.0	6.70	0.43	4.20		4.20	117	S
11109	Boxey	0.18	0.00	20.0	15.00	1.28	0.08		6.80	109	S
11855	Harbour Breton	3.70	0.01	21.0	12.00	0.57	0.04		7.20	90	S
10199	Lewin's Cove	1.18	0.06	14.0	14.00	0.47	0.51		6.30	69	S
12178	Epworth	0.01	0.01	490.0	220.00	0.77	0.30	0.011	6.10	1027	S
10635	English Hbr East	0.17	0.01	15.0	34.00	0.85	4.56		4.50	126	S
10201	St. Lawrence	0.31	0.14	24.0	15.00	0.96	5.16		7.00	84	S
10385	Monkstown	0.04	0.06	9.9	57.00	1.05	0.49		64.00	231	S
13095	Harbour Mille	4.80	0.03	610.0	327.00	13.20	0.00	<0.050	27.00	0	S

(shaded) MAC Exceeded

4.3.2 pH

Unlike the surface water, the pH for the groundwater analysis was generally within the range outlined in the CWQG. There were a few samples which were slightly acidic, but all were less than 0.5 pH units below the CWQG lower limit of 6.5 pH units.

4.3.3 Anions

The concentrations of chloride was particularly high in two communities. This combined with high specific conductivity and sodium concentrations suggests that there may be seawater intrusion in these two wells. In all other wells, chloride concentrations were below MAC.

The concentration of nitrates and sulphates were below MAC. Fluoride concentrations were high in three of the wells tested. High fluoride concentrations were expected in the St. Lawrence well, based on the geology, but concentrations in excess of 4.2 mg/L were also detected at Parkers Cove and English Harbour East. The high fluoride concentration in the St. Lawrence area is believed to be associated with fluorspar mineralization in the St. Lawrence granite, hydrostratigraphic Unit B6. The wells at Parkers Cove and English Harbour East are contained in hydrostratigraphic Unit B1. This causes a concern because the source of fluoride, unlike at St. Lawrence, is unknown, even though levels are just as high. Although some fluoride in water supplies can help prevent tooth decay, high fluoride concentrations in drinking water can cause dental fluorosis.

4.3.4 Cations

While the concentrations of all major cations in the tested wells was high, the levels were well below MAC's. In fact, calcium is the only major cation with a

MAC, and all concentrations were well below the 1,000 mg/L established for livestock.

High concentrations of sodium, calcium and magnesium do not generally cause health concerns. High concentrations of these cations make the water hard, leading to scaling and mineral deposition on surfaces. High iron and manganese concentrations, while aesthetically displeasing, do not cause health problems in the present concentrations.

Typically, the groundwater in the study area is calcium-sodium dominated with lesser amounts of magnesium and potassium. The sodium is in part likely due to the proximity of the sea to the study area. The high concentrations of the other major ions is likely due to geochemical weathering of the native geology. The dominance of sodium in surface water, as opposed to calcium in groundwater, indicates the influence of marine aerosols on the chemistry of surface waters. The higher concentration of major ions in groundwater relative to surface waters is likely due to dilution of surface waters from runoff events. These events would not have as significant and effect on groundwater chemistry.

4.3.5 Conclusions

From the limited data available in the area, it is difficult to draw conclusions on groundwater quality. In general, however, the groundwater quality in the study area appears to be good.

Generally, iron and manganese concentrations are high in parts of the region. While this is primarily an aesthetic concern, there can be potential health implications if concentrations become excessive.

High concentrations of sodium and chloride in two of the wells indicate seawater intrusion. Thus, pumping rates in these areas should be reduced and the number of houses using the wells should also be reduced.

Unacceptably high fluoride concentrations in the water at St. Lawrence, Parkers Cove and English Harbour East should be investigated and corrected. The level of fluoride at Wreck Cove should be monitored to ensure the already high concentration does not increase. In addition, future wells in the regions of high fluoride should be discouraged and an alternate surface water supply investigated as a first option.

Future groundwater testing should include tests for more toxic parameters such as mercury, arsenic and cadmium. These parameters can be toxic at very low concentrations.

4.4 Water Quality Concerns

Anthropogenic degradation of water supplies and drainage basins is a frequent occurrence in modern-day society. Through industrial activities such as forestry, construction, manufacturing, farming, and energy development, humans have reduced or altered the water resources available. The principal concerns are

- sedimentation
- nutrients
- micro-organisms
- toxic chemicals, and
- atmospheric pollutants.

The effects of sediment transport, bacteriological and nutritional contamination are less significant in the study area because they have been identified for a long time and there are usually controls in place. The effects of toxic chemicals and atmospheric pollutant transport are new problems for which there are fewer controls. Each is individually discussed below.

4.4.1 Sedimentation

Sediment transport is caused by activities which alter the drainage characteristics of a basin. These include forest clear-cutting, road construction on hillsides and use of ATV's. Since the study area is not extensively developed, and forest cover does not warrant a significant logging industry, sedimentation is not a significant problem in the area. Municipalities in the area which reported sediment loading as a problem were few, and the reports normally corresponded with periods of high runoff. The problem usually went away with normal hydrologic circumstances.

Proper development practices such as constructing hillside roads parallel to topographic contours, reforestation of clear-cut areas, and only well planned drainage diversions should continue to be followed in any future development to ensure sediment transport does not occur.

4.4.2 Nutrients

Nutrient loading for both surface water and groundwater was assessed for the study area on the basis of concentrations of nitrogen, nitrite-nitrate, and phosphorous. Analysis of chemical data from the region indicates concentrations are well below MAC's. Groundwater analysis was performed for only nitrate concentrations and there was only one sample above MAC, at Epworth, which in itself was insignificant.

Mean nitrogen concentrations in surface waters were generally less than 0.2 mg/L over the entire area. The maximum concentration observed in the area was 0.9 mg/L. Generally, while there was little variation in mean values, high maximum concentration occurred on the Burin Peninsula. This can be attributed to more farming development on the Burin Peninsula, resulting in higher nitrogen concentrations, compared to less farming development at Bay Du Nord/Jeddore Lake, resulting in lower nitrogen concentrations.

Nitrite-nitrate and phosphorous concentrations were also low for the study region. Typical sources of phosphorous are fertilizers and animal waste. Since there is limited dairy and agricultural farming in the region, phosphorous is not expected to be a concern.

4.4.3 Micro-organisms

DOH generally tests for coliforms in water supplies. While there were some coliform counts which caused concern, in all but one supply the count was sufficiently small to allow disinfection by chlorination. The supply of concern was at Grand Le Pierre where a boil order was ordered.

DOH also tests for free chlorine residual in water supplies. Trace amounts were found in some supplies such as at Fortune, Grand Bank, Garnish, Hermitage/Sandyville, Pool's Cove and Rushoon. None of these supplies was considered dangerous for consumption, however.

Bacteriological contamination in treated waters can result from improper operation of chlorinators used in treating. Also, surficial contamination of wells can occur as a result of poor sewage disposal practices. DOH continually monitor drinking water supplies and will issue boil orders when concentrations of micro-organisms become too high.

4.4.4 Toxic Chemicals

Toxic chemicals in a water supply can occur naturally or anthropogenetically. The presence of toxic chemicals, even in low concentrations, could have adverse effects on human health, aquatic life, and animals.

Data on toxic chemical pollution in municipal water supplies in Newfoundland was published by Environment Canada in 1988. Of the forty sites selected for testing, six of these sites fall within the study area and they are highlighted in Table 4.2.

These samples were tested for physical, inorganic, organic and volatile organic compounds which could cause adverse health effects. The Minimum Detection Levels (MDL's) were established well below the MAC's of Health and Welfare Canada.

The toxic organic and volatile organic constituents which cause a concern are discussed below. Note that physical and inorganic constituents of sufficient concentration to cause concern were discussed in the surface water quality section.

Organic Constituents

Polynuclear Aromatic Hydrocarbons (PAH's) were detected above the detection limit at all six sites. With the exception of the Hermitage water supply, however, the only PAH present was fluoranthene. The Hermitage water supply also contained detectable limits of PAH compounds Benzofluoranthene and Benzopyrene. The MAC of 0.01 μg/L was well above the 0.001 μg/L MDL. There were no MAC's for the other PAH compounds detected. PAH concentrations were sufficiently small not to cause concern, but the levels should be monitored to detect any increases.

Other organic parameters detected were alpha-BHC and Trithon. Both these were detected in only the Hermitage and Morrisville water supplies, and the concentrations were sufficiently low so as not to cause concern.

The presence of Alpha-BHC and fluoranthene in the water supplies suggest atmospheric transport and deposition of contaminants occurs in the region. The PAH fluoranthene is produced anthropogenetically through incomplete combustion of fossil fuels, or through forest fires and volcanoes. The widespread occurrence of fluoranthene and alpha-BHC both suggest atmospheric transport of pollution occurs in the region. This is examined more closely in Section 4.4.2 on acidification.

Volatile Organic Constituents

Trihalomethane (THM) was detected in quantifiable levels in all six water supplies except at Rushoon where it is detected in trace amounts only. Health and Welfare Canada guidelines for THM of 350 $\mu g/L$ were not exceeded in any of the supplies and the maximum quantifiable concentrations were 100 $\mu g/L$. As discussed previously, typical waters in the study area have low pH, high DOC and colour. These characteristics can indirectly cause high levels of THM in waters which are treated with chlorine.

Environment Canada's toxic chemical municipal water survey also identified the presence of trace amounts of dichloroacetonitrile ($CHC_{12}CN$) in five of forty municipal water supplies surveyed. It is not known if any of the water supplies in the study area contained dichloroacetonitrile. Since there was little confidence in the testing procedure, these water supplies should be further tested.

Pesticides and Herbicides

The Department of Forestry and Agriculture was contacted to assess whether there might be a potential for pesticide and herbicide pollution in the area. It was discovered that there are only six to ten small farms in the area and the use of pesticides is insignificant. Also, the area has never been aerially sprayed by herbicides. Overall, there does not seem to be an immediate concern of pesticide and herbicide contamination in water supplies in the study area.

4.4.5 Atmospheric Pollutants

Acid rain is the best known atmospheric pollutant, but pollutants other than those causing acid rain can also be transported through the atmosphere and deposited. DFO has conducted several major studies to assess the effects of acid rain in Newfoundland.[4-6, 4-7, 4-8] The conclusions of its work indicate the study area has moderate to high sensitivity to acidification. Acid precipitation is defined as rain, snow, freezing rain, hail and fog with a pH below 5.6.

To assess if acidification of surface waters was occurring, pH data of four NAQUADAT stations with long periods of recorded data were compared over time. The results were tabulated and presented in Table 4.6.

Rattle Brook is the only sample site with median and average pH levels at or below 5.6 units. The pH values have been consistent since 1965 with a median pH increase of 0.2 units in the 1981 to 85 data, followed by a return to previous normals from 1986 - 91. Otherwise, Tides Brook was also slightly acidic with between 25 to 50 percent of the sample data below pH 5.6.

This data does not indicate a trend toward increasing pH values with time. The low pH values for Rattle Brook and, to a lesser extent, Tides Brook, can more likely be attributed to a low to medium buffering capacity of the local lithology.

This is supported by the large occurrence of mafic to felsic volcanics, granite, and metasediments in the study area. These units have a low to medium buffering capacity compared to carbonate limestones and dolomites, which would increase the buffering capacity.

The occurrence of compounds of acid rain such as fluoranthene and alpha-BHC in waters tested in the study area indicate that atmospheric transport of contaminants plays a role in water contamination. This is supported by DFO studies indicating sulfate concentrations correlating positively with hydrographs for the area. Thus, while atmospheric transport does contribute to water quality in the study area, the influence has not been catastrophic.

Table 4.6
Acidification on the Burin Peninsula

	Garnish River - 01NF02ZG0016		
	1965-80	1981-85	1986-91
No. Samples	88	30	50
Low	4.80	4.20	5.30
High	7.10	6.70	7.00
Mean		5.90	6.12
Std Dev.	.	0.40	0.39
10th	5.70		
25th	5.90		
50th	6.20	5.90	6.00
75th	6.40		
90th	6.60		

	Tides Brook - 01NFO	
	1965-80	1981-85
No. Samples	31	66
Low	4.50	5.50
High	8.90	6.80
Mean		6.10
Std Dev.		0.30
10th	5.30	
25th	5.40	
50th	6.00	6.20
75th	6.20	
90th	6.50	

	Rattle Brook - 01NF02ZG0002		
	1965-80	1981-85	1986-91
No. Samples	27	65	59
Low	5.10	4.80	5.00
High	6.30	6.90	6.30
Mean		5.70	5.58
Std Dev.		0.40	0.28
10th	5.20		
25th	5.40		
50th	5.60	5.80	5.60
75th	5.90		
90th	6.10		

	Pipers Hole - 01NFO	
	1965-80	1981-85
No. Samples	129	68
Low	3.80	5.00
High	7.50	7.10
Mean		6.20
Std Dev.		0.40
10th	5.70	
25th	6.00	
50th	6.30	6.10
75th	6.60	
90th	6.90	

5 - Instream Uses

5 Instream Uses

5.1 Introduction

The demands for freshwater can be classified as either instream or withdrawal demands. Instream uses do not consume water, although they may alter the physical characteristics or water quality of rivers or lakes. Withdrawal demands, on the other hand, actually extract water.

Three instream uses are important in the study area. These are

- hydropower production
- recreation and tourism
- freshwater fishery.

These are discussed in this chapter. Other instream uses such as navigation and waste disposal are negligible in the study area.

5.1.1 Hydroelectric Power Production

There are two major hydroelectric power plants in the study area, and four smaller installations. Newfoundland and Labrador Hydro (NLH) operates a 604 MW station at Bay d'Espoir and an 84 MW station at Upper Salmon. In addition, NLH operates an 8 MW station at Paradise River. Newfoundland Power (NP) operates the three other smaller installations, a 700 kW station at West Brook, a 670 kW station at Lawn, and a 400 kW station at Fall Pond.

The three NP stations on the Burin Peninsula were built by United Towns Electric Company. Fall Pond was originally built in the 1920's but was rebuilt in 1940 after a dam failure in 1939. A few miles away, West Brook was developed during the reconstruction of Fall Pond. The Lawn station was originally built in 1927, but was refurbished and later rebuilt in 1984.[5-1]

NLH, incorporated in 1954, has since become the principal energy producer on the island of Newfoundland. About two-thirds of NLH's energy comes from hydroelectric stations, and of this, about three-quarters comes from the Bay d'Espoir basin developed in the mid-1960's. So overall, approximately one half of the total island energy comes from Bay d'Espoir. Made up of half dozen lakes and reservoirs, the total drainage area is almost 6,000 km^2. In the 1980's, the Upper Salmon development was constructed, adding 84 MW to the system.

The drainage areas for the hydropower systems in the study area are shown in Figure 5.1. Details of the upper sub-basins of the Bay d'Espoir system are shown in Figure 2.2. Table 5.1 lists the pertinent data for each plant.

Table 5.1 shows that the utilization rate of the water at the two large stations is very high. At Bay d'Espoir, the spill is only 1 percent of the average annual flow and at Upper Salmon it is less than 3 percent. The smaller NP stations as well as NLH's Paradise River station have little storage and consequently spill is relatively higher.

5.1.2 Future Developments

Potential for future hydroelectric developments in the region is limited to about a half-a-dozen sites, at present values of energy. The abundant precipitation and even distribution of precipitation are advantageous for hydropower; the potential would be greater if there were larger differences in elevation so that higher heads could be developed.

Three potential additional developments have been identified within the Bay d'Espoir system, at Round Pond, Island Pond and Granite Canal. The proposed Round Pond station is of the order of 10 - 15 MW, and Island Pond and Granite Canal are of the order of 35 MW each. These would be in-line stations to take advantage of intermediate head between existing reservoirs. They would use the regulation already present in the Bay d'Espoir development, and consequently no new storage reservoirs would be required.

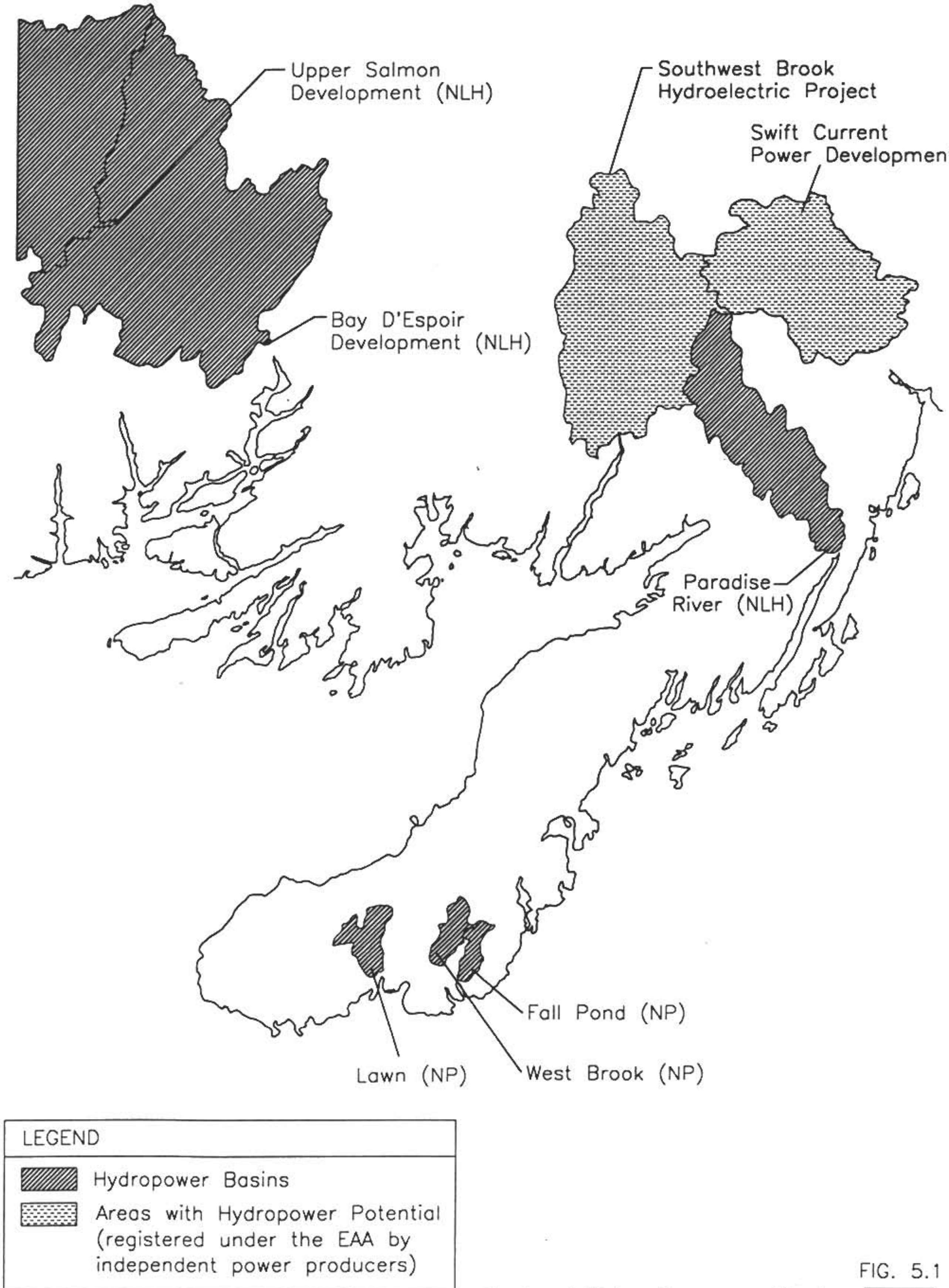

FIG. 5.1

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Hydropower Basins

Table 5.1

Characteristics of Existing Hydropower Stations

Plant	Lawn	West Brook	Fall Pond	Paradise River	Bay d'Espoir	Upper Salmon
Year Completed	1930	1942	1939	1989	1967	1982
Capacity (MW)	0.670	0.700	0.400	8.0	604	84.0
Drainage Area (km^2)	78.5	46.0	40.0	477	5910	920
Gross Head (m)	24.3	47.0	15.2	44.0	176	50.0
Average Annual Energy (GWh)	1.4	3.1	1.1	36	2541	541
Average Annual Power Flow (m^3/s)	21.55	7.27	12.31	13.85	186.8	133.1
Average Annual Spill (m^3/s)	11.48	0.414	4.23	3.04	1.88	3.72

These projects have been registered under the provincial Environmental Assessment Act (EAA) and some environmental impact studies have been carried out. Although these projects are attractive from the point of view of long-term planning, reduction of fossil fuel imports and use, and reduction of atmospheric emissions, NLH has not made a decision on whether or not these developments will be built. For Granite Canal and Island Pond, some component studies have been completed, but at the present time, these projects are relatively inactive due to recent incentives in small hydro developments.

The potential for small scale hydro development (1 MW to 20 MW) suitable for interconnection to the island power grid has been studied by NLH, first in an inventory study, then in a follow-up ranking study. NLH recently issued a Request for Proposals (RFP) for small scale hydro projects (up to 15 MW). Several sites in the study area were identified in earlier studies but only two have been registered under the Environmental Assessment Act (EAA) in response to NLH's RFP. They are Swift Current Power Development and Southwest Brook Hydroelectric Project.

The proposed development at Swift Current would have a total installed capacity of 10 MW and would contribute an average of 55.7 GWh annually to the island's power supply. The catchment area is about 768 km^2, and the maximum gross head is 43 m. A 5.1 MW station is proposed for the Southwest Brook project, with an average annual contribution of 37.2 GWh. The catchment area is 150 km^2 and the gross head is approximately 120 m. These details are based on preliminary designs and may change as development plans continue. The locations of these two proposed independent stations are shown in Figure 5.1. Other potential projects identified in earlier studies are not expected to be economic within the current planning horizon.

Hydropower projects are environmentally attractive when compared with alternative thermal projects because they do not produce atmospheric pollutants or greenhouse gases. There are always environmental concerns with the construction of a major project such as hydropower station, however. The most likely concerns in the study area include the effects on recreation, fish, and wildlife. Issues such as these will be addressed in the Environmental Impact Statements which have been requested for the proposed projects. Possible conflicts are discussed in Section 5.4.

5.1.3 Value of Water Used to Produce Electricity

The value of water used for hydropower production can be determined from the value of the energy generated. Assuming that the hydro energy produced would be replaced by energy produced by burning Bunker C fuel at the Holyrood thermal plant, the current value of the energy is about 2.8¢/kWh. The assumed fuel cost is $17/barrel, and the assumed net energy conversion rate is 605 kWh/barrel (current 1993 winter values as provided by NLH). On this basis, the value of water at the plants ranges from 0.008¢/m^3 to 1.2¢/m^3, as shown in Table 5.2. The wide range of values is a result of the different heads; the higher the head, the more energy per unit of water.

The value of water used at a new hydropower station, however, can be higher because of the additional capacity provided. Based on the rates presented in NLH's RFP, the value of water could be over twice as high for new stations.

5.2 Recreation and Tourism

Newfoundland's recreation and tourism industry to a large extent takes advantage of people's enjoyment of nature. Many people like spending some time away from developed areas, in a relatively clean environment. A key element associated with these spaces is clean water.

Although it is difficult to document the use of water for recreation directly, its importance can be inferred from the map in Figure 5.2. It shows parks and other areas presently used for recreation, or identified as having recreational potential in the Canadian Land Inventories.[5-2]. All of these are near water. Rivers and ponds

Table 5.2

Value of Water for Hydropower

Plant	Average Annual Energy (GWh)	Average Annual Power Flow Volume (Mm^3)	Annual Value of Energy ($M)	Annual Value of Water (¢/m^3)
Lawn	1.4	680	0.0812	0.012
West Brook	3.1	230	0.104	0.045
Fall Pond	1.1	390	0.0308	0.008
Paradise River	36	437	1.008	0.231
Bay d'Espoir	2541	5894	71.15	1.207
Upper Salmon	541	4201	15.15	0.361

Note : Value based on present fuel displacement. For new hydropower stations providing additional capacity, value could be over twice as high.

at these sites provide a main attraction for boating, swimming or fishing, and for enhancing the aesthetic quality of campgrounds, picnic areas and hiking trails. Due to the abundance of fresh water (ponds and brooks) throughout the study region, and the large areas of undeveloped terrain, there is considerable informal use of water resources.

Cottage development is another of the most important recreational uses of fresh water in the study area. According to the Water Resources Atlas[5-3] there are about ten major cottage areas in the study area, identified on Figure 5.2. Since most residents have cottage lots adjoining water bodies, any development of these or other waters will have some effect on the cottage areas.

Many of the recreational users are residents, but approximately 3,600 people from outside the province visit the area as well, according to 1990 unpublished statistics from the Department of Development and Tourism. The Regional Tourism Study for the Burin Peninsula[5-4] estimated that the 3,600 nonresidents represented about 20 percent of the visitors to the region, which suggests that nearly 20,000 provincial residents visited the Burin Peninsula. These large numbers indicate the attraction of the surrounding environment.

5.2.1 Provincial Parks

The total number of visitors to all provincial parks in the province in 1988 (the latest date for which statistics are available) was 400,000 per year. Park officials have noted that in order to attract visitors a provincial park must be located near a water body which offers water based activities.

There are five provincial parks in the study area which all offer some sort of water based attraction to the public. These activities vary from swimming to boating and angling. The provincial parks in the study area are listed in Table 5.3 with their use, major water attraction and the annual number of visitors where available.

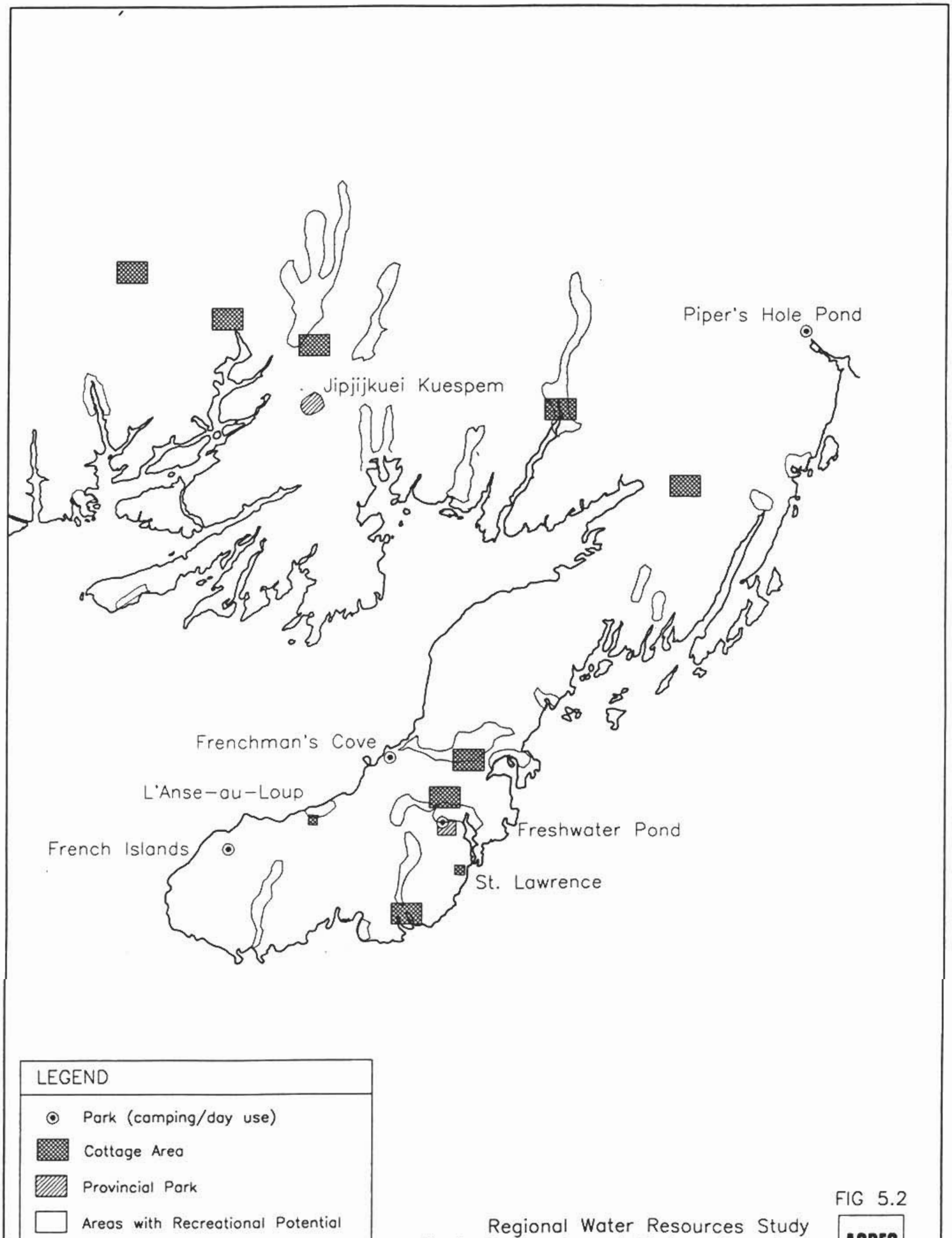

FIG 5.2

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Recreational Areas

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Table 5.3
Annual Visitors to Provincial Parks and Water Based Activities

Park	Use	Water Attraction	Visitors
Piper's Hole Park	Camping	Salmon fishing waterfall hike	Not Available
Freshwater Pond	Camping	Angling/boating swimming	34,293
Frenchman's Cove	Camping	Angling/swimming	29,138
French Island	Day Use	Natural scenic attraction	Not Available
Jipjijkuei Kuespem	Camping	Swimming/angling	Not Available

5.2.2 Water-Related Attractions

Other sources of information confirm the importance of water-related attractions for recreation and tourism. Some statistics extracted from a survey of out-of-province visitors, presented in Table 5.4, show that visitors have a strong liking for water based activities, and for water related activities such as sightseeing and touring. These activities rank among the highest in visitor participation.

Table 5.4
Results from a Survey of Nonresident Auto Visitors

Water Based Activities	Percent Liking	Water Related Activities	Percent Liking
Canoeing/Kayaking	30.6	Boat Tours	72.0
Fishing	61.0	Picnic/Cookouts	80.9
Sailing/Boating	55.2	Sightseeing	90.8
Going to the Beach	74.4	Photography	85.8
Swimming (Beach)	74.7	Visiting Parks	80.9

[Data provided by Department of Development and Tourism, Auto Exit Survey]

The Regional Tourism Plan for the Burin Peninsula identified various existing and potential attractions beneficial to the area's economic development. Many of these attractions are water-related and include

- hiking, camping, canoeing
- upgrading the Seaman's Museum
- tours of the fish plant
- interpretive displays of shipbuilding
- boat tours
- cod-jigging packages
- picturesque fishing villages
- scenic lookouts.

The report concluded that the future for tourism in the area is bright. With the majority of the Burin Peninsula's present attractions related to fresh water and marine activities, it is clear that the water resources will play an important role in future development.

5.2.3 Value of Water Used for Recreation

It is difficult to quantify the importance of water resources to the recreation and tourism industry in the study area, but the information presented in the previous sections shows that water based activities and the presence of aesthetically pleasing rivers and ponds are attractive to both tourists and residents. The Department of Tourism has estimated that the annual total expenditure by nonresidents visiting the Burin Peninsula and Fortune Bay area is of the order of $1.5 million.

Despite changing economic circumstances, the Department of Tourism estimates that in 1992 pleasure trips declined by only three percent. Although the department does not prepare official forecasts, it expects that in 1993 travel activity will still be slow, assuming similar economic conditions. A slight growth is anticipated in 1994, however, as the economy strengthens.

The rivers, ponds, and associated open spaces contribute to the regional economy by attracting visitors as well as by encouraging residents to holiday at home. Good quality ponds, rivers, and surrounding areas constitute an important economic resource both now and in the future.

5.3 Freshwater Fishery

The freshwater fishery is important for its contribution to recreation and tourism. It is discussed here separately, however, because of the inherent value in preserving natural fish and aquatic life.

The clean waters of the study area, together with good spawning and rearing areas, are well suited to salmon and trout. Species reported include sea-run salmon, sea-run brown and brook trout, resident brook trout, and resident (land-locked) salmon. Many of these are favorite sport fish. Their presence in the waters of the study area is important to residents and nonresidents, who derive considerable pleasure from angling, or from simply watching fish. The presence of healthy fish is an indication of good water quality to the public at large.

Table 5.5 lists rivers of particular interest to DFO, either because they are scheduled salmon rivers, or because they have proposed or existing enhancement projects, but almost any river in the study area can support natural fish species and is therefore important to DFO.

Table 5.5

Rivers of Particular Interest for Fisheries

Cape Rodger River	Scheduled Salmon River (SSR)
Pipers Hole River	SSR, proposed enhancement project
Nonsuch Brook	SSR
Bay de l'Eau	SSR
Red Harbour River	SSR

Table 5.5 (continued)

Rivers of Particular Interest for Fisheries

Northeast and Northwest Branch and tributary streams	SSR
Tides Brook	SSR, proposed enhancement project
Mortier Bay	SSR
Main Brook and tributary streams	SSR
Shearstick Brook	SSR
West Brook	SSR
Northwest Arm and tributary streams	SSR
Salmonier River, Burin	SSR
Little St. Lawrence River and tributary streams	SSR
Lawn River and tributary streams	SSR
Taylor's Bay River and tributary streams	SSR
Salmonier Lamaline River and tributary streams	SSR
Piercey's Brook and tributary streams	SSR
Grand Bank Brook and tributary streams	SSR
Garnish River	SSR
Lower Garnish	SSR
Upper Black River and tributary streams	SSR
Long Harbour River, Fortune Bay and tributary streams	SSR
Bay du Nord River	SSR
Simmons Brook and tributary streams	SSR
Old Bay Brook,Bay d'Espoir	SSR
Taylor's Bay Brook	SSR
Conne River and tributary streams	SSR
Bernard's Brook	SSR
Twillicks Brook	SSR
Salmon River	Atlantic Salmon and Trout Hatchery

5.3.1 Value of Water Used for Fisheries

The quantity, flow regime and quality of water and surrounding spaces are all important to the freshwater fishery. The value of the fishery in the study area arises from its economic contribution to tourism and recreation and the inherent value of preserving natural fish and aquatic life.

The most recent survey by DFO, in association with the provincial Department of Culture, Recreation and Youth, provides some information on sports fishing in Newfoundland.[5-5] On the basis of the survey data, DFO estimates that in 1985 there were about 160,000 active anglers in the province (including children and nonresidents). They caught over 12 million fish weighing nearly 11 million pounds. Since each angler spent an average of 23 days fishing, angling is clearly a major recreational activity. About six percent of the total effort was on the Burin Peninsula and about 14 percent in the Central and Bonavista area. The study area takes in about a third of this latter area, including such important fishing rivers as Conne River, Long Harbour River and Bay du Nord River. The total number of anglers in the Burin Peninsula, Central and Bonavista areas was estimated to be 21,000. Based on these statistics, the effort in the study area is estimated to be approximately 12,000 anglers. Their estimated expenditure was about $4.5 million in the study area. Approximately ten percent of this was by nonresidents.

According to fisheries officials, the recent moratorium on the commercial salmon fishery has led to an increase of 50 - 60 percent in the numbers of salmon/grilse in freshwater streams and rivers on the island. This means an increase in angling and therefore increased revenues from the sports fishing industry.

The responses to the survey questions bear out the importance of overall environment to fishing as well as to other recreational activities. It is interesting to note that of those nonresident anglers surveyed, 62 percent said they would not return to Newfoundland at all if there was no sport fishing. Perhaps surprisingly, anglers ascribed little importance to catching the desired species or size or number of fish. They emphasized the importance of the beauty of the surroundings, the quality of the water, and the access to wilderness. They also appreciated the opportunity to fish for wild, not hatchery, fish.

5.4 Potential Conflicts Among Instream Users

There are undoubtedly some potential conflicts among instream users, but to date no major problems have been reported. The freshwater fishery is the most sensitive to other uses, and is therefore likely to be the key issue in most conflicts. The potential conflicts are described below.

5.4.1 Fisheries - Hydropower Conflicts

Any hydropower project in the study area will affect fish habitat, since all rivers in the study area can support native species of fish. With the development of a hydropower system the reach of river between the dam and the powerhouse will be dewatered at least part of the time. Fish passage both upstream and downstream may be obstructed. As well, water movement in any intake structure may be attractive to migrating fish and could lead to possible entrapment or injury as fish pass through the turbine. Depending on the size of the reservoir, changes in water temperature may have an effect. Because of such possibilities, DFO must approve all projects, and its policy of "no net loss" ensures that fish habitat is preserved or developed elsewhere in compensation.

The most likely areas of conflict are the sites with potential for hydropower development shown in Figure 5.1.

Another conflict, in the sense of an environmental effect, is the bioaccumulation of mercury in fish flesh. Concentrations of mercury in fish flesh exceeding Health and Welfare guidelines for human consumption have been detected in fish caught in Long Pond reservoir. These levels have been monitored for several years by NLH and DFO, and are not increasing. There is some suggestion from statistical analysis of data from other reservoirs that levels can be expected to decrease. NLH and DFO are in the process of establishing a long term monitoring program.

Bioaccumulation of mercury is associated with flooding of large areas, and with large volumes of storage (with the result that flushing is infrequent). Since the proposed hydropower developments flood relatively small areas, and will have frequent flushing, bioaccumulation of mercury in fish tissues is not expected to be a problem in the proposed hydropower projects.

In some cases, fisheries may benefit from hydropower stations, as in Bay d'Espoir where the warm water from the hydropower turbines is used for fish farming. As well, augmentation of low flows and attenuation of high flows may occur below hydro projects. At the Upper Salmon project, NLH and DFO have worked together to ensure that compensation flows were provided in the West Salmon River to maintain spawning beds and there is evidence from field studies by NLH and DFO that the West Salmon River remains productive.

5.4.2 Fisheries - Recreation/Tourism Conflicts

Expenditures on the freshwater fishery are often justified because of the contribution the sports fishery makes to the economy. The environmental conditions desired by the anglers are generally in agreement with those necessary to preserve natural fish and aquatic life. The main recreational attractions of the study area for most tourists, cottage owners, and other residents are similar - unspoiled nature, clean water, and fresh air.

Nevertheless, in their search for a clean environment people can degrade fish habitat, for example in constructing roads and tourist facilities, and by use of all terrain vehicles. Cottage areas may increase the amounts of pollutant in the water supply through improperly designed or maintained septic systems. Anglers themselves can also create great pressure on the natural fish species by over fishing. So conflicts can arise between tourism/recreation and the inherent value in protecting freshwater fish species.

The areas where these conflicts are most likely to occur are shown on Figure 5.2, and along access roads to these areas.

5.4.3 Hydropower and Recreation/Tourism Conflicts

Hydropower and recreation uses are not likely to produce much conflict in the study area. Although hydropower projects take water from scenic rapids and waterfalls, they can benefit recreational uses by creating and providing access to lakes and areas which were previously inaccessible (e.g., Bay d'Espoir), and by regulation to reduce flooding (e.g., Salmon River). Power plants, dams, and spillways are themselves often considered interesting attractions worth visiting (e.g., Paradise River). As well, hydropower can be a benefit in that some communities rely on these systems as the source of water for their own water supply systems (e.g., St. Lawrence).

6 - Withdrawal Use

6 Withdrawal Use

6.1 Introduction

In this chapter, withdrawal uses for the towns and incorporated communities in the study area are assessed and a supply/demand ratio for each is calculated. The total withdrawal for all uses in the study area is estimated to be about 35,000 m^3/day. About 95 percent is estimated to be from surface sources.

The major withdrawal uses include

- Municipal water supply. An estimated average of about 25,000 m^3/day of water is withdrawn for domestic purposes. About 90 percent is from surface sources. Surface supplies are the primary source of water for about 27 of the towns and incorporated communities in the study area; the other nine use groundwater. Most of the remaining unincorporated communities use groundwater or mixed systems.

- Industrial water supply. The total industrial demand is estimated to average about 10,000 m^3/day. Almost all of this demand is from fish plants. Some fish plants have their own fresh or salt water supply systems or both; others draw from the municipal water supplies. There is considerable variation in consumption through the year because fish processing is not continuous.

- Rural residential supply. Very small communities, isolated homes and summer cottages obtain their water from local groundwater or surface sources. This withdrawal use represents only a very small percent of the total.

Figure 6.1 shows the locations of the towns, incorporated communities and local service districts in the study area. Detailed descriptions of the water supply systems for each of these communities (as well as some other small communities) and maps

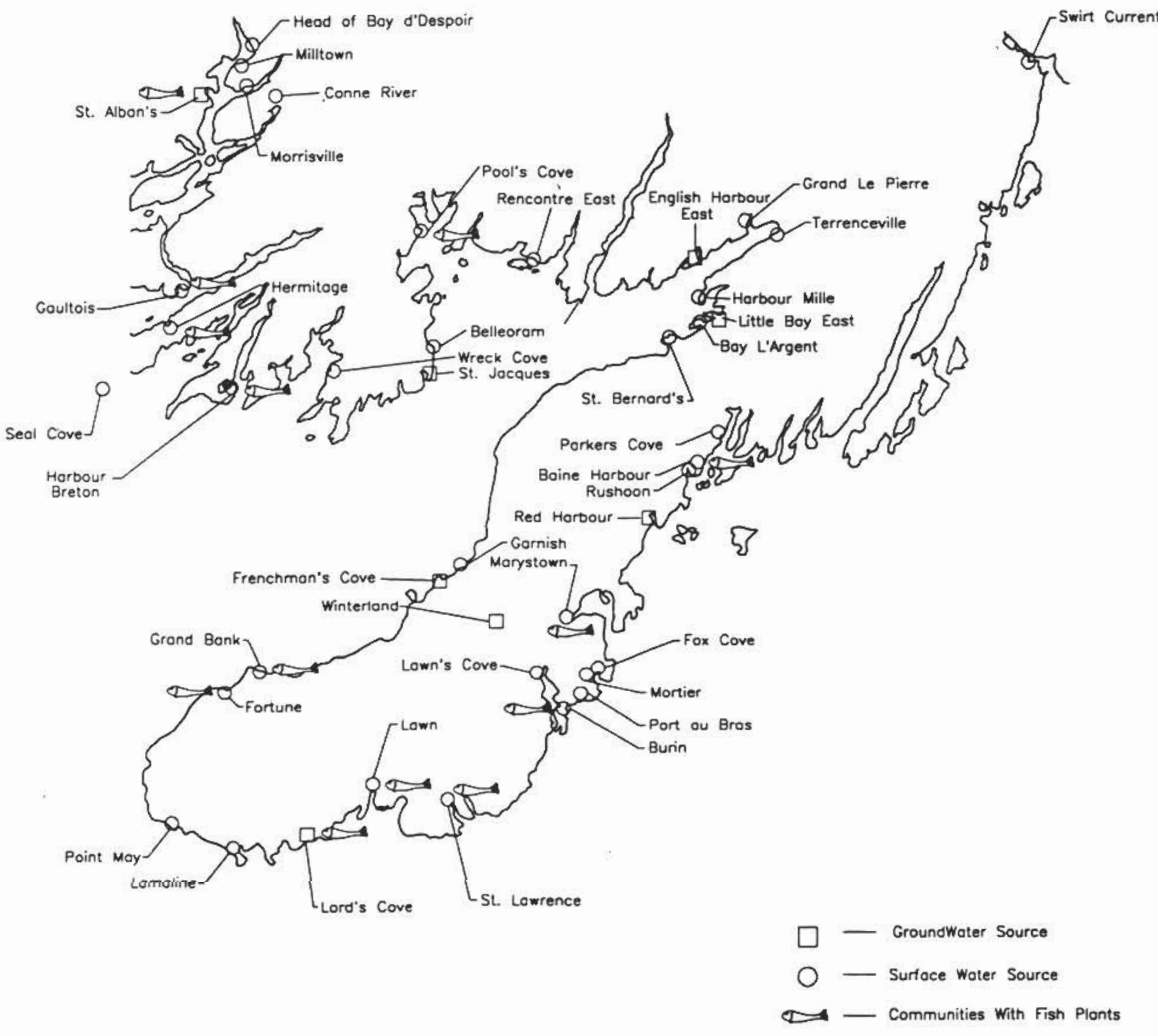

FIG. 6.1

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Locations of Communities

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of the watersheds are provided in Volume 2, **Inventory of Water Supply Infrastructure**.

The purpose of this chapter is to compare present and projected demands with the available supply for each community. A different approach was required for communities with surface water systems than for those with groundwater systems. The methods and assumptions used to obtain the estimates of demand and supply are described in the following sections.

6.2 Demand Assumptions and Analysis

6.2.1 Domestic Demand

Domestic demand was calculated by applying a per capita demand rate to population. The rate chosen was 0.65 m^3/day per capita based on available data for communities in the study area from the Inventory and from the Municipal Water Use Data Base (MUD).[6-1] This rate accounts for all residential, institutional, and commercial uses. (Fire fighting requirements are not included; these depend on the characteristics of the distribution system, and in some situations on short term (tank) storage. Because of the very low average demand for fire fighting, these requirements do not affect the present analysis.)

The demand rate is assumed to remain the same to the end of the 25 year planning period. Any increase in the demand rate (e.g., resulting from a higher standard of living) is assumed to be balanced by improvements in the systems to reduce losses.

These demand rates were applied to 1991 population figures to estimate present domestic demand, and to project populations in 25 years (2016) for future demand. The population growth rate was calculated from recent trends in each community. Approximately 75 percent of the communities have experienced a declining population over the past five to ten years. The populations of these communities in 2016 were conservatively predicted to be equal to that of 1991, rather than continuing to decline. For the communities experiencing an increase in population in recent years, the trend during the past 15 years was assumed to continue at the same rate for the next 25 years to determine the 2016 projected population.

A check was then made on the total projected population of the overall study area. This total is slightly greater than the peak population level experienced in 1981. This check is consistent with the worst case scenario approach of assuming at least a constant population level following trends of a negative population growth rate. Table 6.1 shows the past, present, and projected populations of the communities in the study area.[6-2]

6.2.2 Industrial Demand

The predominant source of industrial demand in the study area is the fish processing plants. There are 14 fish plants in the area, most of which are equipped to meter fresh water demand. Information on the industrial demand was obtained from the **Inventory**, and through personal interviews with municipal officials, representatives of DMPA, and plant operators. The demand rate ranged from about 50 m^3/day to 1,000 m^3/day depending on the size of the fish plant. A poultry farm in Garnish currently not served by the municipal water supply, has an estimated future demand of 27 m^3/day.

Little growth is expected in the region over the next 25 years, as evident in the population trends previously discussed and confirmed by discussions with DMPA officials. It is therefore assumed that there will be no increase in industrial water use over that same time period. If large volumes of fresh water were available, however, some fish plants might switch from salt water to fresh.

Table 6.1
Population Estimates

COMMUNITY	1976	1981	1986	1991	2016 PROJECTED
Baine Harbour	204	208	205	189	189
Bay L'Argent	474	483	489	403	403
Belleoram	536	565	578	639	811
Burin	2892	2904	2892	2940	3020
Conne River	531	588	92	108	188
English Harbour East	278	316	299	288	288
Fortune	2406	2473	2370	2177	2177
Fox Cove-Mortier	469	469	500	464	464
Garnish	678	761	756	716	716
Gaultois	558	558	583	516	516
Grand Bank	3802	3901	3732	3528	3528
Grand le Pierre	368	381	401	356	356
Harbour Breton	2317	2464	2432	2418	2418
Hermitage	830	863	831	756	756
Jacques Fontaine	197	221	210	200	200
Lamaline	543	548	514	482	482
Lawn	1025	999	1015	1005	1005
Little Bay East	213	202	196	201	226
Lewin's Cove	470	507	555	609	841
Lord's Cove	409	384	346	329	329
Marystown	5915	6299	6660	6739	8112
Milltown-Head of Bay D'Espoir	1325	1376	1276	1161	1161
Morrisville	217	233	221	201	201
Parker's Cove	381	424	428	441	541
Point May	372	427	456	435	435
Pool's Cove	242	244	259	258	258
Port au Bras	395	366	363	319	319
Red Harbour	206	231	263	252	329
Rencontre East	214	230	218	212	212
Rushoon	504	520	505	482	482
Seal Cove-White Bay	510	498	517	467	467
St. Alban's	2040	1968	1780	1586	1586
St. Bernard's	611	696	689	652	652
St. Jacques	1061	1048	994	701	701
St. Lawrence	2258	2012	1841	1743	1743
Terrenceville	764	796	827	818	818
Winterland	184	233	260	272	419
TOTALS	36399	37396	36553	35063	37348

6.3 Supply Assumptions and Analysis

6.3.1 Surface Systems

The available supply or yield was estimated using the methods developed in Chapter 2. The surface systems fall into one of two categories, unregulated (run-of-river) or regulated (with storage), although some systems combine run-of-river with some storage. About half are regulated and half unregulated. The yield for each of the two categories was obtained as follows.

Unregulated Systems

For run-of-river systems, with little storage other than natural ponds, the yield was based on the seven day low flow having a return period of ten years. This was done using the low flow frequency analysis equations[2-1] as applicable to the Burin Peninsula/Fortune Bay region. The daily yield was calculated as a function of drainage area and percent forest area. Table 6.2 shows the estimated yield from these systems.

Regulated Systems

For systems with storage, the storage yield curve presented in Figure 2.11 was used to estimate the reliable yields. If the ratio of storage volume to mean annual flow volume was less than 0.05, the system was assumed to be run-of-river.

The storage volume is calculated from pond area and live storage head. The mean annual flow volume is calculated from the mean annual runoff and drainage area. The storage ratio is the ratio of the two volumes, and the yield ratio is taken from Figure 2.11. The daily yield is obtained by multiplying the yield ratio by the mean annual flow volume. (A detailed sample calculation is provided in Chapter 2.)

Table 6.2
Estimated Reliable Yield for Surface Supplies

Community	Water Source	Reg Unr	Pond Area (km^2)	Live Stor. Head (m)	Drainage Area (km^2)	Stor. Vol. (Mm^3)	Mean Annual Runoff (mm)	Mean Annual Q Vol. (Mm^3)	Stor. Ratio (2)	Yield Ratio (2)	Reg. Yield (m^3/day)	Comment	Percent Forest Area	Unreg. Yield (m^3/day)
Baine Harbour	*Baine Harbour Pond*	U	0.011	0.6	0.2	0.0066	1000	0.17	0.039	0.000		low flow	1	36
Bay L'Argent	*Sugar Loaf Hill Bk*	U			0.9	0.0004	1200	1.092	0.000	0.000		low flow	89	79
Belleoram	*Rabbit's Pond (M)*	R	0.025	1.8	0.303	0.0450	800	0.242	0.186	0.570	379			
	Big Pond (B)	R	0.313	1.5	1.560	0.4695	800	1.248	0.376	0.795	2718			
Burin/Lewin's Cove	*Long Pond*	R	0.340	1.0	1.650	0.3400	800	1.32	0.258	0.715	2586			
	Mortier Big Pond	R	0.76	1	1.256	0.7600	800	1.004	0.756	0.795	2189			
Conne River	*unnamed*	U		1.5	9.280	0.0005	1200	11.13	0.000	0.000		low flow	38	1414
Fortune	*Horse Brook Pond (M)*	U	0.016	5.3	1.900	0.0680	1000	1.9	0.038	0.000		low flow	10	319
	Reserve reservoir (B)	R	0.108	4.3	2.190	0.4644	1200	2.628	0.177	0.550	3960			
Fox Cove–Mortier	*Deep Pond*	U	0.029	1.9	1.880	0.0551	1000	1.88	0.029	0.000		low flow	42	219
Garnish	*Wych Hazel Pond*	R	0.100	1.5	0.385	0.1500	1200	0.462	0.325	0.795	1006			
Gaultois	*Cluett's Pond*	R	0.140	2.0	2.030	0.2800	1100	2.233	0.125	0.450	2753			
Grand Bank	*Grand Bank Brook*	U		5.5	56.000	0.1580	1000	56	0.003	0.000		low flow	20	13178
Grand le Pierre	*Line Pond*	U			0.260	0.0010	1000	0.26	0.004	0.000		low flow	47	22
Harbour Breton	*Hutchings Pond (M)*	R	0.078	2.0	0.663	0.1560	1000	0.663	0.235	0.670	1217			
	Connaigre Pond (B)	R	0.090	2.0	0.683	0.1800	1000	0.683	0.264	0.725	1357			
Hermitage	*Granfer's Pond*	R	0.057	2.9	0.800	0.1636	1050	0.84	0.195	0.585	1346			
Lamaline	*Upper Hodges Pond*	U	0.117	1.7	4.370	0.1989	1000	4.37	0.046	0.000		low flow	3	1131
Lawn	*Brazil Pond*	U	0.129	1.2	36.900	0.1483	900	33.21	0.004	0.000		low flow	3	13187
Marystown	*Clam Pond*	R	2.16	1.5	13.93	3.2400	800	11.14	0.291	0.780	23815			
	Linton Lake	U	0.420	0.3	5.500	0.1260	800	4.4	0.029	0.000		low flow	20	911
Milltown	*Jersey Pond*	U	0.010	0.6	3.277	0.0056	1200	3.932	0.001	0.000		low flow	92	341
Morrisville	*Morrisville Pond*	U	0.000	0.9	4.200	0.0001	1200	5.04	0.000	0.000		low flow	85	463
Parker's Cove	*Big Pond*	R	0.130	1.2	2.700	0.1599	1200	3.24	0.049	0.200	1775			
Point May	*Shorts Pond*	U	0.100	1.0	2.250	0.1000	1000	2.25	0.044	0.000		low flow	8.5	404
Pool's Cove	*Widgeon Pond*	U	0.000	1.4	0.045	0.0004	1200	0.054	0.008	0.000		low flow	90	2
Port au Bras	*Gripe Cove Pond*	R	0.042	2.5	0.160	0.1050	1000	0.16	0.656	0.795	348			
Rushoon	*Northwest Pond*	U	0.000	2.7	6.790	0.0006	1200	8.148	0.000	0.000		low flow	4	1746
Seal Cove–White Bay		R	0.120	1.0	1.800	0.1224	1000	1.8	0.068	0.285	1405			
St. Bernard's(JF)		U	0.006	1.5	6.870	0.0090	1000	6.87	0.001	0.000		worst case	95	793
St. Lawrence	*St. Lawrence River*	U		2.0	45.000	0.0000	1000	45	0.000	0.000		low flow	10	12213
St. Lawrence Mines	*Clarke's Pond*	R	0.087	1.0	0.500	0.0870	800	0.4	0.217	0.630	690			
Terrenceville	*Harbour Brook*	U		1.0	2.380	0.0003	800	1.904	0.000	0.000		low flow	1	742

6.3.2 Groundwater Systems

Nine of the incorporated communities in the study area use groundwater supply systems, usually from private wells serving individual homes. A few community wells sometimes serve groups of homes. The town of St. Alban's has a full scale municipal supply/distribution system served by drilled wells.

Information on yields from groundwater supply systems during dry periods is not available, but an indication of reliability can be obtained from reported performance by the residents affected. The most recent dry year, 1987,[6-3] is often cited by residents if the system failed, and thus serves as an indicator of adequacy. A qualitative analysis based on the Inventory is shown in Table 6.3.

6.4 Results of Surface Systems

The results of the supply demand analysis are presented in Table 6.3. The communities with surface water supplies are grouped into three categories.

1. Communities with potential water supply shortages in dry years. These include

   (a) Baine Harbour
   (b) Bay L'Argent
   (c) Fox Cove/Mortier
   (d) Grand Le Pierre
   (e) Milltown
   (f) Pool's Cove

These are all unregulated systems.

Table 6.3
Results of Supply Demand Analysis

Surface Water Sources

Community	Population		Demand (m³/day)					Supply (m³/day)	Supply/Demand Ratio		Comments
			Domestic		Indust.	Total					
	1991	2016	1991	2016		1991	2016		1991	2016	
Baine Harbour	189	189	123	123	100	223	223	36	0.2	0.2	
Bay L'Argent	403	403	262	262	0	262	262	79	0.3	0.3	
Belleoram	639	811	415	527	500	915	1027	3097	3.4	3.0	
Burin/Lewin's cove	3549	3861	2307	2510	500	2807	3010	4775	1.7	1.6	no complaints
Conne River	108	188	70	122	0	70	122	1414	20.1	11.6	
Fortune	2177	2177	1415	1415	2273	3688	3688	4279	1.2	1.2	
Fox Cove-Mortier	464	464	302	302	0	302	302	219	0.7	0.7	
Garnish	716	716	465	465	27	492	492	1006	2.0	2.0	
Gaultois	516	516	335	335	104	439	439	2753	6.3	6.3	
Grand Bank	3528	3528	2293	2293	0	2293	2293	13178	5.7	5.7	
Grand le Pierre	356	356	231	231	0	231	231	22	0.1	0.1	new system
Harbour Breton	2418	2418	1572	1572	936	2508	2508	2574	1.0	1.0	
Hermitage	756	756	491	491	820.	1311	1311	1346	1.0	1.0	
Lamaline	482	482	313	313	0	313	313	1131	3.6	3.6	F.A. not in range
Lawn	1005	1005	653	653	124	777	777	13187	17.0	17.0	F.A. not in range
Marystown	6739	8112	4380	5273	3000	7380	8273	25000	3.4	3.0	
Milltown	1161	1161	755	755	0	755	755	341	0.5	0.5	F.A. not in range
Morrisville	201	201	131	131	0	131	131	463	3.5	3.5	F.A. not in range
Parker's Cove	441	541	287	352	0	287	352	1775	6.2	5.0	
Point May	435	435	283	283	0	283	283	404	1.4	1.4	
Pool's Cove	258	258	168	168	200	368	368	2			not adequate
Port au Bras	319	319	207	207	0	207	207	348	1.7	1.7	
Rushoon	482	482	313	313	0	313	313	1746	5.6	5.6	F.A. not in range
Seal Cove-White Bay	467	467	304	304	0	304	304	1405	4.6	4.6	
St. Bernard's(JF)	852	852	554	554	0	554	554	793	1.4	1.4	
St. Lawrence	1743	1743	1133	1133	1000	2133	2133	12213	5.7	5.7	
Terrenceville	818	818	532	532	0	532	532	742	1.4	1.4	F.A. not in range
TOTAL	31222	33259	20294	21618	9584	29878	31202	94328			

Groundwater Sources

Community	Population		Demand (m³/day)					Supply (m³/day)	Supply/Demand Ratio		Systems Identified as Questionable in Inventory
			Domestic		Indust.	Total					
	1991	2016	1991	2016		1991	2016		1991	2016	
English Harbour East	288	288	187	187	0	187	187	wells			questionable
Frenchman's Cove	229	229	149	149	0	149	149	wells			adequate
Little Bay East	201	226	131	147		131	147	wells			not adequate
Lord's Cove	329	329	214	214		214	214	wells			reasonable
Rencontre East	212	212	138	138	0	138	138	wells			not adequate
Red Harbour	252	329	164	214	0	164	214	wells			adequate
St. Alban's	1586	1586	1031	1031		1031	1031	wells			adequate
St. Jacques	701	701	456	456	0	456	456	wells			adequate
Winterland	272	419	177	272	0	177	272	wells			pollution
TOTAL	4070	4319	2646	2807	0	2646	2807				

* Note: Population Demand Factor = 0.65 m3/day per capita

2. Communities with adequate water supplies, but with no major surplus. These include

		S/D ratio
(a)	Burin/Lewin's Cove (R)	1.6
(b)	Fortune (R)	1.2
(c)	Garnish (R)	2.0
(d)	Harbour Breton (R)	1.0
(e)	Hermitage (R)	1.0
(f)	Marystown (R)	3.0
(g)	Point May (U)	1.4
(h)	Point au Bras (R)	1.7
(i)	St. Bernards/Jacques Fontaine (U)	1.4
(j)	Terrenceville (U)	1.4

3. Communities with abundant water.

All remaining communities.

The communities in Groups 1 and 2 (i.e., without abundant water) are discussed in more detail below. Complete details on the water supply systems for all communities, including Group 3, are provided in the Inventory.

6.4.1 Group 1: Communities with Potential Water Supply Shortages

The six communities with surface water supplies which may experience shortages in dry years are Baine Harbour, Bay l'Argent, Fox Cove/Mortier, Grand Le Pierre, Milltown and Pool's Cove. Several of these communities are presently improving their water supply systems, and the analysis presented here assumes new or proposed systems are in place. Even with the improvements, the results indicate that the systems will fail in dry years.

Because of the uncertainty inherent in a regional analysis, we recommend that careful monitoring begin immediately in these communities to obtain site specific data on water availability and consumption. If the new data confirms the potential for shortages, it may be possible to upgrade the new systems before construction is complete.

A brief review of each system is given below.

(a) Baine Harbour

To date Baine Harbour has relied on wells for water supply with an ad-hoc distribution network of small diameter pipes. These systems have proved inadequate, and in 1992 Baine Harbour Pond was selected as a surface water supply source. Since the catchment area is small (17 ha), the natural flow during dry periods is low; the seven day 1 in 10 year low flow, as estimated from the low flow frequency equations, is 36 m^3/day. For a population of 189, the domestic consumption is estimated to be 123 m^3/day. If the fish plant is operating, the consumption will increase to over 200 m^3/day. The fish plant demands are relatively low because the plant uses salt water for processing. The supply is likely to be inadequate, as shown below.

Estimated Demand (m^3/day)			Estimated Supply	Supply/Demand
Domestic	**Industrial**	**Total**	**(m^3/day)**	**Ratio**
123	100	223	36	0.16

Based on a reconnaissance walkover carried out during the **Inventory**, it appears that it is feasible to construct a dam on the pond to increase live storage by about 1 m. This additional storage should make the supply adequate. Raising the water levels with a dam should also improve water quality by reducing the amount of bottom sediments stirred up by wave action.

Recommendations for Baine Harbour are

1. monitor present use to verify demands;
2. monitor outflows and levels at Baine Harbour Pond to provide better estimates of inflows;
3. if monitoring confirms that shortages may occur, as indicated above, then consider incorporating a dam into the proposed design;
4. ensure that good water quality is maintained in the harbour so that the fish plant can continue to use saltwater for processing.

(b) Bay L'Argent

Bay L'Argent has embarked upon the construction of a new main water distribution system supplied from a brook. The new supply is taken from a concrete tank, which captures flow from an upstream watershed.

The drainage area is small (91 ha), and the regional low flow equations indicate that the supply is inadequate to meet the demand, as shown below.

Estimated Demand (m^3/day)			Estimated Supply	Supply/Demand
Domestic	Industrial	Total	(m^3/day)	Ratio
262	0	262	79	0.30

The concrete tank provides less than two days of storage, which could be depleted during dry weather or fire fighting.

It is recommended that the system be monitored by measuring the levels in the tank and by metering and recording the usage regularly.

(c) Fox Cove/Mortier

For many years Fox Cove/Mortier has relied on dug and drilled wells for supply. In 1992 it started to replace groundwater sources by constructing a main water distribution system supplied from Deep Pond.

The daily yield of 219 m^3/day was determined using the low flow equations assuming the new supply is in place. This supply is lower than the estimated demand of about 300 m^3/day (i.e., S/D = 0.7).

The **Inventory** indicated that the storage in the pond could be increased by 1 m by constructing a dam. If this option were chosen, then the resulting supply would be more than adequate to meet the demand.

The recommendations for Fox Cove-Mortier are to

1. monitor the new system to determine in-service effectiveness to meet the demands of the community;

2. maintain the existing groundwater supply sources until the new system proves its adequacy.

(d) Grand Le Pierre

Grand Le Pierre is presently supplied from Line Pond, which has serious water quality problems. A new dam is being built on the feeder brook to Line Pond. The catchment area is small (26 ha), however, and the new storage volume is expected to be only about 1,000 m^3. This will not significantly improve the regulation.

The estimated supply and demand are as follows.

Estimated Demand (m^3/day)			Estimated Supply (m^3/day)	Supply/Demand Ratio
Domestic	Industrial	Total		
231	0	231	22	0.1

The recommendations for Grand Le Pierre are to

1. monitor present use and water levels;
2. investigate the possibility of diversion from an adjacent catchment to augment supply (including the possibility of storage on the adjacent catchment).

(e) Milltown

Milltown is supplied by a small reservoir behind a dam. The system is being upgraded primarily to improve water quality. The daily yield as estimated from the low flow equations is about 340 m^3/day, considerably less than the estimated demand of about 750 m^3/day. (This demand rate is supported by several measurements made in 1990.)

The community has reported that the supply has always proved adequate, even in the dry year of 1987. The discrepancy may either be due to the uncertainties of the low flow equations, or perhaps a conscious reduction of water use by the residents during dry periods.

The recommendation for Milltown is to meter water usage and, in addition, to monitor and record the reservoir water levels to estimate spill.

(f) Pool's Cove

Pool's Cove obtains its water from Widgeon Pond, a very small pond (300 m^2) with a drainage area of only 4.5 ha. This area is too small to provide the estimated domestic demand of 168 m^3/day. In dry periods, water is rationed, or water is pumped into Widgeon Pond from a pond about two kilometres distant.

The problem has been recognized for some time, and DMPA has commissioned a study to evaluate alternatives. Possible solutions are presented in the **Inventory**.

6.4.2 Group B: Communities with Adequate Supplies, No Excess

These communities have adequate water supplies, but if major additional development is anticipated, the water demands and availability should be carefully evaluated in case new supplies are required.

The supply/demand analyses are presented in Table 6.3; a brief description of each situation is presented below.

(a) Burin/Lewin's Cove

Burin, Salt Pond and Lewin's Cove are served by two systems, Long Pond and Mortier Big Pond. Long Pond was the original source and always provided an adequate supply (to 1982), but as the region developed an additional source was required.

The two systems can be interconnected if required. Since the supply/demand analysis is concerned with unusual low flow periods, the two systems were treated together.

The total yield is estimated to be 4,770 m^3/day, and the demand is estimated at about 3,000 m^3/day, assuming about 500 m^3/day for the fish plant. The resulting supply/demand ratio is about 1.6.

No shortages have been reported, and the community does not expect any in future. If additional water is required due to some unusual and unexpected development, several options are presented in the **Inventory**.

(b) Fortune

Fortune's water supply comes from Horse Brook Pond, a small pond formed by damming a brook. The main reserve reservoir for the system is upstream, at the second dam. A salt water line was installed in the early 1980's for fish plant use.

The supply/demand situation is very dependent on fish plant use. The supply can support typical fish plant use of nearly 2,300 m^3/day, but the supply/demand ratio is only 1.2. Considering the long term average fish plant use in the range of 500 m^3/day (current) to 900 m^3/day (previous), the system is quite adequate, with a supply/demand ratio in the range of 1.8 to 2.2.

(c) Garnish

Part of the town of Garnish is supplied by Wych Hazel Pond; the remainder will be supplied when the distribution system is complete.

With a supply/demand ratio of 2.0, the system should be adequate to serve the whole community and a poultry farm (the only industrial user). If a larger supply is required, a dam could be constructed to provide more storage on the pond.

(d) Harbour Breton

Harbour Breton obtains its water from two ponds, a main reservoir, Hutchings Pond, and a backup at Connaigre Pond. Although the drainage areas are less than 1 km² each, storage has been developed in Hutchings Pond, which improves the yield considerably.

The total supply from the two ponds is estimated to be about 2,570 m³/day. With a domestic and fish plant demand totalling about 2 500 m³/day, the supply/demand ratio is approximately 1.0.

No shortages have been reported, and the community does not anticipate any changes.

(e) Hermitage

The Hermitage water supply has a somewhat different arrangement than most others. The intake is located in a small area ponded behind a dam. The main storage is two upstream ponds, joined by a submerged conduit. Although the drainage area is very small (80 ha), the storage is sufficient to provide an estimated reliable yield of about 1,350 m³/day. This is just adequate to satisfy the peak year demand of 1,310 m³/day on the average. About 60 - 65 percent of the demand is estimated to be from the fish plant. No shortages have been reported.

(f) Marystown

Marystown is supplied by a small reservoir at Fox Hill, which in turn is supplied by two ponds in adjacent catchments. The first supply pond is Linton Lake; water is pumped from Linton Lake to the intake at Fox Hill. Linton Lake is supplemented by pumping from Clam Pond.

Clam Pond has a storage volume of over $3 \times 10^6 m^3$, and its drainage area is nearly 14 km², compared with a volume of about $1.9 \times 10^6 m^3$ for Linton Lake and a drainage area of about 5.5 km². The total supply is of the order of 25,000 m³/day. This supply is well in excess of the expected demand of 8,300 m³/day.

At present the system appears to be adequate, with the one caution that the pumping capacity from Clam Pond to Linton Lake, at about 17,000 m^3/day is significantly less than the total supply of 25,000 m^3/day. The town may be required to increase this pumping capacity if the total demand meets or exceeds the previous peak annual demand of 16,700 m^3/day.

(g) Point May

Point May takes its water from a small shallow pond; it is essentially a run-of-river system. Because the watershed area is reasonably large (225 ha) and the community is small (population 435),. the system is adequate to meet the demands, with a supply/demand ratio of 1.4.

(h) Port au Bras

Port au Bras obtains its water from Gripe Cove Pond. Although the drainage area of 16 ha is small, there is good storage in the pond. The supply is adequate for the community's needs, with supply/demand ratio of 1.7.

(i) St. Bernard's/Jacques Fontaine

St. Bernard's has recently constructed a new dam to improve its supply from Rattle Brook. Jacques Fontaine is presently connecting to this supply. The dam creates a small headpond, so the system is essentially run-of-river. The watershed area is relatively large (627 ha), however, so the supply should be adequate for both communities.

(j) Terrenceville

Terrenceville obtains its water from a run-of-river system on Harbour Brook, which drains an area of 238 ha. Because there is no controlled storage, the estimates of reliable yield used for the supply/demand analysis in Table 6.3 are based on the low flow equations. These lead to a S/D of 1.4. The system is reported to have failed in 1987, the most recent dry year.

Above the abstraction dam is a large uncontrolled pond, Harbour Brook Pond, and when the system failed in 1987, the community simply pumped from this pond. This pond is likely already providing a considerable amount of natural regulation, and if a more secure system is required, some control could be placed at the outlet.

If the community anticipates connecting more homes to the surface system, the recommendations for Terrenceville are

1. meter the existing use;

2. consider establishing a permanent control at the outlet of Harbour Brook Pond.

6.5 Groundwater Systems

6.5.1 Communities with Adequate Supply

The following communities have a reasonable supply of groundwater.

- Frenchman's Cove
- Lord's Cove
- Red Harbour
- St. Alban's
- St. Jacques - Coombs Cove

6.5.2 Communities with Inadequate Supply

The following communities have inadequate or questionable groundwater supplies.

English Harbour East

Presently has a mixed surface/groundwater system. The community is moving to a system of drilled wells, each supplying a few houses, which is expected to be adequate.

Little Bay East

The local supplies are inadequate and the Council has proposed a study for municipal services.

Rencontre East

A study is already underway; a surface source seems likely but no final details are available.

Winterland

The supply is adequate but some wells are contaminated, apparently from domestic sewage. The present plans are to use existing clean wells, and drill others in unpolluted areas. This action should alleviate the problem.

6.6 Value of Water Supply Systems

The value of the water systems, as presented in Table 6.4, is based on an accepted average value of $20,000 per service connection. The communities listed are those which are supplied by surface water systems only. Groundwater supply distribution systems have not been developed to an extent which would allow their value to be quantified.

The number of connections listed for each community represents, in most cases, the estimated number of existing houses supplied by the distribution system. In those communities where the construction of the entire distribution system is nearing completion, this number represents the proposed number of connections.

Table 6.4
Value of Municipal Water Systems

Community	Approximate Number of Connections	Approximate Value
Baine Harbour	58	$1,160,000
Bay L'Argent	145	$2,900,000
Belleoram	141	$2,820,000
Burin/Lewin's Cove	1240	$24,800,000
Conne River	200 *	$4,000,000
Fortune	726	$14,520,000
Fox Cove–Mortier	142	$2,840,000
Garnish	131	$2,620,000
Gaultois	30	$600,000
Grand Bank	1272	$25,440,000
Harbour Breton	628	$12,560,000
Hermitage	171	$3,420,000
Lamaline	163	$3,260,000
Lawn	271	$5,420,000
Marystown	1930	$38,600,000
Milltown	281	$5,620,000
Morrisville	45	$900,000
Parker's Cove	53	$1,060,000
Point May	65	$1,300,000
Pool's Cove	73	$1,460,000
Rushoon	145	$2,900,000
St. Bernard's(JF)	214 *	$4,280,000
St. Lawrence	525	$10,500,000
Terrenceville	194	$3,880,000

TOTAL **$176,860,000**

* Proposed number of connections

7 - Overall Water Resource Assessment

7 Overall Water Resource Assessment

The previous chapters described the water resource in terms of the availability of water (Chapters 2 and 3), quality of water (Chapter 4), instream uses (Chapter 5) and the supply and demand situation for communities and industries (Chapter 6). This chapter provides an overall assessment of the water resource, considering all those separate components.

The study area was broken down into four sub-areas or regions as shown in Figure 7.1, following geographical and hydrological boundaries, and taking into account population clusters. The regions are

1. Bay d'Espoir Basin - the entire drainage area supplying the hydroelectric generation station at Bay d'Espoir.

2. Fortune Bay North - all the area draining into the northern part of Fortune Bay, from the Connaigre Peninsula to Terrenceville.

3. Burin Peninsula North - from Piper's Hole River to the knee of the Burin Peninsula (Red Harbour/Rushoon).

4. Burin Peninsula South - the remaining area on the southern part of the Burin Peninsula, including Marystown, Grand Bank and Burin.

This assessment examines the present water resource situation by sub-area for each of the following factors

- availability;
- supply/demand situation;
- instream uses;
- potential conflicts.

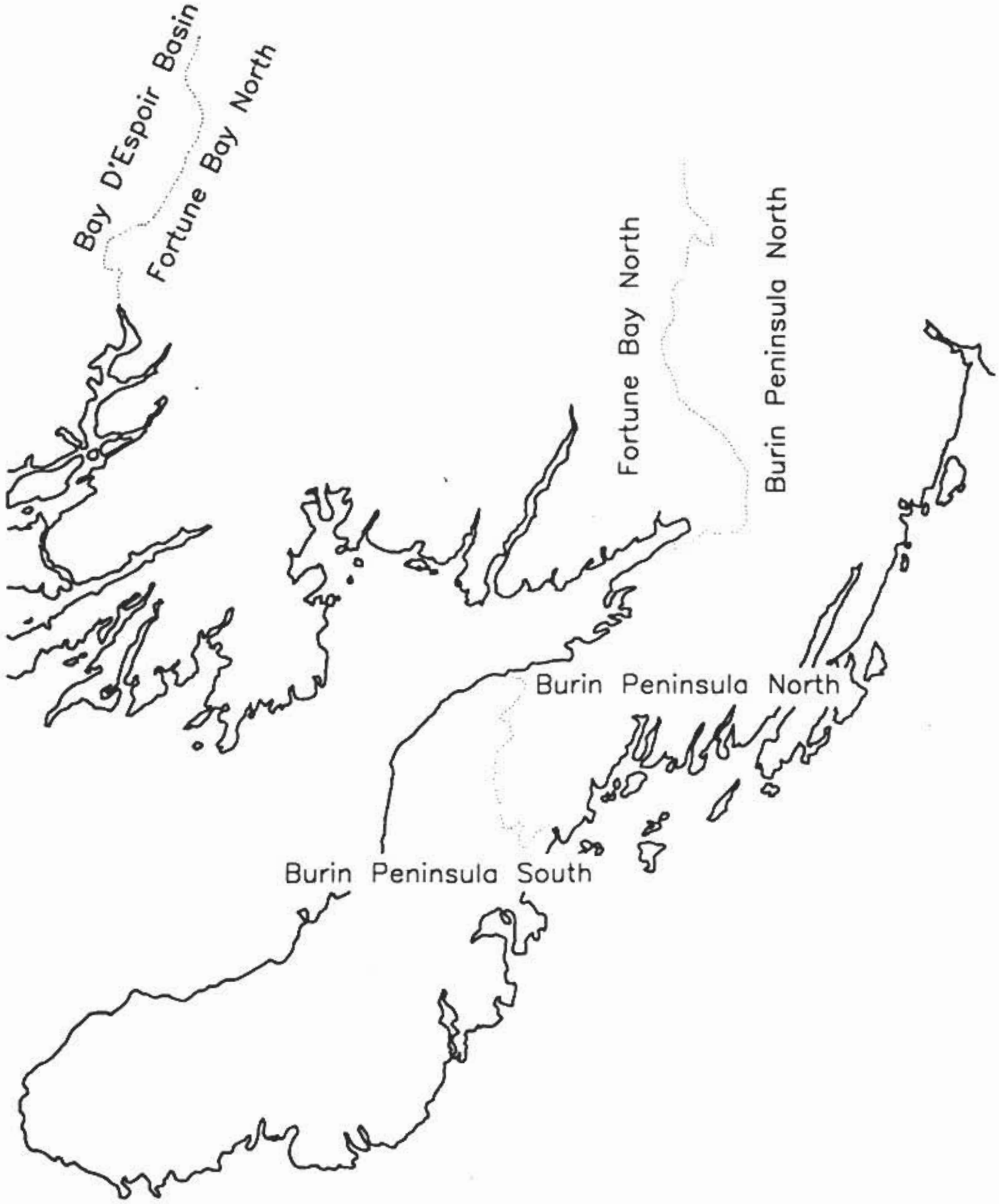

FIG. 7.1

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Regional Boundaries

ACRES

Table 7.1 summarizes the findings of this study as they relate to the various factors for each subarea. The following sections discuss regional similarities and differences, and provide an overall assessment.

7.1 Availability

All subareas have abundant surface water of similar quality. None has abundant groundwater. The Burin Peninsula subareas, both north and south, are slightly wetter, with average specific runoffs of 0.037 and 0.035 m^3/s per km^2, compared with 0.034 and 0.033 m^3/s per km^2 for the Fortune Bay North and Bay d'Espoir areas. Within the Fortune Bay area, it may be noted that the Connaigre Peninsula and surrounding coastal area is quite wet (see Chapter 2).

7.2 Supply/Demand

Most communities are adequately served by their water supply systems, but few have a great excess. Despite the general abundance of water, the coastal location of most communities puts them at an uneconomic distance from inland surface supply sources. Development of storage has allowed many of them to obtain an adequate yield from relatively small surface sources.

Fortune Bay North:

Three of the eleven communities in this region which utilize surface water sources are classified as having potential water supply shortages in dry years. These include Grand Le Pierre (S/D = 0.1), Milltown (S/D = 0.5), and Pools Cove (S/D ≈ 0). This region also has the lowest overall S/D ratio of 1.8. These observations indicate that the Fortune Bay North region has the greatest requirement for further water supply investigations.

Table 7.1
Subarea Assessment

	Bay d'Espoir	Fortune Bay North	Burin Pen. North	Burin Pen. South
Availability				
General	Abundant	Abundant	Abundant	Abundant
Average Specific Runoff (m^3/s per km^2)	0.033	0.034	0.037	0.035
Supply/Demand				
Population	-	10,000	3,000	22,000
Total Supply (m^3/day)	-	14,159	4,429	75,740
Total Demand (m^3/day)	-	7,728	1,704	21,771
Overall S/D Ratio	-	1.8	2.6	3.5
Communities with Inadequate Supply (Surface Water = S) (Groundwater = G)	-	Pool's Cove (S) Grand Le Pierre (S) Milltown (S) Rencontre East (G)	Baine Harbour (S) Bay L'Argent (S) Little Bay East (G)	Fox Cove (S) Winterland (G)
Instream Uses				
Power Generation	Highly developed for hydro, some additional generation potential.	None at present, one possible small scale project.	One small existing project, one possible small scale project.	Three existing small projects, little additional potential.
Tourism Fisheries	Local Angling	7 scheduled salmon rivers, local angling, 1 Provincial Park.	7 scheduled salmon rivers, local angling, 1 Provincial Park.	16 scheduled salmon rivers, local angling, 3 Provincial Parks.
Wildlife Fisheries	-	Large area of wilderness and wildlife reserve.	-	-
Potential Conflicts	Hydro/-Fisheries	Low	Low	Moderate

Burin Peninsula North:

The S/D ratio of 2.6 indicates that there is no major concern about surface supply sources. Baine Harbour (S/D = 0.2) and Bay L'Argent (S/D = 0.3) are the only communities with surface water deficiencies.

Burin Peninsula South:

The supply/demand analysis demonstrates that water supply systems are quite adequate in this area. The overall S/D ratio of 3.5 is good, and the only community with an insufficient surface water system is Fox Cove - Mortier (S/D = 0.7).

Those communities that rely on groundwater are more likely to experience shortfalls; about a third of communities with groundwater sources report inadequate yield.

7.3 Instream Uses

The instream uses vary among subareas. All areas except Fortune Bay North have at least some **hydroelectric development**, and there is one potential small hydro project in that region. In the Bay d'Espoir area, however, the use of water for hydroelectric generation predominates; in fact, the basin exists in its present form because of diversions made to enhance generation. The hydroelectric stations in the other subareas are orders of magnitude smaller.

Recreational use is most important in the Burin Peninsula areas, particularly Burin Peninsula north. Piper's Hole Provincial Park provides a focus for recreation, and in addition there is considerable angling and informal camping on or near the numerous ponds and brooks throughout the subarea. In the Burin Peninsula south subarea, recreational use tends to be focused in cottage areas (e.g., around Grand Beach) and developed facilities (e.g., Golden Sands). The recreational salmon fishery is important in all areas, perhaps especially in the Fortune Bay North area, which has a few large scheduled salmon rivers and in the Burin Peninsula South area which has several smaller salmon rivers.

Conservation uses predominate in the Fortune Bay North area because of its remoteness. Over 3,500 km^2 has been declared wilderness or wildlife reserve. Much of the Bay d'Espoir area is also remote, and although it has not been declared a reserve it does provide a wildlife conservation function.

The two Burin Peninsula subareas are generally quite accessible throughout, and consequently do not provide much opportunity for conservation.

7.4 Potential Conflicts

Bay d'Espoir Subarea:
At present most of the study area is sparsely populated. The low population, the relative abundance of the resource, and the static economic base have meant that there are few conflicts among water uses.

The original development of the Bay d'Espoir system in the late 1960's for hydroelectric generation has affected the freshwater environment, but litle information is available to quantify effects. As it presently exists, the development is a popular area for fishing and hunting.

With adequate habitat protection measures, the principal potential negative effect on aquatic biota results from large scale flooding. Future proposed projects in the Bay d'Espoir area require relatively little flooding, and would be subject to DFO approval. Consequently, no major conflicts among water users would be expected.

Fortune Bay North:
Because of its general inaccessibility, there appear to be few conflicts at present. With its attractiveness for recreation, particularly salmon fishing, conflicts are possible between recreation and conservation.

Burin Peninsula (North and South):
Conflicts in these regions are likely to be relatively small and local, e.g., cottages/protected watersheds, small hydro/fishery conservation. Since there may

be related beneficial uses, e.g., hydro/recreation, conflict resolution may require compromises among several parties.

There are two areas in the Burin Peninsula South region classified as designated cottage areas by the DOEL. These areas include a series of cottages on the L'Anse Au Loup Brook and Salmonier Pond near St. Lawrence. Neither of these cottage areas are within the bounds of the drainage basins used for water supply as identified in the **Inventory**.

8 - Conclusions and Recommendations

8 Conclusions and Recommendations

8.1 Conclusions

8.1.1 Availability

- The region, in general, has abundant surface water resources. The average annual runoff is high, about 1,100 mm per year. Runoff in many areas is relatively evenly distributed through the year. Natural dependable flows tend to be low, but reliability can often be improved with relatively small amounts of storage.

- The Provincial Hydrometric Network provides valuable data on small drainage basins, although records are still quite short.

- No data are available for the Fortune Bay North area from Bay du Nord to Piper's Hole River, hence, this area could not be adequately analyzed.

- Confined aquifer yield rates are a function of local geologic discontinuities rather than regional geologic stratigraphy. This makes the reliable prediction of high yield drilled well locations difficult.

- Groundwater can be a good source for a few homes, and several wells can combine to form a reasonable supply for a community. In general, however, groundwater cannot be expected to be a major water resource.

8.1.2 Water Quality

- Most surface water sources can be characterized as high in iron, manganese and DOC concentrations. The most common complaints of residents are aesthetic, relating to taste, odour and colour.

- Concentrations of fluoride at St. Lawrence, Parkers Cove and English Harbour East exceed drinking water guidelines.

- Other than the possibility of local point sources of pollution, the main future water quality concern is deterioration from atmospheric deposition (e.g., acid rain).

8.1.3 Instream Uses

- Hydroelectric power production is the major instream use. It averages about 3,100 GWh per year, with a value of approximately $87 million. There is potential for additional generation, principally within the Bay d'Espoir system, with the possibility of one or two small projects elsewhere.

- Tourism/recreation as well as fisheries/wildlife conservation are the other major instream uses. Recreation and conservation are not always compatible uses, and require careful planning and management.

8.1.4 Withdrawal Uses

- Despite the general abundance of water, about ten communities occasionally experience shortages, due to the fact that they are located at uneconomic distances from good sources. In some of these communities, improvements are planned or are underway, but even with these, shortfalls may occur.

- Overall, only 40 percent of the communities in the study region are classified as having abundant water supply systems. The few communities with large surpluses are primarily benefiting from the storage of developed hydropower systems.

8.2 Recommendations

8.2.1 Availability

- Provincial and federal hydrometric networks are very important in providing data to assess the availability of water. Governments must put a high priority on maintaining high quality continuous flow records.

- At least one or two streamflow and climate stations should be established in the Fortune Bay north area (between Bay du Nord and Piper's Hole). Because of the necking of the entrance to Fortune Bay, the orographic effect of the steep coast, and the jagged topography of the coastline (e.g., Long Harbour fjord), the distribution of rainfall and runoff is difficult to estimate.

- A data collection and analysis program should be undertaken to investigate precipitation/runoff relationships along the south coast.

8.2.2 Water Quality

- A program should be implemented to increase the total number of chemical analyses performed on drilled well water samples. The parameters tested should be expanded to include bicarbonate and mercury.

- Water quality at the end of the distribution system (i.e., at the tap) should be analyzed for metals, particularly in locations with low alkalinity and pH. Depending on the results, some treatment may be required. Government is also aware of the possibility of the formation of trihalomethanes when chlorine is used in organic rich environment, and should regularly test for the presence of THM's where such conditions exist.

- High fluoride concentrations in the waters at St. Lawrence, Parker's Cove and English Harbour East should be investigated, and appropriate action taken if required.

8.2.3 Instream Uses

- All the present instream uses bring economic and other benefits to the region, without major conflicts to date because the uses are widely dispersed. Government should undertake such studies and planning as are required to ensure that when conflicts do arise, the decisions are made on a sound rational basis for the greatest public good.

8.2.4 Withdrawal Uses

- The government should immediately review the water supply systems in communities identified as having potential shortages. This is particularly important in those communities where improvements are presently planned or underway.

- The Water Resources Division of the Department of Environment and Lands should work with the Department of Municipal and Provincial Affairs to help ensure that proposed water supply schemes will be sufficient.

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List of References

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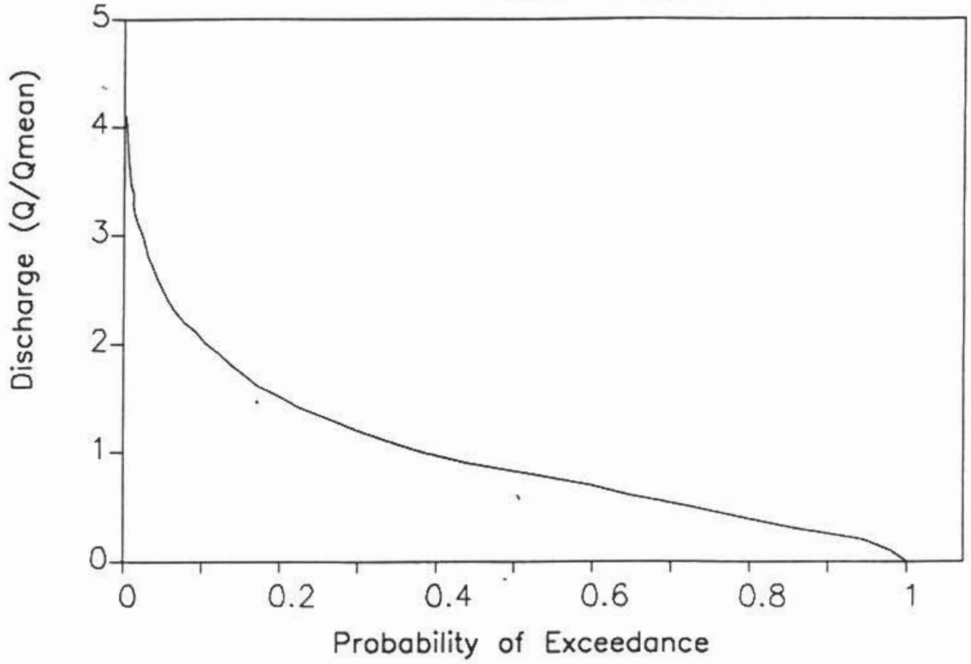
Appendix A
F-D Curves

Salmon River at Long Pond
Period of record: 1944 – 1964



Salmon River at Round Pond
Period of Record: 1966 – 1979, 1981

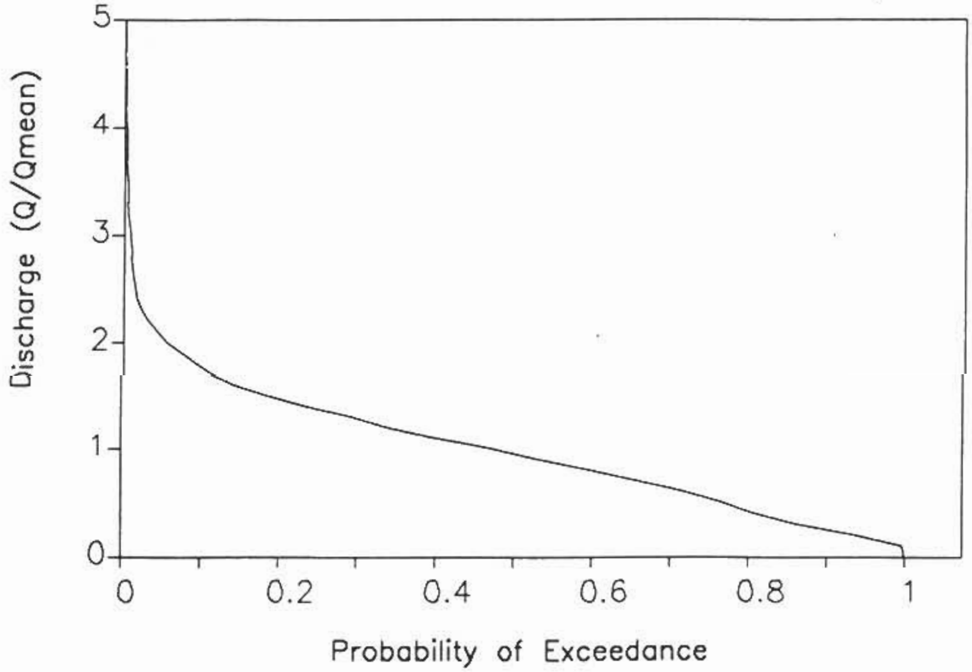
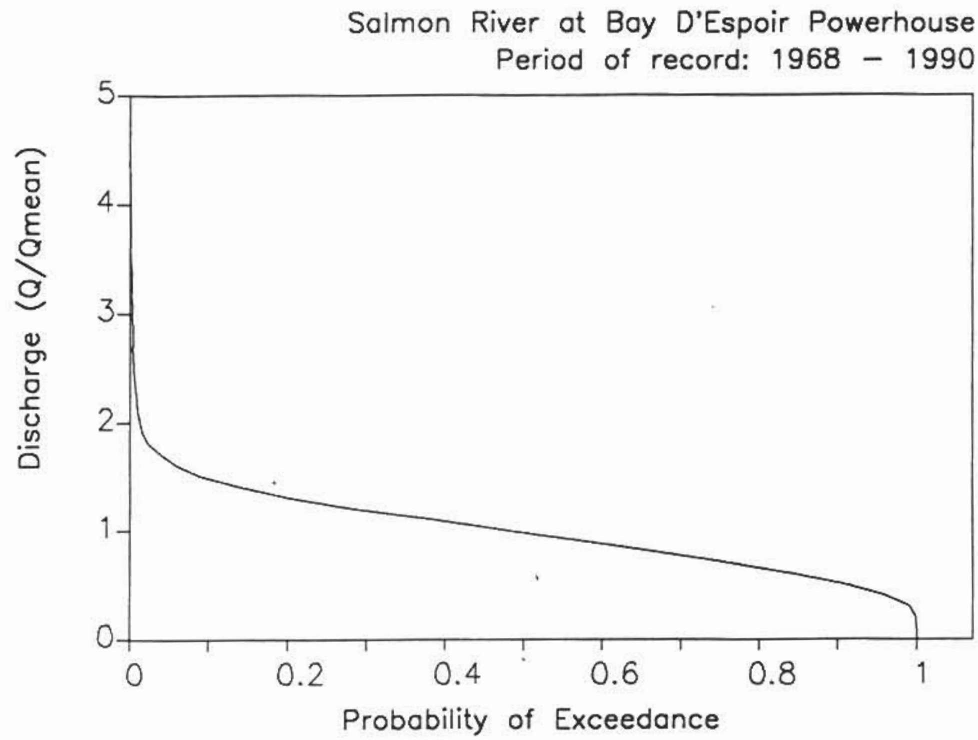


FIG. A–1

Department of Environment and Lands
Water Resources Division

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Flow Duration Curves

ACRES



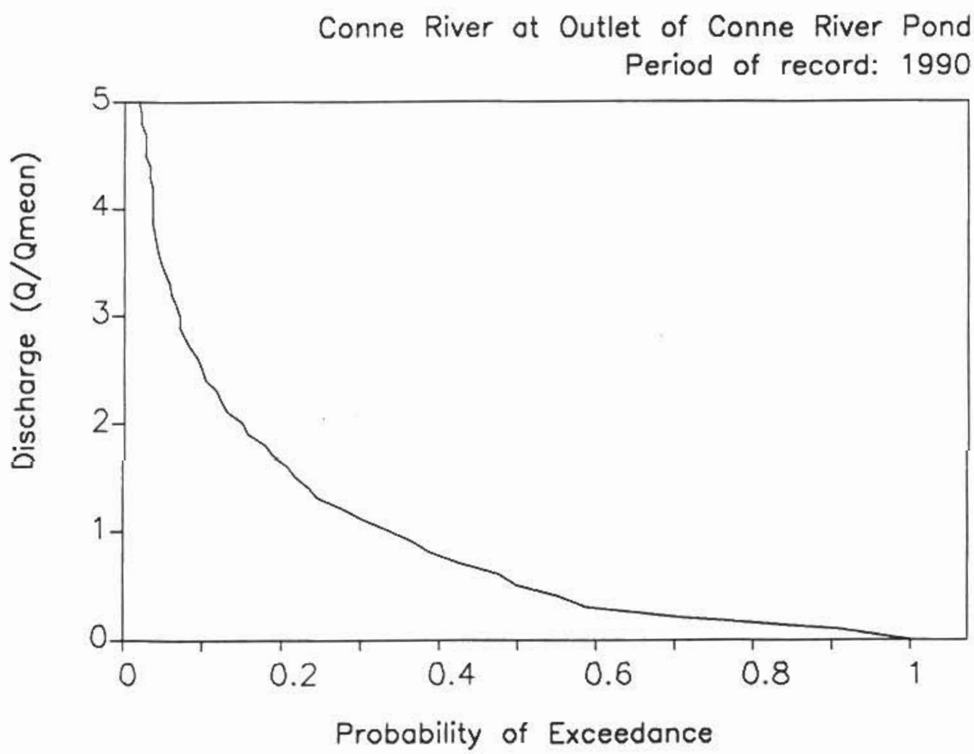


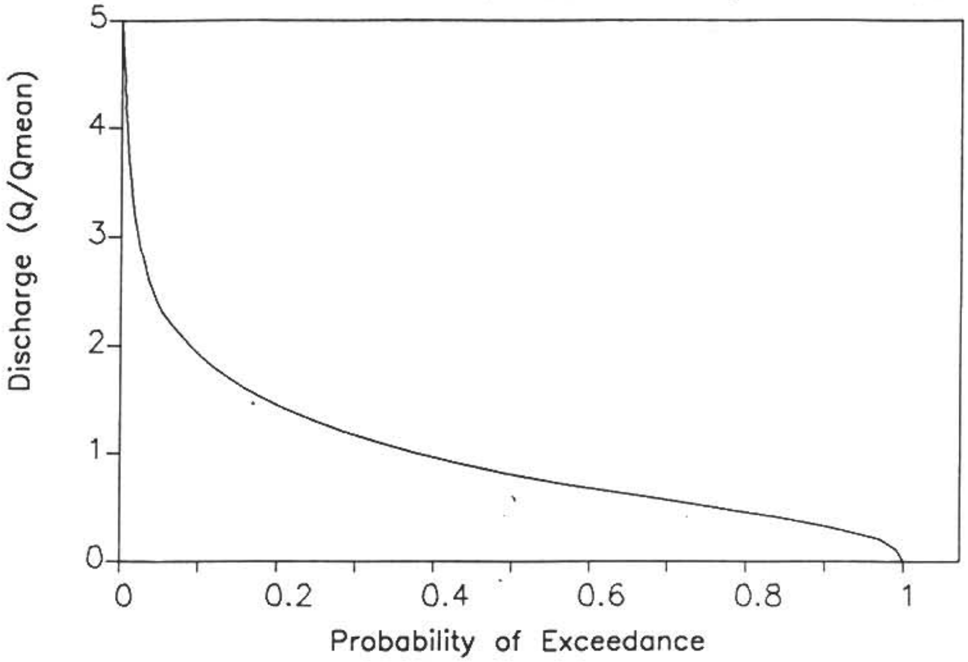
FIG. A–2

Department of Environment and Lands
Water Resources Division

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Flow Duration Curves

ACRES

Bay Du Nord River at Big Falls
Period of record: 1952 - 1979, 1981 - 1990



Garnish River near Garnish
Period of record: 1959 - 1990

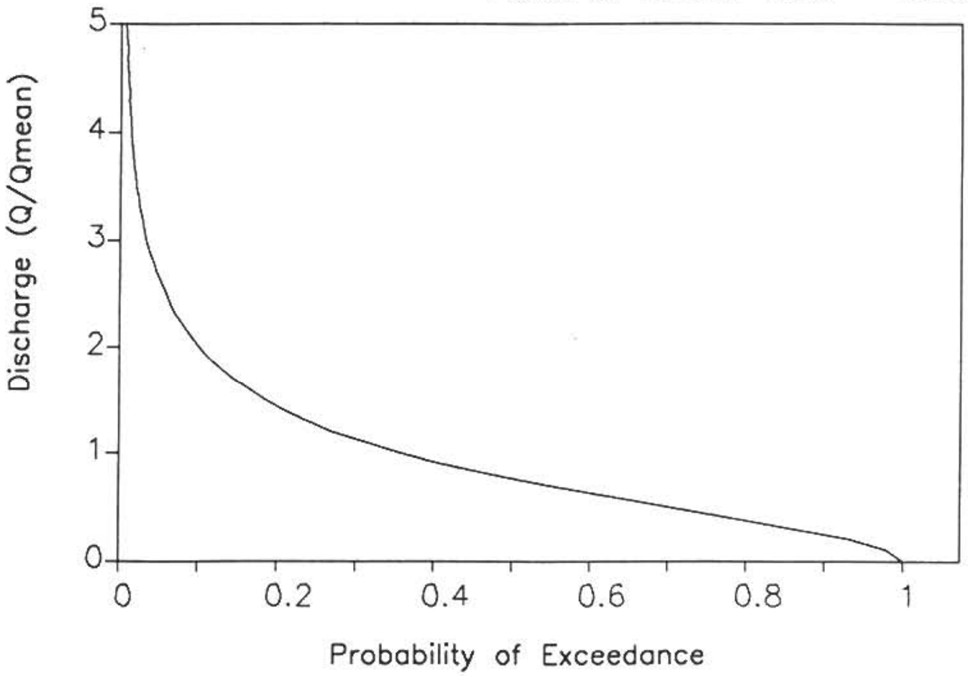
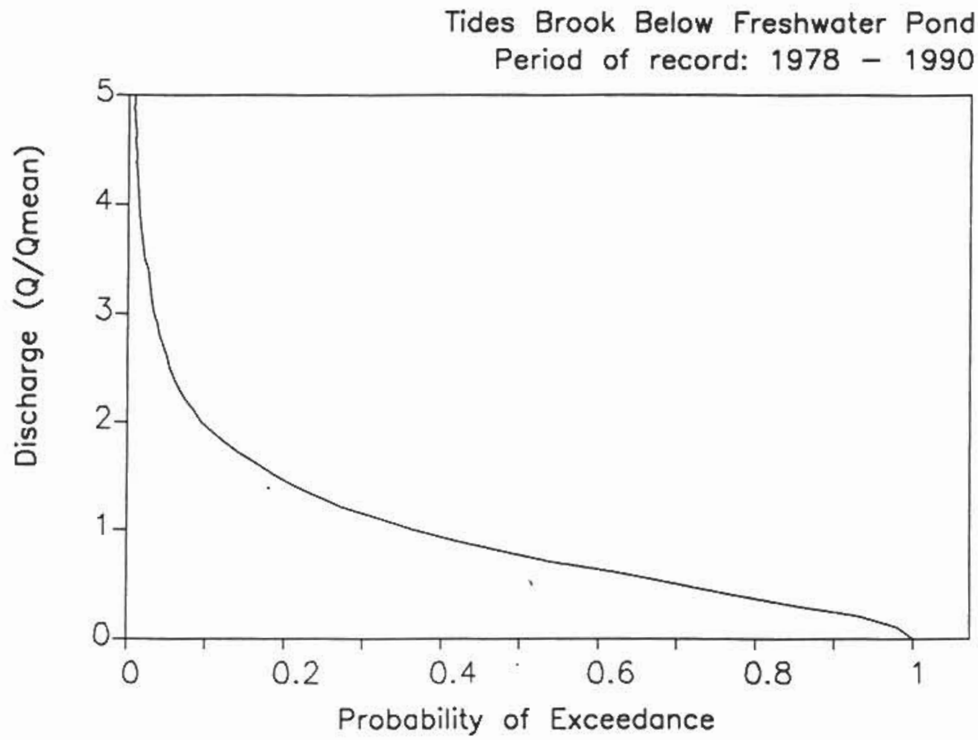


FIG. A-3

Department of Environment and Lands
Water Resources Division

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Flow Duration Curves

ACRES



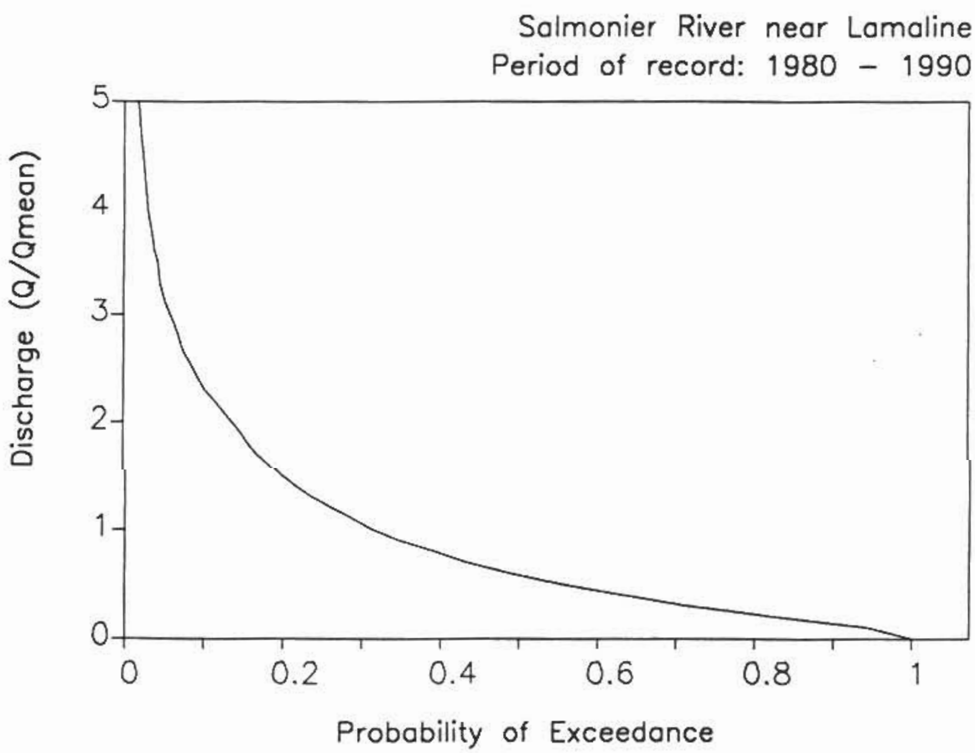
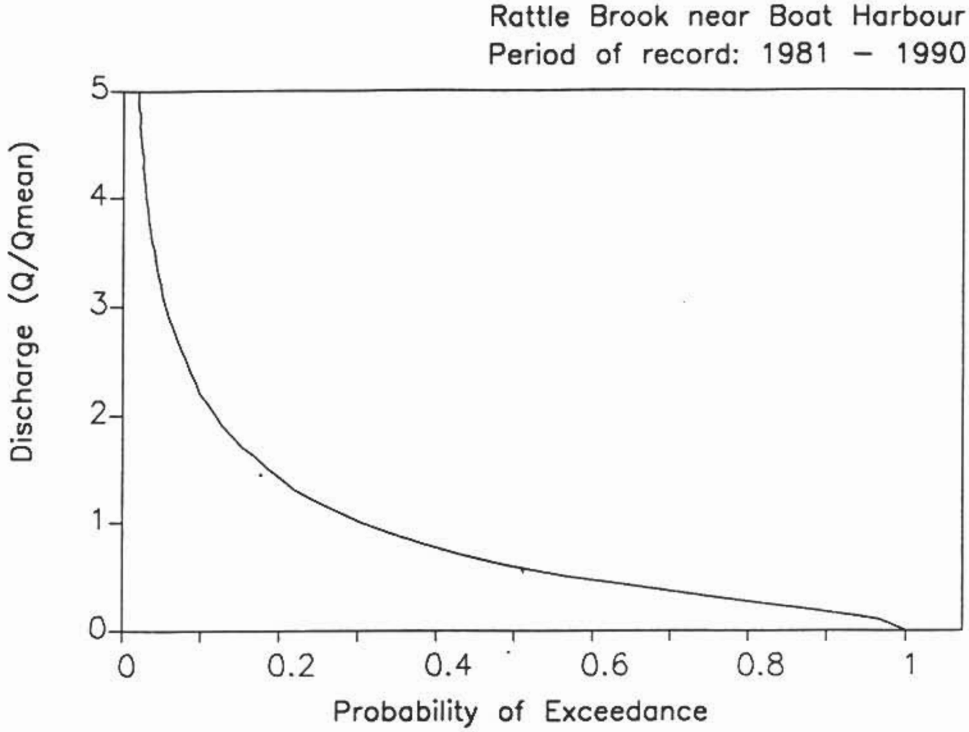


FIG. A–4

Department of Environment
and Lands
Water Resources Division

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Flow Duration Curves

ACRES



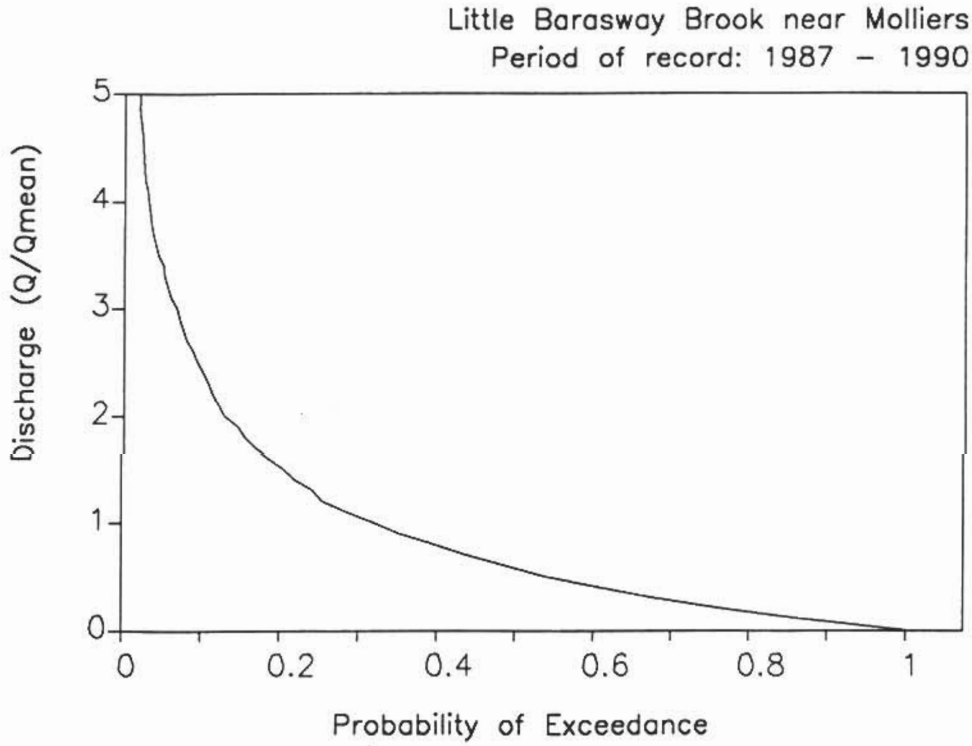
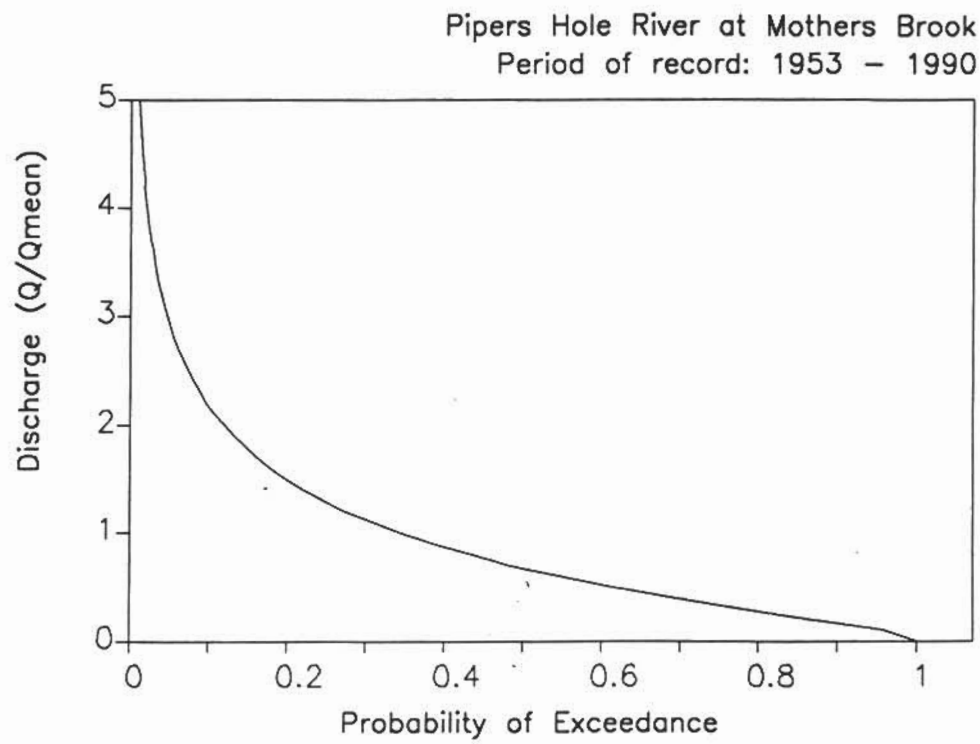


FIG. A–5

Department of Environment and Lands
Water Resources Division

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Flow Duration Curves

ACRES



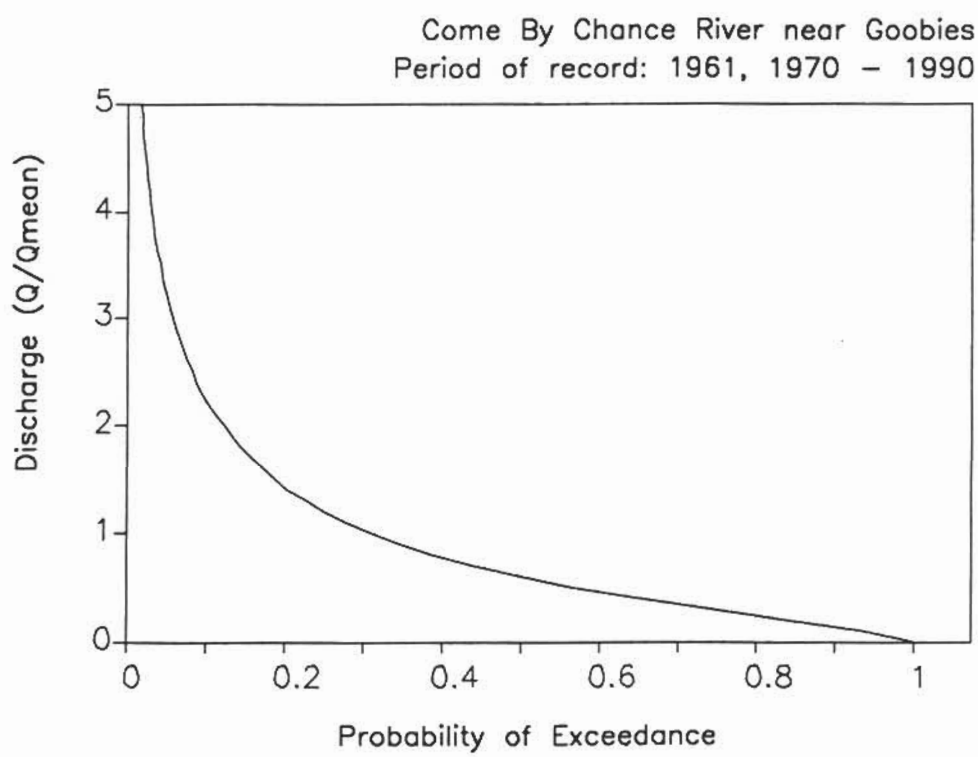


FIG. A-6

Department of Environment
and Lands
Water Resources Division

Regional Water Resources Study
Burin Peninsula and Fortune Bay Area
Flow Duration Curves

ACRES

Appendix B
Municipal Water Quality

Municipal Water Quality

There are three sources of water available to residents of the study area. Historically, residents have relied on individual surface dug wells to meet their water requirements. Recently, however, there has been an effort to improve water quality through the use of impoundment of lakes and rivers and through drilled wells to access deep aquifers. Each of these options has advantages and disadvantages.

A surface well is more susceptible to surficial contamination from sewage and other anthropogenic actions than are deep drilled wells. Also, if the quality of the groundwater is poor, it is not economically practical to treat the water. Surface wells are not recommended for larger population areas due to the high demand on the near-surface aquifer.

Drilled wells in the study area tend to have low yields. This limits the number of houses which can use a single well thereby increasing the cost. Also, if treatment is required, it is not practical if there are too many wells. Nonetheless, drilled wells generally yield good quality water.

Surface waters are increasingly becoming the most prominent water supply system in the area. Most surface water in the study area has high colour values indicating potential problems with organics and iron concentrations. Dissinfection, when applied, is by chlorination in all supplies in the area. Chlorination of water with high organic contents can result in the formation of THM's.

The following table lists each community along with the main water supply source and residential concerns for water quality, based on data obtained as part of the **Inventory**. The most common complaints appear to be colour, odour, and poor taste.

Table B-2
Municipal Water Quality Summary

Community	Main Water Source	Water Quality
Baine Harbour	Historically dug wells with high bacteria counts.	Pond water good in winter, but often has high bacteria counts, sediment, and odour in summer (i.e., vegetation). High colour, turbidity, and poor taste at certain times of year.
Bay L'Argent	Historically dug wells, recently switched to surface source.	No adverse opinion. Simple chlorination is satisfactory for disinfection.
Beau Bois	Most houses use dug wells. There are four drilled wells in the community.	No health hazards are reported.
Belleoram	Surface reservoir - Rabbits Pond.	Water has low pH, but no adverse comments from users.
Burin/Lewin's Cove	Surface reservoir - Long Pond.	Simple chlorination for disinfection. No adverse comments.
	Surface reservoir - Big Pond.	Simple chlorination for disinfection. No adverse comments.
Conne River	Historically shallow wells and drilled wells. Recently switched to surface reservoir - unnamed river.	Simple chlorination for disinfection. No adverse opinion.
English Harbour East	Surface sources and drilled wells. Drilled wells are becoming more popular.	Surface water is poor quality. A series of drilled wells, each servicing two to three houses seems superior.
Epworth/ Great Salmonier	Combination of dug wells and drilled wells.	No adverse comments from users or DOH.

Community	Main Water Source	Water Quality
Fortune	Surface reservoir - Horse Brook Pond.	There is free chlorine residual on testing. Reports of sedimentation and odour and bad taste on the water. The latter is attributed to a dark red fibrous algae buildup.
Fox Cove/ Mortier	Historically relied on dug wells and drilled wells. Recently switched to surface source - Deep Pond.	Simple chlorination for disinfection. Slight colouration, and slightly corrosive. Overall, good quality.
Frenchman's Cove	Historically relied on drilled wells. Now using shallow surface well.	Simple chlorination for disinfection. Water from drilled wells is high in iron and manganese with sulphurous odour. Shallow surface water, better quality.
Garnish	Surface reservoir - Wych Hazel Pond. Most households still use dug wells.	Chlorine residuals in water distribution network. Users regard as good quality water.
Gaultois	Surface reservoir - Cluett's Pond.	Possible algae problem, high colour, potentially corrosive. No adverse opinion from users.
Grand Le Pierre	Surface pond - Line Pond, new source @ Line Pond Brook.	Total coliform and faecal coliform occurrence. These have potential adverse health effects. Also, high colour, potential corrosiveness, high organic content. Appreciable sediment loads and sometimes insect larvae in the water are concern points. A "boil order" is in force. New site in plans.
Grand Beach	Dug wells.	No reported problems.

Community	Main Water Source	Water Quality
Grand Bank	Surface reservoir - Grand Bank Brook.	Chlorine residuals in water. Three charcoal filters in parallel improve water quality. No adverse opinions.
Harbour Mille/Little Harbour East	Surface reservoir, no longer in use. Drilled wells.	No complaints.
Harbour Breton	Surface reservoir - Hutching's Pond.	No bacteria problems. A "boil order" was enforced, however, due to problems with the chlorination system. There is a publicly perceived problem related to the location of a solid waste site upstream of the supply. This is not supported by chemical data.
Hermitage/ Sandyville	Two reservoirs - Pond X and Pond Y. Also, approximately 10% of households rely on private wells.	Chlorine residual reported throughout the system except at Sandyville. Water is corrosive to household plumbing and there are complaints of sediments in water after rain.
Jean De Baie	Surface pond - Colleen's Pond. Council also uses drilled wells. Some households have dug wells.	Drilled wells have not proved sufficient for community use. There is a boil order on surface water because there is no chlorinator on the system. Users find the water high in colour and iron, and it has a muddy taste.
Lamaline	Most households rely on dug wells. There are six drilled wells. There is a surface water supply under construction.	The water has high iron and colour. These parameters are expected to worsen during high runoff.
Lawn	Surface pond - Brazil Pond.	Simple chlorination for disinfection. Colour is high, but there are no adverse opinions.

Community	Main Water Source	Water Quality
Little Bay East	Mostly dug wells. There are a few drilled wells.	Some wells have a high coliform count.
Little St. Lawrence	Two surface water sources.	
	Butler's Brook	High colour and low pH. Potentially corrosive, but there are no adverse opinions.
	.Waterfall Pond	Same as Butler's Brook.
Lord's Cove	Privately dug wells.	No problems reported.
Marystown	Surface reservoirs - Linton Lake and - Clam Pond.	Disinfection by simple chlorination. No adverse opinion.
McCallum	Drilled well. Shipped by boat in barrels during summer.	Clean water in winter, brown in summer.
Head of Bay d'Espoir	Surface reservoir now under upgrading construction.	Water has been termed "dirty, highly coloured". Not considered to be good tasting or good for cooking. Improvements in the system should make the water better.
Morrisville	Surface supply on brook from Morrisville Pond.	"Boil order" in force because chlorinator is not working. Users feel it is good quality water.
Parkers Cove	Surface reservoir - Big Pond.	Adequate chlorine levels and there are no adverse opinions.
Petit Forte	Surface pond - Reddy's Pond.	Good quality water.
Point May	Surface pond - Shorts Pond.	Simple chlorination for disinfection. Users who found the water satisfactory prior to chlorination complain of bad taste and colour since chlorination commenced.

Community	Main Water Source	Water Quality
Pool's Cove	Drilled wells and a small pond - Wedgeon Pond.	Chlorine residuals adequate. Water quality deteriorates with a muddy taste when pond water levels drop.
Port au Bras	Traditionally relied on dug wells. Recently, a surface pond is planned for a new supply.	Simple chlorination is considered adequate for disinfection in the new supply.
Recontre East	Primarily dug wells with some drilled wells. New plans are in the works for a surface supply.	High bacteria counts in the individual dug wells.
Rushoon	Surface pond on North West Brook.	Sometimes chlorine residuals are a problem due to problems with the chlorinator. There are no adverse comments.
Seal Cove, Fortune Bay	Traditionally relied on privately dug wells. Presently changing to a surface water supply.	Water is acidic, low alkalinity and high colour. Simple chlorination for disinfection.
Southeast Bight	Privately owned dug wells.	Poor quality. Water emanates from bogland and is highly coloured and contains high ferrous iron contents.
Spanish Room	Privately dug wells and drilled wells.	No adverse reports.
St. Bernard's /Jacques Fontaine	Surface supply - Rattle Brook.	Simple chlorination for disinfection. No adverse opinion.
St. Jacques/ Coomb's Cove	Supplied by privately dug and drilled wells.	No adverse opinions.
St. Joseph's Cove/St. Veronica's	Privately dug wells.	No adverse opinions.

Community	Main Water Source	Water Quality
St. Lawrence	West Brook Hydro Electric Development Utilities Reservoir owned by Newfoundland Power.	Satisfactory chlorine residuals. Water becomes brownish during high runoff.
St. Alban's	Drilled wells - six in total.	Reported good quality water. Chlorine disinfection.
Swift Current	Most houses rely on privately dug wells. There are sixteen drilled wells, two of which are managed by the community. An attempt at surface water in 1982 yielded poor quality water.	DOH has issued a "boil order" for all water in Swift Current. Opinion of both dug wells and drilled wells is good, however.
Terrenceville	Most households are supplied by a surface reservoir. 10% - 15% of households have private dug or drilled wells.	Good water quality reported. Satisfactory for treatment by simple chlorination.
Winterland	Privately dug wells and drilled wells.	Some wells have high coliform counts likely due to pollution from sewage. There is no adverse opinion of the drinking water otherwise.

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Water Resources Division
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Water Resources Study
Burin Peninsula and Fortune Bay Area
Volume 2
Inventory of Water Supply Infrastructure

April 1993

Colin Karasek Limited
in association with
Acres International Limited

WATER SUPPLY SYSTEMS INVENTORY REPORTS

Reference notes for data sources

Procedure for determining live storage head

Reports included:

Baine Harbour
Bay l'Argent
Beau Bois
Belleoram
Burin - Lewin's Cove
Conne River
English Harbour East
Epworth - Great Salmonier
Fortune
Fox Cove - Mortier
Frenchman's Cove
Garnish
Gaultois
Grand le Pierre
Grand Beach
Grand Bank
Harbour Mille - Little Hbr. East
Harbour Breton
Hermitage - Sandyville
Jean de Baie
Lamaline
Lawn
Little Bay East
Little St. Lawrence
Lord's Cove
Marystown
McCallum
Milltown - Head of Bay D'Espoir
Morrisville
Parker's Cove
Petit Forte
Point May
Pool's Cove
Port au Bras
Red Harbour
Rencontre East
Rushoon
Seal Cove
Southeast Bight
Spanish Room
St. Bernard's - Jacques Fontaine
St. Jacques - Coomb's Cove
St. Joseph's Cove - St. Veronica's
St. Lawrence, Town
St. Lawrence, Mine
St. Alban's
Swift Current
Terrenceville
Winterland

REFERENCE NOTES FOR DATA SOURCES

The inventory has covered Towns, Communities, Local Service Districts and one mine for a total of 49 individual reports.

Date of surveys

The field surveys were carried out in September and October, 1992.

Information sources

1. Department of Municipal and Provincial Affairs. Parts of two DMPA Regions were covered, namely the Eastern and Central Regions. The study area in each Region was discussed with the respective Regional Engineers, R. Dillon, P. Eng. and J. Harty, P. Eng. and their staff before embarking on the field work. By this means all communities using water in significant amounts were identified and scheduled for a report. In effect, the study has covered all Towns, Communities and Local Service Districts in the study areas.

2. Department of Health. The sanitary conditions in each community were discussed with the Department of Health Officer covering the area.

   Boot of Burin Peninsula - R. Grikis, Grand Bank

   Remainder of Burin Peninsula - Sherri Rees, Salt Pond

   Fortune Bay Area - P. Beson and Craig Young, Grand Falls

   Western Placentia Bay - Whitbourne Office

   Swift Current - Clarenville Office, Gwen Elliott

3. Municipal officials. An elected or employed official was contacted in each surveyed community unless the information required was available from a recent report.

4. Other. Other information sources have included consulting engineers, for example.

Population

For Towns and Communities, census data is available and has been used. For Local Service Districts the population count from the Department of Municipal and Provincial Affairs list of Local Service Districts is included.

Pond and Watershed Areas

Areas by grid method, applied to the 1:50,000 map sheets.

Watershed Protection

Refers to Section 26 (1) of the Department of Environment and Lands Act, 1989. The specific protected water supply areas were obtained from the records of the Department of Environment and Lands and the maps shown in these records were compared with the watershed areas determined in this study and any significant differences noted.

Drilled Wells

Records of the Department of Environment and Lands, Water Resources Division, were used to determine information on drilled wells. Under the "Well Drilling Regulations" 1982 and amendments, each well driller is required to submit a well log to the Department upon the completion of each drilled well.

Demands

The number of connections to the water system or proposed water system was obtained from municipal officials. This figure is usually reliable because it is obtained from service fee billings for an existing system, or from the "Municipal Five Year Plan" submission for capital funding for systems under construction. Also, for recent projects, an engineering report giving the number of connections is sometimes available. Meter readings have been given where such information has been recorded.

Adequacy of Supply

Based on judgement by reviewing the watershed area plan, community size and local industries. This judgement is based upon the status-quo independent of the comments made under "means of increasing supply".

Means of Increasing Supply

Information on raising pond levels or spillway crests is based upon a site investigation or a consultant's report. Other recommendations are based upon consultants' engineering drawings.

PROCEDURE FOR DETERMINING LIVE STORAGE HEAD

To estimate the available drawdown of water from storage into consumption requires a classification of the supply system infrastructure because the analysis for live storage head differs, depending upon the type of infrastructure. This is discussed in the following paragraphs:

1. Run of the river, gravity flow.
2. Reservoir, gravity flow.
3. Pumping systems.

1.0 RUN OF THE RIVER, GRAVITY FLOW

1.1 No storage

This system requires a permanent pool of water created by a dam, if necessary. The river flow must always be sufficient to replenish the pool. The intake in the pool must be deep enough to stop floating debris and ice entering the water supply system.

The water supply yield estimate has to be made by low stream flow hydrology analysis. A field reconnaissance can only judge the adequacy of such a system by stream size and local enquiry as to the adequacy of the supply in the past. (Examples: Morrisville, Rushoon)

1.2 Fire flow storage

Water storage and flow volume to satisfy fire fighting requirements is a useful benefit of a public water supply. Hence a run of the river system often includes a small reservoir created by a dam. (Example: Terrenceville) The limited storage provided by such a dam is sufficient for only a day or two of normal demand so the estimate of the supply adequacy again requires a low river flow analysis.

1.3 Major storage at intake

The storage provided behind the dam may be sufficient to materially improve the supply/demand relationship (example: Conne River) This type of supply is then analyzed as a reservoir as discussed below.

1.4 Upstream storage

Sometimes the downstream storage is supplemented by a reservoir upstream which has a controlled flow outlet to feed the downstream reservoir. (Example: Hermitage) Such storage is analyzed as a reservoir.

Most run of the river systems have a back-up supply identified for drought periods. This could be, for example, a portable pump or siphon which delivers water from a pond on the watershed into the stream channel towards the downstream intake.

2.0 RESERVOIRS, GRAVITY FLOW

2.1 Intake in Transmission Line

If the transmission main has a high point, as sometimes occurs leaving a pond, two depths are required. These depths are in reference to the spillway elevation, for a dam, or the bed of the outlet brook for a natural pond reservoir.

1. Depth of water over intake.

2. Elevation of high point in transmission main below water level.

If there is no high point in the transmission main then only the depth at the intake is necessary.

For recently constructed work, or work under construction, "As Built" drawings or contract drawings are the best source for the foregoing information. For older systems there is usually reliable information locally on the intake depth because of repair and cleaning operations carried out. Sometimes local information is also available on the depth of the pipeline as it leaves the pond. Failing this, it is reasonable to assume that the line is below frost depth and also deep enough to permit a drop in the pond level without causing siphon problems.

With upstream storage dams, a pipe through the dam with a free discharge into the downstream feeder channel is frequently used. The discharge pipe depth below the spillway sill can therefore be measured directly and used to provide a rough check of the live storage head at the intake.

It is also useful to check the design of the intake structure. This should have an open receiving area several times the area of the supply main. Otherwise excessive suspended fine materials will be drawn in during high flows, such as fire flows. An occurrence like this would reduce the potable quality of the water supply.

2.2 Fine Screen Chamber near the Intake

A fine screen chamber is sometimes included in the supply infrastructure to reduce the amount of suspended solids in the delivered water. The screen chamber is a small buried tank open to atmospheric pressure, containing vertical screens at right angles to the direction of flow. The screens are frequently about 1.2 M wide and up to 3.0 M high. Two or three screens of different sized mesh are used in series, with the finest mesh on the discharge side.

The inclusion of a screen chamber requires analysis of the following depths below water level.

1. At intake.
2. Pipe invert at entry to screen chamber.
3. Sill supporting the bottom of the screens.
4. Pipe invert at discharge from screen chamber.

The live storage head is the minimum value among these four measurements. The best information source is "As Built" drawings or, for projects under construction, the contract drawings. In many cases screen chambers are found to have been designed so that the sill, rather than the pipes, is the limiting factor for drawdown of the reservoir. This feature has been noted in several cases (for example Fortune, existing, Seal Cove Fortune Bay, proposed). If the reservoir water level is drawn down, the area of flow available through the screens reduces and the screens serve increasingly to block the flow. A differential head develops between the supply and discharge sides of the screens, particularly when they have collected a load of suspended matter. (This occurs, for example, in Fortune.) Hence it is assumed that the screens will be removed if it is ever necessary to develop the maximum drawdown available from the reservoir.

3.0 PUMPING SYSTEMS

There are basically two types. (1) Pumps with a positive head of water on the impeller, i.e. the impeller is submerged. (2) Pumps with a suction lift from the water supply level to the impeller.

These types of pumping systems may be used with a run of the river supply source or a reservoir.

3.1 Submerged Impeller Pumps

In common practice there are two types of pumps in use. (1) Vertical turbine pumps in which the pump motor is above water level and is connected to the impeller by a long vertical shaft. (2) Submersible pumps, in which the pump and the motor are coupled together and are both below the water surface.

For the pumps to function properly and without damage the water level must not fall below a certain height above the intake to the pump. This depth, termed the "minimum submergence", is recommended by the pump manufacturers; for example typically 1.4 M for a 40 HP pump. Vertical turbine pumps, (and pumps with a suction lift as described below) are installed in a pumphouse over a wet well. The wet well is connected to the reservoir through an intake pipe. Critical features are the depth of water over the intake pipe at the intake and the wet well.

Thus the minimum live storage head may be governed either by the depth at the intake pipe at the intake, or at the wet well, or by the depth of the pump intake and the required submergence depth, all referenced to the spillway elevation. The required information is best obtained from accurate drawings if such are available. Otherwise the local operator or consulting engineer is usually knowledgeable in respect to this information.

3.2 Pumps with Suction Lift

These pumps are fed by a suction pipe in a wet well with a foot valve at the intake set below the wet well water level. The available reservoir drawdown is computed the same as for the submerged impeller type pumps but it is subject to a further important overriding criterion, namely the net positive suction head for the suction lift pump.

To avoid cavitation damage inside the pump, the suction lift, measured from the water surface to the centre of the pump impeller above, must not exceed a calculated value. This calculated value depends upon the intake pipe and foot valve friction losses, the atmospheric pressure, the water vapour pressure and also the "net positive suction head required" (NPSHR) for the pump. The NPSHR is determined by the pump manufacturer and is specific for the pump concerned. It is usually presented as a curve which relates head (NPSHR) and pump discharge.

To analyze an existing system, calculations are carried out using the suction lift friction losses, barometric pressure and water vapour pressure for the reservoir water temperature to arrive at the net positive suction head available (NPSHA) for the layout concerned. The NPSHA must always exceed the NPSHR and if this is the case then the analysis can continue the same as for a pump with a submerged impeller.

With several similar pumps working simultaneously in parallel the combined effect is to reduce the NPSH required.

NPSH analysis is available in respect to the Marystown pumping systems, and in fact is a critical factor for the Linton Lake pumphouse. In other cases it is assumed that the original design is satisfactory in respect to NPSH.

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF BAINE HARBOUR

GENERAL INFORMATION

Information source: Information on file, Colin Karasek Ltd; Department of Health, Sherri Rees.

Census data: Population: 204 (1976), 208 (1981), 205 (1986), 189 (1991). Dwellings: 60 (1991). Average: 3.15 persons per dwelling.

Service fee: $36.00 per year per house for water service.

History: This community relied on shallow wells and one drilled well for water supply. The water was distributed through small diameter pipes which have proved extremely troublesome because of freezing and leaks. In an attempt to find an adequate groundwater source for the whole community, the Department of Municipal and Provincial Affairs has financed the drilling of ten wells. In 1992 a decision was made to use Baine Harbour Pond as the municipal water source. This is described below.

SURFACE WATER SOURCE

Name: Baine Harbour Pond. A natural pond which will require a dam to serve as an adequate surface water source. Surface water elevation 61.6 M. Most of this pond is shallow with a depth of about 0.7 M.

Users: This source is used by the Baine Harbour Fish Plant and the Community.

Dams: This pond has no dam, but requires a dam to store water because the watershed is small, and to improve water quality.

Reservoir surface area: 1.1 Hectares

Watershed area: 17 Hectares. The side slopes are generally steep with not much vegetation.

Live storage head: There is a portion of the pond with a depth of about 1.6 M where an intake could be placed. (At the time of the survey this intake had not been constructed.) However, since most of the pond is shallow the maximum live storage head from about 50% of the existing pond would be 600 mm.

Watershed protection: Not protected.

Developments on watershed: No developments.

GROUND WATER SUPPLIES

Existing: See "History", above.

Ownership of drilled wells: Council owned.

Adequacy of yield: Only 3 of the 10 drilled wells have yielded sufficient water to be considered for a community source. One of these wells has been developed and used for a limited number of houses.

Chemical quality: The best yielding wells contained excessive amounts of iron.

Abandonment: The use of ground water for a supply for the community will be abandoned and a surface water system will be developed, using Baine Harbour Pond, as described above, as funds permit.

WATER QUALITY

Bacteria: The existing shallow wells feeding the community have high bacteria counts and a "Boil Order" is in force because these supplies are not chlorinated.

Department of Health: Salt Pond

User opinion, dug wells: High colour, turbidity and poor taste occurs during periods of the year.

User opinion, drilled well: The one drilled well used at present has satisfactory water quality but can supply only a few houses. The other drilled wells with adequate yield have an excessive ferrous iron content.

Chemical data, Baine Harbour Pond: This is a soft acidic water with noticeable colour (65 units).

User opinion, Baine Harbour Pond: In the winter this source provides good tasting water but in summer the source suffers from excessive sediments, high bacteria counts and a musky smell on boiling the water. This smell may be due to the die-off of the vegetation that grows in the pond.

EXISTING STRUCTURES

Fish plant: The fish plant supply line, 580 M in length, runs directly from Baine Harbour to the plant. The pipe is 50 mm diam. HDPE, installed in 1980.

Council system: A network of small diameter waterlines run from dug wells and a drilled well to the buildings. An interconnection is also made with the fish plant line. Council lines are prone to leaks, they freeze in cold weather and the system is essentially obsolete.

Proposed construction: Council has funding to run a 200 mm ductile iron pipe into Baine Harbour Pond to connect with the existing distribution network.

DEMANDS

Metering: There is no metered water consumption data.

Community: 54 occupied dwellings, 3 small local stores, Community Centre.

Fish plant: Built about 1977, operated by H. B. Dawe Ltd. In 1989 and 1990, for example, the plant opened in about April or May on a one-shift basis and worked two shifts during June, July and August. Up to 60 persons are employed. The plant usually closes in October. Fresh water is used for domestic purposes, high pressure cleaning of equipment, for the ice machine, ice machine cooling system and for cleaning and watering boats. Estimated consumption 20,000 cubic metres per year (report, November 1990, Colin Karasek Ltd).

Future: The fish plant has a 150 mm diam. salt water intake line 365 M long with pumps to draw water from the harbour. Probably most of the water used in the plant is salt water. The harbour is almost landlocked and at present raw domestic sewage runs into the harbour. The harbour is up to 18 M deep and regular bacteria counts have never found any excessive contamination. However, it is possible that in the future the plant may not be permitted to use the salt water for aesthetic or other reasons. This would place a greater reliance on fresh water. No significant increase in domestic demands are anticipated.

SUPPLY

Adequacy: In a dry year it is questionable whether the Baine Harbour Pond system would be able to supply both the plant and the Community, if the Community had a full-scale water distribution system. Substantial storage will be required at the pond. More detailed analysis is required. See note above on possible increased future demand for fresh water through inability to use salt water supply.

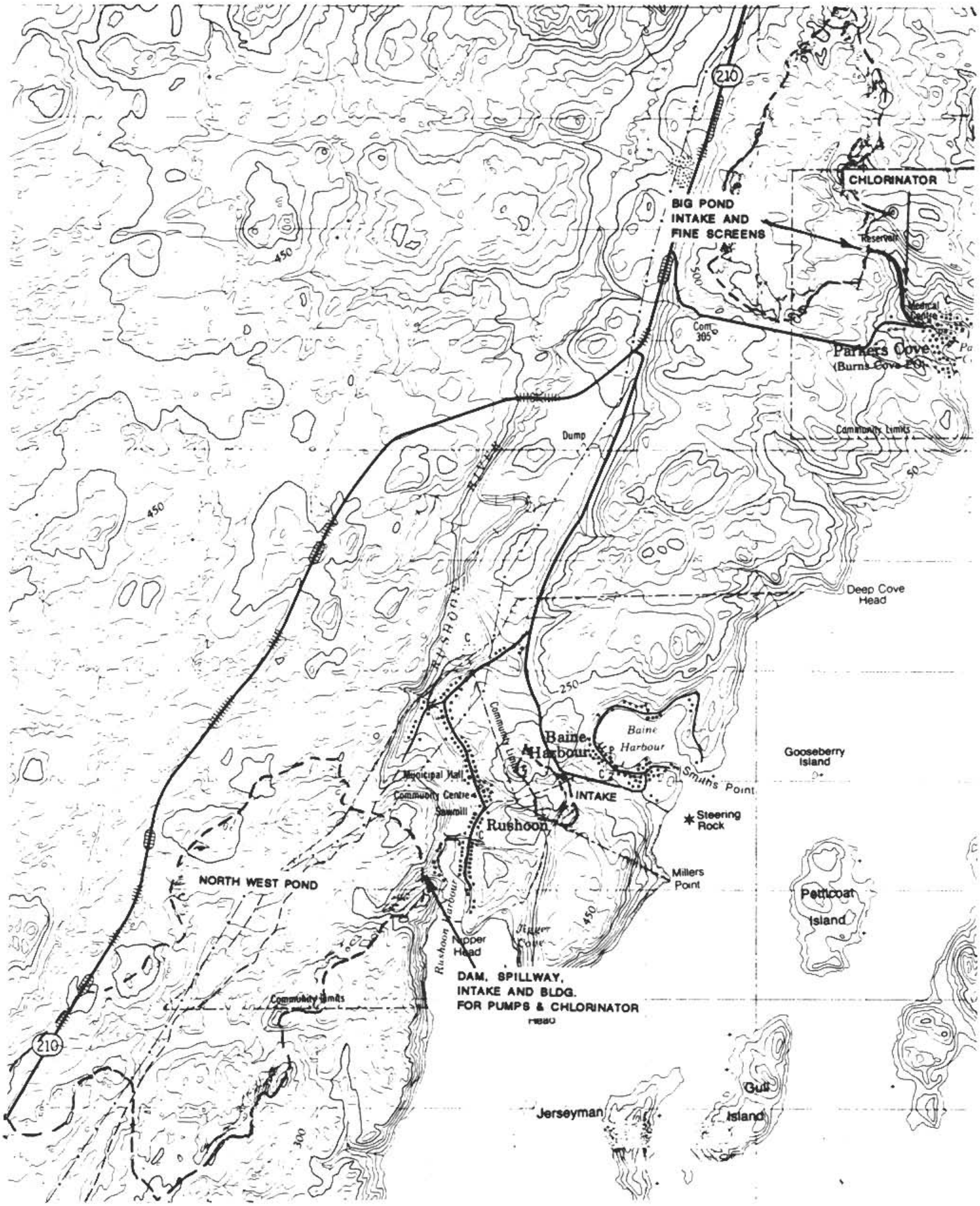
Means of increasing supply: Use a dam about 150 M long to raise the water level. The flooded area would be barren ground with fairly steep slopes, so the flooded area would not be excessive. If the water level is raised it will also reduce the amount of bottom sediments stirred up by the wind and therefore improve the quality of the water and also would likely deter the growth of aquatic plants and again improve the taste of the water (bad taste occurs when these plants die off and decay).

WASTE WATER DISPOSAL

All private systems. Lines to salt water in the harbour are used as well as septic tanks and drain fields.

COMMENTS

This community and the fish plant may run short of water in a dry year unless more storage is provided at Baine Harbour Pond. A detailed investigation is required.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

BAINE HARBOUR, RUSHOON, AND PARKER'S COVE

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF BAY L'ARGENT

GENERAL INFORMATION

Information sources: Town Clerk, Wanda Stewart; Engineering Drawings for Construction, Newlab Consultants Ltd. Personal communication, Newlab Consultants, Max Mercer, P.Eng. Department of Health, Sherri Rees.

Census data: Population: 474 (1976), 483 (1981), 489 (1986), 403 (1991). Dwellings: 134 (1991). Average 3.01 persons per dwelling.

History: The Town relied upon privately owned dug wells and a total of 7 drilled wells. In 1990, with financing arranged through the Provincial Government (Department of Municipal and Provincial Affairs), the Town embarked upon the installation of main water and sewer services.

SURFACE WATER SOURCE

Source: Abstraction dam and reservoir on Sugar Loaf Hill Brook by gravity supply.

User: The Town is the only user.

Dam: A brook falls down a cliff into a reinforced concrete tank anchored to bed rock. Inflow approximately 300 L per minute (difficult to estimate). Outflow at spillway, zero. Flow from rock fissure below dam, a spring or leak, approximately 50 L per minute (difficult to estimate).

Reservoir size: 18 M x 6.6 M in area, average depth 3.0 M.

Reservoir storage volume: 360 cubic metres. (From dimensions measured and estimated by eye on site.)

Spillway: A depression in the concrete wall 9.0 M wide by 300 mm deep, elevation 84.5 M above sea level.

Watershed area: 91 Hectares.

Watershed protection: Protected.

Developments on watershed: None apparent.

Back-up storage: No controlled back-up storage; four small natural ponds in the watershed.

WATER QUALITY

Bacteria: Simple chlorination is satisfactory for disinfection.

Department of Health: Salt Pond

User opinion: No adverse opinion.

EXISTING STRUCTURES

Transmission main: 250 mm ductile iron pipe, sized for fire flows. Part of the route follows an abandoned highway made in side hill cut/fill with a cliff on the south side. Insulated pipe is used where this line follows an isthmus or causeway across salt water.

Chlorinator: Hypochlorinator, flow-paced, with water meter.

Storage for fire fighting: Adequate. Reservoir sufficient for 136 L/sec. over 2 hours.

DEMANDS

Existing: This system is under construction. At the end of 1992, 30 hookups are expected.

Future at the end of the construction program: A total of 145 hookups are expected for houses and small businesses. There are no industrial demands.

Future: No significant increase in demand is expected.

SUPPLY

Adequacy: A simple verification of supply adequacy for a run of a river system is that the spillway must always overflow. Even though the distribution system is not complete, the spillway was not discharging at the time of the survey. Hence, on the basis of this reconnaissance survey, a detailed investigation for water supply should be carried out.

Means of increasing supply:

1. Install controlled storage at the ponds in the watershed.

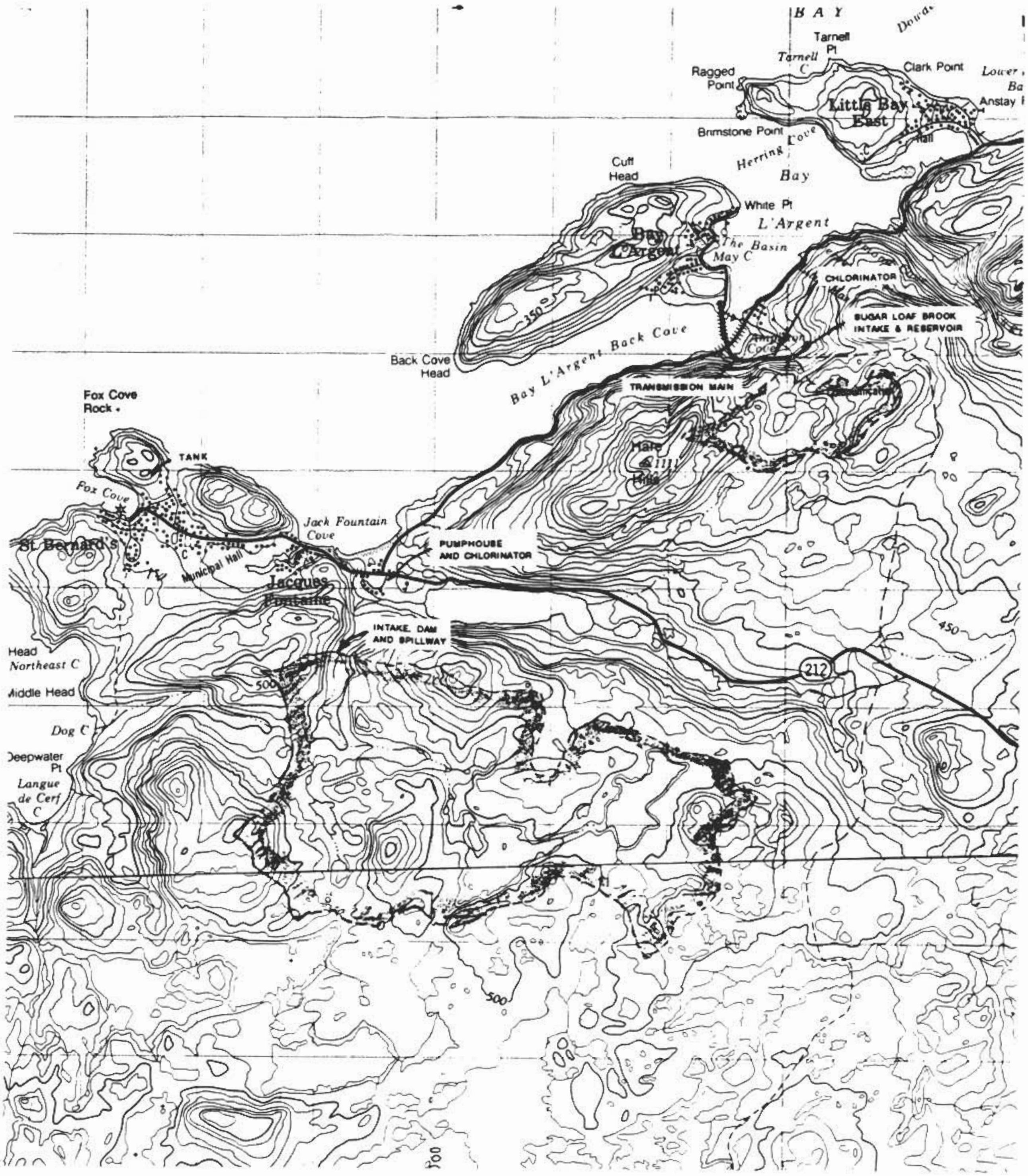
2. Greatly enlarge the existing reservoir so that it stores sufficient water to overcome low flow periods.

WASTE WATER DISPOSAL METHODS

Present systems are private, on-site systems, or lines to salt water. A full-scale sewage collection and disposal system is proposed under the current construction program.

COMMENTS

This system needs a detailed study to determine the adequacy of the water supply and the means of increasing the supply if this is necessary. According to the consulting engineer the problem may be beaver dams on the watershed, which are holding back the flow.



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REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

BAY L'ARGENT, ST. BERNARD'S AND JACQUES FONTAINE

ACRES

UNINCORPORATED AREA, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF BEAU BOIS

GENERAL INFORMATION

Information sources: Chairman of Council, Dan Drover; Department of Health, Sherri Rees.

Population: 72 (Department of Municipal and Provincial Affairs records).

GROUND WATER SUPPLIES

Dug wells: Most houses use dug wells. In summer these frequently go dry and in winter the water lines freeze.

Drilled wells: Four wells have been drilled in the community, of which two were dry, one yielded 25 L per minute and the other 7 L per minute. The best yielding wells are private wells.

Adequacy of yields: For most of the community the present water supplies are inadequate.

WATER QUALITY

Bacteria: No health hazard reported.

Department of Health: Salt Pond.

DEMANDS

Existing: There are 21 houses in the community, no school and no industry.

Future: No increase in demand is anticipated.

SUPPLY

To overcome present supply problems the community has approached the Provincial Government for funding for an improved water system. Detailed investigations have not been carried out.

WASTE WATER DISPOSAL METHODS

Mostly lines to salt water. No pollution hazard reported.

COMMENTS

See "Supply".

MUNICIPALITY SURFACE WATER SOURCE

TOWN OF BELLEORAM

GENERAL INFORMATION

Information sources: Mayor, Stewart Smith; Town Foreman, Ches Vallis; Department of Health, Craig Young.

Census data: Population: 578 (1986), 739 (1991). Dwellings: 204 (1991). Average 3.62 persons per dwelling.

Water and sewer rates: $13 per month

SURFACE WATER SOURCE

A. Main Reservoir

Description: Rabbits Pond, the main supply reservoir, is a natural pond augmented by a dam which feeds water by gravity to the whole Community. To back up Rabbits Pond, water is pumped from Big Pond as required.

Users: The Town and the fish plant in the town are the only users.

Dam, main supply pond: Earth-filled dam with sloping concrete upstream face, reported locally to have a concrete diaphragm wall. Length 85 m (paced). Maximum height about 4.5 m (estimated). Dam was built about 10 years ago to replace an old timber crib dam.

Spillway: Concrete, built into the dam, 3.6 m wide, 0.9 m freeboard to top of dam (measured).

Water levels: At the time of the survey on September 24, 1992, water level was 1.75 m below the spillway; usually there is less water, according to local report. (The concrete sloping face of the dam is marked in paint to show water depths above the intake, according to the Town Foreman.) Highest water level reported locally about 480 mm above the spillway.

Leak in dam: There is a serious leak, say 0.5 cubic metres per minute, along the reservoir drainpipe. According to local report there were wet and difficult conditions when the concrete diaphragm wall was being built. Hence honeycomb concrete may have occurred, but the exact reason for the leak is not entirely definite and the location of the leak is not known. The leak started as soon as the reservoir was filled. Despite the leak the reservoir has functioned satisfactorily to supply water to the Town.

Live storage head: At the time of the survey, the live storage head was 1.8 M, as determined from the paint marks. The vertical distance from the intake to the spillway is 3.55 M, as estimated from the paint marks.

Surface area: 2.5 hectares

Watershed area: 30.3 hectares

Status of watershed protection: Protected (Rabbits Pond).

Developments on watershed: No developments seen except access roads.

Replenishment of main reservoir: Big Pond is pumped, sometimes three or four days per week, sometimes very infrequently. No set pattern. Eight or nine years ago a lot of water had to be pumped, due to a dry season and a heavy demand.

B. Back-up reservoir:

Description: A natural pond, called Big Pond, with a wooded, fairly steeply sloping watershed.

Dam, spillway: No dam or spillway.

Surface area: 31.3 hectares

Watershed area: 156.0 hectares

Live storage head: Approximately 1.5 M from pond surface to invert of intake pipe. Estimated on site in discussion with Town Foreman.

Developments on watershed: No developments apparent.

Status of watershed protection: Although Rabbits Pond is designated as protected, this does not appear to be the case with Big Pond.

WATER QUALITY

Bacteria: The Department of Health checks for bacteria; the Town does not have a test kit. Difficult to obtain satisfactory free chlorine residual with the present arrangements. A flow paced chlorination system is not in use.

Department of Health: Grand Falls

Chemical parameters: Water has low pH. Formerly the chlorination system included soda ash injection.

User opinion on taste: No adverse comments reported.

EXISTING STRUCTURES

Pumphouse, back-up pond: A 77.5 h.p. diesel engine drives a pump which draws water from a wet well.

Transmission line, Big Pond to Rabbits Pond: 150 mm diam. PVC pipe, about 400 m long. This old pipe is being replaced as funds permit.

Chlorinator: Hypo-chlorinator, formerly flow-paced through a water meter, now set for a fixed feed rate. The chlorinator is about 800 m from the first customer, which should provide good contact time.

Transmission line and distribution system: Distance from Rabbits Pond to town is about 1200 m. Most of the transmission main is 200 mm diam. PVC, installed about 10 years ago. The remainder of the piping is cast iron, 150 mm diam., installed about 1946. About four or five breaks occur per year in the old cast iron mains, due to rust.

Fire hydrants: Good pressures reported.

DEMANDS

Metering: Water flows to the fish plant are metered.

Existing:	Domestic:	About 140 connections
	School:	100 pupils
	Fish plant:	Has not operated for the last 3 years. Expects to open soon as a partial filleting operation, working as a feeder plant (Daleys, P.B.). The fish plant has a salt water line which reduces its reliance on fresh water.
Future:	Domestic:	No increase anticipated; virtually all the houses are hooked up to the water system.
	Fish plant:	Depends on the future of the fishing industry.

SUPPLY

Adequacy: The supply system has been adequate in the past despite the leak in the dam, and is likely to prove adequate in the future.

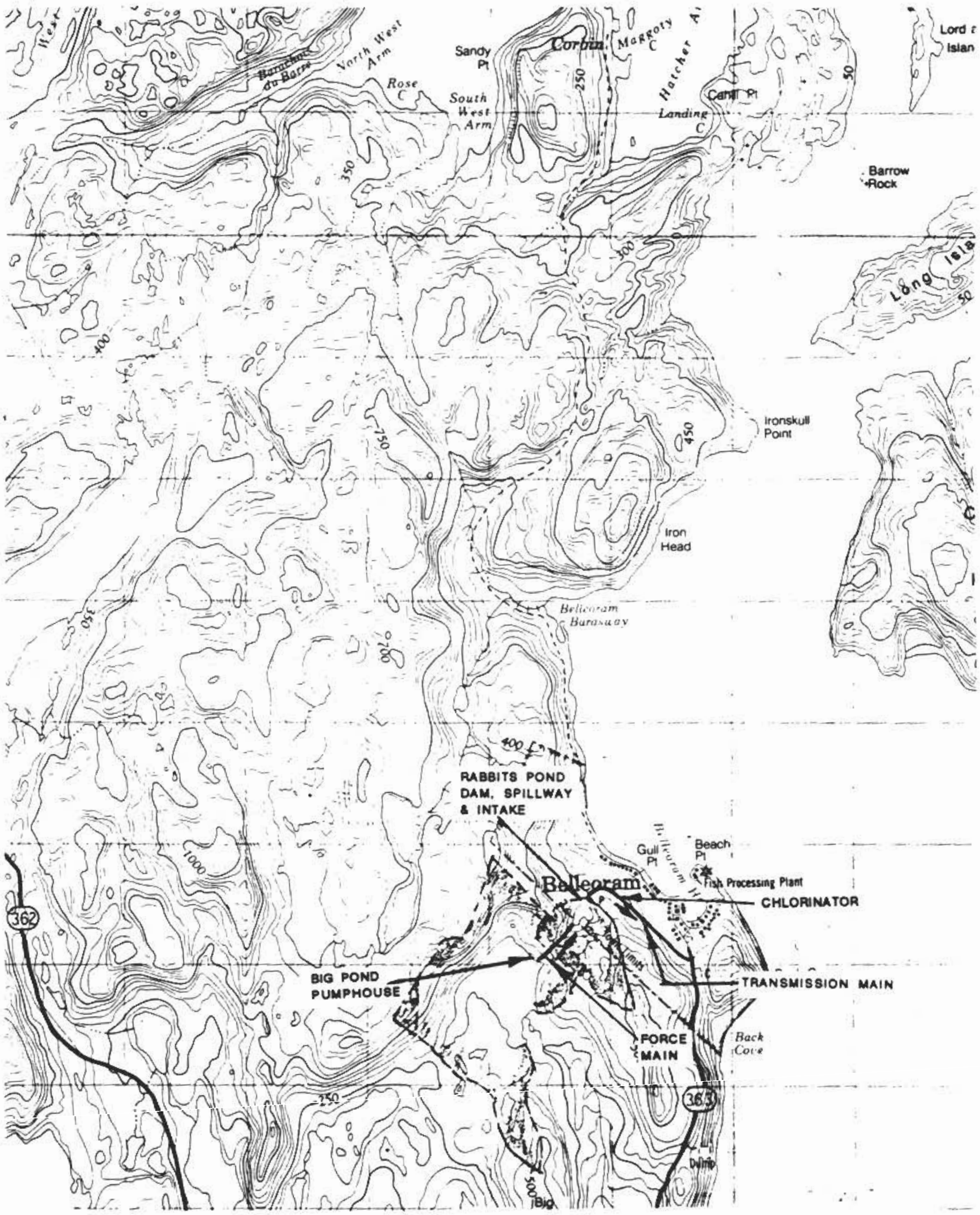
Means of increasing supply: If there were any need to increase the supply for this Town, first efforts should be devoted to repairing the leak in the dam in the main reservoir.

WASTE WATER DISPOSAL

The sewer system was installed in the 1940's; an all-gravity system with several outfalls. No significant pollution problems.

COMMENTS

If possible, water meter readings on the consumption of the whole community should be made to check on the progress of leaks. Also, a pressure-reducing valve should be considered, to reduce system pressures and possibly forestall any new leaks.



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REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
BELLEORAM

MUNICIPAL AND INDUSTRIAL REGIONAL SURFACE WATER SYSTEM

TOWN OF BURIN - COMMUNITY OF LEWIN'S COVE

GENERAL INFORMATION

Information sources: Burin Works Superintendent, Harvey Brenton; Burin Town Manager, Leo Bailey; Community of Lewin's Cove, Linda Inkpen.

Ownership: The water supply system is owned and operated by the Town of Burin which has supplied the Community of Lewin's Cove since 1981.

Census data:

	Year	Burin	Lewin's Cove	Total
Population:	1976	1892	470	3362
	1981	2904	507	3411
	1986	1892	555	3447
	1991	2940	609	3549
Dwellings:	1991	873	181	1054
Avg.persons per dwelling:	1991	3.37	3.36	3.37

Service fees: Burin: $13/month for water
Lewin's Cove: $12/month for water

SURFACE WATER SOURCE, LONG POND

Name: Long Pond. Provides gravity supply. Installed in 1972. A natural pond, augmented with a dam.

Users: This source served the whole Town of Burin up until 1982. Currently old Burin uses this system, including the fish plant and trawler refit base. The remainder of the distribution area is served by Mortier Big Pond.

Dam: Rockfilled timber crib 10 M long and 1 M high across outlet brook.

Spillway: Part of dam. Water level at time of survey 300 mm below spillway.

Reservoir surface area: 34 Hectares.

Watershed area: 165 Hectares.

Live storage head: From pond surface to intake, 4.2 M (estimate by Works Superintendent). However, a drawdown of this amount may result in a siphon effect at the point where the pipeline leaves the pond, which is usually a high point in the line. As a practical figure use LSH = 1.0 M.

Status of watershed protection: Protected.

Developments on watershed: No apparent developments; a remote wooded area.

WATER QUALITY, LONG POND

Bacteria: Simple chlorination is adequate for disinfection.

Department of Health: Salt Pond.

User opinion: No adverse comment.

EXISTING STRUCTURES, LONG POND SOURCE

Pipeline: 355 mm diam, asbestos cement pipe. Asbestos cement mains extend throughout the old Burin system. When old Burin was first serviced, the main road was very narrow so a 250 mm diam. watermain was taken over high ground, Kean's Hill (see plan). This is obviously a critical point in the hydraulic grade line.

Strainer: Double basket strainer in chlorination building.

Chlorinator: A gas type with feed rate controlled manually. Booster pumps for injection.

Separation of Big Pond and Long Pond systems: A main line gate valve, normally closed (see plan), separates the two systems. If required, the Long Pond system can be shut off and the Big Pond system can be brought in to serve old Burin. A pressure-reducing valve is used to protect the asbestos cement mains from excessive pressures.

Condition of mains: The old asbestos cement pipe and building connections are believed to be deteriorating. Several leaks have to be repaired each year.

Low pressures: Hydrant pressures are low in old Burin, according to a survey carried out by the Underwriters Advisory Group.

SURFACE WATER SOURCE, BIG POND

Name: Mortier Big Pond, referred to locally as Big Pond, is a pumped supply. It is a natural pond with an outlet brook.

Users: This system serves Salt Pond and the institutional buildings there, as well as Lewin's Cove and all the demands north of the connection from the Long Pond source to the main along the main highway. The Big Pond system became operational in May 1982 because of new demands from the new institutional buildings in Salt Pond and the connection to Lewin's Cove.

Reservoir surface area: 76 Hectares.

Watershed area: 1256 Hectares.

Live storage head: Governed by the water level at spillway elevation over the pump intakes in the wet well minus a safety head to prevent drawing air into the intake. This is providing that the required net positive suction head of the pumps will be available at the drawdown depth, which has not been investigated. Use live storage head 1.0 M (based on information from the Works Superintendent).

Watershed protection: Protected.

Developments on watershed: Highway to Fox Cove - Mortier.

WATER QUALITY - BIG POND

Bacteria: Simple chlorination is adequate for disinfection.

Department of Health: Salt Pond

Use opinion: No adverse comment.

EXISTING STRUCTURES, BIG POND

Intake: The original intake gave problems by drawing unsuitable material and organisms into the system. The new intake turns up 1.8 M from the bottom under about 12 M of water. An extensive pigging program to clean the mains was carried out in 1987.

Pumphouse: Two centrifugal pumps with 60 HP motors lift water from the wet well through a transmission main to a gravity storage tank. The primary pump control is through a signal line from water level electrodes in the storage tank. Both pumps come on together but lag 5 minutes at shut-off.

Chlorinator: Gas chlorinator in the pumphouse. The pressure drop between the discharge header and the wet well is used to draw chlorine gas into solution and into the wet well.

Water meter: In the pumphouse. This is read daily.

Storage tank: Steel storage tank on high ground, 1100 cubic metres capacity (250,000 gallons).

Transmission main: From the tank a 400 mm main runs through back country to Salt Pond, with a branch to old Burin which is normally closed off.

Back-up: The Long Pond system can supply the Big Pond system, if needed, in emergencies.

DEMANDS, LONG POND SYSTEM

Metering: No metering is carried out.

Connections: 580 connections to houses and small businesses.

Industry: Fish plant and trawler refit base.

Losses: Leakages are suspected in the asbestos cement pipe; 5 leaks repaired in 1992.

DEMANDS, BIG POND SYSTEM

Metering: A functioning water meter is in the pumphouse and also the water entering Lewin's Cove system is metered for billing. Typical meter readings:

Pumphouse:	1659 cubic metres per day
Lewin's Cove:	277 cubic metres per day
Burin:	1382 cubic metres per day, by difference

Connections: Burin: 401 Lewin's Cove: 175 (all but 8 houses are connected to the main system.

Institutional demands:
Hospital: estimated consumption 81 cubic metres per day.
Integrated schools, 1300 pupils)
RC school, 300 pupils) estimated consumption 70 cubic metres per day
Eastern college, 500 students)

Future proposals: Normal growth is expected and a few houses remain to be connected. Otherwise no major increases in demand are foreseen.

Losses: Difficult to estimate because the consumption by the institutions is not measured. However, rough calculations suggest that a substantial part of the demand is unaccounted for if normal per capita water consumption data is used.

SUPPLY

Adequacy: Both Big Pond and Long Pond supply will be adequate in the foreseeable future. Long Pond supplied all of Burin up to 1982.

Means of increasing supply: Long Pond; could raise water level 1.8 M by a dam 60 M long. Big Pond; it may be possible to raise the water level 1.5 M with a dam about 130 M long. However, raising the water level increases the risk of flooding the pumphouse during an historic peak flood. Detailed investigation required.

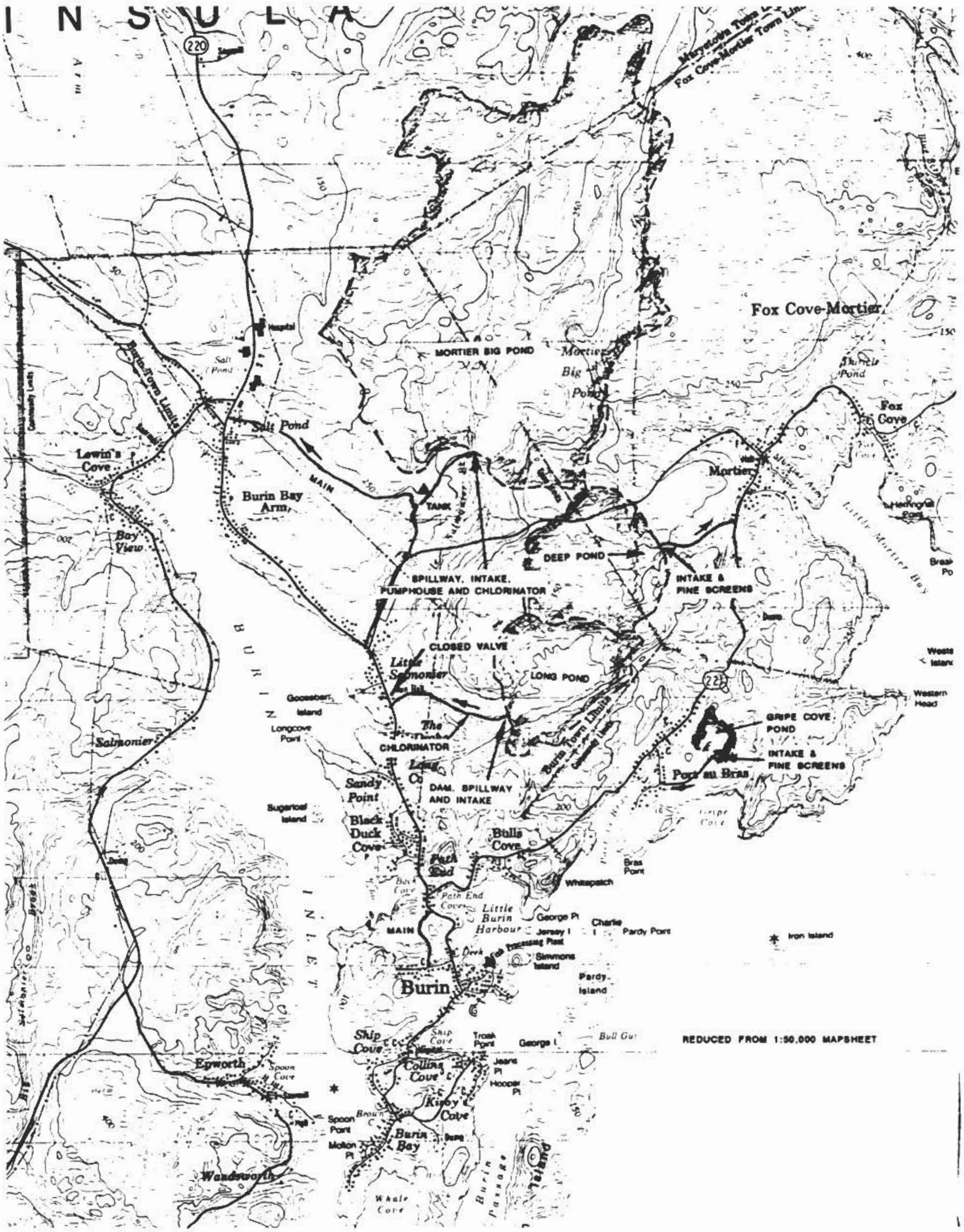
WASTE WATER DISPOSAL

Burin: About 90% of the houses in old Burin have connections to the main sewer system. The rest of the town is virtually all serviced with main sewer except houses on the highway from Salt Pond to Grand Beach.

Lewin's Cove: Almost all houses are on a main sewer system. No new buildings are permitted unless they can be connected to main services.

COMMENTS

In the foreseeable future the asbestos cement watermains in old Burin will need to be evaluated for replacement.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

BURIN, FOX COVE–MORTIER, PORT AU BRAS, AND LEWIN'S COVE

MUNICIPALITY, SURFACE WATER SOURCE

CONNE RIVER

GENERAL INFORMATION

Administration: Council of the Conne River Micmacs

Information sources: Director of Public Works, Renbert Jeddore; Director of Capital Projects, Eric Humphrey; As-Built Drawings, Procon Ltd., Grand Falls; Department of Health, Craig Young.

Population: Approximately 650, and 200 homes. (Statistics Canada gives a population of 108 for 1991, with 26 dwellings.)

Water and sewer rates: No fees charged.

History: Previously, the community depended upon shallow and drilled wells for a water supply. A new water and sewer system has been under construction since about 1985, funded by the Department of Indian Affairs, for a total cost of about $7.1 million, to be finished in 1993. As of September, 1992, about 80% of the population is served by the new surface water system.

SURFACE WATER SOURCE

Supply: Abstraction dam on unnamed river. This is basically a gravity supply, although about 20% of the community will need to be served through a pressure boosting station.

Users of this source:

1. Conne River community through a 200 mm diam. main.
2. Fish hatchery through a 100 mm diam. main.

Dam: Concrete gravity dam, 24.0 m top width, and 5.0 m maximum height on bed rock. Screen chamber built into the dam.

Spillway: Concrete broad crested weir with long sloping discharge apron. Spillway width 9.0 m.

Operating water levels:	Top of dam	100.00 m AAD
	Full supply level (FSL)	100.00 m
	Sill of spillway	99.00 m
	1:150 year flood	100.74 m
	Invert of intake	97.50 m
	Top of screens	100.80 m
	Bottom of screens	96.84 m
	Bottom of reservoir	96.50 m approx.

Reservoir surface area: 892 square metres at FSL calculated from engineering drawings. 590 square metres at spillway elevation.

Watershed area: 928 Hectares.

Live storage head in reservoir: 1.5 m spillway sill to invert of intake from the drawings.

Live storage volume in reservoir: 470 cubic metres. Estimated from cross sections of the reservoir taken prior to filling the reservoir, deducting the dead volume below the invert of the intake.

Adequacy of storage for fire flows: 38 Lps (500 I gpm) for over three hours. Adequate.

Status of watershed protection: The watershed is within the Band Council control area. It is also protected under the Department of Environment and Lands Act.

Developments on watershed: Probably minimal pollution hazard, e.g. woodcutting.

WATER QUALITY

Bacteria: Simple chlorination suffices to remove bacteria. Checks on chlorine residual are carried out by Council engineering staff weekly, also periodically by the Department of Health, Grand Falls, and the Federal Department of Health.

User opinion: No adverse opinions on water quality.

SYSTEM INFRASTRUCTURE

Water mains: From the dam to the main road the transmission main is 200 mm diam., length 1720 m. From this point 150 mm diam. mains extend east and west, about 3200 and 3000 m respectively. Some 200 mm diam. main has been used in these branches. The pipe mains are all PVC, mostly SDR 26 with some DR 18.

The fish hatchery is fed with a 100 mm line taken from the 200 mm supply line between the raw water screens and the control valve mentioned below.

Intake and raw water screens: There are two sets, of two screens each, in parallel, each fed by a 250 mm diam. intake pipe through the dam. The area of each screen is 1260 x 3964 mm. The design is such that each set of screens can be gated off. One set of screens is used at a time.

Chlorination: The chlorinator is near the edge of the built-up area, about 140 m upstream from the junction of the 200 mm and 150 mm diam. mains. To increase chlorine contact time there is a 40 m length of 600 mm diam. main immediately downstream from the chlorinator. This will provide about twenty minutes of contact time under peak domestic flows. There is a flow-paced hypochlorinator controlled from a 100 mm diam. Rockwell W1000DR turbometer.

Booster pumping station: This is a continuous pumping booster station with a battery of three pumps which can be activated as required. All controls are automatic, based upon flow and pressure sensors in the pumphouse. The pumps are reported as 7.5 hp. There is also 70 hp diesel pump which is for standby and to serve as a fire pump.

Control valves:

1. An "excess flow valve" is in place immediately downstream of the dam. According to local report this is intended to limit the flow out of the reservoir should a break occur in the main.

2. A pressure reducing valve is in line in the 200 mm main near the junction of the 200 mm diam. main and the 150 mm diam. main.

Hydrants: Hydrant static pressures are reported as 80 to 100 psi. Flows not checked to date.

DEMANDS

Metering: No metering is carried out.

Domestic: About 200 connections, when completed.

Institutional: One school, 200 students, and Community Centre Building.

Commercial: Local stores.

Industrial: Nil.

SUPPLY

Adequacy: The supply will be adequate for present and future demands.

Means of increasing supply: The main upstream storage pond could be developed with control structures and a pump or sluice gate to store water and feed into the river to the abstraction dam during dry periods.

WASTEWATER DISPOSAL METHODS

The sewer system includes eleven lift stations and two ocean outfalls. The effluent from about 170 houses receives secondary treatment by aeration prior to discharge through the first outfall. About 30 houses discharge untreated sewage through the second outfall. The aeration system consists of two lagoons made of concrete, each being 30 x 46 m in plan and 4.3 m deep. These lagoons are in series. The aeration is carried out by a Framco floating aerator, 5 hp, one in each lagoon.

COMMENTS

Install a cumulative water flow meter in the chlorination building. The existing in-line meter (which controls the chlorinator) emits about 1492 pulses for every 1000 gallons. A Rockwell "Act-pak" or a similar device is needed to convert these signals to flow readings.

COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
CONNE RIVER

ACRES

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF ENGLISH HARBOUR EAST

GENERAL INFORMATION

Information sources: Former Mayor, Walter Simpson; Department of Health, Sherri Rees; Department of Municipal and Provincial Affairs, Rick Martin.

Census data: Population: 278 (1976), 316 (1981), 299 (1986), 288 (1991). Dwellings: 68 (1991). Average: 4.24 persons per dwelling.

User fees: The Council does not impose user fees.

SURFACE WATER SOURCE

Existing:

1. Point Pond: This supplies gravity flow to ten families. The water is reported to be of poor quality and has been turned down as a supply by the authorities.

2. Boat Pond: This supplies water about five houses. It is reported to be of poor quality, supplying dirty water.

Future: Surface water sources are now out of favour and a drilled well program is considered the best option for a water supply.

GROUND WATER SUPPLY

Drilled wells: Twenty-four wells have been drilled, of which twenty yield 4 L per minute or more, which is enough for two or three houses per well, provided there is adequate storage. The maximum yield reported is 135 L per minute for one well. Depths drilled varied between 12 and 128 M.

Adequacy: Most drilled wells have been satisfactory for quantity and for quality.

DEMANDS

Apart from the houses there is a school with grades from K to 8.

SUPPLY

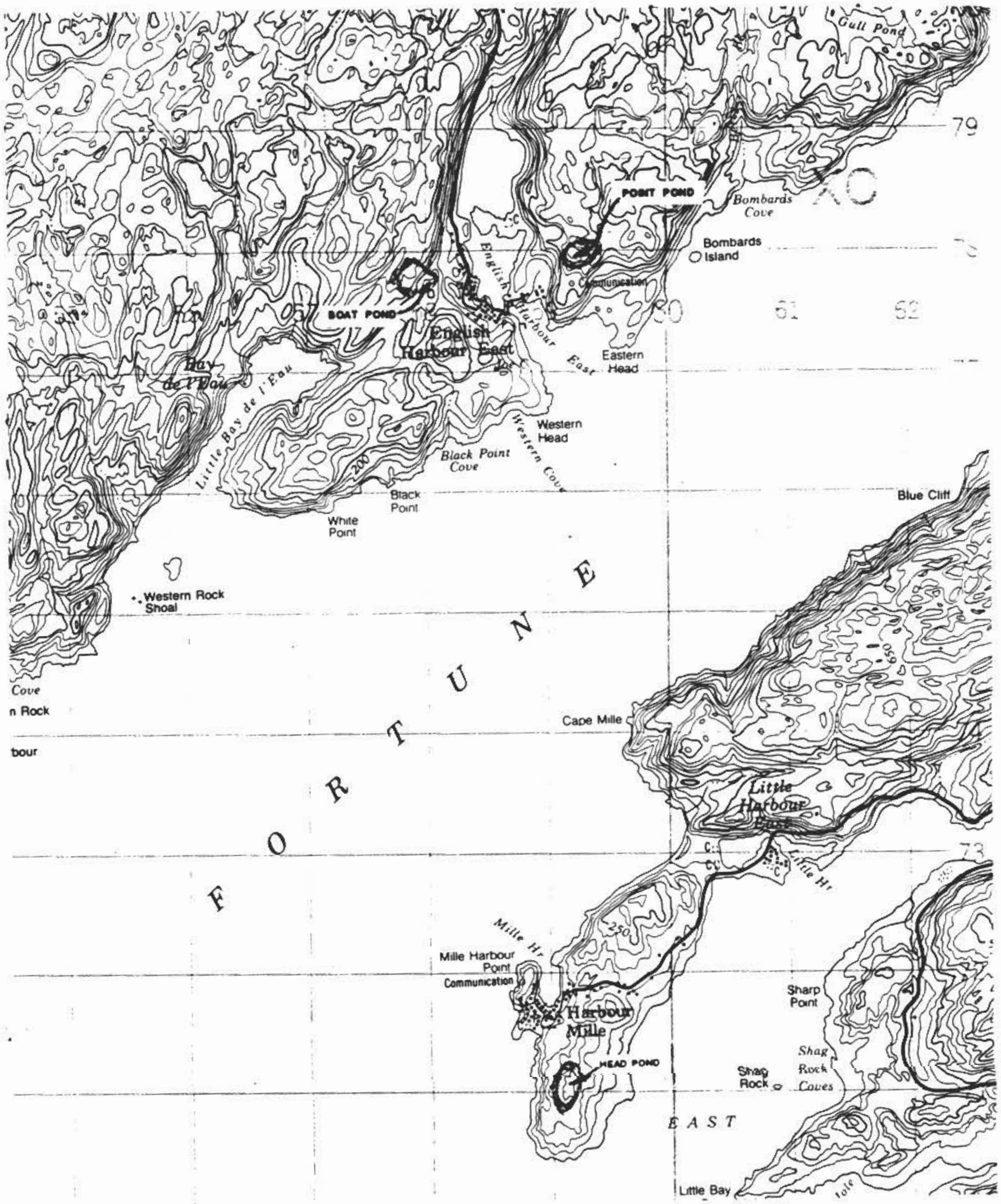
Council believes that this Community should be supplied by drilled wells. An additional six wells would be necessary to provide the Community with a water supply. The pond sources would then be abandoned.

WASTE WATER DISPOSAL

New houses have septic tanks and drain fields. The older houses near the harbour have pipes to salt water. There was a minor problem about two years ago when one of the drainpipes broke. This has been rectified. At present no sanitation problems are apparent.

COMMENTS

It appears that this Community will solve its water supply problems by means of drilled wells, with each well connected to a few houses. This has been the pattern of development for water supply for the last few years.



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REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

ENGLISH HARBOUR EAST AND HARBOUR MILLE–LITTLE HARBOUR EAST

ACRES

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF EPWORTH - GREAT SALMONIER

GENERAL INFORMATION

Information sources: Mrs. Brewer, wife of Chairman of Council; Department of Health, Rick Grikis.

Population: 269 (Department of Municipal and Provincial Affairs records).

Service charges: No services charges are imposed because waster and sewer systems are privately owned.

GROUND WATER SUPPLY

Drilled wells: Five privately owned wells have been drilled in Epworth, but only two have yielded water sufficient enough to warrant a hook-up for domestic use.

Dug wells: Privately owned dug wells serve as the water supply.

Adequacy: The yield of the dug wells is generally adequate but some run dry in extended periods of dry weather. These households have been obliged to collect water from other local sources.

WATER QUALITY

Bacteria: No adverse opinion by the Department of Health.

Department of Health: Grand Bank

User opinion: No adverse comment.

WASTE WATER DISPOSAL

Septic tanks with drain fields or lines to salt water are used. No sanitation problems are reported.

COMMENTS

There are no plans for a municipal system. If it were necessary to increase the water supply a detailed investigation would be required to examine any available sources.

MUNICIPALITY AND INDUSTRY, SURFACE WATER SOURCE

TOWN OF FORTUNE

GENERAL INFORMATION

Information sources: Town Manager, Jacob Thornhill; Works Superintendent, Earle Rose; Fish Plant Manager, Wilson Fudge. Department of Health, Grikis. Information on file, Colin Karasek Ltd. Design drawings for regional water system, R. J. Noah and Associates, 1967. Design drawings for new screen chamber and chlorinator, NewPlan Consultants, 1988.

Census data: Population: 2406 (1976), 2473 (1981), 2370 (1986), 2177 (1991). Dwellings: 673 (1991). Average: 3.23 persons per dwelling.

Water and sewer rates: Residential $16 per month for water and sewer. Commercial, varies. Fish plant, 35 cents per 100 gals.

Ownership: Originally this was an Industrial Water Supply, owned by the Department of Municipal and Provincial Affairs. The construction financed by Federal/Provincial shared cost agreement. Since 1982 the system has been under the Town's management. The Town bears all operation and maintenance costs although the Provincial Government still covers major capital costs.

SURFACE WATER SOURCE

Description: The main reservoir, Horse Brook Pond, provides a gravity feed to the Town and fish plant. There is a back-up pond, the Reserve reservoir. When additional water is required, the Reserve reservoir feeds by gravity through a pipeline to a brook running into Horse Brook Pond.

Users: A common supply main serves the Town and fish plant.

Dam, Horse Brook Pond: This pond was created by an earth dam 80 m long, with maximum height at the old river bed of 9.1 m and a top width of 9.0 metres. (Data from the 1967 drawings.) The dam appears to have been raised about 0.6 m since it was constructed in about 1968.

Reservoir, Horse Brook Pond: According to the design drawings, excavation was carried out behind the dam to leave a plain surface for the reservoir bottom with side slopes at 1V:2H. The reservoir bottom slopes towards the intake.

Dam, Reserve reservoir: Earth-filled dam 225 m long (from drawings), and with maximum height at the old river bed of about 6.9 m.

Spillway, Horse Brook Pond: A weir, in the form of a concrete channel, built into the dam. Width, 9.1 m, freeboard to top of dam 1.8 m. Spillway elevation 53.4 m (175 ft.) above LWOST.

Spillway, Reserve reservoir: The spillway is built into the dam. Freeboard to top of dam 1.70 m (field measurement). Width of spillway 6.1 m.

Reservoir surface area:

Horse Brook Pond	Approximately 15,500 sq. m., estimated using the design drawings.
Reserve Reservoir	10.8 hectares

Live storage head:

Horse Brook Pond

1. Using the 1967 design drawings, from the sill of the spillway, the top of a concrete box forming the intake; LSH = 5.26 m. The top of a wire screen over the intake box is shown at a water depth of 4.4 m, which is close to the visual estimate of 4.3 m given by the Works Superintendent.

2. Using the 1988 screen chamber design drawings, from the intake of the sill on which the bottom of the screens rest, to the spillway, is 1.66 m. The aluminum frame of the screen is at a 75 mm angle, so the effective LSH, for screened water at least, will be 1.66 - 0.075 = 1.585 m.

3. The screen chamber can be bypassed to draw down more of the reservoir, i.e. revert to the original system. However, this water will not be screened or chlorinated and will therefore require a temporary chlorinator.

Reserve Reservoir

Estimated from former pumphouse floor elevation and spillway elevation. From spillway to top of intake to the 300 mm gravity line to Horse Brook Pond, LSH = 4.3 m.

Live storage volume:

Horse Brook Pond

Estimated using the 1967 design drawings at approximately 68,000 cubic metres.

Watershed area: Horse Brook Pond: 190 hectares
Reserve Reservoir: 219 hectares

Watershed protection:
Horse Brook Pond; protected. Also within the Town boundary.
Reserve Reservoir; not protected.

Developments on watersheds: Both watersheds are barrens and boglands, uninhabited, but accessible to ATV's. There is an access road from the highway to the screen chamber/chlorinator building and to the Reserve reservoir dam.

WATER QUALITY

Bacteria: Free chlorine residual invariably obtained on testing. Tested by Council forces and the Department of Health.

Sediment in the water: The fish plant reports that a sediment appears after ice made in the plant has melted.

Department of Health: Grand Bank

Fibrous material in raw water: For the first time ever, in 1992, a problem with odour and bad taste in the water was noticed. This may be due to algae which appears as a dark red fibrous material on the raw water screens. There is a considerable amount of this fibrous material in the water supply, so much so that the screens have to be cleaned at least twice a week. The blockage in the screens is such that there is a significant head differential between the upstream and downstream sides of the screens.

Reservoir cleanout: The Horse Brook reservoir has not been cleaned out since it was constructed. Council proposes to carry out this work in the near future. It is anticipated that this might improve water quality by removing excessive fine material from the pond and possibly the algae problem.

EXISTING STRUCTURES

Pipelines:
Reserve reservoir to feeder brook to Horse Brook Pond, 300 mm diam. gravity line, controlled by a valve at Reserve reservoir. Installed about 1989.
Horse Brook Pond to fish plant, 460 mm diam. gravity line. A reinforced concrete pipe, installed about 1968.

Screen Chamber: Completed February 1990. Two sets of three screens each, in parallel, each screen 1625W x 1650H. Not enough water can pass the finest screen, 20 mesh, when the fish plant is working, so this screen is used infrequently.

Chlorination: The chlorine system is in the new screen chamber; the chlorine flow rate is adjustable manually, and the chlorine is injected at a fixed rate, independent of the flow volume of water. There is a rate indicator and a rate setter to change the chlorine dosage. Two submersible pumps in the wet well of the screen chamber are used alternately as booster pumps to draw in chlorine gas through an injector on the discharge line of these pumps, and to inject the solution into the 460 mm diam. discharge main.

Pumphouse, Reserve reservoir: When the Reserve reservoir was constructed in 1973, a pumphouse was included to pump from the Reserve reservoir through a pipeline into a brook leading into Horse Brook Pond. However, it was found out that in dry periods many days of pumping was required to wet the ground sufficiently for the brook to carry flow to Horse Brook Pond. It is apparent from the contour maps that a gravity line should be possible. Hence two or three years ago the pumphouse was abandoned and a gravity line was built.

DEMANDS

Metering:

1. A water meter was available, up to three years ago, in the former chlorination building that was associated with the original supply system. This meter read the total output of the fresh water supply system, including Town and fish plant. The Works Superintendent states that typical consumption a few years ago, based upon these meter readings, was as follows:

Town only:	1364 cubic metres/day (300,000 I gal. per day)
Plant working:	2273 cubic metres/day (500,000 I gal. per day)

2. The fish plant water supply is metered, typically now 227,000 cubic metres a year (50 million gallons) according to the fish plant manager.

Existing:	Domestic:	684 connections
	Business:	40 connections
	Schools:	2 schools, totalling 450 pupils
	Fish plant:	Domestic requirements and some production equipment; see note below.

Fish plant: The fish plant has a salt water line which draws about 150,000 cubic metres (30 million gallons) per year. The plant relies as much as possible on salt water. Under certain wind and tidal conditions the salt water supply becomes blocked and hence the fresh water demand is stepped up, to be used instead of salt water. In any case, a substantial volume of fresh water is required for washing down the equipment. This is a ground fish processing plant. The fish plant manager does not foresee any major increases in water demand in the future.

SUPPLY

Shortage: The supply ran short in 1990. In order to continue to provide water for the Town, the plant's fresh water supply was shut off. According to the municipal officials water conservation has been practised at the plant since that period and the volume of fresh water used has stabilized.

Adequacy: The adequacy of the present system for future requirements is difficult to assess. The new screen chamber and chlorination system has altered the dynamics of the supply system in respect to the storage that can be taken from the Horse Brook reservoir. Because of the fibrous material and the silt in the water it seems essential that the water passes through fine screens. However, as the water level in the Horse Brook reservoir drops, the area available for screening reduces proportionately and the resistance to flow increases. Hence the water level in the Horse Brook reservoir can be taken down by only a limited amount, if screened water is required. With deeper screens, a greater drawdown of the reservoir would have been possible. The reservoir also serves as a settling basin for the run-off and flow from the reserve reservoir.

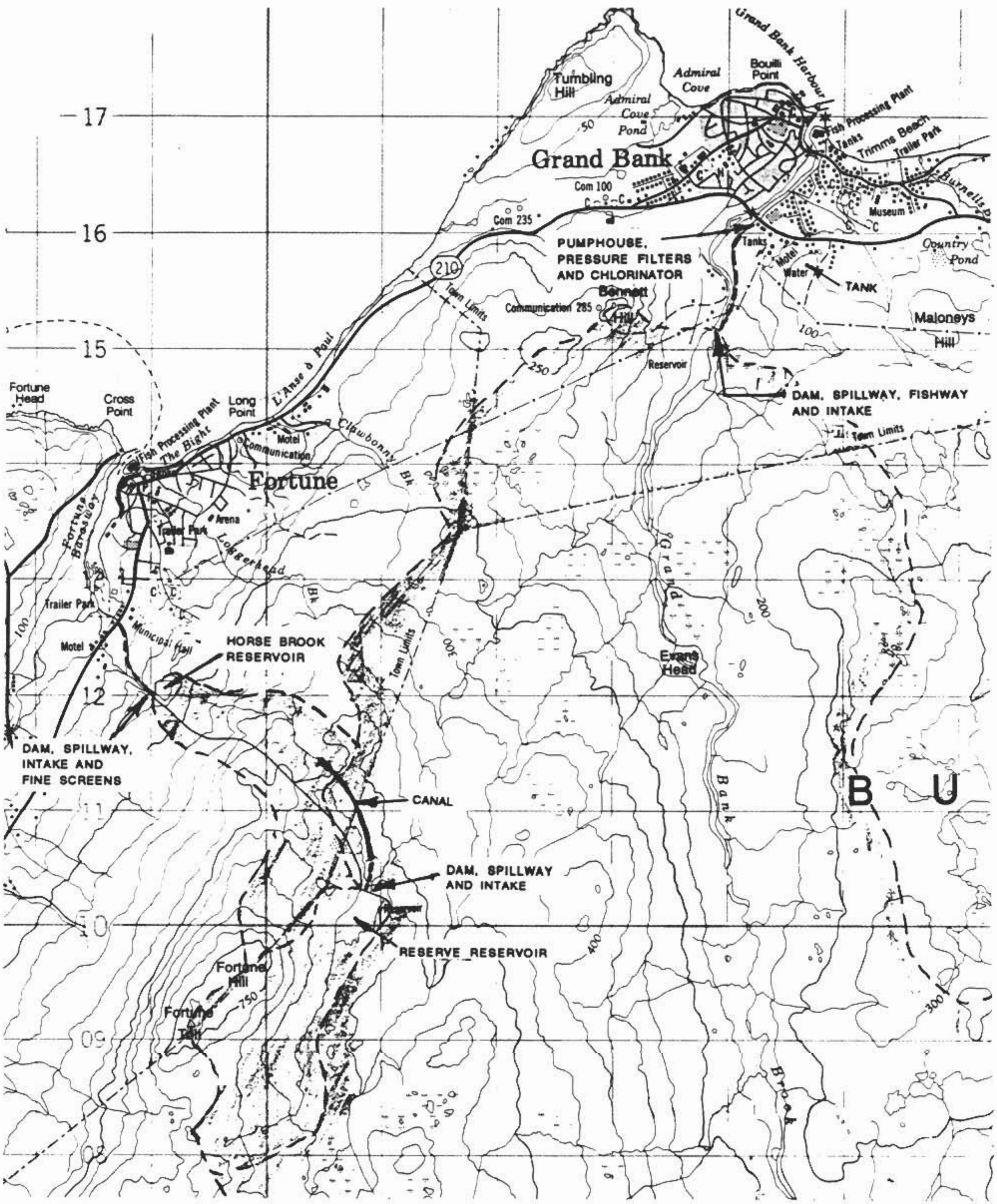
Means of increasing supply: There is no readily apparent method of increasing the total supply. The volume of screened supply could be increased by building a screen chamber with a lower sill.

WASTE WATER DISPOSAL

The Town has a full-scale sewage collection and disposal system.

COMMENTS

See previous remarks concerning "Adequacy of Supply".



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
FORTUNE AND GRAND BANK

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF FOX COVE - MORTIER

GENERAL INFORMATION

Information sources: Engineering report, Newplan Consultants, 1990. Contract drawings, May 1992, Newfoundland and Labrador Consulting Engineers. Consultant's Branch Manager, Gerard Corchoran, C.E.T.

Census data: Population: 469 (1976), 469 (1981), 500 (1986), 464 (1991). Dwellings: 134 (1991). Average: 3.46 persons per dwelling.

History: This town has relied on dug wells and 12 drilled wells for supply. Construction of a new gravity supply started in the fall of 1992. The following description is of the new supply. At the time of the survey only a part of the transmission main had been constructed.

Map: See Burin.

SURFACE WATER SOURCE

Name: Deep Pond. A natural pond. Elevation 64.9 M.

User: The Town will be the only user.

Dam: No dam.

Reservoir surface area: 2.9 hectares (Newplan Consultants)

Watershed area: 188.0 hectares (Newplan Consultants)

Live storage head: According to the contract drawings the bottom of the screens in the screen chamber will be the governing factor. LSH = 1.9 M. At the time of the survey the screen chamber had not been constructed.

Status of watershed protection: Not protected.

Developments on the watershed: This is an undeveloped, wooded area.

WATER QUALITY

Bacteria: Water supply accepted for disinfection by simple chlorination.

Chemical tests:

Colour: 16.0 - 25.0 units (three tests). Although these values exceed the recommended high limit of 15.0, this water is far better than many Newfoundland waters.

Hardness: 17.9 - 22.0 mg per litre (three tests). The recommended limits are 80 - 100 mg per litre. This water appears to be corrosive, which is typical of many Newfoundland waters. Addition of soda ash would be desirable.

Department of Health: Salt Pond

EXISTING STRUCTURES

Proposed intake: Horizontal pipe 315 mm diam. HDPE with a coarse screen. Under a fire flow this type of arrangement would create high intake losses which may bring in small fish and silt. This may not be significant because the fine screens would trap such material.

Proposed screen chamber: Two sets of screens, of two fine screens each in parallel. Each screen 2700H x 9500W mm. Gated so that one set of screens can be used at a time. Screen mesh sizes 20 and 25 meshes per inch.

Proposed chlorination: Hypochlorinator, proportional feed through a water meter. Distance to first connection 450 M.

Transmission main: PVC DR 18 200 mm diam., length 1,000 m from the pond to the highway.

DEMANDS

Metering: There will be a water meter in the chlorination system.

Existing: Mortier: 93 dwellings
Fox Cove: 48 dwellings
School

Future: No major increase in demand is expected.

SUPPLY

Adequacy: The supply is expected to be adequate for the foreseeable future.

Means of increasing supply: The water level in the pond could be raised up to 1 m by constructing a dam about 40 m long, up to about 3 M high, at the outlet brook. Modifications to the screening system would be required. This information is based upon the contract drawings.

WASTE WATER DISPOSAL

The system will include main sewage collection and disposal.

COMMENTS AND RECOMMENDATIONS

None.

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF FRENCHMAN'S COVE

GENERAL INFORMATION

Information sources: Council Secretary, Elaine Cluett. Personal communication, Bren Davis, P.Eng., Nolan Davis and Associates, Consulting Engineers. Department of Health, Rick Grikis.

Census data: Population: 307 (1976), 295 (1981), 275 (1986), 229 (1991). Dwellings: 76 (1991). Average: 3.01 persons per dwelling.

History: The original water supply from drilled wells provided water of poor quality. A shallow well has recently been installed, which appears to be providing water of better quality.

GROUND WATER SUPPLIES

Drilled wells, Council: 3 wells were drilled for the community by the Provincial Government about 16 years ago. These have served as a water supply until recently (see "Water Quality", below). Depth of wells 10 M, water table about 1.25 M below ground surface.

Drilled wells, other: 3 drilled wells are recorded, in addition to those of the Council.

New well: A shallow well, consisting of a concrete tube 1.8 M diam., has been installed to a depth of 2.5 M.

WATER QUALITY

Bacteria: Simple chlorination is satisfactory for disinfection.

User opinion, drilled wells: Water is high in iron and manganese and the water tastes sulphurous.

Shallow well: A layer of better quality water, probably rain water, rests over the deeper water of poorer quality.

EXISTING STRUCTURES

Pump: The shallow well has a submersible pump with the On-Off cycle controlled by the water level in a hydropneumatic tank.

Tank: A 2270 L tank is pressurized through an air compressor which is automatically controlled by the water level in the tank.

Distribution mains: Domestic flows only.

DEMANDS

Metering: A water meter is in the line.

Existing: About 80 houses and small businesses. No industrial demand.

SUPPLY

Existing: The supply volume in the new shallow well is ample, based upon a pump test by the consulting engineer.

Means of increasing supply: Provide a similar well, at distance from the existing well.

WASTE WATER DISPOSAL

No problems are reported.

COMMENTS

No comments.

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF GARNISH

GENERAL INFORMATION

Information sources: Town Manager, Steve Grandy; Works Superintendent, Gary Banfield; egg farmer Mr. Cluett; Department of Health, Rick Grikis.. Construction drawings, Newplan Consultants.

Census data: Population: 678 (1976), 761 (1981), 756 (1986), 716 (1991). Dwellings: 246. Average 2.91 persons per dwelling.

Service fees: Water: $13.00/month. Sewer: $2.00/month.

History: The Town started to install a municipal water and sewer system about 8 years ago, using financing through the Department of Municipal and Provincial Affairs. The work is about 40% completed towards full servicing of the Town and proceeds each year as funds permit.

SURFACE WATER SOURCE, GRAVITY

Name: Wych Hazel Pond. Elevation 22.57 M. Reported to be 5.0 M deep, or more.

Users: The Town is the only user.

Watershed area: 38.5 hectares (Newplan Consultants)

Reservoir area: 10.0 hectares (Newplan Consultants)

Dam: No dam.

Spillway: Natural brook.

Live storage head: Governed by pond level and bottom of screens in the screen chamber, based upon the engineering drawings. LSH = 1.50 M.

Status of watershed protection: Protected.

Developments on watershed: Remote area, but accessible to ATV's.

GROUND WATER SUPPLIES

Houses not on main water have private wells. About 155 buildings, plus elementary school, are not on main water.

WATER QUALITY, SURFACE SOURCE

Bacteria: Chlorine residuals are achieved in the distribution network. Tested by Town and the Department of Health.

Department of Health: Grand Bank

Fine screens: There is very little suspended matter. The screens have to be washed only once or twice a year.

User opinion: A good quality water.

EXISTING STRUCTURES, SURFACE WATER SYSTEM

Pipeline: 300 mm diam. PVC. The pipeline route involves a crossing of the Garnish River about 100 M wide where ductile iron pipe is used. The water depth is sometimes affected by the tide but can be usually forded by a high wheel base vehicle. The pond is 3.1 km from the edge of the built-up area of town.

Screen chamber: One set of three screens. Each screen is 2500H x 810W in area. Building is 4.8 x 3.6 M in plan area, concrete block with brick facing. The building is located 165 M from the pond.

Chlorinator: A chlorine gas through a regulating valve is injected into the wet well of the well screens through a diffuser.

Hydrants: Static pressures range between 20 and about 30 psi.

Future booster pump: A booster pump will be needed if water services are extended to the south end of town towards the highway.

DEMANDS

The following tabulation shows the present hook-ups and also the number expected when the water and sewer system is completed to the extent planned by Council.

Houses and other small buildings:	existing: 131	Future total 286
School:	existing: nil	Future about 88 pupils
Poultry farm:	existing: insufficient supply*	Future 7,000 gals/day

*At present the egg farm, which has 10,000 birds, is connected by a 50 mm diam. line, 300 M long. This is inadequate for the farm.

The local fishery has no demand for fresh water. In the long term no significant increase in demand is anticipated.

SUPPLY

Adequacy: Adequate at present, and expected to be adequate in the future.

Means of increasing supply:

1. About 1.5 M additional storage could be provided in this pond by constructing a dam 60 M long on the outlet brook. (Information from Newplan Consultants.) This will be a low dam, up to about 3 M high.

2. Lower the concrete screen sill, screenhouse. According to the drawings it should be possible to increase the drawdown from the pond by doing this but detailed engineering surveys would need to be made to check out the relevant elevations before a decision is made.

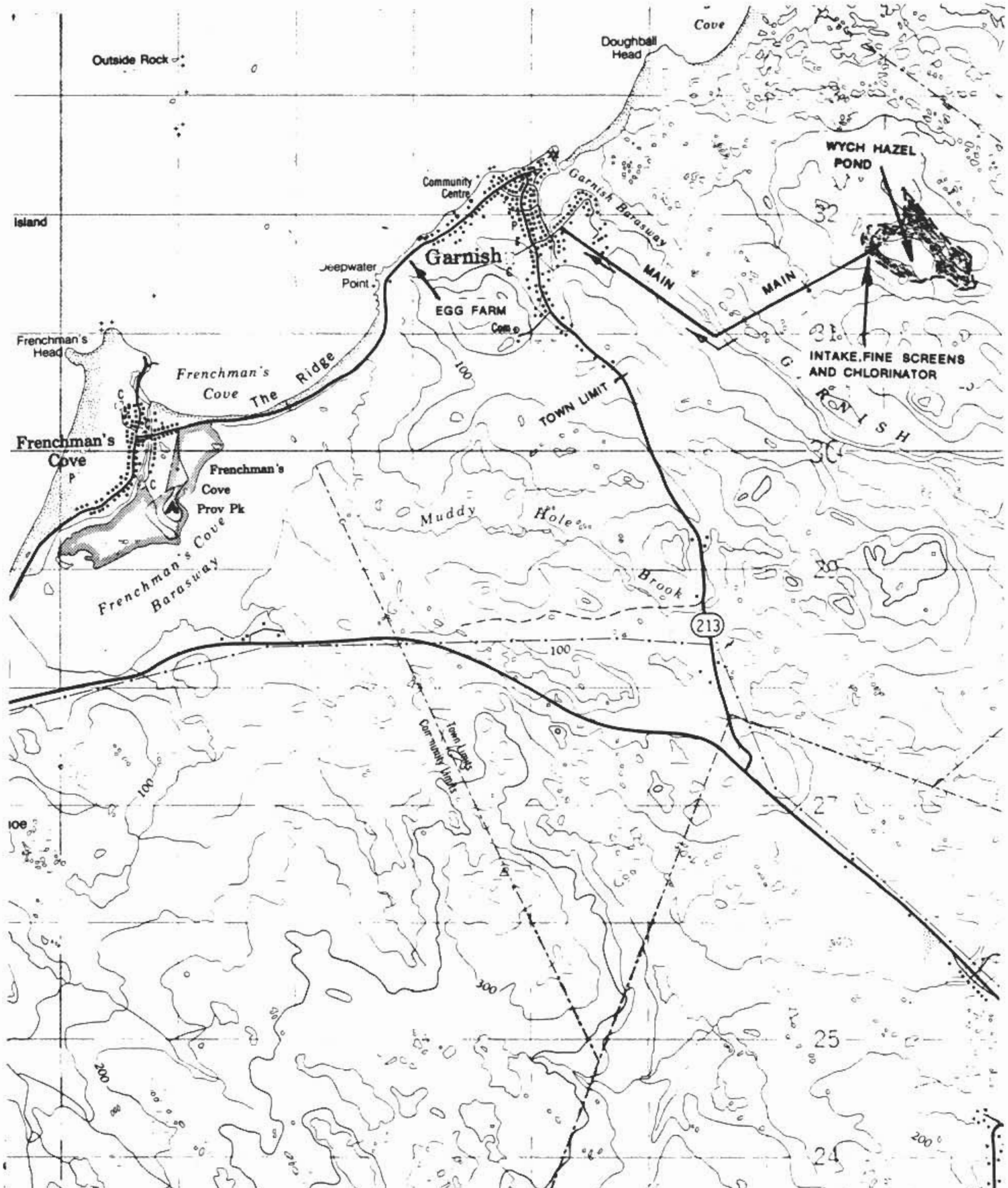
WASTE WATER DISPOSAL

At present the system is a mixture of main drainage and individual septic tanks or pipes to salt water. One area of Town involving 8 houses has a high priority for the installation of main sewage because the existing private systems cannot function properly. The final sewer system will require one lift station.

COMMENTS

1. New chlorinator: At present it is sometimes difficult to get chlorine cylinders to the screen chamber because of the Garnish River. A new building with the power supply and a flow-paced chlorinator should be built on the Garnish side of the Garnish River. This system should have a water meter, and a booster pump for injecting the chlorine solution. A small amount of chlorine should be injected at the screen chamber to keep the lines clear of bacteria. Because of the relatively large size of the mains, the long distance and the relatively low demand, the water is slow moving in the pipeline. Hence it is quite possible that bacteria could build up in the line between the screen chamber and the chlorination building.

2. The chlorine gas cylinders in the screen chamber should be enclosed in a separate room. At present there is corrosion starting in the steel overhead beam used for removing the screens. This problem is likely worsened by the presence of chlorine gas.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
GARNISH

ACRES

SURFACE WATER SOURCE, FISH PLANT WATER SUPPLY

TOWN OF GAULTOIS

GENERAL INFORMATION

Information sources: Several engineering reports, the most recent being Newplan Consultants, 1990. Plant Engineer Gaultois Fish Plant, Gordon Hunt. Department of Municipal and Provincial Affairs, Gerald Healey. Department of Health, Pat Beson.

Census data for the Town: Population: 583 (1986), 516 (1991). Dwellings: 139 (1991). Average: 3.71 persons per dwelling.

History: The fresh water system for the fish plant was built about 1966 and the salt water system was built about 1970.

Ownership: Both salt and fresh water systems are owned by the Provincial Government and operated by the fish plant on behalf of the Provincial Government.

SURFACE WATER SOURCE

Name: Cluett's Pond, a pumped supply, elevation 13.4 M above sea level.

Users: The fish plant system is used by the fish plant and about 30 houses in the community. There are also about 10 water lines which draw water from the pond to various houses, probably using pumps.

Dam: No dam.

Watershed area: 203 Hectares.

Status of watershed protection: Protected.

Reservoir area: 14.0 Hectares.

Live storage head: 3.5 M, water level in wet well to submersible pump intake (information from Gordon Hunt).

Developments on watershed: There is a walking trail around the pond and a few buildings are built on the watershed of the pond, but mostly on the watershed boundary. The large majority of buildings in the community are outside the perimeter of the watershed. At the outlet end of Cluett's Pond there is a stagnant area of water separated from the main pond by a causeway. The engineering studies referred to consider this water body a potential pollution hazard and recommend that this area should be filled in.

Spillway: There is a culvert through the causeway and the outlet to the pond is a natural brook.

WATER QUALITY

Bacteria: Samples from Cluett's Pond, July 31, 1985, after rainfall, 14 samples taken. The test was satisfactory for coliform bacteria but there were other growths, possibly algae, on 8 of the 14 samples.

Chemical: Colour 120 units. pH 4.7 to 5.0. COD 12 and 15 mg per L. Alkalinity: under 0.5 mg per L. Hardness 6 mg per L. This water is therefore very highly coloured and potentially corrosive. The COD, which is an indicator for organic content, is in the low range for Newfoundland waters.

Department of Health: Grand Falls

User opinion: No adverse opinion.

EXISTING STRUCTURES

Intake: 150 mm diam. pipe from Cluett's Pond into a wet well which has a submersible pump. The pump drives the water through pressure filters into a nearby storage tank 140 cubic metres capacity.

Flow ratings: Pump 4.2 L per second at 9 M head. Filters 3.8 L per second.

Transmission main: From the tank a gravity line 100 mm diam. 335 M long flows to the fish plant.

Chlorination: The water is chlorinated by gas before and after filtration.

DEMANDS

Metering: Readings provided by the Department of Municipal and Provincial Affairs in imperial gallons per year have been converted to cubic metres per year.

Year	Fresh water	Salt water
1984	17,901	85,450
1986	38,043*	264,022
1989	30,344	230,577
1990	16,913	151,909
1991	25,621	129,790

* Peak year for fresh water

Number of connections: Fish plant, clinic, Lion's Club, and houses, for a total of about 30 buildings.

Future proposals that would increase demands: Engineering studies have been conducted to examine a full scale municipal water and sewer servicing scheme for the Town, including the fish plant. This Town is considered high priority for servicing among Government officials because of the current pollution problems. Hence servicing will be carried out when funding is available and the economic conditions warrant. The present fish plant system will be obsolete and will be superseded by a new municipal/fish plant system.

SUPPLY

Adequacy: The water supply has always been adequate in the past for the needs of the fish plant. The supply will be adequate for the proposed municipal/fish plant system providing a dam is included (see below).

Means of increasing supply: A dam to raise the water level in Cluett's Pond by 1.5 M would need to be about 70 M long.* (Such a dam is being considered for the new water supply mentioned above.) Very little additional land would be flooded because the pond has steep sloping sides.

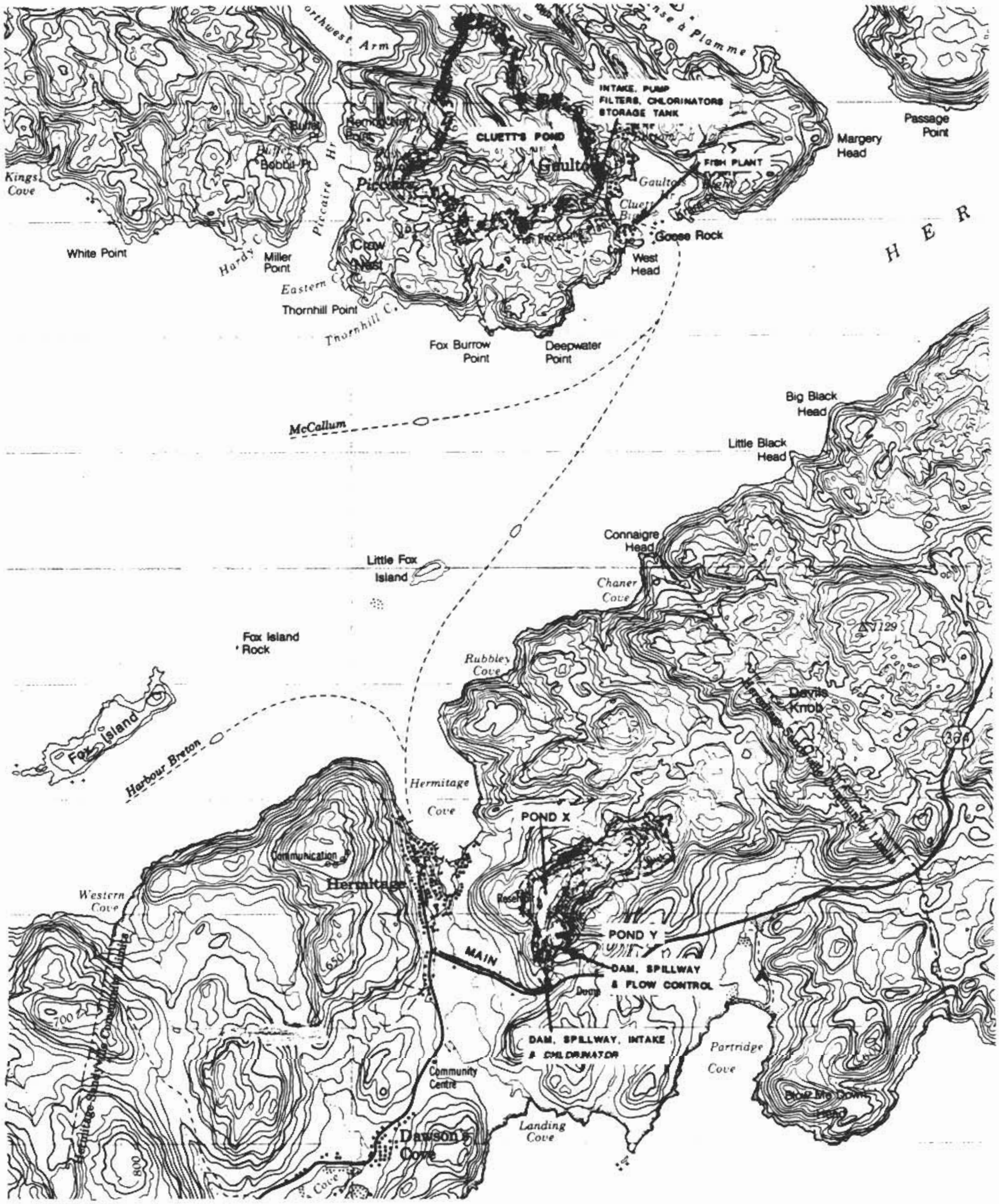
* This analysis is based on a 1:2400 contour map.

WASTE WATER DISPOSAL

Because of the rocky terrain, septic tanks and drain fields cannot be readily constructed and most of the domestic sewage finishes up in Gaultois harbour. The Department of Health considers this to be a high priority area for improving sanitation conditions.

COMMENTS

No comments.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

GAULTOIS AND HERMITAGE—SANDYVILLE

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF GRAND LE PIERRE

GENERAL INFORMATION

Information sources: Deputy Mayor Hazel Bolton; Community Clerk June Kearley; Construction drawings, Newlab Consultants Ltd; Department of Health, Sherri Rees; personal communication, Max Mercer, P.Eng., Newlab Consultants.

Census data: Population: 368 (1976), 381 (1981), 401 (1986), 356 (1991). Dwellings: 97 (1991). Average 3.67 persons per dwelling.

History: The existing water system was installed many years ago with main lines 75 mm diam. and smaller. The water quality was very poor because of the nature of the pond or the way the intake was placed in the pond. Currently the first stage in a new water system is under construction. This is intended to provide better quality water and larger mains for distribution and fire fighting.

SURFACE WATER SOURCE, EXISTING

Pond: Line Pond, a natural pond providing gravity supply.

Users: Community only.

Dams: No dams.

status of watershed protection: Protected.

WATER QUALITY, EXISTING

Bacteria, raw water: Tests in May, 1987:
Total coliform count 6-14 (6 tests).
Faecal coliform count 4-14 (6 tests).
This type of water can usually be disinfected with simple chlorination.

Bacteria, treated water: Tests in May, 1987: 48% of the samples tested showed excessive coliform counts. It was believed that the water was being contaminated from slime that had built up inside the water mains.

Medical opinion: In 1982 the local physician for the community, Dr. Acharya, and in 1990 Dr. Garcia, both wrote letters to Council documenting their concerns regarding a higher than normal incidence of gastro enteritis in residents of the community which may be attributed to the water supply.

Chemical tests: Tests in 1988:
Colour: 62 units, average of 5 tests. (Recommended maximum 15 units.)
Alkalinity: 2.6 mg per L, average of 4 tests. (Recommended minimum 30 mg per L.)
Chemical oxygen demand: 31.3 mg per L, average of 3 tests.
This water is highly coloured, probably corrosive, with a high organic content. A tannin lignin test gave a reading of 1.9 mg per L to compare with boglands which have a value of 3.0 to 4.0 mg per L.

Other problems: The water supplied frequently carries an appreciable sediment load and sometimes insect larvae. A "boil order" is in force.

SURFACE WATER SOURCE, PROPOSED

Source: Dam on Line Pond Brook, just upstream of Line Pond. Information on storage capacity for this dam was obtained from the consulting engineer and from this the storage reservoir is estimated to provide about six days of supply at normal domestic consumption. This will be a gravity supply.

Users: Community.

Dam: Reinforced concrete wall, 3.5 M high, length 51.0 M.

Spillway: 3.5 M in length, 400 mm below crest of dam.

Reservoir storage area: The area of land to be cleared for the reservoir and dam totals 1.1 Hectares according to the drawings. The reservoir surface area will therefore likely be about 10,000 square metres.

Watershed area: 26 Hectares.

Live storage volume: To make the reservoir, 600 cubic metres of rock was excavated, as well as overburden. The volume of water to be stored will be about 1,000 cubic metres (Max Mercer).

Status of watershed protection: Protected.

Developments on watershed: None apparent.

WATER QUALITY, PROPOSED SYSTEM

Bacteria: Simple chlorination has been approved.

User opinion: No opinion available. Because the pond sediments are avoided, this is expected to be better quality water than the original supply from Line Pond.

EXISTING STRUCTURES

Mains: 75 mm diam. and smaller, with frequent leaks.

Fire hydrants: Five fire hydrants. However, the pipes are too small to provide fire flows.

PROPOSED STRUCTURES

Transmission mains: 250 mm diam. high density polyethylene pipe, sized for fire flows.

Fine screens: One series of 2 screens is proposed, each screen 1200 x 1030 mm.

Chlorinator: Hypochlorinator, with Woltmann water meter for flow paced control of solution feed rate.

DEMANDS

Completion of system: 111 connections are proposed.

Future: No significant increase in demand is expected.

SUPPLY

Present adequacy: The present supply is inadequate because it delivers water of very poor quality.

New system: This system will have storage for six days' consumption. There is no upstream storage, and the watershed is small and may be deficient in yield in extended dry periods. A detailed study is required.

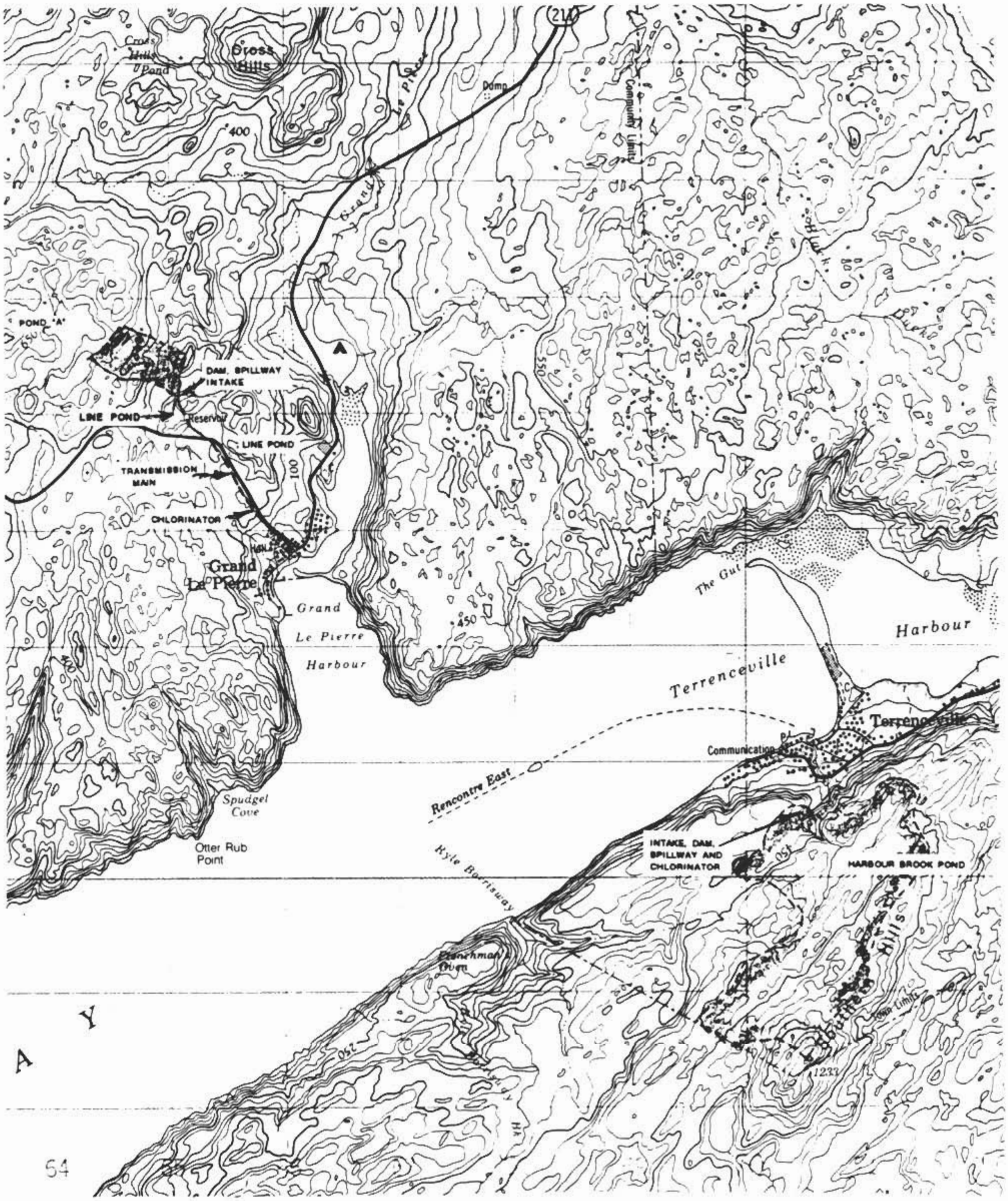
Means of increasing supply: It will be feasible to draw from a pond on another watershed, according to Mr. Mercer; see "Pond A" on plan. No specific investigations have been carried out in respect to this. See "Comments", below.

WASTE WATER DISPOSAL

Presently, 100 mm and 150 mm pipes to salt water are used. The community proposes to install a standard main sewage collection and disposal system.

COMMENTS

This system needs a detailed study to evaluate the adequacy of the water supply and the means of increasing supply, if necessary.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

GRAND LE PIERRE AND TERRENCEVILLE

ACRES

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF GRAND BEACH

GENERAL INFORMATION

Information sources: Chairman of Local Service District, Jessie Hollett; Department of Health, Rick Grikis; Department of Municipal and Provincial Affairs, Randy Dillon P.Eng.

Population: 94 (Department of Municipal and Provincial Affairs records)

GROUND WATER SUPPLIES

Dug wells: The houses are served mostly by dug wells. Some wells have a pump and some are established on a hill and run by gravity to the house.

Adequacy of yields: Most people run short of water in summer.

WATER QUALITY

Bacteria: No problems have been brought to the attention of the authorities concerning excessive bacteria.

Department of Health: Grand Bank

DEMANDS

Existing: 50 houses and a church are reported in the community.

Future: No significant increase in the demand is anticipated.

SUPPLY

Existing: The existing supplies are inadequate because of the shortage of water in summer.

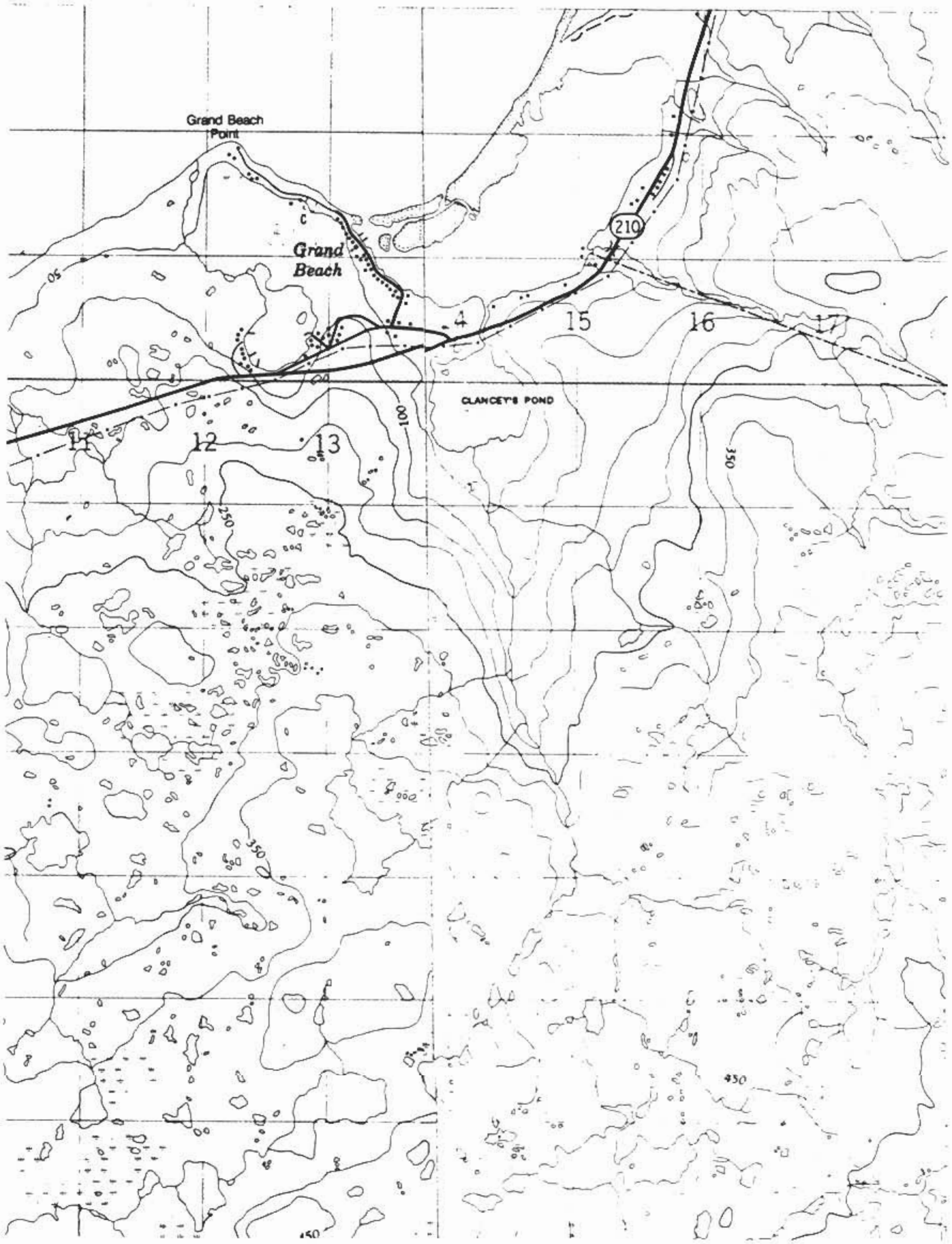
Means of increasing supply: (a) The community has approached the Department of Municipal and Provincial Affairs for funding to develop a surface water source using the pond and river system through Clancey's Pond. However, the ponds in this area are used extensively for recreational purposes and there may be a conflict in uses, or potential uses, if a surface water supply is developed using this pond and river system. (b) The Department of Municipal and Provincial Affairs is therefore considering investigating drilled wells as a source of supply. No drilled wells in Grand Beach are recorded in the "Water Well Data for Newfoundland and Labrador".

WASTE WATER DISPOSAL

Sewage is handled through septic tanks and pipes into the barrachois. No significant pollution problems are reported.

COMMENTS

See above, "Means of increasing supply".



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
GRAND BEACH

ACRES

MUNICIPALITY AND INDUSTRY, SURFACE WATER SOURCE

TOWN OF GRAND BANK

GENERAL INFORMATION

Information sources: Town Engineer, Jim Tessier; Town Manager, Clarence Brooks; Fish Plant Manager, Peter Llewellyn; former Works Superintendent, Norman Drake. Design drawings for dam, Gorman Butler Ltd., Consulting Engineers, 1973. Site inspection, Colin Karasek, Susan Richter, October 1992.

Census data: Population: 3802 (1976), 3901 (1981), 3732 (1986), 3528 (1991). Dwellings: 1140 (1991). Average 3.09 persons per dwelling.

Service fees: Water and sewer, $16.00 per month. All hook-ups have both water and sewer services.

Map: See Town of Fortune.

SURFACE WATER SOURCE

Source: Reservoir created by dam on Grand Bank Brook.

Users:
1. Municipal, Town of Grand Bank pump supply.
2. Fish plant, Grand Bank Seafoods, gravity supply.

Dam: Earth and concrete dam. The main portion is a large concrete gravity dam, 76 M wide, built 1972/73. The maximum height of the dam above bedrock is 12.5 M and the water level in Grand Bank Brook was raised by 7.0 M.

Spillways:

1. Weir, built into the top of the concrete dam. Width 6.10 M, freeboard to top of dam 0.91 M. An apron spillway follows the downstream slope on the concrete dam. Spillway elevation, 19.21 M to the datum used in the 1972 design drawings.

2. There was originally a series of six CSP vertical pipes, 1220 mm diam. with the top of each set at the same elevation as the weir spillway. These spillways are L-shaped with the vertical portion 7.0 M high and the horizontal portion passing through the concrete dam to discharge downstream. Only two are now functioning and four of the spillways have been closed off by a plate bolted to the outlet. Apparently the joint between the horizontal and vertical portions leaked after installation and considerable water was lost. They were therefore closed off.

3. A fish ladder built into the dam also acts as a spillway. See below.

Live storage head: The gate attached to the concrete dam structure, normally open, allows water to pass through a coarse screen into the discharge pipe at a lower elevation than the gate. The live storage head is measured from the sill of this gate to the sill of the spillway using the design drawings. LSH = 5.49 M.

Live storage volume: A detailed hydrographic survey has been made of the reservoir and the volume calculated at 166,215 cubic metres below the spillway elevation. Applying the LSH to the cross-sections of the hydrographic survey shows that about 95% of the storage volume can be withdrawn. Hence LSV = 157,900 cubic metres.

Reservoir area: 14 Hectares.

Watershed area: 56.0 sq. km.

Status of watershed protection: Protected.

Developments on watershed: Watershed is barrens and boglands and is uninhabited. It formerly included the reserve reservoir for Fortune. The watershed is accessible to ATV's.

Fishway: A concrete fish ladder, built into the top of the dam, also acts as a spillway. In terms of a spillway, the fishway is an L-shaped weir. The cross-sectional area is 1370W x 300H mm with a notch on one side at the bottom 450 x 450 mm.

Overflow of dam: The concrete portion of the dam overflows on an annual basis in the spring. Sometimes ice has tumbled over the dam causing damage to the fishway and the CSP spillways downstream. The original dam limited the overflow area to the central part of the dam over the downstream river bed, by means of a concrete block wall about 1.2 M high in from the bank each side on top of the dam. Originally there was a steel catwalk over the block wall which ran right across the dam. The wall and catwalk have been demolished by the ice.

WATER QUALITY

Bacteria: A chlorine residual is obtained, tested by the Town.

Department of Health: Grand Bank

Filtration: Three charcoal filters in parallel improve the quality of the water.

User opinion: No adverse opinion.

EXISTING STRUCTURES

Coarse screen: At the intake at the dam, cleaned a couple of times a year.

Transmission mains: A 600 mm gravity main runs from the dam to near the pumphouse. The line splits here: (a) 356 mm line to the fish plant, (b) suction line into the pumphouse. The Town line from the pumphouse is 200 mm diam.

Pumphouse: Three pumps, each rated 1.36 cubic metres per minute (300 gpm). Head 64 m (210 feet, 91 psi). 40 hp electric motor. All pumps are operated under manual control. Usually two pumps are operated continuously with the discharge pressure of 566 KPa (82 psi). The pumps discharge to the pressure filters.

Pressure filters: *In the pumphouse there are three pressure filters,* Culligan Model HR54, in parallel. These are new filters now being installed to replace similar old filters. Volume 3.0 cubic metres per filter, with each filter rated at about 0.73 cubic metres per minute (200 US gpm). These filters contain charcoal. Pressure loss through filters when backwash is needed: 55 KPa (8 psi).

Tank: Steel storage tank at ground level on high ground, 545 cubic metres capacity (120,000 gals.). Balances on the line without control valves. Top water elevation 58.8 M. Ground level elevation 36.5 M.

Disinfection: Chlorine gas is injected into a water flow stream in a pipe between the discharge and suction mains of the pumps, and hence the suction side of the pumps is chlorinated. The volume of chlorine used per day is manually adjusted. Distance to first consumer about 170 M.

DEMANDS, TOWN SYSTEM

Metering: The meter in the pumphouse is read daily in Imperial gallons. It typically varies between 1270 cubic metres per day (280,000 I.gals per day), and 1450 cubic metres per day (320,000 I.gals per day).

Existing demands:

Domestic:	About 1270 domestic and commercial connections
Schools:	735 pupils
Motels:	Approximately 25 rooms
Fish plants:	1. Grand Bank Seafoods. About 200 employees at peak. Water for potable and washdown uses. A shellfish plant.
	2. G and F Seafoods, about 60 employees, peak. Water for domestic and washdown uses. A shellfish plant.

Fresh water requirements, Grand Bank Seafoods

Metering: Volume not metered.

Previous demand: Originally the plant was groundfish operation with five cutting lines and extensive fresh water use for fluming and washdown. Typical flows: 9 cubic metres per minute for a shift of 8 hours, sometimes peaking to 18 cubic metres per minute (4,000 gpm).

Current demand: The plant is now a shellfish operation with 200 employees, using almost entirely salt water. A new salt water intake line was installed in 1991/92. Fresh water is used only for clean-up and washdown, using the connection to the Town system. The 460 mm line has not been used to any significant extent since the changeover to a shellfish operation.

SUPPLY

Drop in reservoir level: In 1990 the reservoir level dropped about 1 M. Normally the river flow exceeds the demand so that the spillways and fish ladder never cease to discharge. In the 20 year history of this dam the most the reservoir has ever dropped is about 2.4 M around 1986/87.

Adequacy: The system has proved adequate in the past and is likely to prove adequate in the future. (a) Fish plant consumption of fresh water has declined, (b) no major increase in housing is expected.

Means of increasing supply: (1) Check upstream tributaries for a suitable dam site and reservoir. Build additional storage upstream. (2) It is questionable whether the existing dam, a gravity structure, can be raised. The stability of the dam under the increased hydraulic loading would need to be checked.

WASTE WATER DISPOSAL

The Town has a fully functional sewage collection and disposal system. Some parts are becoming outdated and will be replaced.

COMMENTS AND RECOMMENDATIONS

1. The flooding heights over the dam for various flood frequencies up to 1:150 years need to be determined. It is doubtful if the present spillway system can handle even a 1:2 year flood because the concrete dam is reported to overtop each spring. Better control of spilling water over the dam should be established. The idea of the block wall previously constructed and destroyed should be repeated by anchoring a reinforced concrete wall into the top of the dam at each side. This will confine the spill and flood to the centre of the river. The design of this new spillway would be such that major overtopping would occur only rarely, say 1:150 years. The increased water pressures on the stability of the dam need to be checked.

2. Some chlorination before filtration is usually desirable to control the growth of bacteria in the filter media. Sometimes chlorination during backwash is done for the same purpose. However, charcoal filters remove chlorine from water. Hence a chlorination system downstream of the filters should be installed. This will require a booster pump.

3. Consider using the tank water level to automatically control, by electrode floats in the tank, the on/off cycle to the pumps. This will facilitate operations and reduce the potential for power consumption that may occur if overpumping takes place.

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF HARBOUR MILLE - LITTLE HARBOUR EAST

GENERAL INFORMATION

Information sources: Chairman of LSD Council, Sophie Pardy. Water Resources Division, Groundwater Section, Department of Environment and Lands, Keith Guzzwell, P. Geol. Department of Health, Sherri Rees.

Population: 345 (Department of Municipal and Provincial Affairs records).

Buildings: There are about 60 houses and small businesses in Harbour Mille and about 15 in Little Harbour East. There is no school or fish plant.

Map: See Community of English Harbour East.

SURFACE WATER SOURCE

Pond: Head Pond, a gravity source. The pond has an area of 1.5 Hectares, with a watershed of 8 Hectares.

Comment: A water system from this pond, using domestic flow sized plastic water line, was installed about 25 years ago. The quality of the water proved to be very poor and is not used by the local people. Hence a program is underway to develop ground water sources.

Watershed protection: Not protected.

GROUND WATER

Type of wells: In the past the usual shallow dug wells have proved to be inadequate because of the rocky terrain. Hence only drilled wells are suitable for a long term water supply. The following information refers to drilled wells.

Number: 14 wells drilled, 13 in Harbour Mille and one in Little Harbour. 3 wells in Harbour Mille had no yield, the other 10 wells yielded from 3 to 68 L/min.

Ownership: The best yielding wells are in private hands. Others owned by the Provincial Government or Council are insufficient for a community supply.

Adequacy: The quality and quantity of these wells varies considerably. One well yields 68 L/min (15 gpm) of excellent quality water. Two wells were drilled at the old school and yielded poor quality water. Three wells were drilled and yielded salt water or low yielding fresh water.

Households depending upon drilled wells: 9 houses now depend upon ground water.

Well drilling investigation: For the last few years the Department of Municipal and Provincial Affairs has been funding ground water investigations and well drilling programs.

WASTE WATER DISPOSAL

The sewers are privately owned and run to salt water. No serious pollution problems are reported.

COMMENT

The only feasible option for this community appears to be to continue to drill in order to find sufficient ground water. Hence ground water investigations will continue as determined by the availability of Provincial Government funds.

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF HARBOUR BRETON

GENERAL INFORMATION

Information sources: Town Clerk, Bernice Herritt; Works Superintendent, Harold Brace; Dept. of Health, Grand Falls, Craig Young; Consulting Engineer Tom Kendall, H. T. Kendall and Associates.

Ownership: This system was formerly an Industrial Water System owned by the Provincial Government, but is now essentially in the ownership of the Town.

Census data: Population: 2432 (1986), 2418 (1991). Dwellings: 597 (1991). Average 4.05 persons per dwelling.

Water and sewer service fees: Houses: $16.00 per month, water and sewer; $11.00 a month, water only. Fish plant, 30 cents per 1,000 I gals.

SURFACE WATER SOURCES

Description: Water is pumped from the main reservoir, Hutchings Pond, to a storage tank and from there it runs by gravity to the Community and fish plant. A back-up pond, Connaigre Pond, is used to augment the main pond through pumps and a pipeline.

Users: This water system is the only user of the pond.

Dam, main pond: The outlet brook has a dam, which is an earth fill dam with a concrete face and a concrete spillway. Length of dam: 36 m (paced). Height of dam: about 2.5 M.

Spillway: Concrete, built into the dam. Width of spillway: 4.5 M (taped). Freeboard at spillway below top of dam: 635 mm (taped). Water level at time of survey: 635 mm below spillway.

Back-up pond: No dam, natural outlet brook.

Reservoir surface area: Main pond: 7.8 hectares
Back-up pond: 9.0 hectares

Watershed area: Main pond: 66.3 hectares
Back-up pond: 68.3 hectares

Status of watershed protection: Both watersheds are protected.

Developments on watershed: The main highway to Harbour Breton crosses the watersheds of both ponds.

Live storage head: At the main pumphouse the invert of the intake pipe (400 mm diam.) is about 2.2 M below the spillway and the intake for the pumps is at about the same depth. (Information from Tom Kendall.) The minimum depth of submergence for these pumps, as recommended by the pump manufacturer, will probably be about 1.4 M. (This is the minimum depth of water above the pump intake for the pumps to function properly.) Hence the live storage head is 2.2 - 1.4 = 0.8 M.

Back-up pond: the live storage head is measured as the water level to the intake to the pumphouse: 3.0 M (Works Superintendent).

WATER QUALITY

Bacteria: Testing for chlorine residuals is done by Council staff daily, and Department of Health monthly. No problem is reported in obtaining satisfactory residuals throughout the system. However a boil order was enforced because of temporary problems in the pumphouse and chlorination system; there was a minor spill of diesel fuel into the wet well.

Department of Health: Grand Falls

Perception Problem: The Town's solid waste site is a few hundred metres along the highway, downstream of the main supply reservoir. The public suspects that the water is being contaminated by birds from the dump to the pond. Hence many residents do not favour using this water for drinking or cooking. However, no adverse effect has appeared because of the bacteria in the treated water.

EXISTING INFRASTRUCTURE

Control system: The pumphouse at the main pond lifts water into a steel storage tank. The tank water level was designed to control a battery of three pumps through a signal line on poles between the tank and the pumphouse but this control system is presently inoperative, awaiting repair. The back-up pond has a manually operated pump to supply the main pond through a pipeline.

Intake pipe to main pumphouse: 460 mm diam. into the wet well. This intake is reported to be without a screen.

Main pumphouse: Three vertical turbine pumps, two stage, each with a 40 hp rated electric motor. Rating of each pump; 107 ft. head, 900 gpm, 1770 rpm. There is also a standby pump with a 37.5 hp rated diesel engine. Pump control system not working at time of survey (September 24/92) and pumps were under manual control.

Chlorinator: This is a gas chlorinator, in the same room as the main pumphouse. The chlorine dosage rate was originally controlled by a flow meter apparently with tappings each side of an orifice plate in the main discharge line; in other words it was a flow-paced chlorination system. At present the pressure differential between the pump discharge and the wet well is used to create the required suction to draw chlorine solution into the wet well. Thus the dosage rate will be roughly the same whether one, two or three pumps are in use.

Proposals: An investment in 1992 of about $108,000 is to be made in electrical/mechanical equipment to restore the system to automatic control by the storage tank and also to change the chlorination system. The gas cylinders will be housed in a separate room and a flow-paced chlorinator will be installed.

Transmission mains: Pumphouse to storage tank, 300 mm diam.
Storage tank to Town and fish plant, 300 mm and 250 mm diam.
Back-up pond to main pond, 200 mm diam.

Storage tank: Storage capacity to overflow level, 410 cubic metres (90,000 I gals). (Dimensions estimated on site.) At the time of the survey the overflow pipe, estimated at 300 mm diam., was discharging about 60 mm deep. At the top of the tank there is a control box for electrode floats which are wired to a powered control panel in a box on a nearby pole. Thence the control wires run on the pole line to the pumphouse.

Pumphouse at back-up pond: This has a wet well and a 40 hp submersible Flygt pump.

DEMANDS

Existing:	Domestic:	603 connections
	Businesses:	23 connections, including 1 motel
	Schools:	2 schools, totalling 850 pupils
	Industrial:	Fish plant, this is the only metered demand Typical consumption: Plant working (June 4 - July 7 1992), avg. 936 cubic metres per day (6,388,000 gallons in the period). Plant not working (July 8 - September 1 1992), avg. 120 cubic metres per day (1,424,000 gallons in the period).
Future:	Domestic:	About 35 houses now on private wells could be connected to the mains in the future.
	Industrial:	No definite information is available on the future of the fish plant.

SUPPLY

Back-up pond: The back-up pond is pumped into the main pond a few times a year, for a few days at a time.

Adequacy of supply: Supply has been adequate in the past and is expected to be adequate in the future.

Means of increasing supply:

1. Back-up pond. This will be the best option. The water level could be raised 900 mm by a dam about 60 M long and about 2.5 M high on the outlet brook. Such a dam could raise the water level higher, but the pumphouse at the other end of the pond provides a limit to the height the water could be raised. The area around this pond has fairly steep slopes, so an extensive area would not be flooded, but the vegetation would need to be cleared away.

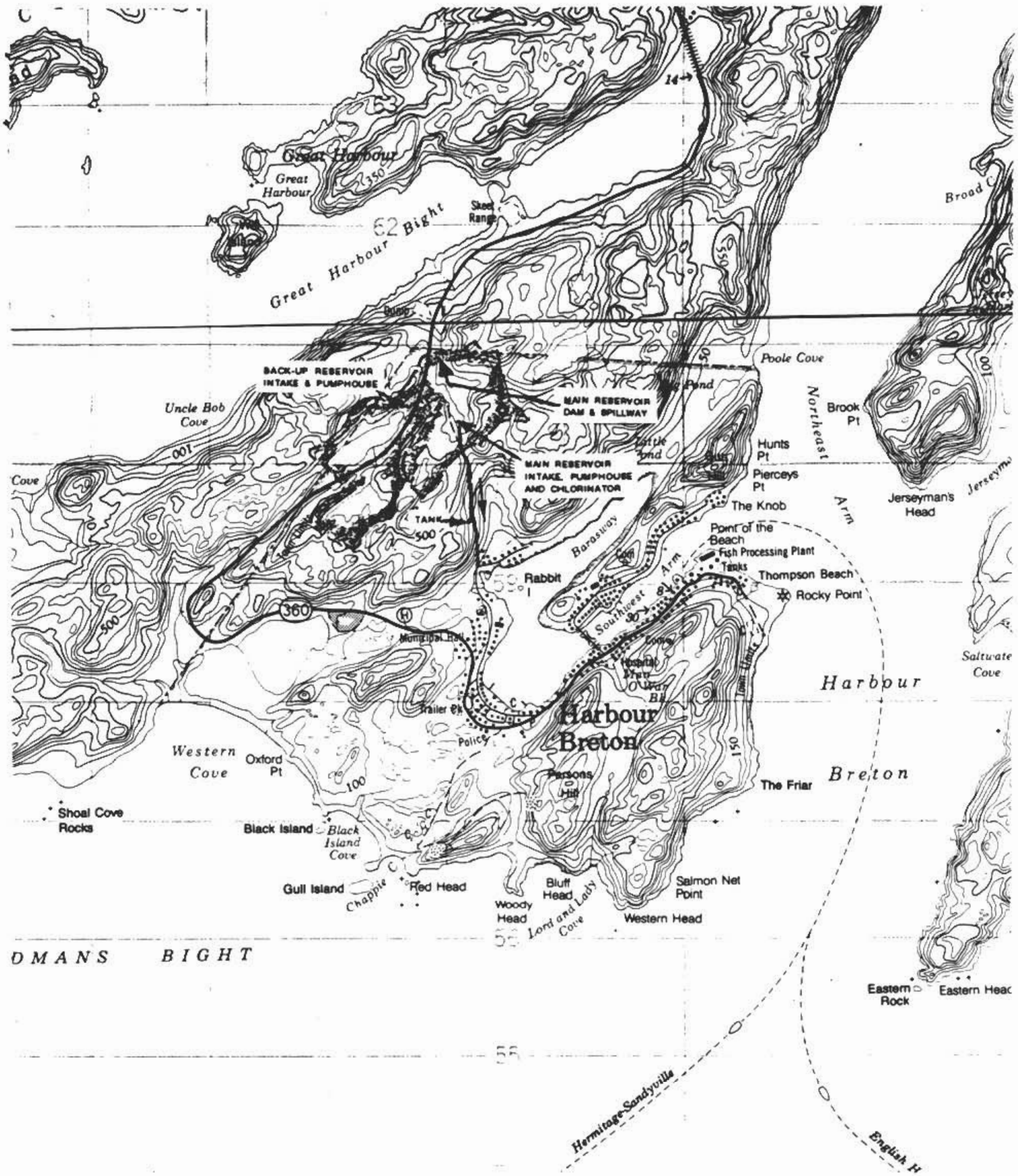
2. Main pond. The amount that the water level could be raised would be limited by the elevation of the pumphouse. It may be possible to raise the water level by about 300 mm by raising the dam and spillway, or putting a stop log on the spillway.

WASTE WATER DISPOSAL

The Town has a main sewage system which serves almost every building, and no sanitation problems are reported.

COMMENTS

No comments.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
HARBOUR BRETON

ACRES

MUNICIPAL - INDUSTRIAL SURFACE WATER SOURCE

COMMUNITY OF HERMITAGE - SANDYVILLE

GENERAL INFORMATION

Information sources: Supervisor, Industrial Water Systems, Department of Municipal and Provincial Affairs, Gerald Healey; Community Clerk, Myrtle Kendall; Municipal Maintenance, Phil Harris; Regional Health Inspector, Craig Young. Construction drawings, Provincial Planning Associates, 1974. Construction drawings, Newplan Consultants, 1988.

Ownership of system: Department of Municipal and Provincial Affairs.

Census data: Population: 831 (1986); 756 (1991). Dwellings: 212 (1991). Average persons per dwelling: 3.57.

Service fees: Water and sewer connection: $160 per year.
Fish plant and bait depot: $0.45 per 1,000 Imperial gals.

Map: See Town of Gaultois.

SURFACE WATER SOURCE (GRAVITY)

Description: Two ponds, Pond X and Pond Y, are linked together by a conduit, and constitute an upstream reservoir. Pond Y has a dam and the stored water discharges down a brook to a downstream reservoir. This downstream reservoir has been made by a dam across the brook. From this reservoir there is gravity flow into the community. Pond X also discharges through a natural brook.

Users: Community, fish plant, bait depot, through a common 250 mm diam. supply line.

Dam, downstream reservoir: Earth fill, constructed 1974, length 52 M, maximum height about 5 M, top elevation 59.40 M.

Spillway, downstream reservoir: Two corrugated steel pipes, in parallel, each 1498 x 914 mm. No control over spillway discharge. Spillway elevation 57.60 M. Running with 460 mm depth of flow at the time of the survey.

Surface area of downstream reservoir: 1134 sq. M. (calculated from construction drawings 1974.)

Live storage head, downstream reservoir: Invert to spillway, 2.7 M. (Scaled from construction drawings. It was not possible to verify this on site without the use of a diver.)

Dam on Pond Y, upstream reservoir: Earth fill, length 205 M, maximum height about 4.1 M, built 1975.

Spillway, upstream reservoir: Concrete channel set in the dam, about 15 M long, to match the downstream slope of the dam. Concrete sill is 1140 mm below the top of the dam, but there are stop-logs 635 mm high. Hence the effective spillway is 510 mm below the top of the dam. Water level in reservoir at time of survey, 300 mm below the concrete sill. Spillway elevation 31.77 M (1988 drawings). Width of spillway 3.0 M.

Discharge pipe from upper reservoir into the brook channel: 250 mm iron pipe, with gate valve control, partially open at time of survey. Depth of flow in pipe at time of survey, 70 mm.

Live storage head, upper reservoir: Invert of 250 mm reservoir drainpipe to stop-log spillway, 2.87 M. (Newplan drawing, 1988, confirmed by measurements on site at discharge pipe, September 1992.) A submerged pipe links ponds X and Y, with the elevation of this pipe lower than the 250 mm discharge pipe. Therefore the live storage head of 2.87 M applies to both ponds X and Y. This live storage head applies only when the reservoir water level is up to the spillway. At the time of the survey, September 23/92, the live storage head was about 2.6 M.

Surface area of upper reservoir: Pond X, 4.2 hectares
Pond Y, 1.5 hectares

Watershed area: This area covers all the watershed collecting through the lower reservoir. Area 80.0 hectares.

Status of watershed protection: Only part of the watershed is protected, namely Pond Y and the downstream reservoir.

Developments on watershed: No developments apparent.

GROUND WATER SUPPLY

Private wells: Fifteen to twenty houses have private wells.

WATER QUALITY

Bacteria: A free chlorine residual is obtained throughout the system, except in Sandyville. There is a large main line (300 mm diam.) with a relatively low demand (not many houses in Sandyville). Hence there is a very low rate of flow and this may be the reason that the chlorine residual is lost before it reaches the consumers.

Department of Health: Grand Falls

Chemical parameters: This water is reported as corrosive to household plumbing and fixtures.

Other: Users complain of sediment in the water after rains. Pond X is reported to have a muddy bottom. From the topographical sheet the watershed appears to be mainly steeply sloping rather than flat and boggy.

EXISTING STRUCTURES

Intake, downstream reservoir: Two Johnson well screens, each 900 mm x 300 mm diam.

Transmission lines: From the lower reservoir to the fish plant there is a 250 mm line, with 200 mm and 100 mm branches. The Sandyville branch is 300 mm diam.

Reservoir drains: Both dams have reservoir drains.

Chlorination: Gas chlorinator, with a fixed feed rate, and injection using a booster pump. Chlorine injection rate is manually adjusted. No water meter.

Fire hydrants: The system includes fire hydrants.

DEMANDS

Existing: Residences and local business, about 170.
School, about 205 pupils.

Fish plant, metered flow.
Bait depot, metered flow.

Water consumption data: Total annual consumption for the supply source from Department of Municipal and Provincial Affairs records:

Year	Imp.gal x 1000	Cubic metres	
1984	19,083	86,740	
1987	93,438	424,720	
1990	105,214	478,520	Peak year
1991	95,713	435,600	

Future demands: Domestic, a slight increase is possible because some houses on private wells may wish to connect. Industrial, no increase anticipated.

SUPPLY

Adequacy: Supply is adequate at present and is expected to be adequate in the future.

Means of increasing supply: It may be possible to raise the level of Pond X with an extensive dam. The feasibility of such a project and the extent of work required will need detailed investigation.

WASTE WATER DISPOSAL

All the houses in Hermitage except seventeen have main sewer. Council would like to extend this sewer system to unserviced houses if funds permit. Also, some buildings in the Sandyville area do not have main services. There are no serious sanitation problems in Hermitage - Sandyville. There are three untreated ocean outfalls for sewage disposal.

COMMENTS

No comments.

UNINCORPORATED AREA, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF JEAN DE BAIE

GENERAL INFORMATION

Information sources: Former Chairman of Local Service District Council, Mr. William Coady. Department of Municipal and Provincial Affairs, Rick Martin. Department of Health, Sherri Rees.

Population: 168, Department of Municipal Affairs listing. The Chairman of Council reports about 300 people. There has apparently been a lot of new building carried out in the area since the Departmental records were compiled.

Water rates: $130 per year, water service fee.

SURFACE WATER SOURCE

Name: Colleen's Pond supplies gravity flow to the community. This is a small shallow pond with a bottom of organic material.

Users: Community only.

Dam: No dam.

Spillway: Natural outlet brook.

Reservoir surface area: 1.5 Hectares.

Watershed area: 25 Hectares.

Live storage head: 450 mm, from pond surface to invert of intake (information from Chairman of Council).

Status of watershed protection: Not protected.

Developments on watershed: No apparent developments. A remote area.

GROUND WATER SUPPLIES

Drilled wells: Three wells have been drilled, of which two were drilled for the council by the Department of Municipal and Provincial Affairs. One Council well yielded 90 L per minute and the other 130 L per minute. One of these wells was developed for a community supply but unfortunately the yield and water quality deteriorated after about 8 months.

Dug wells: Some houses rely on dug wells and springs, particularly for drinking purposes because the supply from the municipal source is of poor quality.

Adequacy: As mentioned above, the ground water supplies that have been developed so far have not proved adequate.

WATER QUALITY, SURFACE SUPPLY

Bacteria: Simple chlorination is sufficient to disinfect this water.

Boil order: Because there is no chlorinator on the water system, a "boil order" is in force.

User opinion: This water has a muddy taste, is coloured and is high in iron.

EXISTING STRUCTURES

Intake: The intake runs 6 M into the pond and the bottom end turns up towards the surface.

Disinfection: No disinfection is carried out.

Transmission mains: 150 mm diam. and 100 mm diam.

DEMANDS

Existing: According to the Chairman of Council there were 35 to 40 houses eight years ago, and the number is now 70 to 75 houses.

Future: From the foregoing information an increase in demand is to be expected.

SUPPLY

Existing: The drilled wells have proved inadequate to date and the pond provides water of poor quality. Hence the current water supplies are inadequate.

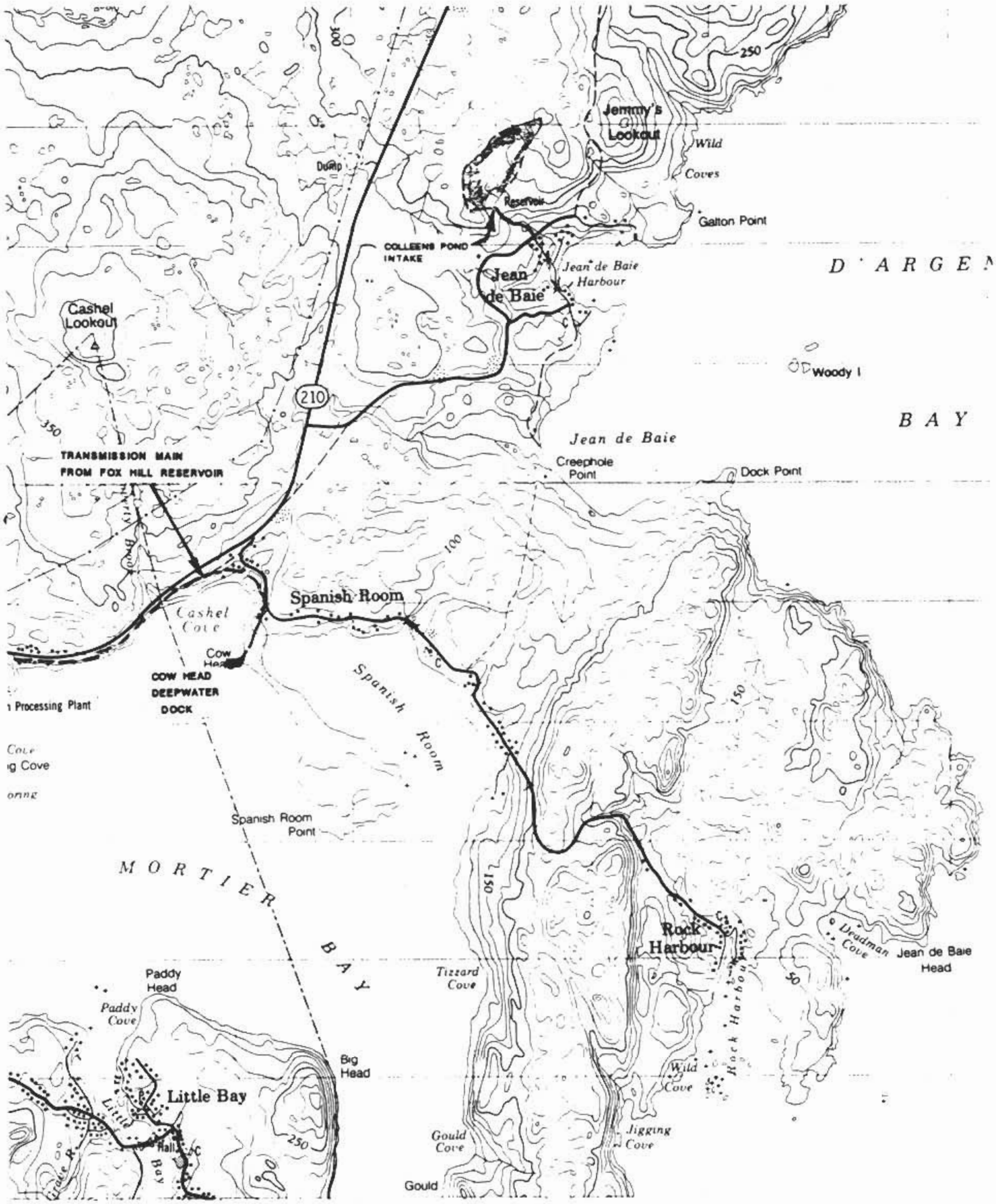
Means of increasing and improving supply: The intention of the Department of Municipal and Provincial Affairs is to investigate a better water source, possibly from drilled wells.

WASTE WATER DISPOSAL METHODS

Septic tanks and drain fields predominate. No serious pollution problems are reported.

COMMENTS

This community has a water supply problem and a solution to the problem is still being sought. The water quality in Colleen's Pond makes this pond unattractive for a long term source of water.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

JEAN DE BAIE AND SPANISH ROOM

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF LAMALINE

GENERAL INFORMATION

Information sources: Engineering Report, 1990, and contract plans 1991, Newplan Consultants. Information on file, Colin Karasek Ltd.

Census data: Population: 543 (1976), 548 (1981), 514 (1986), 482 (1991). Dwellings: 151 (1991). Average: 3.19 persons per dwelling.

History: In the past the Town has relied upon ground water, mostly from dug wells, and is now embarking upon the construction of a new gravity water supply system. At the time of the survey only part of the transmission main had been constructed. The following description of surface water source refers to the proposed system.

SURFACE WATER SOURCE

Name: Upper Hodges Pond. The Town will be the sole user. A gravity system.

Dams: A dam will be required over the outlet brook to raise the pond water level from elevation 27.9 M to 28.7 M above sea level.

Reservoir surface area: 11.7 Hectares.

Watershed area: 437 Hectares.

Live storage head: Using the construction drawings:
Elevated pond level to top of intake structure: 1.70 M
Elevated pond level to invert of transmission main at screen chamber: 2.58 M
Information not available on the pond level to the bottom of the screens in the proposed screen chamber. Hence for LSH, use 1.70 M.

Status of watershed protection: Not protected.

Developments on watershed: Open bogland. No developments. There may be some grazing by domestic animals.

GROUND WATER SUPPLIES

Drilled wells: Six drilled wells are reported, with yields from 1.4 to 31.8 L/min. *The RC School Board well had a yield reported as 13.6 L/min.* but the school now uses a supply from the Salmonier River. (See information later in this section on Lamaline.)

Dug wells: The majority of the community relies on dug wells. These sometimes dry out in summer.

WATER QUALITY, UPPER HODGES POND

Bacteria: Disinfection by simple chlorination is acceptable.

Department of Health: Grand Bank

Chemical: Iron (0.35 mg/L) and colour (50 units) exceed the Canada Drinking Water recommended standards, and manganese (0.05 mg/L) is borderline. Under heavy rainfall these parameters will deteriorate because the runoff is over bogland.

Visual appearance: Ponds in this area have highly coloured water with suspended organic particles.

PROPOSED STRUCTURES

Transmission main: From intake to the screen chamber, 350 mm diam. ductile iron mechanical joint pipe. The remaining line is 300 mm diam. ductile iron Class 50. Distance from pond to highway 2793 M. Operating pressures would be low, maximum about 40 psi.

Fine screens: Large removable fine screens in a building are proposed.

DEMANDS

Existing: Most of the demand on the new surface water system will be domestic, with a few local stores; about 162 new connections. There is no industry, except for a fresh fish handling facility on Allan's Island.

School: There is a regional school with about 420 pupils which is presently supplied by a pumped source from the Salmonier River. When the municipal system is completed it is likely that the school will connect to it. The existing school system is described below.

Future: No significant increases in demand are anticipated.

SUPPLY

Adequacy: The supply is likely to be adequate in quantity for the foreseeable future.

Means of increasing supply: It is not recommended to raise the pond any higher because of the flat surrounding boggy terrain. If additional water is required it can be obtained, for example, by pumping directly from the Salmonier River, which has an abundant continuous flow.

WASTE WATER DISPOSAL

At present there are private systems which in some cases are substandard in respect to sanitary conditions. The new system will be a full-scale piped municipal collection and disposal system.

COMMENTS

No comments.

REGIONAL HIGH SCHOOL, LAMALINE

Owner: Burin Peninsula RC School Board; 420 students.

SURFACE WATER SOURCE

Name: Salmonier River. This is a run-of-the-river system with the intake in the bed of the river under a natural pool.

User: School only.

Watershed area: 111 square km. This is a flat watershed including much bogland which rises only 100 M from the ocean discharge to the head of the watershed.

Status of watershed protection: Not protected.

Developments on the watershed: No buildings. Some animal grazing. This is a scheduled salmon river.

WATER QUALITY

Bacteria: Simple chlorination acceptable for disinfection.

Chemical: Meets CDW parameters except colour (40 units), although water quality probably deteriorates after heavy rainfall.

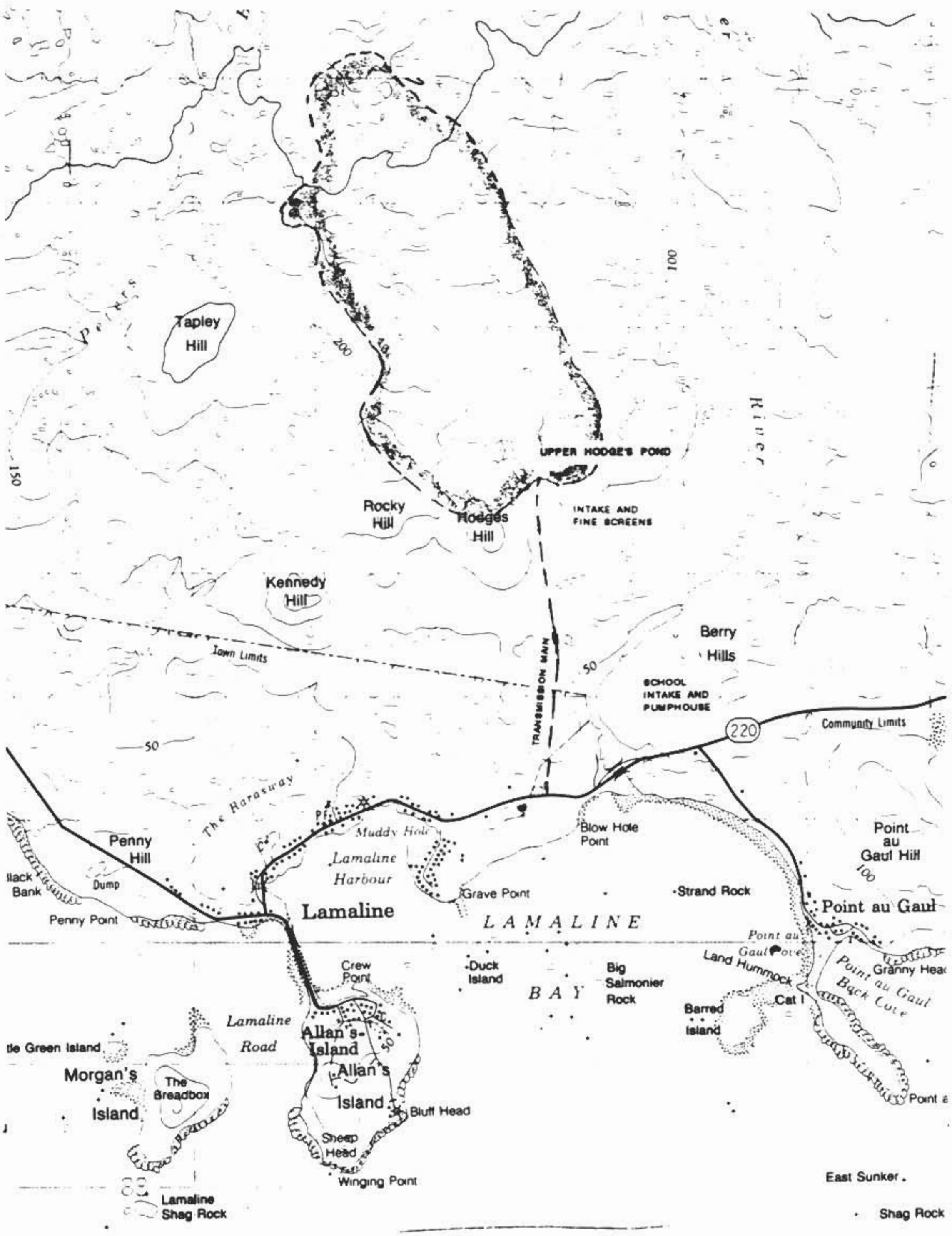
EXISTING STRUCTURES

Pumphouse and intake: Located upstream, about 700 M from the mouth of the river, just beyond the tidal range.

Transmission main: 75 mm diam. HDPE, installed 1981, length 915 M.

SUPPLY

Adequacy: Adequate into the foreseeable future.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
LAMALINE

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF LAWN

GENERAL INFORMATION

Information sources: Information on file, Colin Karasek Ltd. Engineering technician, Town construction project, Adrian Slaney.

Census data: Population: 1025 (1976), 999 (1981), 1015 (1986), 1005 (1991). Dwellings: 259. Average: 3.88 persons per dwelling.

Water and sewer service fees: $144 per year.

History: Originally the Town pumped from the Forebay reservoir for the Newfoundland Power, Lawn Hydro Generator. The municipal water supply and distribution system was built in the mid 1970's. In 1984 the Town started the planning and construction of a gravity supply system from Brazil Pond. The Brazil Pond water supply dam and fishway will be completed in 1993. However, the Town is now using this new water supply. The following information therefore refers entirely to the Brazil Pond water supply.

SURFACE WATER SOURCE

Name: Brazil Pond, which provides gravity supply. Elevation 58.5 M above sea level.

User: The Town is the only user.

Dam: Earth dam with concrete diaphragm wall, with a reinforced concrete spillway. Most of the dam is the flood spillway.

Flood spillway: Reinforced concrete wall, length 23.0 M, with sill at 2.0 M below top of dam. Height of spillway sill above river bed 2.6 M. The operating spillway is a notch in the flood spillway, width 2400 mm, depth 400 mm, but normally less than this because of the stop log.

Fish ladder: Reinforced concrete, waterfall type, ten chambers, typically 2.4 x 1.8 M in plan. This fish ladder was a requirement of the Federal Department of Fisheries. Local anglers report that sea fish have not been known to migrate through the stretch of the river where the fish ladder is located.

Watershed area: 36.9 sq. km.

Reservoir surface area: 12.9 Ha original, approximately 15.5 Ha with the dam in place.

Live storage head: Measured as the height between pond level or spillway and the invert of the transmission main at the high point in the line. Existing pond LSH = 1.15 M, raised pond with dam LSH = 2.25 M.

Watershed protection: Not protected.

Developments on watershed: No developments, but readily accessible for all-terrain vehicles. Possibly some domestic animal grazing.

WATER QUALITY

Bacteria: Simple chlorination is satisfactory for disinfection. (Total coliform count average 14 in 4 samples, Oct.11/83)

Department of Health: Grand Bank

Chemical: Colour is high at 45 units. Alkalinity and hardness are low, although the pH is within the C.S.W. limits.

User opinion: No adverse opinion.

Intake: Muddy water is reported sometimes; see below "Intake".

EXISTING STRUCTURES

Intake: The intake has a large coarse screen cover. The intake is located in a short canal rather than in an open pond as was originally recommended. Soil erosion from the canal may be getting into the intake.

Transmission main: 300 mm, 250 mm, and 200 mm diam PVC SDR 26 watermain.

Fine screens: Two screens, each 200 mm H x 1200 mm W. Cleaned about once every three weeks.

Chlorination: Gas, with injection rate controlled by water flow from a Woltmann water meter.

West tank: This is a steel storage tank, part of the original water system, which balances on the line with Brazil Pond. Effective storage volume 220 cubic metres.

East tank: A steel storage tank, capacity about 300 cubic metres. This tank supplies a separate water system of higher pressure than the main system, and is served by a pumphouse. However, the pumps installed have insufficient head to pump water into this tank.

Pumphouse: This has two pumps (one not functioning at the time of the survey) which are set to operate continuously. Originally they were controlled On/Off by a pressure switch on the discharge line.

Pressures: (a) Because of this problem with the head of the pumps, pressures are low in the area of the east storage tank. (b) Pressures are also low for houses on a high point on the transmission line to the fish plant. This transmission line is fed directly from Brazil Pond and the west tank. Houses in the area of this high point should have been connected into the east tank system, which would have provided them with adequate pressure.

DEMANDS

Metering: Measured in October 1992 over a 3 week period, the average daily consumption was 621.0 cubic metres per day (fish plant not operating).

Existing: 258 residences, 11 small local businesses, 2 local schools and a small feeder fish plant.

Fish plant: This fish plant operates seasonally under normal conditions. Fresh water consumption is not metered but probably constitutes 10 to 20% of the domestic demand when the plant is working. The plant has a salt water supply.

Future: New housing areas are planned. In the last decade many new houses have been built but historically the total population has been static. Hence no significant increase in demand is anticipated in the future.

SUPPLY

Adequacy: The supply will be adequate in the foreseeable future.

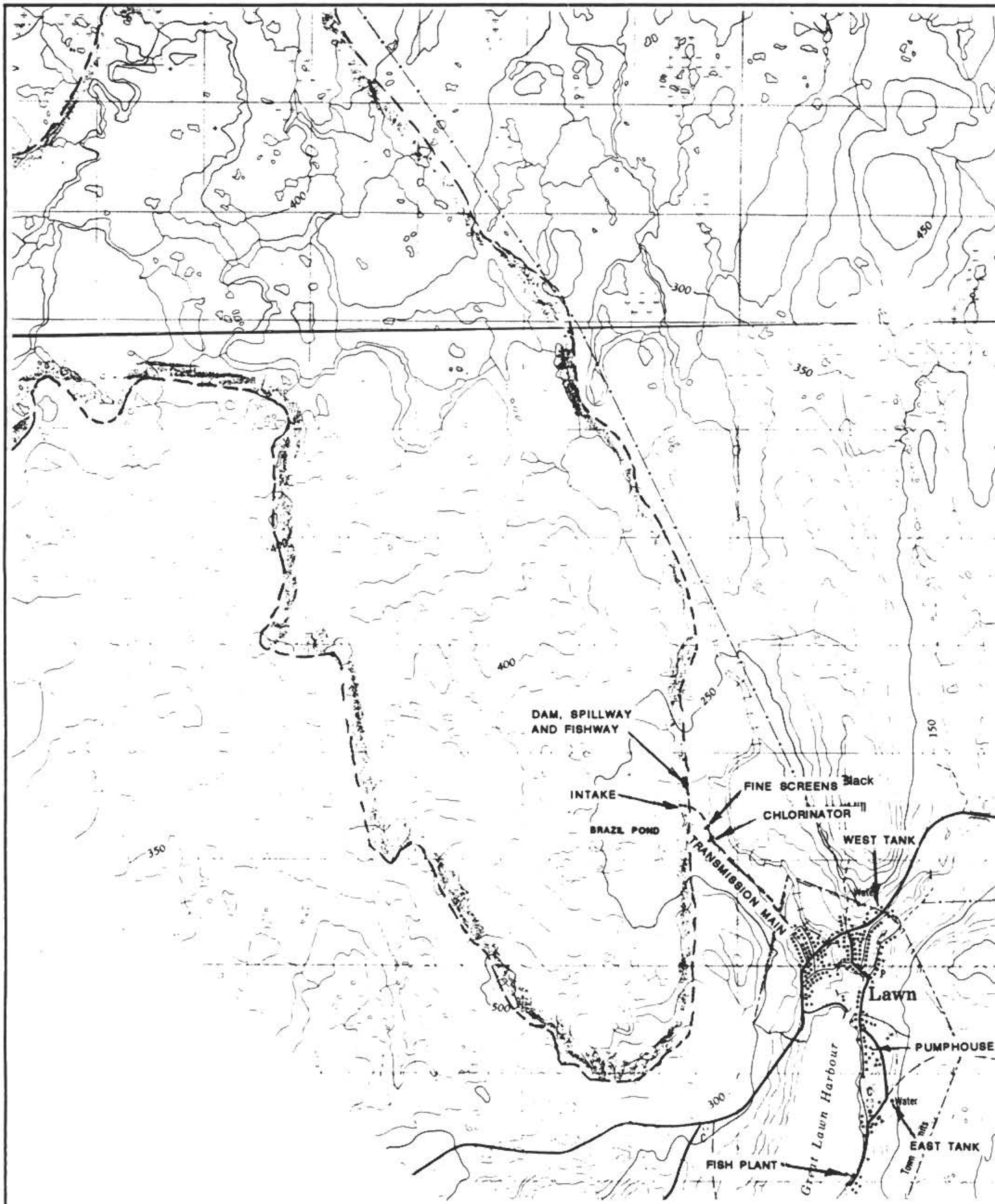
Means of increasing supply: No means readily apparent. The flood spillway could be raised with stop logs. However, the earth dam cannot be raised because it already matches the spillover of the natural terrain for a supply under a 1:150 year flood.

WASTE WATER DISPOSAL METHODS

Most of the community has main sewage collection and disposal. A few areas need main sewer and this is being carried out as funds from the Provincial Government permit.

COMMENTS

No comments.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
LAWN

ACRES

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF LITTLE BAY EAST

GENERAL INFORMATION

Information sources: Mayor, Archie Thornhill; Department of Health, Sherri Rees.

Census data: Population: 213 (1976), 202 (1981), 196 (1986), 201 (1991). Dwellings: 60 (1991). Average persons per dwelling: 3.35.

Water rates: Since the Council provides no water and sewer services there are no Council rates established.

GROUND WATER SUPPLIES

Dug wells: Most houses have their own wells, which sometimes run dry in the summer. The adequacy of these wells varies. There is one well, "Government well", about 4 M deep which has run dry only once in fifteen years.

Drilled wells: There are three drilled wells, each of which supports a few families. They are relatively low-yielding wells, from about 3 - 7 L/m. A fourth drilled well had no yield.

Adequacy of yield: Generally the ground water yields are insufficient to provide an adequate quantity of water to most of the households.

WATER QUALITY

Bacteria: Some of the wells show a coliform count high enough to require boiling or disinfection.

Department of Health: Salt Pond

STUDY

The Council is trying to arrange with the Department of Municipal and Provincial Affairs for a consultant to carry out a municipal services study for the Community.

DEMANDS

Houses and local businesses: 62. There is no school or other major building to be serviced.

Fishery: The local fishery is currently a buying operation for lobsters. Salt water is used. There may be a requirement for fresh water if a municipal system were available.

SUPPLY

Adequacy: Apparently the local supplies are inadequate, but interest in a main water and sewer system has been lukewarm in the past. The present Council came into being last March and appears to be very interested in having main services installed.

WASTE WATER DISPOSAL METHODS

One group of twelve houses has a sewer line to salt water through a large septic tank. The remaining houses mostly have lines to salt water.

COMMENTS

If and when an engineering study on water and sewer is completed for this community, there should be better information on supply potentials. The present water supplies are inadequate in many instances.

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT, LITTLE ST. LAWRENCE

GENERAL INFORMATION

Information source: Information on file, Colin Karasek Ltd.

Population: 224 (Department of Municipal and Provincial Affairs records).

SURFACE WATER SOURCE, #1

Name: The community has constructed a dam on Butler's Brook, set at an elevation to provide gravity flow to the community. The dam was built in 1984 and has been rehabilitated since. The brook is about 1.5 M wide, and shallow.

Users: The community is the only user.

Dam: Concrete and rock-filled cribbing. Width of dam approximately 8.0 M, maximum height 1.6 M. Elevation of dam 46.0 M above sea level.

Spillway: This is a notch in the concrete portion of the dam.

Reservoir surface area and storage: Area approximately 70 square metres based upon a site investigation, storage volume estimated at 100 cubic metres.

Watershed area: 36.1 hectares. The watershed ground surface is mostly bog and barren land and scrub forest. There are no natural storage ponds of any significance.

Live storage head: 1.4 M estimated from site inspection.

Status of watershed protection: Protected along with some of the watershed for Waterfall Pond.

Developments on the watershed: No developments apparent.

Means of increasing supply: A greater volume of storage can be provided by additional excavation. However, this would be comparatively expensive and therefore a back-up source, "Surface Water Source #2", has been provided.

WATER QUALITY, #1

Bacteria: Suitable for treatment by simple chlorination.

Department of Health: Salt Pond

Chemical parameters: Colour is high at 60 units, and iron is almost borderline at 0.27 mg/l (limit 0.3 mg/l). This water is low in hardness and is acidic and therefore potentially corrosive. The chemical oxygen demand at 23 mg/l indicates a fairly heavy organic content, which correlates with the high colour and iron. These test values typically indicate that the water is derived from a watershed with a preponderance of organic soils.

User opinion: No adverse comment.

EXISTING STRUCTURES, #1

Transmission main: The transmission main is 150 mm diam. with the intake protected by a basket strainer.

Chlorinator: Hypochlorinator, 220 M from the reservoir and 70 M from first connection. This chlorinator is flow-paced by a signal from a water meter.

Distribution network: Pipes are sized for domestic supply only.

SURFACE WATER SOURCE, #2

Name: Waterfall Pond, which is a reservoir created by a concrete dam owned by Newfoundland Power, used for power generation. Hydro electric projects are discussed in the main report.

Users: Little St. Lawrence has a small pumphouse which is used if the gravity source fails through shortage of water. However, the main user of the source is, of course, Newfoundland Power for hydro generation.

Live storage head: A submersible pump is used in the pond with a live storage head of about 2.0 M.

Watershed protection: The hydro system is termed the "fall pond" system and entails a very large watershed. Part of this watershed, namely an area around Waterfall Pond, is protected.

Developments on the watershed: There are several cottages on Waterfall Pond, which do not have main drainage.

WATER QUALITY, #2

Bacteria: Simple chlorination is acceptable for disinfection.

Department of Health: Grand Bank

Chemical analysis: Very similar to that described for Butler's Brook.

User opinion: No adverse comment.

EXISTING STRUCTURES, #2

Pumphouse: A submersible pump has been installed in Waterfall Pond which discharges into the municipal system under pressure of a hydropneumatic tank system.

Chlorinator: Solution-feed type, which is activated when the pump is on.

Inter-connection: Manually operated valves close off the gravity system and open the pump system into the distribution network.

DEMANDS

Connections: Approximately 50, houses and small stores.

Community stage: This has a 25 mm line.

Future: No significant increase in demand is expected.

SUPPLY

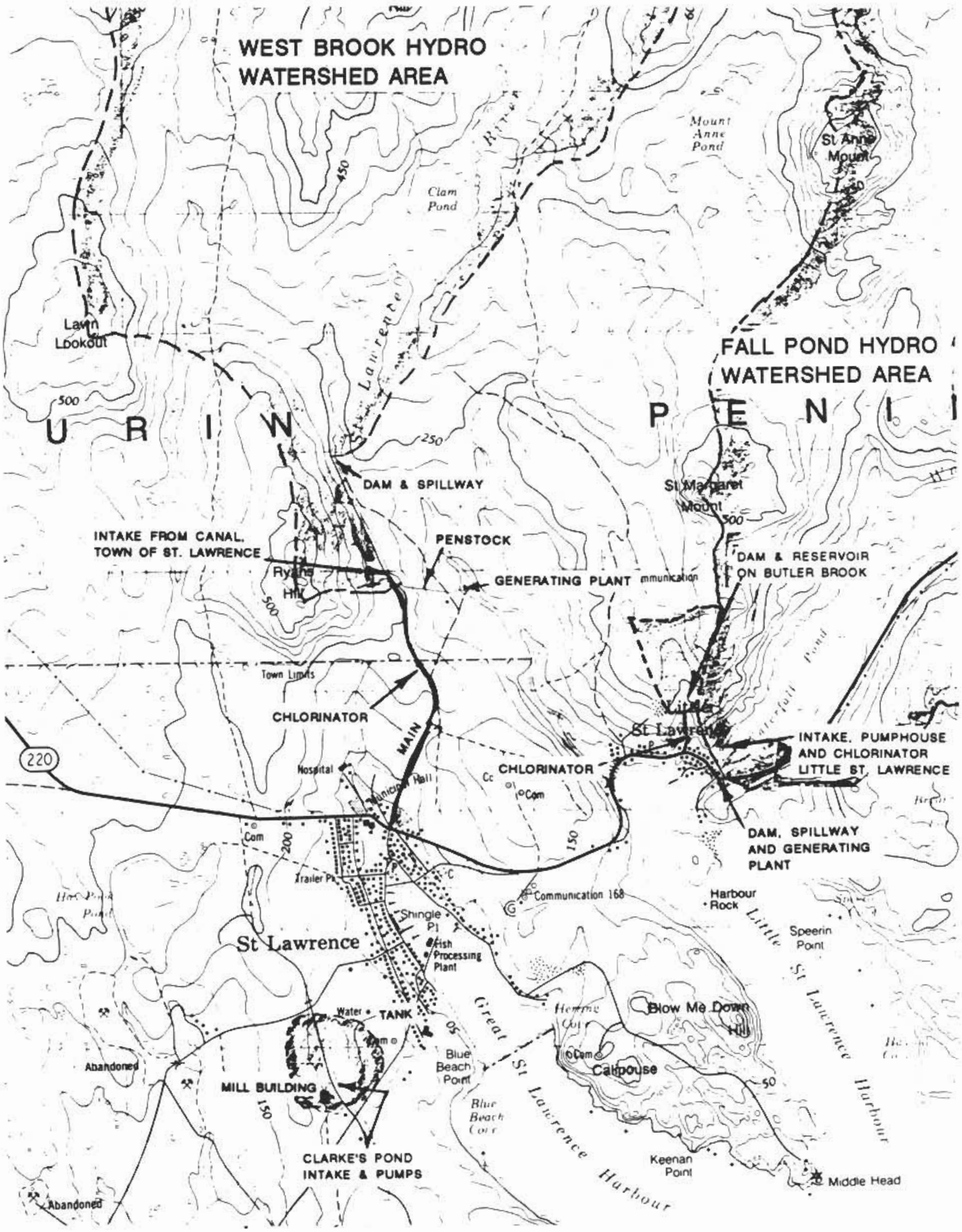
Adequacy: Even if the gravity supply dries up, there is ample water from the pumped source. When supply #2 is being used by the Community, the consumption is in the order of 0.001 cubic metres per second, which is not likely to affect the hydro-electric needs of Newfoundland Power.

WASTE WATER DISPOSAL

The community has for some years been installing a main sewage system through a community solids separating tank with an outfall into the harbour. About 50% of the community is served this way and the remainder have septic tank and drain fields or lines to salt water.

COMMENTS

No comments.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

LITTLE ST. LAWRENCE, TOWN OF ST. LAWRENCE, AND ST. LAWRENCE MINE

ACRES

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF LORD'S COVE

GENERAL INFORMATION

Information sources: Information on file, Colin Karasek Ltd; Department of Health, Rick Grikis.

Census data: Population: 409 (1976), 384 (1981), 346 (1986), 329 (1991). Dwellings: 86 (1991). Average: 3.83 persons per dwelling.

GROUND WATER SUPPLIES

Dug wells: The community relies on privately owned dug wells.

Drilled wells: None reported.

WATER QUALITY

Bacteria: No problems have been brought to the attention of the authorities concerning excessive bacteria.

Department of Health: Grand Bank

DEMANDS

Existing: Private dwellings, a few stores, church, hall, and fish plant.

Fish plant: A feeder plant carrying out rough filleting. Mainly uses salt water through 100 mm intake line, about 180 M long. Fresh water from a dug well.

SUPPLY

Adequacy: The existing supplies are reasonably adequate.

Means of increasing supply:

1. Gravity flow to serve all the community could be obtained from Midway Pond. (Pond area 10 Hectares, watershed area 140 Hectares.) The water level in this pond could be raised by 0.7 M. However the chemical water quality requires evaluation.

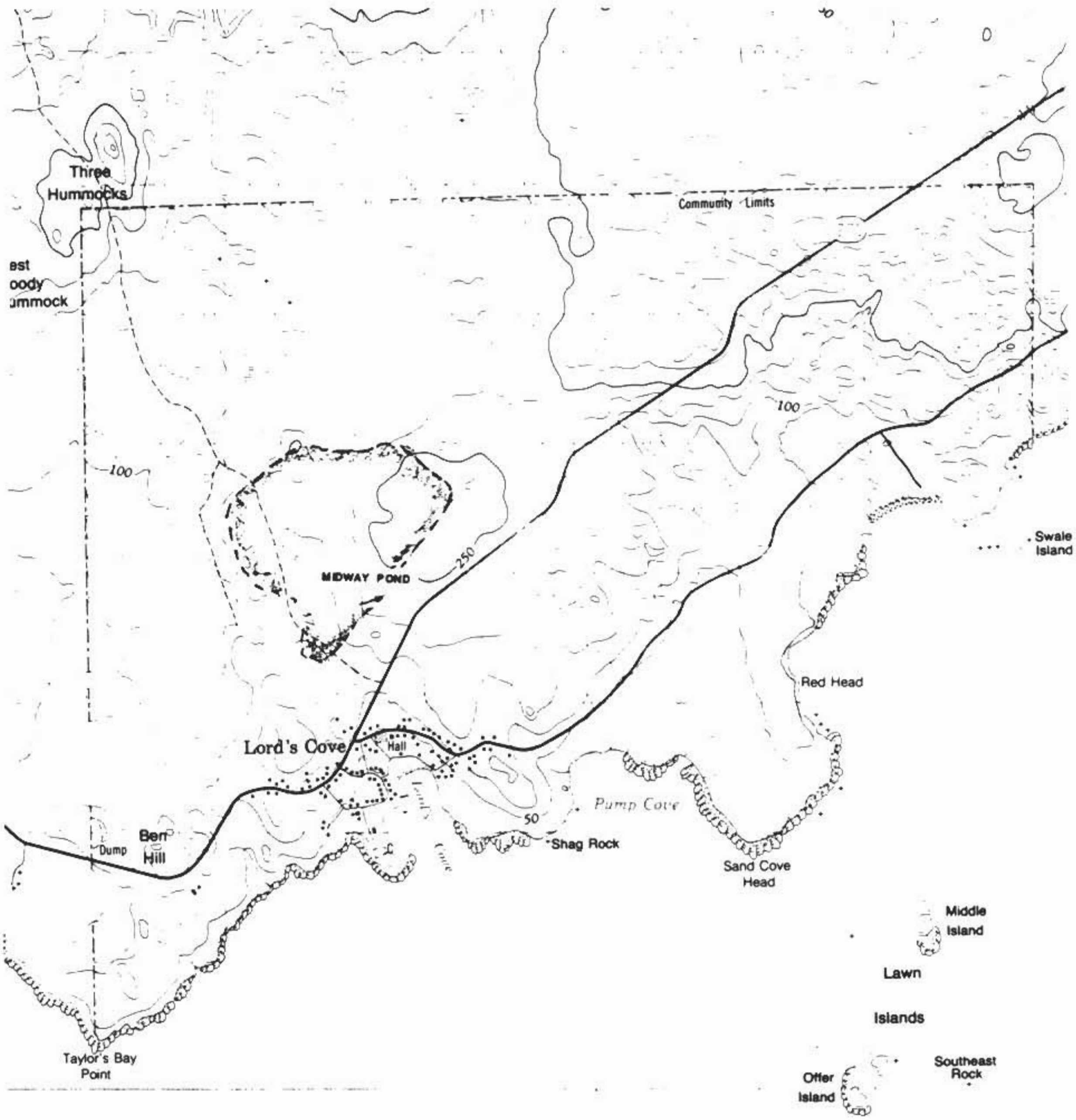
2. Drilled wells could be considered.

WASTE WATER DISPOSAL

Septic tanks and drain fields are mostly used. No significant pollution is reported.

COMMENTS

There has been no request from the Council to seek the installation of main water and sewer services.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
LORD'S COVE

ACRES

MUNICIPAL, INDUSTRIAL SURFACE WATER SUPPLY

TOWN OF MARYSTOWN

GENERAL INFORMATION

Information sources: Several reports from 1984 onwards by Newplan Consultants on the Marystown water supply system. Rupert Pittman, System Operator, on contract to the Department of Municipal and Provincial Affairs. George Hynes, Maintenance, Fishery Products International, Marystown. Town Manager, Town of Marystown, Jim Mayo; Department of Municipal and Provincial Affairs, Gerald Healey.

Census data: Town of Marystown population: 5915 (1976), 6299 (1981), 6660 (1986), 6739 (1991). Dwellings: 1968 (1991). Average: 3.42 persons per dwelling.

Service fees: Water $10/month.

History: The system was constructed in the mid 60's as a water supply to serve the fish plant, dockyard and Town. A fine screen chamber and other improvements were made in 1985 and, more recently, the mains have been extended to take in the Cow Head deep water dock.

SURFACE WATER SOURCE, LINTON LAKE

Main reservoir: Linton Lake, a natural pond augmented by a low dam, elevation 17.7 M. A pumped supply.

Dam: Earth fill, 60 M long, height 2 M.

Spillway: Concrete structure with removable stop log gates. Spillway width 6.7 M. Water level at time of survey 200 mm below top of spillway stop log, 914 mm above floor of outlet channel. Concrete outlet channel 2.1 M deep, 7.0 M wide and 60 M long.

Highway culverts: Also controlling the rate of overflow are three corrugated steel culverts each 940 by 150 mm through the highway Route 210 which crosses Linton Lake near the spillway. Water level 1.7 M below highway surface at time of survey.

Live storage head: Four centrifugal pumps in parallel lift from a wet well to a storage reservoir on high ground, Fox Hill Reservoir. The critical feature as far as drawdown in Linton Lake is concerned is the net positive suction head for the pumps. The required NPSH is a characteristic unique to each pump design. The available NPSH depends upon the physical layout of the site and atmospheric conditions. The available NPSH must exceed the required NPSH, otherwise cavitation will occur in the pump impeller. At normal atmospheric pressure, available NPSH = 7.4 M of water. Under stormy conditions the atmospheric pressure would drop significantly so that the NPSH could be as low as, say, 5.8 M of water in extreme conditions. The required NPSH heads are as follows:

1 pump working	6.7 M
2 pumps working	5.8 M
3 pumps working	4.7 M
4 pumps working	4.1 M

With 3 pumps running a drawdown of 1.0 M would be feasible. However, it is advisable to use a much lower available drawdown, say, 300 mm.

Status of watershed protection: Protected.

Developments on watershed: Highway 201 crosses Linton Lake. Small islands of debris in the lake encourage seabirds and resultant droppings. Access road to Clam Pond passes through the watershed and cannot be closed off because it provides access to a popular salmon river. Eight houses in Lower Mooring Cove are on the watershed although a berm shields the reservoir from run-off.

SURFACE WATER SOURCE, CLAM POND

Name: Clam Pond. A natural pond with no dams.

Watershed area: 1393 Hectares.

Pond area: 216 Hectares. Elevation 22.4 M.

Description of system: Clam Pond feeds Linton Lake through a pump station which pumps water over the height of land, elevation 48 M, between the two ponds so that water can flow in a natural channel into Linton Lake.

Live storage head: The NPSH required with 1 pump running is 4.0 M. Hence NPSH conditions are not critical in the pumphouse. A drawdown of 1.5 M is possible (information from Newplan report).

Status of watershed protection: Protected.

Developments on watershed: No developments.

WATER QUALITY

Bacteria: Disinfection by simple chlorination is adequate.

User opinion: No adverse opinion.

EXISTING STRUCTURES

Dams for Fox Hill reservoir: North dam length 45 M, height 5.2 M. South dam length 60 M, height 5.2 M. Both dams are concrete gravity structures. The north dam has a float house with floats to control the on-off cycles of the pumps in the Linton Lake pumphouse.

Spillway, Fox Hill reservoir: Concrete channel into a natural stream, spillway elevation 105.5 M.

Clam Pond pumphouse: A wet well is supplied by an intake pipe 450 mm diam. with an intake box 24 M into the lake. The water passes through coarse screens. Two 60 HP centrifugal pumps in parallel lift water through a transmission main of 300 mm, 250 mm and 200 mm diam. with overall length of 1280 M. Pump capacity 87.0 l/second for one pump, 139 l/second for two pumps. System built 1968/69.

Linton Lake pumphouse: A wet well is supplied by a 600 mm intake pipe with an intake box about 21 M into the lake. The water passes through coarse screens. Four 150 HP centrifugal pumps in parallel lift water through a 350 mm diam. force main 959 M long to the Fox Hill reservoir. The primary on-off control for three of the pumps is through the water level in the Fox Hill reservoir, with the remaining pump manually controlled. The four pumps together are rated at 16.3 cubic metres per minute.

Fox Hill reservoir: A natural pond augmented by two concrete gravity dams each end, to provide a reservoir. Spillway elevation 105.65 M. Provides gravity flow. This reservoir itself has a small watershed of 22 Hectares.

Fine screen chamber: The building housing the screens and a chlorinator is located at the Fox Hill reservoir and is constructed of brick face concrete block. This building was constructed in 1985. Two sets of three screens, each in parallel. Screen size 1500 mm width x 36 mm height. Beneath the screens there is a 406 x 406 mm sluice gate to make use of the water in the lower part of the reservoir. Chlorine gas is injected into the screen chamber wet well with a manually controlled feed rate. Electric power to operate the screen cleaning pumps.

System network: After the raw water screens the distribution system splits into two branches; municipal branch to Marystown and fish plant branch which also serves the Cow Head deep water dock. Each branch has a chlorinator. Recently a bypass line has been constructed around the Fox Hill reservoir and screen chamber so that inter-lake pumps can pump directly into the transmission mains to the Town and fish plant.

Municipal chlorinator: Gas chlorinator, with feed rate governed by the rate of flow in the mains through a Rockwell 5500 DR turbo meter 250 mm diam. Two meters used in parallel. Rockwell ACT-PAK signal converter. Chlorinator by Capital controls with feed rate adjuster. Two booster pumps in parallel, one for standby.

Chlorine residuals, municipal system: Residuals drop off in the most distant parts of the system.

Fish plant chlorinator: Fixed feed rate chlorinator, using chlorine gas in one-tonne containers with back-up in 150 lb. cylinders. Booster pumps inject chlorine gas/water solution into the main. Downstream of the fish plant chlorinator there is a fish plant, houses in Mooring Cove and the Cow Head deep water dock.

DEMANDS

Metering: The municipal, fish plant and Cow Head dock flows are metered although there is very little flow to Cow Head at present. The municipal flows are the summation of the readings from two meters in parallel in the main chlorination building plus, previously, a meter for Mooring Cove. This latter meter is not functioning now.

Metering: All water deliveries are metered.

Municipal: Meters in chlorination building, two in parallel.
Fish plant: Metered near gate.
Cow Head deep water dock: Metered near gate, although there is very little consumption at present.

The dockyard, a major user, is part of the municipal consumption.

Meter readings:	Year	Cubic metres per year
	1982/83(a)	5,284,713
	1984(b)	4,384,598
	1985(b)	6,106,167 - peak year
	1987(b)	3,023,859
	1991(b)	2,784,435

(a) from engineering study, 1984, Newplan Consultants
(b) Dept. of Municipal and Provincial Affairs records

Discussions: In the early 1980's the Linton Lake pumps were working to the limit in peak periods because of the heavy requirements of the fish plant which is one of the largest such plants in the world. In 1986 a substantial salt water line was installed by the plant and the fresh water demands dropped considerably from about 3.6 million cubic metres per year to 0.5 million cubic metres per year. Fresh water now constitutes only about 17% of the fish plant use. In 1985 67% of the total fresh water supply was used by the plant, but this ratio has now dropped to about 30% in 1992. Municipal consumption now totals 1.9 million cubic metres per year, slightly greater than a decade ago.

Connections: Houses, local businesses, 1930.
Shipyard
Fish plant
Cow Head dock

Losses: According to population data, the municipal consumption should be about 1.1 million cubic metres per year. The difference between this figure and actual consumption of 1.9 million cubic metres per year is attributed to shipyard use, excessive domestic demands or leakages.

Future demands: No significant increase in demands is anticipated apart from normal population growth, and the Cow Head facility. However, the Local Service District of Spanish Room, with a population of about 161, may connect if a new pipeline about 2 km long is provided.

SUPPLY

Adequacy: There has never been a shortage of water in the supply sources. Clam Pond is pumped, usually for a couple of months a year, to top up Linton Lake. In 1984, at peak periods lasting several days all four of the Linton Lake pumps had to work continually to keep up with demand. Peak meter demand in this period was 17,800 cubic metres per day, with the Fox Hill reservoir down to 1270 mm below the spillway. The discharge main from Linton Lake was cleaned by pigging, which has helped increase the pump output. Also, the fish plant has gone over to largely salt water use. Because of these reduced demands the fresh water supply is expected to be adequate in the foreseeable future.

Means of increasing supply: Linton Lake cannot be raised unless the highway is also raised. Means of increasing supply could include:

1. Increase the capacity of the Linton Lake pumphouse.
2. Increase storage capacity of the Fox Hill reservoir. The water level could be raised up to 2.5 M by raising the dams, according to the Newplan report.
3. Provide a new water source, namely Salters Pond. See below.

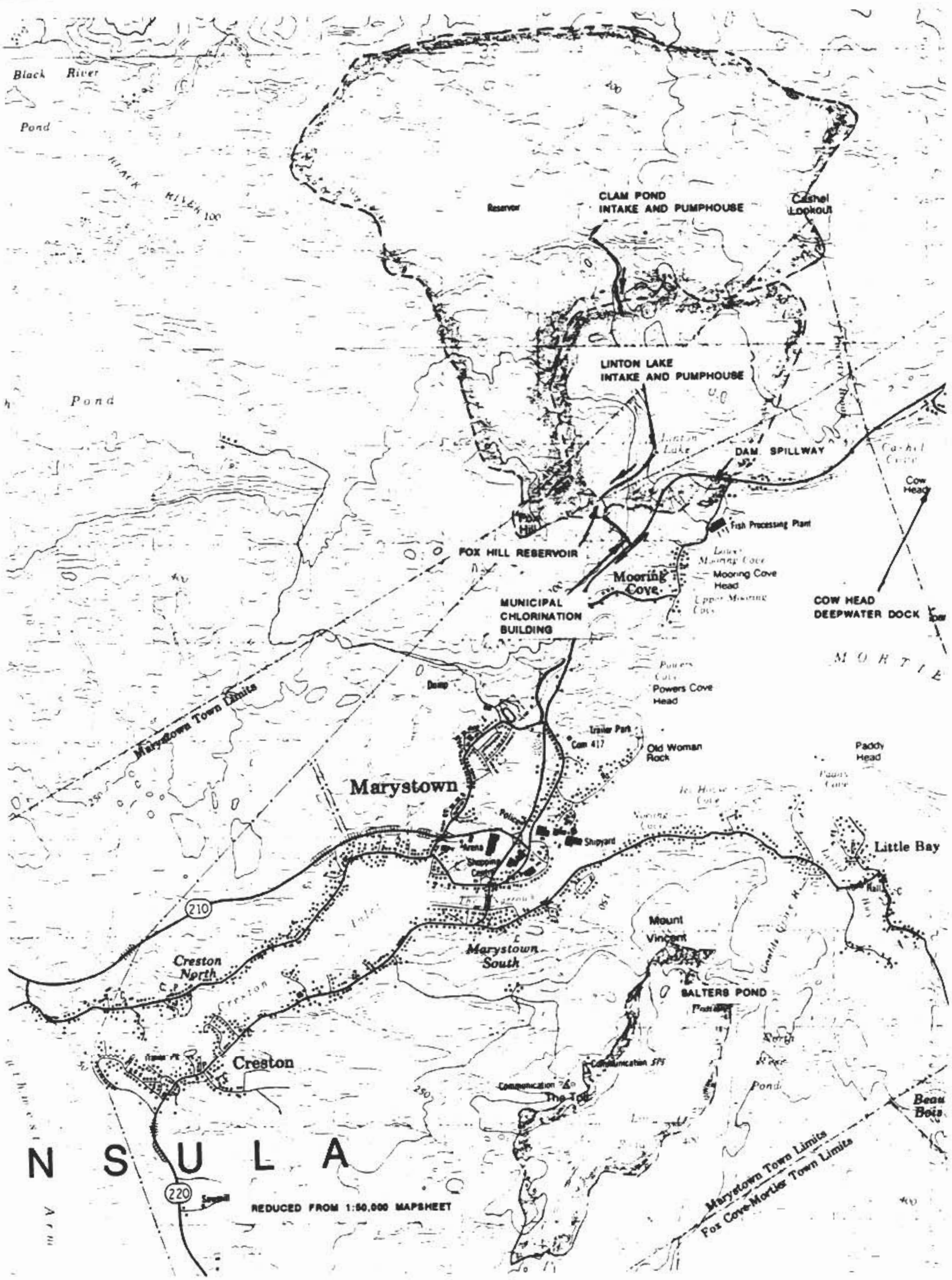
Salters Pond: This could supply gravity flow to Marystown south. Watershed 314 Hectares. Pond area 15 Hectares. Salters Pond is about 30 M lower than Fox Hill reservoir. (From Newplan report).

WASTE WATER DISPOSAL

About 60% of the municipal properties have main sewer, while 40% rely on on-site disposal and will ultimately require main sewage disposal. At present there are 18 separate outfalls and 5 sewage lift stations.

COMMENTS

No comments.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
MARYSTOWN

ACRES

MUNICIPALITY, GROUND WATER SOURCE

MCCALLUM (LOCAL SERVICE DISTRICT)

GENERAL INFORMATION

Information sources: Bob Henkel, Department of Municipal and Provincial Affairs, Grand Falls; Chairman of Local Service District, Everett Durnford; Department of Health, Pat Beson.

Population: 206 (Department of Municipal and Provincial Affairs records)

Water rate: $7 per month

History: In the past, water has been brought to the community in barrels, by boat, from accessible streams on the west shore of Bonne Bay. Well drilling to find a water supply was tried about 16 years ago but was unsuccessful. Due to the inaccessible nature of the community, the usual type of truck-mounted drilling rig, which can make 150 mm diam. and 200 mm diam. wells, cannot be used. Skid-mounted rock core drilling equipment has been used in McCallum for water well drilling. In about 1980, two 100 mm diam. wells were drilled (F J. O'Keefe) near the rink. One of these wells now serves as the supply.

GROUND WATER SUPPLY

Number in use:: One well, 100 mm diam., with a 75 mm diam. submersible pump.

Well ownership: Community Council

Sub-strata at well: Drilled depth 27 M, casing depth 4.9 M, pumped depth 23 M.

Adequacy of yield: Reported yield 32 L/min (7 gpm), which is adequate for the community. However, the community has occasionally run short of water from this well. When this happens, the well is pumped intermittently as the well replenishes. At one time the school was closed for 2 days because of water shortage.

QUALITY

Bacteria: Usually satisfactory disinfection after chlorination.

Department of Health: Grand Falls

User opinion: Clean white water in winter, brown in summer. In summer, drinking water is often obtained from streams along the coast and is brought into the community in barrels by boat.

SYSTEM INFRASTRUCTURE

Storage tank: The well pump lifts into a 2000 gallon storage tank.

Service pump(s): No information available.

Distribution mains: These are 75 mm diam. and 50 mm diam. plastic pipes, some carried in insulated wooden boxes on the ground surface because trenching in the rock was too difficult to carry out.

DEMANDS

Domestic: 47 connections including school with 40 pupils.

Other: Outdoor hockey rink, community hall, medical clinic and diesel power generating station. No industry.

Future: No significant increase expected.

POSSIBLE FUTURE WATER SOURCE

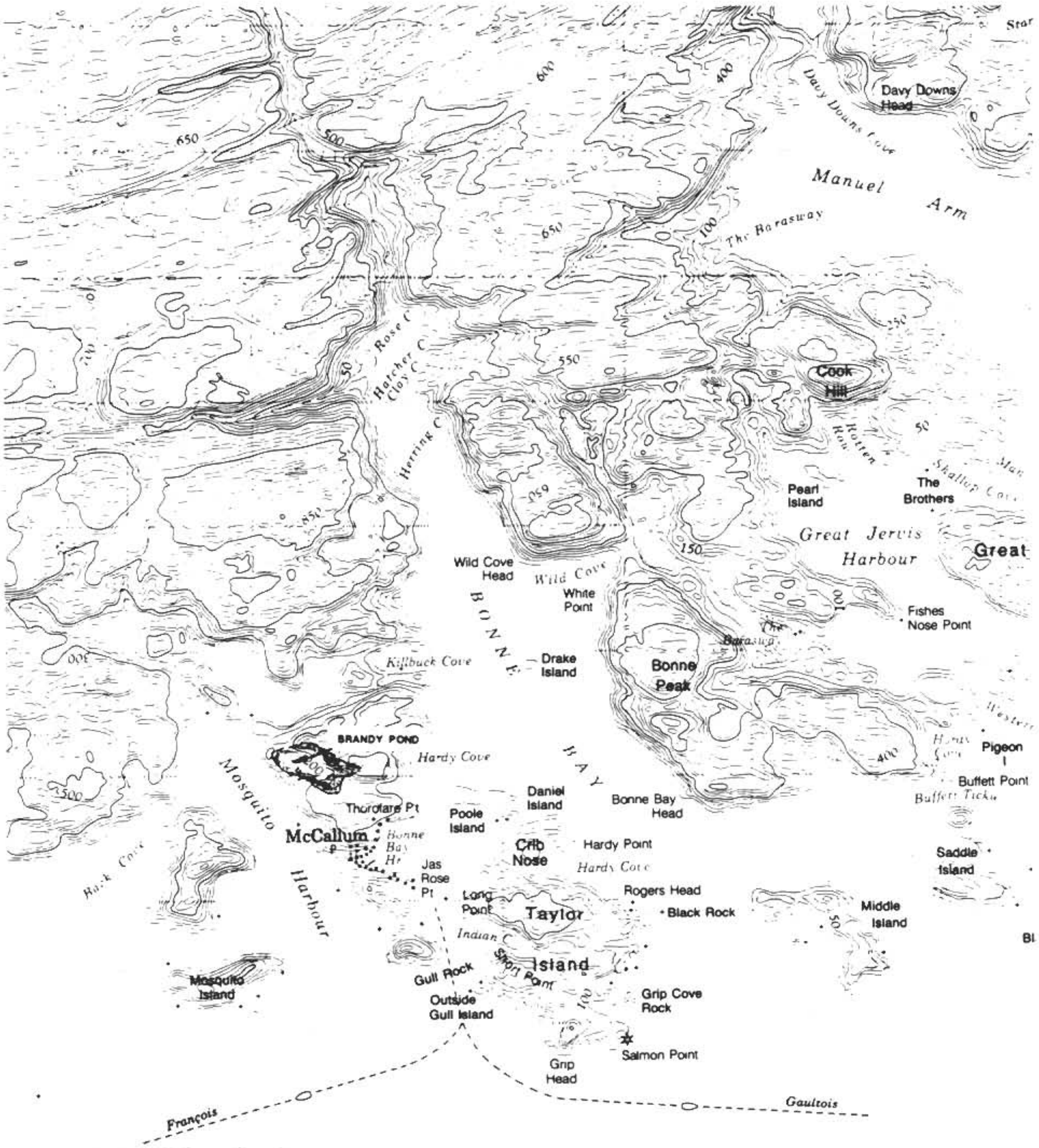
A small pond has been considered, Brandy Pond, about 750 m northwest of the community along a potentially difficult pipeline route because of the steep, high, rocky terrain. This system would need a pumphouse at the pond. The feasibility of constructing a power line from McCallum to Brandy Pond is to be investigated. Pond area is 1.5 Hectares and the watershed area is 15 Hectares.

WASTE WATER DISPOSAL

All private systems with lines to salt water. No sanitation problems reported.

COMMENTS

The supply yield of Brandy Pond needs to be investigated.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
MCCALLUM

MUNICIPALITY SURFACE WATER SOURCE

TOWN OF MILLTOWN - HEAD OF BAY D'ESPOIR

GENERAL INFORMATION

Information sources: Town Manager, Gerry Glover; Works Superintendent, Gerry Wells; DelCan Consultants' field representative, Harry Perry, and Engineer Bob Kennedy.

Census data: Population: 1276 (1986), 1161 (1991). Dwellings: 339 (1991). Average: 3.42 persons per dwelling.

Service fees: Water and sewer: $18.00 per month per house.

SURFACE WATER SOURCE

Old system: A concrete weir across a brook backs up a small pond. Discharge is through a screen chamber and to a 300 mm diam. supply main. All gravity flow. The dam was constructed about 1962.

New system: Now under construction. To the old system is added water treatment and a steel storage tank. The new system is intended to improve water quality, increase the chlorine contact time and increase system static pressures by 124 KPa (18 psi). The chlorination point will be moved back into the new treatment building. At present it is close to the first user.

Description of new system: The existing dam and screen chamber will be retained and the raw water will flow by gravity into the treatment building wet well. From there it will be pumped through filter equipment and will then pass into a clear water well. It will be pumped from there into a steel storage tank at ground level 680 cubic metres capacity (150,000 I gals). From this tank there will be gravity flow to the existing transmission main.

Users: The Town is the sole user of this water system.

Dam: An earth and concrete dam, about 20 M long, not including the spillway.

Spillway: A concrete wall about 1.0 M above exposed bed rock and 23.5 M across the crest (scaled from DelCan plan). Flow depth over spillway at time of survey on September 22/92 about 25 cm depth. Reservoir area 2.1 Hectares (DelCan consultants).

Watershed area: 327.7 hectares

Live storage head: 560 mm measured from water surface to top of stop log at entrance to screen chamber.

Status of watershed protection: Protected (Jersey Pond).

Developments on watershed: Undeveloped. However, timber harvesting may have increased the rate of run-off and this may have contributed to the "dirty water" problem.

WATER QUALITY

Bacteria: Checks are made by the Department of Health, Grand Falls. Satisfactory.

Quality: The raw water has been termed "dirty, highly coloured water".

User opinion on water quality: Not considered to be good-tasting water, or good for cooking or drinking. Local spring water is preferred. Improvements in quality are expected after the ongoing improvements are completed.

Suspended matter in the water: There is evidence that this water carries a lot of suspended matter. (a) The Council staff have to clean the raw water screens several times a week, and last year almost every day. (b) The screen for the chlorinator is also cleaned frequently and found to be blocked with fibrous matter. (c) The water mains have to be flushed out twice a year to remove deposits. (d) Pigging of the water mains has been necessary; this was done in 1984.

EXISTING STRUCTURES

Fine screens: A concrete channel 1.2 M wide and 2.4 M deep runs from the reservoir to feed the transmission main. At the reservoir end of this channel is a stop log which reduces the water channel depth to 560 mm. Presumably this is at this rather shallow depth to reduce the amount of sediment that is carried into the system. On the land side end of the channel there is a wooden shed which constitutes a screen house. Two sets of removable screens, each set in three portions, provide a screened flow area of 2440 H x 1220 W mm. There appear to be sumps on each side of the screens.

Transmission main: 300 mm ductile iron.

Spillway controls: No controls.

Chlorination: The existing gas chlorinator is located close to the built-up area. This is a flow-paced system, using a signal from the meter (which is a 150 mm diam. meter) to control the chlorine injection rate and also to determine the flow at an "Act-Pack" recorder. This system has allowed satisfactory chlorine residuals to be maintained throughout the distribution network. The chlorination system will be transferred to the new treatment building.

New treatment building: This is 10.6 x 10.6 M in plan area and will contain the raw water well with two pumps to the filtering system, and two pumps from the clear well to the tank. Chlorination will take place in the clear well.

Waste lagoon: Waste materials from the filter backwash will be carried in a 200 mm diam. gravity sewer to a small storage lagoon with earth berms.

Fire hydrants: Adequate static pressure are obtained in the fire hydrants.

DEMANDS

Metering: Although the "Act-Pack" recorder can record the cumulative flow on a digitizer. Recordings are generally not made on a regular basis. The instrument also gives a read-out on the flow rate in GPM. At the time of the survey this was 293 GPM. According to the Works Superintendent the flow rate drops to about 80 GPM at about 2 a.m.

DelCan Consultants provided the following information on flows using information that was collected to design the ongoing project.

October 1-31 1990
Average flow 967 cubic metres per day

November 8-30 1990
Average flow 799 cubic metres per day

December 3-31 1990
Average flow 772 cubic metres per day

Existing demands:	Houses and small business:	279 connections
	Motels:	42 rooms
	Schools:	310 pupils
	No major industries	

Future demands: Only about 2 buildings remain to be connected to the water system. Hence a significant increase in demand is not expected.

SUPPLY

Supply has proved adequate in the past, even in the dry year of 1987. It is expected to be adequate in the future.

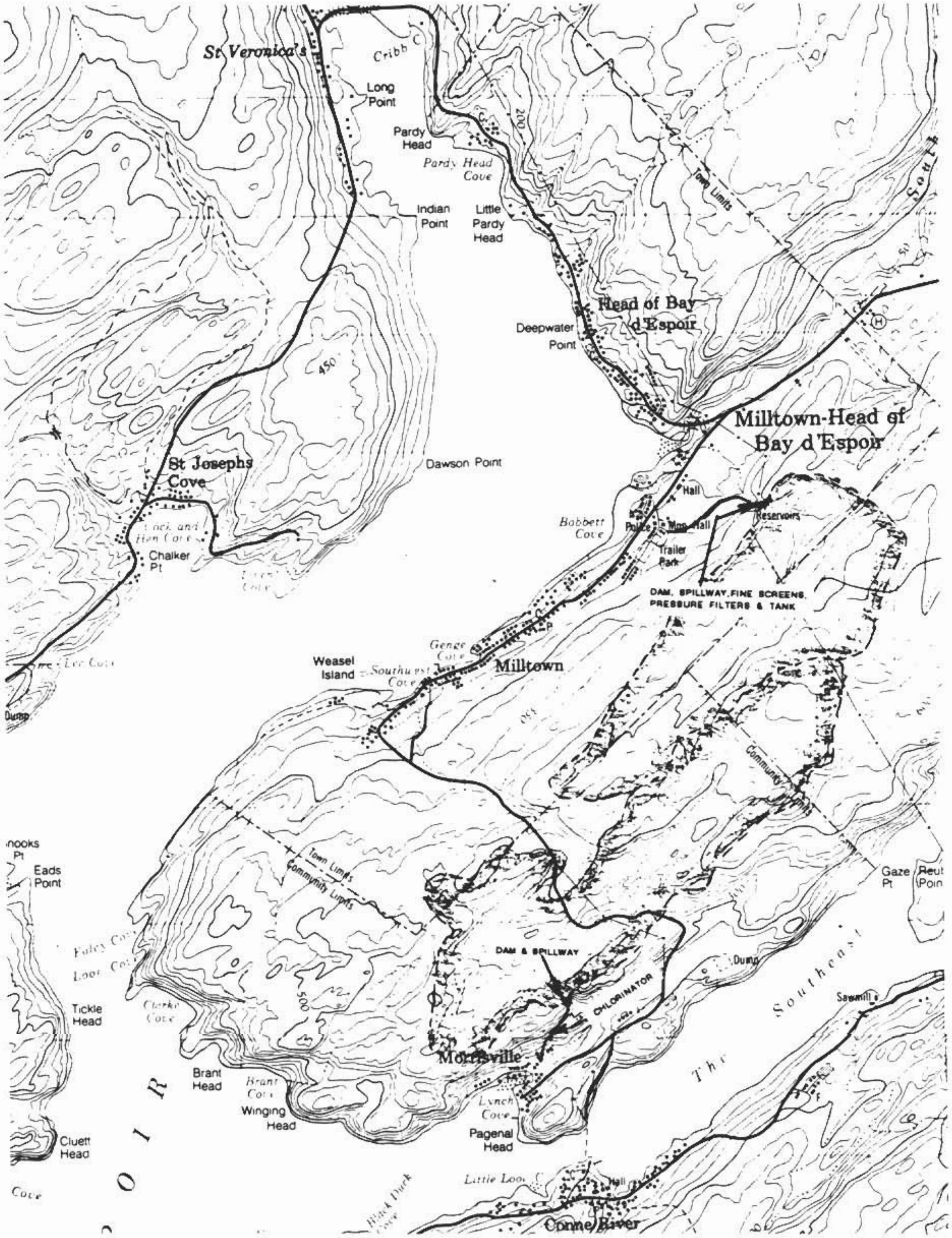
Means of increasing supply: No means of increasing the storage behind the reservoir is readily apparent. The top of the dam is only about 200 mm above the water level and the top of the weir. Because of the thick bush on either side of the reservoir the implications of a new higher dam cannot be determined by reconnaissance.

WASTE WATER DISPOSAL

The main sewer has been extended to as much of the Town as possible, with 330 connections. Some areas cannot be serviced with main drainage. The system includes two sewage lift stations and six untreated outfalls into the bay.

COMMENTS

Raw water screens: The original water system was put in place in Milltown and was subsequently expanded to service the whole Head of Bay d'Espoir area. Considering the heavy load of suspended matter and the flow rate of 1.36 cubic metres per minute (300 gpm), an increase in screen size could be considered. Possibly a new screen system, in parallel with the existing one, could be added if funds permit.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

MILLTOWN–HEAD OF BAY D'ESPOIR AND MORRISVILLE

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF MORRISVILLE

GENERAL INFORMATION

Information sources: Maintenance Person, John Taylor; Councillor Sandy Downey.

Census data: Population 221 (1986), 201 (1991). Dwellings 51 (1991). Average 3.94 persons per dwelling.

Service fees: Water: $5 per month.

Map: See Milltown - Head of Bay D'Espoir.

SURFACE WATER SOURCE, GRAVITY

Description: A run of the river system using an abstraction dam on brook from Morrisville Pond.

Users: Community only.

Dam: Concrete dam across brook in rocky ravine. Width of dam 8.5 M. Height of dam 1.8 M. The dam has a sluice gate to drain the reservoir.

Spillway and flows: Notch in dam 1140 mm wide x 250 mm deep. Flow depth at time of survey 75 mm. Maximum depth of flow recorded in the past, 150 mm over the top of the dam.

Reservoir surface area: 70 sq. M estimated by eye.

Live storage head: Intake invert to spillway 0.92 M (measured on site).

Watershed area: 420 hectares.

Status of watershed protection: The western portion of the watershed is protected.

Developments on watershed: The Milltown to Morrisville highway crosses the watershed but otherwise it is hilly and remote except for possible logging.

WATER QUALITY

Bacteria: A "boil order" is in force because the chlorinator is not working. The water shows some coliform bacteria, probably due to rotting vegetation.

Department of Health: Grand Falls

User opinion: Good quality water.

EXISTING STRUCTURES

System: Installed about 18 years ago by hand. Domestic supply only. Extended to serve new housing recently.

Intake at dam: Screen. Sometimes requires cleaning of leaves etc.

Transmission line and distribution lines: Main is 75 mm diam. PVC, bell and spigot type pipe. Distribution lines are 50 mm diam. The pipe recently installed is 50 mm diam. HDPE.

Chlorinator: The system relies on the pressure differential between the upstream and downstream sides of a pressure reducing valve to draw a hypochlorite solution into the main. This system functioned satisfactorily but suffered recently from frost damage. It is proposed to install a portable propane heater after the system is repaired. Another method being considered is to run in a power line and use a standard flow-paced hypochlorite system with a booster pump.

Distance to first user: The chlorinator is approximately 200 M from the first user.

Pressure zones: Only the PRV chlorinator was installed.

DEMANDS

Metering: No metered records.

Existing: Residential and local commercial outlets for a total of 45 connections.

Future: No significant growth in demand is anticipated.

SUPPLY

Adequacy: The brook has always provided water since the dam was installed. Supply is adequate at present and is expected to be adequate in the future.

Means of increasing supply: A dam and control structure or a pump could be installed on Morrisville Pond to provide water into the brook to the dam if the river flow should prove inadequate.

WASTE WATER DISPOSAL

All the sewer systems are privately owned, with about 50% using septic tanks and drainfields, and the remainder with pipes to salt water. However, officials have stated that some pollution through domestic sewage is occurring in the river that runs through the middle of the community.

COMMENT

No comment.

MUNICIPALITY SURFACE WATER SOURCE

COMMUNITY OF PARKER'S COVE

GENERAL INFORMATION

Information sources: Contract drawings, Newplan Consultants, 1992; Mayor, Cecil Murphy; Department of Health, Sherri Rees.

Census data: Population: 381 (1976), 424 (1981), 428 (1986), 441 (1991). Dwellings: 106 (1991). Average: 4.16 persons per dwelling.

History: This system has used an abstraction dam on Big Pond Brook for several years. Water has run short on occasions. The present improvements will extend the supply line back to a new intake in the pond to increase the available supply. The following information refers to the proposed new system.

Service charges: Not available.

Map: See Baine Harbour.

SURFACE WATER SOURCE

Name: Big Pond, a natural pond.

Users: The Community is the only user.

Dam: No dam.

Reservoir surface area: 13 Hectares.

Watershed area: 270 Hectares.

Live storage head: Using the drawings:

Pond water surface to intake:	1.8 M
Pond water surface to intake of transmission main at screen chamber:	2.81 M
Pond surface level to sill at bottom of screens:	1.23 M

Hence the live storage head is governed by sill in the screen chamber, i.e. LSH = 1.23 M.

Status of watershed protection: Protected.

Developments on the watershed: Undeveloped, wooded land.

WATER QUALITY

Bacteria: Adequate chlorine residuals generally obtained.

Department of Health: Salt Pond

User opinion: No adverse opinion.

PROPOSED STRUCTURES

Intake: A box, screened at the top. The intake is 1.8 m below the water surface according to the drawings.

Screen chamber: This will consist of two sets of three screens each, in parallel (20 mesh, 40 mesh, 60 mesh). Size of each screen 1430W x 1700H.

Transmission main: This is specified as 200 mm diam. ductile iron. The length of this main from the pond to the first building in the community is 1,000 m.

Chlorinator: Hypochlorinator. Distance to first connection: 159 m.

DEMANDS

Metering: No meter.

Existing: About 50 houses, 2 businesses and a clinic.

Future: No major increase in demand is expected. There has been a population growth in this community.

SUPPLY

Adequacy: Expected to be adequate in the longterm future.

Means of increasing supply: Lower the sill in the screen chamber.

WASTE WATER DISPOSAL

The Community has a sewage collection with outfall disposal into the harbour.

COMMENTS

No comments.

MUNICIPALITY, SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF PETIT FORTE

GENERAL INFORMATION

Information sources: Council Member, Kevin Hefford; Department of Municipal and Provincial Affairs, Gerald Rowe.

Population: 114 (Department of Municipal and Provincial Affairs records)

Service fees: $100 per year per house.

SURFACE WATER SOURCE

Name: Reddy's Pond, a natural pond which provides gravity flow.

Users: The community is the only user.

Dam: No dam. A natural brook is the outlet.

Reservoir surface area: 7 Hectares

Watershed area: 56 Hectares

Live storage head: There is a high point in the waterline where it leaves the pond. Use live storage head = 1.0 M.

Status of watershed protection: Not protected.

Developments on watershed: No developments.

WATER QUALITY

Bacteria: Satisfactory for simple chlorination.

Department of Health: Whitbourne.

User opinion: Good quality water.

EXISTING STRUCTURES

Intake: Placed at 3.0 M water depth with a coarse screen over the intake pipe.

Chlorinator: A hypochlorinator with a booster pump is used.

Transmission main: 100 mm PVC extending to the north end of the community. Total length of pipe, 2000 M.

DEMANDS

Metering: No metering is recorded.

Number of connections: 32 houses are connected. No industry.

Future: No significant increase in demand is anticipated. Only one house not connected.

SUPPLY

Adequacy: Adequate into the foreseeable future.

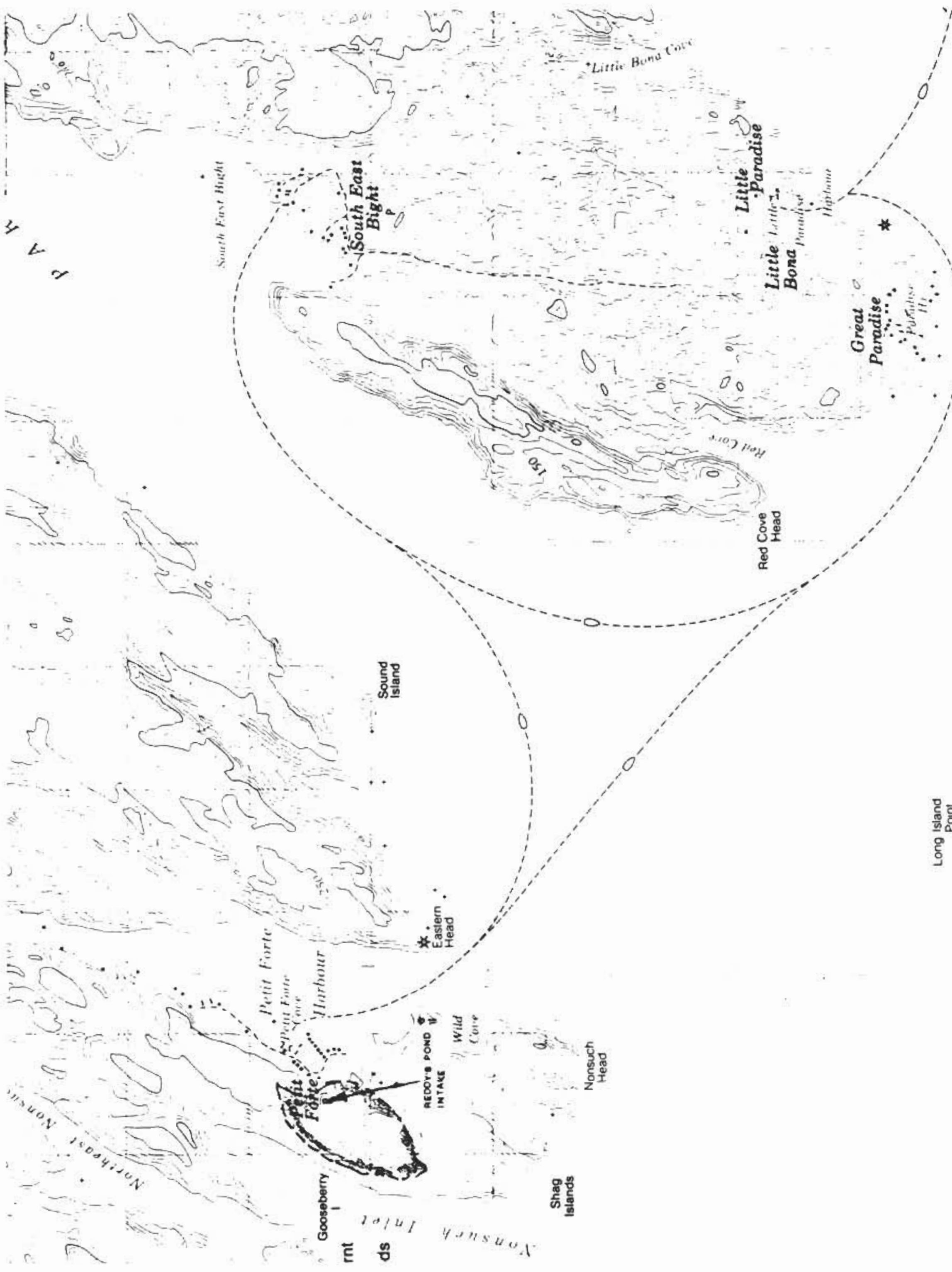
Means of increasing supply: A dam at the outlet brook could raise the water level 400 mm, according to Mr. Hefford.

WASTE WATER DISPOSAL

Each house has a line to the harbour for sewage disposal.

COMMENTS

This system was installed about four years ago as a Canada Works project. In late 1992 a new access road was built into the community over the route of the waterline. There were some breakages caused in the pipe but the road contractor repaired these. There is some concern that the frost penetration resistance of the ground above the pipe may be reduced because of the new road.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA

PETIT FORTE AND SOUTHEAST BIGHT

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF POINT MAY

GENERAL INFORMATION

Information sources: Resident Engineer, Newplan Consultants, Walter Pittman. As-Built drawings of water supply system, 1988, Newplan Consultants. Department of Health, Rick Grikis. Site inspection, Colin Karasek, P.Eng., October 1992.

Census data: Population: 372 (1976), 427 (1981), 456 (1986), 435 (1992). Dwellings: 107 (1991). Average: 4.07 persons per dwelling.

Water and sewer rates: $5 water, $3 sewer, per month.

History: This system has been constructed over a 7 year period. The project will be finished this year.

SURFACE WATER SOURCE, GRAVITY SUPPLY

Name: Shorts Pond, a fairly shallow pond originally 1.6 M deep at the intake, raised to 2.0 M. Muddy bottom is shown on the drawings.

User: Community is the sole user.

Dam: The pond water level has been raised by 0.4 M by damming the outlet brook using sandbags filled with cement/sand mixture.

Reservoir area: 10 Hectares.

Watershed area: 225 Hectares.

Live storage head: The intake is shown on the drawings as a T with a portion of pipe added to the vertical branch. The top of this pipe constitutes the intake of the water supply system. It is given as 1.0 m below the raised level in the pond. In the screen chamber the bottom of the screen mesh is shown as 0.48 m below the intake. Hence the intake is the governing factor for the live storage head. LSH = 1.0 m.

Status of watershed protection: Not protected.

Developments on the watershed: Open bogs and barrens, uninhabited.

WATER QUALITY

Bacteria: Simple chlorination is acceptable for disinfection. Before the chlorinator was commissioned there was a "boil order" in force.

Local Department of Health: Grand Bank

User opinion: Before the system was commissioned the householders used the water for 5 years with satisfaction. Recently, chlorination commenced and it is reported to spoil the taste of the water and to turn the water green when soap is added.

EXISTING STRUCTURES

Intake: According to the drawings the intake is a 200 mm diam. pipe. Under a fire flow demand the velocity of flow through the intake would be excessively high. However, this may not be of significance because any materials or fish drawn in would be taken out at the screen chamber.

Pipeline: The pipeline from Shorts Pond to the first house in the community, which is on Highway 220, is 2.2 km. The main is 200 mm diam., ductile iron.

Screen chamber and chlorination building: This building, located about 100 M from the pond, is 5.4 x 5.4 M in plan area. There is a single run of three screens, with the screen area 1140W x 2000H for each screen. The gas chlorinator uses the pressure of the gas cylinder to inject the gas into the water supply. There is no electric power at this building.

DEMANDS

Metering: No water meter has been installed.

Existing: About 65 hook-ups, all to residences, have been completed.

Completion of current program: About 35 additional connections will be made, consisting of residences and local stores. There is no industry or school.

Future: There may be some growth in the community but this is likely to be quite small.

SUPPLY

Adequacy: The supply is likely to prove adequate now and in the future.

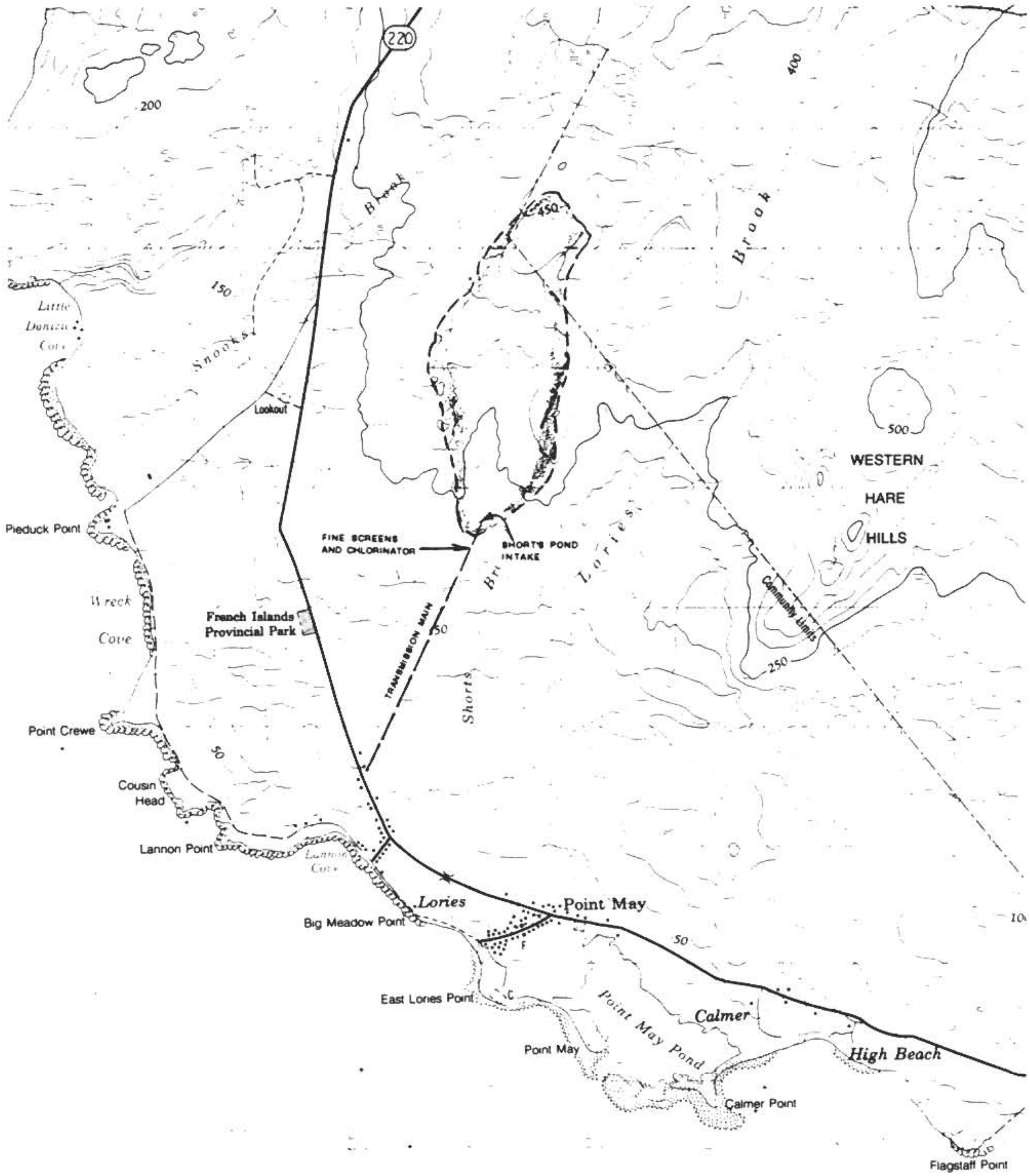
Means of increasing supply: The land around the pond is flat in many areas and it will be inadvisable to raise the water level by any significant amount. Hence no obvious means of increasing the supply is immediately apparent.

WASTE WATER DISPOSAL

There is a full-scale gravity sewer system with two outfalls. Only 8 houses do not have a main sewer connection.

COMMENTS

No comment.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
POINT MAY

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF POOL'S COVE

GENERAL INFORMATION

Information sources: Department of Municipal and Provincial Affairs, James Hardy, P. Eng.; Department of Health, Craig Young; Chairman of Council, Gerald Buffett.

Census data: Population: 259 (1986), 258 (1991). Dwellings: 79 (1991).Average: 3.27 persons per dwelling.

SURFACE WATER SOURCE

Source: A small pond, Widgeon Pond, with a very small watershed. Pond has a bottom of organic material with a lot of vegetation growing. Most of the community is served by gravity from this pond.

Dam: Concrete wall about 1.2 M high, 8 M long.

Spillway: Notch in the concrete dam, 150 mm x 1140 mm.

Reservoir surface area: 300 sq. metres.

Watershed area: 4.5 Hectares

Live storage head: When the reservoir is full the live storage head is 1.37 M, spillway to invert of intake pipe, as measured on site. At the time of the survey the water level was 250 mm above the invert of the intake pipe.

Status of watershed protection: Not protected.

Developments on watershed: None.

Back-up pond: In October 1992, water was pumped to fill the Widgeon Pond reservoir from Big Hill Pond, in a different watershed, a distance of 2,000 M, using a portable pump and a pipeline over the ground.

GROUND WATER SUPPLIES

Drilled wells: Several houses and the Council building along the road approaching the community have drilled wells. This area is too high for the gravity water supply. Four wells have been drilled with yields ranging from 14 to 270 L per minute. The 270 L per minute well is a Council well, pump-tested for 60 minutes.

WATER QUALITY

Bacteria: Adequate chlorine residuals generally obtained.

Department of Health: Grand Falls

User opinion: Water quality deteriorates with a muddy taste as the water level drops in the pond.

EXISTING STRUCTURES

Intake: 100 mm diam. extending 30 M or more into a deep part of the pond.

Fine screens: These are situated in a wet well in a building adjacent to the pond.

Chlorinator: Hypochlorinator, located in the screen chamber building. The chlorinator feeds a chlorine solution drip at a fixed rate into the screen chamber wet well.

Distance of chlorinator from first house: Approximately 200 M.

Distribution mains: Sized for domestic flow. These mains are of the type that required metal straps to hold insert fittings to the joints. These straps are corroding and the pipes are developing leakages.

DEMANDS

Metering: No metering.

Existing: 72 houses, school with 50 children. Fishermen's wharf with 38 mm diam. line.

Future: An improved water supply will probably increase the per capita demand and therefore the quantity of water required. No significant growth in housing is anticipated. A new fish plant to process scallops, "Shell Fresh Farms", is under construction. This will require a 19 mm diam. line. There is no information on demand requirements.

SUPPLY

Adequacy: The Widgeon Pond supply is inadequate in quantity and water rationing is frequently imposed.

Rationing: In the last 10 years water rationing has taken place for up to several weeks each summer and also in late winter after the pond has iced up.

Means of increasing supply:

1. The water storage level in the pond could be increased by 1 M by raising the existing dam and extending it by about 10 M or by building a new dam. The sides of the pond are steep and well defined. Although storage could be increased, the watershed area is probably too small to support this size of community with an adequate water supply on a long term basis.

2. The back-up pond on an occasional basis could be used, e.g. Big Hill Pond as described above.

3. Another surface source could be found. (See "Comments", below.)

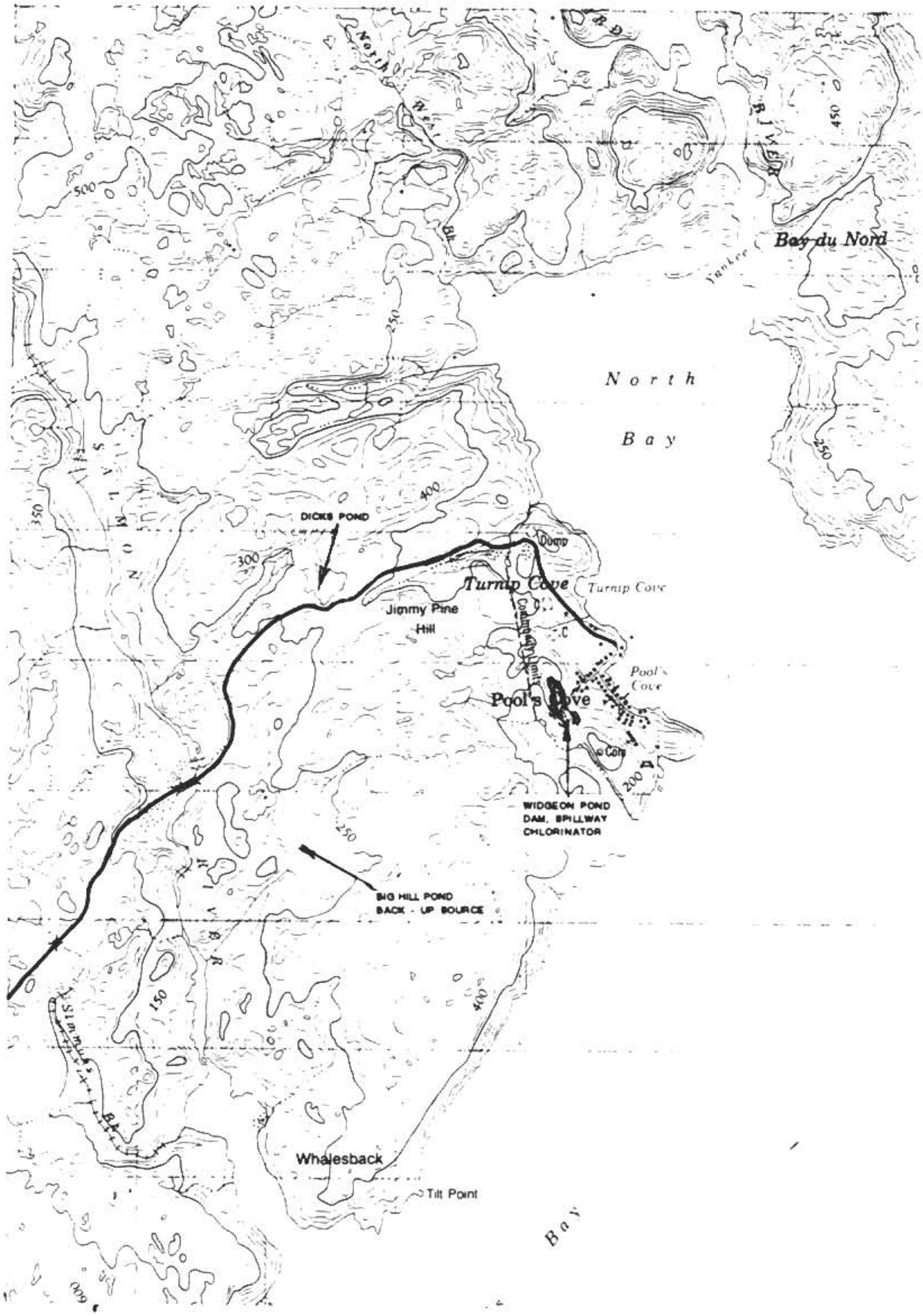
4. Drilled wells. Average water demand for this community without excessive leakage in the mains or wastage would be about 102 L per minute. The existing Council well tested at 270 L per minute. (But only a 60 minute test; a 24 hour test would be a better measure of potential well yield.) Hence drilled wells appear to be a possible water source.

WASTE WATER DISPOSAL

All systems are private with lines to salt water or with septic tanks and drain fields. Many systems function inadequately, e.g. evidence of pollution at the ground surface or in boggy areas.

COMMENTS

This community has a water supply problem. An engineering study has been commissioned by the Department of Municipal and Provincial Affairs to find a solution. Recent advice is that this study has recommended Dick's Pond, which would require a pipeline to the community about 2 Km in length. This source has been included in the Council's 5-Year Plan submission. This report should be updated when the actual system improvements are finally decided upon and approved.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
POOL'S COVE

ACRES

MUNICIPALITY SURFACE WATER SOURCE

COMMUNITY OF PORT AU BRAS

GENERAL INFORMATION

Information sources: Tender drawings, Edwards Turpin, Consultants, 1992. Resident Engineer, Ian Edwards. Mayor, Maurice Fudge. Site visit, Colin Karasek, P.Eng., October 1992.

Census data: Population: 395 (1976), 366 (1981), 363 (1986), 319 (1991). Dwellings: 91 (1991). Average persons per dwelling: 3.51.

Water and sewer rates: Not decided, system is under construction.

History: The Community has relied on dug wells for water supply but a new system has been financed and is now under construction. At the time of the survey only a portion of the supply line to the pond had been constructed.

Map: See Burin

SURFACE WATER SOURCE, GRAVITY

Reservoir: The water source is a natural pond, called Gripe Cove Pond.

Users: The Community will be the only user of this source.

Dams and spillways: No dams or spillways are proposed.

Reservoir surface area: 4.2 hectares.

Watershed area: 16.0 hectares

Live storage head: An examination of the contract drawings revealed that the critical point in the supply system, as far as live storage head is concerned, will be the invert of the intake pipe at the screen chamber. Hence live storage head, measured from the difference of the water level of the pond and the proposed invert of the intake pipe at the screen chamber, is 2.5 M.

Status of watershed protection: Not protected.

Developments on the watershed: This watershed is in a remote area. The land around the pond is fairly steeply sloping, heavily tree covered.

WATER QUALITY

Bacteria: Simple chlorination has been determined as satisfactory for disinfection of the water supply from Gripe Cove Pond.

PROPOSED STRUCTURES

Transmission mains: Pipe from intake to screen chamber, HDPE Series 60, 350 mm diam. Pipe from screen chamber into Community, HDPE 200 mm diam. Distance from pond to existing Community main road, 800 M.

Screen chamber: This will consist of two screens in series, each screen 3250H x 1175W in a building.

Chlorinator: This will include two flow meters in parallel to accommodate domestic and fire flows. Upon a drop in pressure through opening a hydrant, a valve in the chlorination building will automatically open and draw water through the larger water meter. Chlorination will be by means of a hypochlorinator. Distance of chlorinator from first house, 560 M.

DEMANDS

Existing: The Community includes about 128 houses, of which 120 will be serviced by the new system as well as one small commercial outlet. There are no industrial demands.

Future: No significant increases expected.

SUPPLY

Adequacy: The watershed is rather small but the pond has a good capacity and the storage in it could be readily increased (see below). Difficult to determine adequacy by reconnaissance alone.

Means of increasing supply: The main body of the pond extends through a long neck to the outlet brook. This neck could be closed off with a dam about 20 M long and about 3 M high, which would raise the water level of the pond by, say, 1.0 M.

WASTE WATER DISPOSAL METHODS

The proposed system includes sewers.

COMMENTS

See "Adequacy".

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF RED HARBOUR

GENERAL INFORMATION

Information source: Chairman of Council, Ann Clarke; Department of Health, Sherri Rees.

Census data: Population: 206 (1976), 231 (1981), 263 (1986), 252 (1991). Dwellings: 78 (1991). Average: 3.23 persons per dwelling.

Service fees: $144 per year for water and sewer.

GROUND WATER SOURCE

Drilled wells: Two wells are in use, which adequately serve the 78 houses in the community.

Ownership: Council-owned wells.

Adequacy: Adequate.

WATER QUALITY

Bacteria: No problems with bacteria are reported.

Local Department of Health: Salt Pond

User opinion: Excellent water.

EXISTING STRUCTURES

The two wells pump to a storage tank and a service pump then pressurizes the system for distribution.

Chlorinator: The pumphouse has a hypochlorinator.

DEMANDS

Existing: 78 houses.

Future: No significant increase in demand is anticipated.

SUPPLY

Adequacy: The supply is adequate.

WASTE WATER DISPOSAL METHODS

The Community has a complete sewage collection and disposal system with a sewage treatment plant at the harbour.

COMMENTS

No comments.

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF RENCONTRE EAST

GENERAL INFORMATION

Information sources: Department of Municipal and Provincial Affairs, Gander, James Harty, P.Eng.; Department of Health, Grand Falls, Pat Beson.

Census data: Population: 218 (1986), 212 (1991). Dwellings: 55 (1991). Average: 3.85 persons per dwelling.

SURFACE WATER SOURCE

Proposals are in hand to plan a new water supply and distribution system. A surface water source will probably be used. An engineering study is being undertaken to determine the technical requirements of the new system. At the time of the survey the information was not specific enough to include in this report. This report should be updated when the study is completed.

GROUND WATER SUPPLY

Drilled wells: Three wells have been drilled, two for Newfoundland and Labrador Hydro, and one private. Yields varied between 7.0 and 91.0 L per minute.

Dug wells: The community relies on individual wells.

WATER QUALITY

Bacteria: The individual wells are of concern to the Department of Health because of high bacteria count.

Department of Health: Grand Falls

DEMANDS

Existing: Dwellings, school and local stores. No industry.

Future: No increase in demand is anticipated.

SUPPLY

Adequacy: The existing wells are unsatisfactory in quantity of water supplied and quality.

Future: As mentioned, the Provincial Government is financing a full-scale gravity water and sewage collection and disposal system.

WASTE WATER DISPOSAL

Raw sewage drains into a tidal gut in the community. About 90% of the houses drain untreated sewage into the gut and pollution problems are severe.

COMMENTS

The Community has very high priority for water and sanitation improvements, according to the Department of Health in Grand Falls.

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITY OF RUSHOON

GENERAL INFORMATION

Information sources: Mayor, Greg Whiffen; Community Clerk, Jackie Gaulton. Site inspection, Colin Karasek, P.Eng., September 1992.

Census data: Population: 504 (1976), 520 (1981), 505 (1986), 482 (1991). Dwellings: 124 (1991). Average: 3.89 persons per dwelling.

Water rates: $8/month per house.

Map: See Baine Harbour.

SURFACE WATER SOURCE

Name: This is an abstraction dam on North West Brook, running from North West Pond.

Users: The Community is the only user.

Dam and spillway: The river runs in a V-shaped rocky defile, just upstream of the community and a concrete dam is built from rock-face to rock-face across this valley. The dam is about 14 M wide at the top and approximately 4.3 M maximum height. The spillway section of the dam is 4.3 M wide and is 1.4 M lower than most of the concrete dam.

Reservoir surface area: 210 square M (Estimated by eye. It was not possible to pace or measure this area).

Watershed area: 679.0 hectares

Live storage head: From spillway to intake 2.7 M (estimated from measurements on site).

Status of watershed protection: Protected.

Developments on the watershed: The old Burin Highway passes through this watershed.

WATER QUALITY

Bacteria: Sometimes there is a problem maintaining satisfactory chlorine residuals because of the chlorination equipment. Testing is carried out by the Department of Health.

Department of Health: Salt Pond

User opinion: No adverse comment.

EXISTING STRUCTURES

Pipelines: The pipelines are sized for domestic consumption only, e.g. from 100 mm diam. down to 50 mm diam. The original system was installed about 1974.

Pumphouse: The pumphouse and chlorination plant is just below the dam so that water under positive head is provided to the pumps. One pump, 5 HP, operates continuously, with an output pressure of 70 psi. There is also a back-up pump in parallel.

Chlorination: This is a hypochlorite system, using a "Chemtec" metering pump. This provides a fixed rate of flow which can be manually adjusted.

DEMANDS

Metering: No metering is carried out.

Existing: Houses and small businesses: 144 connections
No industrial or major commercial users.
School. See footnote.

Future: About 95% of the community is hooked up but a few families still use their own wells and new houses are being built so the demand in the future will probably increase slightly.

Firefighting flows: In the future the Community would like to see the present system replaced so that fire flows can be provided.

SUPPLY

Adequacy: The supply from the dam has always been adequate except for a dry year, about 1987. Council then provided a portable pump at North West Brook Pond to pump into the stream, and this proved to be satisfactory for supply.

Means of increasing supply: The best means will be to make use of the storage capacity of North West Pond; for example a pumping station could be constructed to pump water into the river to flow to the downstream dam.

WASTE WATER DISPOSAL METHODS

There is no main sewage system in the community. New homes are required to have septic tank and drain fields. There is some concern by Council about sewage effluent in the Rushoon River. However, no health or sanitation problems have been reported. If funds permit, the Council will install a main sewer system, and probably also a water system at the same time.

COMMENTS AND RECOMMENDATIONS

No comments apart from those given in the foregoing information.

School
R. C. School Board. 302 pupils, serving Rushoon, Baine Harbour and Parker's Cove. One drilled well adequately serves the school. No sanitation problems are reported.

MUNICIPALITY SURFACE WATER SOURCE

COMMUNITY OF SEAL COVE, FORTUNE BAY

GENERAL INFORMATION

Information sources: Mayor, Alvin Loveless. Information on file, Colin Karasek Ltd. Engineering Study, Newplan Consultants, 1990. Engineering drawings for contract construction, Newplan Consultants, 1992. Department of Health, Pat Beson.

Census data: Population: 517 (1986), 467 (1991). Dwellings: 138 (1991). Average 3.8 persons per dwelling.

Water and sewer rates: No rates imposed because no hook-ups have been made to the water and sewer system that is under construction.

History: The Community has relied on private dug wells for water supply, and individual septic tanks with drain fields for pipeline to salt water for sewage disposal. Also, six wells were drilled over the last 10 years and have not been successful as a source for community water supply. Installation of a new water and sewer system was commenced in 1991 with a partial sewer system in the Community. In 1992 the construction of the water transmission line commenced from the supply pond to the highway.

SURFACE WATER SOURCE, GRAVITY SUPPLY

Source: Big Black Duck Pond.

Users: The Community will be the sole user.

Pressurization: This will be a gravity source requiring a pressure reducing valve; the pond elevation is 93.43 M, geodetic datum.

Pond surface area: 12.0 hectares.

Watershed area: 180 hectares

Live storage head:
At proposed intake chamber in pond, 1.32 M; water level to top of intake.
At proposed screen chamber sill, 1.02 M; water level to top of sill.
At transmission main at screen chamber, 2.24 M; water level to pipe invert.
Hence the screen chamber design limits the live storage head, i.e. LSH = 1.02 M.
However, this live storage head will be achieved only if the screens are removed *because of the constriction in flow* caused by the screen mesh.

Status of watershed protection: Not protected.

Developments on watershed: An isolated area, mostly open bog land, no developments apparent.

WATER QUALITY

Bacteria, raw water: Total bacteria count: 0. Fecal bacteria count: not available. Suitable for disinfection by simple chlorination.

Department of Health: Grand Falls

Chemical parameters: This water is acidic (pH 5.2), with low alkalinity and high colour (55 to 71 units). It is likely that the colour will worsen after heavy rains.

PROPOSED STRUCTURES

Intake: 300 mm diam. restrained mechanical joint, ductile iron pipe, running 70 M into the pond to intake chamber with screen on top. Water depth at intake pipe 2.08 M. Top of intake 1.32 M below pond surface shown on drawings.

Raw water screens: Two sets of three screens each in parallel. with each screen 1430 w x 1700 h mm. Both sets are in the same chamber, i.e. a set of screens cannot be gated off and used separately. The screens will be housed in a concrete block building 6.0 x 3.6 M in plan.

Spillway: A natural outlet brook.

Supply mains: Ductile iron 250 mm diam., about 3.35 km long, to the edge of the Community.

Disinfection: Chlorination is proposed. The building will be alongside the highway, about 1.7 km from the edge of the Community.

Pressure zones: A pressure reduction valve is proposed in the chlorination building.

DEMANDS

Future demands:	Domestic:	138 dwellings
	School:	About 250 pupils (K to 12)
	Commercial:	A few local establishments
	Industrial:	Nil

SUPPLY

Adequacy of supply: This source will be adequate in the foreseeable future.

Means of increasing supply:

1. The concrete sill on which the bottom of the screens rest in the screen chamber is shown on the contract drawings as 1.5 M above the bottom of the screen chamber floor, and 1.22 M above the inverts of the inlet and outlet pipes. So by lowering the sill of the screens, full advantage could be taken of the live storage head at the intake, i.e. the live storage head could be increased by 0.32 M.

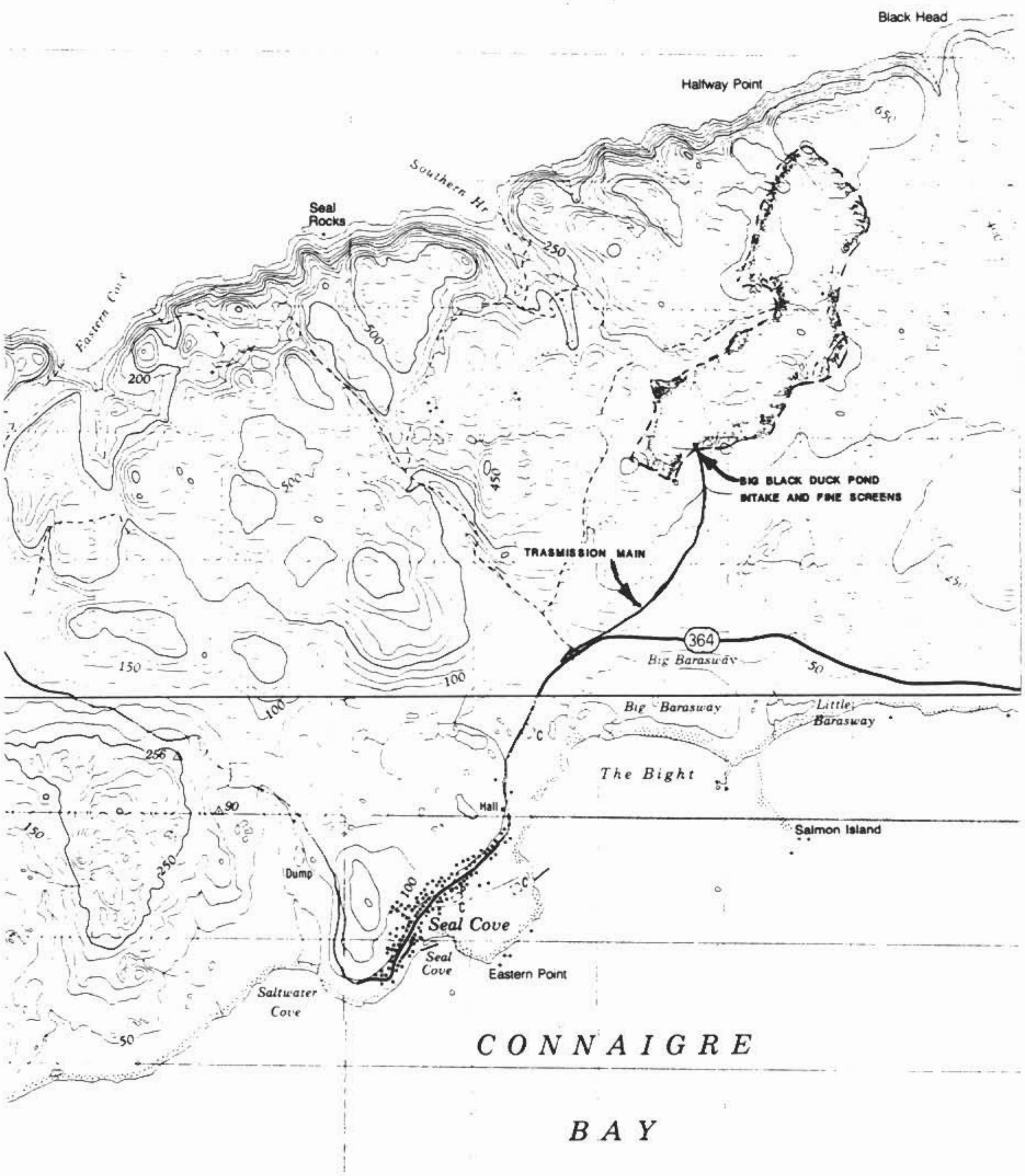
2. The live storage head in the pond can be increased by 1 metre by building a dam about 2.0 M high, 12.0 M long, across the outlet brook.

WASTE WATER DISPOSAL METHODS

A gravity sewer system is proposed, with two outfalls to the ocean.

COMMENT

Under domestic demand it will take about 18 hours for the water to travel from the pond to the edge of the community. It may be necessary to disinfect at the screen chamber, as well as near the community. This needs to be investigated.



COLIN KARASEK LTD.

REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
SEAL COVE

ACRES

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF SOUTHEAST BIGHT

GENERAL INFORMATION

Information sources: Former Chairman, Raphael Hepditch.

Population: 111 (Department of Municipal and Provincial Affairs records).

Buildings: 26 houses, school (2 classrooms, 45 pupils), church, no fish plant.

Map: See Petit Forte.

GROUND WATER SUPPLIES

All wells are privately owned dug wells.

Adequacy of yields: About two families have adequate wells, whereas the remainder often run dry in the summer.

WATER QUALITY

Bacteria: No information available.

Department of Health: Whitbourne

User opinion: Poor quality water. Water is said to emanate from boglands and is highly coloured and contains excessive quantities of ferrous iron.

DEMANDS

Existing: See above, under "Buildings", no industry.

Future: No significant increase is expected.

SUPPLY

The supply is inadequate for many of the householders in terms of quantity and quality.

Means of increasing supply: Council has asked the Department of Municipal and Provincial Affairs for funding to develop a surface water source. No detailed information is available.

WASTE WATER DISPOSAL

These are all private systems, mostly with pipes to salt water. Some problems are reported, such as freezing in winter and damage at the outfall through storms and ice.

COMMENTS

When funds permit, the Provincial Government will finance an engineering study and/or a community water and sewer system.

UNINCORPORATED AREA, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF SPANISH ROOM

GENERAL INFORMATION

Information sources: Chairman of Council, Greg Pittman; Department of Health, Sherri Rees.

Population: 161 (Department of Municipal and Provincial Affairs records).

Map: See Jean de Baie.

GROUND WATER SOURCES

Dug wells: Most of the houses use or share dug wells, about 30 dug wells in all. Some of these wells run dry in summer and the pipelines freeze in winter.

Drilled wells: Four drilled wells are reported for private homes, with yields from 2 to 14 L per minute.

Adequacy: The existing ground water sources are not entirely adequate.

WATER QUALITY

Bacteria: No adverse reports.

User opinion: No adverse information.

Department of Health: Salt Pond.

DEMANDS

Present: The Local Service District includes 50 houses.

Future: There may be a slight population growth.

SUPPLY

Adequacy: Some of the local people believe their supplies are inadequate. A survey is being carried out by the Council to determine if people wish to seek a public water supply.

Means of increasing supply: An investigation is needed. The most feasible possibility would be to connect to the existing water main that serves the Cow Head offshore construction yard.

WASTE WATER DISPOSAL

All systems are private. The newer houses have septic tanks and drain fields or a line to tide water and a soak pit full of stones. The older houses generally have a line to salt water. No significant pollution problems are reported.

COMMENTS

Some houses in this community have a water supply problem. One solution would be to run a pipeline connected to the Cow Head water system. Since this community is rather spread out the pipeline would need to be about 3 KM long. Whether or not such a scheme could proceed depends upon the available funding.

MUNICIPALITY, SURFACE WATER SOURCE

COMMUNITIES OF ST. BERNARD'S AND JACQUES FONTAINE

GENERAL INFORMATION

Information sources: Engineering Report, Follett Gosse and Associates, September 1992. Personal communication, Rick Gosse, P.Eng. Community Clerk, St. Bernard's, Marie McCarthy. Maintenance Foreman, St. Bernard's, Hughie McCarthy.

Census data:

	Year	St.Bernard's	Jacques Fontaine	Total
Population	1976	611	197	808
	1981	696	221	917
	1986	689	210	899
	1991	652	200	852
Dwellings	1991	158	59	217
Average persons/ dwelling		4.13	3.39	3.92

Service fees: $8.00 per month.

History: The St. Bernard's system was installed some years ago with service pumps and a storage tank, using for supply an abstraction dam at a lower level than the present dam. There were leakages in this dam which led to supply problems. A new dam was installed in 1989 at a higher elevation which permitted the use of pumps of lower capacity than the previous pumps. Jacques Fontaine is now in the process of connecting to the system. A study (Follett Gosse) has determined that the supply is quite adequate for St. Bernard's and Jacques Fontaine combined.

Ownership: Community of St. Bernard's.

Map: See Town of Bay l'Argent.

SURFACE WATER SOURCE

Name: Dam on Rattle Brook. Water elevation 49.0 M above sea level.

Users: St. Bernard's and Jacques Fontaine, including regional school.

Pressurization: Most of the demand is below the storage pond level but the storage tank (on a hill in St. Bernard's), top elevation 56.0 M, is filled by pumping.

Dam: A concrete wall supported with earth and rock fill, length 25 M including spillway, height 1.5 M.

Spillway: Two slots in the concrete, each 3,000 mm long, with 530 mm freeboard from the spillway stop logs to the top of the dam. The height of the stop logs in place is 800 mm.

Watershed area: 6.87 square km.

Reservoir area: 0.6 Hectares, estimated by eye. There was a small natural pond which has been increased in size by the dam.

Live storage head: 1.5 M, spillway to intake pipe (from site survey).

<u>Status of watershed protection:</u> Not protected.

<u>Developments on watershed:</u> None apparent.

GROUND WATER SUPPLIES

<u>Drilled well:</u> The regional school well yields 68.2 L per minute, but the school is now on main water.

WATER QUALITY, SURFACE SOURCE

<u>Bacteria:</u> Simple chlorination is satisfactory disinfection.

<u>Department of Health:</u> Salt Pond

<u>User opinion:</u> No adverse opinion.

EXISTING STRUCTURES

<u>Pumphouse:</u> From the intake the pipeline runs down a steep slope to the pumphouse in Jacques Fontaine. Two 3.0 HP centrifugal pumps have on-off control through the water level in the storage tank.

<u>Chlorinator:</u> In pumphouse. Gas chlorinator with feed rate manually controlled. Booster pump injection.

<u>Transmission main:</u> 150 mm diam.

<u>Tank:</u> On high ground in St. Bernard's. Capacity 225,000 L.

DEMANDS

<u>Metering:</u> No metering is carried out.

<u>Number of connections:</u> St. Bernard's: 192 connections including school with 100 pupils. No industrial demands. Jacques Fontaine: only a few connections at present but will have about 20 connections including school of 260 pupils. No industrial demands.

<u>Leakage and wastage:</u> No information.

SUPPLY

<u>Adequacy:</u> The supply will be adequate into the foreseeable future.

<u>Means of increasing supply:</u> The supply dam could be raised. The valley in which the supply pond is located is steep-sided, so that raising the dam by, say 1 M, would cause no problems. The dam would have to be about 200 M long.

WASTE WATER DISPOSAL

St. Bernard's has a main sewer system, and a system is being installed in Jacques Fontaine. No significant pollution problems are reported.

COMMENTS

No comments.

MUNICIPALITY, GROUND WATER SOURCE

TOWN OF ST. JACQUES - COOMB'S COVE

GENERAL INFORMATION

Information sources: Department of Environment and Lands, Water Resources Division, Ground Water Section, Keith Guzzwell, P.Geol; Mayor, Max Taylor; Department of Health, Craig Young.

Description: This Town consists of six distinct communities; starting from the east, St. Jacques, English Harbour West, Mose Ambrose, Boxey, Wreck Cove, Coomb's Cove.

Census data: Population: 994 (1986), 701 (1991). Dwellings: 218 (1991). Average: 3.22 persons per dwelling.

GROUND WATER SUPPLIES

Ownership: The Town is supplied with drilled and dug wells, all in private ownership. The following table summarizes the drilled wells.

Community	Total No.of wells	No. of wells over 3.9 L per minute	Maximum yield, L per minute	Well depth M Min.	Well depth M Max
St. Jacques	8	8	136	15	46
English Harbour West	55	48	546	14	91
Mose Ambrose	6	6	270	12	46
Boxey	9	7	46	14	63
Wreck Cove	4	3	18	24	46
Coomb's Cove	2	1	14	32	134
Totals	84	73			

Adequacy of yields: A yield of over 3.9 L per minute should satisfy two or three houses if adequate storage is provided. Hence it appears that the Community is sufficiently served by drilled wells. Some houses have dug wells.

WATER QUALITY

Bacteria: No adverse information.

Department of Health: Grand Falls

User opinion: No adverse information.

DEMANDS

Apart from the Census data no information on water demand is available because all the demands are met by individual sources from groundwater. There is no significant industrial demand for fresh water.

SUPPLY

Adequacy: Ground water supplies are providing an adequate source of water.

WASTE WATER DISPOSAL

Private systems: Individual septic tanks or drainfields or pipes to salt water are used.

Council system: In English Harbour West there are two roads where the housing layout makes unsatisfactory conditions for on-site disposal systems. Two gravity sewers are being constructed here, each of which will discharge through a large septic tank into salt water.

COMMENT

A few years ago Council circulated a questionnaire concerning the installation of main services. There was no interest in such main services for water supply.

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF ST. JOSEPH'S COVE - ST. VERONICA'S

GENERAL INFORMATION

Information sources: Chairman of Local Service District, Pat Organ; Department of Health, Grand Falls, Pat Beson.

Community: This Local Service District consists of two communities; St. Joseph's and St. Veronica's, separated by a few kilometres.

Population: 229 (Department of Municipal and Provincial Affairs records).

Service charges: No service charges are imposed because water and sewer systems are privately owned.

GROUND WATER SUPPLY

Dug wells: The water supply is entirely from dug wells, privately owned. There are no drilled wells. There are approximately 26 houses in St. Joseph's, and 15 in St. Veronica's. Many of the wells are set on the hillside behind the communities so that gravity flow is obtained.

Adequacy of yield: Sometimes the supply runs out in some of the wells in periods of dry weather.

WATER QUALITY

Bacteria: No adverse comment from the Department of Health.

User opinion: No adverse comment.

Department of Health: Grand Falls

WASTE WATER DISPOSAL

Septic tanks and drain fields or lines to salt water are used. No sanitation problems are reported.

COMMENTS

There are no plans for a municipal system. If it were considered necessary to increase the supply by means of a public water supply and distribution system, a detailed investigation would be required. This would need to consider, for example, surface water supplies from hillside brooks, or groundwater from drilled wells.

MUNICIPAL AND INDUSTRIAL SURFACE WATER SOURCE

TOWN OF ST. LAWRENCE

Information sources: Newfoundland Power, Manager, Energy Supply, J. L. Simmons; Town Manager, Leo Slaney.

Map: See Local Service District of Little St. Lawrence.

SURFACE WATER SOURCE

Introduction: The Town derives its supply from a Newfoundland Power hydro-electric scheme. Hydro electric projects are discussed in the main report. The following is a brief description of aspects of the hydro scheme as it relates to the Town's supply.

Source: West Brook Hydro Electric Development utilizes a river and pond system shown as the St. Lawrence River on the 1:50,000 topographic map sheets. The hydro electric scheme was constructed in 1942 with a capacity of 700 KW under a net head of about 47 M. The drainage area of the West Brook hydro scheme watershed is 45 sq. km.

Forebay dam: The forebay dam is built across the St. Lawrence River and is of reinforced concrete gravity construction about 6.1 M high at the highest section. It includes a 79 M long main spillway section, a 21 M long arched dam section, a 5 M long spillway section and an inlet structure to the canal.

Canal: A power canal 1250 M in length and an average 4.9 M wide and 4.6 M deep, made by earthwork grading, follows a side hill contour to carry water from the dam to the penstock intake.

Intake to penstock: The penstock is a reinforced concrete structure topped with a wooden gatehouse. The bottom of the intake gate is approximately 2.50 M below full supply level.

Canal spillway: Reinforced concrete spillway 4.9 M wide is located adjacent to the penstock intake structure. The spillway discharges over several concrete and rock-filled timber crib steps.

Penstock: 536 M long, 1372 mm diam., fibreglass reinforced plastic pipeline, under earth fill. Installed in 1987 to replace the original 1219 mm diam. wood stave penstock.

Water supply intake for Town of St. Lawrence: The municipal supply derives from an intake in the canal approximately 30 m upstream of the penstock intake. The elevation of the water level at the West Brook canal intake is about 72.7 M (238.5 feet) in reference to sea level. The water level at the intake is the same as the canal spillway elevation. The intake is located about 2.0 M below the water level.

Watershed protection: The whole watershed to the forebay dam and the ground slopes to the canal are protected.

TOWN OF ST. LAWRENCE

GENERAL INFORMATION

Census data: Population: 2258 (1976), 2012 (1981), 1841 (1986), 1743 (1991). Dwelllings: 512 (1991). Average persons per dwelling: 3.40.

Water and sewer rates: Houses: $13.00 per month, water and sewer
$11.50 per month, water only
Commercial: $15.00 per month
Fish plant: 40 cents per thousand gallons.
Mine: Agreed rate

Payment for raw water: The municipality does not pay Newfoundland Power a fee for water use.

GROUND WATER SUPPLIES

Drilled wells: The original water supply for St. Lawrence was drilled wells, installed 1953/54 and abandoned about 1971. The problems with this supply are not readily discernible now. Possibly because of pumping problems and possibly because the water was suspected to emit radiation, this system was replaced with a gravity source from the West Brook hydro canal.

WATER QUALITY, WEST BROOK SURFACE SOURCE

Bacteria: Satisfactory chlorine residuals are obtained.

Local Department of Health: Grand Bank

User opinion: The water becomes brownish during periods of high run-off.

EXISTING STRUCTURES

Coarse screen: The intake at the canal has a coarse screen; there is no fine screening.

Transmission main: A 356 mm diam. ductile iron main was installed from the canal in 1971 to connect with the existing network in the Town. Most of the older mains are asbestos cement pipe, installed in 1953/54.

Chlorination: The original chlorinator, installed in 1971, was a proportional feed chlorinator controlled by a water meter. This became dysfunctional and was replaced in 1984 with a new proportional feed system. The system is currently operated under manual control with a fixed rate of chlorine injection.

Distance of chlorinator from first house: Approximately 1100 m.

Storage tank: A steel storage tank 2270 cubic metres (500,000 gallons) capacity stands at ground level on high ground in the Town. This tank was part of the system when the wells were used. The top elevation of the tank is at 67.1 M (220 feet), tank height 12.2 M. Apparently this tank "floats on the line" so overflow occurs on occasions because the source head is higher than the tank.

Pressures: Some of the houses on the high ground in the Town readily lose pressure if the intake at the West Brook canal becomes partially blocked with sticks or leaves.

Study: There is an ongoing technical study by a consulting engineering firm to investigate the problems with the water supply and distribution and to make recommendations.

DEMANDS

Metering: The fish plant is metered, and also the domestic line to the mine. The meter at the Town's chlorinator is dysfunctional.

Existing demands: Domestic: About 525 connections to houses and small business.

Fish plant: The fish plant has a salt water line but when production is at a low level it frequently relies entirely on fresh water, thus the plant uses much more salt water when it is fully operational and the fresh water demand declines. At present the plant is serving a few crab vessels and local fishermen. Ice-making requires 887 cubic metres (195,000 gallons) in 24 hours.

Typical fish plant readings: January 7 - June 2, 1992 862.4 cubic metres per day, average
June 2 - August 25, 1992 978.6 cubic metres per day, average

Fluorspar mine: The mine administration building has a connection to the municipal water supply. When the mine was operational, apart from the office staff there were ten shower heads used for about 3 hours a day for clean-up purposes for the mine and mill workers. Also, the company was in the process of constructing a 150 mm diam. line from the municipal system to the mill, but this line was never completed before the company closed down. Presumably this line was to supplement the water supply from Clarke's Pond, or perhaps even to replace it.

Future demands: If the mine started up again it will be likely be a larger operation than before. In addition, a much greater production of the fish plant should be considered. If these industries get going again, then there would probably be a slight growth in population.

Power generation, West Brook Hydro Electric Development: The following information has been provided by Newfoundland Power for 1991:

	Monthly Average Data (Cubic metres/second)	
Month	Spill	Generation*
January	0	0.424
February	0.217	0.507
March	0.157	0.720
April	0.040	1.462
May	0	1.079
June	0	0.420
July	0	0.057
August	0	0.239
September	0	0.803
October	0	1.245
November	0	0
December	0	0.316

*Average monthly flow through turbine.

SUPPLY

Adequacy, municipal: The Town has always received an adequate quantity of water from the hydro system.

Adequacy, power generation: Very little water is wasted according to the records given above for 1991.

Future: This needs a detailed assessment, allowing for the possibility of an improved fishery and a new and larger fluorspar mining operation.

Means of increasing supply: No apparent means of increasing supply unless more water is taken at the expense of hydro generation.

WASTE WATER DISPOSAL

The Town has a complete municipal sewer system, with untreated outfalls. There are about 25 - 30 houses which do not have main services either for water or sewer, and these houses have adequate on-site disposal systems.

COMMENT

Some of the water system is 30 years old and is of materials which may be deteriorating. The old mains are of asbestos cement, which is inclined to be brittle, and the laterals were made with plastic pipe and steel clamps which are now rusting and breaking. Hence the metering of the municipal water supply should be considered. By minimizing water losses through the municipal system it may be possible to increase power generation although this subject is beyond the scope of this reconnaissance survey.

INDUSTRIAL SURFACE WATER SOURCE

FLUORSPAR MINE, ST. LAWRENCE

GENERAL INFORMATION

Information source: Local Manager, Ernst and Young, Receivers, Jim Tuff.

Map: See Local Service District of Little St. Lawrence.

SURFACE WATER SOURCE

Source: When the mine was operating, water for mill processing was pumped from Clarke's Pond. This is a natural pond with no dam.

User: The mine was the only user. Also, water from the underground workings was pumped into the pond.

Watershed area: 50.0 hectares

Reservoir surface area: 8.7 hectares

Live storage head: With the former pumping system at the mine, the live storage head was about 1.0 M. The pumps have been removed; if they are replaced for future use the live storage head should be re-estimated.

Watershed protection: Within the control of the mining company.

Developments on watershed: Roads, mine buildings and undeveloped land.

WATER QUALITY

Suitability: This was suitable for use in the mill without treatment.

EXISTING STRUCTURES

Pipeline: A 150 mm diam. pipeline ran from the pumps to a storage tank in the mill.

Pumps: A steel frame has been constructed to rest on the bottom of the pond near the shoreline. This frame supported a wooden structure housing pump controls and two submersible Flygt pumps in parallel, each within 150 mm diam. steel pipe. Power was run in by waterproof Teck cable. Each pump was rated 28 hp. The basic on/off control was through pressure in the tank in the mill.

Frost protection: The pump casings and the exposed pipeline to shore were wrapped with 25 mm of fibreglass insulation inside a metal jacket, with heat tracing wire included.

DEMANDS

The output of both pumps combined was probably about 2.0 cubic metres per minute (440 gpm).

SUPPLY

Adequacy: The supply was always adequate which was perhaps not surprising because the mine operations pumped as much as 1200 to 1500 gallons a minute into Clarke's Pond.

Means of increasing supply: The water level in Clarke's Pond could be raised 600 mm by means of a dam about 60 m wide on the outlet brook. This is based upon an on-site survey.

Future: If the mine re-opens it will likely use the same process method as the existing operation, but in order to become viable the scale of operations will have to be greatly increased (according to Mr. Tuff). Hence the adequacy of Clarke's Pond for a future operation has to await a decision on the scale of operation of any future mine.

COMMENTS

The mine also used water from the municipal supply; see inventory for Town of St. Lawrence.

MUNICIPALITY, GROUND WATER SOURCE

TOWN OF ST. ALBAN'S

GENERAL INFORMATION

Information sources: Works Superintendent, Calvin Young: Town Clerk, Genevieve Tremblett. Old blueprint drawings of the original system in the Council office. Department of Health, Pat Beson.

Census data: Population: 1,780 (1986), 1,1586 (1991). Dwellings: 476 (1991), 3.33 persons per dwelling.

Water and sewer rates: Water: $120 per year. Sewer: $72 per year. A total of 520 connections.

Brief description of water system: The water source is a well field in gravel and bed rock in a river basin. Submersible well pumps feed a ground surface reservoir. Service pumps supply water from this reservoir into distribution system and to a storage tank on high ground which balances on the line and serves fire flow storage. The water level in this tank controls the service pumps. See Figure 1.

GROUND WATER SUPPLIES

Drilled wells: There are six active wells of which four are in use. Two wells are pumped together and alternate, unless the demand is high when four wells are pumped together. Two wells are kept in reserve.

Well field: This is a broad valley containing Swanger's Brook and tributaries. The well field area appears to be a huge bed of sand and gravel.

Sub strata at wells: 41.0 m of sand and gravel over slate bed rock.

Typical well depths: 92.0 m drilled, 41.5 m cased.

Typical well yield data: 205 L/min per well.

Typical depth to water level: 1.0 to 10.0 m

History: The source was developed into a municipal supply about 1973. Over the years several wells have been abandoned and new wells drilled. The supply appears inexhaustible.

WATER QUALITY

Bacteria: Satisfactory chlorine residuals are maintained and are checked by the Town Council staff daily, and Department of Health monthly.

Department of Health: Grand Falls

User opinion: Reported to be of good quality.

EXISTING STRUCTURES Please refer to Figure 1.

Pump controls and chlorination:

Bldg.No.1 Well controls. The basic control for the wells (on-off), is the water level in the reservoir, Building #2. The controls in Building #1 can override the basic controls by allowing the wells to be controlled automatically or by hand. Also there is an electrode in each well which serves as emergency cut-off for the pump if the water level in the well draws down to leave the pump exposed. There is buried cable from Building #1 for power supply to each well pump and low voltage lines for the well electrodes.

Chlorination. An injection pump draws chlorine solution made from calcium hypochlorite powder from a 200 L tank and pumps this into the supply main. The injection pump operates when the well pumps operate. However, the dose is the same whether two or four pumps operate. Raw water for mixing the powder is drawn from the main.

Comment:

The chlorination room is served by a door from the room containing the pump controls. It would be better if there were two separate rooms with two separate outside doors because the powder is reported to give off corrosive chlorine gas when the initial mixing with water takes place. In the chlorination room there is no forced ventilation system.

Reservoir and service pumps:

Bldg. No.2 Reservoir, concrete tank. The old blueprint drawings in the Town workshop give the depth as 3.6 m, and the plan area 5.5 x 5.5 m. Hence storage volume is approximately 90 cubic metres (20,000 I gals).

Three service pumps (submersible well pumps). Pump #1 operates continuously, probably about 3 hp pump. Pumps #2 and #3 are controlled by the water level at the storage tank. On the day of the survey the output gauge read 70 psi and the flow metre with one pump operating read 80 gpm.

Three magnetrol water level electrodes project down into the reservoir to control the well pumps. Presumably the high level cuts off all pumps, the middle level operates two pumps, and the lowest level four pumps.

Tank and Control House: Two Murphy pressure gauges, which respond to the tank water level, control pumps 2 and 3. The on-off range is adjustable in each case. The top water level in the tank is 1.2 m below the overflow and no overflow has ever been recorded. The tank holds about 320 cubic metres (70,000 I gal).

System upgrade in 1990: This involved constructing the storage tank referred to above, and converting the pumps in Building #2 to the control system governed by the water level in this new tank. This has probably saved on pumping costs because the two main service pumps can now be selected to operate under almost constant head and flow at the peak efficiency point on the pump curve. System pressures were also improved from about 60 psi to 72 psi.

Distribution network: Original installation about 1973. Pipe materials now include cast iron, ductile iron, and PVC DR 18 pipes. All have performed satisfactorily.

Hydrant pressures: Static pressures are all reported to be excellent with a maximum of about 90 psi close to sea level.

Chlorine residual: Residual of 0.15 to 0.35 mg/L is retained, as checked by the Council.

DEMANDS

Metering: No water meter in place.

Domestic: About 476 connections.

Institutional: Three regional schools, plus Government offices.

Commercial: St. Alban's is a regional shopping centre and there are also the usual local businesses.

Industrial: One small fish plant which processes salmon and trout from the fish farm. This plant operates intermittently and has a 38 mm line.

SUPPLY

Adequacy of supply: The supply is adequate and likely to remain so in the future.

Future: No significant increase in demand is expected.

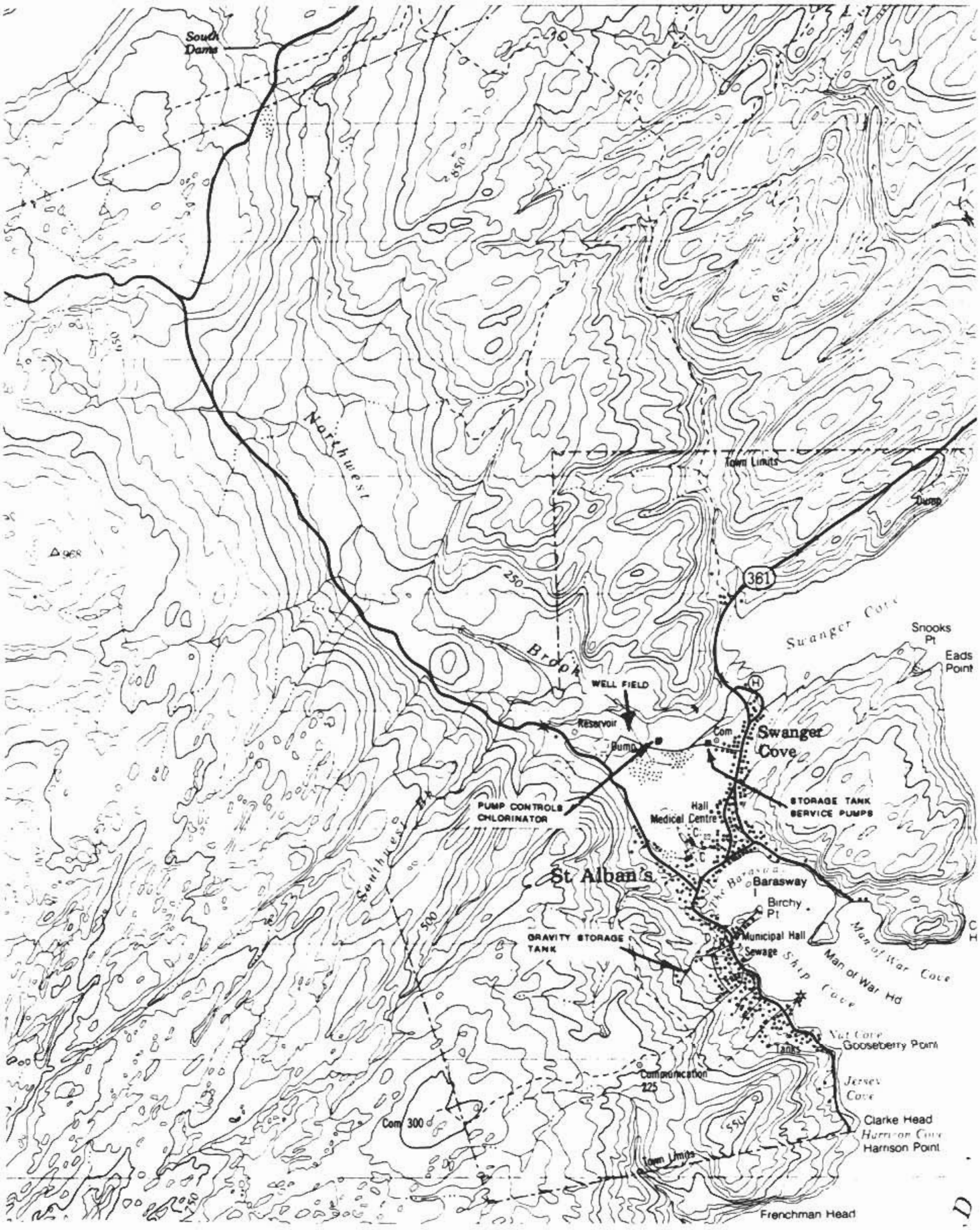
Means of increasing supply: Additional wells should be drilled.

WASTE WATER DISPOSAL

There is a sewage treatment plant which provides primary and secondary treatment by the "extended aeration" process, constructed in 1976. The sludge is pumped out about once every five years. The raw effluent is entirely from domestic sources. Thirteen lift stations are required to collect to the plant. There are a few areas in the Town which will need main sewer lines, but these will be taken care of by the Council as the need arises.

COMMENTS

See previous comments on chlorination. A fan to draw fresh air into the chlorination room, controlled by a switch near the door, and exhaust ducting to the outside from close to floor level, should be provided.



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REGIONAL WATER RESOURCES STUDY
BURIN PENINSULA
ST. ALBAN'S

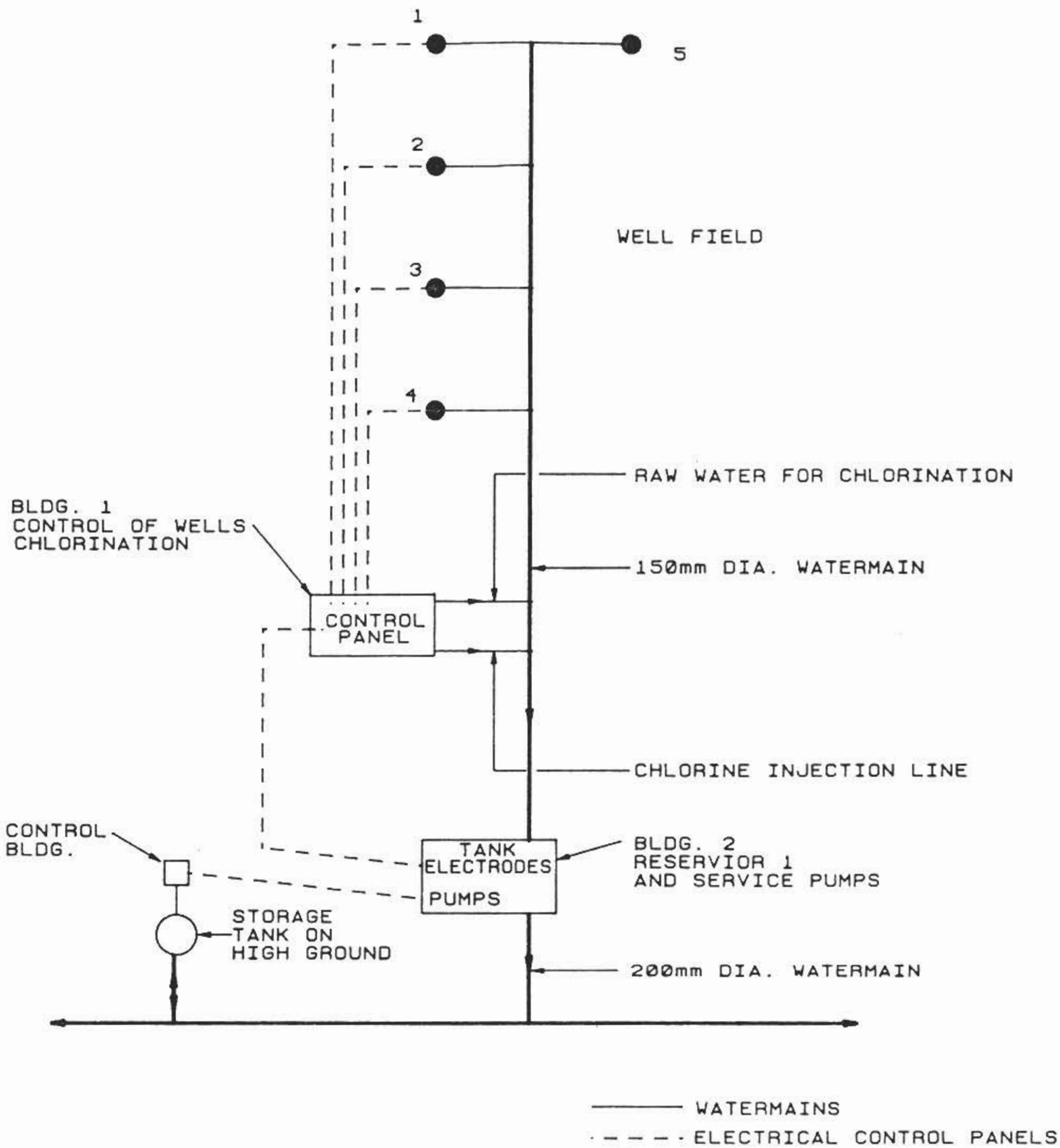


FIG. 1
SCHEMATIC PLAN
TOWN OF ST. ALBANS

MUNICIPALITY, GROUND WATER SOURCE

LOCAL SERVICE DISTRICT OF SWIFT CURRENT

GENERAL INFORMATION

Information sources: Engineering report, Colin Karasek Ltd., March 1984; Department of Municipal and Provincial Affairs, Eastern Region, Rick Martin; Department of Health, Clarenville, Gwen Elliott.

Population: 303 (Department of Municipal and Provincial Affairs records).

User fees: There are two existing wells organized on a "water supply committee" basis. These committees impose a fee of $3.00 per month to cover the cost of electricity.

SURFACE WATER SOURCE

Black Duck Pond: By means of a dam on a brook, a reservoir was created and a supply line and distributions system were installed in about 1982. This source yielded water with excessive sediments and bad taste. The distribution system experienced hydraulic grade problems and pipe blockages through sediments drawn into the intake from the pond. Most of the houses originally served by this system cannot use it. Council accepts no responsibility for this system and in fact there is no Council operated water supply in Swift Current.

Watershed area: 142 Hectares.

Reservoir surface area: 2.8 Hectares.

Live storage head: The end of the flexible intake pipe was held at a depth of about 2.0 M by means of a float on the surface.

GROUND WATER SUPPLY

Dug wells: Most of the houses rely on dug wells. Some wells experience a shortage of water during dry periods.

Drilled wells: A total of sixteen wells have been drilled in the community, of which twelve provide yields of 4.0 L per minute or more, which is sufficient for two or three houses with adequate storage. Maximum yield reported was 137 L per minute for one well. The school and the Irving station each have a drilled well.

Community drilled wells: Two of the drilled wells are managed by water supply committees to serve groups of houses by pipes from the pumphouse and storage tank at the wellhead. One of these wells serves fourteen households, and the other eleven households.

WATER QUALITY

Bacteria: None of the water supplies in Swift Current are chlorinated and the Department of Health has recommended a "Boil Order" for all water used in the community.

Department of Health: Clarenville

User opinion: Five of the seven dug wells investigated reported satisfactory taste and appearance. The surface water supply from Black Duck Pond was rated as poor quality because of colour, excessive sediments and organic taste. The drilled wells are satisfactory.

DEMANDS

Existing: Dwelling units, local stores, one school and a few community buildings. There is no industry or fish plant.

Future: No significant increase in demand is anticipated.

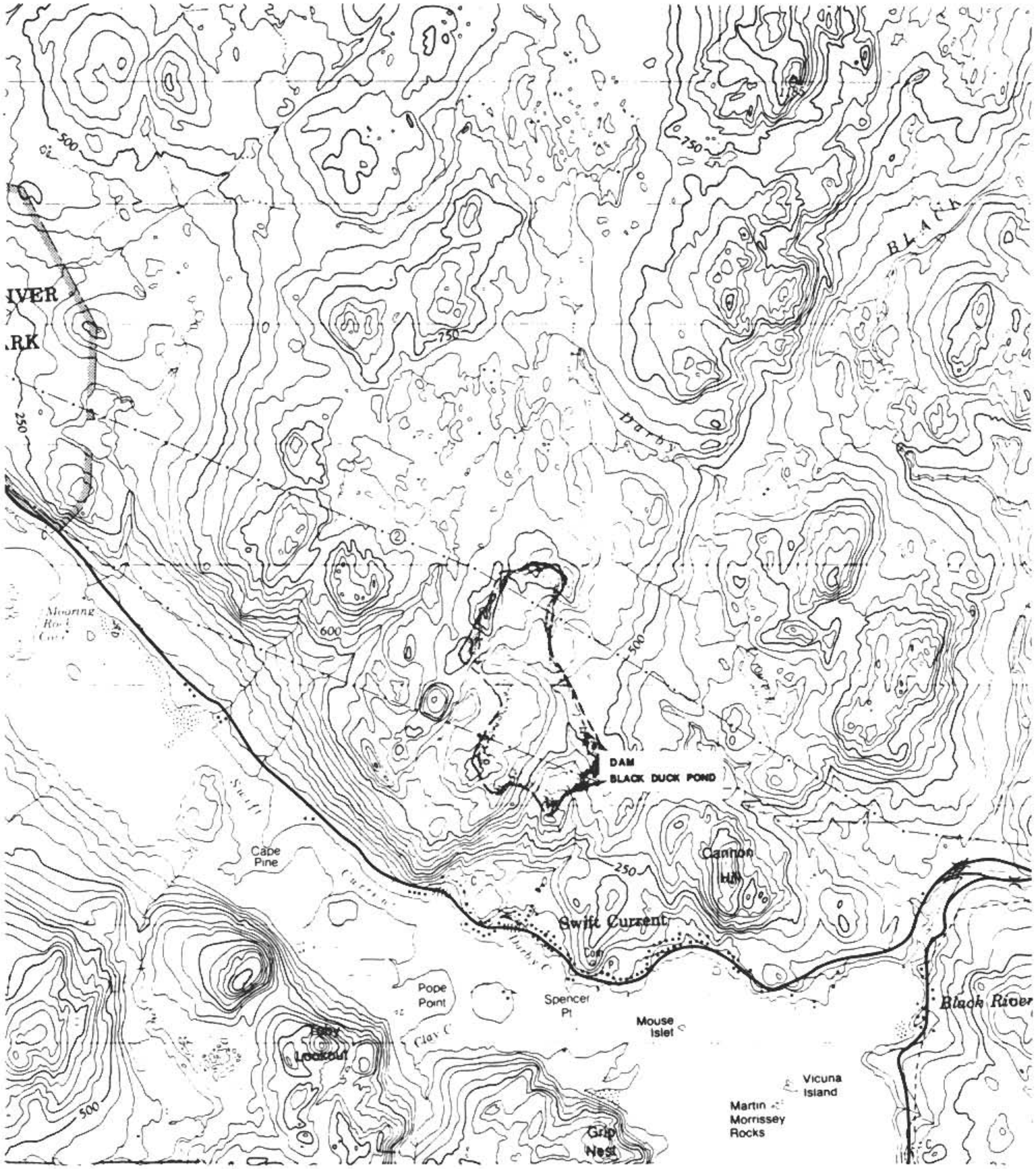
SUPPLY

Existing: Only the drilled wells provide an adequate supply for a limited number of houses.

Means of increasing supply: Drill additional wells.

COMMENTS

Plans are in hand by the Department of Municipal and Provincial Affairs for a well drilling programme so that the whole community may be served from drilled wells.



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SWIFT CURRENT

ACRES

MUNICIPALITY, SURFACE WATER SOURCE

TOWN OF TERRENCEVILLE

GENERAL INFORMATION

Information sources: Town Clerk, Lucy Hickey; Maintenance Foreman, Mike Senior. Department of Health, Sherri Rees.

Census data: Population: 764 (1976), 796 (1981), 827 (1986), 818 (1991). Dwellings: 203 (1991). Average: 4.03 persons per dwelling.

Map: See Community of Grand le Pierre.

SURFACE WATER SOURCE

Description: A small abstraction dam on Harbour Brook, which runs in a ravine at this point. Elevation of dam is sufficient to provide gravity flow to the whole community.

Users: The Town is the only user.

Dam: About 18 M wide, consisting of timber crib with a vertical timber wall on top of the crib, surrounded each side with earth and rock fill.

Spillway: Two CMP pipes, each 940 x 1470 mm. At the time of the survey the flow was 50 mm over the spillway invert. No controls for spillway.

Watershed area: 238 Hectares

Live storage head: Spillway invert to top of intake approximately 1.0 M (estimated after discussion with Maintenance Foreman).

Live storage volume: Difficult to estimate due to the irregularities of the site. Approximately 250 cubic metres (from dimensions estimated by eye).

Watershed protection: Not protected.

Developments on watershed: None apparent.

GROUND WATER SUPPLIES

Private wells: There are about 23 houses on private wells.

Drilled wells: Three drilled wells *are reported, of which two are for* private households. Yields 1.0 to 5.0 L per minute.

Adequacy: Ground water supplies are reported as adequate.

WATER QUALITY, SURFACE SUPPLY

Bacteria: Satisfactory for treatment by simple chlorination.

Department of Health: Salt Pond

User opinion: Reported as good quality water. Also used by CN Marine Coastal Service.

EXISTING STRUCTURES

Intake: Coarse screen on intake, which is a pipe.

Screening: 200 mm diam. basket strainer in chlorination building.

Chlorinator: A flow paced system using a 50 mm diam. water meter. There is also a 200 mm diam. water meter in parallel. Under high flow conditions a Smith Blair detector check valve automatically diverts the flow from the 50 mm meter through the 200 mm meter. An electronic metering pump injects chlorine solution made from Javex into the main line. The chlorinator has no bypass line.

Transmission mains: Ductile iron pipes sized for fire flows.

Testing for chlorine residuals: Done by Council staff about twice a week, and Department of Health.

Control valves: There are no pressure reducing valves or booster pumps.

DEMANDS

Metering: Metering is not carried out. However, the chlorination system could be readily adapted to measure water flows.

Domestic: There are 193 houses and small businesses connected to the water system.

School: 20-classroom school from K to Grade 12.

Industrial/commercial: There are no major industrial/commercial demands.

Future: The Council has requested funding from the Department of Municipal and Provincial Affairs to service the 23 houses using private wells with main water and sewage. Since there are no reported water shortages or pollution problems this request may not be given high priority.

Leakage and wastage: No information available.

SUPPLY

Adequacy: The only water shortage reported during the last ten years was in 1987, an overly dry year. The supply pond water level dropped below the lip of the outlet brook. Council staff pumped from the pond into the supply brook and thereby overcame the shortage problem.

Adequacy of storage for fire flows: The minimum fire flow should be 38 L per second (500 Igpm) for 2.0 hours, requiring storage volume of 273 cubic metres. A greater fire flow might be desirable if the local fire brigade personnel and equipment could handle this for fire protection of major buildings such as the school. The impoundment reservoir should be surveyed accurately to determine that it has sufficient storage for fire flows.

Means of increasing supply: Make use of the supply pond by means of a pump or a pipeline with a control valve.

WASTE WATER DISPOSAL

Apart from the 23 houses referred to, all other buildings are connected to a main sewage collection and disposal system. Two lift stations and three outfalls dispose of untreated sewage into the bay. No pollution problems are recorded.

COMMENTS

1. Storage for fire flows. The volume of impounded water at the dam should be determined. If necessary, additional storage volume under gravity flow should be provided.

2. Water consumption. The flow meters should be used to provide water consumption data. This will require a minor purchase of new equipment.

MUNICIPALITY, GROUND WATER SOURCE

COMMUNITY OF WINTERLAND

GENERAL INFORMATION

Information sources: Report, Newplan Consultants Ltd., 1989; Department of Environment and Lands, Water Resources Division, Ground Water Section, Keith Guzzwell, P.Geol.; Department of Health, Grand Bank, Rick Grikis.

Census data: Population: 184 (1976); 233 (1981); 260 (1986); 272 (1991). Dwellings: 86 (1991). Average 3.16 persons per dwelling.

GROUND WATER SOURCES

Drilled wells owned and operated by Council:

Well No.	Depth (M)	Yield, cubic metres/day	No.of houses connected	Chlorinator
1	114.3	6.5	9	No
2	76.2	49	14	Yes
3	45.7	26	13	Yes
4	40.2	52	9	Yes
5	30.5	78	16	No
		Total	61	

These wells are spread fairly regularly along the community main road over a distance of 1.8 km.

Privately owned drilled wells: There are 10 drilled wells with varying yields from 33 to 130 cubic metres per day per well. These wells serve approximately 25 houses and other buildings.

Drilled wells owned by Government: Two wells are used for buildings owned by the Provincial Government.

Adequacy of yields: The Council wells were drilled from 1975 to 1977. A review of the foregoing information shows that this is a good area for long term ground water supplies for a municipality of this size.

WATER QUALITY

Bacteria: Wells # 2, 3 and 4 are reported to show high coliform counts, most likely due to pollution from sewage.

Department of Health: Grand Bank

User opinion: No adverse opinion.

EXISTING STRUCTURES

Each of the Council wells supplies its own storage tank, varying from 600 to 1270 litres capacity, housed in a small building. Supply lines to the houses are taken directly from the tanks.

DEMANDS

No metered information.

SUPPLY

Existing: The supply has been adequate but the problem has been the well pollution. Also, the connections from the tanks to the houses are small in diameter and create substantial pressure drops.

Future: It is proposed to utilize the existing clean wells (#1 and #5) and supplement the supply, if necessary, with additional drilled wells in an area remote from potential pollution. A main line inter-connecting the wells with new connections to the houses is an option.

WASTE WATER DISPOSAL

These are all private systems, with septic tanks and drain fields of varying standards of adequacy. As mentioned above, it is believed that contamination of the wells has occurred from domestic sewage. There are no plans to install main sewer systems; rather the intent is to relocate the wells.

COMMENTS

No comments.