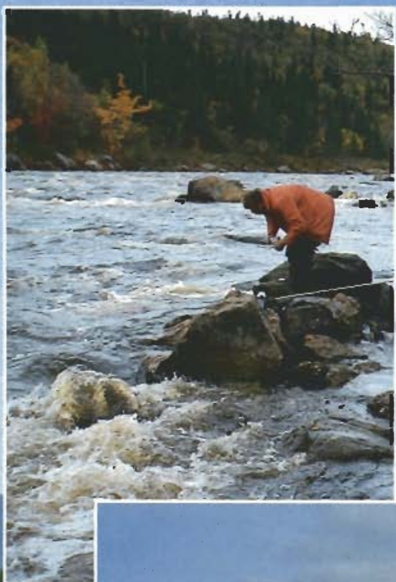
Regional Water Resources Study of the Western Avalon Peninsula



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WATER RESOURCES DIVISION

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REGIONAL WATER RESOURCES STUDY OF THE WESTERN AVALON PENINSULA

FINAL REPORT

PREPARED FOR

WATER RESOURCES DIVISION
DEPARTMENT OF ENVIRONMENT AND LANDS
GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR

JUNE 1988

EXECUTIVE SUMMARY

The Regional Water Resources Study of the Western Avalon Peninsula is the second 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 as follows.

- To assess the availability of water in the study area, considering mean annual runoff, low flows and the improvement in yield through the addition of storage.

- To assess the availability and quality of groundwater.

- To document surface water quality and identify areas of concern.

- To identify and evaluate instream uses.

- To project population and demand for all the communities in the study area and to estimate yield from all surface water supply systems.

- To group the communities according to the availability of water to meet their demands. The groupings were based on a supply/demand ratio for each community and a consideration of the type of improvements required to alleviate potential shortages.

- To rank the regions according to their potential for water resource developments.

It was concluded from this study that the surface waters constitute an important resource in the study area. The abundant water has led to important instream uses of surface water, specifically for generation of electricity, recreation, tourism and freshwater fishing. These activities all bring economic and social benefits to the area.

The average annual runoff over the study area is high, but dependable flows are low; some communities experience shortages in dry periods. The supply/demand analysis for this study identified three communities with potential water supply shortages - Bay Roberts, Carbonear and Harbour Grace. Shortages in several other communities may be avoided in dry periods by reducing demand, particularly of fish plants. The regional storage/yield curve developed in this study provided an important means of assessing yield, and should prove useful in future assessment of available yield from existing and proposed sources.

Many small communities and individual homes are supplied by groundwater. Groundwater and surface water are closely connected, so groundwater supplies are vulnerable to shortages during droughts.

Generally water chemistry data indicate that water quality is good, but seasonally high organic content remains a problem in many water supplies. It can result in an unpleasant taste and/or odor, and may possibly have health effects in chlorinated water supplies. Natural waters can usually meet drinking water standards if treatment is provided to adjust pH and reduce bacteriological counts.

The southern parts of the Placentia Bay and St. Mary's Bay regions offer the most potential for water resource development. These areas have high unit runoff, and at present little development on the watersheds. Water resources in the southern part of the Conception Bay region are the most utilized.

Recommendations

The main recommendations arising from this study are as follows.

1. Surface Water Availability:
   - Improve estimates of availability with additional studies of low flows and of precipitation/runoff relationships.

2. Water Quality:
   - Expand monitoring programs to include sampling in order to document the effects of anthropogenic activities.
   - Investigate the problem of seasonally high organic content, and identify the most effective and economic treatment methods.
   - Sample water used for water supplies at the end of the distribution system, i.e., in homes and businesses.
   - Institute a public education program in the study area to increase the public's awareness of the value of the water resource, and of the role of the public in maintaining good water quality.

3. Water Supply:
   - Undertake a regional water supply study for the southern part of the Conception Bay area.
   - Establish municipal and industrial water use data bases for the province, based on measured data.
   - Evaluate unprotected watersheds presently used for water supply to determine whether protection is required.

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1 - INTRODUCTION

1.1 - Study Objectives

The Water Resources Division 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 Department is commissioning a series of regional studies to provide information and analysis for the planning and management of these resources. The present study of the western Avalon Peninsula is the second in this series. The objectives of this study were:

1. to assess the availability of water based on existing data

2. to examine the consumptive and non-consumptive uses of water

3. to assess water quality

4. to rank regions within the study area according to their potential for water resource developments.

Chapters 2 and 3 of this study describe surface and groundwater availability respectively. Water quality data are presented in Chapter 4, instream uses are discussed in Chapter 5, and the supply/demand balance is analyzed for each community in Chapter 6. In Chapter 7, the regions within the study area are ranked, and conclusions and recommendations are presented in Chapter 8.

1.2 - Sources of Data

A large number of reports and other sources were used to obtain data for this study. These sources 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 include

- Government of Newfoundland and Labrador
  - Department of Environment and Lands (DOEL)
  - Department of Development and Tourism (DODT)
  - Department of Fisheries (DOF)
  - Department of Municipal Affairs (DMA)
  - Department of Health
  - Department of Culture, Recreation and Youth
  - Executive Council, Newfoundland Statistics Agency
  - Executive Council, Economic Research and Analysis
  - Department of Forest Resources and Lands (DFRL)
  - Department of Rural, Agricultural and Northern Development
  - 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 Light and Power Co. Ltd.

- Newfoundland and Labrador Hydro

Information on the community water supply systems was obtained in the field program as part of this study, and is presented in Appendix D.

1.3 - Study Area

The study area of nearly 5000 km^2 is located in the western part of the Avalon Peninsula of the island of Newfoundland as shown in Figure 1.1. The major physical features are two smaller peninsulas aligned approximately northeast - southwest and the isthmus of Avalon. The central parts of each of the two peninsulas are composed of highlands, with peaks over 250 m high. A central lowland lies between the two peninsulas.

Much of the study area is characterized by barren, irregular and rough topography with numerous rock outcrops. The soil cover is generally thin, and the proximity of bedrock has led to the formation of many bogs and ponds.

The population of the area is about 66,600 (1986 census), with the major concentration along the western shore of Conception Bay. The economies of most communities depend on fishing and fish processing. Other important industries include a phosphorus plant at Long Harbour and an oil refinery at Come By Chance.

The climate is cool, temperate, and wet as expected from the proximity of the area to the North Atlantic Ocean. The cold Labrador current keeps summer temperatures low; the warmest month is August, with a mean August temperature at both Argentia and Colinet of about $15^{o}C$. The ocean moderates the climate in the winter, and mean temperatures in February, the coldest month, at Argentia and Colinet are $-2^{o}C$ and $-4^{o}C$ respectively.

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Study Area

FIG. 1.1

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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 the yield from systems with storage.

Mean annual runoff is a commonly used hydrological characteristic. It describes the average surface water generated per unit area in a region. Mean annual runoff has a continuous distribution over an area, and can thus be conveniently represented on a map using isolines. The integral of runoff over any area represents the mean annual runoff in any basin of interest. Streamflow and precipitation data were used to prepare such a map for this study. This work is described briefly in Section 2.2, and in more detail in Appendix A.

Estimates of mean annual runoff have to be supplemented by analyses of the variability of flow. Analyses were carried out to determine the lowest flow to be expected for a given return period, and the improvement in yield that would result from the addition of storage.

Section 2.2 of this chapter describes the variation in flow through the year, and Section 2.3 presents the results of the low flow analysis. Section 2.4 provides a method of estimating yield from a water supply system with storage. The chapter concludes with a summary of mean annual flow and low flow for all drainage basins in the study area. The methods of estimating yield documented in this chapter were applied to the supply/demand analysis in Chapter 6 and to the overall water resource assessment in Chapter 7.

2.2 - Mean Annual Runoff

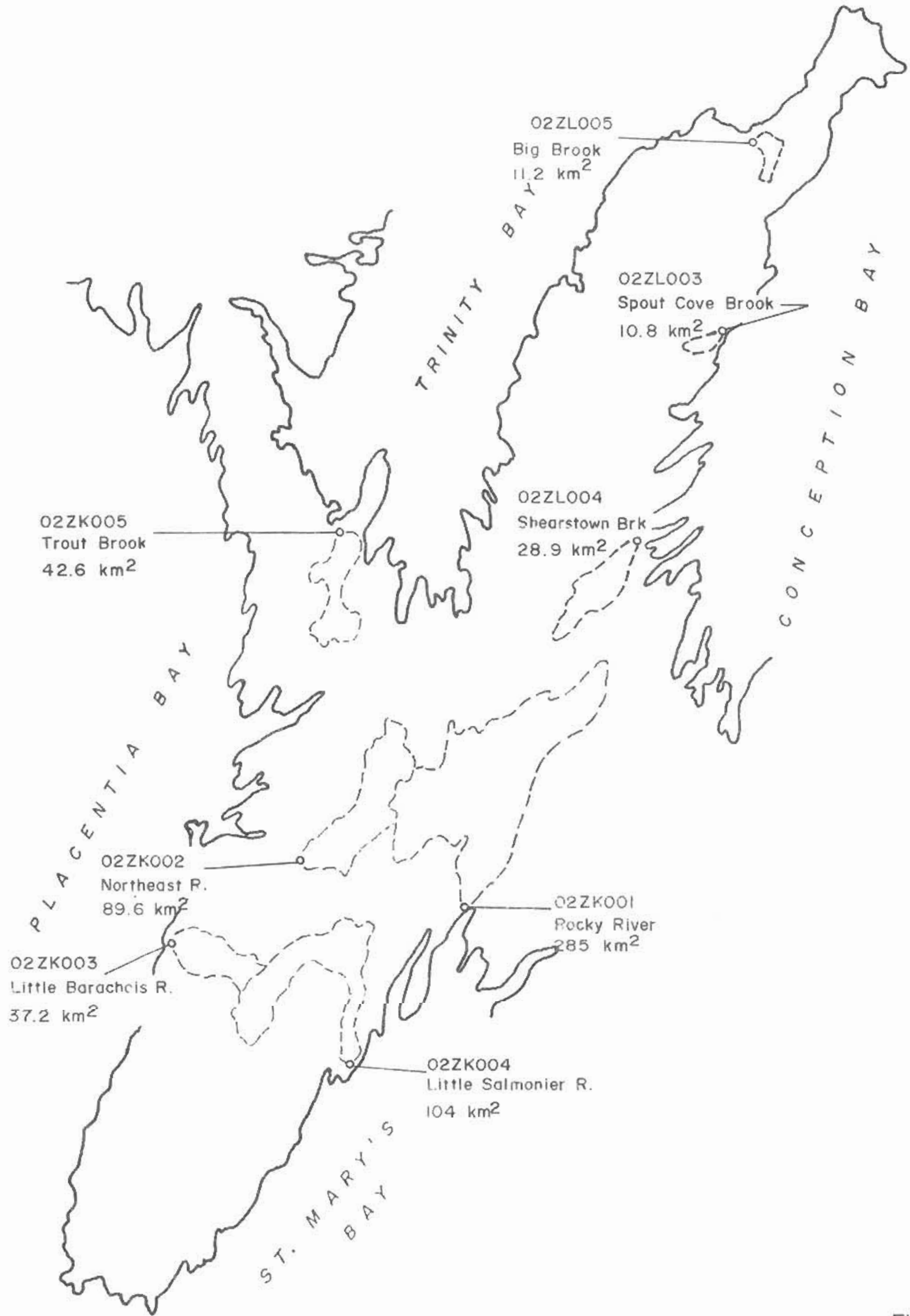
Mean annual runoff is the average annual discharge over an area expressed as a depth, e.g. millimetres or inches. The Water Resources Division of DOEL published a map of mean annual runoff for the Island of Newfoundland in 1984 (4), and the purpose of this part of the study was to prepare a revised runoff map of the study area. The runoff estimates were based on analysis of streamflow data from the hydrometric stations operated by WSC under the Canada-Newfoundland Hydrometric Surveys Agreement, supplemented by precipitation data from the AES network. The locations of the streamflow gauges and the climate stations are shown in Figures 2.1 and 2.2.

The data used and the methodology are included in Appendix A. Figure 2.3 shows the resulting map of the mean annual runoff from the study area.

2.2.1 - Distribution of Mean Monthly Flows

Rivers on the Avalon Peninsula have a relatively uniform distribution of flows throughout the year, as shown in Figure 2.4. The main reason is that winter precipitation is often in the form of rain rather than snow. The mean rainfall and total precipitation for each month are presented in Figure 2.5 for Colinet, a station with a long reliable record. On the average, well over half the winter precipitation falls as rain.

The mean monthly flows for the 6 gauges with at least four years of records are presented in Table 2.1 as a proportion of mean annual flow. This same information is presented graphically in Figure 2.6. The pattern is very similar for all gauges. The month with the highest average flow is April, and the month with the lowest average flow is August, except in the case of Rocky River, where July has the lowest average flow.



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Locations of Streamflow Gauges

FIG. 2.1

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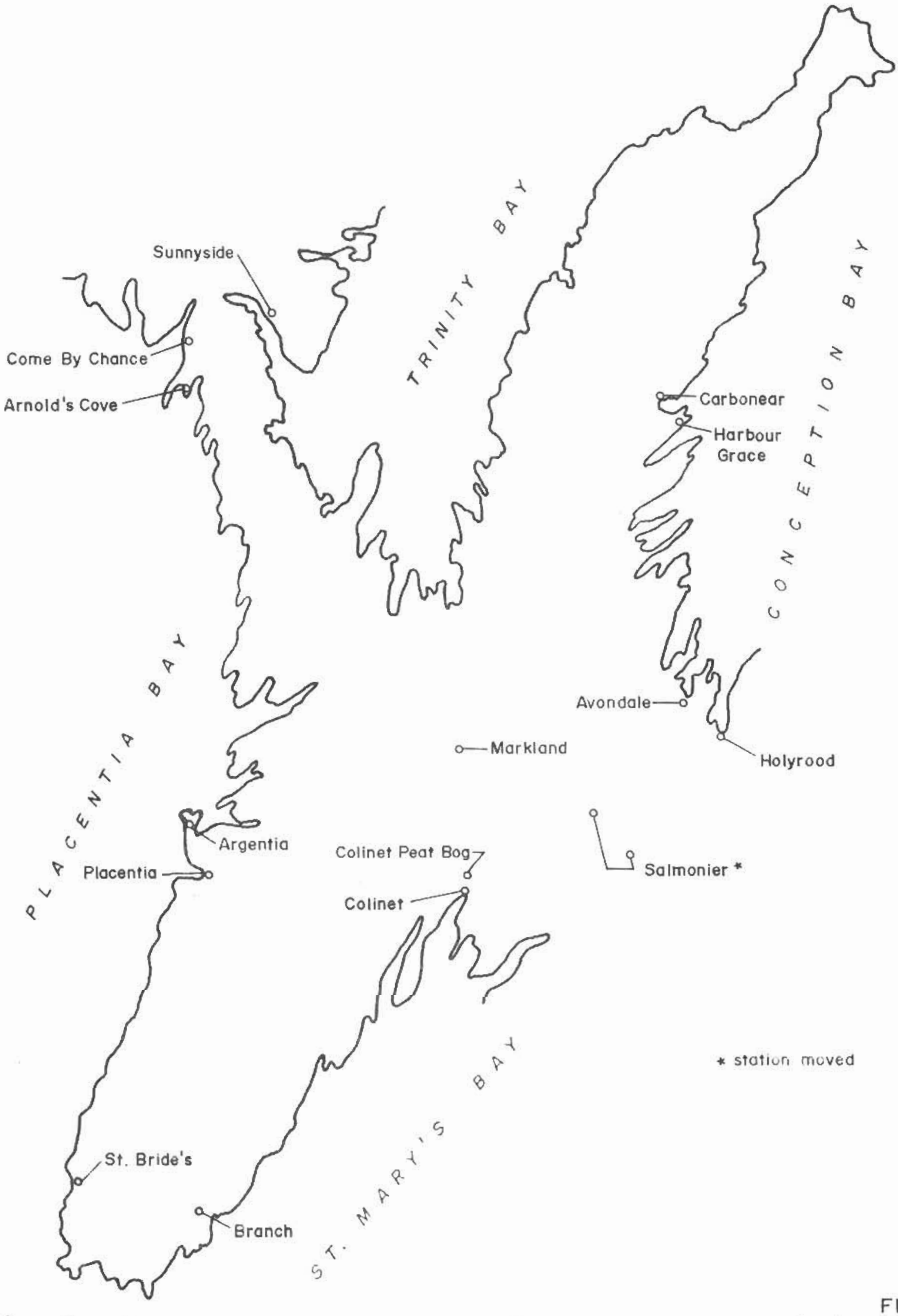

FIG. 2.2

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Locations of Climatological Stations

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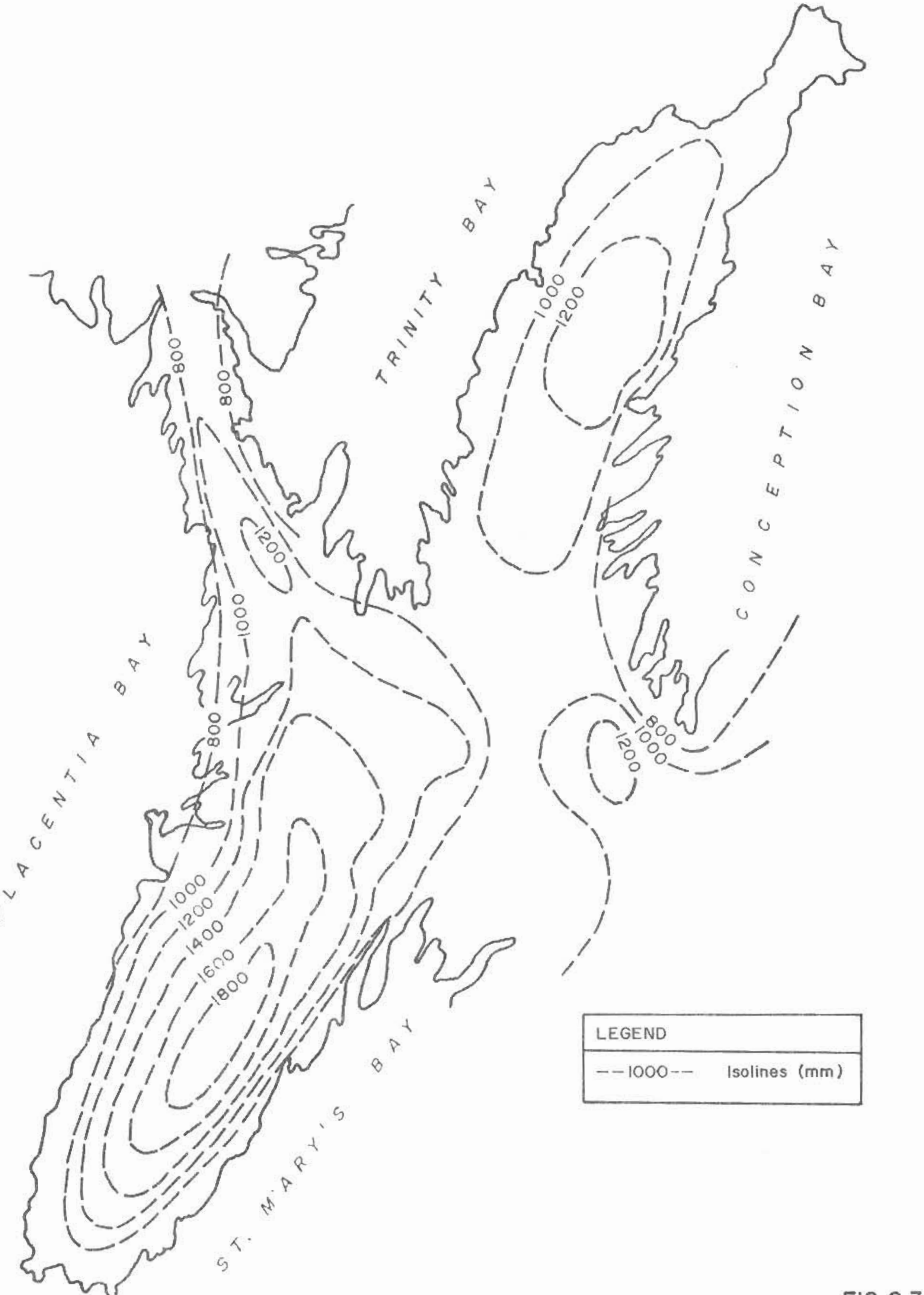

FIG. 2.3

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Isolines of Mean Annual Runoff

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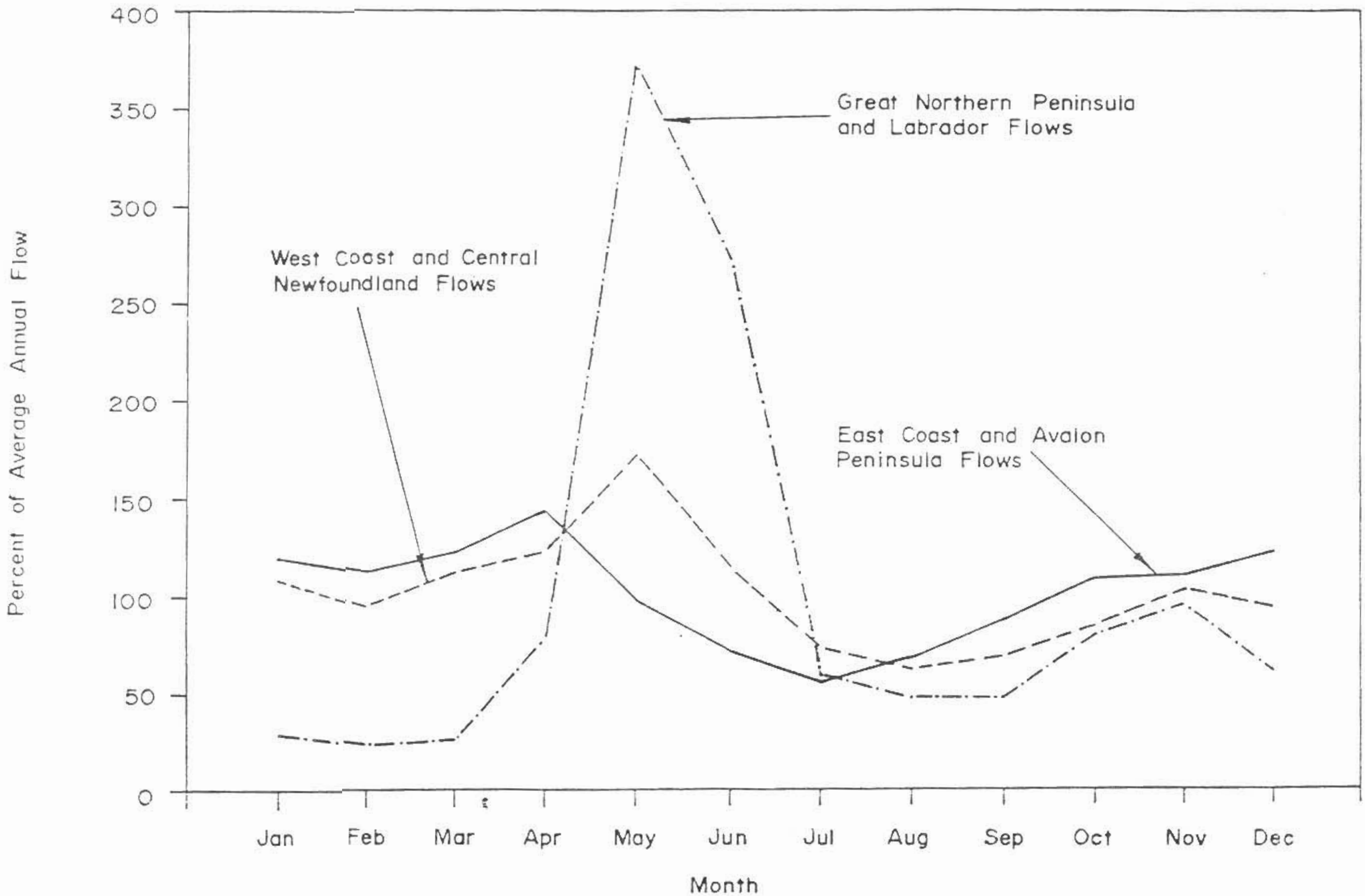

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FIG. 2.4

Mean Monthly Flow in Three Regions

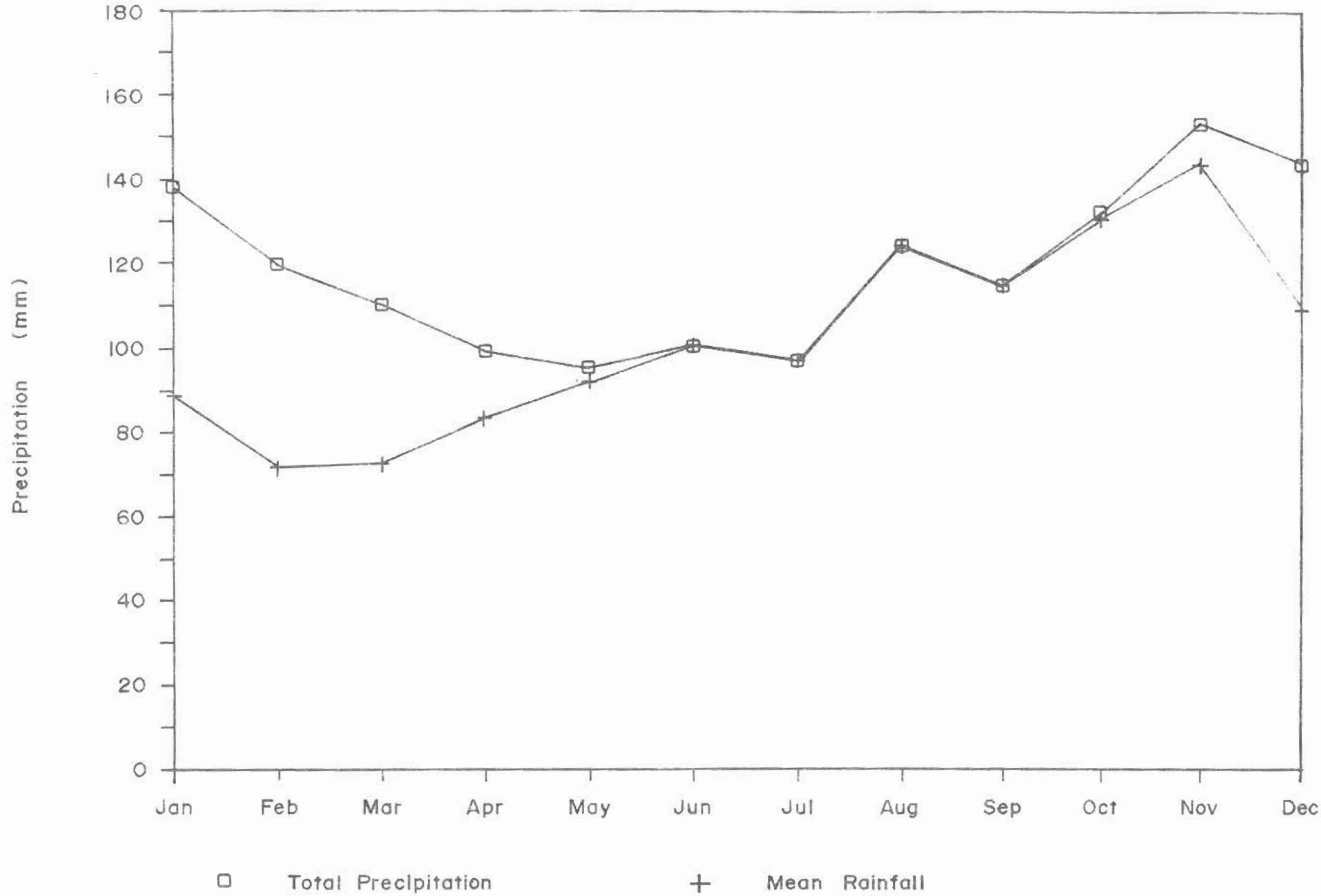

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FIG. 2.5

Rainfall and Total Precipitation at Colinet

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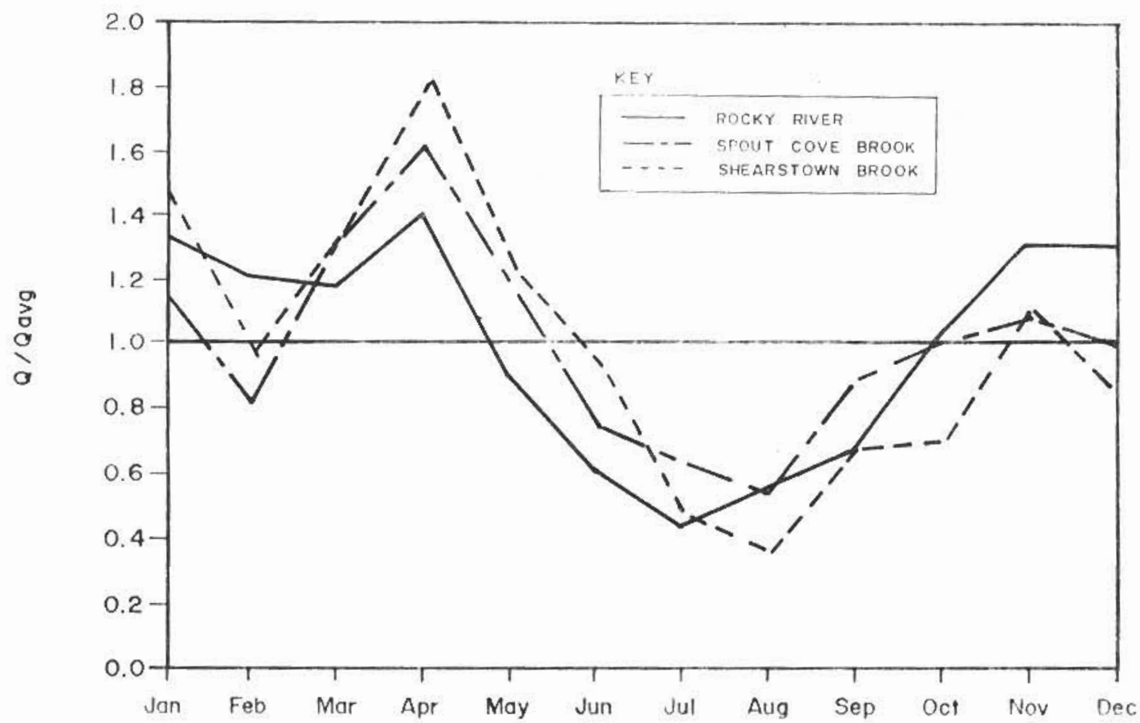
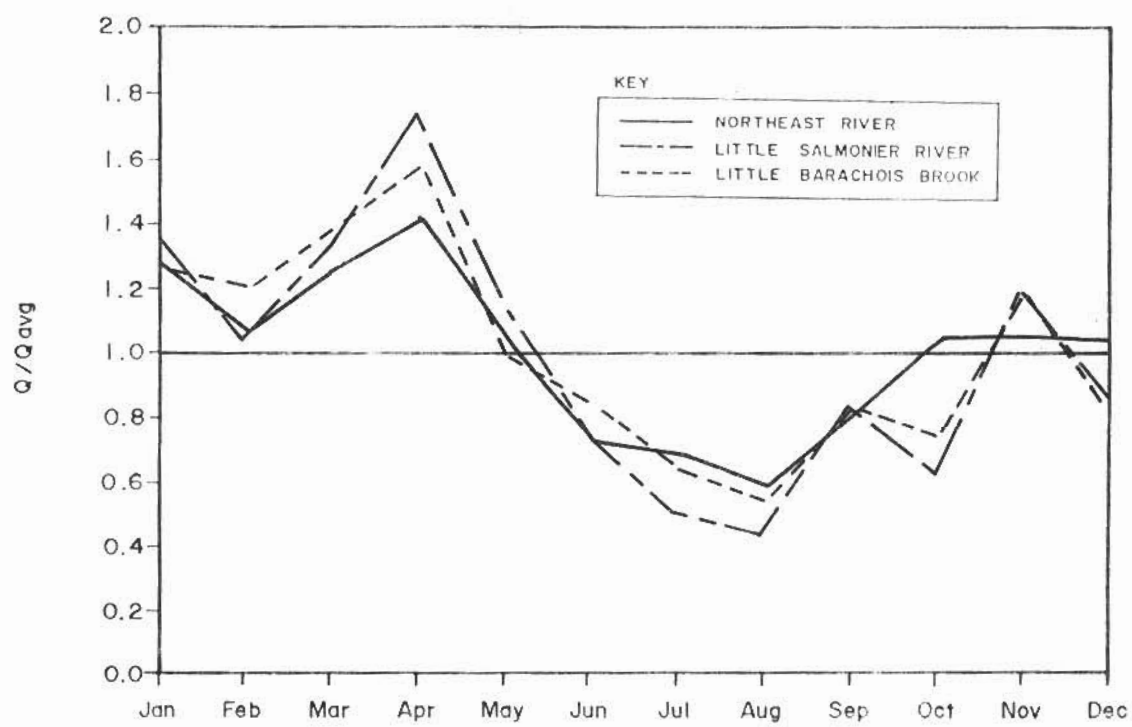
TABLE 2.1

SEASONAL DISTRIBUTION OF FLOWS AS PROPORTION OF MEAN ANNUAL FLOW

Month	Rocky River 02ZK001	Northeast River near Placentia 02ZK002	Spout Cove Brook 02ZL003	Little Salmonier River 02ZK004	Shears-town Brook 02ZL004	Little Barachois River 02ZK003	Mean
Drain. Area (km2)	285	89.6	10.8	104	28.9	37.2	
January	1.35	1.28	1.15	1.38	1.47	1.26	1.31
February	1.22	1.08	0.82	1.05	0.98	1.20	1.06
March	1.18	1.26	1.32	1.34	1.35	1.39	1.31
April	1.41	1.42	1.62	1.75	1.83	1.59	1.60
May	0.91	1.03	1.16	1.17	1.24	0.99	1.08
June	0.62	0.72	0.76	0.76	0.95	0.84	0.78
July	0.44	0.69	0.64	0.52	0.48	0.64	0.57
August	0.57	0.58	0.55	0.45	0.36	0.54	0.51
September	0.67	0.81	0.89	0.85	0.68	0.84	0.79
October	1.03	1.05	1.01	0.63	0.71	0.74	0.86
November	1.31	1.06	1.08	1.21	1.12	1.19	1.16
December	1.31	1.03	0.99	0.89	0.83	0.80	0.97





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Mean Monthly Flow

FIG. 2.6

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The ranges of flows that can be expected in any month are shown in Figure 2.7 for the three gauges with record lengths longer than eight years. The 10 percent and 90 percent exceedence values were obtained by analysis of the daily flow duration curves for each month for each station record.

This analysis indicates that the natural flows in the study area can vary within a wide range. Because of this year to year variability, the evaluation of surface water quantity for water supply systems requires analyses of natural low flows and of the improvement in yield that can be obtained by incorporating additional storage.

2.3 - Low Flow Analysis

The purpose of the low flow analysis for this study was to provide a method of estimating daily and monthly low flows in the study area. Both low flow frequency and flow duration curve analyses were undertaken.

2.3.1 - Frequency Analysis

The two low flow indexes selected from the frequency curves for use in this study are defined below.

Q1:10(1 day) - The daily low flow having a return period of one in ten years.

Q1:10(1 month) - The monthly low flow having a return period of one in ten years.

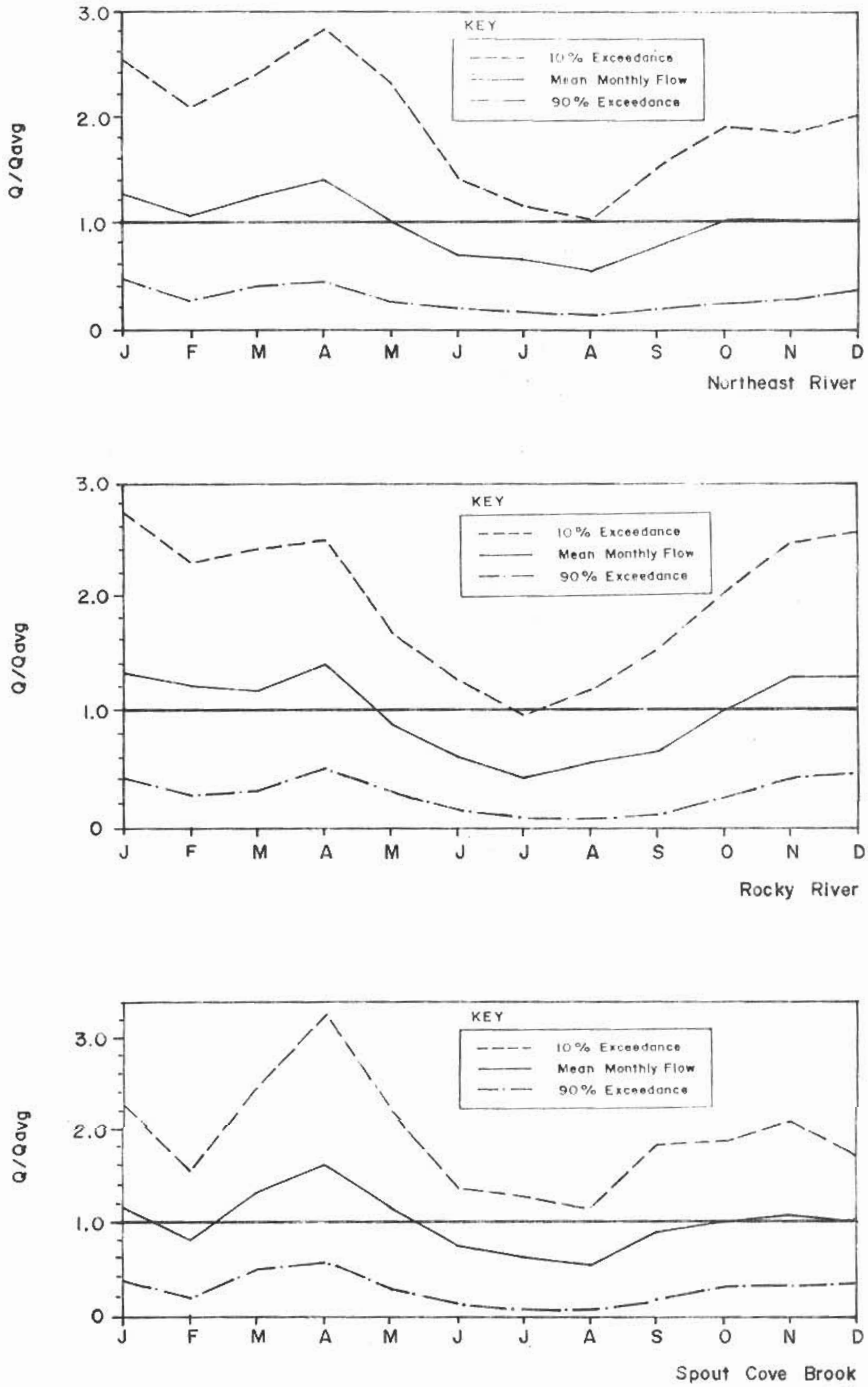

FIG. 2.7

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Monthly Flow Variation

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Descriptions of the data and analyses used to obtain values for these two indexes for the gauged catchments are provided in Appendix A. The results are summarized in Table 2.2. Non-dimensional values are also given; these were obtained by dividing the low flow for each station by the mean annual flow for that station. The mean nondimensional indexes, 0.049 and 0.129 for one day and one month low flows respectively, can be used as preliminary estimates of low flows at ungauged catchments.

TABLE 2.2

Q1:10(1 DAY) AND Q1:10(1 MONTH) FOR SELECTED GAUGED BASINS

			Q1:10(1 Day)		Q1:10(1 Month)	
Gauge 02Z	Name	D.A. (km^2)	(m^3/s)	Non-dim*	(m^3/s)	Non-dim*
K001	Rocky R.	285.	0.429	0.038	1.162	0.103
M006	N.E. Pond	3.9	0.002	0.016	0.006	0.048
N001	N.W. Brk	53.3	0.276	0.092	0.537	0.178
M008	Waterford R.	52.7	0.155	0.074	0.328	0.157
M009	Seal Cove Brk	53.6	0.174	0.060	0.514	0.177
K002	N.E.R. at Plac.	89.6	0.227	0.052	0.630	0.144
L003	Spout Cove Brk	10.8	0.006	0.013	0.043	0.097
	Mean			0.049		0.129
	Standard Dev.			0.029		0.048

* Made nondimensional by dividing the low flow by mean annual flow.

Low flows predicted using these nondimensional mean flows will only be approximate. A better estimate could be obtained by developing a regression equation to also take into account physiographic differences among basins. A regression analysis was undertaken for this study in order to develop such equations, but the results were inconclusive because of the lack of data. These analyses are documented in Appendix A. With expansion of the region to include more gauge records and some modifications of the independent variables, the analysis should prove more fruitful.

2.3.2 - Flow Duration Curve Analysis

Daily flow duration curves were included from all the gauge records in the study area. These are presented in Appendix A.

From the flow duration analysis another low flow index was obtained Q95(1 day).

Q95(1 day)	-	The daily flow having a probability of exceedence of 95 percent (i.e. 1 day out of 20, on average)

This index was first developed for the gauged catchments and then made nondimensional. A mean value was obtained for application to ungauged catchments. Results are presented in Table 2.3. The mean value of 0.146 can be used as an alternative low flow estimate at an ungauged catchment.

2.4 - Storage/Yield Analysis

Assessing the availability of water for any major use such as water supply or hydroelectric generation requires an estimation of the effect of storage. The natural low flow measures are not appropriate for estimating yield when dams and intakes have been installed.

TABLE 2.3

Q95(1 DAY) FOR SELECTED GAUGED BASINS

Gauge 02Z	Name	D.A. (km^2)	Q95(1 Day) (m^3/s)	Q95(1 Day) Non dim*
K001	Rocky River	285.	1.441	0.127
K002	N.E. River	89.6	0.858	0.187
K003	Little Barachois R.	37.2	0.336	0.210
K004	Little Salmonier R.	104.	0.822	0.138
K005	Trout Brook	42.6	0.114	0.068
L003	Spout Cove Brook	10.8	0.061	0.131
L004	Shearstown Brook	28.9	0.134	0.148
L005	Big Brook	11.2	0.064	0.157
	Mean			0.146
	Standard Deviation			0.042

*Made nondimensional by dividing by mean annual flow.

Assessment of the benefits of storage usually requires a site specific analysis. A daily or monthly series of inflows is obtained from a long term gauge 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, such site specific analyses were carried out for all the gauged rivers, assuming that they were being used for water supply. Each of the gauged basins was analysed 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.

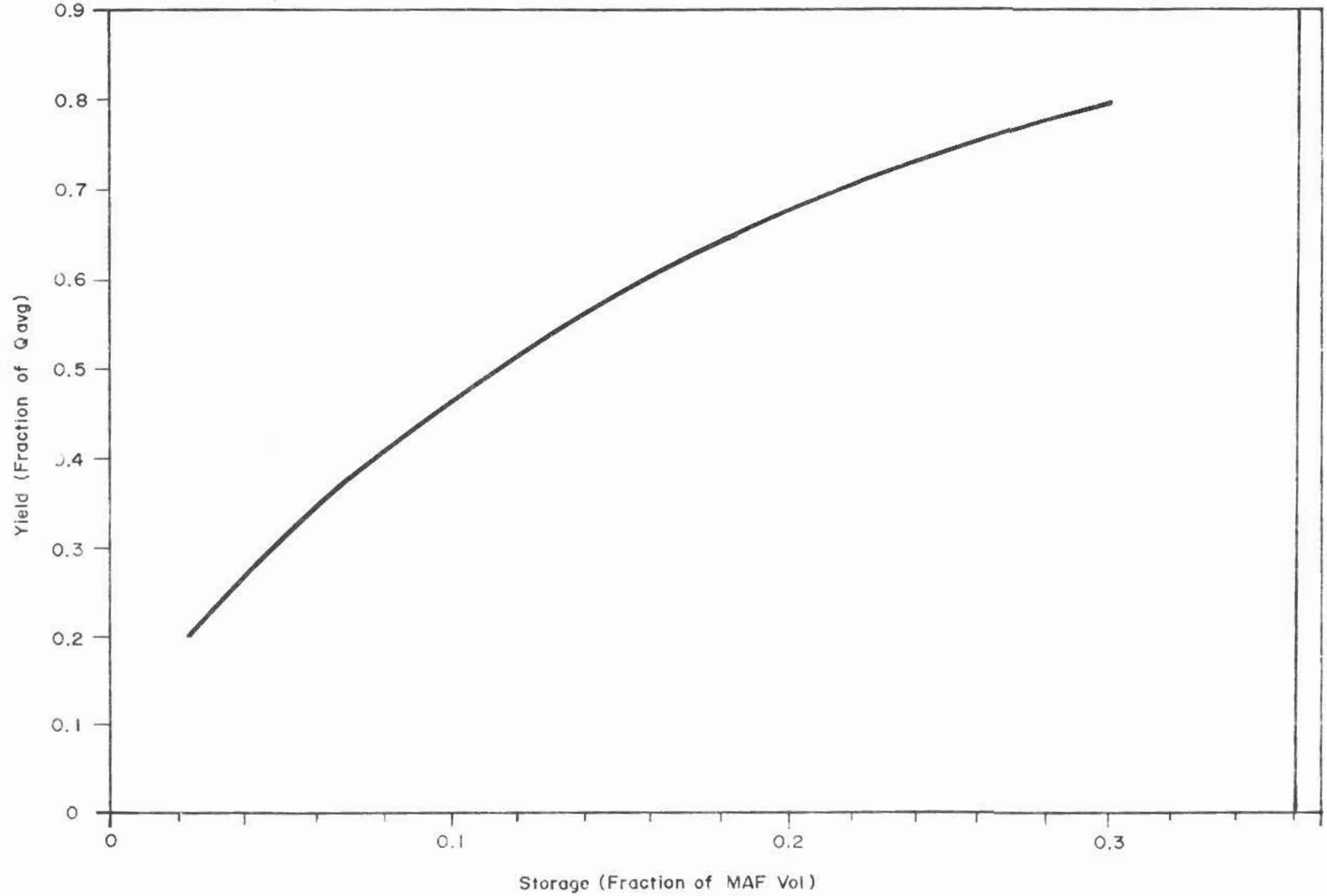
The results were made nondimensional by expressing the volumes of storage and the withdrawal rates as fractions of mean annual flow. By examining the yields from each basin, a regional non-dimensional curve was prepared. The results are summarized in Table 2.4 and in Figure 2.8. These yields are approximately

TABLE 2.4
YIELD/STORAGE RELATIONSHIP

Yield (Fraction of Average Flow)	Storage (Fraction of Average Annual Volume)
0.2	0.025
0.4	0.075
0.6	0.015
0.8	0.300

equal in dependability to the low flow frequency indexes, i.e. the storage will be insufficient on the average about once in ten years.

Figure 2.8 was used extensively in the supply/demand analysis in Chapter 6 to estimate reliable yield for the communities with surface supplies in the study area, since data on reliable yields are not available for most community water supply systems.



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Storage / Yield Curve

FIG. 2.8

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2.5 - Natural Surface Water Availability

To estimate the total natural surface water availability, the study area was divided into over 140 natural drainage basins. In addition, nearly 70 coastal areas drained by surface runoff or small brooks were identified.

These were grouped into four regions, according to the bays into which they drain, i.e. Trinity Bay, Conception Bay, Placentia Bay and St. Mary's Bay. For each of these basins, the average flow and Q1:10(1 month) low flow were calculated.

The procedure was as follows

- Identify all the major streams draining to the sea
- Mark their watershed boundaries
- Locate the centroid of each basin
- Select appropriate mean annual runoff from Figure 2.3
- Calculate mean annual flow, using Figure 2.3 and the drainage basin area
- Calculate Q1:10(1 month) from Table 2.2.

Plate 1 shows the locations of the identified watersheds, and Table 2.5 lists all the basins identified in the study area, together with their estimated average and low flows.

The total mean annual flow volume is over 5.5×10^9 m^3 in the study area. The average annual runoff is about 1120 mm.

TABLE 2.5a

DRAINAGE BASIN DATA : TRINITY BAY REGION

REF. NO.	Drainage Basin	Drainage Area (km^2)	Avg. Annual Runoff (mm)	Mean Ann. Flow (m^3/s)	Q1:10 1 month (m^3/s)
T 1	Cooks Cove	4.23	800	0.11	0.014
T 2	Old Perlican Cove	12.83	800	0.33	0.042
T 3	Russels Cove (east)	7.64	800	0.19	0.025
T 4	Big Brook at Lead Cove	10.69	1000	0.34	0.044
T 5	Sibley's Cove	8.77	1000	0.28	0.036
T 6	Brownsdale Cove (east)	4.26	1000	0.13	0.017
T 7	Brownsdale Cove (west)	19.09	1100	0.67	0.086
T 8	Pitman's Pond	62.00	1100	2.16	0.279
T 9	Halfway Brook	18.90	900	0.54	0.070
T 10	Winterton Cove	12.33	1000	0.39	0.050
T 11	Turk's Cove	11.82	1000	0.37	0.048
T 12	New Perlican River	42.66	1200	1.62	0.209
T 13	Heart's Content Brook	96.49	1200	3.67	0.473
T 14	Heart's Desire (north)	2.42	800	0.06	0.008
T 15	Heart's Desire Brook	10.16	900	0.29	0.037
T 16	Heart's Delight Brook	43.28	1000	1.37	0.177
T 17	Heart's Delight	6.74	900	0.19	0.025
T 18	Island Cove	17.60	1000	0.56	0.072
T 19	Long Pond Brook	8.74	800	0.22	0.029
T 20	Pitcher's Pond Brook	24.48	1000	0.78	0.100
T 21	Backside Pond	6.03	800	0.15	0.020
T 22	Scotch Pond	29.00	1000	0.92	0.119
T 23	Hopeall	57.98	1000	1.84	0.237
T 24	Broad Cove Pond	101.52	1000	3.22	0.415
T 25	Dildo Pond	53.61	1100	1.87	0.241
T 26	Spread Eagle Bay (south)	56.86	1200	2.16	0.279
T 27	Beaver Pond	37.47	1200	1.42	0.184
T 28	Cole's Pond	31.9	1200	1.21	0.156
T 29	Collier Bay Brook	18.58	1000	0.59	0.076
T 30	Thornlea	2.82	800	0.07	0.009
T 31	Bellevue	2.46	800	0.06	0.008
T 32	Trout Bk. near Bellevue	42.57	1200	1.62	0.209
T 33	Broad Lake	16.39	1200	0.62	0.080
T 34	Tickle Bay	6.4	900	0.18	0.024
T 35	Little Chance Cove	10.94	1000	0.35	0.045
T 36	Rantem Cove	14.98	1000	0.47	0.061
T 37	L. Southern Hrbr.(north)	6.25	900	0.18	0.023
T 38	Rantem Cove (north)	7.81	800	0.20	0.026
T 39	Bull Arm (east)	5.31	800	0.13	0.017
T 40	Bull Arm (southwest)	4.38	900	0.12	0.016
T 41	Bull Arm (north)	4.69	800	0.12	0.015

TABLE 2.5b

DRAINAGE BASIN DATA : PLACENTIA BAY REGION

REF. NO.	Drainage Basin	Drainage Area (km^2)	Avg. Annual Runoff (mm)	Mean Ann. Flow (m^3/s)	Q1:10 1 month (m^3/s)
P 1	Come By Chance	6.88	800	0.17	0.023
P 2	Big Pond	31.25	800	0.79	0.102
P 3	Big Pond (east)	4.69	800	0.12	0.015
P 4	Jack's Pond	15.63	900	0.45	0.058
P 5	Little Southern Harbour	4.06	800	0.10	0.013
P 6	Lamanche Bay	3.62	900	0.10	0.013
P 7	Island Cove	4.28	900	0.12	0.016
P 8	Little Harbour East	7.32	900	0.21	0.027
P 9	Pumbly Cove	6.50	900	0.19	0.024
P 10	Hollis Cove	9.14	1100	0.32	0.041
P 11	Little Pinchgut	4.33	1000	0.14	0.018
P 12	Little Pinchgut (south)	18.93	1100	0.66	0.085
P 13	Fair Haven	21.10	1100	0.74	0.095
P 14	Fair Haven (east)	24.15	1100	0.84	0.109
P 15	Trinny Cove	27.19	1000	0.86	0.111
P 16	Grassy Pond	19.32	900	0.55	0.071
P 17	Cove Nan Drioch-Clochan	9.94	800	0.25	0.033
P 18	St. Croix Bay	10.61	1100	0.37	0.048
P 19	St. Croix Bay (south)	2.51	1000	0.08	0.010
P 20	Maturin Brook	24.37	1100	0.85	0.110
P 21	Warrens Pond	19.75	1200	0.75	0.097
P 22	Sandy Pond	5.33	1200	0.20	0.026
P 23	Rattling Brook	36.52	1300	1.50	0.194
P 24	Little Seal Cove	6.20	800	0.16	0.020
P 25	Little Rattling Pond	6.78	1000	0.21	0.028
P 26	Big Rattling Brook	5.89	1100	0.21	0.026
P 27	Ship Harbour Brook	32.66	1500	1.55	0.200
P 28	Fox Harbour Pond	6.04	1000	0.19	0.025
P 29	Placentia Sound	32.92	1500	1.56	0.202
P 30	Shalloway Pond	8.80	1200	0.33	0.043
P 31	Broad Cove Brook	3.17	800	0.08	0.010
P 32	Freshwater	6.28	800	0.16	0.021
P 33	Northeast Arm	2.69	900	0.08	0.010
P 34	Dunville	4.29	1100	0.15	0.019
P 35	NE River near Placentia	89.60	1500	4.26	0.549
P 36	MacDonald Cove	11.82	1200	0.45	0.058
P 37	Southeast River	88.47	1600	4.49	0.579
P 38	Southeast Arm (central)	39.21	1200	1.49	0.192
P 39	Southeast Arm (west)	3.52	1000	0.11	0.014
P 40	Little Barasway River	38.67	1400	1.72	0.221
P 41	Great Barasway	64.90	1500	3.09	0.398
P 42	Ship Cove	33.96	1300	1.40	0.180
P 43	Gooseberry Cove	15.32	1000	0.49	0.063
P 44	Patrick's Cove	29.30	1000	0.93	0.120
P 45	Angel's Cove	13.06	1100	0.46	0.059
P 46	Cuslett Brook	36.83	1200	1.40	0.181
P 47	St. Bride's	32.19	1200	1.22	0.158
P 48	Distress Cove	5.32	1000	0.17	0.022
P 49	Norther Head	7.10	800	0.18	0.023
P 50	Lears Cove	12.71	1000	0.40	0.052
P 51	Golden Bay (east)	6.26	1000	0.20	0.026

TABLE 2.5c

DRAINAGE BASIN DATA : ST. MARY'S BAY REGION

REF. NO.	Drainage Basin	Drainage Area (km^2)	Avg. Annual Runoff (mm)	Mean Ann. Flow (m^3/s)	Q1:10 1 month (m^3/s)
S 1	Salmonier Arm	8.47	800	0.21	0.028
S 2	Warrens Waters	24.4	800	0.62	0.080
S 3	Harricott	8.49	800	0.22	0.028
S 4	Harricott Longpond	3.82	800	0.10	0.012
S 5	Colinet	6.53	800	0.17	0.021
S 6	Colinet River	171	1000	5.42	0.699
S 7	Rocky River near Colinet	285	1200	10.84	1.398
S 8	North Harbour River	72.1	1300	2.97	0.383
S 9	North Harbour Pond	9.44	1200	0.36	0.046
S 10	Flinn River	11.6	1400	0.51	0.066
S 11	Dog Cove Pond	18.1	1200	0.69	0.089
S 12	Little Salmonier River	120	1800	6.85	0.883
S 13	Big Barachois River	73.6	1700	3.97	0.511
S 14	Little Barachois River	49.4	1700	2.66	0.343
S 15	Jigging Cove	37.3	1400	1.65	0.213
S 16	Red Head River	31.6	1500	1.50	0.194
S 17	Beckford Head	42.8	1300	1.76	0.227
S 18	Branch River	117	1600	5.93	0.765
S 19	Gull Cove	10.2	1000	0.32	0.042
S 20	Lance River	51.9	1200	1.97	0.255
S 21	Lance Cove	11.7	1000	0.37	0.048

TABLE 2.5d

DRAINAGE BASIN DATA : CONCEPTION BAY REGION

REF. NO.		Drainage Basin	Drainage Area (km^2)	Avg. Annual Runoff (mm)	Mean Ann. Flow (m^3/s)	Q1:10 1 month (m^3/s)
C	1	Red Head Cove	14.13	800	0.36	0.046
C	2	Caplin Cove	10.2	800	0.26	0.033
C	3	Lower Island Cove	11.2	800	0.28	0.037
C	4	Job's Cove Brook	8.3	800	0.21	0.027
C	5	Gull Island Brook	20.6	1000	0.65	0.084
C	6	Northern Bay Brook	57.6	1100	2.01	0.259
C	7	Smooth Cove	3.04	800	0.08	0.010
C	8	Ochre Pit Brook	13.3	1000	0.42	0.054
C	9	Western Bay Brook	26.88	1200	1.02	0.132
C	10	Western Bay	9.56	1000	0.30	0.039
C	11	Black Head Brook	12.93	1000	0.41	0.053
C	12	Broadcove Brook	21.87	1200	0.83	0.107
C	13	Spout Cove Brook	15.1	1200	0.57	0.074
C	14	Perry's Cove	5.51	1200	0.21	0.027
C	15	Rocky Pond	57.43	1200	2.18	0.282
C	16	Island Pond Brook	36.78	1200	1.40	0.180
C	17	Mosquito Brook	11.64	1000	0.37	0.048
C	18	Bannerman River	36.3	1100	1.27	0.163
C	19	South River	34.19	1100	1.19	0.154
C	20	Mill Brook	12.36	900	0.35	0.045
C	21	Ryans Brook	23.69	1000	0.75	0.097
C	22	Shearstown Brook	32.1	1000	1.02	0.131
C	23	North River	65.43	1000	2.07	0.267
C	24	South River	75.01	1000	2.38	0.307
C	25	Rodger's Brook	10.08	800	0.26	0.033
C	26	Lambs Brook	12.44	800	0.32	0.041
C	27	Turks Gut Long Pond	18.06	800	0.46	0.059
C	28	Colliers River	51.85	1000	1.64	0.212
C	29	Avondale River	59.75	1200	2.27	0.293
C	30	Maloneys River	21.7	1000	0.69	0.089

TABLE 2.5e

DRAINAGE BASIN DATA

Ref. No.	Drainage Basin	Drainage Area (km^2)	Avg. Annual Runoff (mm)	Mean Ann. Flow (m^3/s)	Q1:10 1 Month (m^3/s)
TRINITY BAY COASTAL					
TC 1	Daniel's Cove	67.27	800	1.71	0.220
TC 2	Cooks Cove (sth)	2.42	800	0.06	0.008
TC 3	Mizzen Cv/Bull Gulch Pt	7.27	800	0.18	0.024
TC 4	Russels Cove	2.42	900	0.07	0.009
TC 5	Brownsdale Cove (nth)	1.21	900	0.03	0.004
TC 6	Brownsdale	21.82	900	0.62	0.080
TC 7	New Chelsea Cv/Hant's Hr	24.24	900	0.69	0.089
TC 8	Winterton	10.30	800	0.26	0.034
TC 9	New Perlican Pond	15.15	900	0.43	0.056
TC 10	Seal Cove Brook	16.36	800	0.41	0.054
TC 11	Heart's Delight	9.09	800	0.23	0.030
TC 12	Islington	2.42	800	0.06	0.008
TC 13	Cavendish	9.70	800	0.25	0.032
TC 14	Greens Harbour	5.45	800	0.14	0.018
TC 15	Hopeall Bay	13.33	800	0.34	0.044
TC 16	Dildo Arm	64.24	1000	2.04	0.263
TC 17	Chapel Arm	35.15	1100	1.23	0.158
TC 18	Collier Bay	9.7	1000	0.31	0.040
TC 19	Tickle Harbour Point	29.09	800	0.74	0.095
TC 20	Little Chance Cv.(north)	20	800	0.51	0.065
TC 21	Bull Arm (south)	22.42	900	0.64	0.082
TC 22	Bull Arm (west)	6.67	800	0.17	0.022
PLACENTIA BAY COASTAL					
PC 1	Come By Chance (east)	15.15	800	0.38	0.050
PC 2	Great Southern Harbour	11.52	800	0.29	0.038
PC 3	L. Southern Hrbr.(north)	3.03	800	0.08	0.010
PC 4	Little Harbour East	9.09	800	0.23	0.030
PC 5	Great Pinchgut	5.45	800	0.14	0.018
PC 6	Fair Haven (south)	9.70	1000	0.31	0.040
PC 7	Trinny Cove (west)	12.72	800	0.32	0.042
PC 8	St. Croix Bay (nth)	12.12	1000	0.38	0.050
PC 9	Ship Harbour	23.03	1000	0.73	0.094
PC 10	Murry Barasway	11.51	900	0.33	0.042
PC 11	Carin Head/McAndrew	75.15	1100	2.62	0.338
PC 12	Point Verde	13.33	800	0.34	0.044
PC 13	Seal Point	14.55	1000	0.46	0.059
PC 14	Gooseberry Cove (south)	16.97	800	0.43	0.055
PC 15	Breme Point	10.91	800	0.28	0.036
PC 16	Muskrat Brook	21.21	800	0.54	0.069
PC 17	Brierly Cove	18.18	800	0.46	0.059

TABLE 2.5f

DRAINAGE BASIN DATA

Ref. No.	Drainage Basin	Drainage Area (km^2)	Avg. Annual Runoff (mm)	Mean Ann. Flow (m^3/s)	Q1:10 1 Month (m^3/s)
ST. MARY'S BAY COASTAL					
SC 1	Salmonier Arm (nth)	9.7	800	0.25	0.032
SC 2	Salmonier Arm (sth)	28.49	800	0.72	0.093
SC 3	Pinchgut Tickle	9.7	800	0.25	0.032
SC 4	Bushy Head	32.12	800	0.81	0.105
SC 5	North Harbour	20	1200	0.76	0.098
SC 6	Barachois Point	3.03	800	0.08	0.010
SC 7	Big Barachois	13.94	1000	0.44	0.057
SC 8	Wild Cv/Maggotty Pt	21.82	1000	0.69	0.089
SC 9	Wild Cove	1.82	900	0.05	0.007
SC 10	Red Cove	10.91	800	0.28	0.036
SC 11	Gull Cove (south)	5.45	800	0.14	0.018
SC 12	Lance Cove (nth)	1.21	800	0.03	0.004
SC 13	Redld Pt/Big Gulch Rvr	16.36	1000	0.52	0.067
CONCEPTION BAY COASTAL					
CC 1	Split Point Cove	15.8	800	0.40	0.052
CC 2	Kettle Cv/Monday Pd	12.7	800	0.32	0.042
CC 3	Isld Cv Pd/Beachy Cv Pd	10.91	800	0.28	0.036
CC 4	Northern Bay	7.9	800	0.20	0.026
CC 5	Adams Cove	12.12	800	0.31	0.040
CC 6	Broad Cove	7.3	800	0.18	0.024
CC 7	Freshwater Pd/Powells Bk	24.9	1000	0.79	0.102
CC 8	Harbour Grace	10.91	800	0.28	0.026
CC 9	Bryants Cove	56.97	800	1.44	0.186
CC 10	Spaniard's Bay	2.42	800	0.06	0.008
CC 11	Beaver Pond	24.85	900	0.71	0.091
CC 12	Clarke's Pond	6.67	1000	0.21	0.027
CC 13	Cupids	11.52	800	0.29	0.038
CC 14	Whalens Brook	13.94	800	0.35	0.046
CC 15	Silver Springs	25.45	800	0.65	0.083
CC 16	Salmon Cove Point	4.85	800	0.12	0.016
CC 17	Chapel Cove	12.73	800	0.32	0.042

3 - GROUNDWATER AVAILABILITY

3 - GROUNDWATER AVAILABILITY

The geology and hydrogeology of the study area have been described in detail in Reports 2-4 and 2-6 of the Department of Environment Groundwater Report series (21,22). Much of the material in this section is based on these reports and on supplementary material provided by the Groundwater Branch of the Water Resources Division. Report 2-4 contains information on the Isthmus of Avalon and the Bay de Verde Peninsula, and Report 2-6 describes the hydrogeology of the remainder of the study area.

The area is characterized by a mantle of glacially derived overburden material, overlying fractured sedimentary bedrock of Precambrian origin. The till mantle is thin, typically less than 5 m in depth, and bedrock outcroppings are frequent. North of the Town of Victoria and on the Isthmus of Avalon, there are large areas of exposed bedrock. The central part of the Avalon Peninsula has been interpreted as a subglacial deposit called a Rogen or ribbon moraine. Drift thicknesses over the moraine are generally less than 5 m.

Deposits of fluvial sands and gravels are limited. The most extensive beach deposits occur at Argentia and Placentia.

As a result of this geology, groundwater flow systems are closely tied to surface water systems. Wells are dug or drilled in both overburden and bedrock. Both till and bedrock flow systems are closely connected with surface water. Lakes and ponds serve as both local and regional discharge points. The implication of the close surface water/groundwater connection is that groundwater levels are very sensitive to dry periods, unless substantial storage is available.

3.1 - Surficial Hydrogeology

Most wells are developed in overburden, but little information is available, and as a result, groundwater potential is difficult to assess. Two major hydrostratigraphic units have been identified in the surficial layer, moraine deposits and outwash deposits.

The eskers and meltwater channels occurring in the coastal areas in the southern part of the study region have been identified as possibly significant aquifers, but no yield data are available.

The moraine deposits have low permeability; average well yields are less than 9 L/min. The outwash deposits have a greater groundwater potential; the mean yield of the outwash deposit wells examined in Groundwater Report 2-6 was 40.6 L/min. Aquifer tests on a well in Clarkes Beach reported a safe yield of 113 L/min.

3.2 - Bedrock Hydrogeology

In the bedrock, fractures are the primary groundwater conduits; the main fracture features are joints, fracture zones, and shear zones. The best yield comes from wells located in highly fractured areas, but these areas are difficult to identify.

Bedrock hydrostratigraphic units were identified in the groundwater reports. The systems used to classify the units are slightly different in the two reports. From the information given, however, four units can be identified. These are listed in Table 3.1, together with the locations in which they occur.

TABLE 3.1

BEDROCK HYDROSTRATIGRAPHIC UNITS

Unit #	Description	Locations
1	Low yield, about 10 L/min. All < 45 L/min.	Isthmus of Avalon. Scattered coastal locations.
2	Moderately productive, about 20 L/min. (Similar to Unit B, Report 2-6).	Isthmus of Avalon. Other locations throughout area. Not prevalent on Bay de Verde Peninsula.
3	Moderate yield, close to 30 L/min.	Near Chapel Arm.
4	Moderate to high yields, mean about 33 L/min, up to 450 L/min. Similar to Units C and D, some B in Report 2-6.	Most of study area.

Note: See References 21 and 22 for detailed mapping of surficial and bedrock hydrostratigraphic units.

The classification scheme is taken from Report 2-4, because it covers the most populated areas, with the most groundwater information. The units identified in Report 2-6 are also included where they correspond.

In general, the region has sufficient groundwater to supply domestic needs. Some of the better constructed and developed wells, located in the better-producing units, can supply several homes or low-demand industrial or commercial uses. The close connections with surface water suggest that there is little groundwater reserve, and shortages occur in very dry periods.

Wells are an important source of water in small communities and rural areas in the study region. Properly located, they can continue to supply domestic users in many locations.

4 - WATER QUALITY

4 - WATER QUALITY

4.1 - Available Data

Surface water quality data are available for four rivers in the study area monitored by DOEL under a joint program with Environment Canada. The data are archived in the National Water Quality Data Base (NAQUADAT) of Environment Canada.

The monitored rivers and the number of samples from each are

Rivers	Number of Samples*
Hearts Content River	3 - 92
Northeast River near Placentia	14 - 84
Rocky River	1 - 264
Spout Cove Brook	3 - 91

* Varies for each parameter

Sampling data are also available from NAQUADAT for six of the water supplies in the study area. These are

Source	Number of Samples
Arnold's Cove Pond	1
Arnold's Cove Water Supply	4
Bannerman Lake	2 - 4
Sunnyside Pond	20
Terrence Pond	4
Wyses Pond	2 - 4

Data are presented in Tables 4.1 to 4.4 for the monitored rivers, and in Tables 4.5 to 4.10 for the water supplies. Detailed discussions of each of the parameters are contained in Reference 2.

TABLE 4.1

WATER QUALITY DATA : HEART'S CONTENT RIVER (00NL02ZL0002)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	90	62	L.1	3	L1.0	1
Arsenic Dissolved	mg/L	13	9	0.004	0.061	L.005	0.017
Cadmium Total	mg/L	24	20	L.00	L.01	L.01	0.00
Calcium Dissolved	mg/L	42	0	0.35	8.41	0.6	0.97
Chloride Dissolved	mg/L	90	0	4.8	53.6		9.01
Coliforms Fecal	NO/DL	87	67	0	60	L10	11
Coliforms Total	NO/DL	88	34	2	1120	20	121
Colour Apparent	Rel.units	89	0	0.0	45	15	18
Copper Total	mg/L	27	17	L.01	L.04	L.01	0.01
Iron Total	mg/L	91	5	L.01	0.2	0.069	0.077
Lead Total	mg/L	30	18	L.001	0.022	L.005	0.006
Magnesium Dissolved	mg/L	51	0	0.3	3.6	0.4	0.5
Manganese Total	mg/L	45	5	0.009	0.11	0.024	0.029
Nickel Total	mg/L	3	2	L.01	0.01	L.01	0.01
Nitrogen Dsv. Nitrate	mg/L	53	26	L.002	0.808	L.005	0.027
Nitrogen Tot. Ammonia	mg/L	54	30	L.005	0.059	0.005	0.01
Nitrogen Tot.Kjeldahl	mg/L	75	1	L.0	1.7	0.2	0.3
Oxygen Dissolved	mg/L	80	0	5.4	14.4		10.2
Oxygen Total	mg/L	19	0	2	64	13	17
pH	pH units	90	0	4.2	6.1		5.4
Phosphorous Total	mg/L	63	12	L.00	0.19	0.02	0.04
Potassium Dissolved	mg/L	55	0	0	31.5	0.2	0.8
Residue Filterable	mg/L	92	3	L2.	839	26	36
Residue Nonfilterable	mg/L	91	64	0	123	L4.	5
Sodium Dissolved	mg/L	40	0	2.8	227.6	4.3	10.2
Specific Conductivity	uS/cm	72	0	12	282		27.25
Sulphate Dissolved	mg/L	76	4	1	6		2.4
Turbidity	NTU	90	0	0.1	3.2		0.82
Zinc Total	mg/L	46	27	L.01	0.73	L.01	0.03

L : Less than detection limit

Flags : Number of samples outside detection range.

TABLE 4.2

WATER QUALITY DATA : NORTHEAST RIVER NEAR PLACENTIA (00NL02ZK0002)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	84	11	0.4	28	1.9	2.2
Arsenic Dissolved	mg/L	12	10	L.005	L.05	L.005	0.016
Cadmium Total	mg/L	18	15	L.00	L.01	L.01	0.00
Calcium Dissolved	mg/L	40	0	1.18	3.64	1.58	1.77
Chloride Dissolved	mg/L	84	0	5.6	29		9.50
Coliforms Fecal	NO/DL	72	34	0	450	L10	31
Coliforms Total	NO/DL	71	21	6	1520	72	139.00
Colour Apparent	Rel.Units	81	2	10	G70	40	40
Copper Total	mg/L	20	11	0.00	0.05	L.01	0.0
Iron Total	mg/L	84	0	0.06	0.41	0.18	0.194
Lead Total	mg/L	24	10	L.001	0.08	0.004	0.009
Magnesium Dissolved	mg/L	43	0	0.5	1.2	0.7	0.7
Manganese Total	mg/L	42	6	0.004	0.05	0.02	0.022
Nitrogen Dsv. Nitrate	mg/L	45	14	0.001	5.35	0.006	0.13
Nitrogen Tot. Ammonia	mg/L	50	30	L.003	0.035	L.005	0.008
Nitrogen Tot.Kjeldahl	mg/L	69	0	0.0	1.2	0.3	0.3
Oxygen Dissolved	mg/L	76	0	5.2	15.2		10.3
Oxygen Total	mg/L	14	0	14.0	30.0	22.0	21.0
pH	pH units	84	0	5.0	6.8		6.1
Phosphorous Total	mg/L	57	7	0.00	0.13	0.03	0.0
Potassium Dissolved	mg/L	49	0	0.1	0.4	0.2	0.2
Residue Filterable	mg/L	84	0	12	101	34	36
Residue Nonfilterable	mg/L	84	55	L1.	53	L4.	6
Sodium Dissolved	mg/L	26	0	3	9.2	5	5.40
Specific Conduct.	uS/cm	70	0	12.0	60		29.9
Sulphate Dissolved	mg/L	71	4	1.4	40		3.1
Turbidity	NTU	82	0	0.2	3.5		0.84
Zinc Total	mg/L	38	20	L.00	0.05	L.01	0.01

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.3

WATER QUALITY DATA : ROCKY RIVER (00NF02K0001)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Phenol	mg/L	133	0	0.0	0.0	0.0	0.0
Alkalinity Total	mg/L	238	5	2.4	9.8		3.6
Aluminum Dissolved	mg/L	4	0	0.00	0.12	0.04	0.05
Aluminum Extrble.	mg/L	98	0	0.02	0.27		0.09
Aluminum Total	mg/L	9	0	0.044	0.138	0.101	0.082
Arsenic Dissolved	mg/L	1	0	0.01	0.01	0.01	0.01
Arsenic Total	mg/L	16	15	L.001	0.008		0.005
Barium Total	mg/L	9	0	0.001	0.003	0.001	0.002
Beryllium Total	mg/L	9	9	L.05	L.05	L.05	L.05
Bicarbonate	mg/L	7	0	2	9	4	5
Boron Dissolved	mg/L	2	0	0.00	0.01	-	0.01
Cadmium Extrble	mg/L	133	125	L.001	0.004		0.001
Cadmium Total	mg/L	9	8	L.000	0.000	0.000	0.000
Calcium Dissolved	mg/L	256	0	0.7	7.3		1.7
Calcium Total	mg/L	7	0	1.1	2.8	1.6	1.686
Carbon Dsolv. Inorg.	mg/L	19	9	L.5	L4.0	L1.0	1.3
Carbon Dsolv. Organic	mg/L	87	0	3.7	30		7.8
Carbon Total Inorg.	mg/L	17	6	L.5	2	0.5	0.8
Carbon Total Organic	mg/L	18	0	1	21	11.4	11.4
Chloride Dissolved	mg/L	263	0	1.1	37.6		7.71
Chromium Extrble.	mg/L	2	1	L.0005	0.0005		0.0005
Chromium Total	mg/L	9	4	L.000	0.001	0.000	0.000
Cobalt Total	mg/L	9	8	L.000	0.000	L.000	0.000
Colour Apparent	Rel.Units	264	21	10	450	60	67
Copper Dissolved	mg/L	5	1	0.00	0.03		0.0084
Copper Extrble.	mg/L	134	106	L.001	0.07		0.0048
Copper Total	mg/L	9	1	L.000	0.007	0.002	0.002
Fluoride Dissolved	mg/L	150	132	L.01	6.9		0.105
Hardness Total	mg/L	27	0	3.1	4.2		7.3
Humic Acid	mg/L	48	0	5	34		14.2
Iron Dissolved	mg/L	22	0	0.000	0.24		0.0685
Iron Extrble.	mg/L	133	0	0.051	1		0.269
Iron Total	mg/L	11	0	0.182	0.283		0.225
Lead Extrble.	mg/L	126	104	L.001	0.006		0.002
Lead Total	mg/L	9	2	L.000	0.001	0.000	0.000
Lithium Total	mg/L	9	0	0.000	0.001	0.001	0.001
Magnesium Dissolved	mg/L	232	0	0.1	1.8		0.82
Magnesium Total	mg/L	7	0	0.4	0.8	0.6	0.6
Manganese Dissolved	mg/L	20	14	0.000	0.05		0.011
Manganese Extrble.	mg/L	135	16	L.01	0.16		0.026
Manganese Total	mg/L	11	2	L.01	0.049		0.017
Mercury Extrble	mg/L	123	103	L.02	0.9		0.05

TABLE 4.3

WATER QUALITY DATA : ROCKY RIVER (00NF02K0001)

		Samples	Flags	Low	High	Median	Mean
Molybdenum Total	mg/L	9	7	L.000	0.000	L.000	0.000
Nickel Total	mg/L	9	4	L.000	0.001	0.000	0.000
Nitrogen Dissolved	mg/L	9	0	0.1	0.25	0.16	0.16
Nitrogen Dsv. Ammonia	mg/L	56	9	L.005	0.8		0.169
Nitrogen Dsv. Nitrate	mg/L	7	0	0.2	3.2	1.6	1.571
Nitrogen Dsv. NO3&NO2	mg/L	226	138	L.001	2.2		0.04
Nitrogen Total	mg/L	116	40	L.01	1.25		0.13
Nitrogen Tot. Ammonia	mg/L	3	1	L.005	0.02	0.02	0.015
Oxygen Consumed	mg/L	13	0	6.6	24.3	14	14.9
Oxygen Dissolved	mg/L	12	0	9.7	13.8		11.03
pH	pH Units	373	0	3.6	7.1		6.17
Phosphate Total	mg/L	1	1	L.01	L.01	-	0.00
Phosphorous Total	mg/L	117	0	0.001	0.08		0.009
Phos.Dsv.Inorg.PO4	mg/L	25	4	L.002	0.029		0.011
Potassium Dissolved	mg/L	264	2	0.0	2.4		0.32
Residue Filterable	mg/L	4	0	32	42	35	36
Residue Fixed Filter.	mg/L	4	0	14	23	16	17
Residue Fixed NonFilt.	mg/L	1	1	L1	L1	-	1
Residue Nonfilterable	mg/L	2	0	3	28	-	16
Silica Reactive	mg/L	222	1	L.1	18		1.73
Sodium Dissolved	mg/L	264	0	1.9	3.2		4.6
Specific Conductivity	uS/cm	276	0	25	144		41.2
Strontium Total	mg/L	9	0	0.005	0.012	0.008	0.008
Sulphate Dissolved	mg/L	328	0	0.9	19		3.03
Turbidity	JTU	262	3	0.0	5		0.89
Vanadium Total	mg/L	9	3	L.000	0.001	0.000	0.000
Zinc Dissolved	mg/L	5	0	0.007	0.07		0.0156
Zinc Extrble.	mg/L	134	95	L.001	0.09		0.009
Zinc Total	mg/L	9	0	0	0.002	0.001	0.001

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.4

WATER QUALITY DATA : SPOUT COVE BROOK (00NL02ZL0002)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	90	8	L.1	44	2	2.4
Arsenic Dissolved	mg/L	12	10	L.005	L.05	L.005	0.012
Cadmium Total	mg/L	24	17	L.00	0.01	L.01	0.00
Calcium Dissolved	mg/L	41	0	0.81	3.48	1.26	1.51
Chloride Dissolved	mg/L	89	0	4	19		7.9
Coliforms Fecal	NO/DL	86	69	0	G600	L10	18
Coliforms Total	NO/DL	87	39	2	G1600	20	97
Colour Apparent	Rel.units	88	0	0.0	30	10	11
Copper Total	mg/L	27	14	L.01	0.06	0.01	0.02
Iron Total	mg/L	91	27	L.01	0.24	0.02	0.035
Lead Total	mg/L	29	17	L.001	0.01	L.005	0.006
Magnesium Dissolved	mg/L	50	0	0.4	0.9	0.5	0.5
Manganese Total	mg/L	44	20	L.005	0.16	0.01	0.017
Nickel Total	mg/L	3	2	L.01	0.01	L.01	0.01
Nitrogen Dsv. Nitrate	mg/L	52	4	L.002	0.3	0.022	0.043
Nitrogen Dsv. Ammonia	mg/L	53	32	0.002	0.141	L.005	0.0
Nitrogen Tot.Kjeldahl	mg/L	75	1	L.0	1.2	0.2	0.2
Oxygen Dissolved	mg/L	81	0	5.3	15.0		10.2
Oxygen Total	mg/L	20	0	0	19	10	10
pH	pH units	89	0	4.8	6.8		6.1
Phosphorous Total	mg/L	62	17	L.01	0.23	0.02	0.03
Potassium Dissolved	mg/L	54	0	0.1	44.5	0.2	1
Residue Filterable	mg/L	91	1	L2.	83	24	27
Residue Nonfilterable	mg/L	90	63	L1.	53	L4.	5
Sodium Dissolved	mg/L	39	0	2.7	358.6	3.9	13.3
Specific Conductivity	uS/cm	71	0	12	160		26.8
Sulphate Dissolved	mg/L	76	5	1	6.4		2.6
Turbidity	NTU	89	0	0.1	2.9		0.62
Zinc Total	mg/L	45	24	0.01	0.07	L.01	0.02

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.5

WATER QUALITY DATA : ARNOLD'S COVE POND (01NF02ZK0003)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Gran	mg/L	1	0	1.6	1.6	1.6	1.6
Alkalinity Total	mg/L	1	0	1.1	1.1	1.1	1.1
Calcium Dissolved	mg/L	1	0	1.2	1.2	1.2	1.2
Chloride Dissolved	mg/L	1	0	5.3	5.3	5.3	5.3
Colour Apparent	Rel.units	1	0	50	50	50	50
Magnesium Dissolved	mg/L	1	0	0.54	0.54	0.54	0.54
pH	pH units	2	0	6	6		6
Potassium Dissolved	mg/L	1	0	0.2	0.2	0.2	0.2
Silica Reactive	mg/L	1	0	0.5	0.5	0.5	0.5
Sodium Dissolved	mg/L	1	0	3.8	3.8	3.8	3.8
Specific Conduct.	uS/cm	1	0	32	32	32	32
Sulphate Dissolved	mg/L	1	0	2.9	2.9	2.9	2.9
Turbidity	JTU	1	0	0.6	0.6	0.6	0.6

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.6

WATER QUALITY DATA : ARNOLD'S COVE WATER SUPPLY (00NF02ZK0004)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	4	0	4.5	6.5	5.5	5.5
Aluminum Extrble.	mg/L	4	0	0.03	0.04		0.035
Arsenic Total	mg/L	4	4	L.000	L.000	L.000	0.000
Cadmium Extrble.	mg/L	4	4	L.001	L.001		0.001
Calcium Dissolved	mg/L	4	0	1.9	2.7	2.35	2.33
Carbon Dsv. Organic	mg/L	4	0	5.0	5.2	5.2	5.1
Chloride Dissolved	mg/L	4	0	5.4	6.5	6	6
Colour Apparent	Rel.units	4	0	5	10	10	9
Copper Extrble.	mg/L	4	4	L.002	L.002		0.002
Fluoranthene	mg/L	4	1	0.002	0.008	0.005	0.0
Fluoride Dissolved	mg/L	4	4	L.05	L.05	L.05	0.05
Humic Acid	mg/L	4	0	5	6	6	6
Iron Extrble.	mg/L	4	0	0.06	0.13		0.095
Lead Extrble.	mg/L	4	4	L.002	L.002		0.002
Magnesium Dissolved	mg/L	4	0	0.6	0.71	0.62	0.63
Manganese Extrble.	mg/L	4	1	L.01	0.03		0.02
Mercury Extrble.	mg/L	4	4	L.02	L.02		0.02
Nickel Extrble.	mg/L	4	4	L.002	L.002		0.002
Nitrogen Dsv. NO3&NO2	mg/L	4	0	0.03	0.03	0.03	0.03
pH	pH units	4	0	6.6	6.8	6.8	6.7
Potassium Dissolved	mg/L	4	0	0.2	0.3	0.2	0.2
Silica Reactive	mg/L	4	0	1.7	2.01	1.85	1.853
Sodium Dissolved	mg/L	4	0	3.5	4.5	4	4
Specific Conductivity	uS/cm	4	0	36	43	40	40
Sulphate Dissolved	mg/L	4	0	2.4	2.7	2.7	2.60
Turbidity	JTU	4	0	0.3	0.7	0.5	0.5
Zinc Extrble.	mg/L	4	4	L.01	L.01		0.01

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.7

WATER QUALITY DATA : BANNERMAN LAKE (01NF02ZL0002)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	4	0	2.6	3.9	3.2	3.2
Aluminum Extrble.	mg/L	4	1	0.01	0.02		0.013
Cadmium Extrble.	mg/L	4	3	L.001	0.001		0.001
Calcium Dissolved	mg/L	4	0	1.1	1.5	1.3	1.3
Carbon Dsvd. Organic	mg/L	4	0	2.3	2.7	2.6	2.5
Carbophenothion	mg/L	4	1	0.00	L.03	0.02	0.02
Chloride Dissolved	mg/L	4	0	5.2	5.6	5.4	5.4
Colour Apparent	Rel.units	4	4	L5	L5	L5	5
Copper Extrble.	mg/L	4	4	L.002	L.002		0.002
Fluoranthene	mg/L	4	1	L.005	0.006	0.0055	0.0055
Fluoride Dissolved	mg/L	4	4	L.05	L.05	L.05	0.05
Humic Acid	mg/L	4	0	2	2	2	2
Iron Extrble.	mg/L	4	0	0.002	0.019		0.0095
Lead Extrble.	mg/L	4	4	L.002	L.002		0.002
Magnesium Dissolved	mg/L	4	0	0.47	0.58	0.52	0.52
Manganese Extrble.	mg/L	2	0	0.01	0.01	-	0.01
Mercury Extrble.	mg/L	4	4	L.02	L.02		0.02
Nickel Extrble.	mg/L	4	4	L.002	L.002		0.002
Nitrogen Dsv. NO3&NO2	mg/L	4	4	L.01	L.01	L.01	0.01
pH	pH units	4	0	6.5	6.6	6.6	6.6
Potassium Dissolved	mg/L	4	0	0.2	0.2	0.2	0.2
Silica Reactive	mg/L	4	0	0.8	1.2	0.95	0.975
Sodium Dissolved	mg/L	4	0	3.1	3.9	3.5	3.5
Specific Conductivity	uS/cm	4	0	30	33	32	32
Sulphate Dissolved	mg/L	4	0	2.2	2.4	2.4	2.3
Turbidity	JTU	4	0	0.3	0.4	0.4	0.4
Zinc Extrble.	mg/L	4	4	L.01	L.01		0.01

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.8

WATER QUALITY DATA : SUNNYSIDE POND (01NF02ZJ3002)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	20	0	5.0	22	11.5	12.7
Calcium Total	mg/L	20	0	4	15.2	6.2	7.145
Chloride Dissolved	mg/L	20	0	11.0	90.0	18.8	27.8
Hardness Total	mg/L	20	0	13	72	25.5	28
pH	pH units	20	0	6.1	7.4	6.9	6.9
Specific Conductivity	uS/cm	20	0	66.0	325	121	138
Sulphate Dissolved	mg/L	20	0	1	14.7	8.3	7.6
Turbidity	JTU	20	0	0.5	12	3.2	3.9

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.9

WATER QUALITY DATA : TERRENCE POND (01NF02ZL0003)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	4	0	3.4	4	3.7	3.7
Alpha-BHC	ug/L	4	2	L.001	0.001	0.001	0.001
Aluminum Extrble.	mg/L	4	0	0.02	0.03		0.024
Arsenic Total	mg/L	4	4	L.000	L.000		0.000
Cadmium Extrble.	mg/L	4	2	L.001	0.001		0.001
Calcium Dissolved	mg/L	4	0	1.6	1.9	1.75	1.75
Carbon Dsv. Organic	mg/L	4	0	2.6	3.6	2.9	3
Chloride Dissolved	mg/L	4	0	10.1	10.4	10.3	10.3
Colour Apparent	Rel. Unit	4	4	L5	L5	L5	5
Copper Extrble.	mg/L	4	4	L.002	L.002		0.002
Fluoranthene	ug/L	4	1	0.004	0.005	0.005	0.0047
Fluoride Dissolved	mg/L	4	4	L.05	L.05	L.05	0.05
Humic Acid	mg/L	4	0	2	2	2	2
Iron Extrble.	mg/L	4	0	0.002	0.017		0.01
Lead Extrble.	mg/L	4	4	L.002	L.002		0.002
Magnesium Dissolved	mg/L	4	0	0.76	0.85	0.8	0.8
Manganese Extrble.	mg/L	4	4	L.01	L.01		0.01
Mercury Extrble.	mg/L	4	4	L.02	L.02		0.02
Nickel Extrble.	mg/L	4	3	L.002	0.002		0.002
Nitrogen Dsv. NO3&NO2	mg/L	4	0	0.01	0.02	0.015	0.015
pH	pH units	4	0	6.6	6.7	6.7	6.7
Potassium Dissolved	mg/L	4	0	0.3	0.3	0.3	0.3
Silica Reactive	mg/L	4	0	1.9	2.1	2	2
Sodium Dissolved	mg/L	4	0	5.6	6.5	6.1	6.1
Specific Conductivity	uS/cm	4	0	50	52	51	51
Sulphate Dissolved	mg/L	4	0	2.6	2.9	2.8	2.8
Turbidity	JTU	4	0	0.2	0.5	0.3	0.3
Zinc Extrble.	mg/L	4	4	L.01	L.01		0.01

L : Less than detection limit
Flags : Number of samples outside detection range.

TABLE 4.10

WATER QUALITY DATA : WYSES POND (01NF02ZK0006)

		Samples	Flags	Low	High	Median	Mean
Alkalinity Total	mg/L	2	0	2	2.3	-	2.2
Alpha-BHC	ug/L	4	2	L.001	0.002	0.002	0.001
Aluminum Extrble.	mg/L	4	0	0.04	0.086		0.063
Arsenic Total	mg/L	4	2	L.000	0.000	0.000	0.000
Cadmium Extrble.	mg/L	4	2	0.001	0.001		0.001
Calcium Dissolved	mg/L	4	0	1.2	1.5	1.35	1.35
Carbon Dsv. Organic	mg/L	4	0	4.7	8.4	6.5	6.5
Chloride Dissolved	mg/L	4	0	9.5	11.6	10.3	10.4
Colour Apparent	Rel.units	4	0	5	20	13	13
Copper Extrble.	mg/L	4	4	L.002	L.002		0.002
Fluoranthene	ug/L	4	1	L.004	0.005	0.0045	0.0045
Humic Acid	mg/L	4	0	5	9	7	7
Iron Extrble	mg/L	4	0	0.05	0.23		0.145
Lead Extrble.	mg/L	4	4	L.002	L.002		0.002
Magnesium Dissolved	mg/L	4	0	0.7	0.8	0.7	0.7
Manganese Extrble.	mg/L	4	1	0.01	0.02		0.015
Mercury Extrble.	mg/L	4	4	L.02	L.02		0.02
Nickel Extrble.	mg/L	4	4	L.002	L.002		0.002
Nitrogen Dsv. NO3&NO2	mg/L	4	3	L.01	0.03	L.01	0.01
pH	pH units	4	0	5.8	6.3	6.0	6.0
Potassium Dissolved	mg/L	4	0	0.2	0.3	0.2	0.2
Silica Reactive	mg/L	4	0	0.6	1.3	1	0.975
Sodium Dissolved	mg/L	4	0	5.9	6.3	6.2	6.1
Specific Conductivity	uS/cm	4	0	47	50	48	48
Sulphate Dissolved	mg/L	4	0	2.9	3	3	3
Turbidity	JTU	4	0	0.4	0.5	0.4	0.4
Zinc Extrble	mg/L	4	4	L.01	L.01		0.01

L : Less than detection limit
Flags : Number of samples outside detection range.

These water chemistry reports indicate that naturally occurring surface waters tend to be acidic and colored. Concentrations of major ions are low. Metal concentrations also tend to be low, with the exception of iron and manganese, reflecting the composition of the sedimentary bedrock.

None of these reports included information on water quality at the end of the distribution system i.e. in homes and businesses. The most likely problems in the distribution systems are bacteriological contamination and the presence of copper and lead from pipes, which could dissolve into solution in the presence of soft, low pH water.

4.2 - Water Quality Requirements for Various Uses

The primary uses of concern in the study area are

- drinking water supply
- industrial water supply
- maintenance of aquatic life
- recreation.

Guideline values for various parameters for different uses are given in Canada Water Quality Guidelines (40). Table 4.11 presents values for which local water quality data are available for drinking and industrial water supplies and for maintenance of aquatic life. Guidelines for recreational water use quality are presented separately in Section 4.3.4, since they are related more to aesthetic parameters than to water chemistry.

For all uses except drinking water, the values given are guidelines, i.e. recommended values to support and maintain a designated water use. For drinking water, the guideline values presented in Table 4.11 are not simply guidelines; they are the recommended limits establish by Health and Welfare Canada.

TABLE 4.11

GUIDELINE VALUES FOR VARIOUS USES (mg/L)

Parameter	Drinking Water Max Acc	Aquatic Life(1)	Once Through Cooling Systems	Feed & Boiler Water(2)	Typical Value in Study Area(3)
Inorganic					
Alkalinity	-	-	<500	<700	2.5
Aluminum	-	0.005	-	-	-
Arsenic	0.05	0.05	-	-	0.014
Bicarbonate	-	-	<600	-	-
Cadmium	0.005	0.002	-	-	0
Calcium	-	-	-	-	1.5
Carbonate	-	-	<200	-	-
Chloride	250	-	-	-	4
Chromium	0.05	0.02	<600	-	-
COD	-	-	-	-	-
Copper	1	0.002	<75	<0.05	0.01
Dissolved Oxygen	-	9.5	-	<0.04	9.4
Fluoride	1.5	-	-	-	-
Hardness	-	-	-	<1	-
Iron	0.3	0.3	<850	<0.1	0.1
Lead	0.05	0.001	-	-	0.006
Magnesium	-	-	-	-	0.6
Manganese	0.05	-	-	-	0.02
Mercury	0.001	0.0001	-	-	-
Nickel	-	0.0025	-	-	0.01
Nitrate	10	-	-	-	0.4
Nitite	1	0.06	-	-	0.01
N-Ammonia	0.5	2.2	-	-	0.008
pH (pH units)	6.5-8.5	6.5-9.0	5.0-8.3	7.0-10.0	6.0
Silica	-	-	<50	<150	-
Sulphate	500	-	<680	-	3.0
TDS	500	-	<1000	-	-
Zinc	5	0.03	-	-	0.03
Physical					
Color (TCU)	15	-	-	-	30
Turbidity (NTU)	5	-	-	-	0.8
Temperature (°C)	15	-	-	-	-
TSS	-	-	<5000	-	-
Microbiological					
Total Coliforms	10 per 100ml		-	-	120
Faecal Coliforms	0 per 100ml		-	-	20

(1) Some of these guidelines vary with other parameters. Guideline given is for typical value.
(2) Industrial firetube steam generator without superheater, turbine drives or process restrictions on steam purity.
(3) Of four regularly sampled natural rivers, Tables 6.1 to 6.4. These values are only presented for general information; analytical methods vary among samples and may also be different from those assumed in the guideline values.
(4) TCU: true color units NTU: neophelometric turbidity units

Drinking water that contains substances in excess of these maximum acceptable concentrations is capable of producing deleterious health effects or is aesthetically objectionable.

The water quality parameters of concern for the four principal uses in the study area are discussed in the following sections.

4.2.1 - Drinking Water Supply

As Table 4.11 shows, the natural waters in the study area typically meet all the maximum acceptable limits for drinking water supplies, with the exception of color, pH and coliform counts. Raw water can therefore usually be used for drinking water, with pH adjustment and with disinfection to ensure bacteriological control. Of the spot samples taken from the raw water supplies, only the ones from Arnold's Cove Pond and Wyses Pond (Dunville) exceeded the drinking water standards, and these exceedences were for pH only.

The naturally soft waters in the region are desirable for domestic water supply because of the ease of lathering. Local natural waters generally have a pleasing taste, except when occasional high levels of organics are present. These high levels can lead to an unpleasant taste and odor. Levels of total dissolved solids as well as metals other than iron and manganese are usually low.

Those parameters exceeding the recommended limits, i.e., color, turbidity, iron and manganese levels, are controlled for aesthetic considerations, rather than health. The water may have an unattractive appearance or taste, and may stain clothes and porcelain or enamel plumbing fixtures. It is also possible that the combination of high organic content with chlorine can lead to the formation of toxic substances. Since this combination is common in the study area, it requires further investigations.

Of the 40 surface water supply systems documented in the Inventory of Water Supply Systems (Appendix D to this report), about three quarters report no water quality problems. About one quarter of the systems report some aesthetic concerns, in particular a boggy taste and color caused by seasonally high levels of organics. The low natural alkalinity in the study area can also cause problems in water supply systems because of the potential for corrosion in the distribution systems. According to the inventory in Appendix D, the alkalinity is low enough to be potentially corrosive in several of the systems (at least six).

Four communities in the study area were included in a 1985 survey of water supply systems, which tested for toxic chemicals as well as the more commonly tested water chemistry parameters. These communities were Dunville, Arnold's Cove, Harbour Grace and Hearts Desire. The data show no indication of the presence of any toxic chemicals in the water supply sources. The toxic chemicals included in the sampling program are listed in Table 4.12.

4.2.2 - Industrial Water Supply

The major industry in most of the communities in the study area is fish processing. Many of the fish processing plants share a water supply with the community, so the quality of their water is identical to that of the municipal source. Some fish plants, as well as the oil refinery at Come By Chance and the phosphorus plant at Long Harbour, have their own water supplies.

The water used in fish plants is not incorporated into the final product, but is used only for general purposes such as washing and transporting the fish. The major parameter of concern for these uses is bacteriological levels. These are monitored by the provincial Department of Fisheries.

TABLE 4.12

LIST OF TOXIC CHEMICALS TESTED FOR PRESENCE IN WATER SUPPLIES

P,P-DDT
O,P-DDT
P,P-DDD
P,P-DDE
P,P-MethoxyChlor
Heptchlor
Heptachlor Epoxide
Alpha-Endosulfan
Beta-Endosulfan
Alpha-(cis)Chlordane
Gamma-(trans)Chlordane
Lindane
Alpha-BHC
Mirex
Aldrin
Endrin
Dieldrin
Arochlor Total (PCB's)
1,3-Dichlorobenzene
1,2-Dichlorobenzene
1,3,5-Trichlorobenzene
1,2,4-Trichlorobenzene
1,2,3-Trichlorobenzene
1,2,3,5-Trichlorobenzene
1,2,4,5-TetraChlorobenzene
1,2,3,4-Tetrachlorobenzene
Pentachlorobenzene
Hexachlorobenzene
Fluoranthene
Benzo(b)Fluoranthene
Benzo(k)Fluoranthene
Benzo(a)Pyrene
Indeno(1,2,3CD)Pyrene
Benzo(g,h,i)Perylene
Azinphosethyl
Azinphosmethyl
Carbophenothion
Crufomate
Diazinon
Disulfoton
Ethion
Fenitrothion
Imidan
Malathion
Parathion-Methyl
Parathion
Phorate
Fenchlorphos (Ronnel)
2,6-Dichlorophenol
2,5-Dichlorophenol
2,4-Dichlorophenol
3,5-Dichlorophenol
2,3-Dichlorophenol
3,4-Dichlorophenol
2,4,6-Tetrachlorophenol
2,3,6-Tetrachlorophenol
2,3,5-Tetrachlorophenol
2,3,4-Tetrachlorophenol
3,4,5-Tetrachlorophenol
2,3,5,6-Tetrachlorophenol
2,3,4,5-Tetrachlorophenol
Pentachlorophenol
Aldicarb
Aldic.Sulfox.
Aldic.Sulfon.
Carbaryl

Water is also used by most industries, institutions and businesses as hot water or steam for heating and cooling. The standards of water quality for process steam are included in Table 4.11. It can be seen from this table that the natural waters in the study area are quite suitable for such uses; the softness and low solids and metal contents indicate that scaling is not likely to occur. The natural softness if combined with low pH, however, may cause corrosion.

4.2.3 - <u>Maintenance of Aquatic Life</u>

Native aquatic life is naturally adapted to the characteristics of local waters and the guidelines need only be applied when human activity changes the natural quality. The guidelines are required when anthropogenic activities have led to changes in the natural conditions. These guidelines can be used, for example as objectives in a rehabilitation program for degraded waters, or as standards to measure the effect of existing or proposed projects.

Table 4.11 shows that the natural waters in the study region are within the guidelines for aquatic life, with the exception of pH. Local fish populations and other forms of aquatic life can be assumed to be acclimated to a naturally low pH. Any decrease in pH, however, may well lead to episodic losses or chronic effects, such as spawning failure and diminished hatching success. The most likely cause of a decrease in pH would be deposition of atmospheric pollutants (acid rain) or local anthropogenic sources.

4.2.4 - <u>Recreational Water Use</u>

The natural surface waters in the study area meet all required guidelines for recreational water use. The recreational parameters and guidelines are listed in Table 4.13. The range of values

TABLE 4.13

GUIDELINES FOR RECREATIONAL WATER QUALITY

Parameter	Guideline	Typical Natural Value in Study Area
Bacteriological		
Faecal coliforms	The geometric mean of not less than 5 samples taken over a 30-d period should be less than 200 faecal coliforms per 100 mL. Resampling should be performed when any sample exceeds 400 faecal coliforms per 100 mL.	0 - >600*
Pathogens) Coliphages) Enterococci) E. coli) P. aeruginosa) G. lamblia)	No guidelines set. May be indicators, or monitoring may be required.	-
Clarity	The water should be sufficiently clear that a Secchi disc is visible at a minimum of 1.2 m.	-
pH	5.0-9.0	3.6 - 7.1
Turbidity	The turbidity of water should not be increased more than 5.0 NTU over natural turbidity when this is low (< 50 NTU).	0.0 - 5
Aesthetics	All water should be free from - materials that will settle to form objectionable deposits: - floating debris, oil, scum and other matter; - substances producing objectionable color, odor, taste or turbidity; and - substances and conditions or combinations thereof in concentrations which produce undesirable aquatic life.	- (Pollen may occasionally form an oil-like sheen for a brief period)

TABLE 4.13 (Continued)

GUIDELINES FOR RECREATIONAL WATER QUALITY

Parameter	Guideline	Typical Natural Value in Study Area
Oil and grease	Oil or petrochemicals should not be present in concentrations that - can be detected as a visible film, sheen or discoloration on the surface; - can be detected by odor; or - can form deposits on shore-lines and bottom deposits that are detectable by sight and odor.	-
Aquatic plants	Rooted or floating plants which could entangle bathers should be absent; very dense growths could affect other activities such as boating and fishing.	-

Source: Canadian Water Quality Guidelines (40). -

from the four regularly sampled rivers is provided for comparison. The microbiological parameters are most important when users are frequently immersed in water, i.e., swimming or certain types of boating. For scenic pleasure, the appearance of the water and the overall setting are as important as the quality of the water itself.

No data are available for surface waters in developed areas.

4.3 - Types of Degradation

Degradation of surface waters can occur as a result of human activity. They can be categorized as increased loadings of

- sediment and other solids
- microorganisms
- nutrients
- toxic chemicals
- atmospheric pollutants.

The types of degradation and their significance in the study area are briefly discussed in the following sections; additional discussion and data are provided in Reference 2.

4.3.1 - Sediment

Increased loadings of sediments and other solids generally arise from changed land use or drainage regimes. Any activity which removes vegetation or protective cover, such as construction, quarrying, road building, or many farming activities will increase erosion and resulting sediment loads. In addition, changed flow patterns, particularly channeling of flows for drainage in urban areas or bogs, will usually increase flow velocities and consequently scouring potential.

The principal adverse effect of increased sediment is on fish habitat and food supply. High turbidity levels during the spawning season will seriously disrupt spawning activities, because visual stimuli are required for successful reproduction. Sediments settling on the bottom will fill in rearing pools, reduce intragravel flow in spawning areas, and suffocate eggs (28). In addition, silt-laden rivers are aesthetically unattractive.

Of continuing concern are developed areas. Channelization, development along the banks, and concentration of pollutants in episodic events can degrade the quality of water in these areas. Outside developed areas, impacts are usually local, although often serious. The construction of Highway 100 to Argentia, for example, resulted in the loss of the best spawning beds on an important salmon river (9).

The deleterious effects of sediment loading can be substantially mitigated by simple measures, including

- Maintaining as much vegetation as possible and reducing the length of time that ground is bare (e.g., during construction).

- Using settling pools at outflows of quarries and construction sites.

- Avoiding straightening of natural streams.

- Maintaining streambank vegetation.

The problems of increased sediment are generally recognized, and environmental agencies are attempting to reduce the negative impacts of human activities on siltation and erosion. Since these activities are widespread and increase with development, constant attention is required to minimize or prevent deterioration.

4.3.2 - Microorganisms

The surface waters in the study area are naturally very low in pathogenic organisms. In inhabited areas some contamination from human and animal sources often occurs.

In developed areas, with piped sewerage systems, bacteriological pollution can occur from cross-connections of storm water and sanitary sewers, from leaking sanitary sewers, and from animal wastes washing into storm sewers. In rural residential areas, well-placed and well-maintained septic tanks control bacteriological pollution, but occasionally malfunctions or leaks can occur, causing local increases in bacteriological loadings. Animal husbandry (chiefly dairy cattle, swine, and chickens in the study area) can result in increased loads of microorganisms through pasture runoff, manure spreading, and manure lagoons.

Disposal locations and procedures for animal wastes (e.g. manure spreading, manure lagoons) are occasionally the source of complaints. Disposal practices are subject to DOEL approval. Nevertheless, bacteriological contamination has been reported in the study area, from agricultural areas such as Roaches Line (Goulds Brook), Whitbourne, Bay Roberts (Country Road, Delaney's Road area). Sewage contamination is likely in some cottage areas (e.g., Line Road near Carbonear) and at Victoria.

4.3.3 - Nutrients

Developed Areas

As discussed in Reference 2, levels of nutrients are naturally low in surface waters in the study area. Degradation of water quality due to excess nutrients is most likely to occur in developed areas as a result of human and animal waste and agricultural residues, particularly fertilizers.

Another source of nutrients is airborne pollutants. High phosphorus levels and large blooms of plankton in Samson's Pond were reported in a study of four ponds in Newfoundland (30). This pond is located about 5.5 km northeast of the phosphorus plant in Long Harbour. According to the study, the elevated phosphorus levels and the presence of the particular type of algae found in the pond (Anabaena flos-aquae) indicate airborne pollution from the phosphorus plant.

Rural Areas

A common source of excess nutrients is agricultural runoff. In the study area, however, the small scale of the farming together with the natural dearth of nutrients in the environment have generally prevented problems. The potential exists for local pollution from animal wastes and nonpoint pollution sources from fertilizer runoff where agricultural activity is most concentrated, e.g., in the Whitbourne area and on the Bay de Verde Peninsula, particularly along the Shearstown River. The most common applications are of lime and of an all-purpose fertilizer containing nitrogen, phosphorus, and potassium, often in a mixture with a variety of trace elements. Boron is also added where certain crops such as turnips are grown.

Over 100 blueberry management units have been designated on the Bay de Verde Peninsula, almost all on the eastern side. Pollution from these units seems unlikely. Only a few commercial growers are using fertilizer, and the amounts applied are low. The recommended treatment is a single application of an all-purpose fertilizer at the start of operations and nitrogen alone in subsequent years.

4.3.4 - Toxic Substances

No pollution by any of the toxic substances shown in the list in Table 4.12 has been reported in the surface waters of the study area, although undocumented episodic events may have occurred. Nonetheless, the use of many relatively new chemical substances is widespread, and they have the potential for serious adverse effects due to their persistence in the environment and accumulation in living tissues. Reference 2 provides a list of the major substances of concern, and possible sources.

In some areas, the possibility of spills or chronic pollution is a concern. These areas include the refinery at Come by Chance, the phosphorus plant at Long Harbour, gasoline and/or diesel spills at Cupids Crossing, and Harbour Grace, PCB contamination at Makinsons, and various types of waste and debris in Northern Cove Pond near Spaniards Bay.

4.3.5 - Deposition of Atmospheric Pollutants: Acid Rain

A fourth type of potential water quality degradation results from the long range atmospheric transport and subsequent deposition of pollutants. Acid precipitation is defined as rain, snow, freezing rain, hail and fog with a pH below 5.6 (the pH of normal rain). It is formed in the atmosphere as a result of emissions of sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) from the combustion of fossil fuels. These substances can be further oxidized in the atmosphere to form sulfuric and nitric acids. In addition to the acid rain itself, other pollutants, such as toxic chemicals and metals, can be transported and deposited.

The implications of acid rain, from experience in Europe and other parts of North America, are the decline and disappearance of fish in freshwater lakes and rivers, and the serious deterioration of forests. These effects are due not only to the low pH, but also to the increased mobilization of minerals in rock.

The federal Department of Fisheries and Oceans has conducted several major studies to assess the effects of acid rain in Newfoundland (33-37). The conclusions of its work to date are that lakes and streams in the study area are extremely sensitive and with current or increasing rates of deposition, may be on the threshold of acidification. Although chronic acidification is not a widespread problem at present, pH excursions below 5.0 occur, and these are of sufficient magnitude to affect fish. The lowest recorded annual pH of rainfall on the Avalon peninsula is about 4.5 to 4.7; a rainfall pH of 4.6 has been considered a threshold level for acidification.

Newfoundland is vulnerable for several reasons. First, it is in the path of weather systems carrying substantial pollutant loads from the industrialized east coast of the United States and central Canada. Most of the sulphate deposited in Newfoundland originates in the Ohio Valley, the mid-western United States, the eastern seaboard, and southern Ontario. Second, Newfoundland is an area of high precipitation, and the total deposition of sulphates and nitrogen oxides is a function of total precipitation as well as the concentration of these pollutants in the atmosphere. Third, the rocks and soils of the island have very little natural buffering capacity.

Most of the Island of Newfoundland is highly sensitive, with the exception of some areas containing carbonate rocks such as limestones and dolomites on the west coast. The thin soil cover tends to accentuate the problem. Table 4.14 presents values for four other criteria for determining sensitivity. These also indicate the high sensitivity of the surface waters of the Avalon Peninsula to acid precipitation.

TABLE 4.14

SENSITIVITY OF AVALON PENINSULA RIVERS TO ACID PRECIPITATION

River	Alka-linity ueq/L	Cal-cium ueq/L	Conduc-tivity uS/cm	CSI	pH
Biscay Bay (Back) Brook	23	51	22	-5.41	5.75
Colinet River	51	86	20	-4.51	6.08
Rocky River	30	81	21	-5.12 (-4.3*)	5.71

*Long-term average

Interpretation Key

Alkalinity	0- 40	extremely sensitive
	40-200	highly sensitive
Calcium	0-200	highly sensitive
Conductivity	0- 35	highly sensitive
Calcite Saturation Index (CSI)	<-3	deleterious effects possible
	-2 to -3	danger
	-1 to -2	moderate sensitivity
	>-1	low sensitivity

ueq/L - microequivalents per litre (micromol charges per litre)

uS/cm - microsiemens per centimetre

The CSI is employed as an index of freshwater sensitivity to acidification. The CSI of water is the logarithm of its degree of saturation with respect to calcium carbonate. High negative values indicate extreme sensitivity to acidification.

Source: Scruton(37)

4.4 - Groundwater Quality

Hydrogeological Reports 2-4 and 2-6 produced as part of the Groundwater series by the Water Resources Division of the provincial Department of Environment contain information on groundwater quality (21,22). The following section summarizes the information in those reports, supplemented with recent data.

Overburden groundwater quality is similar to surface water quality, with low values of total dissolved solids and low pH (5 to 6). High iron and manganese levels are also common. Bedrock groundwater quality varies among the three groundwater groups. Typical water quality for each of the groups is as follows.

Group I - Calcium bicarbonate type waters, having higher hardness and pH than is typical of the surface waters (> 50 mg/L as $CaCO_3$ and pH between 6.5 and 9).

Group II - Sodium bicarbonate type waters having high pH (>8), high alkalinity, and low hardness.

Group III - Soft, acidic water, with low total dissolved solids, much like the waters from overburden wells.

Many wells are reported to have one or more parameters whose values exceed acceptable limits for drinking water. The exceedances are usually of aesthetic parameters, rather than health-related, i.e. parameters exceeded include pH, manganese, iron, sodium and chloride. Report 2-4 indicates that the most serious concern is excessive manganese values; about three quarters of the analyses had manganese concentrations exceeding the 0.05 mg/l limit, and about a quarter had iron values exceeding the 0.3 mg/l limit (2-4). Almost all the water quality data came from wells on the Bay de Verde Peninsula.

The high sodium and chloride concentrations are attributed to airborne sea salts, seawater intrusion, or less often to anthropogenic such as road salt.

The Groundwater Branch of the DOEL has also surveyed seven waste disposal sites on the Avalon Peninsula to assess the potential for groundwater contamination from these sites. Two were in the study area, one the Northern Bay landfill site near Northern Bay and the other the Upper Trinity landfill site near Dildo (23). The results showed little or no pollution at the Northern Bay site, but some pollution at the Upper Trinity site. The ions of chloride, calcium, magnesium, potassium and sulphate were identified as the major pollutants.

5 - INSTREAM USES

5 - INSTREAM USES

The demands for fresh water can be classified as either instream requirements or withdrawal demands.

The most common instream uses in the study area are

- hydroelectric power production
- fisheries
- recreation and tourism

These are the most important instream uses in the study area, and are discussed in this chapter. Other instream uses, such as logdriving, inland navigation or use of natural rivers for waste disposal, are not significant in the study area.

5.1 - Hydroelectric Power Production

5.1.1 - Existing Developments

The drainage areas developed for hydroelectric power cover about 12 percent of the total area of the Bay de Verde Peninsula. There are no other hydroelectric developments in the study area. The plants are listed in Table 5.1, together with their capacities, net heads, average annual flows, and spills. The plant with the highest installed capacity is New Chelsea at 4.1 MW. It also has the highest head, at 84 m. The plant at Pittman's Pond is upstream of New Chelsea in the same basin. The locations of the plants and drainage basins are shown in Figure 5.1. These stations are all owned by Newfoundland Light and Power (NLP).

TABLE 5.1

HYDRO POWER PLANT INFORMATION

Plant	Capacity (kW)	Avg. Net Head (m)	Avg. Annual Flow (1) (m^3/s)	Avg. Annual Spill (m^3/s)
Victoria	560	64.3	0.70	0
Pittman's Pond	895	21.3	2.28	0
New Chelsea	4100	83.8	2.53	0
Heart's Content	2685	46.3	3.60	0.05

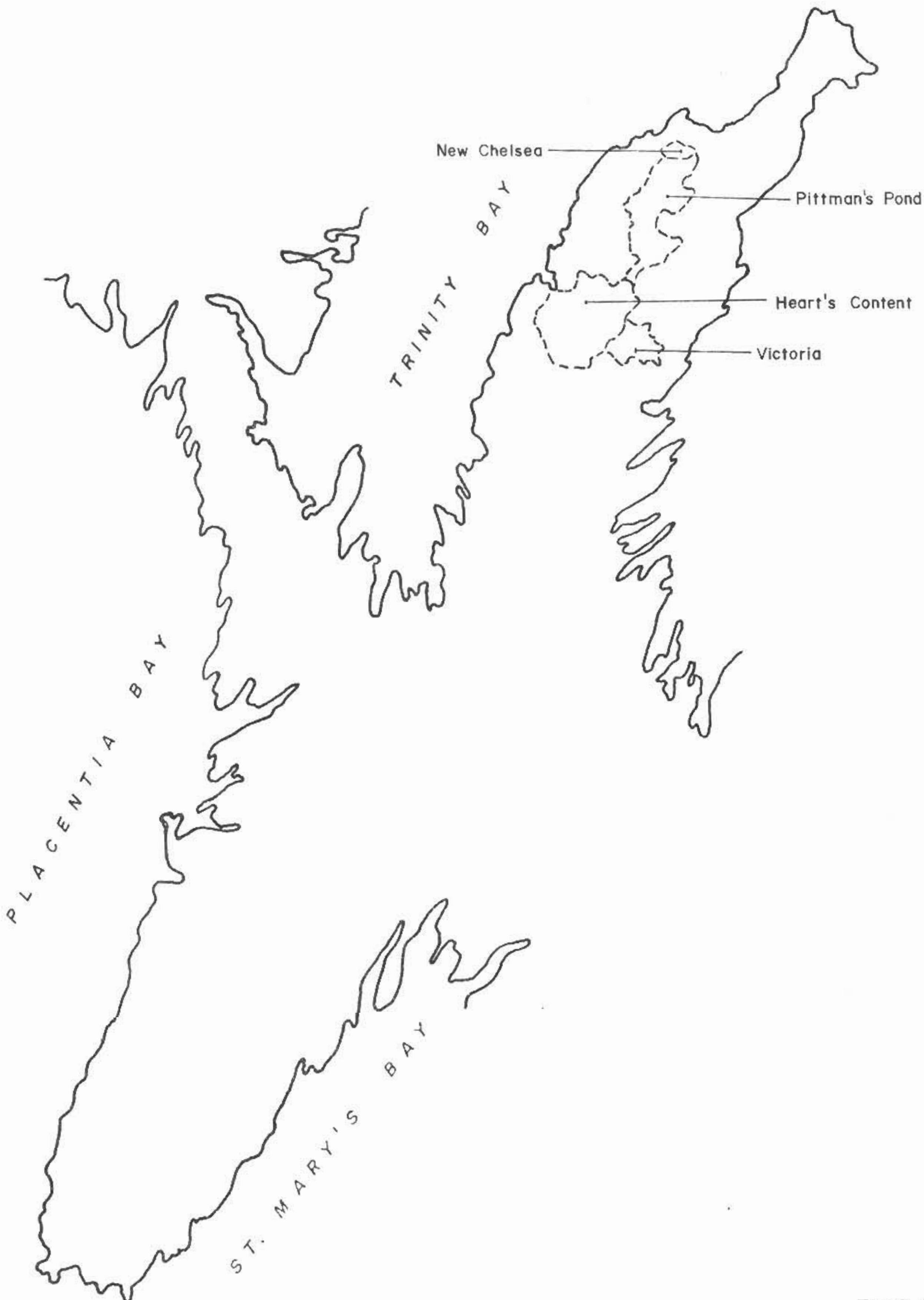
(1) Obtained using methods described in Chapter 2. Data from NLP appear to underestimate flow.

The annual total water use by hydroelectric power plants averages over 250 Mm^3. The plants have high utilization rates, using almost all the water from the basin to generate electricity with little spill. As shown in Table 5.1, the only plant with spill is Heart's Content, at just over 1 percent of average annual flow. Average annual energy generation by all plants is over 25 million kWh.

Two reservoirs also serve as water supply sources. Rocky Pond, the main storage reservoir for the Victoria hydroelectric station supplies the Town of Victoria, and the Heart's Content reservoir supplies the Town of Heart's Content. The ponds in the other NLP basins are used to a small extent for recreation.

5.1.2 - Future Developments

Because of the hilly topography and high runoff in the study area, there is some potential for development of other small scale hydroelectric projects (defined as < 20 MW). A few suitable sites have been identified in the study area. These



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Water Resources Division

Regional Water Resources Study
Western Avalon Peninsula

Basins Developed for Hydro Power

FIG. 5.1

ACRES

include a tributary of the Salmonier River (Back River), Rocky River and Southeast River (Placentia).

Capital costs for these projects are high relative to annual benefits under present economic conditions. Since other small sites on the island outside the study area have more favorable benefit/cost ratios, these sites are unlikely to be developed for some time. Environmental considerations may also affect the feasibility of these projects because all these proposed sites are likely to conflict with freshwater fisheries.

Numerous other sites in the study area are suitable for micro-hydro development (i.e., to serve perhaps a few homes) but these are not likely to be economically feasible. Energy produced from a microhydro project is expensive because of the high capital costs of developing such projects. For projects on the Avalon Peninsula, these high costs cannot be offset by fuel savings since relatively inexpensive energy is already widely distributed by NLP throughout the study area. It therefore seems unlikely that any microhydro projects will be developed unless the economic conditions change.

Combined hydropower and water supply developments are also possible, but none of the developments mentioned above is particularly promising for joint development. Southeast River could serve Placentia, but Placentia is already adequately supplied from Larkin's Pond. In fact, the Southeast River watershed is protected for water supply, but the town prefers to use Larkin's Pond because the water quality is better. Rocky River could supply Colinet but the population is small, and the homes are fairly spread out. Even with the hydro project in place, the cost of distribution is likely to be very high. As for Back River (Salmonier), there are no population centers in the immediate area. Cottages could perhaps be served, but again distribution costs are likely to be too high to make such a development feasible.

5.1.3 - Value of Water Used for Hydroelectric Power Production

The value of water used for hydro power can be determined from the value of the energy generated. Assuming that the four plants on the Western Avalon Peninsula displace thermal energy from the plant at Holyrood at a cost of 5¢/kWh, the value of the water from the plants averages nearly $1.4 million per year, as shown in Table 5.2.

5.2 - Recreation and Tourism

The surface waters of the study area are important centers for recreational activities, both for residents and tourists. The area has about 10 percent of the total provincial population, and many of the residents use the surface waters for recreation. The area also attracts numerous St. John's residents, who go to their summer cabins on ponds or brooks, visit the parks, and go fishing or touring.

TABLE 5.2

VALUE OF WATER USED FOR HYDROELECTRIC ENERGY

Plant	Avg. Annual Energy Generation (GWh)	Annual Value (1) ($M)	Water Used (Mm^3)	Value (¢/m^3)
Heart's Content	8.5	0.43	114	0.38
New Chelsea	13.8	0.69	80	0.86
Pittman's Pond	2.3	0.11	72	0.15
Victoria	3.0	0.15	22	0.68
Total	27.6	1.38	288	0.35 (Avg.)

(1) 5¢/kWh is based on oil at $30/bbl and 600 kWh/bbl, the approximate energy value of a barrel of oil burned at the Holyrood Generating Station. No account is taken of other costs such as operating and maintenance.

In addition to the local population, nearly 15,000 people visiting the province choose the northwest and/or southwest Avalon as a major destination, according to unpublished surveys carried out by the Department of Development and Tourism. As Table 5.3 indicates, visitors to Newfoundland show a strong liking for waterbased activities, and for sightseeing and touring. Ponds and rivers are important focal points on such tours.

TABLE 5.3

RESULTS FROM SURVEY OF NON-RESIDENT AUTO VISITORS

Water-based Activities	Percent Liking	Percent Participating
Canoeing	44.5	9.8
Sailing/Boating	55.2	33.0
Swimming	72.0	41.1
Going to the Beach	74.4	63.9
Fishing	61.0	40.2
Other Activities		
Taking Day Tours	58.7	61.0
Sightseeing	90.8	95.4
Photography	85.8	92.6

Although there is little or no documentation of the use of water for recreation, the importance of outdoor recreation can be inferred from the number of recreational areas and facilities shown on the maps in Figures 5.2 and 5.3. The first map shows the areas presently used for recreation, or which have been identified as having recreational potential in the Canada Land Inventories (18). Rivers and ponds are important in most of these areas, providing a main attraction for boating, fishing or swimming, or enhancing the aesthetic quality of the facilities.

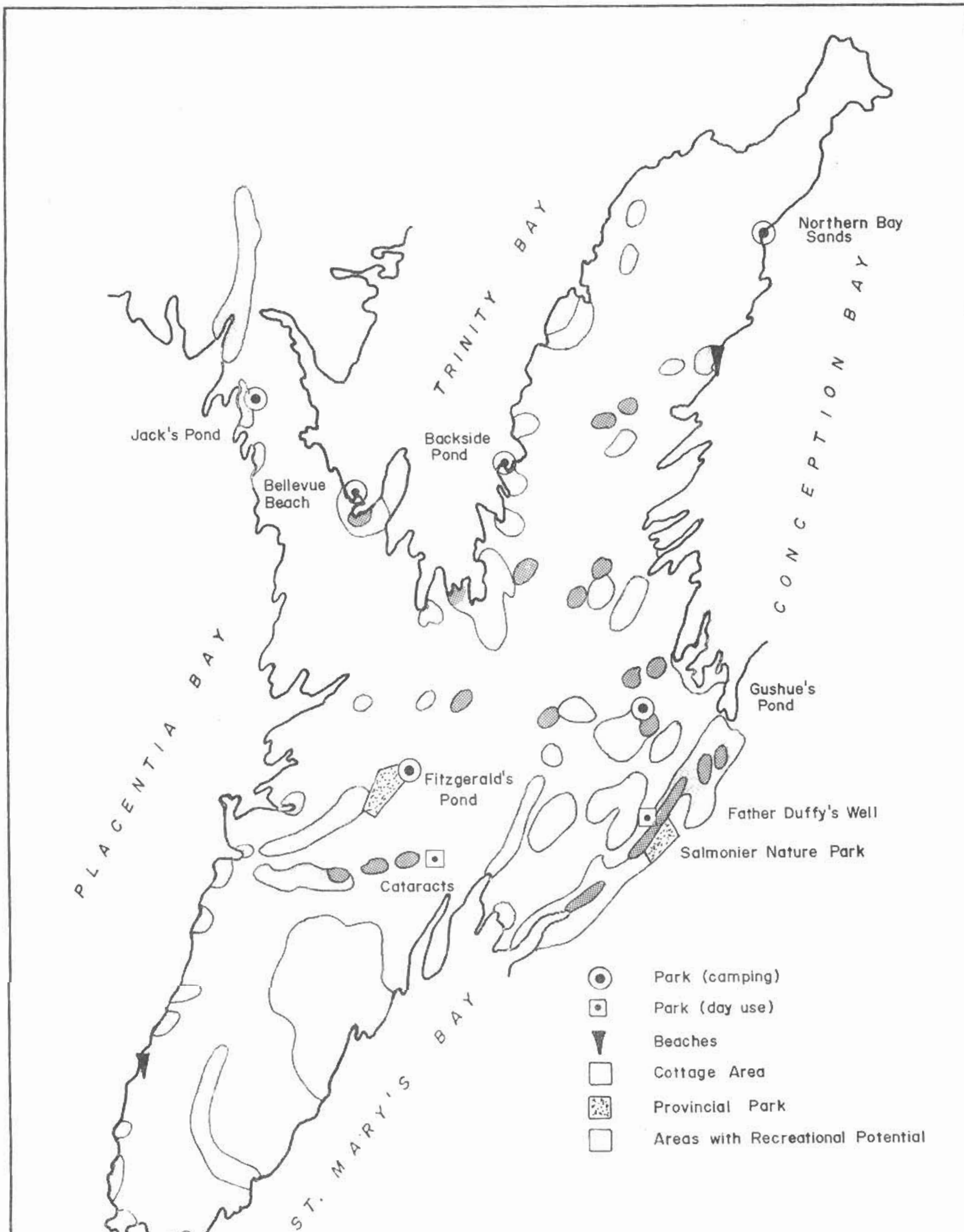

FIG.5.2

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Western Avalon Peninsula
Recreational Areas

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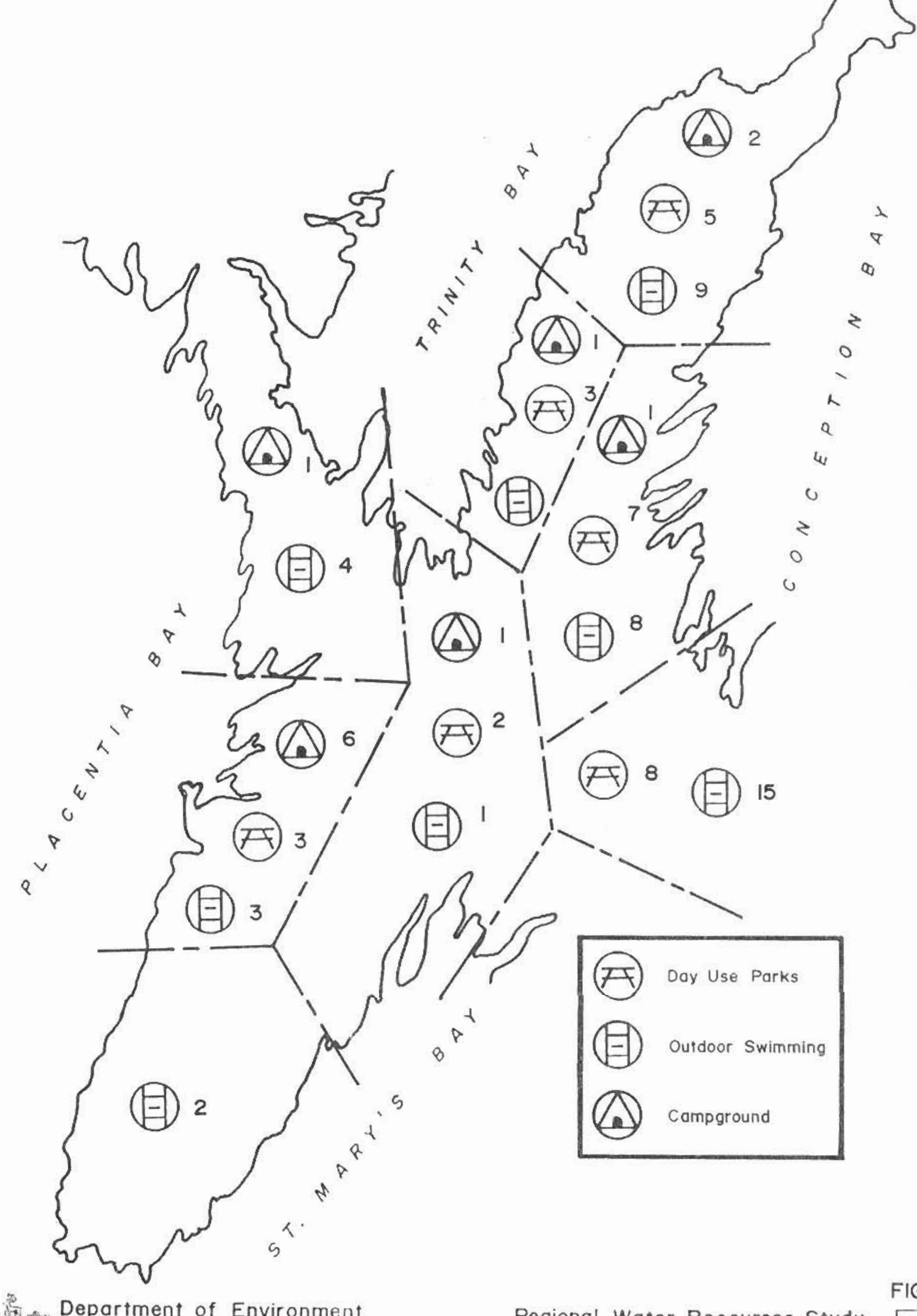

FIG.5.3

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Water Resources Division

Regional Water Resources Study
Western Avalon Peninsula

Municipal Recreational Facilities

Figure 5.3 reinforces the impression of the importance of recreation given in Figure 5.2 by showing the number of outdoor swimming facilities, day use parks and campgrounds developed by municipalities.

The only data available on the use of these recreational facilities are for provincial parks with campgrounds, as presented in Table 5.4. Over 300,000 visitors (predominantly residents) were counted at the parks in the study area in 1987, suggesting that use rates of outdoor recreational facilities are quite high. Most of the parks include water based activities, and park officials report that ponds and rivers are an essential attraction at almost all parks.

TABLE 5.4
VISITORS TO PROVINCIAL PARKS ON THE WESTERN AVALON (1987)

Park Name	Total Visitors
Backside Pond	45 393
Bellevue Beach	74 143
Fitzgerald's Pond	33 468
Gushues Pond	105 941
Jacks Pond	40 426
Northern Bay Sands	35 163
Total	334 534

(These data are provided by DFRL.)

5.2.1 - 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 statistics presented in the previous section show that water based activities and the presence of aesthetically pleasing rivers and ponds are important attractions for tourists and residents. It may be noted that estimated annual total expenditures by non-residents visiting the Western Avalon peninsula is of the order of $6 million.

The benefits of everyday amenity derived from the rivers and ponds and associated pleasant open spaces in nearly all communities are difficult to measure. It can be assumed that they have an economic value in attracting and keeping residents and perhaps businesses as well. In a region which cannot match the better climate and more extensive cultural opportunities available outside the province, good quality ponds and rivers constitute an important and unique resource. For both tourism and recreation, the benefits are associated with water quality as well as quantity. To ensure these benefits, it is essential to maintain good water quality, and equally important, the quality of the surroundings.

5.3 - Fisheries

The clean, fresh, steadily flowing waters of the study area, together with good spawning and rearing areas, are well suited to salmon and trout. DFO reports that with very few exceptions, any stream in the study area can support species such as sea-run salmon, sea-run brown and brook trout, eels, resident brook trout and resident (land-locked) salmon. Many of these are favorite sport fish, and their presence in the waters of the study area is important. *Many residents and nonresidents* derive considerable pleasure from angling, or simply watching fish. The presence of healthy fish is also an indication of good water quality to the public at large.

DFO is particularly concerned about degradation of rivers due to pollution from anthropogenic sources and habitat damage resulting from improper construction or development practices. Table 5.5

TABLE 5.5

RIVERS OF INTEREST FOR FISHERIES

Rivers	Relevance to Fisheries
Bellevue, Trinity Bay	Scheduled Salmon river
Salmon Cove River, Conception Bay	Scheduled Salmon river
North River, Conception Bay	Possible salmon enhancement site
South River, Conception Bay	Possible salmon enhancement site
Salmonier River, including Back River below the falls	Possible salmon enhancement site
North Harbour, St. Mary's Bay	Spawning Channel
Little Harbour River, St. Mary's Bay	Spawning Channel
Little Salmonier River, St. Mary's Bay	Spawning Channel
Colinet River, St. Mary's Bay	Scheduled salmon river, salmon enhancement program (stocking with fry)
Hopeall Brook, Trinity Bay	Fish hatchery/fish-out pond facility
Dildo Pond, Trinity Bay	Proposal for caged fish
Rocky River, St. Mary's Bay	Salmon enhancement program (stocking with fry, construction of fishway)
Broad Cove Brook, Conception Bay	Possible salmon enhancement
Northeast River, Placentia Bay	Fishway

lists some of the rivers of importance to DFO in the study area. Other parts of the study area, e.g. between Carbonear and Northern Bay Sands, are possible areas for salmon enhancement in the future.

5.3.1 - Value of Water Used for Fisheries

The quantity, flow regime and quality of water and of the surrounding space 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 in the inherent value of preserving natural fish and aquatic life. There is no commercial fresh water fishery in the study area, and no commercial sports fishing camps. The public appears to assign a high value to the fresh water fishery, as indicated by support of habitat management policies, interest in enhancement and aquaculture programs, and by intensive use of any river or pond with angling potential.

6 - WITHDRAWAL USE: SUPPLY/DEMAND ANALYSIS BY COMMUNITY

6 - WITHDRAWAL USE: SUPPLY/DEMAND ANALYSIS BY COMMUNITY

This chapter assesses withdrawal uses for each community in the study area and calculates a supply/demand ratio for each. The major withdrawal uses include

- Municipal water supply. About 40 communities in the study area have surface water supply systems; the remainder use groundwater. Total surface water demand for municipal uses is about 30 000 m^3/d.

- Industrial water supply. The industry using the most water in the study area is fish processing. Some fish plants have their own fresh or salt water supply systems; others draw from the municipal water supplies. The two other large single industry users, the phosphorous plant at Long Harbour and the refinery at Come By Chance, have private supplies. Total industrial freshwater demand, with all plants operating near capacity, is about 50 000 m^3/d.

- Rural residential supply. Very small communities, isolated homes and summer cottages obtain their water from local groundwater or surface sources.

- Agriculture. The federal Department of Agriculture reports that there are no irrigation schemes on the Avalon Peninsula. Livestock watering is usually from a private well or surface supply.

Only municipal and industrial uses are considered in this chapter. Present and projected municipal and industrial water demands are described by region for each community. The geographical regions used to group the communities are the same as those used in Chapter 2 to group the drainage basins, i.e. Conception Bay, Placentia Bay, St. Mary's Bay, and Trinity Bay.

Only towns and communities (as designated by the DMA) are included here; information on local service districts and water and sewer service districts is included in Appendix D. Plate 2 shows the locations of the communities in the study area and of the watersheds used for surface water supply.

Detailed descriptions of the water supply systems for each community are provided in the Inventory of Water Supply Systems in Appendix D. The purpose of this chapter is to compare present and projected demands with the available supply for each community. Slightly different approaches were 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 below.

6.1 - Demand and Supply Assumptions

6.1.1 - Demand

Domestic demand was calculated by applying a per capita demand to population. The per capita demand rate chosen was 0.70 m^3/d, based on available data for communities in the study area from the Municipal Water Use Data Base (MUD) (13). This rate was increased to 0.75 m^3/d for the larger communities which serve as regional centers, such as Whitbourne, Placentia, Spaniard's Bay, Harbour Grace, Carbonear and Bay Roberts, to account for the increased commercial, institutional and small industrial demands.

These demand rates from surface systems are quite high, compared with a rate of about 240 $m^3/c/d$ (cubic meters per capita per day) for Holyrood, a community of similar size served by groundwater. Possible explanations for the high rates are leakage or wastage in the distribution systems. Because rates are already high, they were assumed to remain the same to the end of the 25 year planning period. Any increase in demand (e.g. resulting from a higher standard of living) is assumed to be balanced by improvements in the system to reduce losses.

These demand rates were applied to 1986 population figures to estimate present demand, and to projected populations in 25 years (2013) for future demand. The present and projected populations are given in Table 6.1. The population growth rate was calculated from recent trends in each community. These rates range from 7 percent per intercensal period (5 years) for the fastest growing towns to no increase for some small rural communities. A check was then made on the total projected population to ensure that it matched overall provincial estimates. These provincial estimates are slightly high according to officials at the Newfoundland Statistics Agency. The provincial estimates are expected to be reduced when the analysis of the 1986 census data is complete. Slightly high estimates are appropriate for the supply/demand analyses in this study because they are conservative and also will account for local fluctuations.

The estimates of fish plant demand were made by several methods, depending on the information available. For plants with water meters, the meter readings for months when the plants were in full production were used. Similar information was also available for several plants from the Industrial Water Use Data Base (13). For the remaining plants, the estimates were based on fresh water pump capacity, assuming the pump to be operating at full capacity two-thirds of the time, or on maximum daily production, assuming about 25 L/kg (38). In the cases where no information could be obtained, the water use was assumed to be the same as that of another plant of approximately the same size. In one or two cases an estimate of total demand was available, so the fish plant demand was obtained by subtracting domestic demand from total demand. No expansion of fish plant capacity was

TABLE 6.1

POPULATIONS

CCS Communities	POP'N 1986	POP'N 2013
A Arnold's Cove	1117	1243
O Avondale	865	865
G Bay De Verde	756	756
K Bay Roberts	4446	5786
J Bishop's Cove	351	391
C Branch	417	417
N Brigus	856	953
I Bryants Cove	421	548
H Carbonear	5317	7691
A Chance Cove	467	467
A Chapel Arm	699	778
M Clarkes Beach	1189	1547
X Colinet	245	245
O Colliers	791	880
A Come-By-Chance	266	266
O Conception Harbour	886	886
M Cupids	789	878
B Dunville	1833	2040
B Fox Harbour	471	471
B Freshwater (Placentia Bay)	1219	1219
F Hant's Harbour	552	614
I Harbour Grace	3053	3973
I Harbour Grace (South)	367	478
O Hbr.Main/Chap.Cv./Lakeview	1293	1293
E Heart's Desire	405	451
F Heart's Content	620	690
E Heart's Delight/Islington	868	966
B Jerseyside	764	764
A Long Cove/Normans Cove	1107	1232
A Long Hbr./Mt.Arlington Hts.	627	627
F New Perlican	329	329
M North River	214	214
G Old Perlican	761	847
B Placentia	2016	2244
C Point Lance	153	170
H Salmon Cove	778	1013
G Sm.Pt./Br.Cv./Blhd./Ad.Cv.	500	500
M South River	720	937
A Southern Harbour	742	826
J Spaniard's Bay	2190	2850
C St. Bride's	601	669
A Sunnyside	634	706
J Tilton	566	630
I Upper Island Cove	2055	2674
H Victoria	1895	2466
Y Whitbourne	1151	1151

assumed, based on discussions with officials from provincial DOF and the Economic Research and Analysis Branch of the Executive Council. Other industrial demands were obtained from the users (Appendix D). In all cases high water use rates are assumed, even if the demand is only short term, since a high demand for water at the fish plant could coincide with a dry period.

6.1.2 - Supply

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

Run of river systems:

For run of river systems, with little storage other than natural ponds, the yield was assumed to be the regional average daily low flow having a return period of 1:10 years, i.e. 4.9 percent of the mean annual flow (from Table 2.2). This criterion was chosen because it was found to successfully predict deficiencies where they are known to exist.

It should be noted that this criterion is not equivalent to the 1:10 year 1-day low flow in a particular basin; many of the basins used for water supply are much smaller than the rivers used in the regional low flow analysis, and the 1-day low flow from these basins could be lower than the regional average of the gauged rivers.

Regulated systems:

For systems with storage, the storage yield curve presented in Figure 2.11 was used to estimate the reliable yields.

Groundwater Systems:

Over 30 of the communities in the study area use groundwater, usually from private wells serving individual homes. A few community wells (also called council wells) sometimes serve groups of homes.

For this study, a method of assessing the adequacy of the groundwater supply systems was required. Information is not available on yields during dry periods, but some indication of reliability can be obtained from reported performance in 1987. This was a dry year, with return periods for low flows on gauged rivers on the Avalon Peninsula ranging from less than 1 in 5 years to over 1 in 50 years. Groundwater and surface water are reported to be closely linked (21), so surface water return periods in this range are probably reasonable estimates of groundwater drought frequency. In the absence of other information, the reported adequacy of the wells in a community in 1987 is used here as an indicator of the adequacy of the groundwater source.

Tables summarizing the community supply/demand analysis for all regions are given in Section 6.5. Detailed descriptions of the water supply systems are given in Appendix D of this report. Locations of communities are shown on Plate 2.

6.2 - Conception Bay Region

The towns and communities in the Conception Bay region are listed below in order of population.

Communities	Population (1986)
Carbonear	5337
Bay Roberts	4446
Harbour Grace	3053
Spaniard's Bay	2190
Upper Island Cove	2055
Victoria	1895
Harbour Main/Chapel Cove/ Lakeview	1293
Clarke's Beach	1189
Conception Harbour	886
Avondale	865
Brigus	856
Colliers	791
Cupids	789
Salmon Cove	778
Bay de Verde	756
South River	720
Tilton	566
Small Point/Broad Cove/ Black Head/Adams Cove	500
Bryants Cove	421
Harbour Grace South	367
Bishop's Cove	351
North River	214

The present and future water supply situation for each of these communities is given in the following sections.

6.2.1 - Carbonear

The Town of Carbonear is served by a surface water system from Little Island Pond. Present and future demand and reliable yield are estimated as follows.

Year	Pop'n	Demand: Municipal (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	5337	4000	5000	9000	4000(1)	0.44
2013	7691	5770	5000	10770	4000	0.37

(1) Regional average 1:10 year daily low flow.

The supply/demand ratios of 0.44 and 0.37 for the present and future demands respectively indicate that the system cannot meet either present or future demands during dry periods. Shortages will occur, and conservation and/or use of alternative sources will be required.

The Little Island Pond watershed is relatively large, and should be capable of supplying the demand without expansion into neighboring watersheds if additional storage is provided. Some ways of improving storage in the Little Island Pond watershed are provided in the inventory of water supply systems in Appendix D.

The watershed is relatively large, and should be capable of supplying the demand without expansion into neighboring watersheds.

6.2.2 - Bay Roberts

The Town of Bay Roberts is served by a surface water supply system from Rocky Pond (also known as Fall Pond). The town does not have sufficient water to meet its present and future estimated requirements during dry periods, as shown in the table below.

Year	Pop'n	Demand: Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	4446	3330	40	3370	790(1)	0.23
2013	5786	4340	40	4380	790	0.18

(1) Regional average 1:10 year low flow.

The situation is similar to that at Carbonear; the watershed is large enough to supply the demand if more storage were available. During the dry period in 1987, for example, a channel was excavated to an upstream pond, thus augmenting flow. This improvement as well as some other ways to increase storage are described in Appendix D.

6.2.3 - Harbour Grace

The source of water for the Town of Harbour Grace is Bannerman Lake. The town does not have sufficient water to meet its present and future estimated demand, as shown in the table below.

Year	Pop'n	Demand: Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	3053	2300	4700(1)	7000	4430(2)	0.63
2013	3973	2980	4700	7680	4430	0.58

(1) No information was available on fish plant water use. However, the town manager provided an estimate for total water use, both domestic and industrial. Fish plant demand was therefore estimated by subtracting domestic demand from the reported total.

(2) Regional average 1:10 year daily low flow.

Some methods for improving the S/D ratio are given in Appendix D. Supply could be increased by improving storage and/or demand could be reduced by cutting back fish plant consumption of freshwater in dry periods.

6.2.4 - Spaniards Bay/Upper Island Cove/Tilton

Spaniards Bay, Upper Island Cove and Tilton share a water supply from Spider Pond. Many homes, especially in Tilton and Upper Island Cove, have private wells. There is ample water from the system to supply all the population. A connection to the Bay Roberts (Rocky Pond) system is available to Spaniard's Bay as a back-up.

Year	Pop'n	Demand Domestic (m^3/d)	Demand Ind. (m^3/d)	Demand Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	4811	3610	-	3610	16700	4.6
2013	6154	4620	-	4620	16700	3.6

6.2.5 - Victoria

The Town of Victoria and some residences in Salmon Cove share a water supply from Spout Brook in Rocky Pond watershed. This watershed is controlled by Newfoundland Light and Power. In addition to the surface water supply there is a community well, plus several private wells. The supply is ample for all present and future demands, as shown in the table below.

Year	Pop'n	Demand Domestic (m^3/d)	Demand Ind. (m^3/d)	Demand Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	1895	1330	-	1330	8140	6.2
2013	2466	1730	-	1730	8140	4.7

6.2.6 - Harbour Main/Chapel Cove/Lakeview

The Town of Harbour Main/Chapel Cove/Lakeview is presently developing Maloney's River as a surface water source to replace council and private wells. The new supply should be adequate, as shown in the table below.

Year	Pop'n	Demand Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986) 2013)	1293	910	30	940	3390	3.6

6.2.7 - Clarke's Beach

The Town of Clarke's Beach is served by groundwater from 11 council wells and about 300 private wells. According to the inventory in Appendix D, the yield from these is not adequate to meet future expected population growth. A surface source, perhaps regional, has been suggested as an alternative. Present and future population and demand estimates are given below.

Year	Population	Demand (1) (m^3/d)
1986	1189	830
2013	1547	1080

(1) Expected demand from a surface supply. Groundwater demand likely to be lower.

6.2.8 - Conception Harbour

The Town of Conception Harbour has a population of 886. Domestic water is supplied from individual wells and from one community well. With no increase in population expected and no industrial growth anticipated, present sources should continue to be able to meet the demand.

6.2.9 - Avondale

Residents of the Town of Avondale obtain their water from one community well and about 250 private wells. According to the inventory in Appendix D, the yield from about half the wells is not sufficient to meet demand; additional wells or a surface source are needed. The table below shows the demand which would likely be placed on a surface source if one were to be developed.

Year	Population	Demand (m^3/d)
1986) 2013)	865	610

6.2.10 - Brigus

The Town of Brigus is served by a surface water supply system from Brigus Big Pond. The system is gradually being expanded, and is expected to serve Brigus, South River and Cupids, including the fish plant in Cupids, which presently has its own water supply. Although fish plant demands are variable, there should be sufficient water to meet all demands, as shown by the following table.

Year	Pop'n	Demand Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	856	600	250	850(1)	4600	5.4
2013	2768	1940	2250	4190(2)	4600	1.1

(1) Based on total present population of Brigus and Brigus fish plants.

(2) Based on total projected population of Brigus, Cupids and South River, and fish plants in Brigus and Cupids.

6.2.11 - Colliers

Residents of the Town of Colliers obtain their water from individual wells and from two community wells. The yield from these wells is not adequate to meet the demand in dry years (see Appendix D). The present and projected population and associated demand from a surface source are tabulated below.

Year	Population	Demand (m^3/d)
1986	791	550
2013	880	620

6.2.12 - Cupids

The population of Cupids is presently served by groundwater. Plans for the future are to connect with the Brigus system, which has ample water for both communities (Section 6.2.10).

The Cupids fish plant has both fresh and salt water systems. The fresh water system draws its water from Lower Cupids Pond. The supply/demand ratio for the fish plant is estimated to be about 1.6, based on a yield of 3100 m^3/d and a demand of 2000 m^3/d.

6.2.13 - Salmon Cove

Most of the Town of Salmon Cove is supplied by groundwater (see Appendix D). About 18 homes are connected to the Victoria system. A study has indicated that it is technically feasible to connect to the Victoria water supply system. If all residents of Victoria and Salmon Cove are supplied by the NLP surface system, the demand will be 2270 m^3/d in the year 2013, for an S/D ratio of 3.6. The supply is ample, but it should be noted that the watershed is controlled by Newfoundland Light and Power and the water is used for hydroelectric power production.

6.2.14 - Bay de Verde

Most of the Town of Bay de Verde is served by the water supply system from Little Island Pond. About 55 homes are served by private wells. The two fish plants are served by the community supply.

The estimates made for this report indicates that the supply is not quite adequate to meet all demands in a dry period. These estimates assume that the fish plant is in full production, however. Since fish plant use is rarely as high as assumed here, no shortages have been reported.

Year	Pop'n	Domestic m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986) 2013)	756	530	1700	2230	1000	0.45

6.2.15 - South River

South River is presently served by groundwater (see Appendix D). Present plans call for connection to the Brigus system; there is ample water in the Brigus system to serve South River (see Section 6.2.10).

6.2.16 - Small Point/Broad Cove/Black Head/Adams Cove

The Town of Small Point/Broad Cove/Black Head/Adams Cove is presently served by 12 council wells and about 200 private wells. Appendix D reports that some wells do not have adequate yield to meet demand in dry periods; a new well is presently under construction. The town has a population of 500 and no increase in population is expected. Since the system is presently being upgraded and no population growth is expected the supply should be adequate for the remainder of the planning period.

6.2.17 - Bryant's Cove

The Town of Bryant's Cove obtains its water from two council wells and about 60 private wells. The majority of wells ran dry in 1987, indicating that the yield is not sufficient to meet demand. The 1986 population of 421 is expected to increase to about 548 by the end of the planning period (2013), so additional sources are required to meet both present and future demand.

6.2.18 - Harbour Grace South

The residents of the Community of Harbour Grace South obtain their water from private wells. About 20 percent of these do not have sufficient yield to meet the domestic demand (Appendix D). The population is expected to increase, as shown in the table below, and additional sources of water will be required to meet both present and future demand. Drilled wells are the most likely source.

Year	Population	Demand (m^3/d)
1986	367	260
2013	478	330

6.2.19 - Bishop's Cove

Residents of the Community of Bishop's Cove obtain their water from groundwater sources, one community well and about 65 private wells. About 20 percent of these failed in 1987, indicating that the present supply is inadequate. The most likely alternative is connection to the Spaniards Bay/Upper Island Cove/Tilton system (a surface water source). This system has ample water to meet the additional demand from Bishop's Cove.

The present (1986) and projected populations and associated demand are tabulated below.

Year	Population	Demand (m^3/d)
1986	351	250
2013	391	270

6.2.20 - <u>North River</u>

Residents of the Community of North River obtain their water from private wells. Nearly one-third of these are inadequate in quantity and/or quality. A possible alternative suggested in Appendix D is joint development of a surface water system with Clarke's Beach, or upgrading of the Bay Roberts surface water system to supply all three communities.

The population and associated demands are tabulated below. No increase in population is expected.

Year	Population	Demand (m^3/d)
1986) 2013)	214	150

6.3 - Placentia Bay Region

The towns and communities in the Placentia Bay region are listed below in order of population.

Communities	1986 Population
Placentia	2016
Dunville	1833
Freshwater	1219
Arnold's Cove	1117
Jerseyside	764
Southern Harbour	742
Long Hbr/Mount Arlington Hts	627
St. Bride's	601
Fox Harbour	471
Come By Chance	266

The present and future water supply/demand situation for each of these communities is given in the following sections.

6.3.1 - Placentia/Freshwater/Jerseyside

Placentia, Freshwater and Jerseyside share a surface water supply system with the naval base at Argentia. The community system draws from the lowest pond in the system, Larkins Pond. The naval base draws from the next pond upstream, Clarke's Pond. There is ample water to supply all the present population of the communities and present naval base requirements, as the following table shows. It should also be adequate for the demand expected by a possible offshore construction yard. If base requirements increase to their maximum historic levels, however, and the population increases, the supply will not quite meet the demand. However, a back-up system exists at Argentia Pond which can be used in the event of increased demand from the naval base. The combined systems will therefore be adequate to the end of the planning period.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	3999(1)	3000	2050(2)	5050	9580	1.9
2013	4227(1)	3170	7000(3)	10170	9580	0.94
					12400(4)	1.2

(1) Placentia, Freshwater and Jerseyside.

(2) Present demand from naval base plus north side from Appendix D plus fish plant at Jerseyside.

(3) Assumes base requirements increase to the maximum historic levels.

(4) Including Argentia Pond back-up.

6.3.2 - Dunville

Dunville is served by a surface water system from Wyses Pond. The supply/demand analysis tabulated below indicates that the system cannot provide sufficient water to meet present or future demands. In 1987, a dry year, the town had to institute conservation measures.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	1833	1280	-	1280	1200	0.94
2013	2040	1430	-	1430	1200	0.84

Water conservation measures or an improved connection to an upstream pond as suggested in Appendix D of this report could improve the supply/demand ratio.

6.3.3 - Arnold's Cove

The Town of Arnold's Cove is supplied by a system which is partly run of river and partly regulated. It is described in detail in

Appendix D; briefly, it consists of an intake behind a small dam on Eastern Pond Brook, with a storage dam at Steve's Pond, about 3.8 km upstream. A valve at the outlet from Steve's Pond is manually opened when additional water is required. At present, shortages are reported, although storage/yield calculations indicate that Steve's Pond can provide enough regulation to prevent shortages if the outflow could be optimally controlled. The present shortages most likely occur because the outlet valve cannot be optimally adjusted, and because losses occur in the open channel between the outlet from Steve's Pond and the intake on Eastern Pond Brook.

The table below summarizes the estimates of the present and future supply/demand ratios for the two cases of partial control of Steve's Pond (as at present) and complete control.

Year	Pop'n	Demand Domestic (m^3/d)	Demand Ind. (m^3/d)	Demand Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
Present						
1986	1117	780	850	1630	1200(1)	0.74
2013	1243	870	850	1720	1200	0.70
With complete control						
1986	1117	780	850	1630	1870	1.2
2013	1243	870	850	1720	1870	1.1

(1) The monthly low flow with a return period of 1:10 years. The assumption is that the present manual operation provides the equivalent of 1 month's storage in a dry year.

Some possible improvements to the present system are outlined in Appendix D. Even with improved control, there is not enough water to supply new industrial demands. Any future expansions or proposed industries (e.g. construction yard to support offshore oil developments) would have to develop another water supply source.

6.3.4 - Southern Harbour

The Town of Southern Harbour obtains its water from Brigade Brook. Storage is provided upstream in Brigade Pond; the intake is located downstream behind a small dam across the brook. The system supplies both the town and the fish plant. When the fish plant is operating at full capacity, serious shortages will occur in a dry year. No deficiencies have been reported, however, because the plant has been shut down most of the time in recent years, and domestic demand is relatively low.

Year	Pop'n	Demand Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	742	520	2200(1)	2720	1200	0.44
2013	826	580	2200	2780	1200	0.43

(1) Estimated by subtracting domestic demand from reported total demand.

Some suggested measures to improve the S/D ratio are outlined in Appendix D.

6.3.5 - Long Harbour/Mount Arlington Heights

Shingle Pond is the water supply source for the Community of Long Harbour/Mount Arlington Heights. This system has ample water to serve the community's needs, as shown in the following table. No population growth is expected.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986) 2013)	627	440	-	440	1450	3.3

6.3.6 - Long Harbour Phosphorus Plant

A series of ponds on Rattling Brook supply the water to the phosphorus plant at Long Harbour. The principal storage pond is Rattling Brook Pond, with some additional storage provided by a smaller pond referred to as Lake A in Appendix D. The table below shows that there is sufficient water to meet plant requirements.

	Est. Yield			
Demand (m^3/d)	Lake A (m^3/d)	R. Brk Pd (m^3/d)	Total (m^3/d)	S/D Ratio
23 000	6370	69 200	75 570	3.3

6.3.7 - St Bride's

The residents of the Community of St. Bride's and the fish plant obtain their water from different sources. The community obtains its water from two watersheds, Murphy's Brook and Conway Brook. These two sources provide sufficient water to meet community demands, as the table below shows.

Year	Pop'n	Demand (m^3/d)	Murphy's Brook (m^3/d)	Conway Brook (m^3/d)	Est. Total Yield (m^3/d)	S/D Ratio
1986	601	420	130	500	630	1.5
2013	669	470	130	500	630	1.3

Although the quantity of water is sufficient, it should be noted the quality of water is poor in St. Bride's. This problem is addressed in Appendix D.

The fish plant at St. Bride's obtains its water from a run of river supply on St. Bride's River. The watershed is relatively large (24 km^2), and even in a dry year should provide sufficient water to meet the fish plant's needs, as shown in the table below.

Demand (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
2000	3220	1.6

6.3.8 - Fox Harbour

Residents of the Community of Fox Harbour obtain their water from private wells. Most of the wells are reported to provide an adequate supply (Appendix D). No increase in the present population of 471 is expected, and groundwater sources should continue to be able to meet the demand.

6.3.9 - Come By Chance

Residents of the Town of Come By Chance obtain their water from private wells. Many of the wells are inadequate, providing insufficient water, often of poor quality. According to Appendix D, the most likely source of additional water is dug or drilled wells, since there are no nearby suitable surface sources. The population is not expected to increase from the 1986 level of 266 despite the possibility of increased industrial activity in the area. According to planners in the Department of Municipal Affairs, one of the main limits to population growth is in fact inadequate water and sewer services. Any growth in population is expected to occur in other communities in preference to Come By Chance.

6.3.10 - Come By Chance Oil Refinery

The oil refinery near Come By Chance has its own surface water supply from Barrasway Brook. The watershed is fairly small (about 8 km^2), but the reliable yield is high (about 2200 m^3/d) because of the large proportion of storage. No information is available on refinery use, although the supply is reported to be adequate. An evaluation of the capability of the system and of the potential to supply other uses requires more detailed investigation because such short term demands as firefighting can be very important. A study is being carried out for the DOD to assess the suitability of the site for other uses, in particular for a construction yard for offshore platforms. Consideration of the adequacy of the water supply system is part of the terms of reference for this study.

6.4 - St. Mary's Bay Region

The communities in the St. Mary's Bay Region, in order of population, are listed below.

Communities	1986 Population
Whitbourne	1151
Branch	417
Colinet	245
Point Lance	153

The supply/demand situation in each of these communities is described in the following sections.

6.4.1 - Whitbourne

The Town of Whitbourne obtains its water from Hodge's River, an upstream tributary of the Rocky River System. It is a run of river system on a large watershed. There is no major industrial demand, and the supply is ample for all present and anticipated future requirements, as shown in the table below.

Year	Pop'n	Demand			Est. Yield (m^3/d)	S/D Ratio
		Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)		
1986) 2013)	1151	860	-	860	7880	9.2

6.4.2 - Branch

The Community of Branch is in the process of developing a surface water supply from Valley's Pond to supply residents and the small fish plant. The yield from this system is adequate to meet the demand as shown in the following table.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986) 2013)	417	290	100	390	820	2.1

6.4.3 - Colinet

The residents of Colinet obtain their water from private wells. The supply is believed to be adequate, and with no expected increase in the population above the 1986 level of 245, groundwater sources should be able to meet demand.

6.4.4 - Point Lance

The Community of Point Lance obtains its water from an unnamed pond; the height of the dam has recently been increased, providing additional storage. The estimated supply is not quite adequate to meet demand, assuming all the community is served, as shown in the table below.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	153	110	-	110	100	0.91
2013	170	120	-	120	100	0.83

Despite the somewhat unfavorable S/D ratio, shortages are not likely to be serious. With modest conservation measures, the demand even at the end of the planning period can be met. The present demand rate in Point Lance is probably lower than assumed here, given that the community did not experience shortages in 1987. In that year yield was probably of the order of 50 m^3/d because the dam had not yet been raised. The consumption rate may therefore have been as low as 300 to 350 L/c/d. A reduction in demand from 700 L/d to just under 600 L/day, for example, results in a S/D ratio greater than one.

6.5 - Trinity Bay Region

The communities in the Trinity Bay Region are listed below in order of population.

Communities	1986 Population
Long Cove/Norman's Cove	1107
Heart's Delight/Islington	868
Old Perlican	761
Winterton	747
Chapel Arm	699
Sunnyside	634
Heart's Content	620
Hant's Harbour	552
Chance Cove	467
Heart's Desire	405
Whiteway	329
New Perlican	329

The water supply/demand situation in each of these communities is described in the following sections.

6.5.1 - Long Cove/Norman's Cove

The Town of Norman's Cove/Long Cove is served by groundwater from ten community wells and a few private wells. The supply appears to be just adequate at the present time, although one well is reported to fail occasionally (Appendix D). A study has identified Norman's Cove River as a suitable surface source. Present and future demands from a surface source are estimated as follows.

Year	Population	Demand (m^3/d)
1986	1107	770
2013	1232	860

6.5.2 - Heart's Delight/Islington

The town of Heart's Delight/Islington obtains its water from Long Pond. The supply is ample and can serve all the present and projected population as shown in the table below.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	868	610	-	610	7580	12
2013	966	680	-	680	7580	11

6.5.3 - Old Perlican

The town of Old Perlican obtains its water from Big Bell Pond. The system was developed for the use of the town and two fish plants. The supply is just adequate for present or future demands as shown in the table below.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	761	530	2100	2630	2680	1.0
2013	847	590	2100	2690	2680	1.0

The situation is probably better than the low S/D ratio indicates, because the water supply system for Old Perlican has a large amount of storage. The maximum short term demand as used above is therefore not as important as a longer term average. High water use rates are assumed for all fish plants in the study, even if the demand is only short term, because a high demand for water in the plant could coincide with a dry period. This assumption is conservative for well regulated systems such as Old Perlican.

6.5.4 - Winterton

The Town of Winterton obtains its water from Western Brook. There is not quite enough water in this system to supply the town and the fish plant, as the table below shows.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986) 2013)	747	520	1000	1520	1350(1)	0.89

(1) Regional average daily low flow having a return period of 1:10 years.

The fish plant has both fresh and salt water lines, and in dry years (such as 1987), fresh water consumption can be curtailed, to bring the S/D ratio above 1.0. Alternative measures to improve the S/D ratio such as increasing storage are outlined in Appendix D.

6.5.5 - Chapel Arm

Residents of the Town of Chapel Arm obtain their water from private wells. The supply is inadequate; in times of shortage residents use local surface sources (brooks). The present and anticipated demands from an all-surface supply would be as follows.

Year	Population	Demand (m^3/d)
1986	699	490
2013	778	540

6.5.6 - Sunnyside

Most of the residents of Sunnyside obtain their water from private wells. Many of these wells cannot provide an adequate yield in dry years.

A surface water system developed for a proposed subdivision serves about 6 buildings. In it present state as a run of river system it has the capacity to serve 610 people, almost the entire present population. With storage, the watershed could likely provide sufficient water to meet the projected future demand. These demands are tabulated below.

Year	Population	Demand (m^3/d)
1986	634	440
2013	706	490

Since the community is spread out, distribution costs are likely to be high, and a more economical alternative might be to supply part of the community from the surface system and the remainder from community wells, as suggested in Appendix D.

6.5.7 - Heart's Content

The Town of Heart's Content obtains its water from Southern Cove Pond. The watershed was developed for hydroelectric power generation by NLP. Because of the large size of the watershed and the high degree of regulation for hydroelectric operation, there is ample water for the town and fish plant, as the following table shows.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	620	430	-	430	14 241	33
2013	690	480	-	480	14 241	30

6.5.8 - <u>Hant's Harbour</u>

The Town of Hant's Harbour obtains its water from Eastern Pond. There is sufficient water from this source for both the town and the fish plant, as the table below shows.

Some problems with transmission have arisen because of the particular configuration of the intake and pipe. These are discussed in Appendix D.

Year	Pop'n	Domestic (m^3/d)	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	552	390	1700	2090	3270	1.6
2013	614	430	1700	2130	3270	1.5

6.5.9 - <u>Chance Cove</u>

Residents of Chance Cove obtain their water from four community wells and about 125 private wells. Both quality and quantity are generally considered adequate, although one of the community wells failed in 1987. The fish plant has its own well.

With no increase expected over the present of 467 (1986), the water supply can be expected to remain adequate.

6.5.10 - <u>Heart's Desire</u>

The Town of Heart's Desire is served by a fresh water system from Terrance Pond. A small fish plant also obtains its water from the municipal system. The town has ample water to meet both domestic and fish plant requirements, as shown in the table below.

Year	Pop'n	Demand Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	405	280	100	380	7200	19
2013	451	320	100	420	7200	17

6.5.11 - Whiteway

The Community of Whiteway is supplied by two separate systems. The southern part of Whiteway is supplied by a surface system from Jimmy Rowe Pond. The southern part of whiteway is presently supplied by groundwater, but a surface source, Long Pond, is being developed. About 200 people live in Whiteway South, and about 130 in Whiteway North. Both these systems have adequate water to meet the demand, as the tables below show. Whiteway South in particular has an abundant supply.

Whiteway North

Year	Pop'n	Demand Domestic (m^3/d)	Ind. (m^3/d)	Total (m^3/d)	Est.(1) Yield (m^3/d)	S/D Ratio
1986	200	140	-	140	940	6.7
2013	222	160	-	160	940	5.9

Whiteway South

Year	Pop'n (m^3/d)	Demand Domestic	Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986	130	90	-	90	6140	68
2013	144	100	-	100	6140	61

(1) Regional average daily low flow having a return period of 1 in 10 years.

6.5.12 - New Perlican

The source of water for the Town of New Perlican is Mount Misery Pond. The supply is adequate to meet the demand, as the table below shows.

Year	Pop'n (m^3/d)	Domestic	Demand Ind. (m^3/d)	Total (m^3/d)	Est. Yield (m^3/d)	S/D Ratio
1986) 2013)	329	230	-	230	300	1.3

6.6 - Summary of Supply/Demand Analysis

The total daily requirement for surface water for municipal and industrial uses in the study area is about 80 000 m^3, as shown in the following table.

	Daily (m^3)
Municipal/Domestic	30 000
Industrial	
- Fish Plants(1)	23 000
- Phosphorus Plant	23 000
- Other (including refinery)	4 000
Total	80 000

(1) Operating at or near capacity.

This daily requirement is equivalent to an annual total of about 30 Mm^3. (Actual annual use would be less because high daily rates have been used for industrial consumption.) This may be compared with an average annual runoff over the study area of over 5500 Mm^3. The maximum yield which could reasonably be developed is considerably less than this; taking into account other basin uses it is probably of the order of 500 000 m^3/d (based on the assumptions described in Chapter 7).

Tables 6.2 to 6.5 summarize the supply/demand analysis by region. The results of the analysis show that all communities with surface systems have an adequate supply of water or could have with improvements to the existing system. Few have supply/demand ratios in excess of 2, however, indicating that there is not much surplus available.

Table 6.6 groups the communities in the study area according to the adequacy of their existing source. The groupings are based on quantity, but a note is provided to indicate quality problems. The communities with S/D ratios less than one have the greatest potential for shortages. They have been placed into one of two groups, depending on whether structural changes are required or whether the shortages can be alleviated by managing demand. Group 1 has the highest priority because structural improvements such as new dams are required. The most likely solution and a very approximate cost taken from Appendix D are given for the Group 1 systems. The addition of storage to the Bay Roberts, Carbonear and Harbour Grace systems would alleviate shortages in those three communities.

Group 2 is assigned a slightly lower priority, because in those communities the demand can be more easily managed during dry periods to avoid serious shortages.

In Southern Harbour, Bay de Verde, Arnold's Cove and Winterton, the fish plant demands dominate the analysis. This report has conservatively made high estimates of fish plant demand, and in these communities, freshwater demand may in fact be lower than assumed or the periods of high consumption may not coincide with dry periods. Even if freshwater use is very high, the S/D ratio can be improved by such measures as increased use of salt water or conservation by the fish plants during dry periods. The best structural solution for Arnold's Cove appears to be better control

TABLE 6.2

CONCEPTION BAY REGION : SUMMARY OF SUPPLY/DEMAND ANALYSIS

Community	Pop'n	DEMAND (m3/d) Dmstc	Indust	Total	Est. Yield (m3/d)	Supply/ Demand	
PRESENT							
Bay De Verde	756	530	1700	2230	1000	0.45	(1)
Bay Roberts	4446	3330	40	3370	790	0.23	(1)
Brigus	856	600	250	850	4600	5.41	
Carbonear	5337	4000	5000	9000	4000	0.44	(1)
Cupids Fishplant	0	0	2000	2000	3100	1.55	
Harbour Grace	3053	2300	4700	7000	4430	0.63	(1)
Hbr Main/Ch Cv/Lkv	1293	910	30	940	3390	3.61	
Sp Bay/Up I Cv/Tltn	4811	3610	0	3610	16700	4.63	
Victoria	1895	1330	0	1330	8140	6.12	
TOTAL	22447	16610	13720	30330	46150	1.52	
FUTURE							
Bay De Verde	756	530	1700	2230	1000	0.45	
Bay Roberts	5786	4340	40	4380	790	0.18	(1)
Brigus/Cupids/Sth Rr	2768	1940	2250	4190	4600	1.10	
Carbonear	7691	5770	5000	10770	4000	0.37	(1)
Harbour Grace	3973	2980	4700	7680	4430	0.58	(1)
Hbr Main/Ch Cv/Lkv	1293	910	30	940	3390	3.61	
Sp Bay/Up I Cv/Tltn	6154	4620	0	4620	16700	3.61	
Victoria	2466	1730	0	1730	8140	4.71	
TOTAL	30887	22820	13720	36540	43050	1.18	

(1) - Supply appears inadequate; detailed investigation required.

TABLE 6.3

PLACENTIA BAY REGION : SUMMARY OF SUPPLY/DEMAND ANALYSIS

Community	Pop'n 1986	DEMAND (m3/d) Dmstc	Indust.	Total	Est. Yield (m3/d)	Supply/ Demand	
PRESENT							
Arg/Plac/Frwtr/Jysd	3999	3000	2050	5050	9580	1.90	
Arnold's Cove							
with part. ctrl.	1117	780	850	1630	1200	0.74	(1)
with full ctrl.	1117	780	850	1630	1870	1.15	
Dunville	1833	1280	0	1280	1200	0.94	(1)
Long Hr/Mt Arl Hts	627	440	0	440	1450	3.30	
Long Hr. Phsph. Plt.	0	0	23000	23000	75570	3.29	
Southern Harbour	742	520	2200	2720	1200	0.44	(1)
St. Bride's	601	420	0	420	630	1.50	
St. Bride's Fshplnt.	0	0	2000	2000	3220	1.61	
Little Hbr East	175	120	0	120	230	1.92	
TOTAL (2)	9094	6560	30100	36660	94950	2.59	
FUTURE							
Arg/Plac/Frwtr/Jysd							
w/o Arg. Pd.	4227	3170	7000	10170	9580	0.94	(1)
with Arg. Pd.	4227	3170	7000	10170	12400	1.22	
Arnold's Cove							
with part. ctrl.	1243	870	850	1720	1200	0.70	(1)
with full ctrl.	1243	870	850	1720	1870	1.09	
Dunville	2040	1430	0	1430	1200	0.84	(1)
Long Hr/Mt Arl Hts	627	440	0	440	1450	3.30	
Long Hr. Phsph. Plt.	0	0	23000	23000	75570	3.29	
Southern Harbour	826	580	2200	2780	1200	0.43	(1)
St. Bride's	669	470	0	470	630	1.34	
St. Bride's Fshplnt.	0	0	2000	2000	3220	1.61	
Little Hbr East	175	120	0	120	230	1.92	
TOTAL (3)	9807	7080	35050	42130	97770	2.3	

(1) - Supply appears inadequate; detailed investigation required.
(2) - Assumes full control Steve's Pond for Arnold's Cove.
(3) - Assumes Argentia Pond is available for Placentia.

TABLE 6.4

ST. MARY'S BAY REGION : SUMMARY OF SUPPLY/DEMAND ANALYSIS

Community	Pop'n	DEMAND (m3/d) Dmstc	Indust.	Total	Est. Yield (m3/d)	Supply/ Demand	
PRESENT							
Branch	417	290	100	390	820	2.10	
Point Lance	153	110	0	110	100	0.91	(1)
Whitbourne	1151	860	0	860	7880	9.16	
TOTAL	1721	1260	100	1360	8800	6.47	
FUTURE							
Branch	417	290	100	390	820	2.10	
Point Lance	170	120	0	120	100	0.83	(1)
Whitbourne	1151	860	0	860	7880	9.16	
TOTAL	1738	1270	100	1370	8800	6.42	

(1) - Supply appears inadequate; detailed investigation required.

TABLE 6.5

TRINITY BAY REGION : SUMMARY OF SUPPLY/DEMAND ANALYSIS

Community	Pop'n 1986	DEMAND (m3/d) Dmstc	Indust.	Total	Est. Yield (m3/d)	Supply/ Demand	
PRESENT							
Hants Hr	552	390	1700	2090	3270	1.56	
Heart's Content	620	430	0	430	14241	33	
Heart's Desire	405	280	100	380	7200	18.95	
Ht's Delight/Isl'ton	868	610	0	610	7580	12.43	
Ld Cv/Sb Cv Fsh Plt			400	400	6430	16.07	
New Hr. Fsh. Plnt.			2000	2000	6816	3.41	
New Perlican	329	230	0	230	300	1.30	
Old Perlican	761	530	2100	2630	2680	1.02	
South Dildo Fsh Plnt			1000	1000	22641	22.64	
Whiteway (north)	200	140	0	140	940	6.71	
Whiteway (south)	129	90	0	90	6140	68	
Winterton	747	520	1000	1520	1350	0.89	(1)
TOTAL	4611	3221	8300	11521	79588	6.91	
FUTURE							
Hants Hr	614	430	1700	2130	3270	1.54	
Heart's Content	690	480	0	480	14241	30	
Heart's Desire	451	320	100	420	7200	17.14	
Ht's Delight/Isl'ton	966	680	0	680	7580	11.15	
Ld Cv/Sb Cv Fsh Plt			400	400	6430	16.08	
New Hr. Fsh. Plnt.			2000	2000	6816	3.41	
New Perlican	329	230	0	230	300	1.30	
Old Perlican	847	590	2100	2690	2680	1.00	
South Dildo Fsh Plnt			1000	1000	22641	22.64	
Sunnyside	706	494	0	494	429	0.87	(1)
Whiteway (north)	222	160	0	160	940	5.88	
Whiteway (south)	144	100	0	100	6140	61	
Winterton	747	520	1000	1520	1350	0.89	(1)
TOTAL	5716	4004	8300	12304	80017	6.50	

(1) - Supply appears inadequate; detailed investigation required.

TABLE 6.6

GROUPING OF COMMUNITIES BY ADEQUACY OF SUPPLY

GROUP 1: S/D<1, improvements to supply system required.

Community	Projected S/D Ratio	Quality	Most likely Improvement	Approx Cost ($)
Bay Roberts	0.18	-	Storage/control	$ 70 00
Carbonear	0.37	-	Storage	$ 80 000
Harbour Grace	0.58	*	Storage	$ 25 000

GROUP 2: S/D<1, can manage in dry periods by reducing demand

Community	Projected S/D Ratio	Quality	Most likely Improvement
Southern Hbr.	0.43	-	Fish plant red'n
Bay de Verde		-	Fish plant red'n
Arnold's Cove	0.70	*	Fish plant red'n
Point Lance	0.83	*	Domestic red'n
Dunville	0.84	*	Domestic red'n
Winterton	0.89	*	Fish plant red'n

GROUP 3: 1<S/D<4 adequate supplies

Community	Projected S/D Ratio	Quality
Old Perlican	1.0	-
Brigus	1.1	*
Plac/Fw/J'side	1.2	*
New Perlican	1.3	*
St. Brides	1.3	*
Hant's Harbour	1.5	-
Little Hbr. E.	1.9	-
Branch	2.1	-
Long Hbr/ Mt. A. Hts	3.3	*
Hrb Main/ C.Cv/Lkvw	3.6	*
Sp. Bay/U.I.Cv/ Tltn	3.6	-

TABLE 6.6 (Continued)

GROUP 4: S/D > 4 abundant supplies

Community	Projected S/D Ratio	Quality
Victoria	4.7	-
Whiteway	5.9	-
Whitbourne	9.2	*
Hts Delight/ Isl	11	*
Heart's Desire	17	-
Heart's Content	30	-
Whiteway	61	

* Water quality problems have been reported (see Appendix D).

of the existing storage, but a more detailed investigation of the economics of the various options is required to choose the optimal improvement.

At Dunville and Point Lance, the S/D ratios are not much below 1.0, and with modest conservation measures in dry periods the supplies should be adequate until such time as improvements have been made to the communities in Group 1.

The third group consists of those communities with adequate water supplies but no large surpluses. Although water quantity is sufficient, water quality should be improved in some of these communities.

In the fourth and last group are those communities with large S/D ratios, indicating substantial surpluses. For two of these communities, Victoria and Heart's Content, the watersheds are controlled by NLP and the large surplus is presently being used to provide hydroelectric energy. Any alternative withdrawal of this water would have to take into account the value of the lost energy. Whitbourne is another community with a large surplus which may not all be available for water supply development because of a competing use. In this case the alternative use is the freshwater fishery; Whitbourne's water is drawn from a tributary of Rocky River, an important salmon river.

The remaining communities in this group are all in the Trinity Bay region. They have abundant supplies of water which could meet the requirements of expanded economic activity.

In communities served by groundwater, the supply appears to be less reliable. Some wells failed in most communities during the summer of 1987, and consequently were not considered adequate. Inspections of over 1000 wells by the Groundwater Branch of DOEL indicate that the problem is lack of water, not improper construction, so upgrading of existing is not likely to solve the problem of inadequate supply. Construction of additional wells or development of surface sources are the only alternatives.

The communities served by groundwater are listed in Table 6.7. Those with inadequate quantity or quality are indicated, and present and future estimates of demand are provided.

TABLE 6.7

GROUNDWATER SUPPLIES

Community	PRESENT 1986 Pop'n	PRESENT Demand (1)	FUTURE 2013 Pop'n	FUTURE Demand (1)	ADEQUACY Quantity	ADEQUACY Quality
CONCEPTION BAY					* - problems	
Avondale	865	355	865	355	*	-
Bishop's Cove	351	144	391	160	*	-
Bryant's Cove	421	173	548	225	*	-
Clarke's Beach	1189	487	1547	634	*	*
Colliers	791	324	880	361	*	-
Conception Harbour	886	363	886	363	*	-
Cupids	789	323	with Brigus		*	*
Hrbr. Grace South	471	193	478	196	*	-
North River	214	88	214	88	*	*
Salmon Cove	790	324	778	319	-	*
Small Pt/Broad Cv./ Blackhead/Adam's Cv.	500	205	500	205	*	*
South River	720	295	with Brigus		-	-
PLACENTIA BAY						
Come By Chance	266	109	266	109	*	*
Fox Harbour	471	193	471	193	-	-
ST. MARY'S BAY						
Colinet	245	100	245	100	-	-
TRINITY BAY						
Chance Cove	467	191	467	191	-	-
Chapel Arm	699	287	778	319	*	-
Long Cv/ Norman's Cv	1107	454	1232	505	*	-
Sunnyside	634	-	surface supply to supplement wells.		*	-

(1) - Groundwater demand is based on 410 L/c/day.

7 - OVERALL WATER RESOURCE ASSESSMENT

7 - OVERALL WATER RESOURCE ASSESSMENT

In this chapter, a broad assessment of the surface water resource in the study area is provided, considering other basin uses as well as water supply. At the end of the chapter, the regions are ranked according to their potential for water resource development. In order to rank the regions, a ratio of developed yield to total developable yield was calculated as follows

$$\text{Proportion Developed} = \frac{\text{Present Yield}}{\text{Developable Yield}}$$

A low ratio indicates that there is considerable potential for water resource development; a high ratio indicates that much of the water resource potential has already been developed.

The present yield is taken from the calculations in Chapter 6. The developable yield for the purposes of this study is the reliable withdrawal after taking into account other uses in the basin. Both present and potential sources are included. The approach taken was to estimate the amount of water available for each basin as listed in Table 2.5 considering not only hydrology but also basin uses. The number and types of basin uses determined what percent of the basin to use in yield calculations. For basins with minor conflicting uses, two thirds of the basin was considered to be available for development; for basins with potentially conflicting uses (e.g. recreation, summer cabins, fisheries) this proportion was reduced to one third. The development was assumed to include sufficient storage to provide the equivalent of the one month low flow with a return period of one in ten years (see Chapter 2), i.e. about 12.9 percent of the mean annual flow. The calculation for each basin was thus

$$\text{Basin Yield} = 1/3 \text{ (or } 2/3) \times .129 \times \text{Mean Annual Flow}$$

The yields from all the basins in each region were combined to obtain the regional total, excluding the coastal basins.

It should be noted that this yield was used only as an indicator of regional yield for the purposes of comparing one region with another. Many of the present water supply systems provide considerably more regulation than this, some as much as 80 percent.

The regional boundaries are given in Figure 7.1; the drainage basins are shown on Plate 1 and are listed in Table 2.5.

7.1 - Conception Bay Region

The Conception Bay Region includes all the basins from Maloney's River near Harbour Main to Red Head Cove just north of Bay de Verde. This region has the highest concentration of population in the study, with six communities of over 1000 people. The supply/demand analysis in Chapter 6 showed the three communities in the study area with the most pressing water shortages are in the Conception Bay Region (Bay Roberts, Carbonear and Harbour Grace). These results suggest that there are already considerable demands on the water resources of the region. Further indication of these demands is given by the list of basin uses in Table 7.1. Nine of the thirty basins are used for recreation, four have particular fisheries interest, about ten are used for agriculture or pastures, and all but one contain blueberry management units.

The region north of the Rocky Pond/Salmon Cove River watershed near Victoria (basin reference numbers C1 to C14) is much less developed than the southern part. All the larger communities are in the southern part except Bay de Verde, and the basin uses are also concentrated there. Separate yield ratios are therefore calculated for each of the two parts of the region.

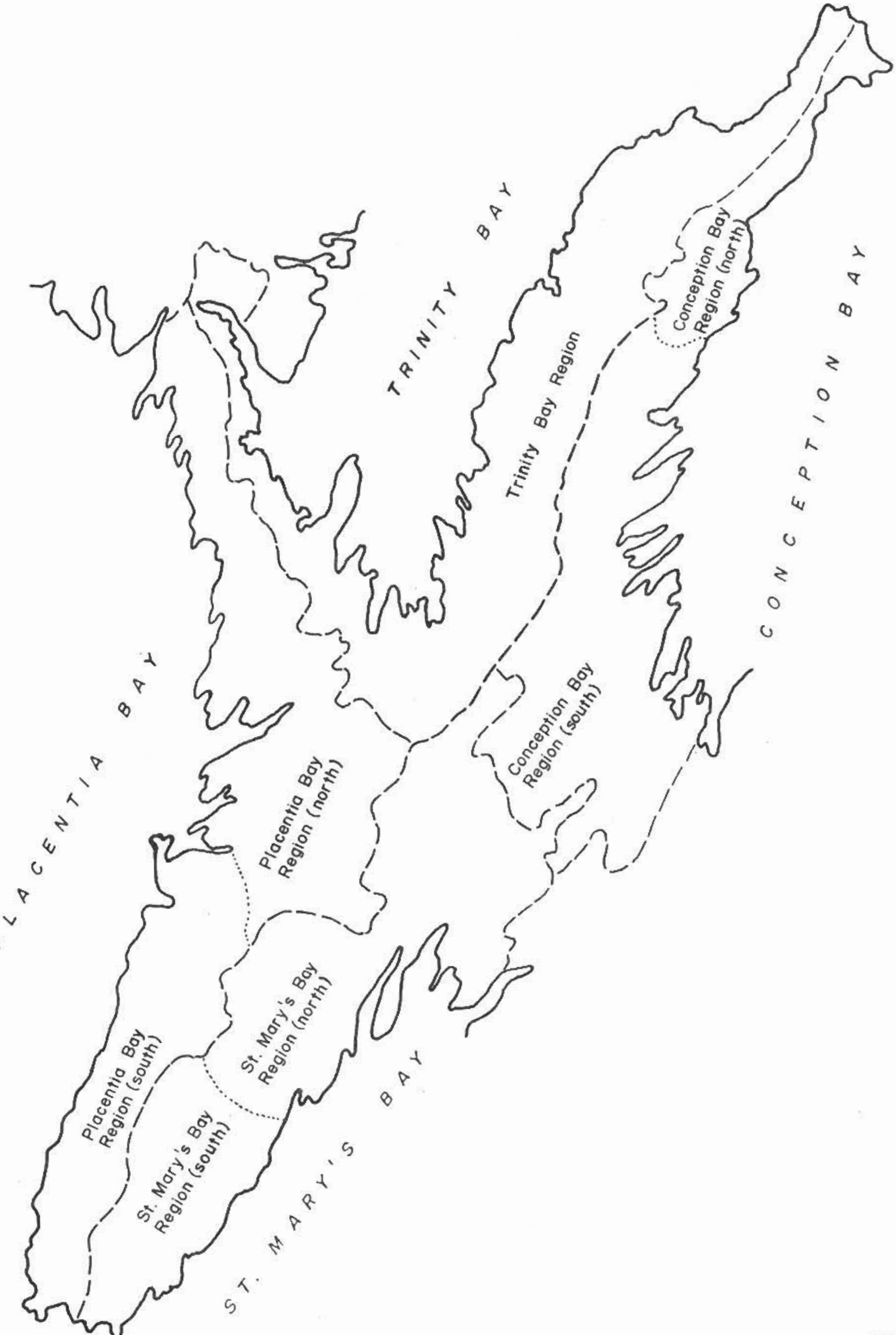

FIG. 7.1

Department of Environment and Lands
Water Resources Division

Regional Water Resources Study
Western Avalon Peninsula

Locations of Regions

ACRES

TABLE 7.1 (a)

CONCEPTION BAY REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Disp. Site	PHC	BMU	Other
C1	Red Head Cove				X		X				
C2	Caplin Cove									X	Arch.
C3	Lower Island Cove							X		X	
C4	Job's Cove Brook							X		X	
C5	Gull Island Brook							X		X	
C6	Northern Bay Brook				X			X		X	
C7	Smooth Cove							X		X	
C8	Ochre Pit Brook							X		X	
C9	Western Bay Brook							X		X	
C10	Western Bay							X		X	
C11	Blackhead Brook							X		X	
C12	Broadcove Brook							X		X	Fish
C13	Spout Cove Brook							X		X	
C14	Perry's Cove									X	
C15	Rocky Pd/Sm Cv Rvr				X		X			X	Fish
C16	Island Pond Brook		X		X					X	
C17	Mosquito Brook					X				X	
C18	Bannerman River				X					X	
C19	South River					X				X	
C20	Mill Brook									X	
C21	Ryans Brook				X					X	
C22	Shearstown Brook		X			X				X	
C23	North River			X						X	Fish
C24	South River		X	X		X				X	Fish
C25	Rodger's Brook				X	X				X	
C26	Lambs Brook				X			X		X	
C27	Turks Gut Long Pd					X		X		X	
C28	Colliers River	X	X					X	X	X	Park
C29	Avondale River		X	X		X			X	X	
C30	Maloneys River		X		X		X		X	X	

KEY

Sc/Tou/Rec - Scenic/Tourism/Recreation
Cott. - Designated Cottage Area
For. - Forestry
PWS - Protected Watershed
Agr. - Agriculture
Reg. Past. - Regional Pasture
Waste Disp. - Waste Disposal Site
PHC - Protected Hydro Corridor
BMU - Blueberry Management Unit
Arch. - Archeological Site
Fish - Rivers of particular interest for fisheries
IDA - Industrial Development Area
PK - Parks
Hyd. - Hydropower

TABLE 7.1 (b)

CONCEPTION BAY COASTAL REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
CC1	Split Cove Point							X			
CC2	Kettle Cv/Monday Pd						X				
CC3	Island Cove Pond							X			
CC4	Northern Bay	X						X		X	Park
CC5	Adams Cove					X		X		X	
CC6	Broad Cove										
CC7	F'Water Pd/Powells Pd					X		X		X	
CC8	Harbour Grace										
CC9	Bryant's Cove									X	IDA
CC10	Spaniard's Bay										
CC11	Beaver Pond									X	
CC12	Clarke's Pond									X	
CC13	Cupids										
CC14	Whalens Brook									X	
CC15	Silver Springs							X			
CC16	Salmon Cove Point										
CC17	Chapel Cove					X					

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Conception Bay, northern subregion (Basins C1 to C14)

The water resource in the northern part of the Conception Bay region is largely untapped, as can be seen from the calculation below.

$$\frac{\text{Developed Yield}}{\text{Developable Yield}} = \frac{1\ 000}{57\ 000}$$

$$= 1.8\ \%$$

Even if it is assumed that Broad Cove Brook cannot be developed because of its fisheries potential, the ratio only increases slightly, to 1.9 percent.

This low proportion of developed to undeveloped yield suggests that the northern part of the Conception Bay region has considerable potential for water resource development.

Conception Bay, southern subregion (Basins C15 to C30)

A similar calculation for the southern part of the Conception Bay region shows quite a different result, as follows.

$$\frac{\text{Developed Yield}}{\text{Developable yield}} = \frac{45\ 000}{89\ 000}$$

$$= 50\ \%$$

If two basins of particular fisheries interest are excluded (North River and South River) the total developable yield decreases to about 72 000 m^3/d, and the proportion developed increases from 50 percent to 63 percent.

These high ratios suggest that the water resources in the southern part of the Conception Bay region are already subject to considerable use, and that a comprehensive regional water resource use plan is appropriate to ensure adequate supplies and to minimize conflicts.

7.2 - Placentia Bay Region

The Placentia Bay region extends from Come By Chance to Golden Bay near Cape St. Mary's. Like the Conception Bay region, it can be divided into two subregions for the purposes of water resource assessment. The northern part from Come By Chance to the Placentia area (basin reference numbers P1 to P37) has the larger population centers and industries. Several of the basins are already used for water supply. The remaining basins do not offer much potential, being either small or used for other purposes such as recreation and fisheries (see Table 7.2).

The southern part of the region, on the other hand, is much less developed. The basins are generally larger, and unit runoff is higher.

Because of these differences, separate subregional yield ratios were calculated.

Placentia Bay, northern subregion (Basins P1 to P37)

$$\frac{\text{Developed Yield}}{\text{Developable Yield}} = \frac{92\ 000}{204\ 000}$$

$$= 45\%$$

TABLE 7.2 (a)

PLACENTIA BAY REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
P1	Come By Chance				X						
P2	Big Pond								X		Arch.
P3	Big Pond (east)	X			X				X		Pk/Arch
P4	Jack's Pond	X							X		Park
P5	Little Southern Hr										
P6	Lamanche Bay								X		
P7	Island Cove								X		
P8	Little Harbour East								X		
P9	Pumbly Cove										
P10	Hollis Cove								X		
P11	Little Pinchgut										
P12	Little Pinchgut (sth)								X		
P13	Fair Haven					X					
P14	Fair Haven (east)					X					
P15	Trinny Cove										
P16	Grassy Pond										
P17	Cv Nan Drioch-Clochan										
P18	St. Croix Bay										
P19	St. Croix Bay (sth)										
P20	Maturin Brook										
P21	Warrens Pond										
P22	Sandy Pond										
P23	Rattling Brook										
P24	Little Seal Cove										
P25	Little Rattling Pd										
P26	Big Rattling Pond										
P27	Ship Harbour Brook						X				
P28	Fox Harbour Pond							X			
P29	Placentia Sound			X			X				
P30	Shalloway Pond				X			X			

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IDA - Industrial Development Area
PK - Parks
Hyd. - Hydropower

Table 7.2(a)

Placentia Bay Region: Basin Uses - 2

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
P31	Broad Cove Brook										
P32	Freshwater					X		X			
P33	Northeast Arm										
P34	Dunville				X			X			
P35	NE River near Plac.	X		X		X	X				Pk/Fish
P36	MacDonald Cove										
P37	Southeast River		X		X						
P38	SE Arm (central)										
P39	SE Arm (west)							X			
P40	Little Barasway Rr					X					
P41	Great Barasway										
P42	Ship Cove	X									
P43	Gooseberry Cove										
P44	Patrick's Cove							X			
P45	Angel's Cove										
P46	Cuslett Brook					X		X			
P47	St. Bride's				X	X		X			Fish
P48	Distress Cove				X	X	X				
P49	Norther Head					X	X				
P50	Lears Cove					X	X				
P51	Golden Bay (east)					X					

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Hyd. - Hydropower

TABLE 7.2 (b)

PLACENTIA BAY COASTAL REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
PC1	Come By Chance (est)										
PC2	Great Southern Hr										
PC3	L. Southern Hr (nth)								X		
PC4	Little Harbour East										
PC5	Great Pinchgut										
PC6	Fair Haven (south)										
PC7	Trinny Cove (wst)										
PC8	St. Croix Bay (nth)										
PC9	Ship Harbour										
PC10	Murry Barasway							X			
PC11	Carin Head/McAndrew										
PC12	Point Verde										
PC13	Seal Point										
PC14	Gooseberry Cv (sth)										
PC15	Breme Point										
PC16	Muskrat Brook					X	X				
PC17	Brierly Cove					X	X				

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Placentia Bay, southern subregion (Basins P38 to P51)

$$\frac{\text{Developed Yield}}{\text{Developable Yield}} = \frac{3\ 900}{87\ 000}$$

$$= 4.5\%$$

These ratios confirm that as expected the southern part of the region offers considerably more opportunity for water resource development than the northern part.

7.3 - St. Mary's Bay Region

The St. Mary's Bay region extends from the Salmonier Arm/Colinet River area to Lance Cove south of Branch. The largest community in the region is Whitbourne, with a population of over 1100. Because the communities are small and there are no large water-using industries in the region, the withdrawal demands are low. The most important uses of the water resource in the area are recreation and fisheries enhancement, as shown in Table 7.3. The three largest basins in the area, Rocky River (S7), Colinet River (S6) and Little Salmonier River (S12), are all important for fisheries, as is North Harbour River (S8). Any major water resource developments such as water supply or hydroelectric generation would likely present serious conflicts with these present uses. Because of these incompatibilities the developable yield is very low so no yield ratio was calculated for this part of the region.

In the southern part of the basin, from Big Barachois River (S13) to Lance Cove (S21) the principal uses are recreation and

TABLE 7.3 (a)

ST. MARY'S BAY REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
S1	Salmonier Arm										
S2	Warrens Waters					X					
S3	Harricott					X	X				
S4	Harricott Longpond		X			X					
S5	Colinet					X					
S6	Colinet River		X	X		X		X			Fish
S7	Rocky River	X	X	X		X		X			Pk/Fi
S8	North Harbour River	X	X	X		X					Pk/Fi
S9	North Harbour Pond										
S10	Flinn River										
S11	Dog Cove Pond	X									
S12	Little Salmonier Rv	X									Fish
S13	Big Barachois River	X									
S14	Little Barachois Rv	X									
S15	Jigging Cove										
S16	Red Head River										
S17	Beckford Head										
S18	Branch River					X		X			
S19	Gull Cove					X		X			
S20	Lance River					X					
S21	Lance Cove					X					

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Hyd. - Hydropower

TABLE 7.3 (b)

ST. MARY'S BAY COASTAL REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
SC1	Salmonier Arm (nth)					X					
SC2	Salmonier Arm (sth)					X					
SC3	Pinchgut Tickle					X	X				
SC4	Bushy Head					X					
SC5	North Harbour					X					
SC6	Barachois Point										
SC7	Big Barachois	X									
SC8	Wild Cv/Maggotty Pt										
SC9	Branch Cove										
SC10	Red Cove					X		X			
SC11	Gull Cove (south)										
SC12	Lance Cove (nth)										
SC13	Rdld Pt/Bg Gulch Rr					X					

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agriculture. In this part of the region, the only presently developed water supplies are for Branch and Point Lance. The ratio of developed to total yield for this part of the region is thus

$$\frac{\text{Developed Yield}}{\text{Developable Yield}} = \frac{900}{96\ 000}$$

$$= 0.94\%$$

This very low ratio indicates that there is good potential for water resource development in the southern part of the St. Mary's Bay region. (It may be noted that the regional yield ratio is the same whether or not the northern basins are included, because both developed and developable yields from these are zero.)

7.4 - Trinity Bay Region

The Trinity Bay region extends from Cooks Cove (T1) just north of Old Perlican to Bull Arm near Sunnyside (T41). There are numerous communities and settlements along the entire coastline, but none has a population over 1000.

The largest withdrawals in the region are by the fish plants. Two basins have been developed for hydropower and several are used for recreation, fisheries, and agriculture as can be seen in Table 7.4.

The ratio of developed to total regional yield is calculated as follows

$$\frac{\text{Developed Yield}}{\text{Developable Yield}} = \frac{65\ 000}{166\ 000}$$

$$= 39\%$$

This calculation excludes all basins with uses that conflict with

TABLE 7.4 (a)

TRINITY BAY REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
T1	Cooks Cove										
T2	Old Perlican Cove				X		X	X			Arch.
T3	Russels Cove (east)							X			
T4	Big Brook at Lead Cv				X						
T5	Sibley's Cove				X						
T6	Brownsdale Cv (est)				X						
T7	Brownsdale Cv (wst)										
T8	Pitman's Pond				X			X			Hydr.
T9	Halfway Brook				X			X			
T10	Winterton Cove				X						
T11	Turk's Cove				X						
T12	New Perlican River										
T13	Heart's Content Bk				X					X	Hydr.
T14	Heart's Desire (nth)				X						
T15	Heart's Desire Bk			X	X			X			
T16	Heart's Delight Bk		X	X							
T17	Heart's Delight				X						
T18	Island Cove					X		X			
T19	Long Pond Brook										
T20	Pitcher's Pond Bk				X					X	
T21	Backside Pond	X									
T22	Scotch Pond			X	X						
T23	Hopeall Brook		X			X		X		X	Fish
T24	Broad Cove Pond		X		X	X				X	
T25	Dildo Pond					X		X	X	X	Fish
T26	Spread Eagle By (sth)					X			X		
T27	Beaver Pond		X	X		X			X		
T28	Cole's Pond								X		
T29	Collier Bay Brook							X	X		
T30	Thornlea				X						

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Fish - Rivers of particular interest for fisheries
IDA - Industrial Development Area
PK - Parks
Hyd. - Hydropower

TABLE 7.4 (a)

TRINITY BAY REGION : BASIN USES - 2

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
T31	Bellevue			X	X						
T32	Trout Brook			X					X		
T33	Broad Lake					X					
T34	Tickle Bay							X			
T35	Little Chance Cove							X	X		
T36	Rantem Cove								X		
T37	L. South. Hr. (nth)										
T38	Rantem Cove (north)										
T39	Bull Arm (east)										Arch.
T40	Bull Arm (southwest)								X		IDA
T41	Bull Arm (north)							X			

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Hyd. - Hydropower

TABLE 7.4 (b)

TRINITY BAY COASTAL REGION : BASIN USES

Ref. No.	Drainage Basin	Sc/Tou/ Rec	Cott.	For.	PWS	Agr.	Reg. Past.	Waste Disp. Site	PHC	BMU	Other
TC1	Daniel's Cove							X			
TC2	Cooks Cove (south)										
TC3	Mzzn Cv/Bll Glch Pt							X			
TC4	Russels Cove										
TC5	Brownsdale Cv (nth)										
TC6	Brownsdale										
TC7	Nw Chlsea Cv/Hnts Hr							X		X	
TC8	Winterton										
TC9	New Perlican Pond										
TC10	Seal Cove Brook					X					
TC11	Heart's Delight										
TC12	Islington										
TC13	Cavendish										
TC14	Greens Harbour										
TC15	Hopeall Bay					X					
TC16	Dildo Arm										
TC17	Chapel Arm								X		
TC18	Collier Bay					X			X		
TC19	Tickle Hr Point										
TC20	Little Chance Cove (nth)										
TC21	Bull Arm (south)										IDA
TC22	Bull Arm (west)							X	X		Arch.

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water supply (i.e. hydroelectric generation, fisheries). The one exception is Heart's Content; it is assumed that the hydropower project will continue to supply the town of Heart's Content but with no additional demands. The two basins developed for hydropower have large yields, but if they are used for water supply, residents will lose the benefit of relative inexpensive electrical energy. A detailed cost/benefit analysis would be required for any project proposing to use water from these basins.

The relatively high ratio of developed to total regional yield indicates that the opportunities for water resource development in the region are limited. This result is not unexpected, considering the fact that of the 41 basins in the region, over one third are already being used for water supply or hydro-electric generation. Most of the remaining ones are along the north side of the Isthmus of Avalon, and are relatively small.

7.5 - Regional Ranking

The results of the overall water resources assessment by region are given in Table 7.5. The regions are ranked in order of decreasing potential for water resources development. The ranking is based on the ratios of presently developed yield to total possible regional yield. A low ratio indicates good potential for further development.

TABLE 7.5

Regional Ranking

Region	Yield Ratio %	Rank
St. Mary's Bay	0.94	1
Conception Bay Northern Part	1.8	2
Placentia Bay Southern Part	4.5	3
Trinity Bay	39.	4
Placentia Bay Northern Part	45.	5
Conception Bay Southern Part	50.	6

These results show that the region with the most potential for water resource development is St. Mary's Bay, in particular the southern portion where conflicts with other uses are less likely.

The northern part of the Conception Bay region and the southern part of the Placentia Bay region rank second and third. These rankings could easily be reversed; in both areas very little development has occurred, and therefore the ratio is very sensitive to small changes in developed yield. The Conception Bay northern subregion has the advantage that there are numerous small settlements nearby, as well as several population centers just down the coast. The Placentia Bay southern subregion has the advantage of a potentially greater yield; the basins are generally larger, wetter, and at higher elevations. (The high elevations are advantageous because developments can use gravity flow.)

The Trinity Bay region and the northern part of the Placentia Bay region rank fourth and fifth respectively. Both include parts of the Isthmus of Avalon, an area characterized by generally small basins with relatively small yields. The remaining basins in both regions are already quite extensively developed both for instream and withdrawal uses.

The southern part of the Conception Bay region has the highest proportion of developed to developable yield. The water resources of this region are the most intensively used, in particular for water supply, recreation and fisheries. Agriculture is also common on many of the watersheds and conflicts can occur. In dry years, several of the communities and industries in this area have an inadequate supply of water, and the preparation of a detailed plan for watershed use and water supply is recommended for this subregion.

8 - CONCLUSIONS AND RECOMMENDATION

8 - CONCLUSIONS AND RECOMMENDATIONS

The principal conclusion of this study is that the natural waters of the study area are an abundant resource which should be managed to maximize benefits to the province. In a region lacking many other natural resources, both the abundant quantity and the relatively good quality of the surface waters offer substantial economic and other benefits including

- plentiful sources for water supply projects, with little treatment required, as well as inexpensive groundwater nearly everywhere in the area for rural homes and agriculture;

- hydro energy production, averaging about 28 GWh per year and valued at about $1.4 million per year;

- recreational opportunities close to population centers, providing activities for tourists and encouraging residents to vacation locally rather than out of the province;

- streams capable of supporting populations of favorite sports fish, even in populated areas if properly maintained. Streams with healthy fish populations not only provide angling opportunities, but also assure residents of the quality of the water and surrounding land. In remote areas, they provide an opportunity to conserve natural fish and wildlife habits.

The areas with the most potential for water resource development are the southern Placentia Bay and St. Mary's Bay regions. The area with the most pressure on its water resources is the southern part of the Conception Bay region. The principal recommendation of this study is that comprehensive planning and positive management are required to ensure that the benefits of the water resources are maximized. The specific conclusions and recommendations arising from each part of the study are presented below.

Surface Water Availability

The average annual runoff in the study area is high, at about 1120 mm. Although runoff is quite evenly distributed through the year, natural dependable flows for water supplies are low. Reliable flows can readily be increased by relatively modest storage in many cases, however. Estimates of mean annual runoff and low flows would be improved with additional data and analyses.

Recommendations:

1. A regional low flow analysis for the Island of Newfoundland should be taken. The present study indicates that data from more gauges must be included in the analysis in order to develop low flow prediction equations.

2. A data collection and analysis program should be instigated to improve the estimates of runoff from rainfall. Several precipitation gauges should be located at higher elevations, near the centroids of basins with streamflow gauges if possible. The analytical study should select and apply appropriate methods of estimating evapotranspiration from climatological data.

3. The precipitation record at Argentia as presented in Canadian Climate Normals, Volume 3, Precipitation (6) should be checked. Rainfall and total precipitation values are inconsistent.

Water Quality

Water chemistry results show that the quality of the natural waters of the study area is generally good. Levels of color, turbidity, iron and manganese are sometimes higher than desirable. The natural water tends to be corrosive because of its softness and low pH, with potential dissolution of lead and copper in plumbing systems.

Local problems can occur which are not identified in standard test results. In particular, the organic content of the water varies seasonally, and sometimes is high enough to make water unpleasant for drinking. This problem may not be detected in water chemistry analysis, or may not be considered serious because taste and odor are aesthetic parameters. Some concern is warranted, however, not only because the water is unpalatable for at least part of the year in many communities, but also because toxic products may be formed when water with high organic content comes into contact with chlorine.

Other water quality concerns identified in this study include degradation of water quality due to anthropogenic activities, particularly in developed areas, high sensitivity to acid rain, and possible coastal and estuarine pollution resulting from discharge of most wastes directly to the sea. Key areas of concern are near large industries (phosphorus plant, oil refinery, fish plants).

Recommendations:

1. The water quality data base should be improved by continued and expanded monitoring. In particular, monitoring of parameters likely to be affected by anthropogenic activities should be expanded to identify problem areas and to detect trends. Parameters related to acid rain and nonpoint

pollution from agricultural and brush control chemicals should be included. The quality of rivers and ponds near developed areas should be assessed. If necessary they should be rehabilitated at least to a level suitable for swimming and recreation.

2. Water quality at the end of the distribution (i.e., at the tap) should be analysed for metals, particularly in locations with low alkalinity and pH. Depending on the results some treatment may be required.

3. The effect of land uses on the water resource should be a fundamental consideration in any land use planning, not only in protected watersheds. The water resource management authority should be involved in interdepartmental land use planning.

4. A public education program should be instituted to increase the public's recognition of the value of its water resources, and of its role in maintaining water quality.

Water Supply

The present surface water supply sources are not adequate to meet demand in several of the communities in the study area. In particular, the water supply sources for Bay Roberts, Carbonear and Harbour Grace cannot meet present or projected demand in dry periods without structural improvements. Six other communities also have potential water shortages but these can be alleviated at least in the short term by demand management in dry periods. These communities are Southern Harbour, Bay de Verde, Arnold's Cove, Point Lance, Dunville and Winterton.

Most of the remaining communities have an adequate supply of water; only a few have large surpluses. Those with surpluses are

Victoria, Whiteway, Whitbourne, Heart's Delight/Islington, Heart's Desire and Heart's Content. Of these, three share their water with other important users. Victoria and Heart's Content obtain their water from reservoirs regulated for hydroelectric generation, and Whitbourne's water comes from the upstream reaches of a major salmon river.

Of the communities served by groundwater, over 70 percent reported shortages of water. Many of these communities are located in the Conception Bay region.

Recommendations:

1. A detailed water supply study should be undertaken for the Conception Bay region to examine the feasibility of developing joint water supply projects. The highest priority should be given to Bay Roberts, Carbonear and Harbour Grace, but the optimal projects for the region should be determined by considering the needs of all the communities. Clarke's Beach, for example, is experiencing problems with its groundwater system; a possible connection to an improved Bay Roberts system seems reasonable.

2. The systems serving Southern Harbour, Bay de Verde, Arnold's Cove, Point Lance, Dunville and Winterton should be investigated in more detail to ensure that demand management is technically and economically feasible. Specific information relating to the variations in fish plant demand and in the possibility of increased use of salt water is required.

3. The Province should maintain its own inventories of municipal and industrial water use. The information should be obtained by the most reliable methods available, e.g. metering or monitoring of reservoir drawdown and inflow.

Watersheds serving the following communities or industries should be checked to determine whether protection is required.

- Spaniard's Bay
- New Harbour
- Harbour Grace
- Whitbourne
- Southern Harbour
- Little Harbour/Mt. Arlington Heights
- Branch
- St. Bride's fish plant.

Instream Uses

The principal instream uses in the study area are hydropower, tourism and recreation, and fisheries/wildlife conservation. These all bring economic and/or other benefits to the study area.

Recommendations:

1. The effect on instream uses should always enter into the evaluation of any proposed development for land or water use.

2. Development trends in small scale hydropower projects and legislation elsewhere should be noted. Because of the abundant water and hilly topography of the study area, there are numerous sites suitable for small hydro projects. At present, they are not economically viable because power from the grid is relatively cheap, but that situation may change.

3. A study should be undertaken to estimate the value of water quantity and quality for recreation, tourism, and fisheries and wildlife uses. A study with a broad scope would provide

needed information to the authority making water management decisions.

APPENDIX A
HYDROLOGY

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A - HYDROLOGY

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A - HYDROLOGY

1 - ESTIMATION OF MEAN ANNUAL RUNOFF

Long term mean annual runoff was estimated from streamflow records in basins gauged by Water Survey of Canada (WSC) supplemented by precipitation data from climatological stations maintained by Atmospheric Environment Service (AES). The purposes of the analysis were to assess the overall availability of water on the western Avalon peninsula, and in particular to prepare a map showing isolines of mean annual runoff.

1.1 - Analysis of Streamflow Data

Ideally a map of mean annual runoff should be based on many gauge records, all with long periods of record. As can be seen in Table A1.1, only eight basins in the study area are gauged, and only one of them, Rocky River, has a period of record longer than eight years. To overcome the lack of long term data, the short term records were extended by proration with Rocky River. This procedure was used to ensure that the estimates for all basins covers the same range of wet and dry years.

An implicit assumption in using Rocky River to extend the records for the other basins is that the Rocky River record represents the wet and dry cycles over the entire study area. Although this assumption cannot be thoroughly tested because of the lack of data, the Rocky River record was compared with another long term streamflow record on the eastern Avalon (Northeast Pond River), and with a long term precipitation record from Colinet, a climate station in the study area starting in 1938. The five year moving means for the three stations are plotted in Figure A1.1. This plot suggests that the runoff from Rocky River is reasonably representative of trends at the two other stations.

TABLE A1.1

ESTIMATED LONG TERM MEAN ANNUAL RUNOFF, GAUGED BASINS (mm)

	Rocky River	NE River Placent.	Spout Cove Brook	Little Salmonier River	Shears-Town Brook	Little Barachois River	Big Brook	Trout Brook
Drainage Area (km2)	285	89.6	10.8	104	28.9	37.2	11.2	42.6
Station No.	02ZK001	02ZK002	02ZL003	02ZK004	02ZL004	02ZK003	02ZL005	02ZK005
1950	1003							
1951	1284							
1952	1307							
1953	1307							
1954	1273							
1955	1495							
1956	1495							
1957	1318							
1958	1085							
1959	1085							
1960	885							
1961	777							
1962	1318							
1963	1005							
1964	1373							
1965	988							
1966	1218							
1967	1068							
1968	1185							
1969	1417							
1970	1705							
1971	1406							
1972	1307							
1973	1340							
1974	1362							
1975	1140							
1976	1351							
1977	917							
1978	1362							
1979	1207	1405	1189					
1980	1650	1747	1946					
1981	1428	1736	1616					
1982	1207	1701	1405					
1983	1329	1507	1233	1805	1021	1323		
1984	1251	1698	1414	1814	985	1323		
1985	1052	1384	1011	1681	835	1196	902	
1986	1362	1754	1107	1936	1146	1595	1158	1252
MAR period of record	1250	1617	1365	1809	997	1359	1030	1252
Est. Long Term MAR	1250	1542	1302	1811	998	1361	1067	1149

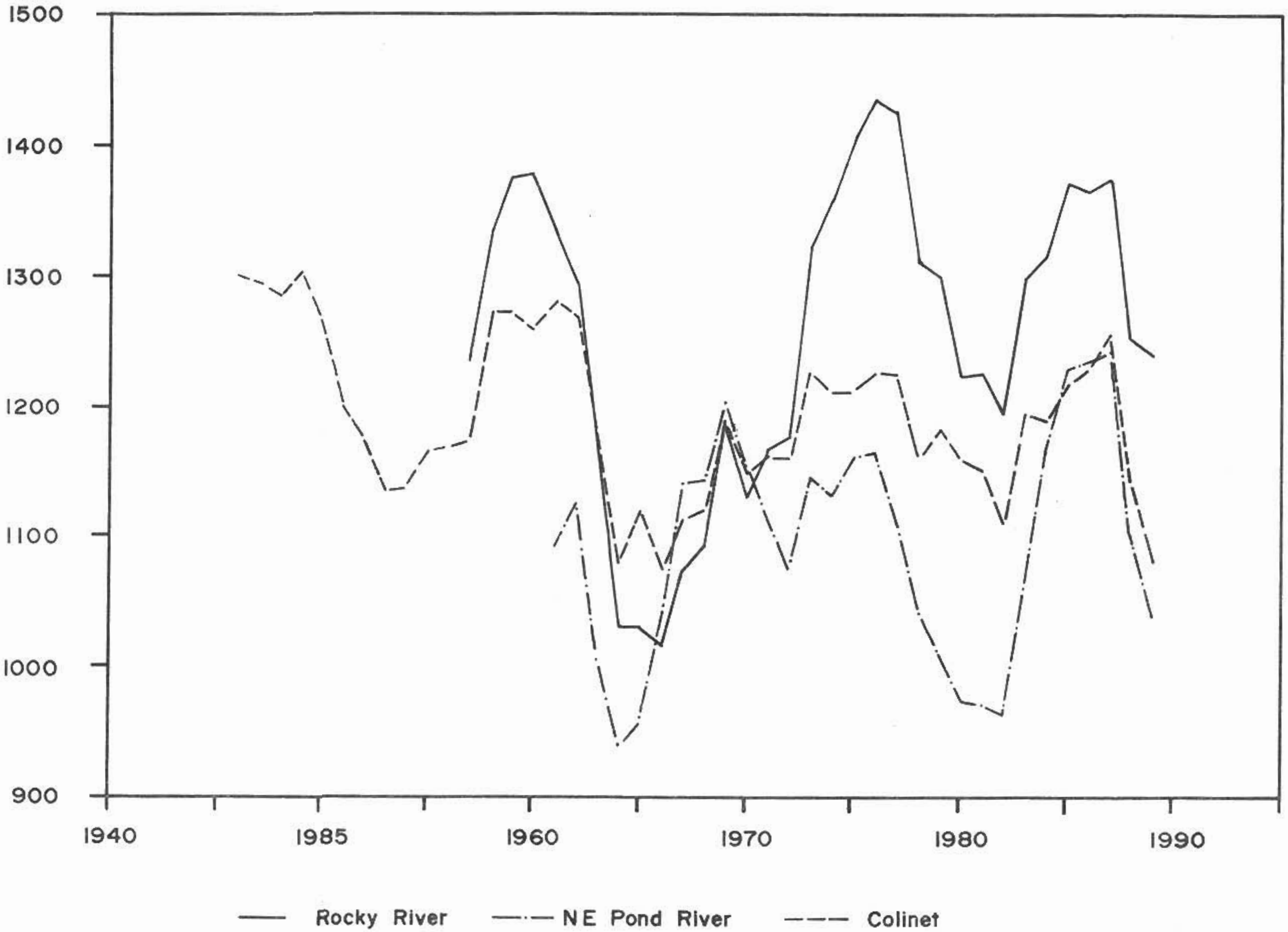

FIG. AI.1

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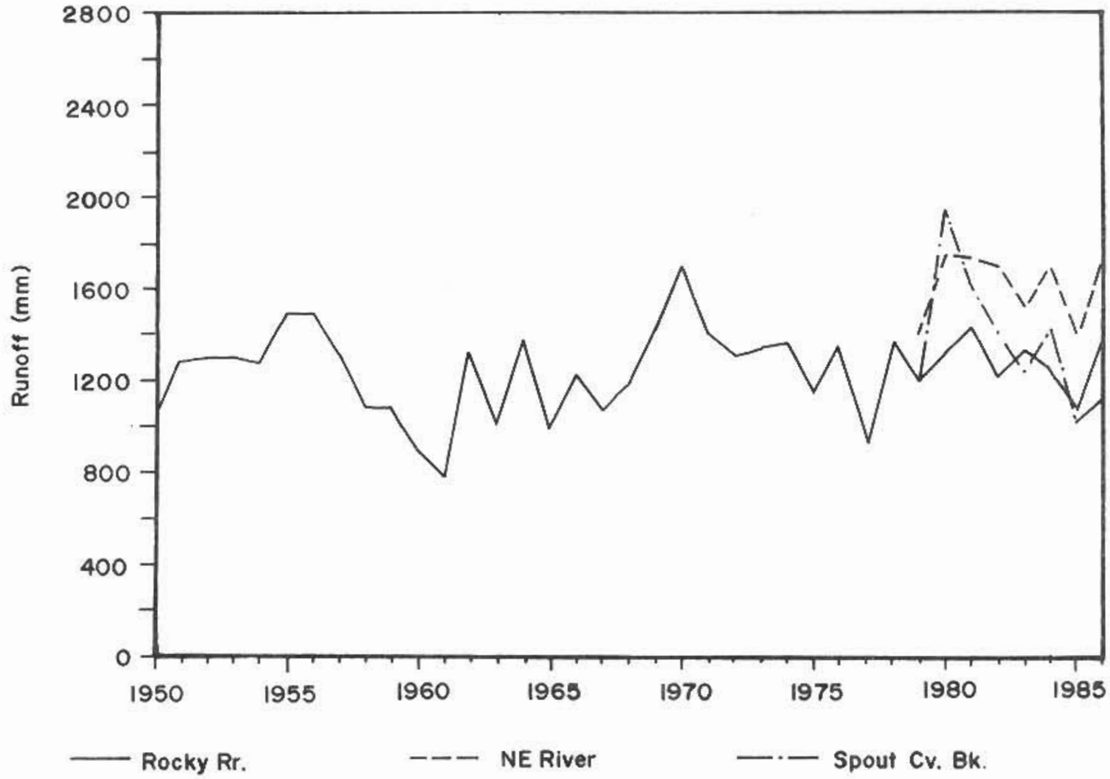
Five Year Moving Means

(It may be noted that precipitation values were missing for a few months in the 37 years of overlapping record. For the purposes of this analysis these were simply filled in using the mean precipitation for the missing month.)

A second assumption of the method is that the relationship between the mean annual runoff at each gauge and the runoff at Rocky River during the period of overlapping record is maintained over time. The plots of mean annual runoff for the six gauges with record lengths of at least four years were plotted as shown in Figure A1.2. These plots suggest that there is a close relationship between mean annual runoff at each gauge and at Rocky River. Correlation coefficients (r values) from a least squares analysis were generally above 0.80. If the physiographic characteristics of the basins remain similar, so should the relationship.

The river showing the most difference from Rocky River during the period of overlapping record was Northeast River at Placentia (r = 0.67). The records from Come by Chance and Pipers Hole River, just outside the study area, were investigated to see whether the long term estimate could be improved. The record lengths of these two rivers are 18 years and 34 years respectively. The records were compared with the Northeast River record to determine whether one of them could be used as the basis for estimating the long term mean for Northeast River, but the correlations were no better. Consequently the Rocky River record was used as the basis for estimating the long term runoff for all gauges in the study area, including Northeast River.

In detail, the proration procedure used was to calculate the mean runoff for the Rocky River gauge and each shorter term gauge for the period of overlapping record. The ratio of the short term means was then used to estimate the long term mean, as follows



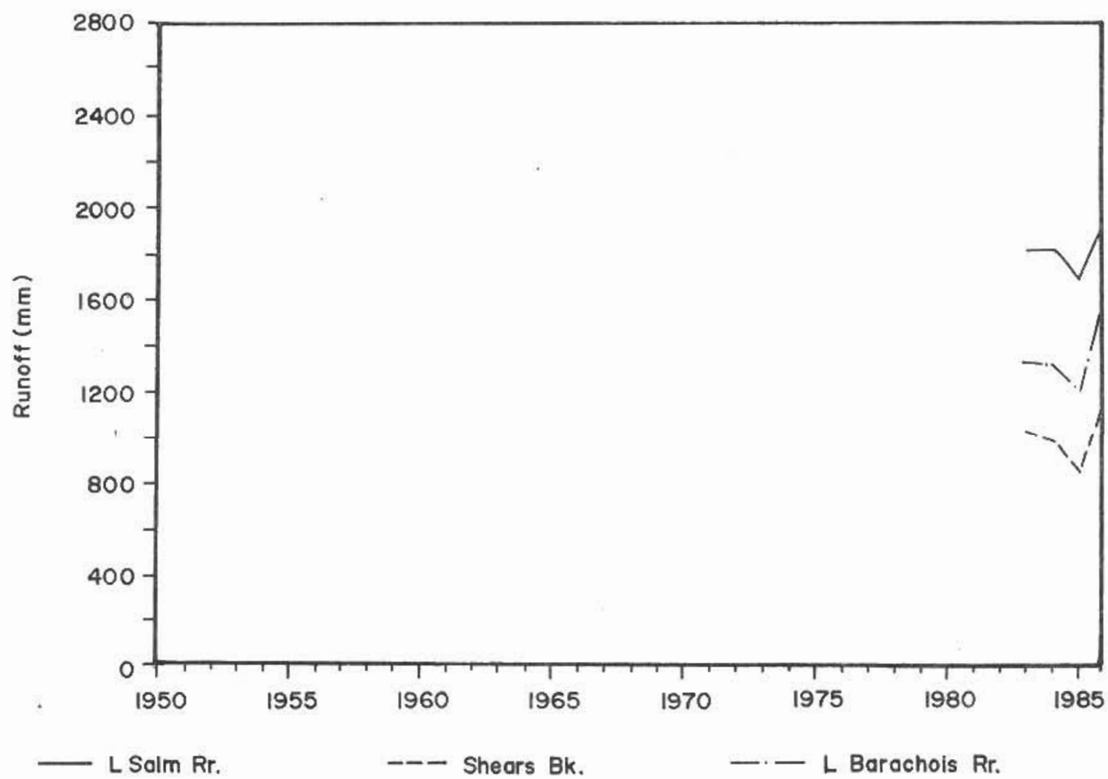


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FIG. AI.2

Mean Annual Runoff Selected Basins

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$Q_{i(ST)}$ $\qquad \frac{Q_{i(ST)}}{Q_{RR(ST)}} = \frac{Q_{i(LT)}}{Q_{RR(LT)}}$

Where Q_i = Mean annual runoff for the gauge with the short term record

Q_{RR} = Mean annual runoff for Rocky River

ST = short term, i.e. period of overlapping record

LT = long term, i.e. period of record of Rocky River gauge.

The results are presented at the bottom of Table A1.1.

1.2 - Analysis of Meteorologic Data

Precipitation records are available for seven AES stations in the study area, and these records were used to provide additional information on the distribution of runoff in the study area. The values of mean annual precipitation were first adjusted to represent a constant long term period of record, using a procedure similar to that described above for the streamflow records. The runoff component of total precipitation was then estimated.

The annual precipitation at each of the climate stations is summarized in Table A1.2 from the detailed records in Appendix B. Since so many values are missing from this table, these values were not used directly to estimate the long term mean. Instead, the AES summaries of mean precipitation were used, as reported in Canadian Climate Normals, Volume 3, Precipitation (6). Missing values were filled in and the records extended by AES in the preparation of this document. For this study, a slight adjustment only was required to incorporate data collected since 1980. The results and a sample calculation are presented in Table A1.3.

TABLE A1.2

MEAN ANNUAL PRECIPITATION AT AES CLIMATE STATIONS

	Colinet	Colinet	Colinet	Avondale	Argentia	Holyrood	Holyrood	Come By Chance	Arnold's Cove
Station No.	8401200	8401250	8401251	8400225	8400100 8400102	8402300 8402310	8402309	8401257	8400135
1939	1279								
1940	1235								
1941	1269								
1942	1206								
1943	*								
1944	*								
1945	*				*				
1946	*				*				
1947	1029				*				
1948	1172				*				
1949	1138				*				
1950	*				*				
1951	*				1399				
1952	1173				796	*			
1953	*				962	921			
1954	1158				906	*			
1955	*			*	*	*			
1956	*			*	*	*			
1957	1101	*		*	895	*			
1958	1297	1206		*	666	827			
1959	*	*		*	*				
1960	1019	*		*	592	*			
1961	*	*		*	487	*			
1962	1309	*		*	871	*			
1963	1073	*		*	888	*			
1964	*	*		*	855	*			
1965	*	*		*	*	*			
1966	1226	*		*	734	*			
1967	1094	*		*	691	*			
1968	1144	*		*	733	720		*	
1969	1274	*		*	889	940		*	
1970	1388	*		*	*	1182	*		
1971	1145	*		*		*	*		*
1972	1111	*		*		*	940		962
1973	1210	*		*		*	802	*	1049
1974	1269	*		*		1058	994	*	1139
1975	1051	*		*		811	786	*	*
1976	1272	*		*	*	755	954	875	1126
1977	998	*		*	845	637	804	600	*
1978	1162	*		*	*	655	*	762	940
1979	1059	*		*	1164	934	824	*	1015
1980	1482		*	*	1390	1146	1037	1291	1317
1981	1237		*	*	1421	1036	920	1233	1251
1982	1143		*	*	1169	*	*	1037	*
1983	1216		*	*	1106		*	1200	*
1984	1197		*	*	1061		*	1212	*
1985	923		*	*	*		*	*	1062
1986	920		*	*	*		*	1123	1051
1987	*						*	*	*
MAR period of record	1171	1206	-	-	933	894	896	1037	1091
AES Tot. Precip. ('51-'80)	1432	-	-	-	1068	1029	-	1128	1265

* - Missing Data

Table A1.2
Mean Annual Precipitation at AES Climate Stations - 2

	Sunnyside	Salmonier	Harbour Grace	Placentia	Markland	Branch	St. Bride's	Carbonear
Station No.	8403818	8403621	8402076	8402956	8402590	8400666	8403418	8401075
1939								
1940								
1941								
1942								
1943								
1944								
1945								
1946								
1947								
1948								
1949								
1950								
1951								
1952								
1953								
1954								
1955								
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1963								
1964								
1965								
1966								
1967								
1968								
1969								
1970				*				
1971	*			1144				
1972	1044			978				*
1973	1021			1139				1032
1974	1129			1239				*
1975	*			1012				
1976	1009							
1977	*							
1978	927	*						
1979	1025	1257	*					
1980	1413	1462	1373					
1981	1360	1367	1342		*			
1982	1154	*	1219		1432			
1983	*	*	1255		1513	*		
1984	1275	*	1184		1382	1314	*	
1985	*	1110	1100		1296	1297	*	
1986	*	*	1128		*	*	*	
MAR period of record	1136	1299	1229	1102	1406	1306	-	1032
AES Tot. Precip.('51-'80)	1261	1425	-	-	-	-	-	-

* - Missing Data

TABLE A1.3

ESTIMATED MEAN ANNUAL LONG TERM TOTAL PRECIPITATION AT SELECTED STATIONS

	Colinet	Argentia	Holyrood	Come By Chance	Arnold's Cove	Sunnyside	Salmonier
Station No.	8401200	8400102 8400100	8402300 8402310	8401257	8400135	8403818	8403621
1951-80	1432	1068	1029	1128	1265	1261	1425
1981	1237	1421	1036	1233	1251	1360	1367
1982	1143	1169	*	1037	*	1154	*
1983	1216	1106	*	1200	*	*	*
1984	1197	1061	*	1212	*	1275	*
1985	923	*	*	*	1062	*	1110
1986	920	*	*	1123	1051	*	*
Mean (1951-86)	1376	1083	1029	1133	1252	1261	1413
Mean based on Colinet	1376	1061	994	1122	1235	1231	1380

* - Missing Data

Sample Calculation (Argentia)

Colinet Long Term - 1376
Colinet Short Term ('51-'84) - 1405

Argentia Long Term - x
Argentia Short Term - 1083

Colinet ST/Colinet LT = Argentia ST/Argentia LT

$1405/1376 = 1083/x$

$x = 1061$

The proportion of total precipitation that is available as runoff was then estimated. These estimates can only be approximate since little joint rainfall/runoff information is available. None of the basins in the study area has a precipitation gauge located within the basin. One basin on the eastern Avalon, the Waterford River, has both precipitation and streamflow gauges, although the precipitation gauge is located in the downstream part of the basin. The data from the WSC and AES gauges for the overlapping period of record indicate that the runoff is about 78 percent of the total precipitation. A short term analysis using a temporary rainfall gauge at a higher elevation in the Waterford basin indicated that the proportion of runoff was 91 percent (20).

The two closest precipitation and streamflow gauges within the study area are at Colinet and Rocky River; their locations are shown in Figure 2.1 and 2.2 of the main report. The runoff at the Rocky River gauge is about 90 percent of the total precipitation at Colinet. The elevation of the Colinet precipitation gauge is 20 m, whereas the centroid of Rocky River basin is at 60 m. Higher precipitation is expected at the higher elevation due to orographic enhancement.

Much lower estimates of mean annual runoff have been made by AES based on water balance calculations for climatological stations across Canada (32). The average proportion of runoff for the stations analyzed on the Avalon Peninsula is about 65 percent.

For the purposes of this study, an intermediate estimate of 75 percent was used. The areas most sensitive to the choice of runoff coefficient are along the coasts where most of the precipitation stations are located. The isolines were drawn conservatively in these areas in order to avoid overestimating yield.

1.3 - Distribution of Runoff in the Study Area

The mean annual runoff points estimated from the streamflow gauge records and meteorological data as described in Sections 1.1 and 1.2 above were plotted on a map of the study area (Figure A1.2). The runoff depths estimated from streamflow records were plotted at the centroids of the gauged basins. The runoff amounts estimated from meteorological records were plotted at the locations of the climate stations.

Using these points, isolines were then drawn to indicate the distribution of runoff over the study area. Greater consideration was given to the streamflow data than to the precipitation data, since streamflow gauges measure runoff directly. Where no data existed, topographic contours (Figure A1.3) were used as a guide in shaping the isolines. The mean annual runoff points for the gauged basins and AES climate stations are shown on Figure A1.4. Details of the gauged basins and climate stations can be found in Tables A1.4 and A1.5. Figure A1.5 is the resulting map of mean annual runoff.

The use of elevation as a guide in shaping the contours is based on the assumption of orographic enhancement of precipitation. This assumption appears reasonable not only from physical considerations and previous studies (38) but also because it is supported by such limited data as are available. Work in progress in the Geography Department of Memorial University of Newfoundland, for example, shows orographic enhancement on the eastern Avalon peninsula during summer and fall rainfall events (3), and an unpublished summer research project showed significantly higher precipitation on the high barrens north of Trepassey than at a nearby coastal precipitation station. A similar effect is expected on the western Avalon between St. Mary's Bay and Placentia Bay, according to researchers in the Department.

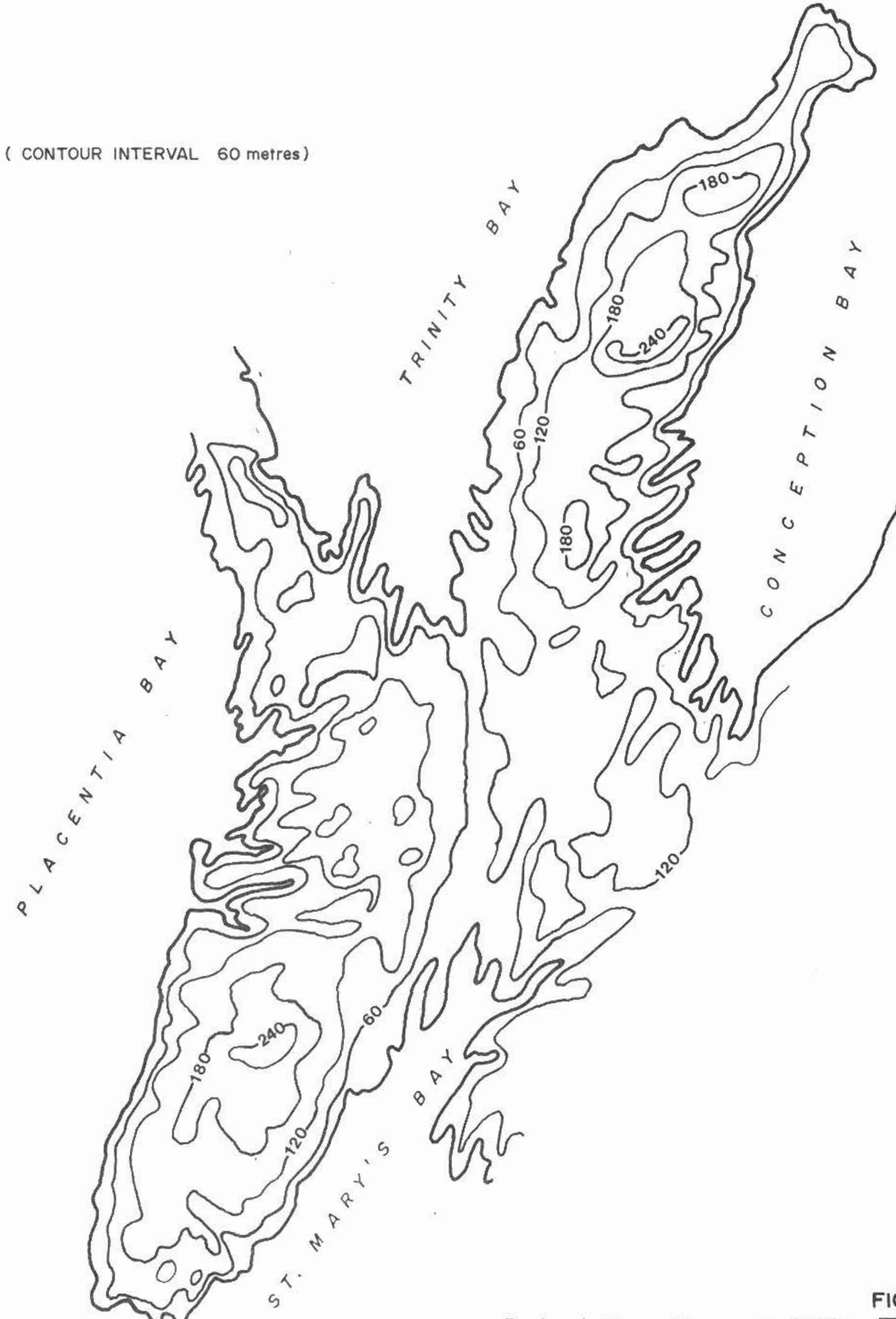

FIG. A1.3

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Topography of Study Area

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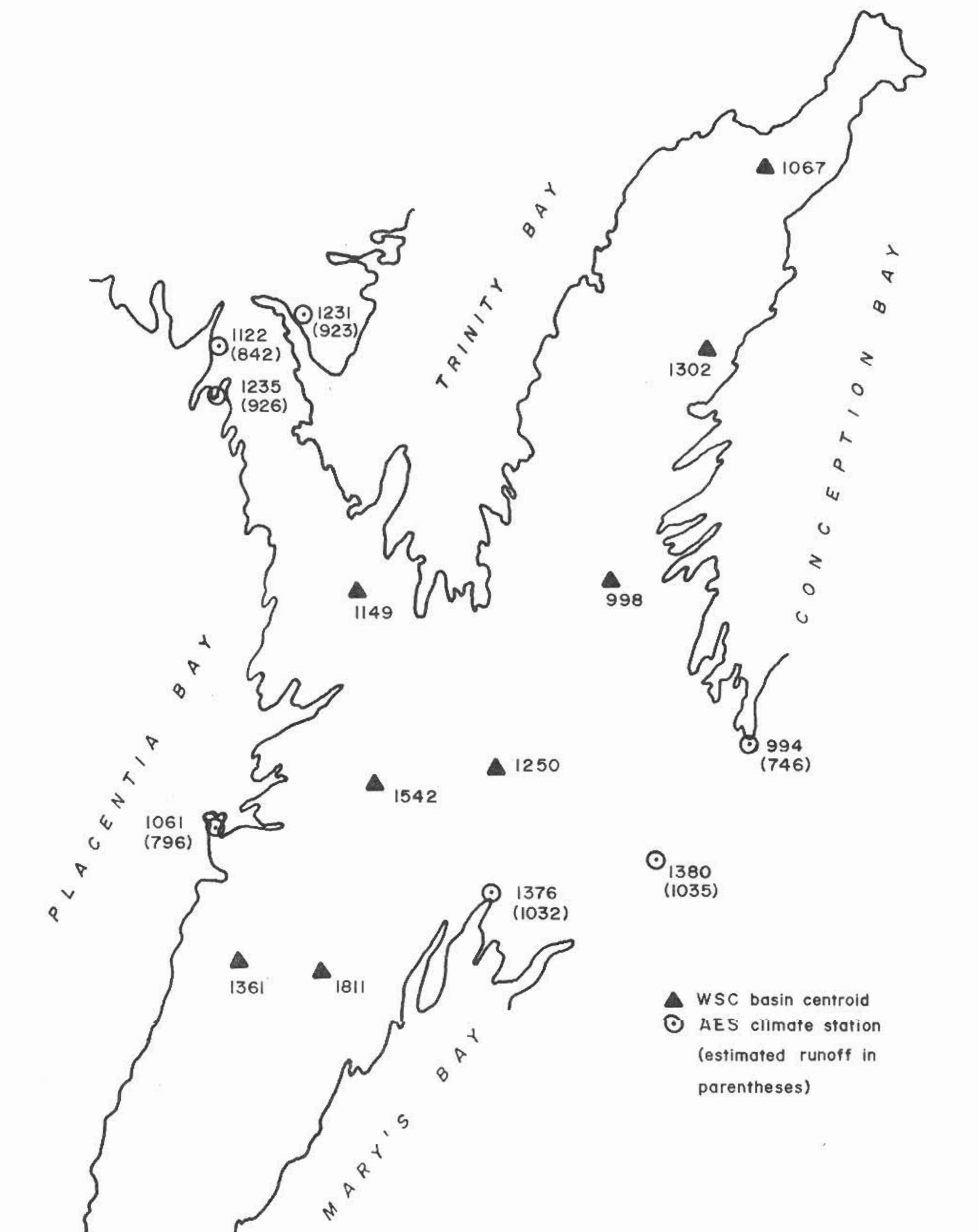

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FIG. AI.4

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Mean Annual Runoff Points

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TABLE A1.4

RUNOFF, ELEVATION, AND LOCATION OF CENTROID OF GAUGED BASINS

Station Name	Drainage Area (km2)	Mean Annual Runoff (mm)	Elev. (m)	Lat. (°W)	Long. (°N)
Rocky River	285	1250	60	47.35	53.55
Northeast River	89.6	1542	120	47.33	53.73
Spout Cove Brook	10.8	1302	170	47.82	53.20
Little Salmonier River	104	1811	180	47.20	53.83
Shearstown Brook	28.9	998	50	47.53	53.37
Little Barachois River	37.2	1361	170	47.22	53.97
Big Brook	11.2	1067	160	48.02	53.10
Trout Brook	42.6	1149	90	47.32	53.78

TABLE A1.5

PRECIPITATION, RUNOFF, ELEVATION, AND

LOCATION OF CLIMATE STATIONS

Station Name	Total Precip.	Estimated Mean Annual Runoff (mm)	Elev. (m)	Lat. (°W)	Long. (°N)
Colinet	1376	1032	20	47.22	53.55
Argentia	1061	796	14	47.30	54.00
Holyrood	994	746	11	47.38	53.13
Come-by-Chance	1122	842	27	47.80	54.02
Arnold's Cove	1235	926	15	47.75	54.00
Sunnyside	1231	923	46	47.85	53.95
Salmonier	1380	1035	145	47.27	53.28

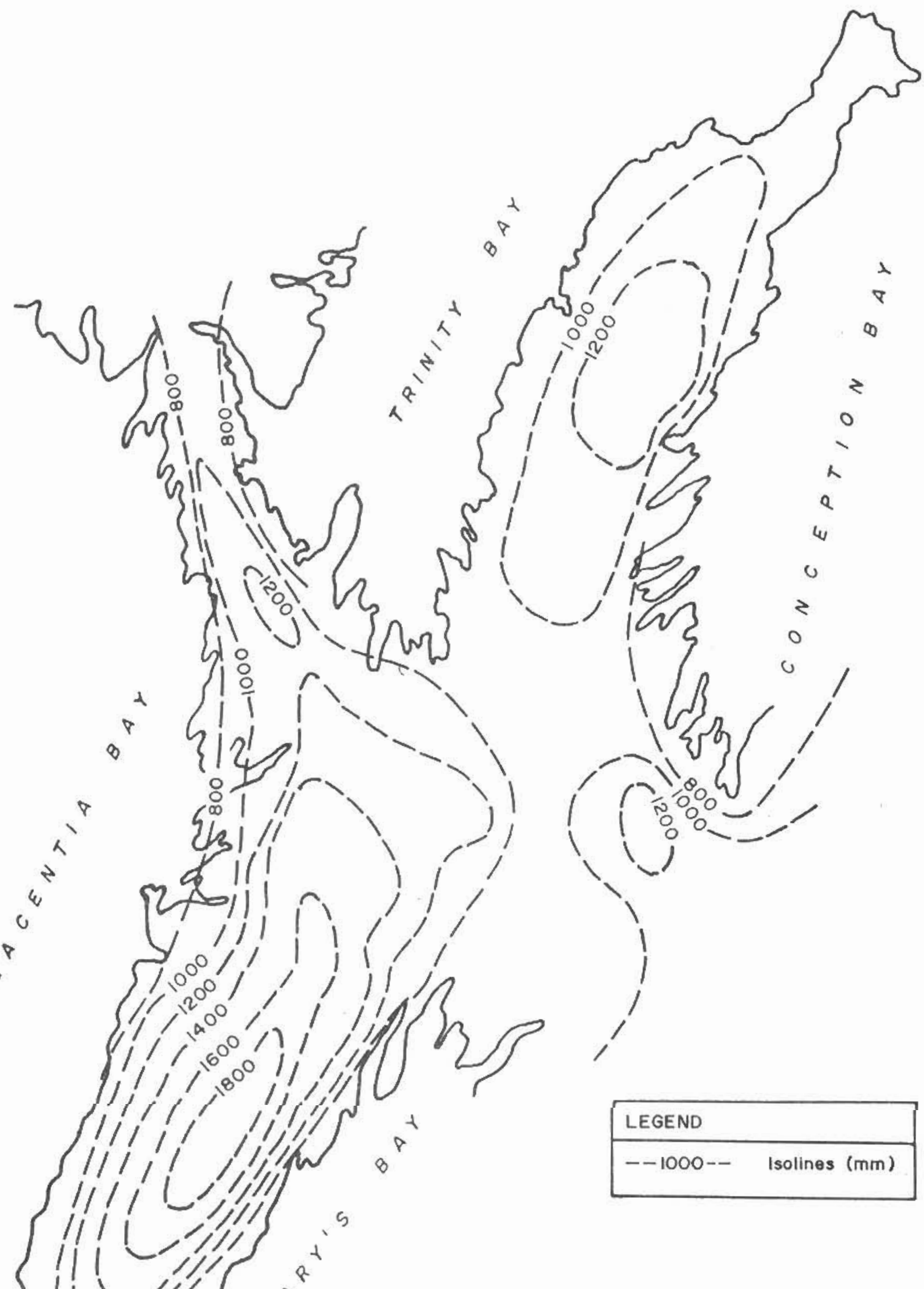

FIG. AI.5

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Isolines of Mean Annual Runoff

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Although most of the AES stations are located at low elevations, one area where a higher station is located near a lower one is near St. John's. The St. John's Airport station is at an elevation of 140 m, and the Logy Bay station is at an elevation of 27 m about 6 km to the northeast. The mean annual precipitation at the airport is 1514 mm, compared with only 912 mm at Logy Bay.

Runoff as a function of elevation is plotted in Figure A1.6 for the AES and WSC stations on the Avalon Peninsula. A line of best fit can be obtained from a least squares analysis, and the correlation coefficient is fairly high (r=0.73). The wide scatter, however, suggests that elevation is not the only variable explaining difference in mean annual runoff over the region.

2 - LOW FLOW ANALYSIS

The purpose of the low flow analysis was to obtain a method of estimating low flows in ungauged basins. The principal low flow measure used in this analysis was flow frequency, with flow duration curve analysis as a secondary measure.

The flow duration curves are presented in Figures A1.7 to A1.10, and the detailed results of the frequency analysis in Appendix C. The results for both analyses were made nondimensional by dividing the low flow by the mean annual flow for each gauge, and are given in Tables 2.2 and 2.3 of the main report. A simple method of obtaining an estimate of low flow for an ungauged catchment is to use the average dimensionless flow from one of these tables.

Since physiographic parameters influence low flows, a regression analysis was also undertaken for this study. The purpose was to obtain an equation incorporating various basin parameters, which could be used to predict 1:10 year low flows on the Avalon

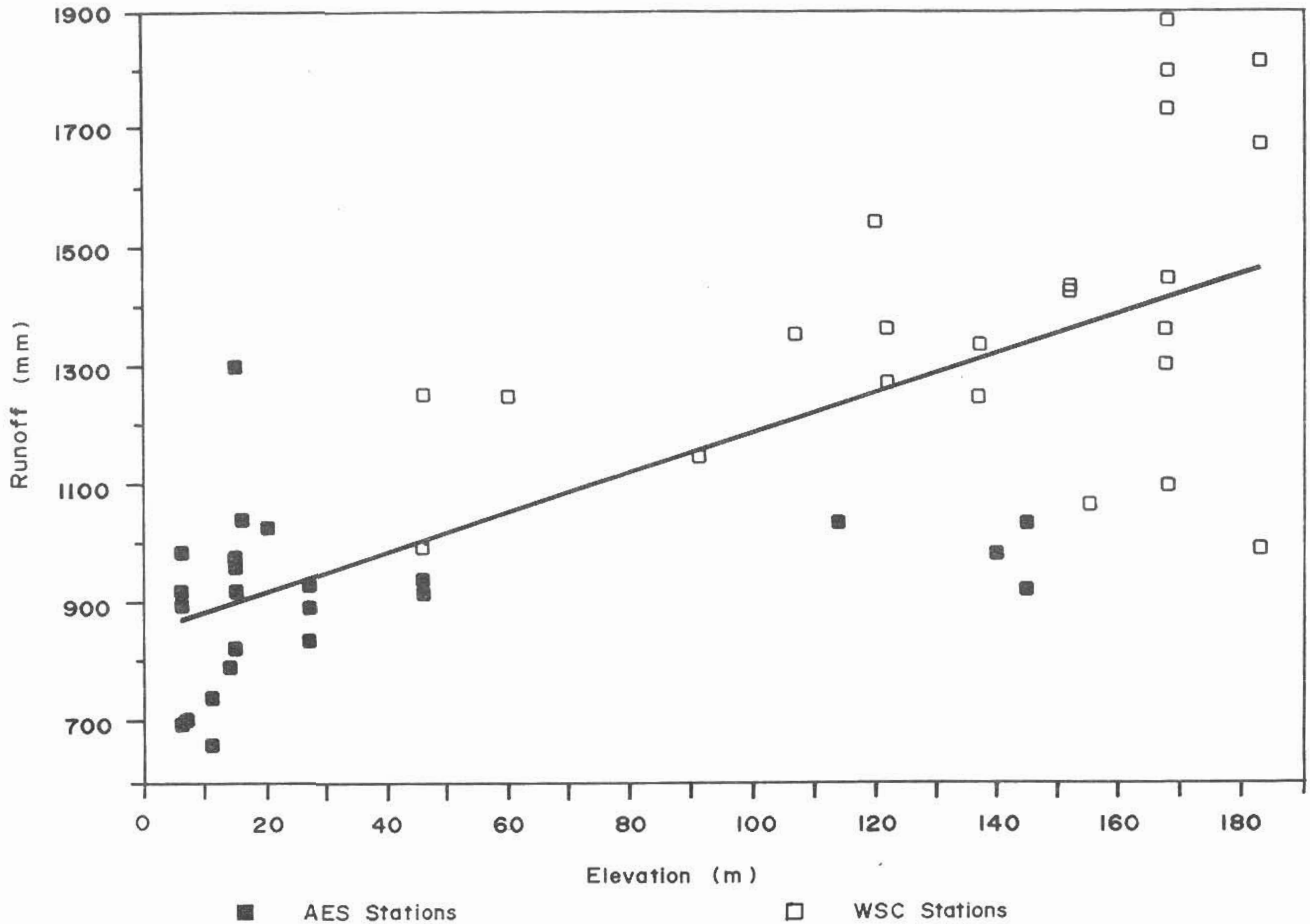

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FIG. AI.6

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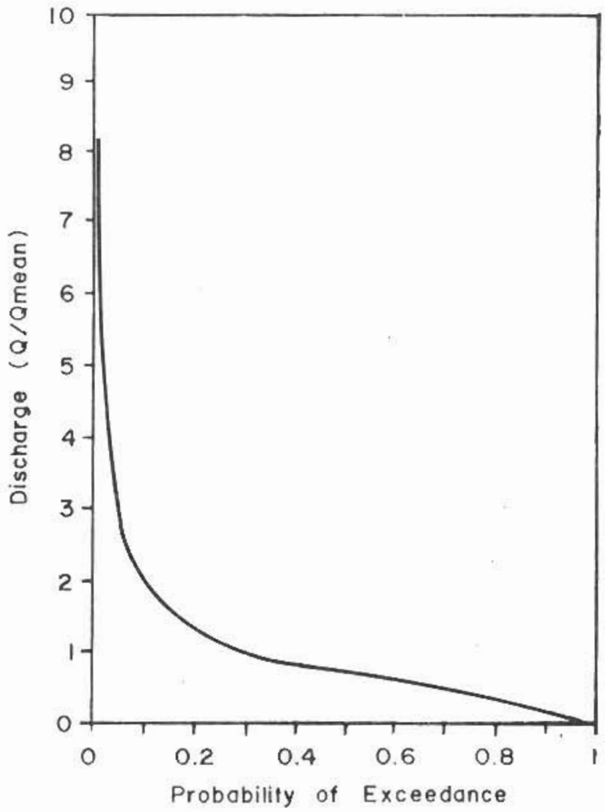
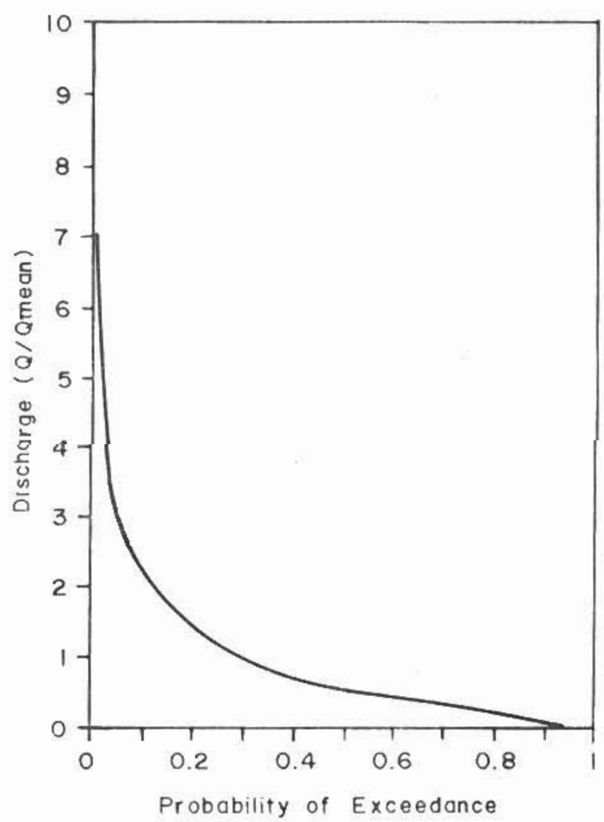
Mean Annual Runoff as a Function of Elevation



SPOUT COVE BROOK



TROUT BROOK near BELLEVUE

FIG. A1.7

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Flow Duration Curves

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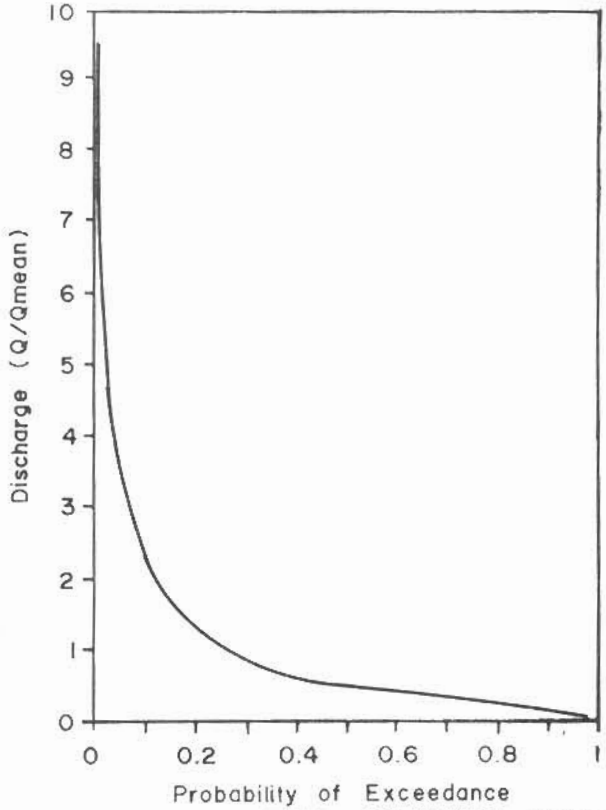
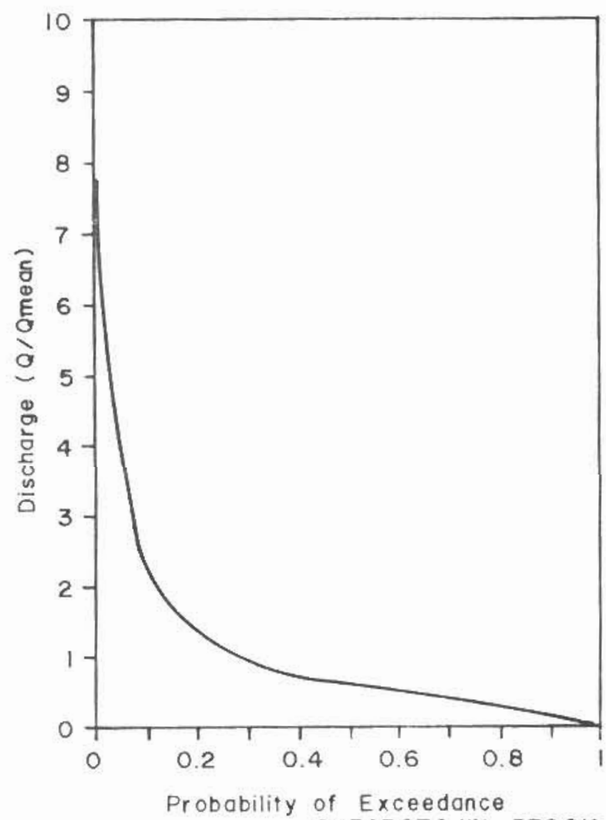


LITTLE SALMONIER RIVER



SHEARSTOWN BROOK

FIG. A1.8

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Flow Duration Curves

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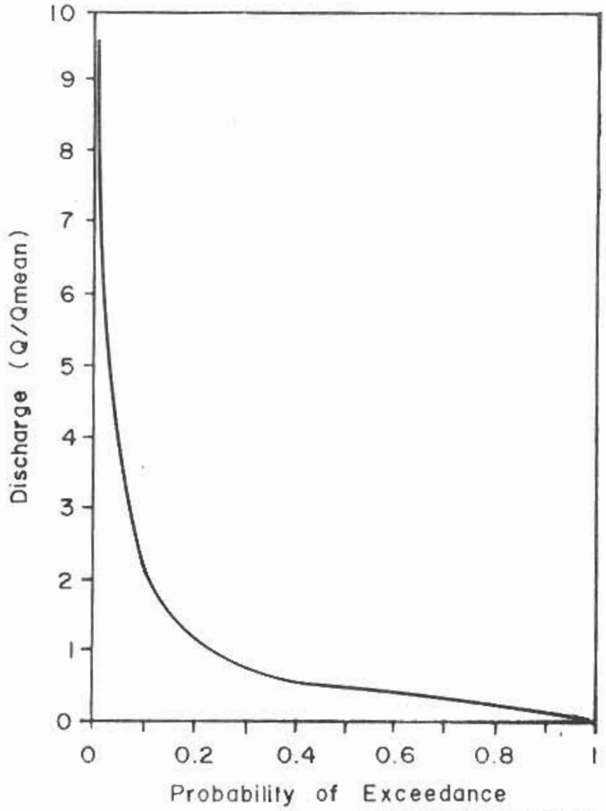
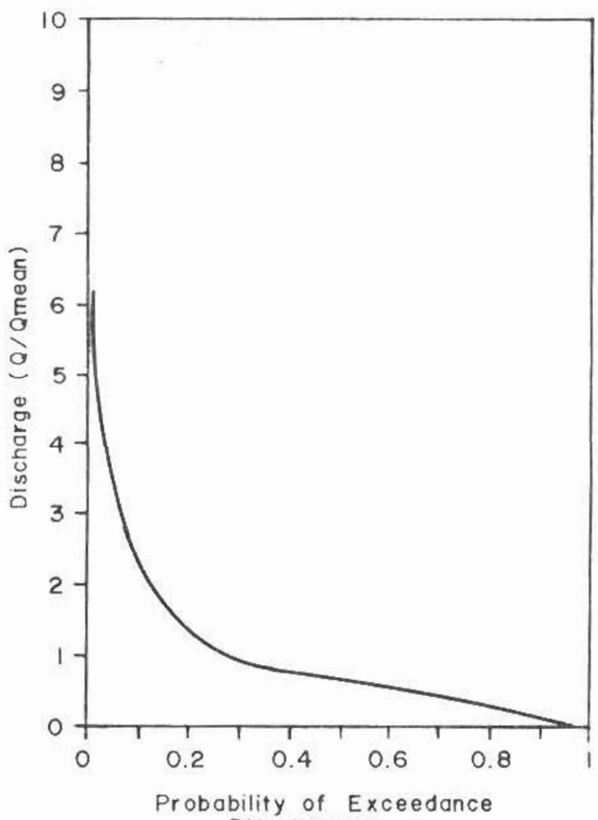


LITTLE BARACHOIS RIVER



BIG BROOK at LEAD COVE

FIG. AI.9

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Flow Duration Curves

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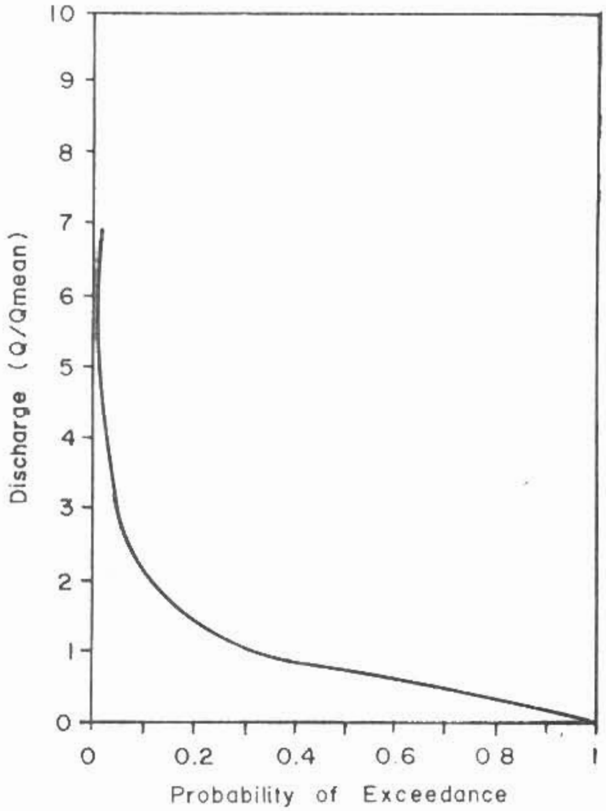
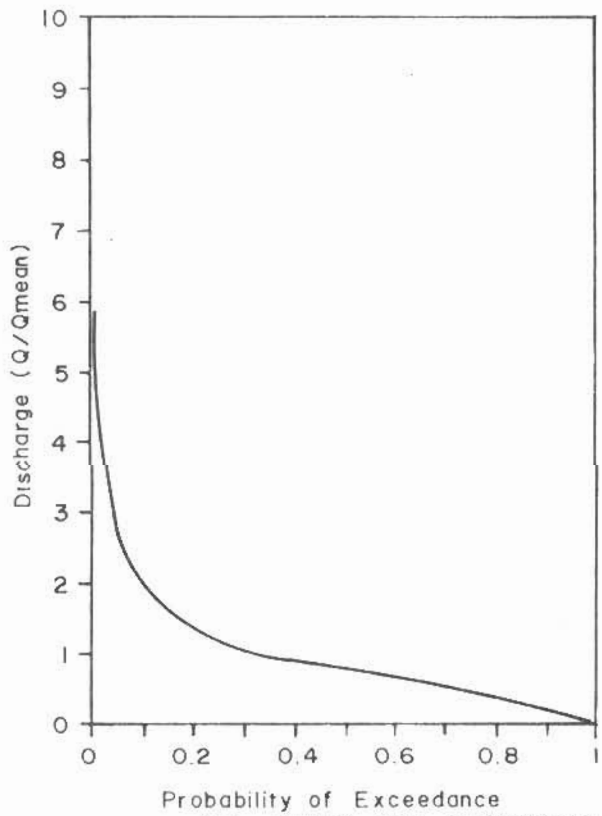


ROCKY RIVER at COLINET



N.E. RIVER near PLACENTIA

FIG. AI.10

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Flow Duration Curves

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Peninsula. Data for 1987 were available to September 1987, and 1987 low flow data were thus be included in the low flow analysis.

2.1 - Regression Analysis

The procedure used in the regression analysis was as follows.

1. The ratio of daily and monthly 1:10 year low flows to mean annual flow was calculated for each of the gauged basins. These normalized values were used as the dependent variables in the analysis.

2. Basin characteristics likely to affect low flows were identified. Values of these parameters were tabulated for the seven gauged basins in the analysis.

3. An exhaustive search stepwise multiple regression computer program was used to determine the regression relationships between the basin characteristics and the normalized low flows. The program computed regression equations for both transformed and nontransformed data and presented statistical significance criteria for all combinations of independent variables taken one, two or three at a time. The transformations automatically carried out were $X^{1/2}$, $Y^{1/2}$, X^2Y^2, LN(X) LN(Y), and X LN(Y), where X is the dependent variable. The interdependency among the independent variables is taken into account in the multiple regression technique. The tabulated dependent and independent variables are presented in Table A2.1.

2.1.1 - Basin Characteristics

The basin characteristics selected for use in the analysis were obtained as described below. The criteria used to select basin

TABLE A2.1

VARIABLES USED IN REGRESSION ANALYSIS OF LOW FLOWS

		RockyR	NEPond	NWBrk	WtrfrdR	SealCv	NEPlac	SpCove
Qd/Qavg	-	0.038	0.016	0.092	0.074	0.060	0.052	0.013
Qm/Qavg	-	0.103	0.048	0.178	0.157	0.177	0.144	0.097
D.A.	km2	285	3.9	53.3	52.7	53.6	89.6	10.8
MAR	mm	1250	1088	1784	1251	1711	1542	1302
Elev	m	60	165	180	150	170	120	170
Lat	W	47.35	47.92	47.65	47.53	46.87	47.33	47.82
Long	N	53.55	53.32	52.82	52.85	53.05	53.73	53.2
Lakes	%	11.9	21.0	12.6	5.0	18.1	32.3	16.7
Slope	-	0.366	2.437	0.634	1.220	0.770	0.673	1.407
Den.	m/m2	1.005	1.038	1.089	1.070	0.580	0.454	1.593
Shape	-	2.00	1.24	2.06	1.13	1.41	1.91	1.62
O'burden	m	22.02	20.61	2.50	2.50	2.50	2.50	2.50
Length	km	45.22	2.63	14.6	9.4	21.7	24.0	8.6
MAF	m3/s	11.29	0.13	3.01	2.09	2.91	4.38	0.45

characteristics were first, that they might reasonably be expected to affect low flows, and second, that they should be readily obtainable at ungauged locations.

The particular form of each of the independent variables was generally chosen for convenience, in some cases (such as shape) because it had already been obtained as part of another study (4). If any of the independent variables showed promise as predictors of low flows, alternative representations could be tested.

Drainage Area: The drainage area above the gauge as calculated by WSC.

MAR: The estimated long term mean annual runoff (Table A1.3).

Elevation, Latitude, Longitude: Taken from Reference 4 if available, or scaled from 1:50 000 topographic maps.

Slope: Elevation difference between the origin of the river and the gauge of interest, divided by the length of the main channel, expressed as a percentage.

Drainage Density: The total length of all the streams in a given basin divided by the drainage area of that basin.

Shape Factor: The dimensionless shape factor was calculated from the following equation. This particular representation of basin shape was convenient to use because it has already been calculated for the gauged basins on the island of Newfoundland (4).

$$SHAPE = 0.28 * P/(D.A.)^{0.5}$$

where

P = Perimeter of the drainage basin

D.A. = Drainage Area

Overburden Depth: Taken from the Energy, Mines and Resources Canada map reproduced in Reference 4. Overburden is divided into three separate categories

Bedrock outcrop	0 m depth
Till Veneer	5 m depth
Till and Blanket	50 m depth

Areas which fall in a 0 to 5 m range were assumed to have a depth of (0 + 5)/2 = 2.5 m, and those in the 5 m to 50 m range were assumed to have a depth of (5 + 50)/2 = 27.5 m. For areas falling within more than one category, a weighted average was used.

Unfortunately detailed overburden data are not readily available. The definition used here results in very crude categories. An alternative is to calculate a base flow index (BFI) from gauge data to represent all sources of base flow. A disadvantage of the BFI is that at least one year of gauge data is required, so it cannot be used on ungauged catchments.

Length: Length of main channel taken from Reference 4 if available, or scaled from 1:50,000 topographic maps.

2.1.2 - Results of the Regression Analysis

The program output was carefully reviewed to ascertain the significance of the equations, both statistical significance and physical significance. An equation was taken to be statistically significant if individual regression coefficients as well as the overall regression equation were significant at a level of not higher than 10 percent. The multiple correlation coefficient, r, and the standard error of the estimate were also considered.

To be physically significant, the equation must be hydrologically realistic. The trends in the predicted relationship should conform with expectations based on an understanding of the physical runoff processes. For example, some of the regression equations predicted an increase in low flow as depth of overburden decreased. Such a relationship was not accepted. It was also considered desirable to use the same parameters for both daily and monthly low flow prediction.

The relationship which provided the best estimate of low flow at the gauged basins used drainage area and elevation as the independent variables. The relationship was statistically significant for both the one day and one month low flows. However, the relationship shows too strong a dependence on elevation. A similar overestimate of the significance of elevation was obtained in a previous study in which a low flow regression analysis was attempted (38). The limited data set, with the largest basin also having the lowest elevation, is probably responsible for this result. Other approaches, such as forcing the data through zero, did not produce good results.

The conclusion from this work is that due to the limitations of the data set, the most physically reasonable relationships did not meet the statistical criteria, and the most statistically significant equations could not be physically justified.

The analysis should be extended to a larger region so that more gauge records are available for the analysis. The inclusion of some smaller basins at lower elevations and larger basins at higher elevations would improve the data set. Other modifications to the analysis could include the separation of summer and winter low flows and the introduction of other independent variables, such as a base flow index and distance from the sea in key directions. Further consideration of the physical processes involved might suggest other combinations and/or transforms of the independent variables.

APPENDIX B
MONTHLY PRECIPITATION DATA

TABLE B1.1

MONTHLY PRECIPITATION

Station Name : Argentia
Station No. : 8400100
Latitude : 47° 18'
Longitude : 54° 00'
Elevation : 14m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1945	-	-	193	478	983	724	1113	485	759	-	719	-	-
1946	-	-	706	-	500	-	886	1298	-	1387	1115	1689	-
1947	-	-	1082	368	1176	955	747	826	221	61	597	1539	-
1948	2050	1082	569	-	-	1072	343	-	1138	160	340	203	-
1949	-	1062	-	1935	516	2167	714	1034	1524	-	-	-	-
1950	-	1966	2007	2195	566	1412	1506	1290	912	-	-	1641	-
1951	4102	2002	833	1237	780	465	838	1435	742	574	1704	2078	1399.2
1952	1788	1207	815	518	254	940	160	1049	838	574	744	660	795.6
1953	1339	526	518	1669	490	704	747	404	579	1433	1298	1836	961.9
1954	1013	732	914	450	1384	323	1090	742	823	1024	1146	1227	905.7
1955	1146	1021	505	676	912	-	1082	1110	762	1290	1808	828	-
1956	869	1689	1107	-	1626	1100	1458	955	1806	589	3216	1026	-
1957	930	696	561	246	483	119	1349	1557	1631	1092	1001	1072	894.8
1958	549	691	170	564	673	734	1184	678	587	610	683	869	666.0
1959	780	719	328	147	152	104	64	-	-	-	1509	968	-
1960	597	437	1377	305	305	358	229	315	394	622	1024	1143	592.2
1961	536	709	871	361	269	333	165	295	335	950	592	432	487.3
1962	739	2007	282	442	269	996	1105	411	782	937	1168	1313	870.9
1963	1732	907	279	996	1153	688	643	744	1049	310	904	1252	888.1
1964	1204	1046	734	605	381	335	1173	762	688	1344	599	1384	854.6
1965	1148	841	589	607	714	516	726	541	211	-	879	699	-
1966	1224	373	678	396	1016	1021	828	480	467	569	676	1085	734.4
1967	826	1496	1135	485	363	307	427	498	739	699	907	404	690.5
1968	744	815	1113	254	323	513	638	574	406	1684	980	754	733.2
1969	709	777	559	632	660	726	658	1996	1146	1295	643	864	888.8
1970	800	2553	757	-	-	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													824.2

TABLE B1.2

MONTHLY PRECIPITATION

Station Name : Argentia
Station No. : 8400102
Latitude : 47° 18'
Longitude : 54° 00'
Elevation : 16m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1976	-	-	-	-	945	953	947	729	1029	1567	932	1621	-
1977	1259	422	340	595	708	563	707	554	1136	631	951	2278	845.3
1978	1708	338	1269	1439	1065	1448	819	666	1808	1028	1094	-	-
1979	1452	444	976	389	958	726	1008	1760	1638	2454	1207	957	1164.1
1980	822	1371	1673	469	1308	1937	1290	1647	1757	2120	1227	1054	1389.6
1981	1537	730	1197	573	663	1858	1958	1198	1618	2805	1770	1141	1420.7
1982	1395	843	753	1074	1188	1226	863	1529	1691	606	925	1933	1168.8
1983	1182	721	1118	742	700	1451	1194	1303	1238	1472	1202	943	1105.5
1984	1257	1557	836	997	1431	879	412	1530	1856	586	742	652	1061.3
1985	831	882	854	580	-	1052	1968	872	794	734	995	1070	-
1986	1199	1128	2281	1064	528	1550	706	628	754	1050	-	-	-
AVG	-	-	-	-	-	1240.3	1079.3	1128.7	1392.6	1368.5	-	-	
													1165.0

TABLE B1.3

MONTHLY PRECIPITATION

Station Name : Arnold's Cove
Station No. : 8400135
Latitude : 47° 45'
Longitude : 54° 00'
Elevation : 15m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1971	-	-	-	-	-	-	1077	1349	643	991	2235	1021	-
1972	1024	869	902	531	782	681	211	859	714	2111	1687	1171	961.8
1973	1356	1920	429	208	1250	919	1143	1537	838	953	1069	963	1048.8
1974	528	914	1692	1217	478	732	866	1059	1267	2042	1219	1648	1138.5
1975	1656	495	-	983	-	422	625	810	338	1999	1275	836	-
1976	2027	2090	790	965	711	663	836	419	869	1626	584	1933	1126.1
1977	1473	648	544	728	825	699	-	-	776	795	1355	1850	-
1978	1751	172	1296	619	1049	1560	644	290	1427	720	734	1019	940.1
1979	1139	410	1155	270	1100	870	976	710	994	2252	1234	1069	1014.9
1980	1176	402	1401	664	842	2182	1136	1970	1830	1534	1210	1456	1316.9
1981	927	727	1175	542	964	1824	1460	1084	1418	2310	1858	722	1250.9
1982	-	386	674	810	1342	1922	1090	1454	1100	544	1263	1006	-
1983	1354	-	1514	1340	930	1546	1100	1608	1640	1076	1696	1334	-
1984	1734	1898	1020	1198	1538	1467	472	2040	1962	598	723	-	-
1985	574	1060	746	928	1151	1369	2334	929	494	762	1002	1400	1062.4
1986	1526	1095	-	1163	564	2166	920	770	965	1127	1724	594	1051.2
1987	1277	1090	814	1092	906	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1091.2

TABLE B1.4

MONTHLY PRECIPITATION

Station Name : Avondale

Station No. : 8400225

Latitude : 47° 25'

Longitude : 53° 14'

Elevation : 133m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1955	-	-	-	-	-	-	785	914	500	-	-	-	-
1956	-	-	-	-	-	1046	1168	1478	1646	411	-	-	-
1957	-	-	-	-	-	-	810	1097	1427	-	-	-	-
1958	-	-	-	-	-	597	1321	800	958	-	-	-	-
1959	-	-	-	-	-	724	419	1069	1003	-	-	-	-
1960	-	-	-	-	-	483	262	650	792	864	-	-	-
1961	-	-	-	-	-	356	399	467	551	-	-	-	-
1962	-	-	-	-	-	833	975	724	1308	-	-	-	-
1963	-	-	-	-	-	787	-	-	1125	564	-	-	-
1964	-	-	-	-	-	643	1102	864	1166	-	-	-	-
1965	-	-	-	-	-	792	869	475	592	-	-	-	-
1966	-	-	-	-	-	752	1057	828	569	-	-	-	-
1967	-	-	-	-	-	229	315	490	1118	-	-	-	-
1968	-	-	-	-	1265	1107	897	1125	231	-	-	-	-
1969	-	-	-	-	833	625	584	2245	1389	-	-	-	-
1970	-	-	-	-	-	792	417	3371	1468	-	-	-	-
1971	-	-	-	-	-	739	925	1280	826	699	-	-	-
1972	-	-	-	-	-	785	208	998	975	1956	-	-	-
1973	-	-	-	-	699	1204	564	-	1067	1387	-	-	-
1974	-	-	-	-	671	432	851	1638	1488	-	-	-	-
1975	-	-	-	-	-	386	803	1181	919	-	-	-	-
1976	-	-	-	-	-	1064	1039	589	1074	-	-	-	-
1977	-	-	-	-	-	460	722	788	1845	-	-	-	-
1978	-	-	-	-	691	1416	855	526	1838	-	-	-	-
1979	-	-	-	-	-	722	672	1354	1188	2300	-	-	-
1980	-	-	-	-	-	1612	1098	2162	1557	2180	-	-	-
1981	-	-	-	-	-	1710	1310	1350	1644	2688	-	-	-
1982	-	-	-	-	-	1328	662	1072	1836	-	-	-	-
1983	-	-	-	-	-	-	1262	1218	1688	-	-	-	-
1984	-	-	-	-	-	-	398	1514	1734	-	-	-	-
1985	-	-	-	-	-	-	1576	890	658	-	-	-	-
1986	-	-	-	-	-	1474	780	788	1006	-	-	-	-
AVG	-	-	-	-	-	-	-	-	1162.1	-	-	-	

TABLE B1.5

MONTHLY PRECIPITATION

Station Name : Branch
Station No. : 8400666
Latitude : 46° 53'
Longitude : 53° 58'
Elevation : 37m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1983	-	-	-	-	-	-	-	-	-	-	-	1172	-
1984	1325	1670	1058	1530	1259	976	809	1122	2389	858	1261	1509	1313.8
1985	1077	1229	726	758	2174	1594	1936	1310	806	1206	1615	1134	1297.1
1986	1546	1335	2294	-	586	1802	1466	1098	968	1694	2660	728	-
1987	1312	1430	1048	1758	926	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1305.5

TABLE B1.6

MONTHLY PRECIPITATION

Station Name : Carbonear
Station No. : 8401075
Latitude : 47° 44'
Longitude : 53° 14'
Elevation : 23m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1972	-	-	-	-	-	-	-	-	-	-	2294	1892	-
1973	1689	1900	681	127	937	1219	663	1808	1153	594	922	693	1032.2
1974	726	518	1364	1016	-	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1032.2

TABLE B1.7

MONTHLY PRECIPITATION

Station Name : Come By Chance
Station No. : 8401257
Latitude : 47° 48'
Longitude : 54° 01'
Elevation : 27m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1968	-	-	-	-	-	1692	-	-	-	-	-	-	-
1969	-	1194	-	-	1092	622	-	1722	-	-	947	-	-
1973	-	-	-	-	-	-	-	-	-	335	869	-	-
1974	-	-	1702	1303	554	805	856	1008	1135	2593	-	2070	-
1975	1415	564	-	1336	422	615	747	853	437	1656	1483	881	-
1976	1369	1039	919	1295	668	452	777	546	714	1143	330	1247	874.9
1977	941	493	434	385	796	676	290	555	585	431	556	1058	600.0
1978	1645	527	859	590	666	1002	466	299	944	606	456	1082	761.8
1979	1110	341	1053	334	842	1064	665	928	745	2145	-	1288	-
1980	832	967	1468	886	1187	1876	1311	1848	1730	963	1306	1116	1290.8
1981	1565	690	853	744	843	1711	1420	1169	1520	1724	1483	1070	1232.7
1982	1668	965	514	995	1001	1172	1056	713	1300	901	1091	1069	1037.1
1983	1307	814	1295	982	1139	1622	1027	1224	1496	1195	1048	1249	1199.8
1984	1612	1378	936	1022	1419	1147	567	2007	1802	582	827	1244	1211.9
1985	630	590	-	791	1182	1310	1875	1125	445	770	1002	1343	-
1986	1430	1150	1567	1052	549	1635	864	732	1008	1135	1623	732	1123.1
1987	1664	1120	888	1107	846	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1036.9

TABLE B1.8

MONTHLY PRECIPITATION

Station Name : Colinet
Station No. : 8401200
Latitude : 47° 13'
Longitude : 53° 33'
Elevation : 20m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1938	-	-	-	-	-	-	-	1191	897	1407	1481	991	-
1939	960	823	1986	1440	1031	785	1300	2296	1224	1516	706	1285	1279.3
1940	1237	1562	1458	1217	1003	1097	960	1255	1341	1201	1166	1321	1234.8
1941	1539	1125	1854	785	1763	892	1240	1229	1046	1115	1455	1181	1268.7
1942	2804	1504	1242	579	450	643	1880	658	264	1648	1184	1615	1205.9
1943	874	2741	2012	1455	846	632	1171	1791	2573	836	-	1770	-
1944	-	879	-	1265	645	1928	866	1135	815	914	1831	2202	-
1945	1511	1123	536	747	1976	937	1397	-	1151	-	1486	2098	-
1946	1100	2403	884	-	937	409	1697	1854	376	1257	1824	2532	-
1947	1316	1275	1704	630	925	1171	861	671	1293	732	610	1156	1028.7
1948	699	594	582	1638	1722	1298	1415	655	2372	1908	508	673	1172.0
1949	1552	1361	2215	861	853	508	658	366	1237	792	1979	1273	1137.9
1950	1044	1450	1372	922	1158	655	556	676	572	1796	152	-	-
1951	1811	1273	1356	1722	579	-	1090	1293	917	838	1994	2507	-
1952	1979	1745	1140	798	391	1049	366	1565	1715	1064	1565	699	1173.0
1953	1148	1214	1135	1364	765	-	-	653	747	1542	1499	3035	-
1954	1435	1067	1702	762	1516	589	1046	945	757	1204	1029	1842	1157.8
1955	2035	1440	1151	1636	1130	1262	993	1313	856	2243	2271	-	-
1956	1110	1575	1334	1214	-	1212	1087	1039	1801	693	2847	1433	-
1957	1750	1184	1041	833	650	188	729	1029	1240	1102	1646	1821	1101.1
1958	1354	1222	335	1374	1389	1267	1427	1125	1516	1036	1679	1844	1297.3
1959	1179	1410	-	1001	602	790	292	792	1214	617	2718	1440	-
1960	1016	650	2009	414	574	742	472	866	729	1260	1765	1730	1018.9
1961	1171	726	1321	894	813	528	592	503	526	1242	-	734	-
1962	1186	2276	744	892	584	1080	1529	1158	1323	1107	2007	1826	1309.3
1963	1882	991	231	955	1115	1064	599	1494	1191	561	1313	1476	1072.7
1964	1806	1402	1001	1740	706	-	1674	975	998	2159	826	1194	-
1965	1369	818	-	998	879	1011	1544	737	526	1212	1506	851	-
1966	1735	389	914	627	1638	1057	1994	701	853	1349	1125	2332	1226.2
1967	1626	2096	927	1265	894	528	457	597	1214	1049	1483	993	1094.1
1968	554	1059	1092	762	1339	1527	1011	1425	610	1478	1702	1171	1144.2
1969	993	1331	1163	1359	991	894	968	2090	1417	1742	1118	1227	1274.4
1970	495	2685	767	780	1473	950	574	3754	1224	699	1689	1565	1387.9
1971	1633	739	1087	1232	655	1011	1199	1448	1003	1036	1951	747	1145.1

TABLE B1.8 (cont.)

MONTHLY PRECIPITATION

Station Name : Colinet
Station No. : 8401200
Latitude : 47° 13'
Longitude : 53° 33'
Elevation : 20m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1972	1554	889	1311	617	914	729	434	1184	932	2050	1702	1016	1111.0
1973	1171	2167	1044	312	1062	1816	719	2062	945	897	1280	1046	1210.1
1974	721	630	1549	1143	803	828	1191	1666	1212	2487	1394	1603	1268.9
1975	1077	513	975	1029	980	630	968	1402	1024	1740	1214	1059	1050.9
1976	2149	1435	1013	1090	1001	1166	1019	800	1133	1608	1003	1852	1272.4
1977	1202	683	544	754	802	559	1012	767	1733	898	1274	1746	997.8
1978	1906	571	1066	971	1572	1488	707	802	2001	811	1046	1006	1162.3
1979	1151	357	1018	468	826	1260	1146	1484	1230	2150	900	720	1059.2
1980	1250	1446	1974	810	1060	2051	1389	1676	1964	1821	1024	1320	1482.1
1981	1721	538	640	746	650	1944	1351	1428	1439	2138	1287	962	1237.0
1982	1327	840	814	860	1313	1289	1212	1152	1536	605	1197	1572	1143.1
1983	1554	680	1196	1034	650	1520	1436	1180	1550	1440	1180	1175	1216.3
1984	1353	1880	980	1220	1698	877	430	1658	1740	520	844	1160	1196.7
1985	790	590	590	540	1668	1088	1478	906	640	756	872	1160	923.2
1986	1300	1050	1450	400	266	1245	670	710	1160	1044	1156	590	920.1
1987	1220	1130	1050	1304	994	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1170.9

TABLE B1.9

MONTHLY PRECIPITATION

Station Name : Colinet
Station No. : 8401250
Latitude : 47° 13'
Longitude : 53° 30'
Elevation : 104m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1957	-	-	-	-	-	-	-	-	1344	1237	1461	1918	-
1958	1240	1463	328	1057	1278	1161	1750	1351	1339	953	1440	1110	1205.8
1959	1100	2027	1621	1049	688	744	328	846	1260	582	-	-	-
1960	-	-	-	-	-	691	569	709	1687	1466	-	-	-
1961	-	-	-	-	-	663	523	495	490	1143	-	-	-
1962	-	-	-	-	-	1003	1509	1092	1557	1377	-	-	-
1963	-	-	-	-	-	-	660	1511	-	582	-	-	-
1964	-	-	-	-	800	-	1532	1021	1074	2543	765	-	-
1965	-	-	-	-	935	833	1448	630	640	973	-	-	-
1966	-	-	-	-	-	942	2040	635	749	1443	-	-	-
1967	-	-	-	-	-	569	686	843	1255	1143	-	-	-
1968	-	-	-	-	-	1486	1184	1204	561	1339	-	-	-
1969	-	-	-	-	-	856	838	2350	1123	-	-	-	-
1970	-	-	-	-	-	846	602	3553	1468	772	-	-	-
1971	-	-	-	-	-	1209	1318	1727	993	1097	-	-	-
1972	-	-	-	-	-	950	455	1173	899	1857	-	-	-
1973	-	-	-	-	1275	1864	795	1961	1034	818	-	-	-
1974	-	-	-	-	-	813	958	1712	1496	2289	-	-	-
1975	-	-	-	-	-	533	869	1311	871	-	-	-	-
1976	-	-	-	-	-	1013	1097	881	1577	-	-	-	-
1977	-	-	-	-	843	561	547	632	947	-	-	-	-
1978	-	-	-	-	-	1560	716	648	1729	1443	-	-	-
1979	-	-	-	-	-	-	1117	1622	1030	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	

1205.8

TABLE B1.10

MONTHLY PRECIPITATION

Station Name : Colinet
Station No. : 8401251
Latitude : 47° 14'
Longitude : 53° 31'
Elevation : 55m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1980	-	-	-	-	-	2200	1174	1694	2006	1946	-	-	-
1981	-	-	-	-	-	2049	1266	1476	1602	1970	-	-	-
1982	-	-	-	-	-	1602	1128	1483	1236	341	-	-	-
1983	-	-	-	-	-	1504	1428	1230	1620	-	-	-	-
1984	-	-	-	-	-	955	502	1617	1802	-	-	-	-
1985	-	-	-	-	-	1312	1648	916	837	-	-	-	-
1986	-	-	-	-	-	1698	682	772	1074	-	-	-	-
AVG	-	-	-	-	-	1617.1	1118.3	1312.6	1453.9	-	-	-	-

TABLE B1.11

MONTHLY PRECIPITATION

Station Name : Harbour Grace
Station No. : 8402076
Latitude . 47° 41'
Longitude : 53° 14'
Elevation : 15m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1979	-	-	-	-	-	-	-	-	-	-	-	1242	-
1980	1266	1204	1735	338	1066	904	692	1862	2200	2393	1535	1277	1372.7
1981	1696	970	1032	502	374	1622	1360	983	2223	2426	1637	1274	1341.6
1982	2053	1340	872	772	1069	1302	459	1188	2233	1161	1064	1117	1219.2
1983	1726	1160	1173	1426	510	988	1130	1224	1832	1550	1366	972	1254.8
1984	1315	1670	980	1470	1580	1140	240	1550	1630	700	800	1130	1183.8
1985	1296	1166	1114	843	1525	1157	1374	729	538	985	1000	1476	1100.3
1986	1328	878	1720	1020	370	2016	680	578	1125	1438	1817	564	1127.8
1987	1681	1569	1107	1010	654	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1228.6

TABLE B1.12

MONTHLY PRECIPITATION

Station Name : Placentia
Station No. : 8402956
Latitude : 47° 14'
Longitude : 54° 01'
Elevation : 14m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1970	-	-	-	-	-	-	-	-	-	-	1285	1638	-
1971	1834	912	1120	1422	500	963	1102	983	775	1019	2281	818	1144.1
1972	1067	660	1379	597	998	859	239	1250	848	1643	1252	947	978.3
1973	1034	1854	752	196	1295	1486	805	2004	1120	1196	1219	701	1138.5
1974	556	508	1123	1775	538	1107	996	1844	1588	2492	1173	1171	1239.3
1975	808	396	886	1176	754	404	907	1781	686	2202	1257	884	1011.8
AVG	-	-	-	-	-	-	-	-	-	-	1411.2	1026.5	
													1102.4

TABLE B1.13

MONTHLY PRECIPITATION

Station Name : Salmonier
Station No. : 8403621
Latitude : 47° 16'
Longitude : 53° 17'
Elevation : 145m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
Oct	Nov	Dec	AVG										
1978	-	674	960	944	1245	2114	1118	428	1576	846	954	1165	-
1979	1466	250	1253	1082	966	750	1118	1996	1534	2470	1244	958	1257.2
1980	754	795	2152	560	1159	2174	1226	1700	1810	2306	1142	1768	1462.1
1981	1507	380	1432	766	637	1804	1392	1124	1700	2558	1632	1473	1367.0
1982	1758	904	968	574	1412	1120	696	1434	1790	961	-	-	-
1983	-	-	-	1004	798	1429	1344	1134	1388	1748	1162	1109	-
1984	-	1911	1148	1368	-	-	572	1588	1868	646	652	1048	-
1985	1058	962	836	756	1988	1224	1646	1010	794	963	850	1234	1110.0
1986	1518	1148	-	774	620	1754	840	880	-	1409	2044	-	-
1987	1392	998	786	1276	1040	-	-	-	-	-	-	-	-
AVG	-	-	-	910.4	-	-	-	-	-	-	-	-	
													1299.1

TABLE B1.14

MONTHLY PRECIPITATION

Station Name : St. Bride's
Station No. : 8403418
Latitude : 46° 55'
Longitude : 54° 10'
Elevation : 79m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1984	-	1713	1006	1408	1045	1020	630	1510	2472	656	892	1191	-
1985	-	-	-	-	1500	-	1796	-	660	890	1114	-	-
1986	1356	-	1790	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	1141	587	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE B1.15

MONTHLY PRECIPITATION

Station Name : Sunnyside
Station No. : 8403818
Latitude : 47° 51'
Longitude : 53° 57'
Elevation : 46m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1971	-	-	-	-	-	-	1138	1379	757	942	-	937	-
1972	1179	549	836	392	1013	828	384	1080	925	2141	1676	1024	1043.9
1973	759	1285	564	206	1382	1041	1308	1613	993	584	1341	1181	1021.4
1974	914	1069	922	1590	478	526	574	1113	1207	2517	737	1900	1128.9
1975	866	635	1306	1130	757	-	-	894	587	2002	1692	584	-
1976	1237	1389	742	1059	737	945	902	523	950	1430	490	1707	1009.3
1977	-	892	622	420	-	471	676	648	992	874	1150	1041	-
1978	925	473	1047	1072	975	1606	844	475	1853	777	641	436	927.0
1979	1073	222	886	317	1011	1017	1009	1098	966	2353	1284	1058	1024.5
1980	888	1080	1824	698	1460	2096	1126	1718	1688	1412	1671	1298	1413.3
1981	1248	845	1235	664	1062	1662	1598	1275	1671	2152	1794	1111	1359.8
1982	1848	926	624	936	1105	1738	1029	932	1500	812	1167	1233	1154.2
1983	944	768	-	1232	923	1618	1240	1616	1722	1147	784	1363	-
1984	1505	1896	1252	1168	1427	1054	612	1940	1970	620	660	1200	1275.3
1985	1280	1600	990	530	1170	1320	2104	1046	566	729	940	-	-
1986	-	-	1314	1025	707	1736	917	1046	1000	1430	1419	-	-
1987	1285	1200	1234	1193	834	-	-	-	-	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1135.8

TABLE B1.16

MONTHLY PRECIPITATION

Station Name : Markland
Station No. : 8402590
Latitude : 47° 23′
Longitude : 53° 33′
Elevation :60m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
1981	-	-	-	-	-	-	-	-	-	2278	1810	1524	-
1982	2535	1494	1195	866	1078	1568	870	1372	1918	910	1528	1854	1432.3
1983	2036	798	1786	1146	1126	1712	1594	1388	1436	1628	2016	1488	1512.8
1984	1836	2067	1279	1736	1778	1058	546	1478	1772	654	960	1420	1382.0
1985	1326	1372	1244	876	2034	1328	1980	976	718	1060	1072	1568	1296.2
1986	2138	1574	2490	922	726	1936	892	972	1366	-	-	-	-
AVG	-	-	-	-	-	-	-	-	-	-	-	-	
													1405.8

APPENDIX C
RESULTS OF FREQUENCY ANALYSIS

ROCKY RIVER NEAR COLINET (02ZK001)

1 DAY LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	1 DAY MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
8	1950	0.2040	0.2040	1	1.57	63.67
6	1951	0.6510	0.2440	2	4.19	23.87
7	1952	0.5950	0.3030	3	6.81	14.69
9	1953	0.6230	0.4560	4	9.42	10.61
9	1954	1.3900	0.5060	5	12.04	8.30
7	1955	1.6100	0.5950	6	14.66	6.82
2	1956	1.5000	0.6230	7	17.28	5.79
8	1957	0.4560	0.6230	8	19.90	5.03
8	1958	2.0700	0.6400	9	22.51	4.44
8	1959	0.6510	0.6510	10	25.13	3.98
8	1960	0.3030	0.6510	11	27.75	3.60
9	1961	0.2440	0.7760	12	30.37	3.29
9	1962	1.0500	0.7790	13	32.98	3.03
7	1963	0.7790	0.7790	14	35.60	2.81
7	1964	1.5300	0.8210	15	38.22	2.62
8	1965	0.6230	0.8860	16	40.84	2.45
8	1966	2.2200	0.9370	17	43.46	2.30
7	1967	0.7790	0.9820	18	46.07	2.17
7	1968	1.5900	1.0500	19	48.69	2.05
7	1969	1.1800	1.1800	20	51.31	1.95
8	1970	1.1900	1.1900	21	53.93	1.85
8	1971	1.7800	1.2200	22	56.54	1.77
8	1972	0.7760	1.3000	23	59.16	1.69
7	1973	2.9200	1.3600	24	61.78	1.62
8	1974	1.5500	1.3900	25	64.40	1.55
7	1975	0.9370	1.5000	26	67.02	1.49
8	1976	0.8860	1.5000	27	69.63	1.44
8	1977	0.8210	1.5300	28	72.25	1.38
8	1978	0.6400	1.5500	29	74.87	1.34
7	1979	1.3000	1.5900	30	77.49	1.29
2	1980	2.8900	1.6100	31	80.10	1.25
5	1981	1.7400	1.7400	32	82.72	1.21
8	1982	1.2200	1.7800	33	85.34	1.17
7	1983	2.2800	2.0700	34	87.96	1.14
8	1984	0.9820	2.2200	35	90.58	1.10
8	1985	1.5000	2.2800	36	93.19	1.07
8	1986	1.3600	2.8900	37	95.81	1.04
7	1987	0.5060	2.9200	38	98.43	1.02

ROCKY RIVER NEAR COLINET (02ZK001)

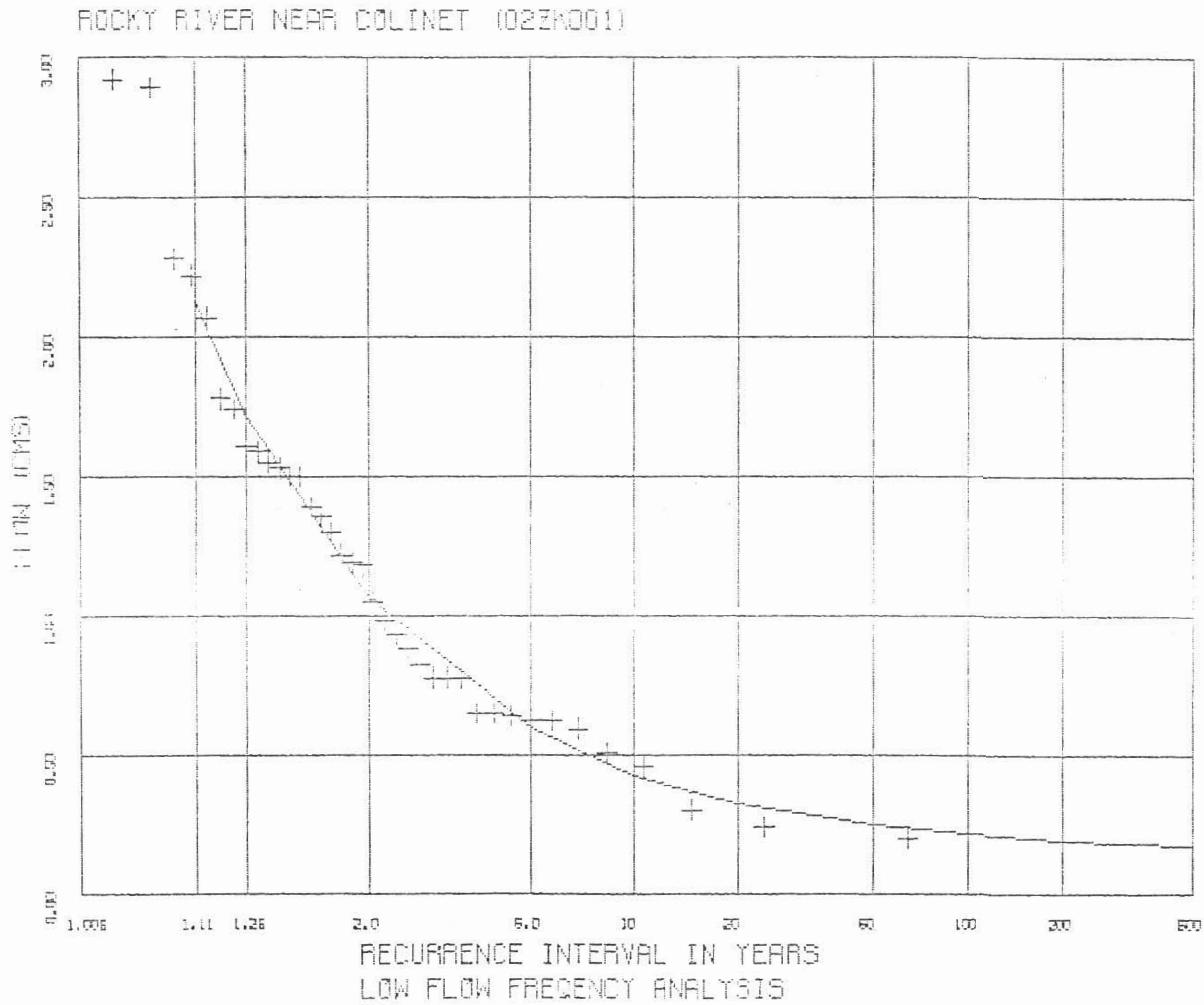
MEAN= 1.19 S.D.= 0.6742 SKEW= 0.8471 C.V.= 0.5652

N= 38 XMIN= 0.20

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 1.56701 E= 0.1541 U= 1.3076

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	3.499
1.010	3.215
1.110	2.123
1.250	1.717
2.000	1.067
5.000	0.5970
10.000	0.4285
20.000	0.3274
50.000	0.2498
100.000	0.2154
200.000	0.1934
500.000	0.1760


ROCKY RIVER NEAR COLINET (02ZK001)
FLOW (CMS)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
1.005
1.11
1.25
2.0
5.0
10
20
50
100
200
500
RECURRENCE INTERVAL IN YEARS
LOW FLOW FRECENCY ANALYSIS

NORTHEAST RIVER NEAR PLACENTIA (02ZK002)

1 DAY LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	1 DAY MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
7	1979	0.5880	0.1350	1	6.52	15.33
2	1980	1.1000	0.2650	2	17.39	5.75
5	1981	0.5620	0.4730	3	28.26	3.54
6	1982	0.4730	0.4960	4	39.13	2.56
7	1983	0.6110	0.5620	5	50.00	2.00
8	1984	0.2650	0.5880	6	60.87	1.64
8	1985	0.5950	0.5950	7	71.74	1.39
9	1986	0.4960	0.6110	8	82.61	1.21
8	1987	0.1350	1.1000	9	93.48	1.07

NORTHEAST RIVER NEAR PLACENTIA (02ZK002)

MEAN= 0.54 S.D.= 0.2670 SKEW= 0.8045 C.V.= 0.4981

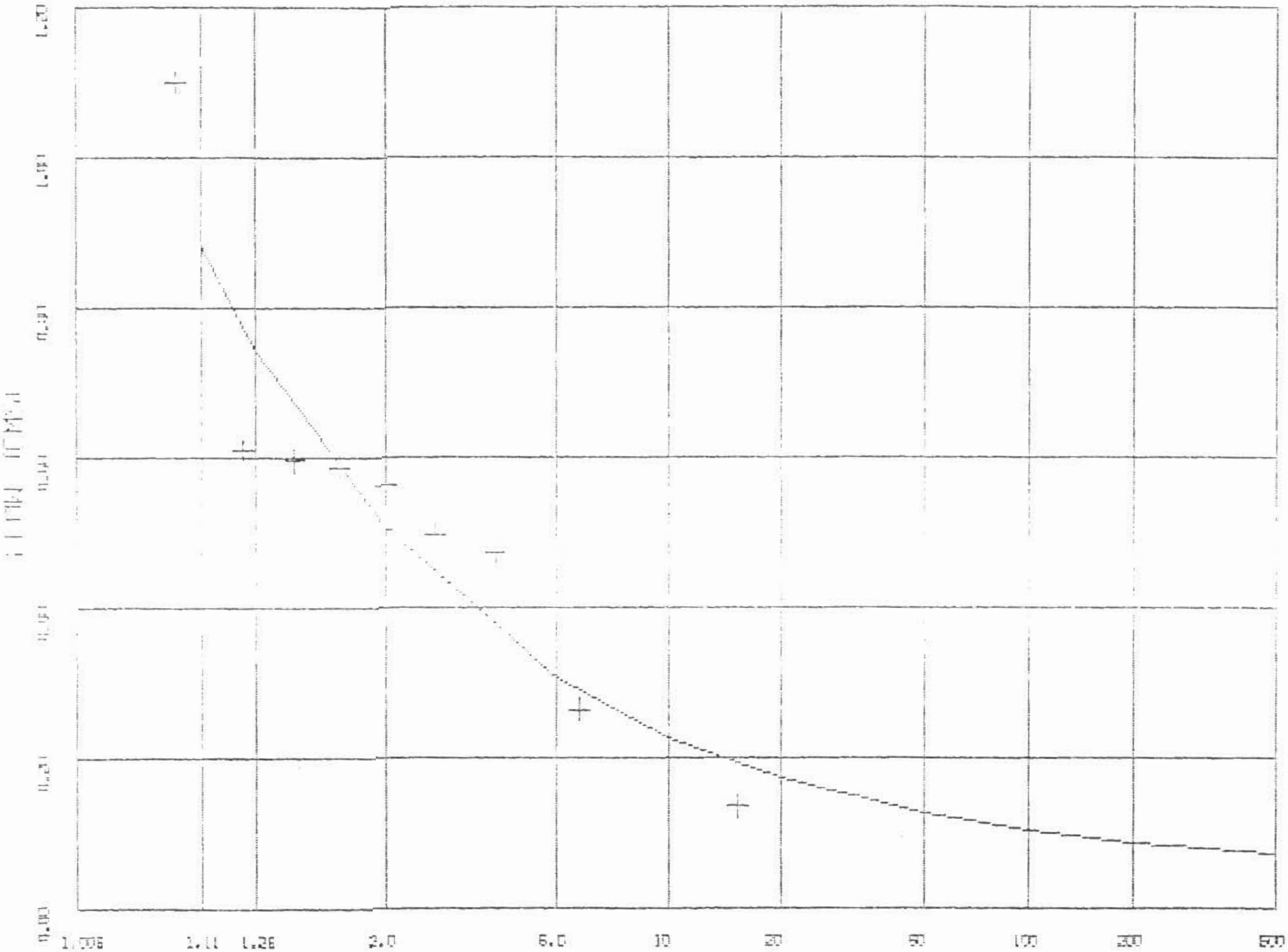
N= 9 XMIN= 0.14

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 1.99391 E= 0.0494 U= 0.5970

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	1.314
1.010	1.229
1.110	0.8831
1.250	0.7446
2.000	0.5051
5.000	0.3075
10.000	0.2266
20.000	0.1729
50.000	0.1268
100.000	0.1040
200.000	0.0879
500.000	0.0737

NORTHEAST RIVER NEAR PLACENTIA (02ZK002)



RECURRENCE INTERVAL IN YEARS
LOW FLOW FREQENCY ANALYSIS

NORTHEAST POND RIVER AT NORTHEAST POND (02ZM006)

1 DAY LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	1 DAY MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
6	1954	0.0030	0.0000	1	1.75	57.00
6	1955	0.0060	0.0030	2	4.68	21.37
6	1956	0.0110	0.0030	3	7.60	13.15
6	1957	0.0060	0.0030	4	10.53	9.50
6	1958	0.0110	0.0030	5	13.45	7.43
6	1959	0.0030	0.0030	6	16.37	6.11
6	1960	0.0030	0.0040	7	19.30	5.18
6	1961	0.0000	0.0050	8	22.22	4.50
6	1962	0.0060	0.0050	9	25.15	3.98
6	1963	0.0110	0.0060	10	28.07	3.56
6	1964	0.0080	0.0060	11	30.99	3.23
6	1965	0.0030	0.0060	12	33.92	2.95
6	1966	0.0110	0.0060	13	36.84	2.71
6	1967	0.0060	0.0060	14	39.77	2.51
6	1968	0.0080	0.0060	15	42.69	2.34
6	1969	0.0080	0.0060	16	45.61	2.19
6	1970	0.0060	0.0060	17	48.54	2.06
6	1971	0.0060	0.0060	18	51.46	1.94
6	1972	0.0060	0.0060	19	54.39	1.84
6	1973	0.0140	0.0080	20	57.31	1.74
6	1974	0.0060	0.0080	21	60.23	1.66
6	1975	0.0080	0.0080	22	63.16	1.58
6	1976	0.0060	0.0080	23	66.08	1.51
6	1977	0.0090	0.0090	24	69.01	1.45
6	1978	0.0050	0.0090	25	71.93	1.39
6	1979	0.0090	0.0090	26	74.85	1.34
6	1980	0.0220	0.0100	27	77.78	1.29
6	1981	0.0140	0.0110	28	80.70	1.24
6	1982	0.0060	0.0110	29	83.63	1.20
6	1983	0.0100	0.0110	30	86.55	1.16
6	1984	0.0040	0.0110	31	89.47	1.12
6	1985	0.0030	0.0140	32	92.40	1.08
6	1986	0.0090	0.0140	33	95.32	1.05
6	1987	0.0050	0.0220	34	98.25	1.02

NORTHEAST POND RIVER AT NORTHEAST POND (02ZM006)

MEAN= 0.01 S.D.= 0.0041 SKEW= 1.3548 C.V.= 0.5569

N= 34 XMIN= 0.00

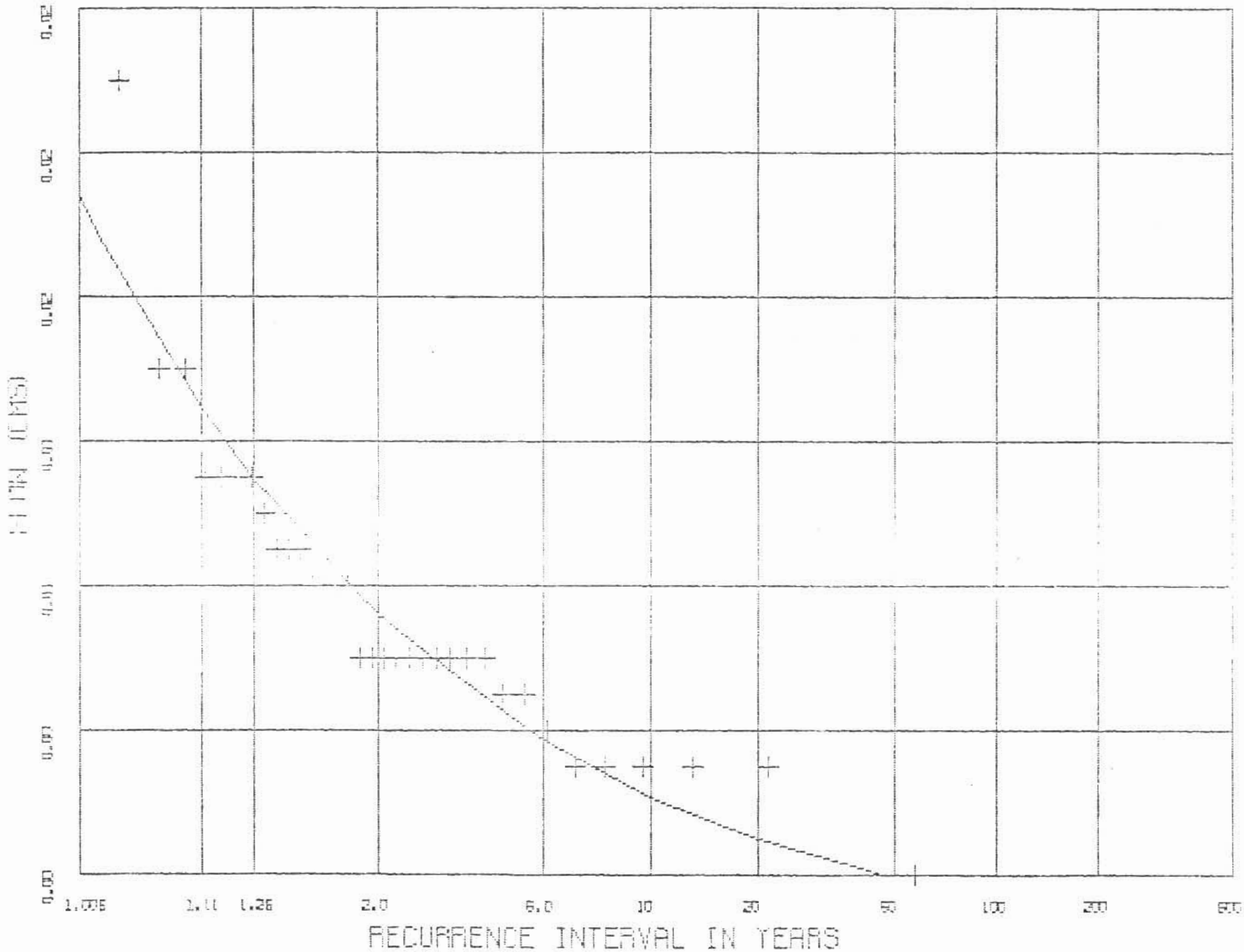
PARAMETERS BY SMALLEST OBSERVED DROUGHT

A= 2.59560 E= -0.0026 U= 0.0087

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	0.0188
1.010	0.0177
1.110	0.0129
1.250	0.0109
2.000	0.0072
5.000	0.0037
10.000	0.0022
20.000	0.0010

RETURN PERIOD OF ZERO FLOW, T= 47 YEARS

NORTHEAST POND RIVER AT NORTHEAST POND (02ZM006)



LOW FLOW FREQENCY ANALYSIS

NORTHWEST BROOK AT NORTHWEST POND (02ZN001)

1 DAY LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	1 DAY MEAN FLOW (CMS)	ASCENDING ORDER (CMS)	RANK	CUMULAT. PROBABIL. (%)	RETURN PERIOD (YEARS)
0	1967	0.3850	0.1600	1	2.83	35.33
0	1968	0.4760	0.2470	2	7.55	13.25
0	1969	0.5070	0.3030	3	12.26	8.15
0	1970	0.5920	0.3200	4	16.98	5.89
0	1971	0.5660	0.3850	5	21.70	4.61
0	1972	0.4160	0.3900	6	26.42	3.79
0	1973	0.7110	0.3940	7	31.13	3.21
0	1974	0.6800	0.4130	8	35.85	2.79
0	1975	0.4160	0.4160	9	40.57	2.47
0	1976	0.3030	0.4160	10	45.28	2.21
0	1977	0.5070	0.4400	11	50.00	2.00
0	1978	0.3200	0.4760	12	54.72	1.83
0	1979	0.4130	0.4810	13	59.43	1.68
0	1980	0.3940	0.5070	14	64.15	1.56
0	1981	0.3900	0.5070	15	68.87	1.45
0	1982	0.4400	0.5660	16	73.58	1.36
0	1983	0.6970	0.5920	17	78.30	1.28
0	1984	0.4810	0.6770	18	83.02	1.20
0	1985	0.2470	0.6800	19	87.74	1.14
0	1986	0.6770	0.6970	20	92.45	1.08
0	1987	0.1600	0.7110	21	97.17	1.03

NORTHWEST BROOK AT NORTHWEST POND (02ZN001)

MEAN= 0.47 S.D.= 0.1498 SKEW= 0.0250 C.V.= 0.3217

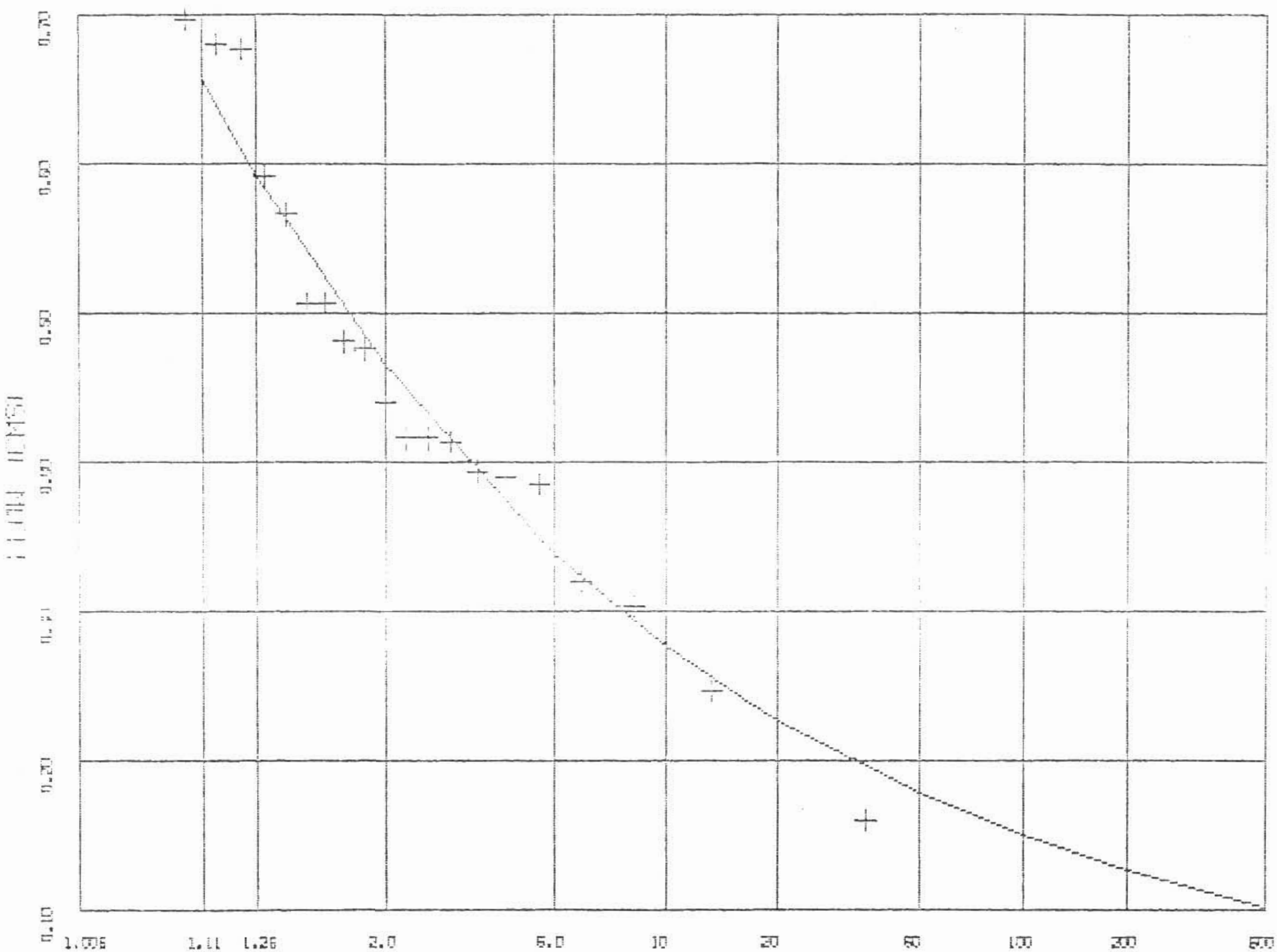
N= 21 XMIN= 0.16

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 3.33915 E= 0.0261 U= 0.5161

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	0.8337
1.010	0.8008
1.110	0.6559
1.250	0.5912
2.000	0.4652
5.000	0.3388
10.000	0.2759
20.000	0.2275
50.000	0.1784
100.000	0.1497
200.000	0.1265
500.000	0.1024

NORTHWEST BROOK AT NORTHWEST POND (02ZN001)



RECURRENCE INTERVAL IN YEARS

LOW FLOW FREQENCY ANALYSIS

SPOUT COVE BROOK NEAR SPOUT COVE (02ZL003)

1 DAY LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	1 DAY MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
7	1979	0.0070	0.0060	1	6.52	15.33
2	1980	0.1130	0.0070	2	17.39	5.75
6	1981	0.0370	0.0190	3	28.26	3.54
8	1982	0.0190	0.0200	4	39.13	2.56
7	1983	0.0240	0.0240	5	50.00	2.00
8	1984	0.0060	0.0340	6	60.87	1.64
8	1985	0.0390	0.0370	7	71.74	1.39
9	1986	0.0340	0.0390	8	82.61	1.21
8	1987	0.0200	0.1130	9	93.48	1.07

SPOUT COVE BROOK NEAR SPOUT COVE (02ZL003)

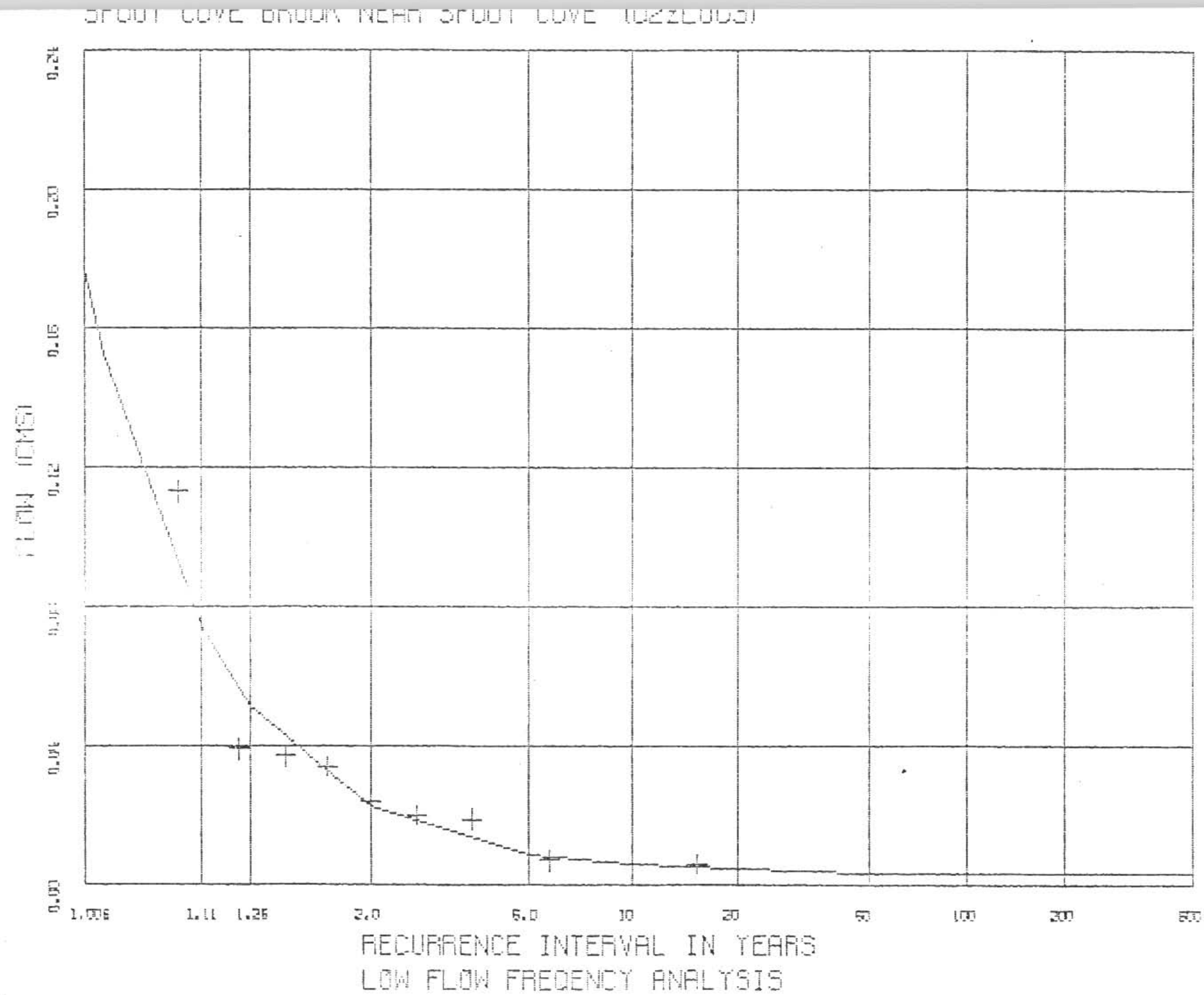
MEAN= 0.03 S.D.= 0.0322 SKEW= 2.2291 C.V.= 0.9697

N= 9 XMIN= 0.01

PARAMETERS BY SMALLEST OBSERVED DROUGHT

A= 0.93459 E= 0.0031 U= 0.0323

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	0.1770
1.010	0.1529
1.110	0.0746
1.250	0.0517
2.000	0.0228
5.000	0.0090
10.000	0.0058
20.000	0.0043
50.000	0.0036
100.000	0.0033
200.000	0.0032
500.000	0.0032


FLOW (CMS)
0.00
0.04
0.12
0.16
0.20
0.24
1.006
1.11
1.25
2.0
6.0
10
20
50
100
200
500
RECURRENCE INTERVAL IN YEARS
LOW FLOW FREQENCY ANALYSIS

SEAL COVE BROOK AT CAPPAHAYDEN (02ZM009)

1 DAY LOW FLOW MEAN DISCH. IN PERIOD JAN 1 DEC 31

STARTING MONTH	YEAR	1 DAY MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS
6	1979	0.4980	0.1160	1	6.52	15.33
2	1980	0.4250	0.1910	2	17.39	5.75
5	1981	0.5250	0.2050	3	28.26	3.54
6	1982	0.6560	0.4040	4	39.13	2.56
7	1983	0.6500	0.4250	5	50.00	2.00
7	1984	0.4040	0.4980	6	60.87	1.64
8	1985	0.2050	0.5250	7	71.74	1.39
7	1986	0.1910	0.6500	8	82.61	1.21
0	1987	0.1160	0.6560	9	93.48	1.07

SEAL COVE BROOK AT CAPPAHAYDEN (02ZM009)

MEAN= 0.41 S.D.= 0.1987 SKEW= -0.2359 C.V.= 0.4872

N= 9 XMIN= 0.12

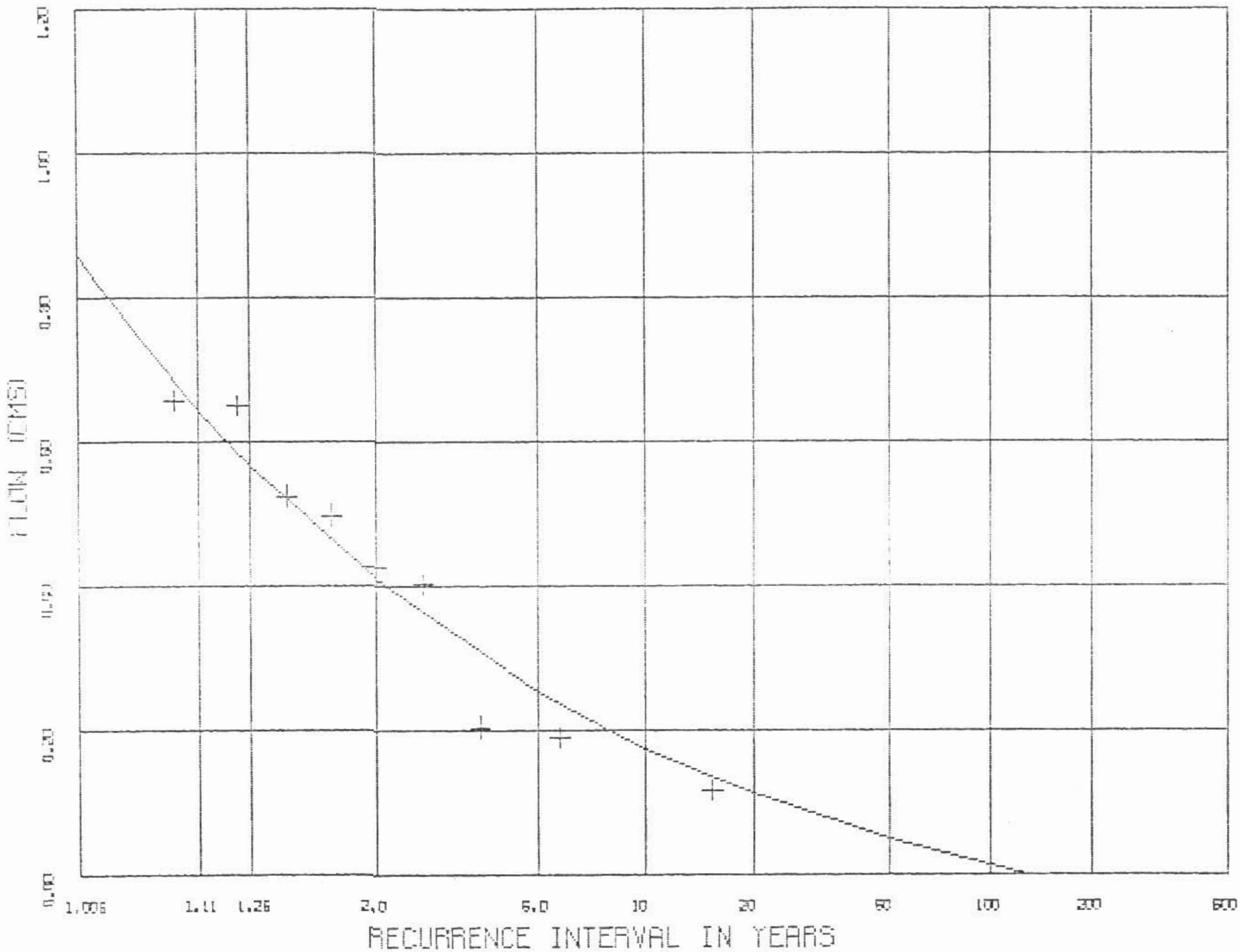
PARAMETERS BY MAXIMUM LIKELIHOOD

A= 3.48717 E= -0.1560 U= 0.4735

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	0.8597
1.010	0.8200
1.110	0.6445
1.250	0.5655
2.000	0.4107
5.000	0.2534
10.000	0.1741
20.000	0.1126
50.000	0.0496
100.000	0.0123

RETURN PERIOD OF ZERO FLOW, T= 130 YEARS

SEAL COVE BROOK AT CAPPAHAYDEN (02ZM009)



LOW FLOW FREQENCY ANALYSIS

WATERFORD RIVER AT KILBRIDE (02ZM008)

1 DAY LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

TARTING MONTH	YEAR	1 DAY MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
0	1974	0.1500	0.1450	1	4.23	23.67
0	1975	0.2010	0.1500	2	11.27	8.87
0	1976	0.1870	0.1500	3	18.31	5.46
0	1977	0.2240	0.1870	4	25.35	3.94
0	1978	0.2720	0.2010	5	32.39	3.09
0	1979	0.1450	0.2220	6	39.44	2.54
0	1980	0.2270	0.2240	7	46.48	2.15
0	1981	0.3560	0.2250	8	53.52	1.87
0	1982	0.1500	0.2270	9	60.56	1.65
0	1983	0.2660	0.2590	10	67.61	1.48
0	1984	0.2590	0.2660	11	74.65	1.34
0	1985	0.2220	0.2720	12	81.69	1.22
0	1986	0.3330	0.3330	13	88.73	1.13
0	1987	0.2250	0.3560	14	95.77	1.04

WATERFORD RIVER AT KILBRIDE (02ZM008)

MEAN= 0.23 S.D.= 0.0640 SKEW= 0.5238 C.V.= 0.2785

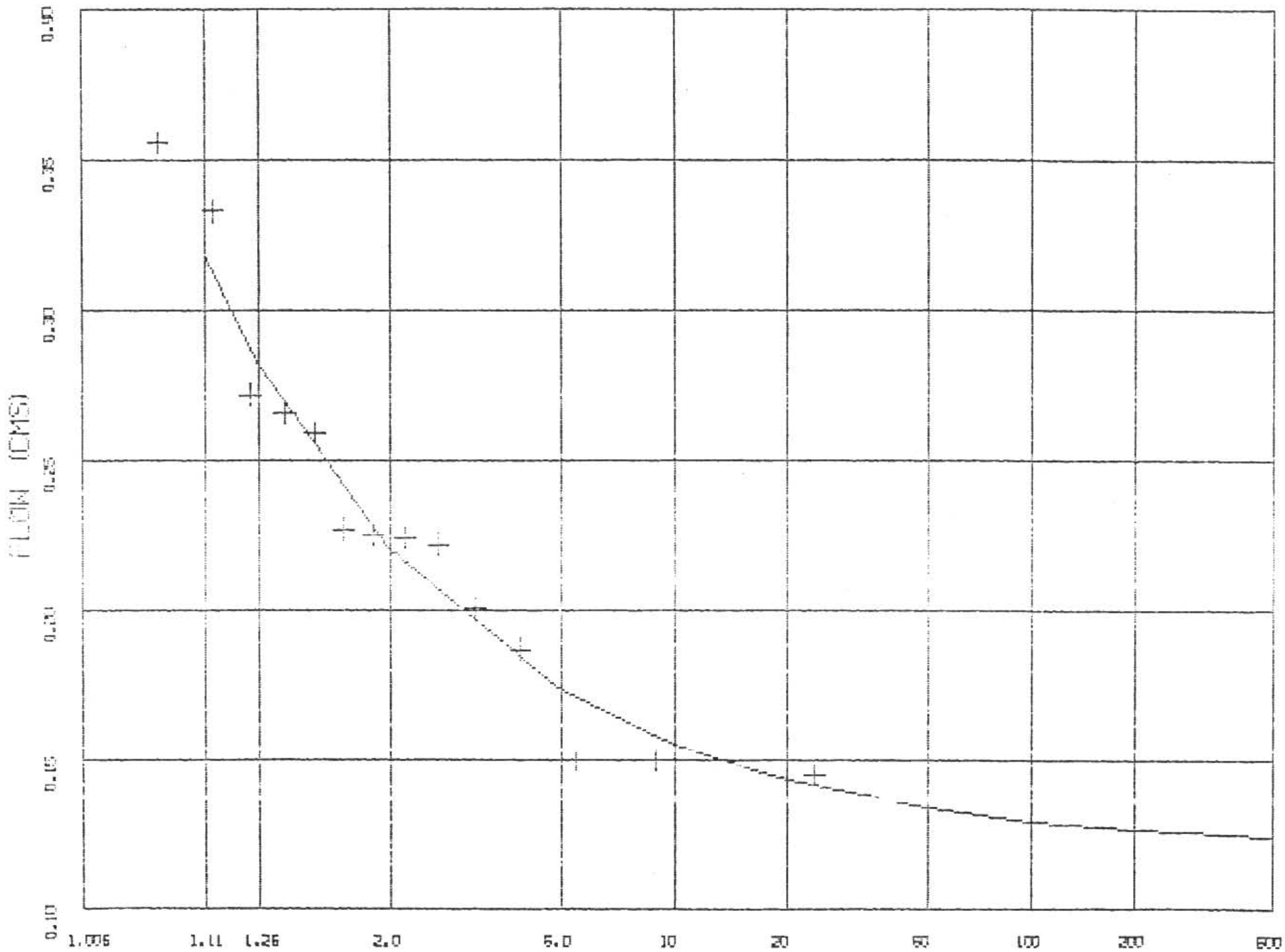
N= 14 XMIN= 0.14

PARAMETERS BY SMALLEST OBSERVED DROUGHT

A= 1.76286 E= 0.1206 U= 0.2433

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	0.4367
1.010	0.4127
1.110	0.3179
1.250	0.2813
2.000	0.2202
5.000	0.1730
10.000	0.1548
20.000	0.1433
50.000	0.1340
100.000	0.1296
200.000	0.1266
500.000	0.1242

WATERFORD RIVER AT KILBRIDE (02ZM008)



RECURRENCE INTERVAL IN YEARS

LOW FLOW FREQENCY ANALYSIS

ROCKY RIVER AT COLINET (02ZK001)

LOW FLOW MEAN DISCH. IN PERIOD Jan 1 to Dec 3

STARTING MONTH	YEAR	MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
8	1950	0.6130	0.5800	1	1.57	63.67
7	1951	2.0700	0.6130	2	4.19	23.87
7	1952	1.5900	1.0900	3	6.81	14.69
8	1953	1.6200	1.1700	4	9.42	10.61
7	1954	4.9300	1.2400	5	12.04	8.30
7	1955	4.8600	1.3400	6	14.66	6.82
10	1956	6.6200	1.4300	7	17.28	5.79
7	1957	2.0200	1.5500	8	19.90	5.03
10	1958	6.9200	1.5900	9	22.51	4.44
7	1959	1.2400	1.6200	10	25.13	3.98
7	1960	1.0900	1.6800	11	27.75	3.60
8	1961	0.5800	1.7600	12	30.37	3.29
5	1962	3.5100	2.0000	13	32.98	3.03
7	1963	1.6800	2.0200	14	35.60	2.81
6	1964	4.2900	2.0700	15	38.22	2.62
9	1965	1.1700	2.2600	16	40.84	2.45
8	1966	4.6000	2.3200	17	43.46	2.30
8	1967	1.5500	2.6900	18	46.07	2.17
9	1968	5.3400	3.1900	19	48.69	2.05
7	1969	4.1900	3.5100	20	51.31	1.95
7	1970	3.1900	3.7000	21	53.93	1.85
9	1971	3.9400	3.7100	22	56.54	1.77
7	1972	1.7600	3.9400	23	59.16	1.69
7	1973	5.3300	4.1600	24	61.78	1.62
2	1974	4.7900	4.1900	25	64.40	1.55
2	1975	2.2600	4.2900	26	67.02	1.49
8	1976	2.6900	4.6000	27	69.63	1.44
7	1977	2.0000	4.7900	28	72.25	1.38
8	1978	1.4300	4.8600	29	74.87	1.34
6	1979	4.1600	4.9300	30	77.49	1.29
2	1980	7.2200	5.3300	31	80.10	1.25
5	1981	5.8900	5.3400	32	82.72	1.21
6	1982	5.4800	5.4800	33	85.34	1.17
7	1983	5.6600	5.6600	34	87.96	1.14
7	1984	2.3200	5.8900	35	90.58	1.10
8	1985	3.7100	6.6200	36	93.19	1.07
7	1986	3.7000	6.9200	37	95.81	1.04
0	1987	1.3400	7.2200	38	98.43	1.02

ROCKY RIVER AT COLINET (02ZK001)

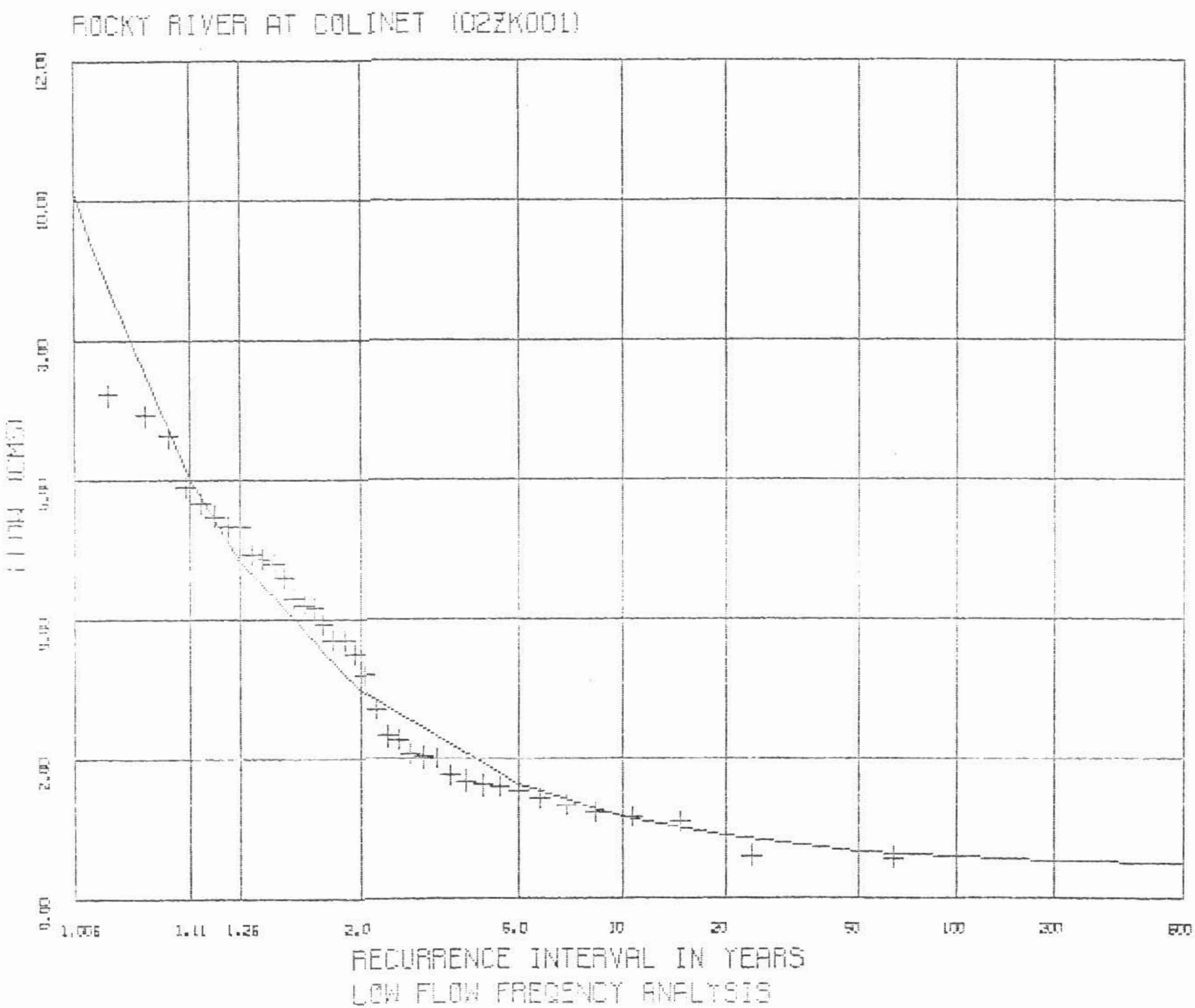
MEAN= 3.35 S.D.= 1.9009 SKEW= 0.3468 C.V.= 0.5672

N= 38 XMIN= 0.58

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 1.51272 E= 0.4343 U= 3.6570

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	10.14
1.010	9.291
1.110	6.042
1.250	4.848
2.000	2.964
5.000	1.630
10.000	1.162
20.000	0.8867
50.000	0.6786
100.000	0.5883
200.000	0.5315
500.000	0.4873


ROCKY RIVER AT COLINET (02ZK001)
FLOW (CMS)
0.00
2.00
3.00
10.00
12.00
1.006
1.11
1.25
2.0
5.0
10
20
50
100
200
500
RECURRENCE INTERVAL IN YEARS
LOW FLOW FREQENCY ANALYSIS

NORTHEAST RIVER NEAR PLACENTIA (02ZK002)

LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	MEAN FLOW (CMS)	ASCENDING ORDER (CMS)	RANK	CUMULAT. PROBABIL. (%)	RETURN PERIOD (YEARS)
6	1979	1.4500	0.3280	1	6.52	15.33
2	1980	3.2100	0.8730	2	17.39	5.75
5	1981	2.0400	1.2880	3	28.26	3.54
6	1982	1.9800	1.4040	4	39.13	2.56
7	1983	1.6100	1.4500	5	50.00	2.00
7	1984	0.8730	1.6100	6	60.87	1.64
10	1985	1.4040	1.9800	7	71.74	1.39
8	1986	1.2880	2.0400	8	82.61	1.21
0	1987	0.3280	3.2100	9	93.48	1.07

NORTHEAST RIVER NEAR PLACENTIA (02ZK002)

MEAN= 1.58 S.D.= 0.8085 SKEW= 0.6714 C.V.= 0.5131

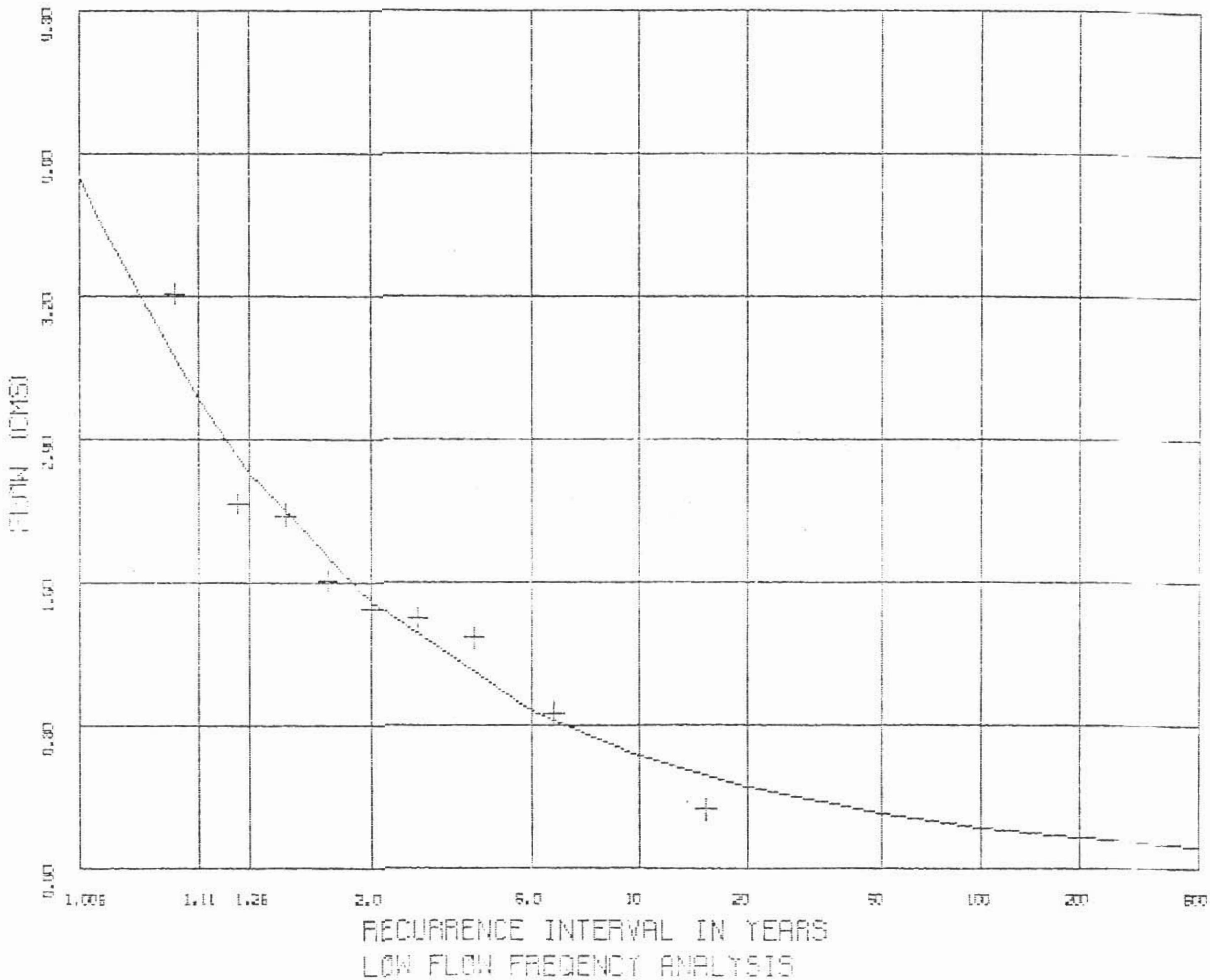
N= 9 XMIN= 0.33

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 2.11249 E= 0.0299 U= 1.7719

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	3.867
1.010	3.623
1.110	2.620
1.250	2.212
2.000	1.494
5.000	0.8863
10.000	0.6303
20.000	0.4569
50.000	0.3046
100.000	0.2273
200.000	0.1719
500.000	0.1219

NORTHEAST RIVER NEAR PLACENTIA (02ZK002)



NORTHEAST POND RIVER AT NORTHEAST POND (02ZM006)

LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 3

STARTING MONTH	YEAR	MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
7	1954	0.0200	0.0010	1	1.75	57.00
9	1955	0.0180	0.0040	2	4.68	21.37
2	1956	0.0710	0.0070	3	7.60	13.15
6	1957	0.0300	0.0070	4	10.53	9.50
9	1958	0.0280	0.0110	5	13.45	7.43
7	1959	0.0180	0.0110	6	16.37	6.11
7	1960	0.0040	0.0120	7	19.30	5.18
8	1961	0.0010	0.0130	8	22.22	4.50
8	1962	0.0290	0.0130	9	25.15	3.98
7	1963	0.0160	0.0130	10	28.07	3.56
7	1964	0.0390	0.0150	11	30.99	3.23
8	1965	0.0070	0.0150	12	33.92	2.95
9	1966	0.0250	0.0160	13	36.84	2.71
8	1967	0.0070	0.0160	14	39.77	2.51
9	1968	0.0210	0.0180	15	42.69	2.34
7	1969	0.0240	0.0180	16	45.61	2.19
7	1970	0.0110	0.0190	17	48.54	2.06
5	1971	0.0400	0.0200	18	51.46	1.94
7	1972	0.0130	0.0210	19	54.39	1.84
3	1973	0.0390	0.0240	20	57.31	1.74
1	1974	0.0190	0.0250	21	60.23	1.66
7	1975	0.0130	0.0250	22	63.16	1.58
8	1976	0.0160	0.0280	23	66.08	1.51
7	1977	0.0150	0.0290	24	69.01	1.45
8	1978	0.0110	0.0300	25	71.93	1.39
6	1979	0.0150	0.0340	26	74.85	1.34
2	1980	0.0700	0.0360	27	77.78	1.29
8	1981	0.0460	0.0390	28	80.70	1.24
8	1982	0.0360	0.0390	29	83.63	1.20
7	1983	0.0410	0.0400	30	86.55	1.16
7	1984	0.0130	0.0410	31	89.47	1.12
10	1985	0.0250	0.0460	32	92.40	1.08
7	1986	0.0340	0.0700	33	95.32	1.05
0	1987	0.0120	0.0710	34	98.25	1.02

NORTHEAST POND RIVER AT NORTHEAST POND (02ZM006)

MEAN= 0.02 S.D.= 0.0164 SKEW= 1.3028 C.V.= 0.6747

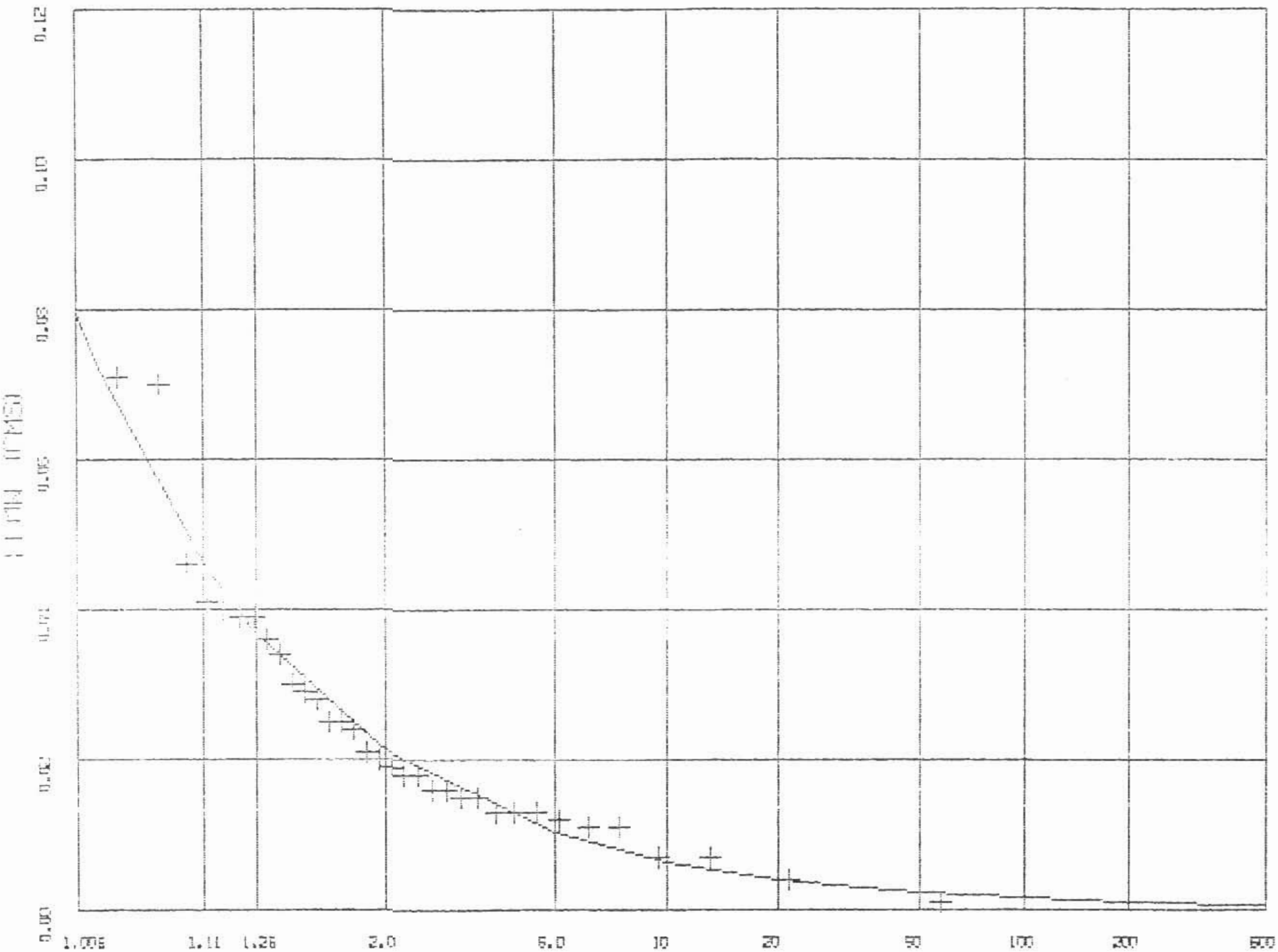
N= 34 XMIN= 0.00

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 1.54142 E= 0.0002 U= 0.0270

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	0.0794
1.010	0.0726
1.110	0.0464
1.250	0.0367
2.000	0.0213
5.000	0.0103
10.000	0.0064
20.000	0.0041
50.000	0.0023
100.000	0.0015
200.000	0.0010
500.000	0.0006

NORTHEAST POND RIVER AT NORTHEAST POND (02ZM006)



RECURRENCE INTERVAL IN YEARS
LOW FLOW FREQENCY ANALYSIS

NORTHWEST BROOK AT NORTHWEST POND (02ZN001)

LOW FLOW MEAN DISCH. IN PERIOD Jan 1 to Dec 3

STARTING MONTH	YEAR	MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
7	1967	0.6940	0.2580	1	2.97	33.67
9	1968	1.1300	0.5140	2	7.92	12.63
7	1969	1.0600	0.5470	3	12.87	7.77
1	1970	1.2100	0.6940	4	17.82	5.61
9	1971	1.1600	0.6950	5	22.77	4.39
8	1972	0.8270	0.8270	6	27.72	3.61
7	1973	1.5100	0.8530	7	32.67	3.06
2	1974	1.0000	0.8560	8	37.62	2.66
2	1975	0.5140	0.8780	9	42.57	2.35
6	1976	0.6950	0.9080	10	47.52	2.10
7	1977	0.8780	1.0000	11	52.48	1.91
8	1978	0.5470	1.0600	12	57.43	1.74
6	1979	0.9080	1.1300	13	62.38	1.60
2	1980	1.5200	1.1600	14	67.33	1.49
6	1982	1.1800	1.1800	15	72.28	1.38
8	1983	1.5800	1.2100	16	77.23	1.29
7	1984	0.8560	1.4190	17	82.18	1.22
2	1985	0.8530	1.5100	18	87.13	1.15
5	1986	1.4190	1.5200	19	92.08	1.09
0	1987	0.2580	1.5800	20	97.03	1.03

NORTHWEST BROOK AT NORTHWEST POND (02ZN001)

MEAN= 0.99 S.D.= 0.3582 SKEW= -0.0639 C.V.= 0.3618

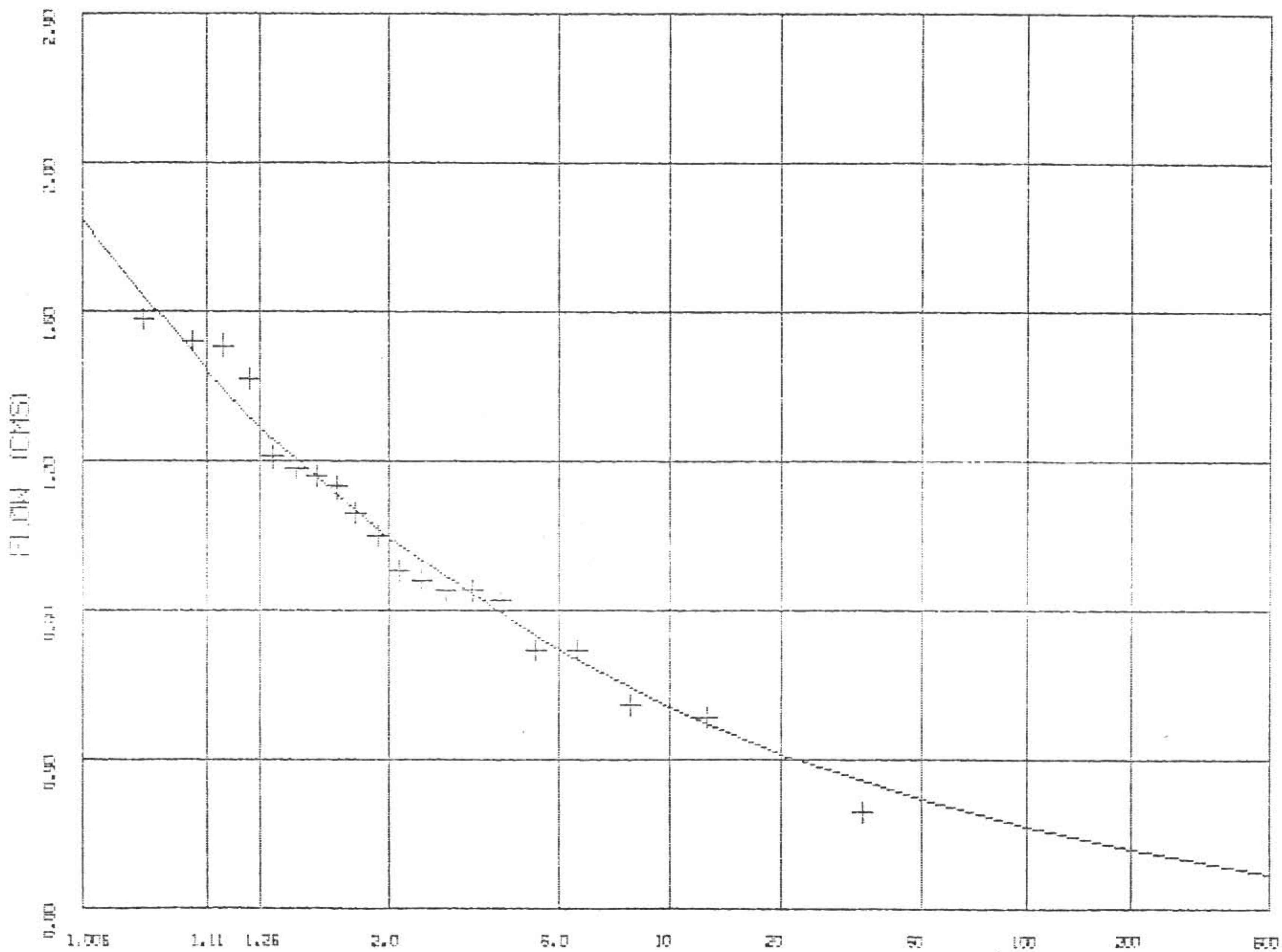
N= 20 XMIN= 0.26

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 3.60318 E= -0.1283 U= 1.1141

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	1.846
1.010	1.771
1.110	1.439
1.250	1.289
2.000	0.9939
5.000	0.6911
10.000	0.5370
20.000	0.4165
50.000	0.2924
100.000	0.2183
200.000	0.1575
500.000	0.0932

NORTHWEST BROOK AT NORTHWEST POND (02ZN001)



RECURRENCE INTERVAL IN YEARS

LOW FLOW FREQENCY ANALYSIS

SPOUT COVE BROOK NEAR SPOUT COVE (02ZL003)

LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS
6	1979	0.0620	0.0430	1	6.52	15.33
2	1980	0.3030	0.0620	2	17.39	5.75
8	1981	0.2380	0.0730	3	28.26	3.54
2	1982	0.1440	0.0800	4	39.13	2.56
7	1983	0.0800	0.1000	5	50.00	2.00
7	1984	0.0730	0.1380	6	60.87	1.64
2	1985	0.1380	0.1440	7	71.74	1.39
8	1986	0.1000	0.2380	8	82.61	1.21
0	1987	0.0430	0.3030	9	93.48	1.07

SPOUT COVE BROOK NEAR SPOUT COVE (02ZL003)

MEAN= 0.13 S.D.= 0.0871 SKEW= 1.1940 C.V.= 0.6637

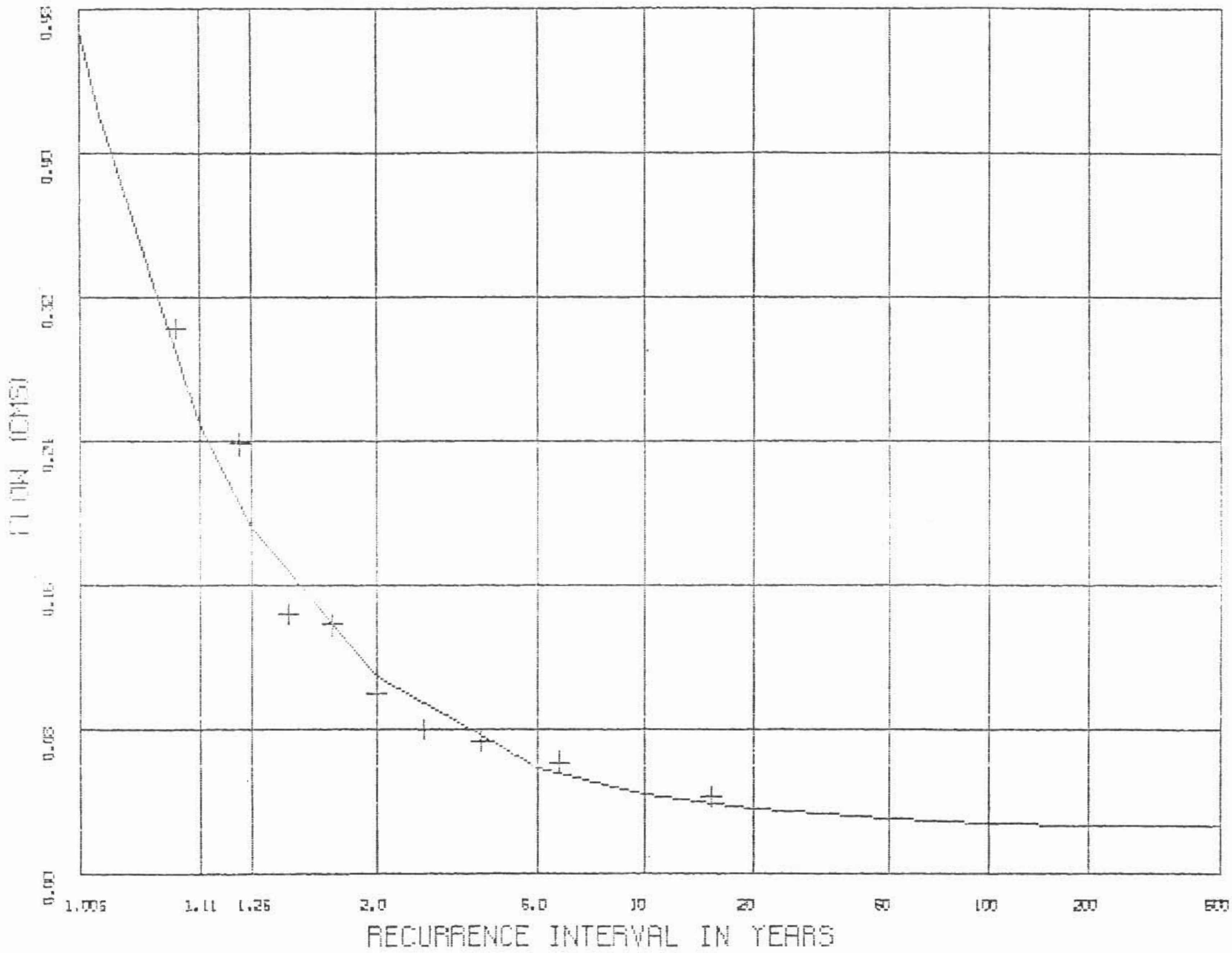
N= 9 XMIN= 0.04

PARAMETERS BY SMALLEST OBSERVED DROUGHT

A= 1.21909 E= 0.0256 U= 0.1383

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	0.4687
1.010	0.4209
1.110	0.2498
1.250	0.1922
2.000	0.1091
5.000	0.0585
10.000	0.0434
20.000	0.0354
50.000	0.0302
100.000	0.0282
200.000	0.0270
500.000	0.0263

SPOUT COVE BROOK NEAR SPOUT COVE (02ZL003)



LOW FLOW FREQENCY ANALYSIS

SEAL COVE BROOK NEAR CAPPAHAYDEN (02ZM009)

LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
6	1979	0.9000	0.2100	1	6.52	15.33
2	1980	2.3300	0.8050	2	17.39	5.75
8	1981	1.3500	0.9000	3	28.26	3.54
6	1092	1.6500	1.2130	4	39.13	2.56
8	1983	1.2600	1.2600	5	50.00	2.00
7	1984	0.8050	1.3500	6	60.87	1.64
2	1985	1.4000	1.4000	7	71.74	1.39
8	1986	1.2130	1.6500	8	82.61	1.21
0	1987	0.2100	2.3300	9	93.48	1.07

SEAL COVE BROOK NEAR CAPPAHAYDEN (02ZM009)

MEAN= 1.24 S.D.= 0.5874 SKEW= 0.1536 C.V.= 0.4755

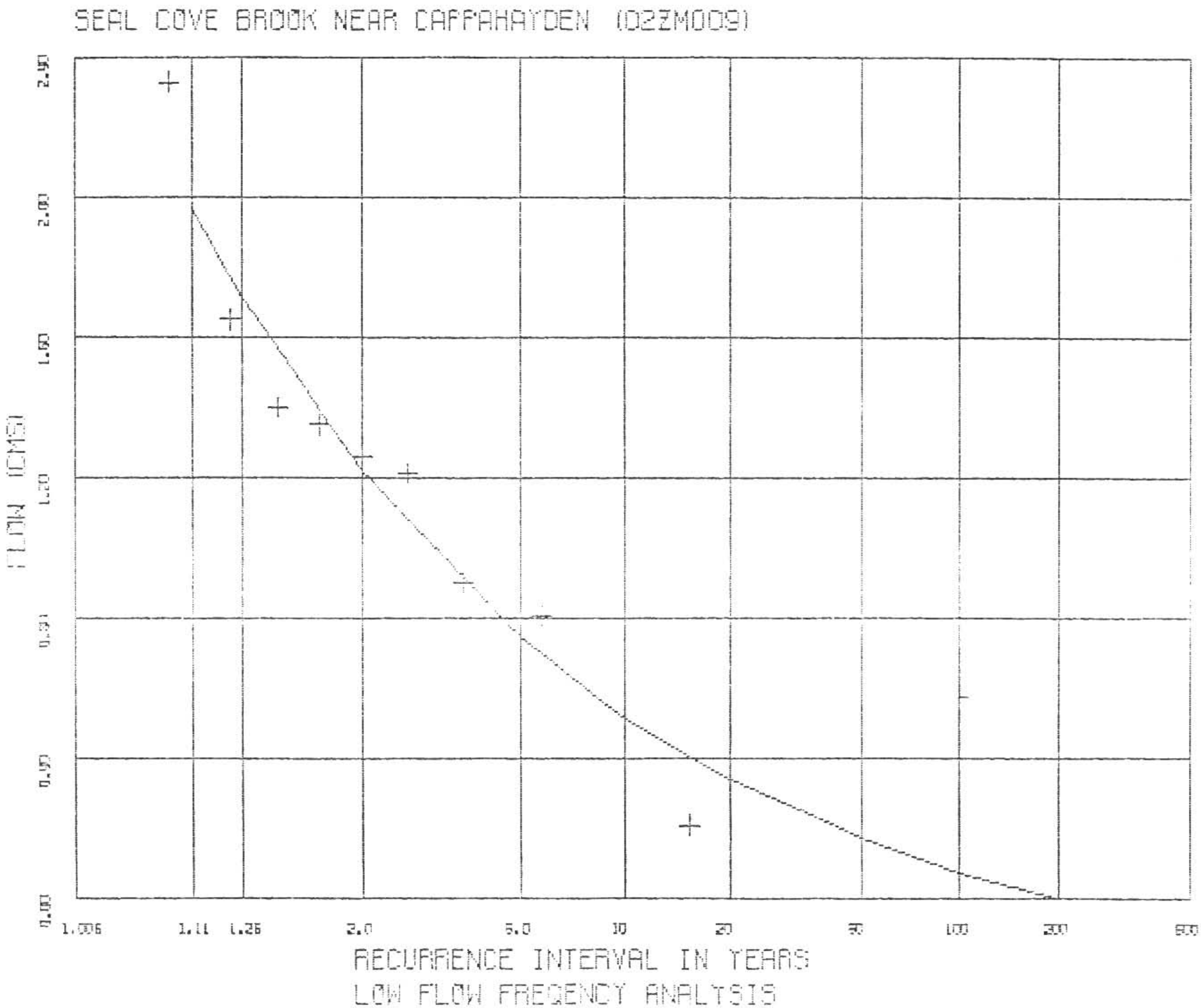
N= 9 XMIN= 0.21

PARAMETERS BY MAXIMUM LIKELIHOOD

A= 3.00530 E= -0.2956 U= 1.4169

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	2.688
1.010	2.553
1.110	1.968
1.250	1.711
2.000	1.220
5.000	0.7440
10.000	0.5143
20.000	0.3418
50.000	0.1719
100.000	0.0750

RETURN PERIOD OF ZERO FLOW, T= 197 YEARS


SEAL COVE BROOK NEAR CAPPAHAYDEN (02ZM009)
FLOW (CMS)
2.00
1.60
1.20
0.80
0.40
0.00
1.11
1.25
2.0
5.0
10
20
50
100
200
500
RECURRENCE INTERVAL IN YEARS
LOW FLOW FREQENCY ANALYSIS

WATERFORD RIVER AT KILBRIDE (02ZM008)

LOW FLOW MEAN DISCH. IN PERIOD jan 1 to dec 31

STARTING MONTH	YEAR	MEAN FLOW	ASCENDING ORDER	RANK	CUMULAT. PROBABIL.	RETURN PERIOD
		(CMS)	(CMS)		(%)	(YEARS)
1	1974	0.5330	0.3150	1	4.23	23.67
7	1975	0.3150	0.3420	2	11.27	8.87
8	1976	0.3540	0.3540	3	18.31	5.46
7	1977	0.4330	0.3790	4	25.35	3.94
8	1978	0.3790	0.3790	5	32.39	3.09
8	1979	0.3790	0.4330	6	39.44	2.54
7	1980	1.1200	0.4580	7	46.48	2.15
7	1981	0.8400	0.4970	8	53.52	1.87
8	1982	0.6200	0.5330	9	60.56	1.65
8	1983	0.8690	0.6200	10	67.61	1.48
7	1984	0.4970	0.7880	11	74.65	1.34
8	1985	0.4580	0.8400	12	81.69	1.22
8	1986	0.7880	0.8690	13	88.73	1.13
0	1987	0.3420	1.1200	14	95.77	1.04

WATERFORD RIVER AT KILBRIDE (02ZM008)

MEAN= 0.57 S.D.= 0.2464 SKEW= 1.0521 C.V.= 0.4352

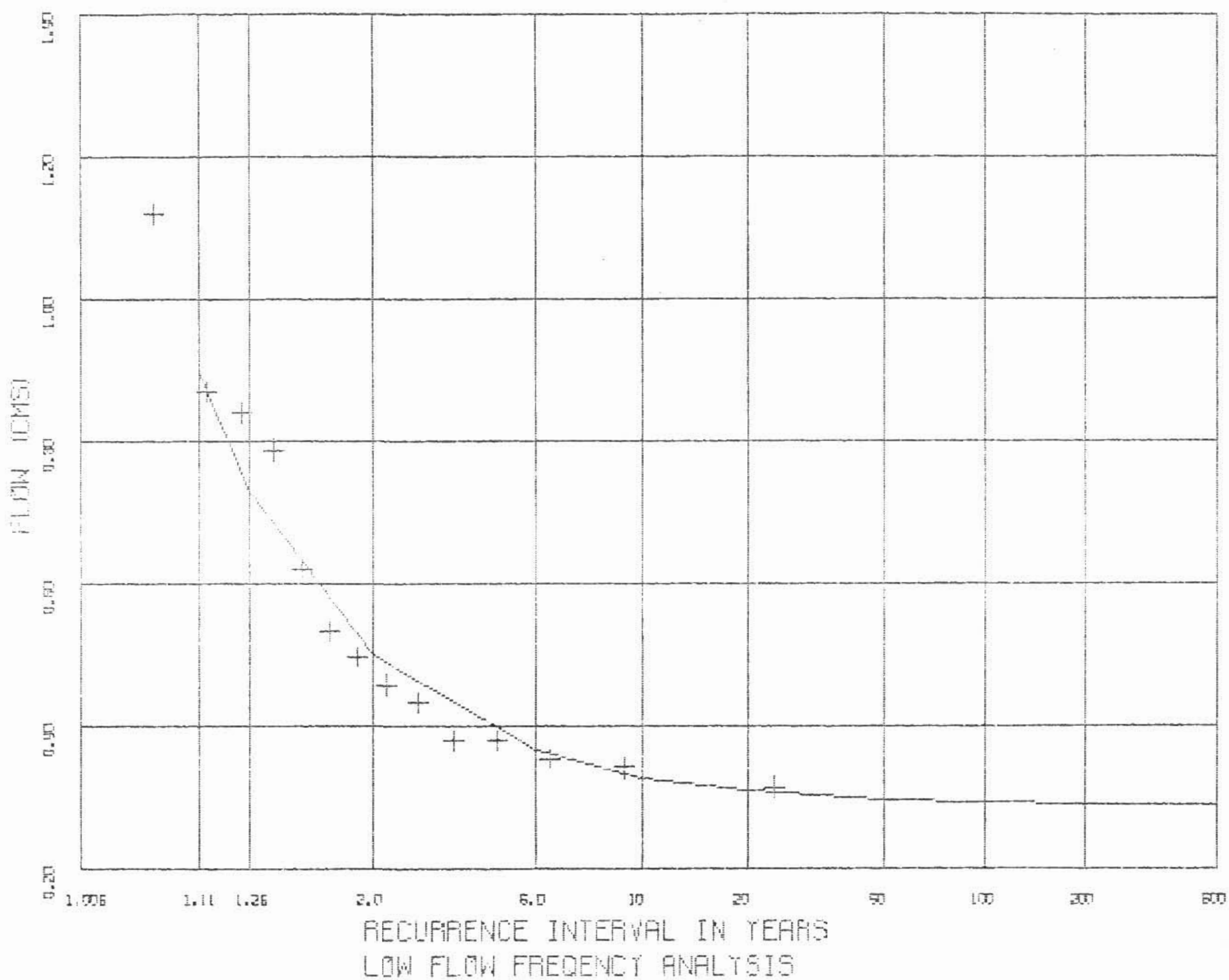
N= 14 XMIN= 0.31

PARAMETERS BY SMALLEST OBSERVED DROUGHT

A= 1.13145 E= 0.2880 U= 0.5789

RETURN PERIOD (YRS)	DROUGHT ESTIMATE (CMS)
1.005	1.559
1.010	1.412
1.110	0.8981
1.250	0.7310
2.000	0.4984
5.000	0.3653
10.000	0.3278
20.000	0.3091
50.000	0.2972
100.000	0.2930
200.000	0.2907
500.000	0.2892

WATERFORD RIVER AT KILBRIDE (02ZM008)



APPENDIX D
INVENTORY OF WATER SUPPLY SYSTEMS

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Ground Water Supplies

INVENTORY OF SURFACE WATER SUPPLY SYSTEMS

SCOPE

The Regional Water Resources Study of the Western Avalon Peninsula, carried out by Acres International Ltd., provides information to assist in the planning and management of the water resources of the Western Avalon Peninsula.

The inventory of surface water supply systems acts as a data source for the Water Resources Study. The inventory therefore concentrates on specific water resources data, including live storage head, and means to increase live storage, based upon field reconnaissance. Other information has been collected for estimating municipal demand, and for identifying problems in water quality and in the supply/transmission/distribution systems. This information was mostly obtained verbally and sometimes backed up by drawings or reports when these were readily available.

INVENTORY FORMAT

A standard report format by community was developed. The headings are discussed below.

Community Name From Department of Municipal Affairs Directory.

Population Census data or Council records in some cases.

Information Names of people supplying verbal data. The survey was initiated in late August and early September 1987 by telephone calls to the municipalities. Using the information collected, a plan of field work was organized to investigate the larger surface water systems. Field work was carried out from October 1987 to January 1988.

Demand Data Based upon information from Council. Some fish plant operators also provided information.

Supply Data Information on dams, intakes, spillways etc. from Council and visual inspection. Field measurements were taken for accessible sites, and sometimes information from drawings was used. Sources are named in the report for specific data, e.g. "spillway dimensions (taped)".

Status of Watershed Protection This refers to controls exercised through Section 25 of the Department of Environment Act. The reference document is the "Inventory of Domestic; Industrial and Fish Plant Water Supplies within the Province of Newfoundland, Eastern Region", Land Management Division of Forests, dated February 1986.

Any watersheds that have become protected since this inventory was published are not recorded as protected in the following reports.

Live Storage Head First it is necessary to determine the point in the supply/intake system which is critical in terms of available head. For example if the pipeline is believed to slope downgrade from the point of intake, the water level over the intake is the best point to measure live storage head. The live storage head has been obtained from verbal sources (local foreman), tape measurements where feasible, or drawings. During the drought of 1987 the local officials in many areas recorded the height of water over the intake pipes. Hence there is often good information on this basis.

Adequacy of supply in summer 1987 Many systems experienced low water levels in summer 1987. This focussed attention on water depth above intake, or below spillways, etc. Hence it was found informative during the survey to refer to conditions in summer 1987.

Ways to Increase Live Storage Based on site inspection, supported by local opinion in some cases.

Water Quality Bacteriological problems, if any, were obtained from municipal officials, or Department of Health officials. The Department of Health tests public water supplies monthly for total coliform bacteria, faecal coliform bacteria and chlorine residual. An unsatisfactory result would show either 5 or more total coliform or one or more faecal coliform per 100 ml. Under these conditions a Boil Order would be issued. Lack of chlorine residual is also unsatisfactory.

Chemical test results were available for a limited number of sources, with reports on water treatment proposals for two troublesome sources. Significant problems, such as periodic poor taste through algal growth, and insect infestations, are not detected by chemical tests but by long term usage, as provided by the local people.

Generally the lack of chemical test data for all the systems was not found to be an obstacle in identifying systems with troublesome water quality.

Water Treatment The basic type of water purification used is simple chlorination, in all cases. Any additional treatment, such as addition of alkali to render the water potentially less corrosive, is identified in the survey data.

Transmission and Distribution A cursory description is given, with more details if there are problems and deficiencies.

Buildings and Plant Buildings contain pumps, wet wells, chlorinators, carbonate or lime soda ash injection equipment, etc. Plant and building layout leaves something to be desired in many cases; for example pressurized chlorine gas cylinders are often seen in the same room as electric panel equipment. However, layout is generally not commented upon in the reports because the survey work involved would be beyond the scope of the project.

Comments/Problems These remarks highlight findings and recommendations. Prior to implementation, the recommended works should be verified by a detailed investigation.

Future Capital Requirements These work items are based upon local opinion, or on judgement and findings from the survey. Capital costs for installation are given where available, or where a reasonable estimate can be made, based upon experience elsewhere. Generally the figures are not very accurate.

Watersheds Watersheds and intake locations are shown on 1 : 50,000 topographic mapsheets. The intake location was determined by a field survey, and the contributing watershed perimeter was drawn using the mapsheet contours etc. Watershed and pond areas have been measured from the 1 : 50,000 mapsheets.

SPECIFIC RECOMMENDATIONS

The Steering Committee requested recommendations be made where feasible on the results obtained.

1. Pipe Corrosion

Transmission systems with asbestos cement (AC) pipe run the risk of interior corrosion if the water is corrosive to asbestos cement. This could release asbestos fibres into the drinking water. Hence it is a priority to check the water quality in systems with AC pipe, and also to check to see if interior cleaning (pigging) is required. If water is potentially corrosive to AC pipe it should be treated to eliminate the corrosion potential and, if possible, to coat the inside of the pipe.

The same approach should be made for systems of ductile iron (DI) and copper, to resist corrosion and possibly extend the life of the pipe.

The treatment required can be simply carried out using equipment available on the market, e.g. water meter driven impulse timer to control (1) chlorine gas feed to an ejector into the line and, (2) feed pump for alkaline solution into the line.

2. Upstream Storage Control

A number of systems have an abstraction dam on a brook as well as a large pond upstream which can be used for back-up. Sometimes the upstream pond storage is controlled by dam and a shut-off flow valve.

These systems fail to be satisfactory when a large demand occurs, e.g. fish plant. In serious cases the downstream storage reservoir behind the abstraction demand is depleted within hours.

Each case requires its own investigation. However, the following comments may be helpful:

i. Look at fish plant demands. How can fresh water use be minimized. The same would apply if there were municipal losses, e.g. leaks. Project the minimum feasible water demand.

ii. Check storage, and whether it needs to be increased to meet the projected demands. Provide sufficient storage if this is feasible; if not reduce the demand requirements.

iii. Devise a system of control for upstream storage that will release sufficient water without wastage by spillage over the lower dam.

. Use float control from lower reservoir via telemetering line to open and close an electric powered valve at the upstream storage.

. Use a diesel motor powered valve at the upper dam controlled by a radio signal from a float device in the lower reservoir.

The foregoing automated systems are rather expensive, say $100,000 or more. Cheaper options include manual control of the upstream dam, or perhaps presetting the upstream valve at a predetermined discharge rate.

3. Water Metering

i. Municipal water consumption should be measured regularly to determine if there are significant leaks or waste in the system. This is becoming increasingly important because the DI systems installed in the 70's are beginning to age. In some of the systems, increasing leakage losses are suspected in the mains and copper building connections.

ii. Major users of water, e.g. fish plants, should be regularly metered. This information is required in conjunction with (i) above to check on wastages and losses in the network. Normal municipal demands can be estimated from empirical data but this is not possible for most fish plants.

iii. The output of booster pumphouses should be metered.

Information on leakages is particularly needed for pumped systems where energy costs are a consideration.

4. Supply Watersheds

The ideal water supply watershed would have the following characteristics:

i. Provide gravity flow, and located close to demand (to minimize capital costs and avoid pumping costs during operations).

ii. Water quality good throughout the year so that simple chlorination is the only treatment required.

iii. Isolated area out of the way of human activity, e.g. no demand for summer cabins, boating, wood haul in winter.

iv. Sufficient run-off and storage, but not overly large in area, or with numerous ponds and rivers, because this tends to make protection in the future more difficult due to public pressures for recreational use, etc.

When the water supplies for small towns were being developed in the 1970's, the prime criterion was probably (i), because a gravity source close by would keep down the construction and operation costs. In recent years the water-using public has become outspoken about seasonal water quality problems such as algae and colour. Such waters were once accepted without complaint. Means of circumventing these problems will evolve in the future.

Items (iii) and (iv) have been given scant weighting in the past but are becoming increasingly critical. In locations of growing population density and recreational mobility the planning objective should be to minimize the watershed and water body requirements for water supply. This would then maximize the lands available for other uses, e.g. recreation, road building, agriculture.

The survey results suggest that many communities now relying on wells will need more water in the future* and will have to look to surface supplies unless there is a good aquifer nearby. The time is opportune to investigate comprehensively the future watershed needs for water supply on a broad scale regional basis. The objective is to minimize the area of watershed and water bodies set aside for water supply, and to pick out the sources with good raw water characteristics. Multi-community supply sources should be considered. Such a study is recommended as a priority for the Bay de Verde peninsula, particularly the east side of the peninsula from Holyrood to Bay de Verde.

The following remarks are from the Provincial Planning Office, Department of Municipal Affairs (Alice Graesser):

In the Conception Bay area between Holyrood and Carbonear the communities continue to spread westwards into 'rural' areas, reflecting a preference in many locales for 'rural' home settings and land prices and availability. Rural land, including ponds and streams, is thus under pressure for permanent residential development as well as cottage sites. Some councils in the area have expressed concern over the generally uncontrolled development of cottage areas. Crown land on ponds has been available for cottage development as long as there is road access. To the extent this conflicts with potential water supplies, some overall cottage development policy should be established at the provincial level.

GROUND WATER SUPPLIES

SCOPE

The survey of ground water supplies was to support the Regional Water Resources Study of the Western Avalon.

In this report the well survey was structured according to the level of government organization.

1. Town or Community
2. Local Service District (LSD)
3. Water and Sewer Service District (WSSD)
4. Water Supply Committee
5. Private

The WSSD is the lowest level of recognized municipal administration. The Water Supply Committee is a local group who have agreed to support the cost of running the particular well that they collectively use.

Interviews were conducted by telephone. Information was obtained from all the Towns and Communities and the majority of the LSD's and WSSD's. This gave a large sample covering ground water supplies, and current problems.

INVENTORY FORMAT

Community name and status From records provided by the Department of Municipal Affairs.

Population Only available for Towns and Communities.

Council wells Information is given on the number of wells managed by the local government as well as the number of houses connected, and any other buildings connected.

Chlorinators are required by regulation on any well developed within the last year or so.

Private wells The private wells are mostly dug wells. The information gives a good idea of the extent of municipal water services in the community.

Quantity and problems This statement provides local opinion on whether or not the wells have had a satisfactory yield or performance in the past. A large percentage of dry wells or polluted wells suggests Government assistance will be sought to provide a better water supply.

Future plans This reflects the local view on what needs to be done in the future, if anything. Sometimes a future pond is named for a surface water source.

WELLS IN PROVINCIAL PARKS

The following is a list of groundwater supplies in the Provincial Parks in the study region. No park has a surface supply, although some of the shallow wells probably draw surface water at least in part. In parks without wells, e.g. Gooseberry Cove, Cataracts, the requirements for water are presumably met from the river.

Park	No.Shallow Wells	No. Drilled Wells
Chance Cove	1	-
Gushues Pond	4	2
Father Duffy's Well	1	-
Cataracts	-	-
Gooseberry Cove	-	-
Salmon Cove Sands	1	-
Northern Bay Sands	1	-
Bellevue Beach	7	-
Jack's Pond	1	-
	16	2

Source: Provincial Park Facility Inventory

SUMMARY FOR ORGANIZED MUNICIPALITIES

A consolidated summary of the findings is given in Table I, page 233, end of report. The majority of the municipalities report that they need a larger quantity of supply.

ARGENTIA NAVAL BASE SURFACE WATER SUPPLY

Also supplies Towns of Freshwater, Jerseyside and Placentia.

Information:
Jeff Hickerson U.T.C., U.S.Base, Argentia

Population: The following areas are provided by water under the control of the Argentia base, from the main source, the Clark's Pond stream and pond network:

Argentia Base US and CAF personnel and dependents - about 600 people
Argentia N.Side - commercial, industrial and recreational uses, under Provincial control.
Town of Freshwater - population 1276)
Town of Jerseyside - population 841
Town of Placentia - population 2276

Freshwater, Jerseyside and Placentia are fed from Larkins Pond, which is fed by Clarkes Pond.

Water sources:

1. Main source is a network of ponds feeding to Clarkes Pond.
2. Back up source, Argentia Pond (this can serve the Argentia Base and N.side only).

DEMAND

Examples of monthly consumption figures, in 1000 m^3/month, converted from the U.S. file data of MG US per month.

Month/year	1964	1965	1966	1967	1968	1986	1987
Jan.							41
Feb.							44
March				204	211		52
April				187	185		42
May				206	197		48
June	217	198		195	206		48
July				193	196		50
August				192	206		44
Sept.				189	196		42
Oct.	133	187			201	29	
Nov.	173	139				31	
Dec.			181	202		31	

As seen, the consumption figures in recent months are about 25% of the earlier data.

A breakdown of water use is available for November 1965. Total does not exactly match the tabulated information above for the same month.

November 1965	Potable Water Demands - M^3
Laundry	49,141
Argentia Station, North and South	6,819
Visiting ships	2,652
Swimming pool	284
McNamara Construction	33
Process Steam and others	74,201
North Side power	12,953
	146,183

Some of these demands, e.g. North Side Steam Plant, no longer exist because the plant is demolished.

A breakdown of current demands among the North Side and the South Side (the U.S. Argentia base) is as follows, for a 12 month period October 1986 to September 1987 (given to nearest 1000 m^3):

	North Side	South Side	Combined
Year	208	203	501
Peak month, March	25.8	26.1	51.9
High month, July	23.1	26.5	49.6

North Side users include a fish plant operating in season, the regional sports arena, ships watering, Marine Atlantic ferry terminal, and other minor uses. The military/civilian population of the US base varies as personnel are transferred in and out. Current population is about 500 to 700. Population in the 1960's was 7,000 to 10,000.

Metering: Metering is carried out at the Clarke's Pond pumphouse, and on the connection between Argentia South Side and the North Side. Flows from Clarkes Pond to Larkins Pond are not metered.

Variations in demand: Historically these have been considerable due mainly to the changes in the US base. On a current basis the fluctuations in demand are relatively minor.

Wastage or losses:

1. In Placentia and Jerseyside (which use water from Larkins Pond) there were extensive leaks and water losses. These have been substantially reduced.

2. The leak situation in Freshwater is reported as minimal by the Town Manager.

Factors in future demand:

a. Potential Major Increases

. No plans have been announced but there is a feeling that there will be a very substantial increase in U.S. and Canadian Military Personnel.

. The Canadian Navy will need an East coast submarine base, and this may be Argentia.

. The Argentia North Side may be used for construction related to offshore oil and gas activities. The Mobil Oil Canada "Preliminary Project Description", Hibernia Project, June, June 1984, estimated 250 m^3 /d of fresh water, excluding fire fighting.

. Argentia North Side could provide a back-up offshore vessel support base for East Coast offshore oil and gas developments.

. Growth in the region is likely to take place in Southeast Placentia.

b. Status Quo or slight increase

The Municipal demands, Freshwater, Jerseyside and Placentia Beach are unlikely to show major increase.

SUPPLY SOURCE - MAIN SOURCE

Description of supply ponds: The watershed includes three major ponds: Larkins Pond, Clarkes Pond and Gull Pond, as well as two smaller ponds: Kidney Pond and Barron Pond. The chain of ponds is as follows.

The lowest pond, Larkins Pond, feeds the Towns of Freshwater, Jerseyside and Placentia. The next highest pond, Clarkes Pond, which feeds Larkins Pond, is the reservoir for the Argentia Base and North Side. Clarkes Pond is fed through a brook from Barron Pond which is fed through a brook from Kidney Pond. Kidney Pond is fed from a ditch and pipe from Gull Pond. Gull Pond has elevation 125.3 m, and Larkins Pond 41.6 m.

Controls:

Gull Pond: The natural outlet for Gull Pond is not into the Clarkes Pond watershed. Gull Pond is tapped into the Clarkes Pond system by gravity through about 200 m of 760 mm diam. RC pipe to a ditch, which runs to Kidney Pond. This flow is controlled by a shut-off valve at Gull Pond. In times of shortage, pumps are used to feed Gull Pond from nearby ponds on different watersheds which have outlet brooks northward into Placentia Sound. Formerly there was a pumphouse at Gull Pond with a longer intake. This reached deeper water and thereby increased the available storage in the system.

Barron Pond: This has a dam and outlet control on the flow to Clarkes Pond.

Clarkes Pond: The current means of controlling the flow from Clarkes Pond to Larkins Pond is by means of a gate valve on a 300 mm line beteween the two ponds. Larkins Pond is normally about 1.1 m lower than Clarkes Pond.

Larkins Pond: This has a semi-circular concrete spillway which feeds the outlet brook to Placentia Bay.

Watershed protection: The system, including Clarkes Pond and upstream, is within the US control boundary. Larkins Pond watershed is protected under Provincial regulations. A main highway runs close to the northern and western perimeters of Clarkes Pond, and the western perimeter of Larkins Pond. The Larkins Pond watershed, on the west side, contains considerable urban development, including a gas station (Alice Graesser).

US Supply System at Clarkes Pond
Intake: 405 mm diam. into the Clarkes Pond pumphouse.
Screens: In pumphouse.
Pumps: 3 x 63L/S (1000 US gpm) in parallel. Two pumps have electric motor drive and the third is a diesel driven standby.The pumps feed a 300 mm transmission main.
Chlorination: By gas. Takes place upstream of the pumps.

Special Agreement: Under agreement with the U.S. Authorities the level of Larkins Pond is to be maintained above elevation 40.85m for the use of the Towns of Placentia and Freshwater.

STORAGE/DEMAND FACTORS
Live storage: The US records provide the following information on watershed and storage volume for the major ponds.

Pond	Watershed area km^2
Larkins	1.27
Clarkes	5.05(a)
Gull	2.49

(a) includes Kidney and Barron Ponds

Live storage head:
Clarkes Pond: A US report states that the pump suction line which is 405 mm diam. is 2.4 m below mean pond surface. This indicates a live storage head of 2.0 m. Some years ago the original intake was lowered to its present level to increase the potential yield. The pump impellers are below normal pond level.

Town of Freshwater, Larkins Pond: Normal live storage head, spillway to top of 300 mm intake pipe is about 1.8 m (Town Manager, Freshwater).

Town of Jerseyside, Larkins Pond: About 2.0 m spillway to top of 300 mm CMP intake pipe (tape measurement WL to intake pipe plus observation of WL below spillway).

Adequacy of supply, summer 1987: Gull Pond normally drops only about 0.3 m or so during summer. The lowest level noted Sept.7, 1987, was about 1.8 m below normal WL. Barron Pond dropped about 0.9 m below normal WL. Clarkes Pond was lowest on August 20 at about 0.6 m below normal WL. Similarly Larkins Pond was about 0.6 m below normal WL.

Ways to increase live storage: On a temporary basis Gull Pond could be augmented by pumping from other ponds (as happened in the sixties). Gull Pond has deeper portions than the intake, so a pump could be used to carry this water to the downslope on the outlet pipe.

Clarkes Pond is reported as 9 m deep, so an extension of the intake (pump suction line) into deeper water could be considered.

WATER QUALITY

Standards used: US Safe Drinking Water Act (SDWA).

Bacteriological: Chlorine residual tests are carried out by the U.S. staff.

Chemical: Tests on raw and chlorinated water in 1976, Clarkes Pond and Argentia Pond. Water does not meet SDWA standard for turbidity (1.0 JTU max). However, maximum turbidity of 5.0 JTU is acceptable providing this does not adversely affect disinfection of water. pH is low: 6.15, 6.03 and 5.89 with negative Langelier Index -3.29, -3.63 and -4.11, and hence severe corrosive potential.

Recommendations: (of a U.S. study):
1. Reduce corrosion potential with a sodium-zinc phosphate inhibitor (e.g. Calgon TG-10).
2. Filter water to reduce turbidity.

WATER TREATMENT
1. Chlorine gas is applied at the Clarkes Pond pumphouse. (5 to 14 Kg/day; average about 6.8 kg/day).
2. Fluoride in pellet form was formerly used but was discontinued about 10 years ago.

TRANSMISSION AND DISTRIBUTION

South Side: From the Clarkes Pond pumphouse a 300 mm cast iron (CI) transmission main runs about 2130 m to the high reservoir 1360 m^3 capacity with a top water level (TWL) about 45 m above Clarkes Pond. This reservoir feeds a high pressure zone on the South Side and also all the North Side.

There is also a lower reservoir, capacity 1890 m^3, which is about 33 m TWL above Clarkes Pond, and which serves a low pressure zone on the South Side.

The upper and lower reservoirs are separated by piping with control valves. The tanks are filled by manual operation of the pumps at Clarkes Pond.

The distribution mains are built as a looped network of CI pipe, with fire hydrants.

North Side; The North Side (and South Side) were started in the 1940's and the North Side was in operation until 1968. From 1968 to 1970 the North Side system was deactivated except for the lines to the CN Marine terminal and Transport Canada. Mains are DI and CI with sizes from 400 mm to 100 mm diam. The original system included numerous storage tanks and three pumping stations. The system presently used is a fraction of the original system.

SUPPLY SOURCE BACK UP

Argentia Pond, a natural pond with storage augmented by a dam. It is kept in readiness as a standby source, with chlorinator. Its elevation, 92 m, enables a gravity feed to the South Side, although high buildings need internal pressurization for the top floors.

Dam: The original dam was raised in 1962. Storage 300,000 m^3. Spillway to top of intake pipe.

Spillway: 7.6 m x 0.7 m.

Intake: 200 mm diam.

Screens: ?

Live storage head: Approximately 3.0 m (new intake). Some uncertainty on this.

Watershed area: 1.61 km^2 (U.S. data).

Transmission: This supply is connected to the South Side by a 200 mm main.

Chemical water quality: Low pH 6.15. Same comments as for Clarkes Pond.

Reliable yield: 760 m^3/day. (From files, US Base)

COMMENTS/PROBLEMS

1. Supply volume: The safe yield of the Clarkes Pond system was estimated in 1957 (Charles Maquire and Associates, of the US) at 19,200 m^3/day. With the subsequent alterations at the Clarkes Pond intake the safe yield rose to 24,100 m^3/day. However, the removal of the pumping station at Gull Pond reduced the yield to about 16,340 m^3/day, but this loss could presumably be replaced. Larkins Pond watershed adds a further 4,800 m^3/day.

2. Future demands: These are indeterminate at present (e.g. fabricating yard, naval submarine base) but could be large.

3. New system: There was discussion a few years ago of the US South Side using Argentia Pond and passing over Clarkes Pond and the watershed supply to the Province. The Province would then build a new transmission main to the North Side, along with the necessary storage. However this idea now seems in abeyance.

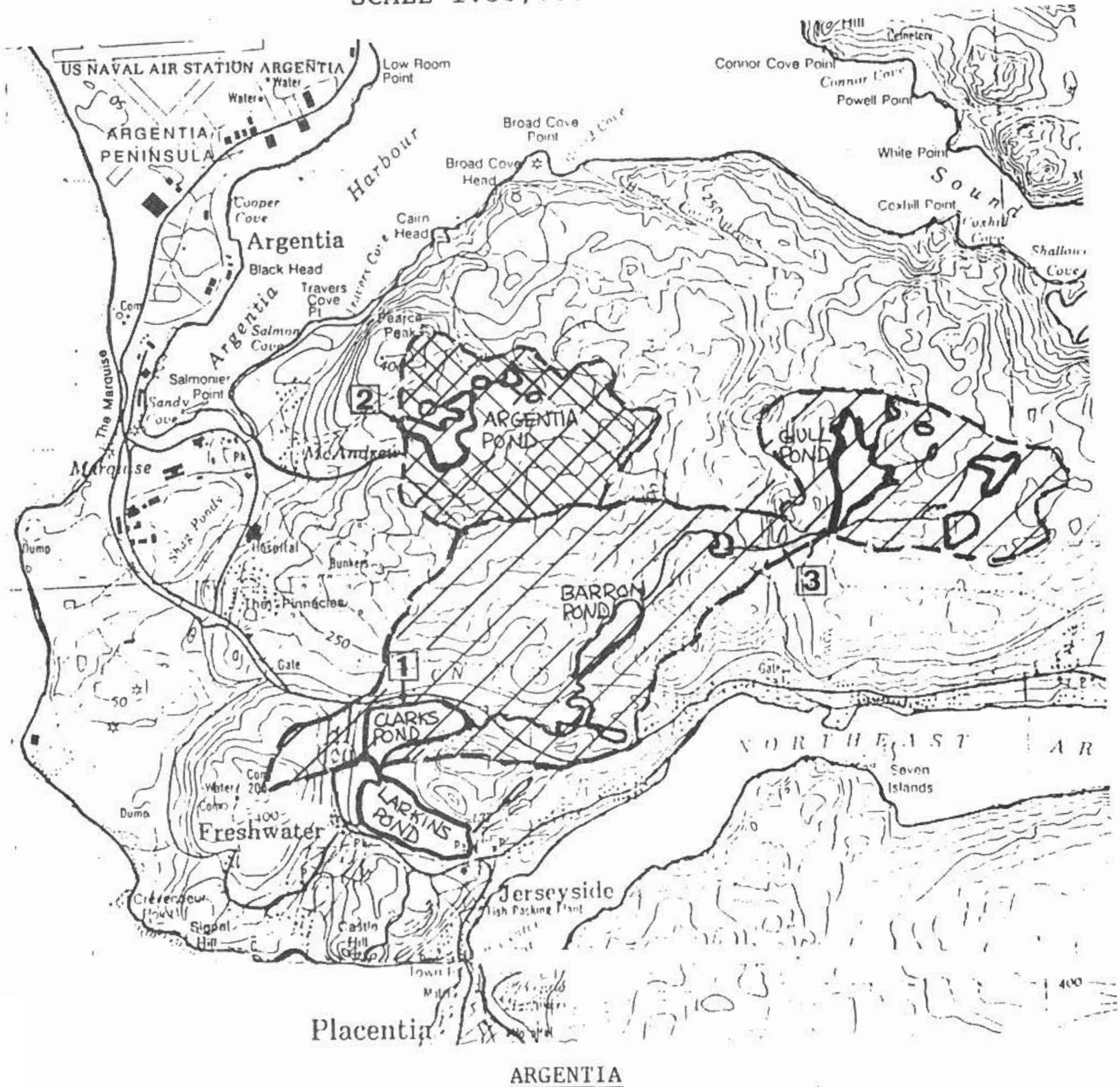
FUTURE CAPITAL REQUIREMENTS

If the Province takes over Clarkes Pond, and rehabilitates the North Side distribution netework the total cost could be about $2 million.

Rehabilitating the North Side water system could cost several hundred thousand dollars. Water would continue to be supplied from the South Side. Such a rehabilitation is likely to be necessary only if there is a large industrial or military development. If this occurs the costs of water system improvements would be part of the overall development cost package.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



ARGENTIA

1. Intake-Clarks Pond
2. Intake-Argentia Pond
3. Pipe and Canal, Gull Pond to Clarks Pond Watershed

Consulting Engineer: Colin Karasek Ltd. January 1988

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF ARNOLD'S COVE

Information:
Wayne Slade, Town Clerk
Kenneth Peach, Town Foreman

Population: 1124 (1981), 1117 (1986)

Water source: Run-of-river abstraction dam on Eastern Pond Brook, sometimes called Steve's Brook, with back-up storage from Steve's Pond, which feeds Eastern Brook. No Council wells.

DEMANDS

Domestic: Approximately 370 homes plus one school, one motel (18 rooms) and a few local businesses.

Industrial:
(1) Large fish plant, 400 workers, National Sea Products Ltd. Consumption 800 m^3/day of fresh water, from average monthly water consumption figure in report by Uday Shah,. P.Eng., Dept. of Municipal Affairs (DMA Report). Additionally metered consumption data given month by month for August 1979 to June 1980 gave an average of 25,763 m^3 per month or 842 m^3/day when the salt water system was working, and 1765 m^3/day for the month during part of which the salt water line was broken down. Ref: Sheppard Hedges Green Report, Dec.1980 (SHG Report). The capacity of the salt water line is given at 30 L/s (SHG).

(2) trawlers washdown and bunker with water. Fifty visits/year at 30 m^3 per visit over three hours. (DMA report)

NOTE: The fish plant came into operation in 1978, and the added demand may not have been included when the original system was designed in 1972.

Wastage and losses: None reported.

Metering: The fish plant has "fairly good records of water consumption). Domestic demands not metered. (DMA Report)

Variations in demand: These are considerable, due to fish plant.

Factors in Future Demand:

A. Without oil related development: A small population growth might occur, as well as slight growth in the industrial demand.

B. With oil related development: Adam's Head, the prospective site for constructing an offshore concrete gravity platform, is about 3 km from Arnolds Cove. The access road to the Adam's Head site will likely pass close to Arnold's Cove.

Hence Arnold's Cove could expect a large, rapid, but probably temporary, population growth, if the platform construction project went ahead.

NOTE: The Arnold's Cove supply is not sufficient enough to supply the water requirements at the construction yard itself, at Adams Head.

SUPPLY SOURCE #1 AND STORAGE (MAIN SOURCE)
Dam on Eastern Brook, about 2.8 km from the community. The supply is the run-of-river flow plus a small amount of storage created by the dam.

Status of watershed protection: Protected.

Dam: Reinforced concrete gravity dam, built 1972. Length of dam 50.8 m. Minimum height of dam, about 3 m. Top width 1,448 mm. Dam is in excellent condition. (Referred to as the "downstream dam".)

Intake and screens: Iron pipe 356 mm diam. The screen chamber, 1.5 x 1.5 mn, is built on the water side of the dam, so that the water flows through the screens to reach the intake.

Spillway: Rectangular, built into dam. Width 9144. Height 1219. (Measured on site). Spillway elevation about 60 m (SHG Report). The downstream part of the spillway is a hydraulically curved concrete apron.

Storage volume to spillway elevation: Approximately 2500 m^3 (estimated by eye).

Ways to increase live storage:

i. Raise spillway with a stop log. In the opinion of the Town Foreman, the present freeboard of 1212 could be reduced to 600 mm and still be adequate. The increase in live storage would be about 1100 m^3.

ii. Raise water level by 1300 mm with a concrete wall on top, and raise spillway. Increase in live storage about 2500 m^3.

In addition, in both cases, the lower part of the dam should be cored through to instal a reservoir drain with a manual valve. To improve dam stability local soil and rock can be bulldozed higher against the downstream face of the dam, subject to investigation. The screen access deck will need to be raised.

SUPPLY SOURCE #2 AND STORAGE (BACK-UP SOURCE)
Steve's Pond. 3.2 km upstream from the dam. A natural pond augmented by a dam. This serves as the main storage reservoir for the system. Water is drawn from Steve's Pond to augment the natural stream flow in dry periods, and to fill the lower reservoir behind the concrete dam.

Dam: Just downstream from the outlet from Steve's Pond is a low dam which has raised the pond water level by about 1.5 km. Dam is of timber crib construction. This dam is reported to be in poor condition and leaking.

Live Storage: The live storage volume given in the SHG report is 291,250 m^3, with a pond area of 191,000 m^2. Dividing volume by area gives a live storage head of 1.52 m.

Control of live storage: There is a natural spillover into the feeder brook to the downstream reservoir. In addition there is a 200 mm line and manual valve which has a discharge capacity averaging 11,870 m^3/day over 24.5 days to deplete the live storage in Steve's Pond (SHG).

In practice the Steve's Pond reservoir is not depleted in a single drawdown, but periodically as required. During 1987, a relatively dry year, the Town staff made 25 trips to open the valve and replenish the lower reservoir. Each trip required a walking time of 1.5 hours.

Ways to increase live storage: The Town Foreman reports that excavation in Steve's Pond behind the dam could increase the amount of water that could be drawn from Steve's Pond. The 200 mm valved line may also be dropped to increase the available head.

Adequacy of supply, summer 1987: The supply proved inadequate and Council purchased a pump and hose to pump from Beaver Pond to Steve's Brook above the abstraction dam.

WATER QUALITY

Bacteriological: Department of Health, Whitbourne.

Chemical: No data available.

Problems: No problems reported with water quality.

WATER TREATMENT

Wallace and Tierman manual controlled chlorinator (check). The chlorinator is located about 900 m downstream of the downstream dam and about 2200 m before the first connection. The system is maintained by the Town.

<u>Problems with chlorinator:</u> The present chlorinator does not provide a chlorination dosage that responds to the large flow variations caused by the fish plant. A flow paced chlorinator is required in which the rate of flow in the pipeline will create a corresponding electic signal to govern the dosage of chlorine gas. Estimated cost $100,000 (DMA Report).

<u>New chlorinator:</u> A new flow paced chlorinator is being installed. Scheduled for completion March 1988.

<u>TRANSMISSION AND DISTRIBUTION</u>

Transmission main 356 m diam, about 3100 m in length. Fire hydrants are served.

<u>Factors in replacement cost estimate:</u>

- timber crib dam
- concrete dam
- chlorinator (fixed rate)
- transmission main 365 mm diam., 3100 m in length
- 380 connections

<u>COMMENTS/PROBLEMS</u>

1. <u>Supply:</u> The supply volume is now being much more utilized than before the National Sea plant was built. This has led to shortages of supply, and has made the control of supply (the upstream valve at Steve's Pond) much more difficult to handle.

2. <u>Demand:</u> The fish plant is the major user of fresh water. An investigation should be made to see how much the fresh water use can be reduced by using salt water for more of the plant requirements. This is a priority.

3. <u>Downstream storage volume:</u> The storage volume at the downstream dam could be almost doubled to about 5,000 m^3 by raising the dam, and other alterations. Estimated cost $60,000. This should help the control of the system supply.

4. <u>Storage at Steve's Pond:</u> Steves Pond dam and reservoir was investigated in 1987. A new earth dam with waterproof membrane to raise the WL by about 600 mm was recommended (letter November 14 1987). Cost $95,000.

5. Sheppard Hedges Green recommended the following in their report, December 1980:

   a. <u>Augment summer flow from storage:</u> For summer months, use a mechanical flow control device at Steve's Pond to feed a predetermined rate of flow from the Steve's Pond storage, to augment the natural flow in the brook to the downstream dam. Updated estimated cost $13,000.

b. Improve reliability of winter flows: To ensure winter flows, when the brook sometimes freezes or blocks with ice, deepen the channel. Updated estimated cost: $100,000.

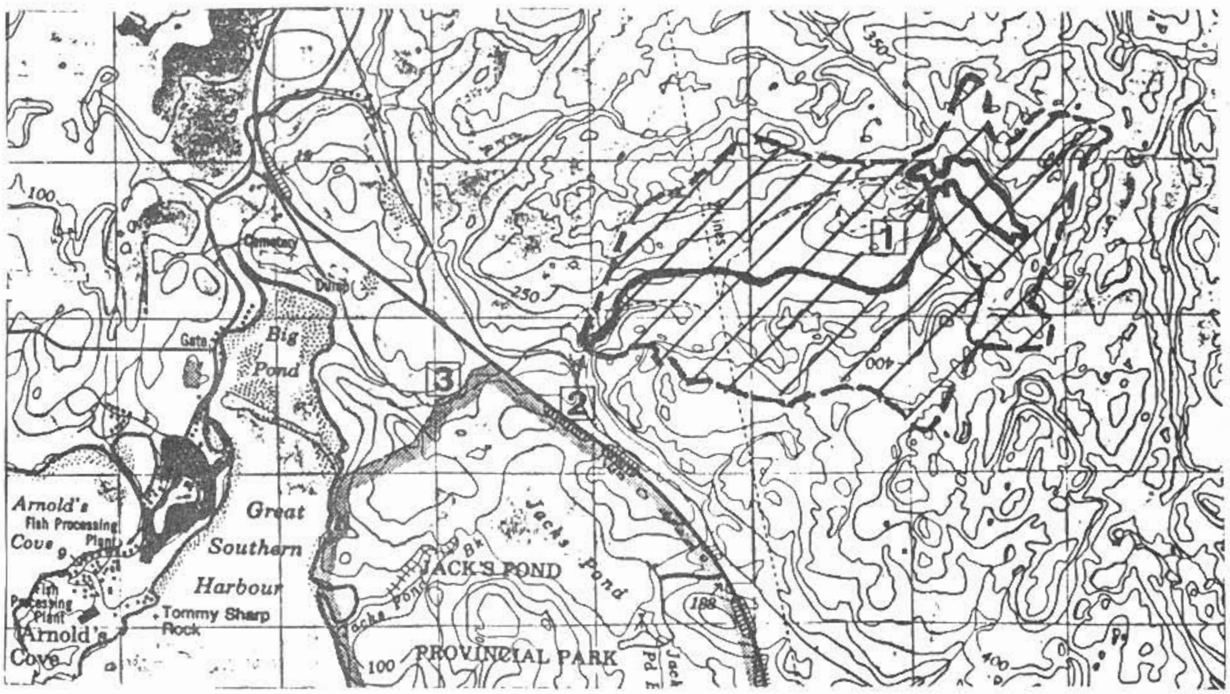
7. Low distribution pressures: When the fish plant is in peak production, or a hydrant is opened, there are severe pressure losses in the higher parts of town. This suggests insufficient capacity in the supply mains (too small or encrusted). One solution would be to instal storage tanks in the Town, but this might be expensive. Conservation measures for fresh water use are indicated.

FUTURE CAPITAL REQUIREMENTS

Town has requested funding for the new dam at Steve's Pond at cost of $95,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



1. STEVES POND CONTROL
2. DOWNSTREAM DAM
3. CHLORINATOR

Consulting Engineer: Colin Karasek Ltd.   November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF BAY DE VERDE

Information:

1. Town Clerk: Mrs. Molly Walsh, tel: 587-2670
2. Maintenance Foreman: Melvin Coish
3. Design drawings, contract construction. The constructed-work probably conforms with the drawings. (BAE Group, Consulting Engineers)

Population: 786 (1981)

Water Source: Little Island Pond. Town is sole user and distributes to the fish plants. Under low flows a gravity system. With high flows the water is pumped to storage and then distributed.

Wells: Council has one drilled well which can be used on a self-collect basis by anyone needing water in buckets or portable tanks.

DEMANDS

Domestic: Approximately 200 homes hooked up, in the lower part of town (harbour area). About 5 houses are not hooked up in this area. On the higher ground at the back of town there are about 50 homes on private wells. A pressure boosting system would be required to serve most of these houses.

Commercial: A few stores serving local needs.

Educational: One elementary school, which has its own well. One high school, with its own well.

Industrial: Fresh fish processing plant and a crab plant. The plants are side by side, owned by Quinlan Brothers. The plants use salt and fresh water.

Wastage or losses: Very few leaks are reported (e.g. two leaks repaired last year), although there is some tap bleeding in winter.

Metering: There is a water meter in the pumphouse-chlorination station which could measure total demand but readings are not taken regularly. The two fish plants are collectively metered for fresh water by the Council (18,000 to 23,000 m^3 per month).

Variations in demand: There are dramatic declines in demand when the fish plants are not working.

Factors in future demand: Serve present population and schools. Serve about 55 new houses on private wells. Slight increase due to population growth, say 1% p.a. Fish plants have not announced plans for expansion. However an allowance should be included for an increased industrial demand, say 25%.

DESCRIPTION OF SUPPLY SOURCE (main source, no back-up source)

Island Pond.
Watershed area 0.69 km² with mostly indefinite boundaries (from 1:50,000 mapsheet)
Watershed topography undulating, vegetation barrens type.

Status of watershed protection: Protected. (The protected area extends further to the NW than shown on the watershed plan. The protected area extends to route 70.)

Dam: The original dam was built in 1974 to serve a 150 mm to 100 mm diameter waterline to the fish plant. In 1986 the water level was raised about 1.2 m with a new dam. This consists of a vertical reinforced concrete wall supported by an earth-rock berm each side. Overall length of wall is about 82m (paced). The spillway is a rectangular notch 750 mm below the top of the concrete wall and 2400 mm wide. Dam and spillway in good condition. No flood spillway. The spillway runs all winter, usually up to 150 to 220 mm above the sill.

Intake pipe and screens: 350 mm diam HDPE leading to screen chamber built into the dam. Exposed gantry for screen lifting. Three screens.

Adequacy of supply, summer 1987: The lowest WL observed in sumnmer 1987 was about 1.2 m below the sill (estimated by Town Foreman). Hence there was still about 2.5 m of drawdown head available to the top of the intake pipe. W.L.estimated Oct.1/87 at 760 mm below sill (Karasek).

STORAGE/DEMAND FACTORS

Live storage head: Spillway to top of intake pipe in wet well, 2.2 m (source:As Built drawings BAE Group). Intake pipe is installed on virtually a level grade (Gunnar Leja, P.Eng., BAE Group).

Ways to increase live storage: Live storage could be increase by means of a stop-log at the spillway. May need to build additional spillway volume.

WATER QUALITY

Bacteriological: Lab., Dept. of Health, Harbour Grace. No problems reported.

Chemical: Data not available.

Problems: No problems reported with water quality.

WATER TREATMENT

Gas chlorinator with injection rate controlled by impulse timer which is served by a signal from an in-line water meter located in the chlorination/pumphouse building. System built about 1983/84.

The chlorinated water passes through 1374 m of 250 mm and 150 mm diam. pipe to a steel tank of about 500 m^3 storage capacity. From here it passes to the consumers. The system is maintained by the Town Foreman, a full time employee. Additional treatment would include pH correction, but this is not proposed at present.

TRANSMISSION AND DISTRIBUTION (Source; BAE Group drawings, metric.)

	Chainage	Elevations	
Dam	0 + 00		Start of 150 mm
Spillway at dam		125.53	PVC line built 1974
Chlorinator and booster pumps	17 + 50		Start of new 250 mm PVC pipe in parallel with 150 mm line
End of 250 mm PVC line	25 + 90		150 mm PVC line built 1974, continues to tank
Base of storage tank valve	31 + 24	89.3	Location of altitude
Top of storage tank		101.3	
To lower Town			Two main lines: 100 mm PVC line built 1974, 200 mm PVC line built 1984
Fish plant	44 + 24 approx.	3.0±	

The system has sufficient head to provide gravity flow but the pipe diameter of 150 mm is too small when demands are high, which occurs with the fish plants operating. Under gravity flow a check valve opens in the pumphouse to bypass the pumps, and to fill the tank. With a large demand the booster pumps come into play. There are three pumps: two service pumps at 30 HP each and one standby or emergency at 20 HP. There is a single acting altitude valve near the tank in the feed line from the pumphouse. The altitude valve allows one-way flow only to the tank. When the tank is full the actuating cylinder of the altitude valve forces the main valve to close, thus isolating the tank from the pipeline from the pumphouse.

The distribution system was started in 1974 and has been added to, with the most recent work in 1986. There are fire hydrants. Mains are of PVC (Series 160 originally, most recently DR 18). There is about 30 m of ductile iron pipe.

FACTORS IN REPLACEMENT COST ESTIMATE:

- dam, screens
- pumphouse
- chlorinator
- steel tank, 12 m H, 14.2m diam.
- transmission mains: 150 mm PVC 2590 m
250 mm PVC 840 m
100 mm PVC 800 m
200 mm PVC 1000 m
- distribution system, about 210 connections
- access road to dam

COMMENTS/PROBLEMS

Ultimately this could become an all gravity system with, say, a 300 mm main to replace the 150 mm main from the dam to the chlorinator.

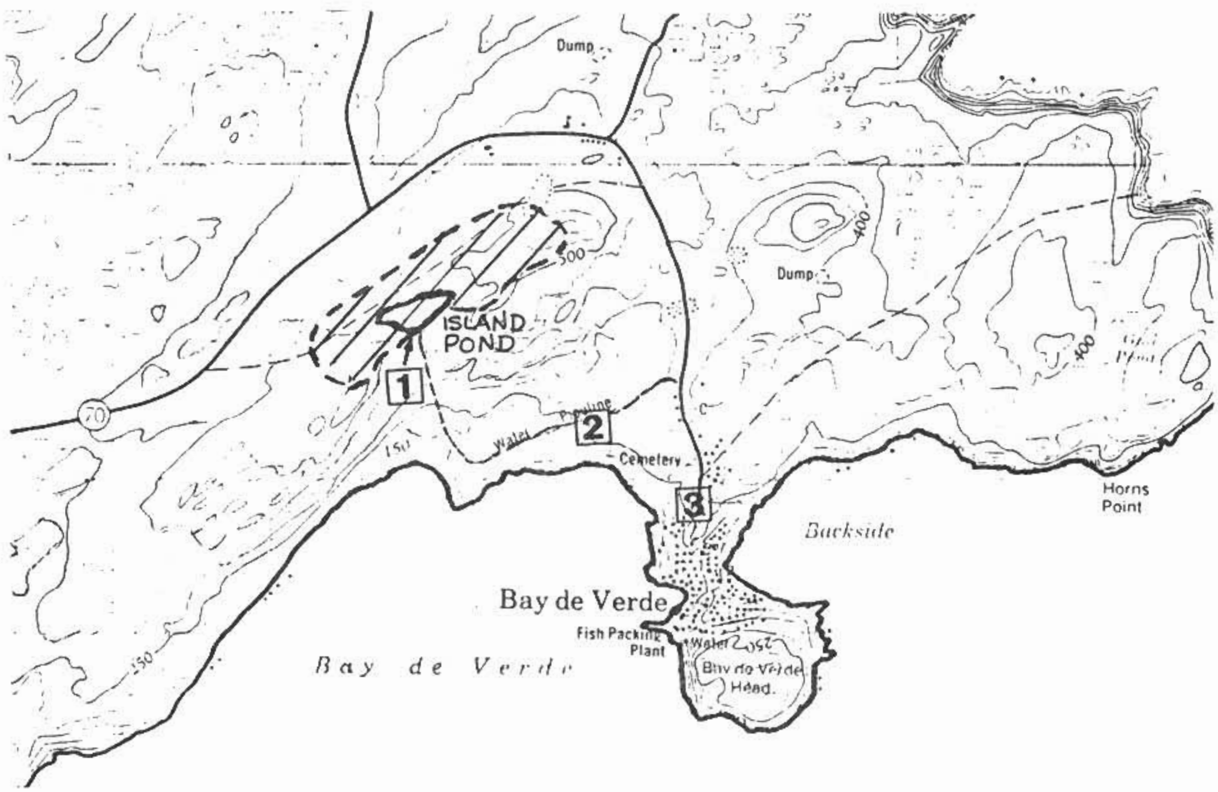
FUTURE CAPITAL REQUIREMENTS

1. Complete servicing of Town (55 houses) with pressure boosting system. $400,000

2. If the system is converted to a full gravity system the capital cost would be about $500,000. (This is very approximate since a new gravity route would probably not follow the present route all the way.)

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF BAY DE VERDE

1. INTAKE
2. CHLORINATOR, PUMPS
3. TANK

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF BAY ROBERTS

Information:
Edwin Fradsham, Town Manager
Patrick Foley, Town Superintendent

Population: 5217 (1981), 5600 (1985) estimated
A projected 2% population growth rate.

Water source: Rocky Pond, sometimes called Fall Pond, a gravity source. This also acts as a standby source for Spaniard's Bay.

Wells: Council has three wells.

DEMANDS

Domestic: About 1200 connections.

Commercial: A major regional service centre. Two shopping centres, auto service stations and car washes, professional services, etc.

Educational: High School, 800 pupils, elementary schools, 1005 pupils.

Institutional: Churches, medical clinics, two private nursing homes, stadium.

Industrial: Bay Roberts Sea Foods, 3 lines, 50 mm diam., a small fish plant.

Wastage and losses: A few leaks are found occasionally and are systematically repaired.

Metering: No metering installed. The Spaniard's Bay branch, not in use now, has a meter.

Variations in demand: Not reported as significant.

Factors in future demand:

- In the unserved area about 500 connections remain to be completed by means of extending the water mains. This will simultaneously require the extension of sewer mains, which could be expensive as many sewage lift stations will be required.

- Population growth projections at 2% p.a. Projected no. of dwelling units 2080 (1995) (source: Bay Roberts Municipal Plan 1985-1995).

- Two fish plants, Coleys Point Fisheries and Seaside Fisheries located on Coleys Point do not have main services (Government well). Freezing plant, Moores Fishery, will be operating next year. Fish processing facilities are not likely to consume large volumes of water, i.e. industrial demand is not expected to be a major component of demand in the future.

<u>SUPPLY SOURCE</u>
Rocky Pond (sometimes called Fall Pond). The watershed includes a series of three large ponds along the Tilton-New Harbour highway which runs through the watershed.

<u>Status of watershed protection:</u> Protected. (Alice Graesser)

<u>Dam:</u> No dam.

<u>Intake:</u> This is a concrete chamber set about 10 m from the shoreline and extending from the bed of the pond to above surface level. The top cover is a galvanized steel grid. The bottom of the chamber is perforated to provide the intake. The intake pipe is 356 mm concrete.

<u>Screens:</u> A battery of 8 basket screens in two parallel lines of 4 in chlorination building.

<u>Spillway:</u> Natural brook, typically 15 m x 400 mm

<u>Adequacy of supply, summer 1987:</u> Normmaly there is 1200 mm of water over the top of the intake pipe. This dropped to 230 mm summer 1987 (Town Manager).

The back-up ponds are Little Pond and Big Pond. The river channel from Big Pond to Little Pond was excavated over about 60 m to improve the flow of water. Little Pond was drained and Big Pond was lowered 900 mm by means of this work.

The supply proved adequate for the dry period with the measures undertaken above.

<u>STORAGE/DEMAND FACTORS</u>

<u>Live storage head, normal conditions:</u> Pond surface to top of intake pipe 1.2 m (Town Manager).

<u>Ways to increase live storage:</u>
1. Use method Council used in 1987 (see above).

2. Low dam on Little Pond and Big Pond with manually operated outlet controls. Channel improvements as necessary. This would increase the volume of upstream storage available.

3. Dam on outlet brook, Rocky Pond. Water level could be raised about 600 mm by means of an earth/rock dam 100 m long up to about 1.2 m high. May have to raise the top of the intake chamber slightly.

WATER QUALITY

Bacteriological: Dept. Health, Bay Roberts. They test regularly for bacteria and residual chlorine. Usually obtain a chlorine residual 0.5 ppm.

Chemical: No test data available. No problems reported with chemical quality.

WATER TREATMENT

Chlorine gas system. Manual setting. Fixed rate at about 1 ppm. The plant is 2000 m downstream of the intake and approximately 1800 m upstream of first house.

TRANSMISSION AND DISTRIBUTION (see map with Spaniard's Bay)

1. Bay Roberts Transmission main 356 mm diam DI, extends from intake to waterfront in Bay Roberts harbour. The system has air release/vacuum valves. There is a 300 mm branch along the Conception Bay Highway. Additional mains are 250 mm, 200 mm and 150 mm. The systems has fire hydrants. The system, which was started in 1972, is being extended along with the sanitary sewer system, as funds permit. No water booster pumps required in system or proposed system.

   The transmission system has no pressure reducing valves (PRV). (Static pressures up to 84 m head of water.) Each individual connection is required by Council to have a PRV installed.

2. Spaniard's Bay Immediately downstream of the chlorinator there is a branch 300 mm diam. to Spaniard's Bay. This connection is through a gate valve, normally closed, and a water meter.

FACTORS IN REPLACEMENT COST ESTIMATES

Intake
Screens
350 mm DI transmission main 3800 m long
Chlorinator
1200 connections

COMMENTS/PROBLEMS

The usual system for raw water screening in a large water supply is a series of removable screens of different mesh, close to the intake.

FUTURE CAPITAL REQUIREMENTS

1. Completion of distribution system.

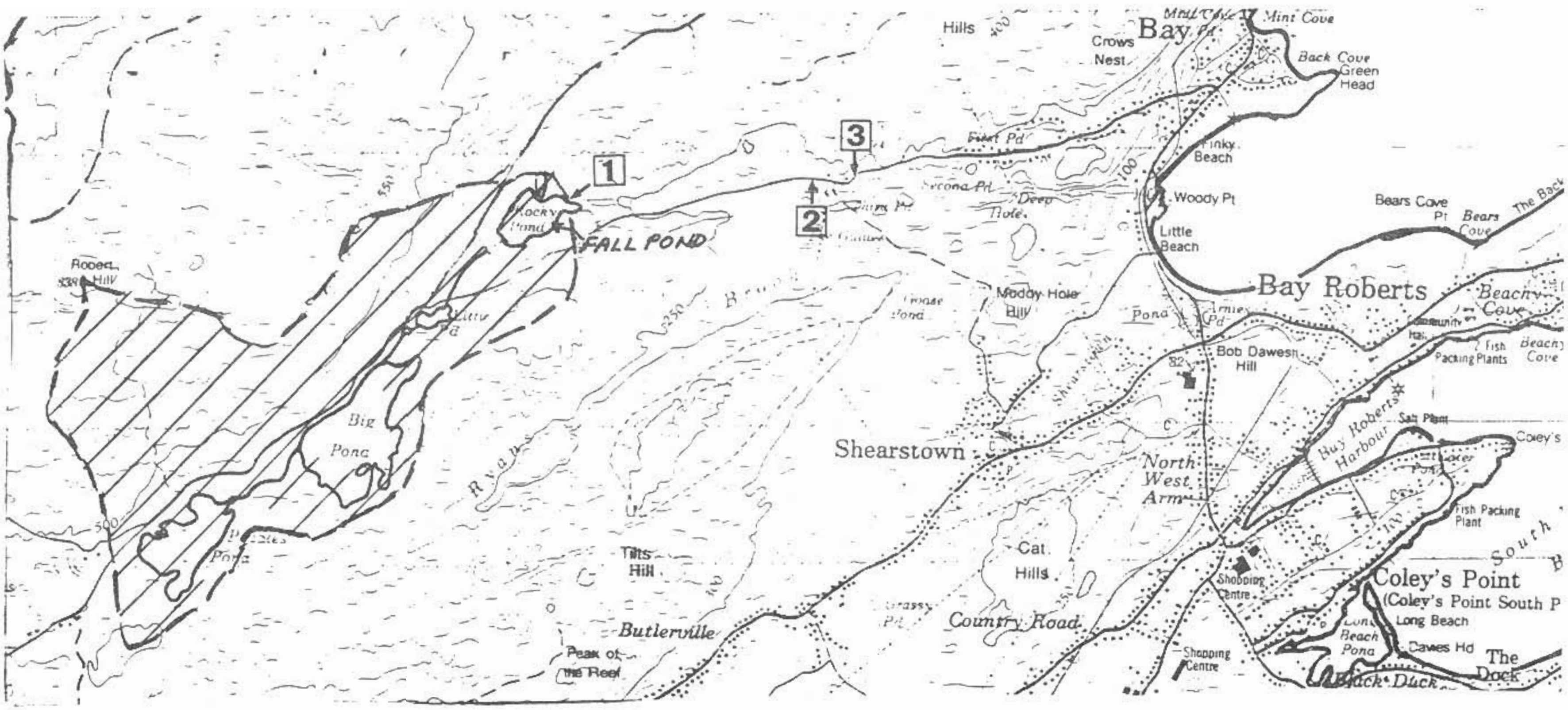
   If more live storage is required:

   a. Build an earth/rip rap dam at Rocky Pond outlet, with fish ladder and control structure. Raise top of concrete structure at water intake.

   b. Control storage upstream of Rocky Pond.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



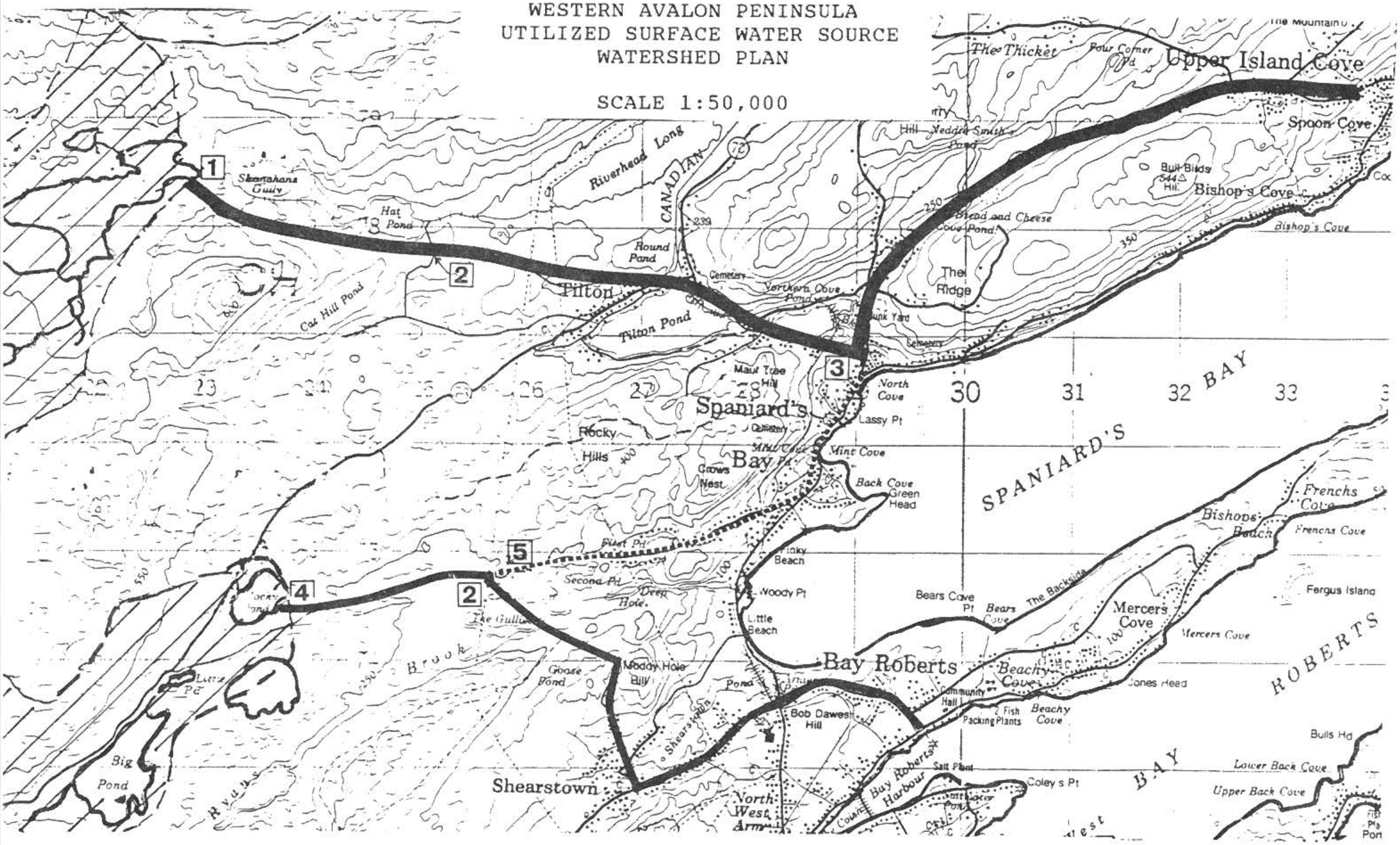
TOWN OF BAY ROBERTS

1. Intake
2. Chlorinator
3. Valve, normally closed-Spaniard's Bay

Consulting Engineer: Colin Karasek Ltd. November 1987

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



MAIN LINE SYSTEMS: SPANIARD'S BAY, TILTON, UPPER ISLAND COVE, AND BAY ROBERTS

1. Intake-Spider Pond
2. Chlorinator
3. Pressure Reducing Valve
4. Intake-Rocky Pond
5. Gate Valve, Normally Closed

TRUNK MAIN SIZE

400 MM DIAM.

350 MM DIAM.

300 MM DIAM.

MUNICIPALITY - SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF BELLEVUE

Information:
Chairman: Terrence Fahey
Walter Vere Holloway, Department of Municipal Affairs

Water source: Bellevue Big Pond - LSD is the sole user. A pumped source.

Wells: No Council wells.

DEMANDS

Domestic: 53 houses connected.

Other: One store, fire hall, hall. (Water not supplied to fishery operations.)

Metering: No meter.

Wastage or losses: None reported.

Variations in demand: Normal.

Factors in future demand: About 10 houses not connected. Mr. Fahey believes future growth depends on external opportunities, e.g. industrial developments at Come by Chance.

SUPPLY

Bellevue Big Pond. A natural pond, no feeder brooks. Highway on watershed.

Dam: No dam.

Spillway: Small brook (runs through 460 mm culvert).

Intake: 150 mm plastic pipe which runs to a pumphouse where there is a 90° upward elbow. This constitutes a wet well for a pump.

Screens: Coarse screen, 25 mm on intake, fine screen on foot valve of pump intake.

Adequacy of supply, summer 1987: Pond water level dropped about 75 mm.

Status of watershed protection: Protected.

STORAGE/DEMAND

Live storage head: From pond normal water level to foot valve of pump suction line. No design information available. Assume 1.0 m.

Ways to increase live storage: Lower intake pipe and pump suction.

WATER QUALITY

Bacteriological: Satisfactory. Generally a chlorine residual is achieved (Dept. of Health, Whitbourne).

Chemical: No test data available.

Problems: Boggy taste sometimes in summer. High winds appear to stir up water and leave suspended solids in the water.

WATER TREATMENT

Chlorinator: Chlorinating by Javex 12 operated by on-off cycles of the pump. Sometimes the rate of chlorination has to be increased in summer to overcome high bacteria.

Chlorine contact time: Contact between the pumphouse and first user is increased by passing the water through four tanks in the discharge on the pumphouse. (These tanks are in addition to the hydropneumatic tanks.)

TRANSMISSION AND DISTRIBUTION

Pumphouse: One 5 hp pump with four hydro-pneumatic tanks, about 500 L each. The pump has a suction lift from a "wet well" which is 150 mm diam. pipe connected to the intake.

Mains: These are PVC bell and spigot; 100 mm diam. about 1830 m; 75 mm diam 915 m; plus smaller sizes. This is a domestic system, not supplying fire hydrants.

Factors in replacement cost estimate:
Pumphouse/chlorinator
Distribution mains

COMMENTS/PROBLEMS

1. Muddy water: Extend the intake into deep quiet water and support the intake on a frame at about 2 m below surface and well above the bottom, say 2 m minimum above bottom. Reduce intake velocity to about 0.03 m/s by enlarging the end of the intake or by some similar means.

2. <u>Screens:</u> The Chairman of Council has suggested water screens to take small particles out of the water. The screen chamber with removable screens would be placed on the intake line near the pumphouse. Depth about 2 m.

<u>FUTURE CAPITAL COSTS</u>

System extension to 10 dwellings. Assume $100,000.
Screens. $10,000.
Modify intake: $5,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000

LEGEND

1. Intake and Chlorinator

Consulting Engineer: Colin Karasek Ltd. January 1988

LOCAL GOVERNMENT - SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT OF BELLEVUE BEACH

Information:
Augustus Whiffen: Chairman

Demands: 12 houses served year round plus six cabins, seasonal. Also Soper's Lounge.

SUPPLY

A gravity supply. Brook, unnamed, is dammed with a small cistern for storage. Built about five or six years ago.

Quality:

Water is of good quality (Mr. Whiffen). Department of Health, Whitbourne, reports that water is satisfactory.

Treatment: Chlorination.

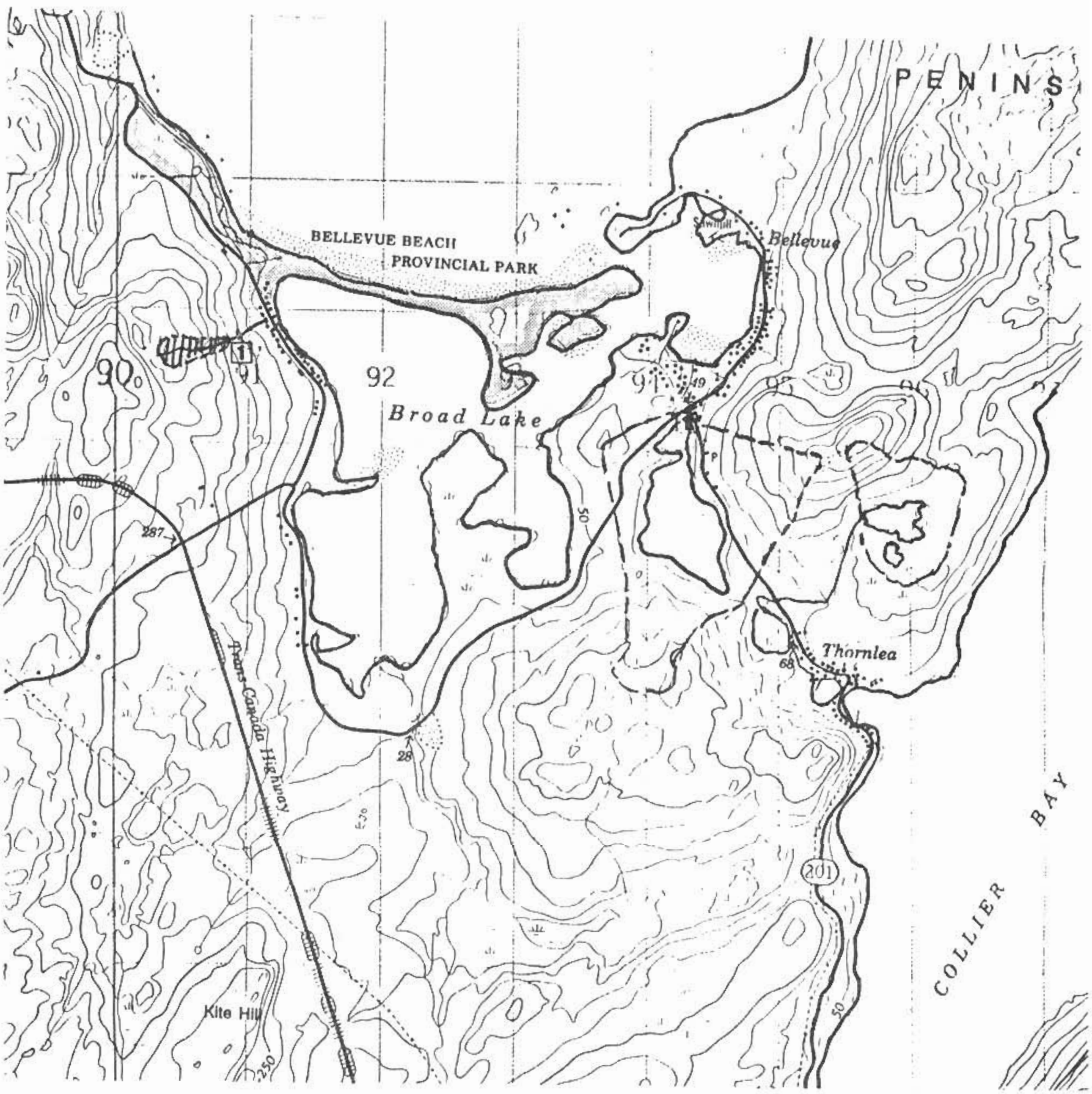
Distribution: 100 mm pipe.

Comments/Problems: None.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

1. Intake and Chlorinator

Consulting Engineer: Colin Karasek Ltd. January 1988

MUNICIPALITY - SURFACE WATER SOURCE

COMMUNITY OF BRANCH

Information:
Colin Karasek, P.Eng.
Tony Kelly, Dept. Health, Whitbourne

Population:

Water source: Valleys Pond, gravity flow. This is a system under construction.

History: There was a 100 mm line from the same source built some years ago, but no longer functional.

Wells: No Council wells.

DEMANDS

Domestic: 500 population

Industrial: Small fish plant.

Variations in demand: Due to fish plant.

Metering: Not known. Possibly a meter will be installed.

SUPPLY SOURCE

Description of pond: Valleys Pond, a natural pond, extended slightly near the outlet brook a few years ago. The outlet brook is dammed and the water supply intake is at the dam. The pond is intersected by the highway to Point Lance, with about one third of the pond downstream of the highway. The intake is in the portion downstream of the highway, and is therefore receiving run-off from the highway and highway ditches.

Status of watershed protection: Not protected.

Dam: Timber and plank structure, about 15 m in length.

Spillway: Rectangular notch in the structure, 1500 mm wide x 150 mm deep.

Intake: 150 mm diam PVC pipe projecting through the dam about 900 mm into the reservoir. A coarse screen projecting vertically covers the intake. Also, to keep out slush ice etc there is a 1.8 m x 2.4 m box structure attached to the dam, around the intake.

Adequacy of supply, summer 1987: Not known; system not in use.

STORAGE/DEMAND FACTORS

Live storage head: 0.6 m,(measured) spillway to top of screen over intake. From spillway to top of intake pipe is 0.3 m, so the live storage head could perhaps be increased with a modified intake.

Ways to increase live storage: Increase the height of the fill along the highway that crosses the pond so that it forms a dam to raise the water level in the upper part of the pond. Extend intake back about 200 m under the highway into the new reservoir. This may also improve water quality by reducing some of the highway run-off into the reservoir, i.e. run-off from the east side highway ditches. (This proposal made by Dermot Roche, Chairman of Council in Branch.)

WATER QUALITY

No tests available. Reported by local residents to be of adequate potable quality.

WATER TREATMENT

The Department of Municipal Afairs proposes to instal a chlorinator.

TRANSMISSION AND DISTRIBUTION

The new transmission main is 150 mm PVC, length 3038 m. It connects to an existing 150 mm PVC line about 1500 long which ends near the fish plant. The system has a few fire hydrants.

FACTORS IN REPLACEMENT COST ESTIMATE

Dam
Transmission main 3038 m of 150 mm PVC pipe
About 150 connections
Fire hydrants
Chlorinator
Pressure reducing system

COMMENTS/PROBLEMS

1. A large portion of the route of the transmission main from Valleys Pond is difficult topographically, and has poor soil conditions (bog) along much of the route. To function properly the line should have uniform grade lines with features to control the build-up of air pockets, and also to control water pressures.

In the bog lands line anchoring of the pipeline is probably not possible.

2. The Valleys Pond source could eventually replace other sources now in use. One of these which serves houses on the north side of the Branch River has a supply from a dam on a small brook. The Dept. of Health has a boil order continually on this water. So replacing this supply, and any other supply of similar poor quality is a matter of urgency.

FUTURE CAPITAL REQUIREMENTS

1. New earth dam, highway fill, intake, screen chamber and extended transmission pipeline. $100,000

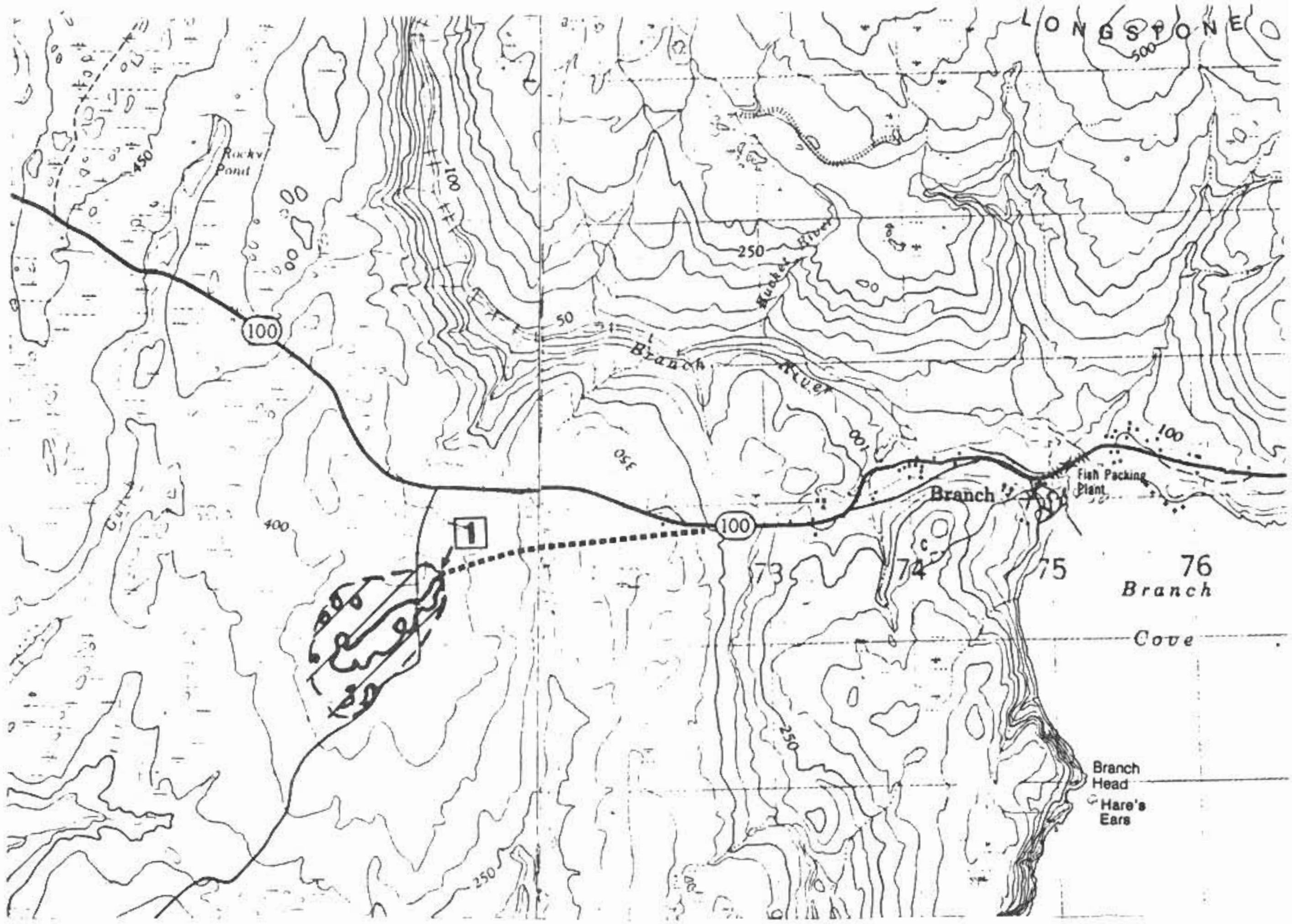
   Before doing this the actual watershed and yield and the volume of storage required should be checked, as well as water quality.

2. Any deficiencies uncovered during operating of the transmission line will need to be rectified. Cost unknown.

3. Extend distribution network to replace present substandard sources of supply. Cost unknown: say $50,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



COMMUNITY OF BRANCH

1. Intake

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF BRIGUS

Information:

1. Town Clerk: Wayne Rose
2. BAE Group drawings. The constructed work appears to conform with the drawings.

Population: 902 (1981); 856 (1987)

Water source: Brigus Big Pond

Regional Plan The supply system has been planned to handle Brigus plus Cupids (pop.864 in 1981) and South River (pop. 656 in 1981). Only Brigus is served at present.

DEMANDS

Domestic: Approximately 185 homes in Brigus are served by the water system. The Town applies for funds every year and if funding is received they extend the water line. In 1986 8 homes were added, and this year they expect to add 10 or 11 more. Houses not on the Town mains use private wells.

Commercial: About 10 businesses, supplying local needs.

Educational: Two elementary schools, a junior high school and a high school are all hooked up to the water system.

Industrial: There are two fish plants, one of which is on the system (Hiscock's, with 20 employees) and uses a small amount of fresh water. The other is not yet hooked up, but may be by April 1988.

Wastage or losses: None reported.

Metering: No metered consumption data.

Seasonal Variations in demand: No unusual variations in demand are reported.

Factors in Future Demand:

- service all houses in Brigus, about an additional 185
- future growth in Brigus
- fish plants in Brigus
- schools
- service to houses in Cupids

- service to fish plant in Cupids (which now has a gravity fed 100 mm fresh water line from Cupids Pond)
- service houses in South River
- restaurant

SUPPLY SOURCE

Brigus Big Pond. A natural pond with steeply sloping watershed topography with trees. A railway track and gravelled back road cross the watershed. The access road to the pond is fenced about 75 m before the pond is reached.

Status of watershed protection: Protected

Dam: No dam.

Intake: (BAE Group drawings) 1,000 mm diam. CMP 14 Ga about 42 m long, sloping to wet well screen chamber in building near edge of pond. Pipe is surrounded with rip-rap. Building houses wet well, three screens and chlorination equipment.

Adequacy of supply, summer 1987: No problems.

STORAGE/DEMAND FACTORS

Live storage head: (Design drawings of intake)

Pond HWL May 1980	59.5 m
Top of intake pipe	58.0 m
Live storage head at Pond HWL	1.5 m

Ways to increase live storage: Pond WL could be raised say 500 mm by a low dam about 250 m long across the neck of the pond. However, this is unlikely to be necessary.

WATER QUALITY

Bacteriological: Lab, Dept. Health, Harbour Grace. No problems reported.

Chemical: No data available.

Problems: In summertime there is sometimes a boggy taste.

WATER TREATMENT

Chlorine gas injection, near the wet well screen chamber, controlled by an impulse timer. The impulse timer is located in the pipeline about 500 m downstream where the head is about 7 to 8 m of water. The signal wire is on the power line poles to the chlorination building. Distance from chlorine injection to first house, about 1650 m. No other forms of treatment used.

TRANSMISSION AND DISTRIBUTION (Mainly from BAE Group design drawings)

This is an all-gravity system. Pipe from wet well, chlorinator-screen buildings to meter chamber (impulse timer) is 500 mm diam, about 550 m in length. Pipe from meter to highway 400 mm diam, 1800 m length. This main is sized to serve Brigus, Cupids and South River. In Brigus, transmission mains of DI, with fire hydrants.

FACTORS IN REPLACEMENT COST ESTIMATE:

- intake
- screen/chlorination building
- control wires 550 m
- meter chamber
- transmission main 580 m x 500 mm diam. DI
  1800 m x 400 mm diam. DI

COMMENTS/PROBLEMS

None.

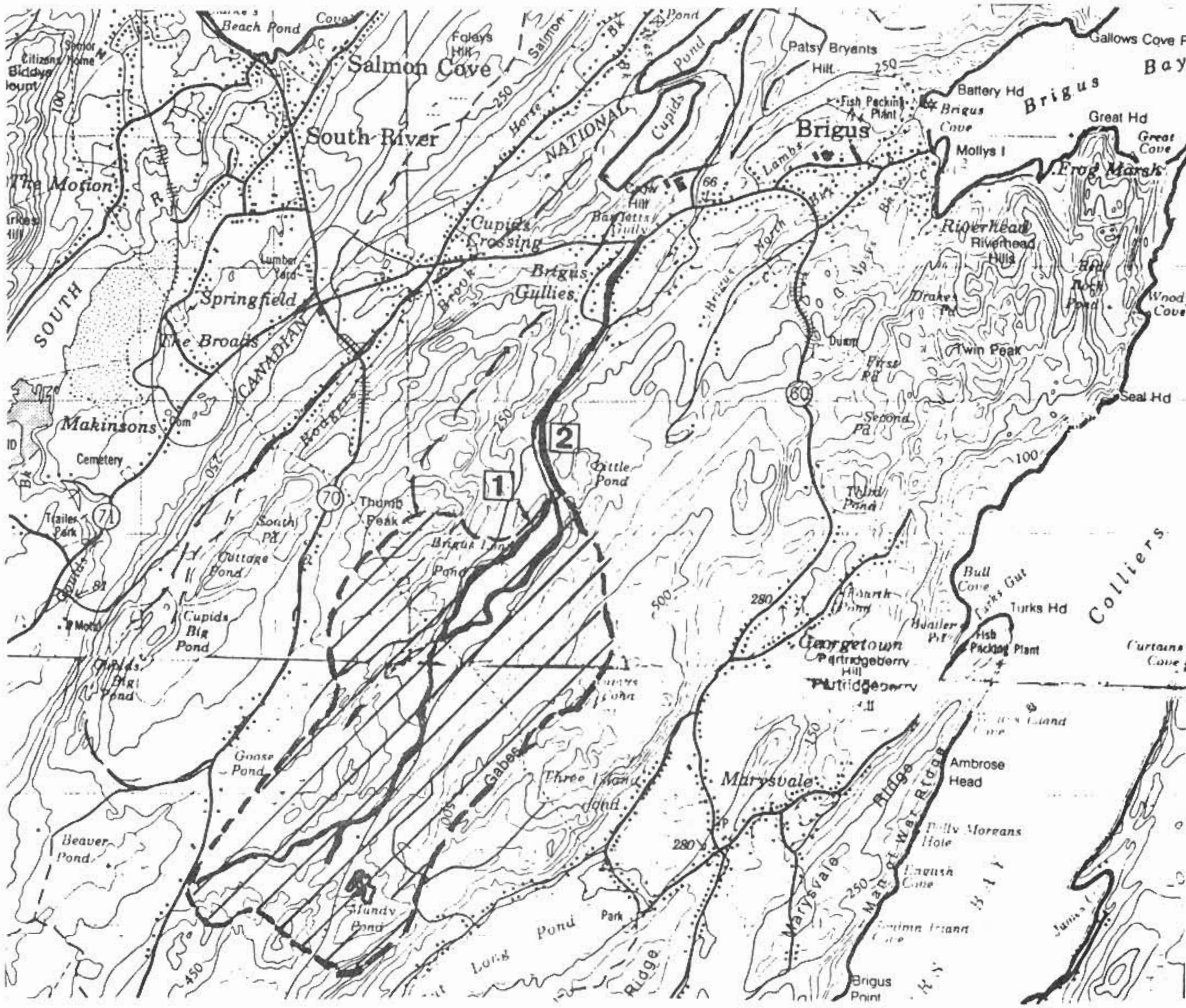
FUTURE CAPITAL REQUIREMENTS

Brigus (water distribution extensions, as part of water and sewer servicing).

Serve Cupids and South River (water). Several million dollars.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



<u>TOWN OF BRIGUS</u>

1. Intake, Chlorinator
2. Impulse Meter

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF CARBONEAR

Information:
Town Manager: James Walsh
Town Foreman: John Hiscock

Population: 5341 (1981)

Water source: Little Island Pond. Town is sole user. Basically a gravity system with booster pumps to high areas of Town.

Wells: No municipal wells.

DEMANDS

Domestic: All the community is served and there is a large commercial/light industry sector. About 1400 connections to houses.

Commercial: A regional service centre. About 300 connections to commercial/list industry establishments.

Educational: Five schools.

Industrial: Large fresh fish plant and fish meal plant. (Sizes of connecting lines?)

Wastage or losses: None reported.

Metering: No metered consumption data. Water meter recorder at chlorination plant is not working.(Present demand estimated at 2MGD by Harris Associates.)

Variations in demand: Considerable, on account of variations in industrial demand.

Factors in Future Demand: This has been a growing regional centre. Continuing future growth is expected and will increase demands for water.

SUPPLY SOURCE

Little Island Pond, a natural pond fed by an extensive network of other ponds and brooks. Topography fairly flat with 30 m hills, with vegetation of fir, spruce and large alders. An old gravel road to Heart's Delight crosses the watershed and serves summer cottages on some of the watershed ponds.

Status of Watershed Protection; Protected.

Dam: No dam.

Spillway: Natural brook about 6 m wide, 600 mm deep, normal condition.

Intake: Two intakes. There is a 1220 mm diam. intake, reducing to 450 mm, and a 300 mm intake. These two intakes pass through a common screen chamber, where each line is separately screened.

	Pipe diam:	Type	Depth, pond level to top of intake pipe - mm (a)		
			HWL	Normal	Summer 1987
1.	1220 mm(b)	conc.	2200	1500	25
2.	300 mm(c)	DI	2700	2360	500

(a) Estimated by Council staff in feet and inches and converted to metric. (b) Built 1974. (c) Built at an earlier date.

Screens: The 1200 mm pipe leads to a valve chamber and wet well, and thence by a 450 mm diam. concrete pipe to a second chamber where its flow is screened along with a separate screen for the 250 mm iron pipe intake.

Adequacy of supply, summer 1987: A serious drop in water level occurred and the edge of Little Island Pond drew back 15 m from the normal perimeter. Essentially the old 300 mm line "saved the day". Service was maintained by public water conservation measures.

STORAGE/DEMAND FACTORS

Live storage head: Estimating live storage head for the 1220 mm intake is problematical because the depth of pipeline in respect to pond level is not measurable at all the points required. When the water level was down to 25 mm above the intake, the downstream portion of the pipe at the second screen chamber was not running full, i.e. intake appears to slope upwards. Live storage head estimated at 1.0 m for the 1220 mm intake. For the 300 mm intake, live storage head estimated at 2.0 m.

Live storage volume:

Ways to increase live storage:
1. Construct dam across outlet brook to Little Island Pond.
2. Pipeline from Little Island Pond to Bower Pond, with manual valve (200 m long).
3. Extend 1220 mm intake further into pond.

WATER QUALITY:

Bacteriological: Lab, Dept. of Health, Harbour Grace. The Town tests for chlorine residual and Department of Health tests for bacteria.

Chemical: No data available.

Problems: Ice damage to screens has brought eels into the system on occasions.

WATER TREATMENT

Chlorination takes place about 2000 m downstream of the screen chamber. Gas chlorination, Wallace and Tiernan. The chlorinator is about 2400 m from the first house through 250 mm diam. main. No other forms of treatment.

TRANSMISSION AND DISTRIBUTION;

Transmission main: From the screen chamber there are two pipes 460 mm diam and 300 mm diam over about 2000 m to the chlorinator. The remaining transmission line is 250 mm diam.

The distribution network of 200, 150 and 100 mm diam. pipes, with fire hydrants. Pipes are of ductile iron and PVC. Reported in good condition.

Pressure zones: Most of the Town is under gravity supply. There are three pumping stations, which create higher pressure zones by pumping on a continuous basis:

P1. South Side Pump Station. Three staged pumps, 7.5 HP, 7.5 HP and 30 HP.
P2. 7.5 HP.
P3. 7.0 HP

FACTORS IN REPLACEMENT COST ESTIMATE;

- intake 50 m 1220 mm main, 50 m 300 mm main
- screen chamber building
- chlorinator and building
- transmission 2090 m 450 mm main, 4400 m 250 mm main
- distribution network
- 3 continuous pumping stations
- access road
- about 1700 connections

COMMENTS/PROBLEMS

A. This system may not have enough live storage.

1. To increase live storage the pond should be sounded and, if feasible, the 1220 mm diam. intake extended into deeper water.

2. A low dam across the outlet brook could be considered.

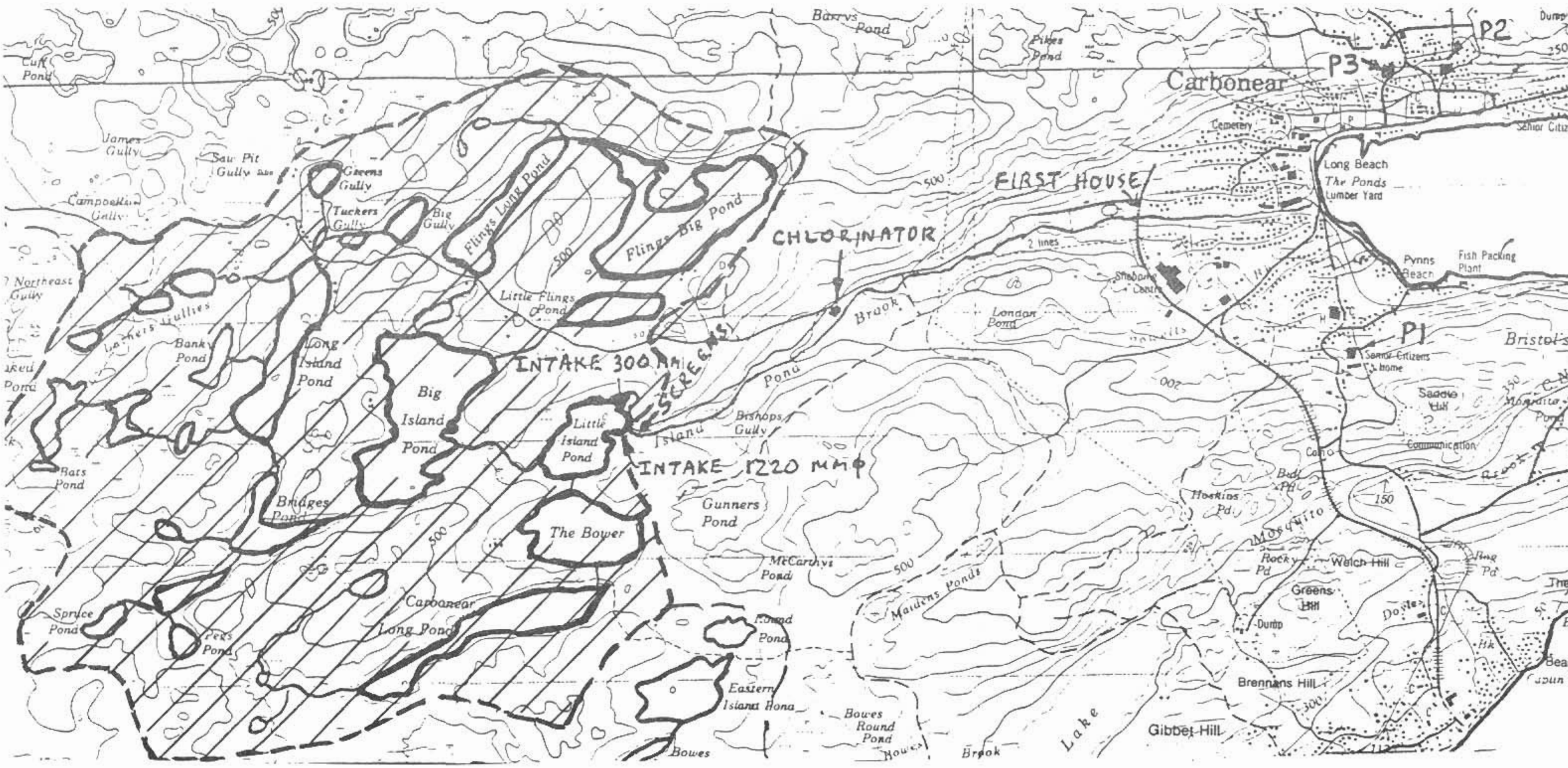
3. Gravity flow pipelines with manually operated valves, to Bower Pond for example.

FUTURE CAPITAL REQUIREMENTS

1. Improve live storage volume.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF CARBONEAR

INDUSTRY - SURFACE WATER SOURCE

COME-BY-CHANCE OIL REFINERY
NEWFOUNDLAND PROCESSING LTD.

Information:
Jost Kieboom, P.Eng., Process Engineer

Water source:
Barrasway Brook

DEMANDS

Fire fighting water
Utility water, process water
Potable water
Boiler feed water

Total consumption of raw water about 7580 m^3/d (2 MGD U.S.). Metered at the Barrasway pumphouse.

FACTORS IN FUTURE DEMAND

No significant increase in demand is expected.

SUPPLY SOURCE

Barrasway Brook reservoir pond. Dam, built 1973.

DESCRIPTION OF SYSTEM (See Fig.2)

- Screened intake, Barrasway Pond

- Pumphouse, Barrasway Pond. Pump capacity 500 L/S (2200 US gpm).

- 2 x 300 mm diam. steel mains from Barrasway Pumphouse to Inkster Pond. Distance 400 m±. Inkster Pond is a natural reservoir which is about 9 metres above Barrasway Pond.

- At Inkster Pond Pumphouse;

  . Fire flows, one set of pumps 3000 US gpm through 300 mm main to plant. Distance 600 m ±.

  . Other water uses 2000 US gpm pumps through 300 mm steel main to clarifier.

- The clarifier is an atmospheric pressure settlement tank. A chemical polymer to floculate organic particles is injected into the tank.

- From the clarifier a series of pumps drives the water through a battery of four pressure filters into the filtered water tank, (12,000 US gal.capacity). This is an atmospheric pressure tank.

- The filtered water tank has two downstream pump streams:

  . Through a water demineraliser (which uses special resin pellets for the demineralisation treatment), to supply boiler feed water.

  . To provide utility and process water, with a branch through a chlorinator to provide potable water.

STORAGE/DEMAND FACTORS

Live storage head: Not available.

Live storage volume: Not available.

Ways to increase live storage: Not investigated.

WATER QUALITY

Bacteriological: Department of Health, Clarenville

Chemical: Data on raw water not available.

Problems: No problem with water quality.

WATER TREATMENT

Fire water; untreated.

Boiler feed water; floculated, filtered, deminerealised.

Process water, utility water: floculated, filtered.

Potable water; floculated, filtered, chlorinated.

FACTORS IN REPLACEMENT COST ESTIMATE

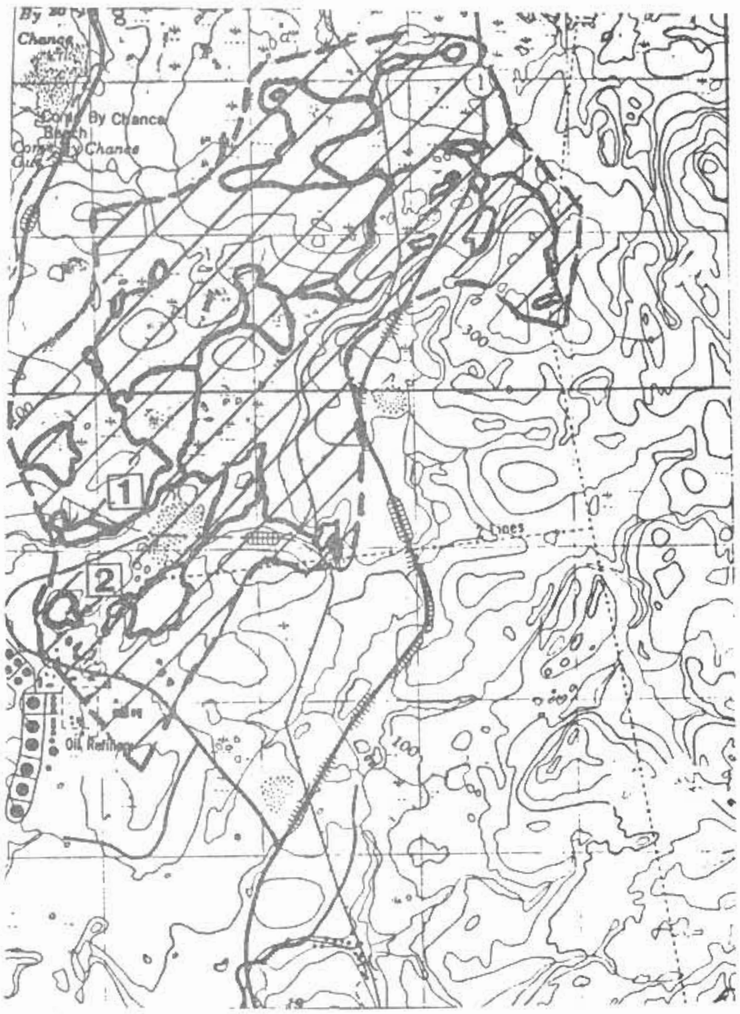
- 2000 m 300 mm diam. steel mains, wrapped
- two intakes
- two pumphouses
- treatment plant

COMMENTS/PROBLEMS

Water supply, Adams Head: When the refinery was out of use the water supply system was being considered as a supply source for the Adams Head Hibernia concrete platform construction yard. This now has to be re-thought. A Provincial Government study is to be commissioned shortly to examine the Adams Head/Argentia sites in terms of concrete platform and steel deck construction yards for the Hibernia project.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

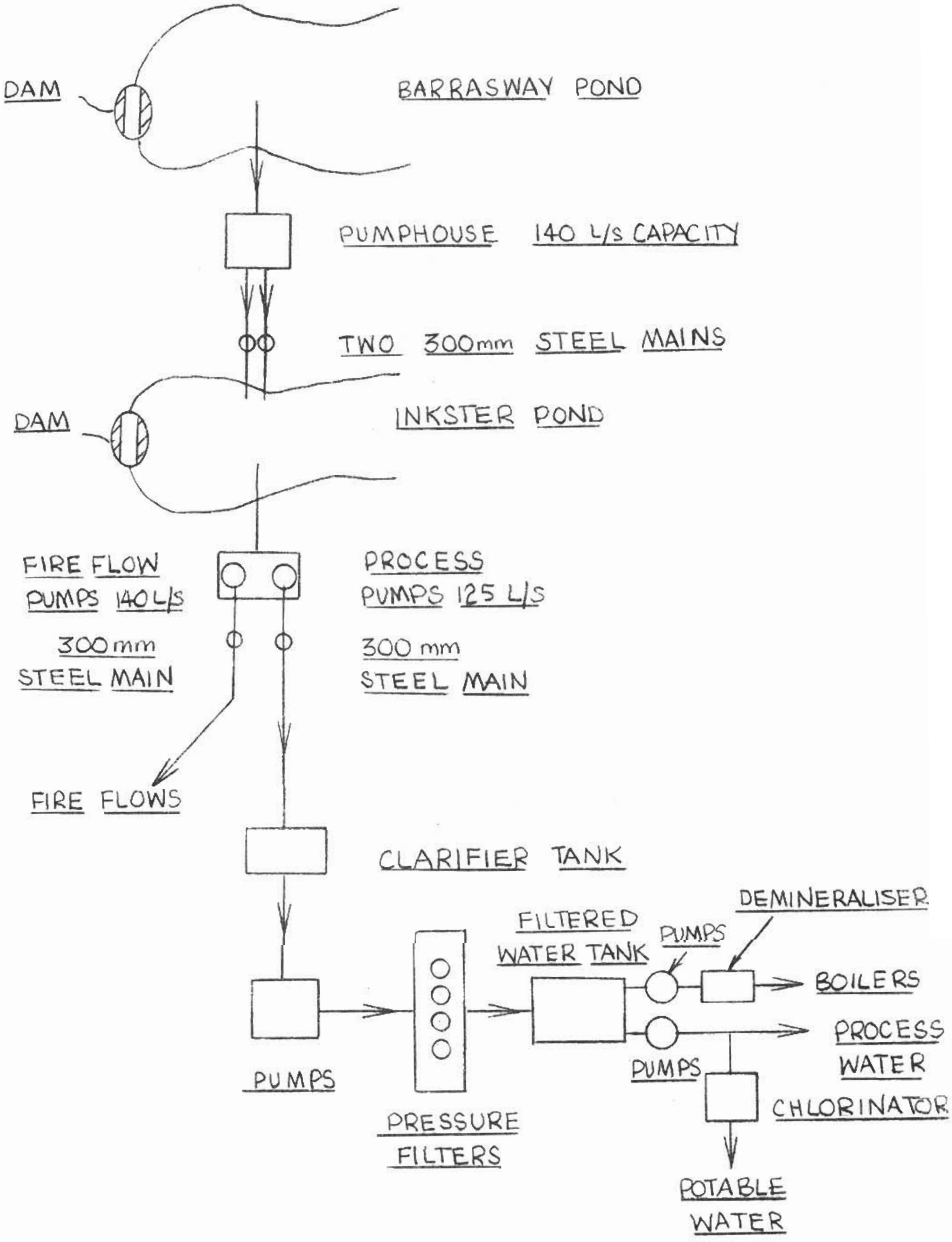
SCALE 1:50,000



COME BY CHANCE REFINERY

1. BARRASWAY POND
2. INKSTER POND

Consulting Engineer: Colin Karasek Ltd. November 1987



REFINERY WATER SUPPLY SYSTEM

FIGURE 2.

FISH PLANT - SURFACE WATER SOURCE

CUPIDS FISH PLANT

Information:
Doug Norman, H.B.Dawe Ltd.

Water source: Lower Cupids Pond. Gravity system. No other users.

Owner of water system: H.B.Dawe Ltd., Cupids.

DEMANDS

Fish plant only. Plant produces salt fish. Also has a sea water system.

Metering: Flow not metered.

Future demands: Same as present. If the Brigus regional water system eventually serves Cupids the plant may connect to that system.

SUPPLY

Cupids Pond - lower (northerly) portion.

Intake: 100 mm diam. PVC pipe led into the pond.

Status of watershed protection: About 50% of the watershed is protected. Previously all of the watershed was protected.

STORAGE/DEMAND

Live storage head: Control point is probably where the pipeline cuts through the perimeter surrounding the pond. Assume 1.0 m.

Adequacy of supply, summer 1987: No shortage.

WATER QUALITY

Satisfactory for the processes used in the plant. Tested for bacteria control by the Dept. of Fisheries.

WATER TREATMENT

Chlorination in plant.

TRANSMISSION

A 100 mm PVC line running from the pond across the harbour bottom to the plant. Gravity flow, adequate pressures.

COMMENTS/PROBLEMS

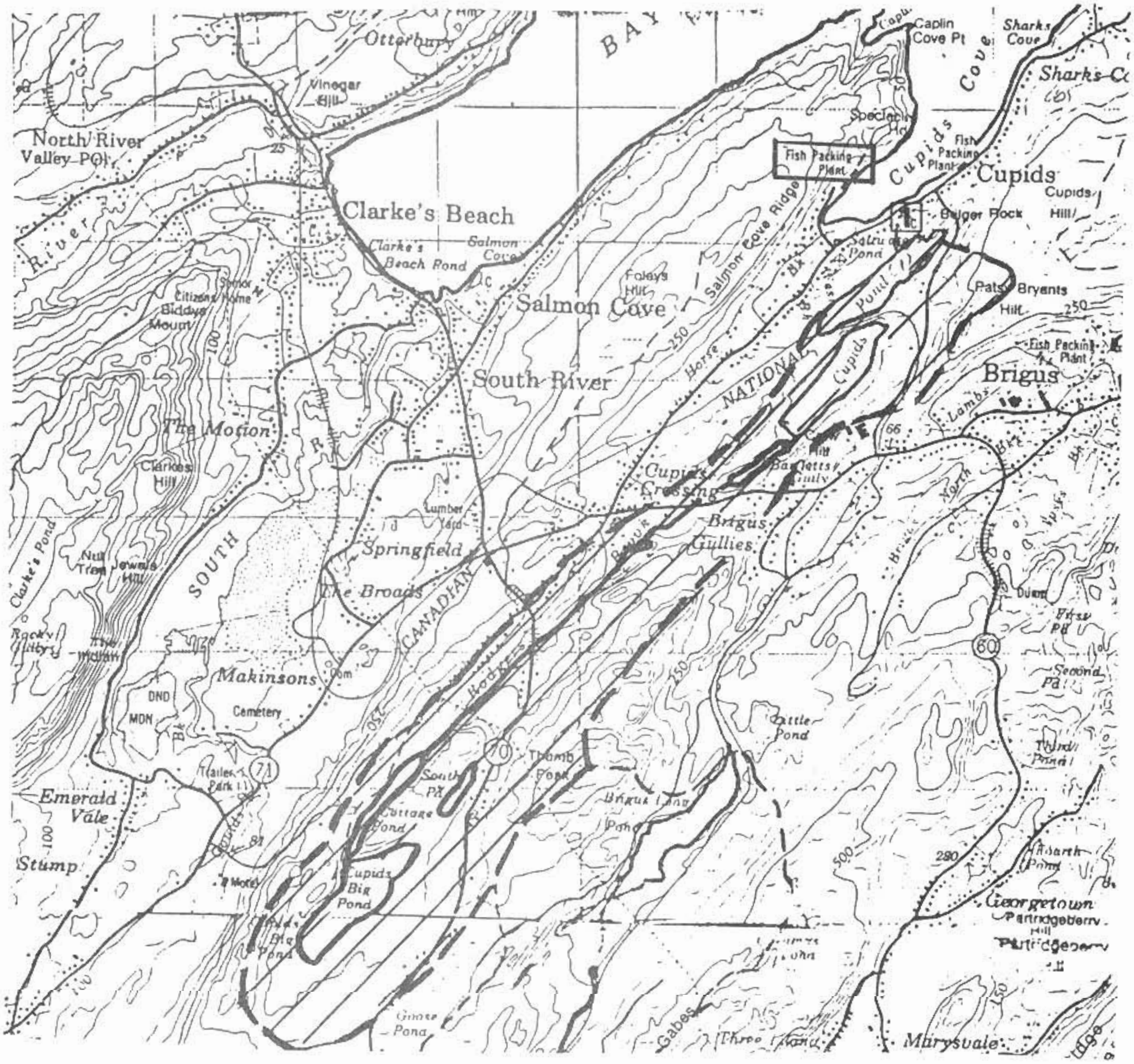
Increasing activity on the watershed may in time create bacteriological problems.

FUTURE CAPITAL REQUIREMENTS FROM GOVERNMENT

Depends on implementation of regional water system.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



1. Intake

<u>FISH PLANT-CUPIDS</u>
<u>H.B. DAWE LTD.</u>

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF DUNVILLE

Information:
Harry Perry, Delcan Consulting Engineers
Robert Kennedy, P.Eng., Delcan Consulting Engineers
Mrs.Gertrude Foote, Town Clerk

Population: 1917 (1981), 1831 (1986)

Water source: Wyses Pond. Town is sole user. Gravity flow.

Wells: No Council wells.

DEMANDS

Domestic: Connections: 418 residences; 40 mobile homes (trailer court); 23 apartments; one 15 room senior citizen's home.

Commercial: 6 shops; 4 clubs; one 12 room motel.

Educational/Institutional: 3 schools, total 600 pupils; 4 churches

Industrial: Nil

Wastage or losses: Some tap bleeding reported in winter at the trailer court. All known leaks have been repaired during the current pipe cleaning programme.

Metering: Metered at chlorination plant, 900 m^3/d. (200,000 gpd, typical meter reading, Harry Perry).

Variations in demand: Normal domestic demand variations.

Factors in future demand: There are only about 20 houses which do not have a connection to the main sewer, so the current water usage represents normal consumption patterns for fully serviced units. No significant change in water demand is anticipated unless there is a major industrial developoment, e.g. Argentia, in which case a population growth can be expected.

SUPPLY SOURCE

Wyse Pond, a natural pond fed by a brook from a feeder pond, Curve Pond. Watershed is gently sloping, with trees and bushes, and includes highway and railroad track.

Status of watershed protection: Protected.

Dam: No dam.

Spillway: Natural brook.

Intake: A 1.2 m diam perforated concrete cylinder standing vertical with a cover above pond level. The intake pipe is 300 mm diam. AC. Installed about 1963.

Screens: Near pond, installed 1986/87. A single screen in a chamber on the pipeline. No gantry or building. Screens are changed weekly.

Adequacy of supply, summer 1987: A vertical gauge was installed at the intake to measure fluctuations in water level during 1987. The reading in late September is be considered normal.

Normal elevation (late September)	zero (assumed datum)
Highest elevation	+ 0.25 m
Lowest elevation (August)	- 0.34
Top of intake pipe	- 0.76

Thus there was a depth of 420 mm of water remaining over the intake during the dry spell. The Town instituted water conservation measures; human consumption only, no car washing or lawn watering, with radio announcements about the shortage. The levels in the feeder pond, Curve Pond, were also observed; very little change.

STORAGE/DEMAND FACTORS

Live storage head: 760 mm (see above)

Ways to increase live storage:
Instal pipeline about 100 m long, or dig a channel, or pump from Curve Pond, the feeder pond to Wyse Pond (Harry Perry). The feeder brook to Wyse Pond from Curve Pond dried up in 1987.

WATER QUALITY

Bacteriological: Coliform tests, Dept. of Health, Whitbourne. Town tests for chlorine residual, target 0.3 ppm. No problems reported.

Chemical: The main problem is that the water is acidic. (typical pH 5.7).

Problems: (1) It is hypothesized that the acidic water may attack the asbestos cement pipe, possibly releasing asbestos fibres into the water. The copper building connections are corroding. (2) The water is high in iron, causing iron bacteria growth.

Action to protect the inside of the mains: The water mains (which are AC pipe) are being pigged, for cleaning out loose fibres. Carbonate will be added to treat the water to increase the pH and to hopefully coat the inside of the pipes to prevent further attack on the pipe (Robert Kennedy).

WATER TREATMENT

The chlorination building is about 100 m from the supply pond. Wallace and Tiernan gas chlorination, maintained by Council staff. The distance from the chlorinator to the first house is about 500 m. Other treatment using carbonate is proposed.

TRANSMISSION AND DISTRIBUTION

This is an all gravity system. The mains are AC pipe, built 1964 to 1967, with some 200 mm in DI for new extensions to the west of town. The main line is 300 mm diam. reducing to 200 mm and 150 mm. The system feeds fire hydrants. The main transmission line, 300 mm diam, runs from the intake for about 450 m along the access road to Highway 102. There is a further 750 m of 300 mm main to the Argentia Access Highway where the system branches east and west.

FACTORS IN REPLACEMENT COST ESTIMATE

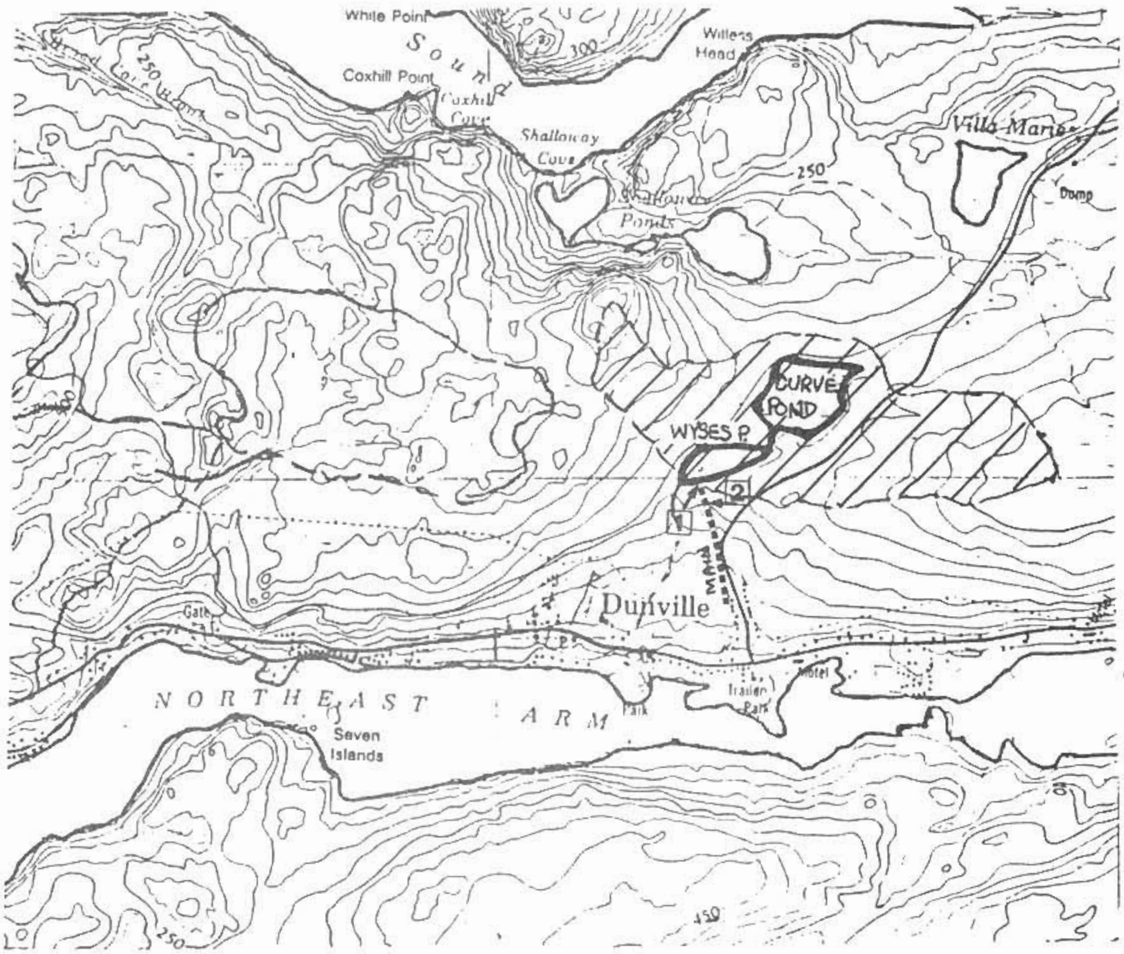
- intake
- screen, no building
- chlorination building with gas chlorination and soda ash (?) treatmnent
- transmission main 300 mm diam, 610 m in length to first house
- 511 connections

COMMENTS/PROBLEMS
The system appears to be in good shape.

FUTURE CAPITAL REQUIREMENTS
Plans for new chlorination building, possibly 1988-89.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF DUNVILLE

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF FRESHWATER

Information:
Frank Smith, Town Manager

Population: 1276 (1981)

Water source: Larkins Pond (see "Argentia")

DEMANDS

Domestic: About 300 homes.

Commercial/Industrial: Local stores, garages.

Educational: 1 school

Metering: No meter readings; meter not functional.

Variations in demand: No significant variations are known.

Wastages, losses: Leakages not considered serious. Up to six leaks per year are repaired. Some wastage through tap bleeding.

Factors in future demand: Very slittle expansion is expected. Town has a complete sanitary sewer system.

SUPPLY SOURCE

Larkins Pond, also used by Jerseyide/Placentia. Water level is controlled by flow from Clarkes Pond (U.S.Base, Argentia). A highway runs along the western side of the pond. No fence between highway and pond.

Watershed protection: Protected.

Spillway: A semi-circular concrete wall 12.7 m in length (tape measure). Elevation 41.25 m (painted on spillway). The spillway is at the mouth of the outlet brook from Larkins Pond.

Intake: 300 mm iron pipe extending about 25 m into pond with perforated steel box over the end.

Screens: In pumping station adjacent to the pond.

Water level, summer 1987: To about 1.5 m over intake whereas it is normally 1.8 m over intake.

STORAGE/DEMAND FACTORS

Live storage head: Normal pond level to top of intake pipe 1.8 m (Town Manager).

Watershed area (Larkins Pond): 1.27 sq. km. (U.S.data)

Ways to increase live storage: Possibly the intake could be extended. Otherwise additional supply will have to come from the Clarkes Pond watershed.

WATER QUALITY

Bacteriological: Dept. of Health, Whitbourne tests every two weeks. Town tests for chlorine residual at Town Office (target 0.3 ppm).

Chemical: Water is potentially corrosive (see Jerseyside) but otherwise of reasonable quality.

WATER TREATMENT

Gas chlorinator in pumphouse. First connection is kabout 60 m, so contact time is probably below the recommended standard.

TRANSMISSION AND DISTRIBUTION

Main pumphouse at Larkins Pond: 25 HP pump plus 2 x 15 hp. On/off controlled by tele signal from water level in south tank.

South tank: Steel tank at ground level, capacity about 118 m^3.

Booster pumphouse: 2 x 10 hp. These feed the north tank.

North tank: Steel tank at ground level. Capacity 180 m^3.

Mains: 250 m to 100 m. CI and DI. Installation started about 1952 and has been extended since.

Building connections: Copper.

FACTORS IN CAPITAL COST REPLACEMENT

- intake
- gas chlorinator
- two pumphouses
- two storage tanks
- about 320 connections
- tele control system for pumps

COMMENTS/PROBLEMS

Life of mains: The unknown factor with this system is the life span of the mains. No extensive leaks have been discovered. Water metering at the main pumphouse should be reinstated to check on rate of consumption and increases. The corrosive potential of the raw water should be resisted by an additive.

FUTURE CAPITAL COSTS

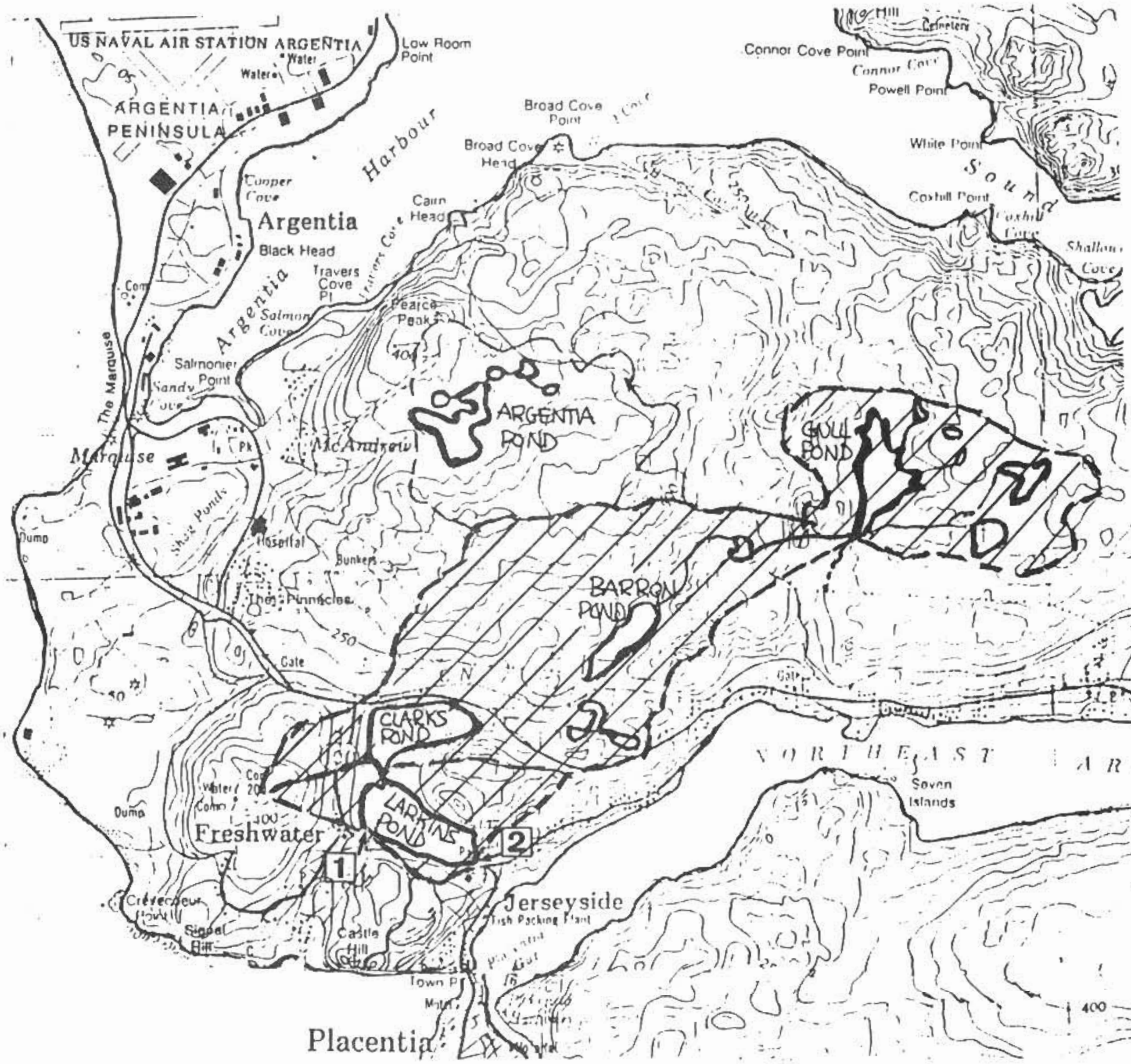
Instal water meter and alkali additive at pumphouse. $60,000.

Other requirements minimal unless the mains have to be replaced.

A detailed inspection of the pumphouse/screen/chlorinator building may determine that the building will have to be rebuilt. If this is the case allow about $120,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWNS OF FRESHWATER/JERSEYSIDE

1. Intake-Freshwater
2. Intake-Jerseyside

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF HANTS HARBOUR

Information:

1. Mayor: Don Green
2. Town Clerk: Mrs. Doris Short
3. Town Foreman: Carman Short
4. Former Town Foreman: Chester Critch

Population: 552, virtually no change 1981 to 1986

Water Source: Eastern Pond. Town is sole user. Gravity supply.

Wells: Council has no wells.

DEMANDS

Domestic: 170 permanent houses plus 30 summer houses. About 6 to 10 houses not served by water.

Commercial: Stores serving local needs.

Education: One elementary school, about 100 pupils.

Industrial: Crab plant and fresh fish plant owned by P.Janes and Company. The plants use fresh and salt water. No meters. Estimated constumption 250 gpm (Don Green).

Wastage and losses: No system leaks or tap bleeding in winter are reported.

Metering: No water meters on system, or plant connections.

Variations in demand: Caused by fish plant.

Factors in future demand:

- The community has no main sewage; main services might increase domestic water demand. (Only about 15 houses, in Caplin Cove, have main sewage.)
- No significant population growth is expected.
- No plans known for new fish plants.

SUPPLY SOURCE

Eastern Pond, a natural pond. Watershed appears free of development. The intake is several hundred meters along the perimeter of the pond from the outlet brook.

Status of watershed protection: Protected

Dam: No dam.

Intake pipe: The original intake pipe, built about 1970, was located in a muddy area. A new intake was built about 1975. This is a 250 mm diam PVC and DI pipe, open end, supported about 1500 mm above the bottom of the pond and about 1800 mm below the surface.

Screen: There is a two screen chamber near the pond) no screen house or gantry). One screen is being used at present. Very seldom needs to be cleaned (two or three times a year.) Each screen is sized about 1500 x 4500 mm. Depth of screen chamber about 3600 mm.

Adequacy of supply, summer 1987: Pond level dropped about 900 mm below normal but there was still plenty of water available, with about 900 mm above the intake. However, the drop in water level caused siphonic problems in the transmission line. (See later).

STORAGE/DEMAND FACTORS

Live storage head: Probably about 300 mm for gravity flow. A drawdown to 900 mm appeared to cause siphonic action.

Ways to increase live storage:

1. Dam outlet brook. Could raise WL 300 to 600 mm by dam 50 m to 100 m long. (Observations by Chester Critch.)
2. Lower supply main to avoid siphon condition.

WATER QUALITY

Bacteriological: Dept. of Health, Harbour Grace, tests for bacteria and chlorine residual. Bacteria counts were high when chlorination was out of action.

Chemical: Raw water quality is excellent. A test Sept. 1987 by "Water Analysis Laboratories", Mount Pearl, stated that all parameters tested were "within acceptable limits". The common problems with Newfoundland surface waters such as high colour, high iron and manganese, low pH, high organisms, were absent. (Colour 5, Iron 0.01, Manganese 0.01, pH 6.2, Chemical oxygen demand 3)

Problems: No problems with raw water.

WATER TREATMENT

The chlorinator is fairly new (about two years old). The present chlorinator uses bleaching powder (65% calcium hypochlorite). It is a Wallace and Tiernan impulse injector with a manual rate adjuster. The chlorination building contains a 250 mm gate valve and a pressure gauge (reading 50 psi 340 KPa).

The chlorinator is about 500 m upstream of first connections through a 250 mm PVC main.

Problems with water treatment: The present chlorinator is not flow paced, i.e. does not adjust to variations in flow which occur, for example, when the fish plants shut down and start.

TRANSMISSION AND DISTRIBUTION

Materials: The system is PVC piping with fire hydrants.

Transmission main and appurtenances:

	Distance from intake
Intake	0
Screen chamber (near edge of pond)	100 m
Air release/vacuum breaker valve	1900 m
Pressure reducing valve	2000 m
Chlorinator	2300 m
Paved side road	2700 m
Highway No.80	3000 m

Distances by odometer are very approximate. The system is operated with the air release/vacuum valve normally closed, to prevent siphonic action (see below).

Transmission main problems: The transmission main does not follow the outlet brook from Eastern pond, but crosses the watershed in a cut. In this cut the pipeline elevation may be almost as high as the pond water surface elevation. During periods of heavy water consumption the hydraulic grade might be drawn down sufficiently to force the line to act as a siphon rather than by gravity flow. This appears to have happened in the summer of 1987 when the pond level dropped about 3 feet below normal. The Town Foreman (Chester Critch) cured this by (1) closing the valve between the intake and screen chamber, (2) closing the valve on the transmission main at the beginning of the distribution system, (3) then pumping water into the screen chamber, and (4) opening the air release valve in the transmission main to help let out the air as the transmission main was pumped full of water. Once the main was full, the air release valve was closed, the gate valve between the screen chamber and intake was opened, the valve to the distribution network was opened and flow recommenced.

Pressure reducing valve: The PRV is probably eliminating about 35 m head of water. (This is a very rough estimate, based upon a judgement of elevations of the chlorinator and pond from the 1:50,000 mapsheet, and the 340 KPa pressure reading in the chlorinator.) Recently a bypass main was installed to permit closing off the flow to allow servicing of the PRV. Pressure gauge readings are needed to properly assess the PRV.

FACTORS IN SYSTEM REPLACEMENT COST ESTIMATE

- screen chamber
- transmission main, 3000 km 250 mm diam. PVC
- chlorinator
- distribution system (about 200 connections)

COMMENTS/PROBLEMS

a. Flow paced chlorinator could be considered in the future. This will require a flow meter in the line to emit an electric pulse signal according to the rate of flow. This signal then controls the chlorine solution injection, and can also be wired to a water flow recorder.

b. Investigation should be carried out to determine flows and hydraulic grade in respect to transmission line grade line and to determine remedial measures needed, if any. Also the mechanics of the PRV can be better determined. This investigation should reveal if any work is needed on the transmission system. Raising the water level with a dam at the outlet brook should also be investigated. Cost of investigation: $5,000.

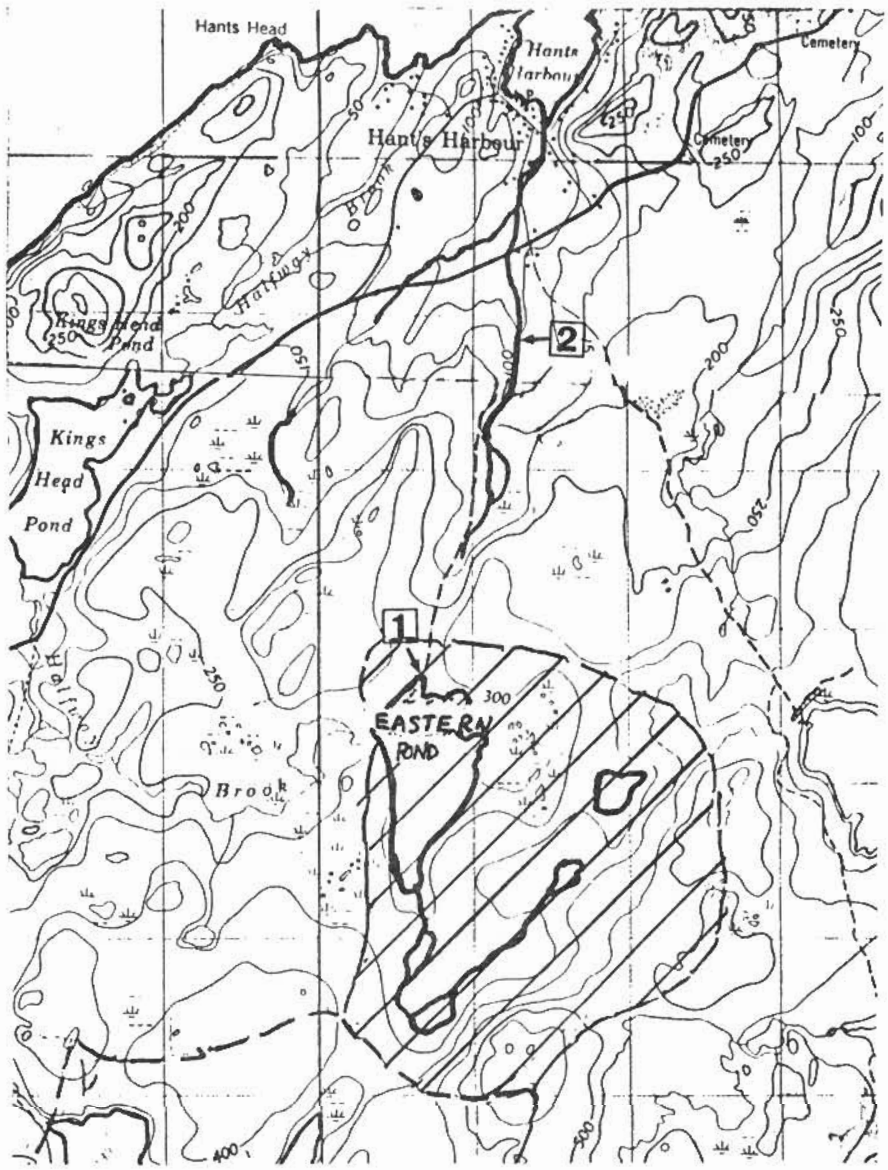
FUTURE CAPITAL REQUIREMENT

a. If a flow paced chlorinator is needed, it will cost about $100,000. Probably it should be relocated upstream of the present chlorinator to give more contact time.

b. Depending upon investigation of hydraulic problems.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



1. Intake
2. Chlorinator

TOWN OF HANT'S HARBOUR

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF HARBOUR GRACE

Information:

Lester Forward, Town Manager
Kathy Tetford, Secretary
Keith Skinner, Maintenance Forman
John Twomey, Harbour Grace Fish Plant (Mechanical Superintendent)

Population: 2988 (1981)

Water source: Bannerman Lake with a large network of back-up ponds. Town is sole user. This is a gravity system with pressure boosting to areas of low pressure.

Wells: No Council wells; about 20 private wells in use in low pressure areas not served by Council mains.

History: This is one of the oldest water systems in Newfoundland, with some of the CI pipes over 100 years old. The Town had two transmission mains from Bannerman Lake. When the Harbour Grace fish plant was taken over by Birdseye, a new 500 mm CI main was built to Bannerman Lake. All three transmission mains are now in use, maintained by the Town.

DEMANDS

Domestic: About 1100 homes hooked up.

Commercial: Regional commercial services; a large commercial sector.

Educational: Two high schools, three elementary schools.

Industrial: Large fish plant, Harbour Grace Fisheries, which has four 100 mm service lines connecting to the main. The fish plant also has a salt water intake. Terra Nova Shoes has 150 mm line. Marine vessel service centre also has a small demand.

Wastage or losses: None reported.

Metering: No records available.

Total estimated present demand: 6800 m^3/d (1.5 MGD estimated by Town Manager)

Variations in demand: Large decline when fish plant is not operating.

Factors in future demand:

- Continuing growth in community as a regional centre.
- Additional demand from recently completed expansion to Terra Nova Shoes.

SUPPLY SOURCE

Bannerman Lake. A natural pond enlarged with a dam. An extensive back-up of feeder ponds. Some of the upper lakes have access via rough tracks. Public access to the dam and waterbody from the access road is limited by a chain link fence. NOTE: Lady Lake, which lies to the east of Bannerman Lake, also contributes to Bannerman Lake through a brook much of the year, and probably also through underground flow. Lady Lake also has its own outlet brook to the east. Therefore only part of the run-off from the Lady Lake watershed flows into Bannerman Lake. No accurate estimate of the flow from Lady Lake to Bannerman Lake is available. (Information from Town Manager.)

Status of watershed protection: Not protected, according to the records available. Lady Lake is used for occasional recreational purposes such as the Harbour Grace Regatta. In the future a bypass highway will be constructed. This should be located outside the watershed if possible.

Dam: Hand placed stone wall at water face backed with earth/rock dam with top and backslope covered in turf. Maximum height 3 m, length 83 m (paced). Top width 10 m. Substantial leakage spring downstream of dam.

Spillway: Concrete wall about 600 mm high, topped with 200 x 200 square lumber bolted on. Length of spillway 26.3 m (taped), freeboard 500 mm or more. (Spillway sill is about 650 mm below top of facing wall of dam.)

Intake: Two pipes through the dam, serving three supply mains.

Adequacy of supply, summer 1987: Lowest water level in many years - about 900 mm below normal. Water level dropped to 710 mm (28") and 1170 mm (46") respectively above the two intake pipes (Town Manager). Fish plant did not use any fresh water for a month. Had to rely entirely on salt water for processing.

Screens: Concrete block building 4.8 x 3.8 x 5.5 m high. Located 150 m downstream of dam.

STORAGE/DEMAND FACTORS

Live storage head: Spillway sill to top of highest intake pipe: 1.63 m (from data given by Town Manager).

Ways to increase live storage:

1. Raise spillway to increase live storage and widen it to maintain adequate capacity.

2. Raise main dam and spillway and adjacent roadway. This would be an expensive option.
3. Pump from Spider Pond.
4. Investigate using Spider Pond and/or Anderson Pond as controlled back-up reservoirs.

WATER QUALITY

Bacteriological: Dept. of Health, Harbour Grace. No problems reported. Town also tests for chlorine residual.

Chemical: No data available. Water reported to be of good quality.

Problems: None reported.

WATER TREATMENT

Chlorination: Takes place about 350 m downstream of the dam. About 1550 m through 500 mm main to first house. The chlorination is by gas, fixed feed rate, manual adjustment, Wallace and Tiernan. No other treatment.

TRANSMISSION AND DISTRIBUTION

Transmission: The newest transmission main (500 mm iron) was built about 20 years ago, to strengthen two older mains 380 mm and 250 mm diam. This is basically a gravity flow distribution system. However there are four pressure booster stations.

Distribution: Distribution mains are almost entirely of CI. Those examined have been found with very little internal corrosion, and with minor external corrosion.

Pumps: There are four pressure boosting stations. One of these stations is shortly to be rendered unnecessary. The booster stations operate by continuous pumping. Two stations each have one 10 HP electric motor pump, and one station has one 20 HP electric motor pump. This station is shortly to be increased by a second 20 HP pump and this will eliminate the need for the fourth booster station.

FACTORS IN CAPITAL REPLACEMENT COST

Dam
Intake
Screen chamber, building
Chlorinator

500 mm DI transmission main
1200 connections
Access road to dam
3 pumping stations

COMMENTS/PROBLEMS

Ways of increasing available storage and upstream storage control should be considered.

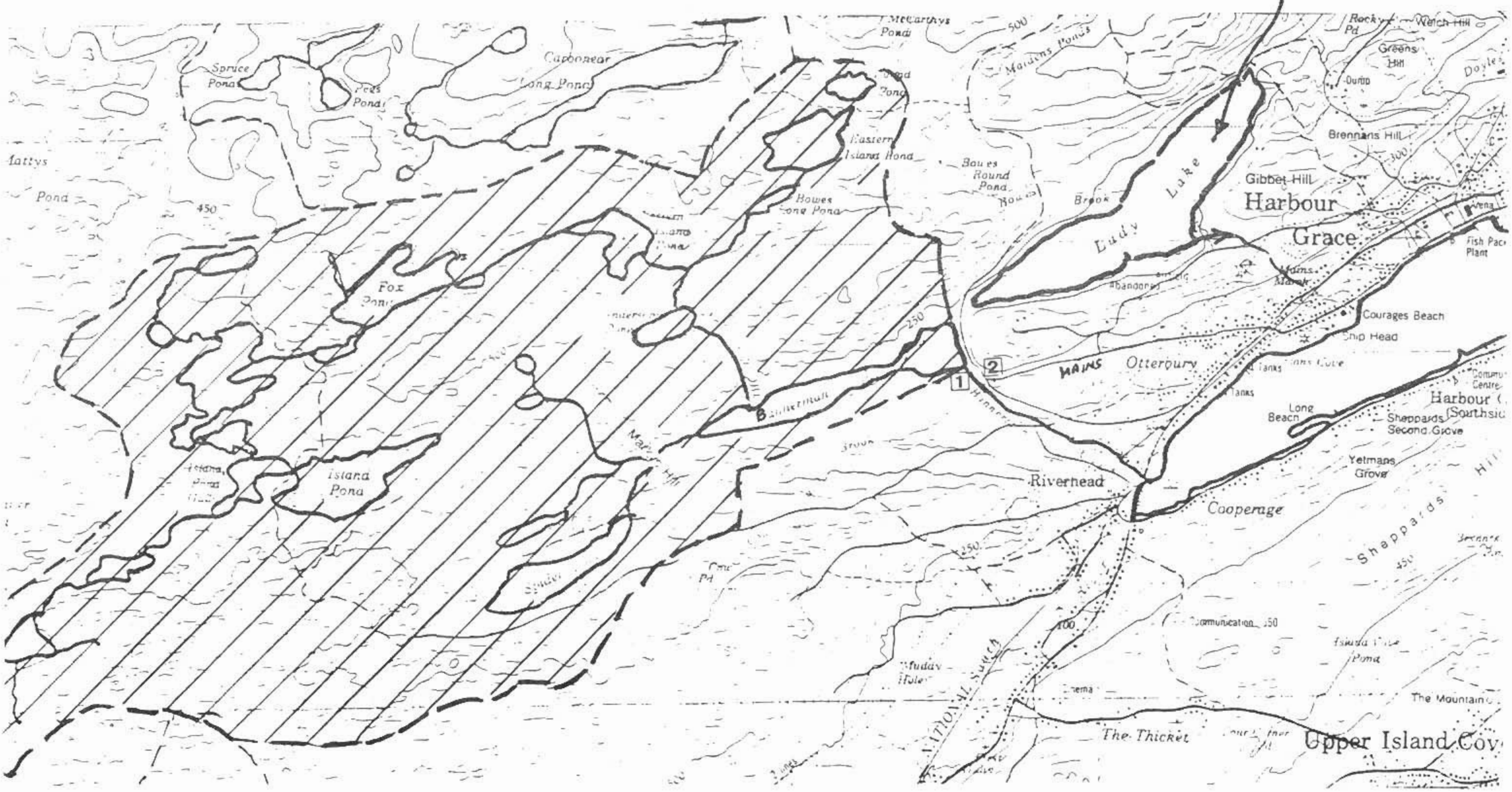
FUTURE CAPITAL REQUIREMENTS.

Raise and widen spillway. $25,000

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000

SEE NOTE CONCERNING LADY LAKE IN TEXT UNDER "SUPPLY SOURCE"



1. Intake
2. Chlorinator

TOWN OF HARBOUR GRACE

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF HARBOUR MAIN - CHAPEL COVE - LAKEVIEW

Information:
Evangaline Dalton: Town Clerk
Patrick Gorman: Gorman Fisheries Ltd.
DELCAN Report

Population: 1303 (1981)

Water source: Maloney's River

Wells: Maloney's River is a source under construction to replace groundwater sources. The Council has four wells serving 42 houses and a fish plant. The majority of the population is served with private wells.

PROJECTED DEMANDS

Domestic: In phases, to ultimately serve all of the population.

Industrial: Gorman Fisheries Ltd., 150 mm line. Fresh water, mainly for use of personnel. Most of processing done with salt water. Lump fish roe needs fresh water. Will connect to main water system in spring 1988, with 150 mm diam. connection. Plant operates May to December. The plant does not expect to re-chlorinate the Town's supply.

Metering: The chlorination plant will include a meter.

Variations in demand: Slight. The fish plant uses mainly salt water.

SUPPLY

Maloney's Brook is the outlet of the Harbour Main Pond and upstream system. Exposed to several roads on the watershed.

Status of watershed protection: Not recorded as protected.

Intake: Based upon design drawings. A cubical concrete chamber 2400 x 2400 mm in plan area, built alongside the river bank. Intake pipe projecting slightly into river at point where bed has been excavated. Top of pipe 900 mm± below W.L. Bottom of chamber about 500 mm below intake pipe. There are sumps in the chamber for well pumps.

Screen: Not shown on the drawing inspected.

STORAGE/DEMAND

This is a run of the river system.

WATER QUALITY

Bacteriological: Suitable for simple chlorination according to DelCan report, Department of Health, Holyrood.

Chemical: Water is potentially corrosive. Langellier Index- 4.2. (Very low calcium hardness.) Otherwise water quality is satisfactory.

WATER TREATMENT

Apart from chlorination, chemicals should be added to combat the corrosion potential (DelCan).

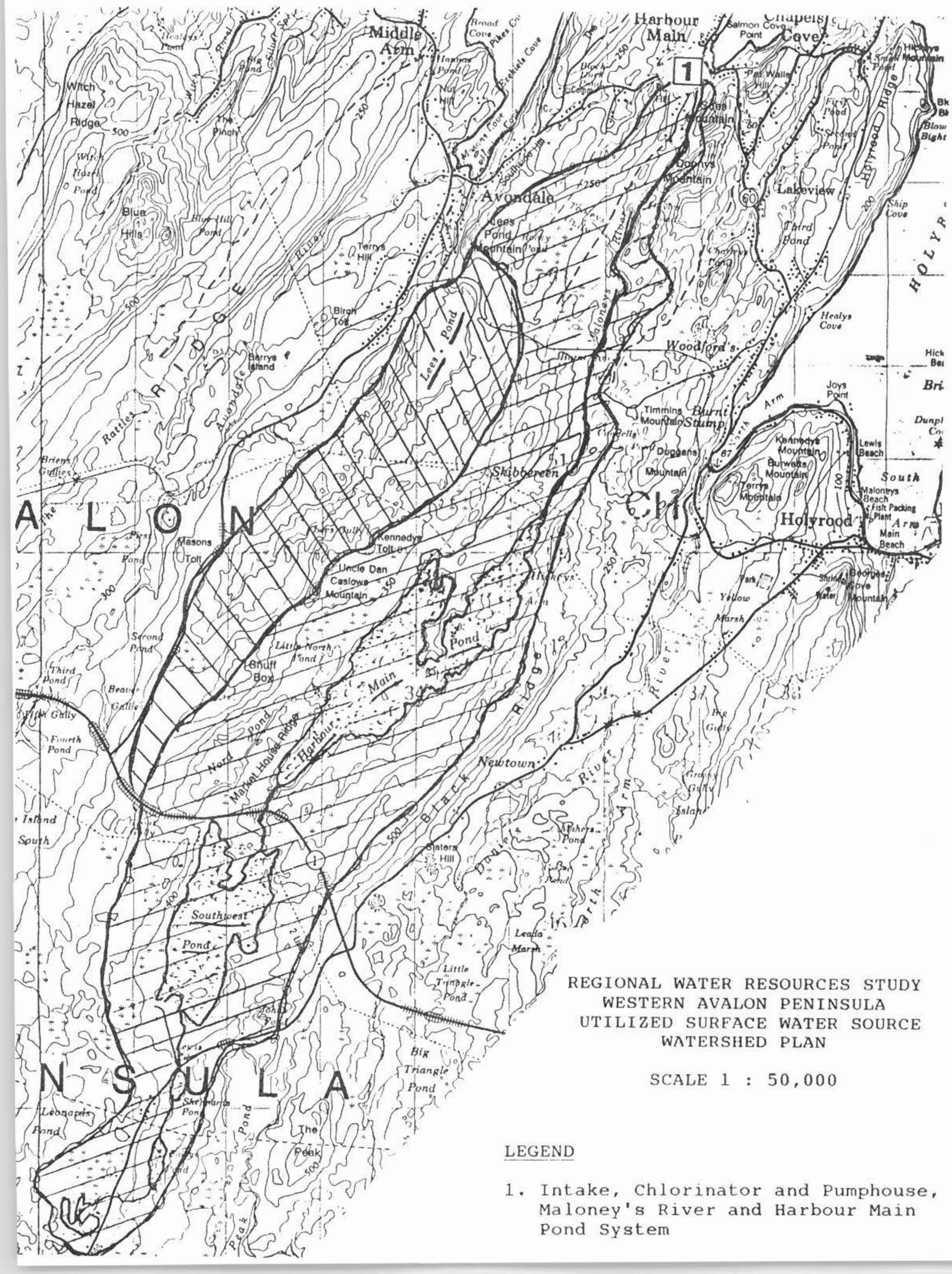
TRANSMISSION AND DISTRIBUTION

Pumps: For Phase I, one pump, submersible, 7.5 hp, is proposed with two 120 gal hydropneumatic tanks.

Mains: Class 52 DI cement mortar lined, up to 300 mm diam. are proposed.

COMMENTS/PROBLEMS

Continuing expansion of the system will be carried out as funds permit.



REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1 : 50,000

LEGEND

1. Intake, Chlorinator and Pumphouse, Maloney's River and Harbour Main Pond System

MUNICIPALITY -SURFACE WATER SOURCE

TOWN OF HEART'S CONTENT

Information:
Town Clerk: Mrs. Alice Cumby
Maint.Foreman: Winston Piercey

Population: 625 (1981), 620 (1986)

Water source: Southern Cove Pond, controlled by Newfoundland Light and Power Co.Ltd., (NLP) who first started to develop the pond about 1940. Gravity water supply to Town.

DEMANDS

Domestic: About 200 houses hooked into main line. 120 of these are hooked into the main sewer system. 2 houses not hooked in.

Commercial: Motel, 16 units and restaurant, and about 5 retail establishments serving local needs.

Educational: High school, 350 pupils.

Industrial: Fish landing facility using one 25 mm diam. wash-down hose. (Raw product weighed and shipped for processing elsewhere.)

Wastage or losses: No major leaks reported, and very little tap bleeding in winter._The last time a leak was discovered and repaired was three years ago.

Metering: Nil.

Variations in demand: Slight increase when wharf is operating in fishing season.

FACTORS IN FUTURE DEMAND:

- Domestic water demand may increase slightly when the 80 homes become serviced by main sewer.
- No significant population increase is expected.
- If fish landing facility is expanded, the 100 mm water supply to plant will have to be augmented.

SUPPLY SOURCE

Southern Cove Pond, a natural pond, elevated by a dam. Numerous ponds and rivers supplying main source, with flows and water levels controlled by NLP. Water is drawn from Southern Cove Pond (1) through a flume to the NLP pipeline, (2) outlet brook,

typically 6 m wide, 300 mm deep, (3) Town's water supply pipeline.
Status of watershed protection: Protected. (See NOTE at end of this text.)

Dam: A wooden retaining wall 1.3 m high, consisting of vertical 150 x 50 plank built by Nfld. Light and Power Co.Ltd. to raise water level. Width of dam approx. 70 m.

Intake pipe and screens: 250 mm ϕ DI pipe, located under the dam wall, and extends 18 m out into Southern Cove Pond into about 3 m of water from the wall. 250 mm ϕ DI pipe runs 12 m out from the dam to exposed screen chamber with three screens.

Adequacy of supply: In 1987 during dry period the water level dropped to about 600 m above intake (information supplied by maintenance foreman) and this level was maintained throughout the summer by Nfld. Light & Power Co.Ltd. to keep the power house in operation.

STORAGE/DEMAND FACTORS:

Live Storage Head: Normal water level to top of 250 mm ϕ DI intake is 1.50 m (information from maintenance foreman).

Ways to increase live storage: Lower the intake and extend into pond where deep water is reported. However, the volume of water available is unlikely to necessitate an increase in supply for domestic purposes.

WATER QUALITY

Bacteriological: Laboratory, Dept. of Health, Harbour Grace.

Chemical: Data not available.

Problems: No problems reported with water quality.

WATER TREATMENT
Wallace and Tiernan Series 94-100 Impulse chlorinator, fixed rate feed. (Graduated 0-10 for feed adjustment.) Water and calcium hypochlorite 65%. Daily tests by maintenance forman, occasionally by Department of Health. No problems. Chlorinator is about 150 m from dam, 250 mm diam. main. First house is approximately 800 m downstream of chlorinator 200 mm main.

TRANSMISSION AND DISTRIBUTION
The gravity water system was built in 3 phases, 1970, 1971, 1972. Mains are of ductile iron. Small branch lines have been added over the years. Now trying to obtain DMA funding to complete sewer system. The water system includes fire hydrants.

FACTORS IN REPLACEMENT COST ESTIMATE

. intake
. transmission main 200 mm DI
. simple screen chamber
. chlorination building
. 250 service connections
. hydrants

COMMENTS/PROBLEMS

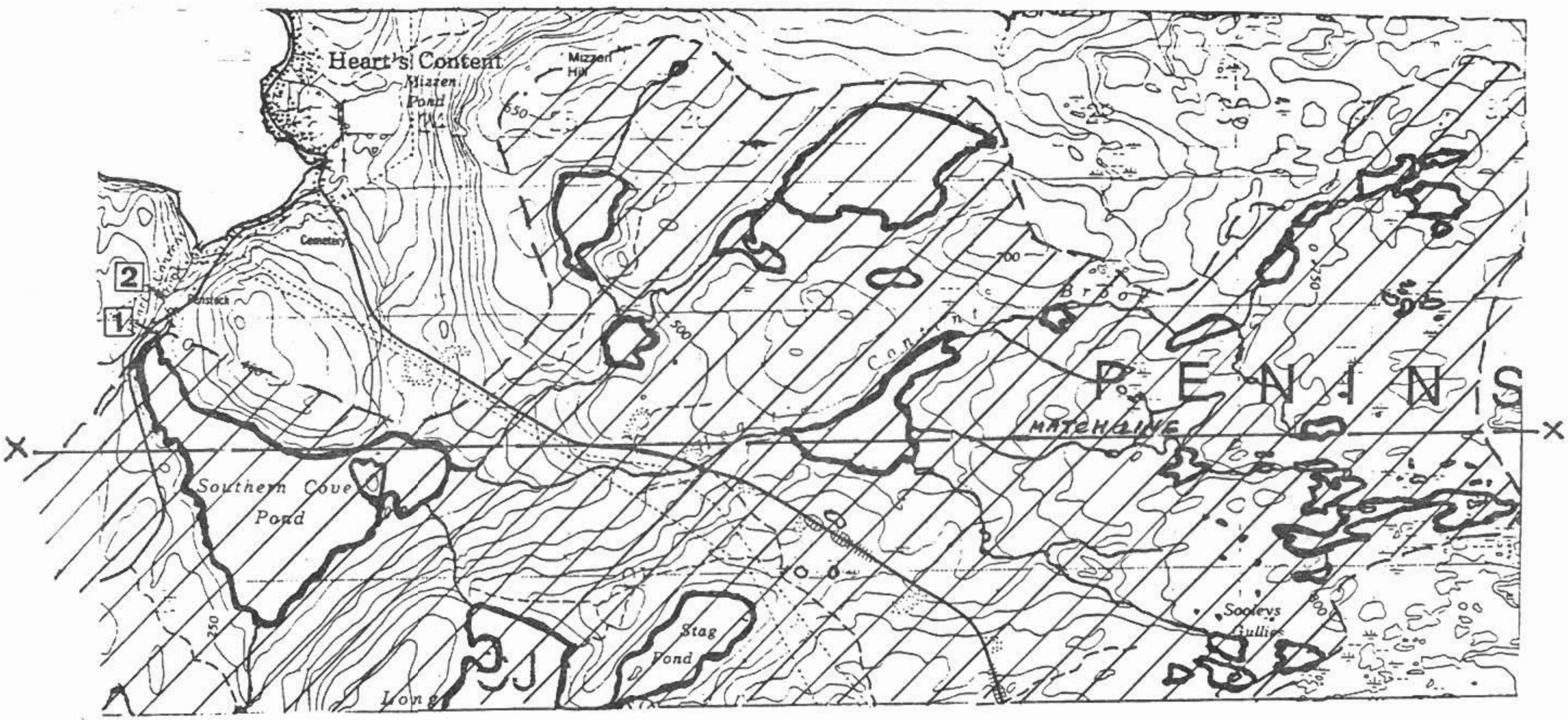
1. NLP control and operations in the pond have not caused problems for the Town's water supply.
2. The 100 mm line from Fishermen's Hall to North Point is too small. There are serious pressure drops when the wharf water line is operating.

FUTURE CAPITAL REQUIREMENTS

1. Replace North Point line with PVC line, probably 200 mm diam. Replace hydrant connections and valves with 150 mm size. Reconnect house service lines. Est.cost $550,000. A booster pump may be installed in 1988.

2. Other needs are likely to be minimal unless the DI system needs replacement because of corrosion.

NOTE: The watershed area shown on the following plans does not show the full extent of the present catchment into the NLP Heart's Content system. By a system of dams and canals to other water bodies the original natural watershed feeding Southern Cove Pond has been extended to the east and south.



REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000

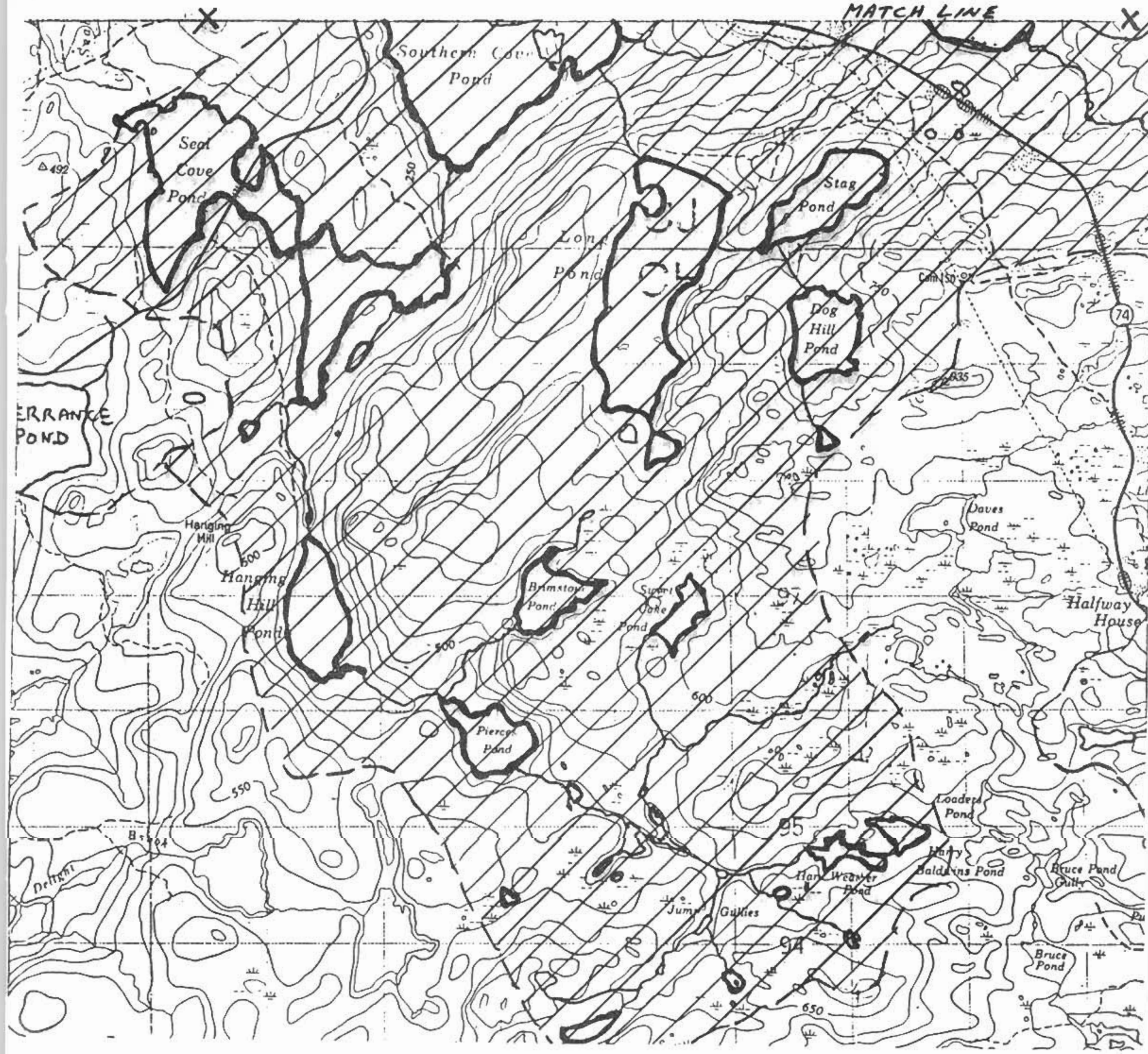
1. Intake
2. Chlorinator

TOWN OF HEART'S CONTENT
NORTH PORTION OF WATERSHED

Consulting Engineer: Colin Karasek Ltd. November 1987

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



<u>TOWN OF HEART'S CONTENT</u>
<u>SOUTH PORTION OF WATERSHED</u>

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF HEART'S DELIGHT - ISLINGTON

Information:
Works Superintendent: Stan Legg
Town Clerk: Pauline Chislett
Thomas Kendell, P.Eng., Newfoundland and Labrador Consulting Engineers

Population: 899 (1981), 868 (1986)

Water source: Long Pond. Gravity supply. Town is sole user.

DEMANDS

Domestic: About 300 houses connected, plus about 12 vacant houses or serviced lots.

Commercial: Local needs.

Education: One elementary school, 165 pupils.

Industry: Two fishermen's wharves with small hoses.

Wastage or losses: Some tap bleeding in winter at a few old houses.

Metering: There is a 150 mm impeller type water meter in the chlorination building. This was read mid p.m. on Dec.11/87, early pm (Karasek). One revolution of the meter pointer is 1 m^3 of water flow (220.2 I galls). This took 4 minutes 16 seconds, and indicates a flow of 3.91 L/S or 52 Igpm. Other readings taken at this time confirmed this flow which would be appropriate for the average daily flow for the population concerned. This also checks with the statement from Stan Legg, who stated the flow was formerly about 80 gpm. The proper way of reading the meter, and the digital portion, which gives the accumulated flow, should be explained to the Town.

Variations in demand: Not reported as significant.

Factors in future demand: About 12 houses remain to be serviced with water and sewer. Otherwise no more than slight increases are expected.

SUPPLY SOURCE:

Long Pond, a natural pond with one feeder brook and no back-up ponds on the watershed. The watershed appears free of development excepting a rough access road to the interior.

Status of watershed protection: Protected.
Dam: There was originally a low dam which was removed about a year ago.

Intake: The intake is a 300 mm diam. PE pipe extending about 400 m from the edge of the pond. The transmission main take-off point borders a very shallow muddy area of the pond. The intake was extended in 1983, and an upturned end was added to get above muddy sediments. The intake pipe has virtually a 0% grade (Thomas Kendall). The muddy bottom is 2 m or more in depth to solid ground. At the head of the intake the water depth is 2.5 m.

Screens: The original screen chamber was duplicated a year or two ago by building a similar type structure in parallel. The original screens are now used alternately with the new screens. The screen chambers, which are located near the edge of the pond, have a concrete well with two vertical screens; no gantry or building. The screens require cleaning every few days, particularly in summer.

Adequacy of supply, summer 1987: The pond level dropped only a few inches. The outlet brook continued to discharge.

STORAGE/DEMAND FACTORS

Live storage head: About 2.0 m. (Thomas Kendall)

Ways to increase live storage: The pond water level could be raised slightly with a low dam.

WATER QUALITY

Bacteriological: Department of Health, Harbour Grace. The muddy bottom creates an environment for a high bacteria count. The original chlorine system eliminated the bacteria indicators, but could not maintain a chlorine residual throughout the system. Boil order issued in August 1984. However the chlorination system, improved in 1985, has kept bacteria in check and a satisfactory chlorine residual can be maintained.

Chemical: Poor raw water quality. The raw water has high iron (0.5 ppm), sometimes high manganese, very low alkalinity, and low pH. The raw water is potentially very corrosive. Much of the iron is bound with organic material which makes its removal more difficult by chemical treatment. Under strong oxidation the iron (and manganese) come out of solution. This occurs when domestic bleach is added to the water for washing clothes; a brown stain results. The water is also potentially highly corrosive. The water on occasion contains a large number of organisms which have been collected on the screens as brown solids and slime.

WATER TREATMENT

Previous: The original chlorinator used chlorine gas at a rate of 1 to 2 kg per day (fixed rate chlorination). This system could not provide satisfactory levels of chlorine residual on a continuing basis.

Existing: Installed 1985. An impeller driven mechanism on the pipeline creates an electrical impulse at a frequency proportional to flow. This drives two feed pumps: chlorine solution and carbonate of soda solution. There is a third tank for mixing thesoda ash which is supplied in powder form. The soda ash reduces the corrosiveness of the water, and also probably improves the action of the chlorine for purification.

Full treatment: A study by Pollutech Ltd., Oakville, Ontario, recommended adjustment to pH 11 with lime (calcium hydroxide), followed by oxidation by potassium permanganate, filtration, pH adjustment and chlorination. Using the Pollutech recommendations, Newfoundland and Labrador Consulting Engineers (NLCE) gave the cost of treatment to be $486,000 capital and $38,000 for O and M per annum (report, March 1985). This system has not been implemented.

TRANSMISSION AND DISTRIBUTION

The transmission main is 200 mm diam. PVC with the chlorinator about 400 m downstream of the screen chamber. About 800 m downstream of the chlorinator the system branches north along the main road to Heart's Delight and south to Islington. The first water users are about 500 m downstream of the chlorinator. All mains are of PVC. The system includes fire hydrants.

FACTORS IN REPLACEMENT COST ESTIMATE

Intake, 400 m 300 mm PE
Simple screen chamber
Chlorinator (flowpaced impulse type)
1200 m of 200 mm PVC transmission main
310 connections
Access road

COMMENTS/PROBLEMS

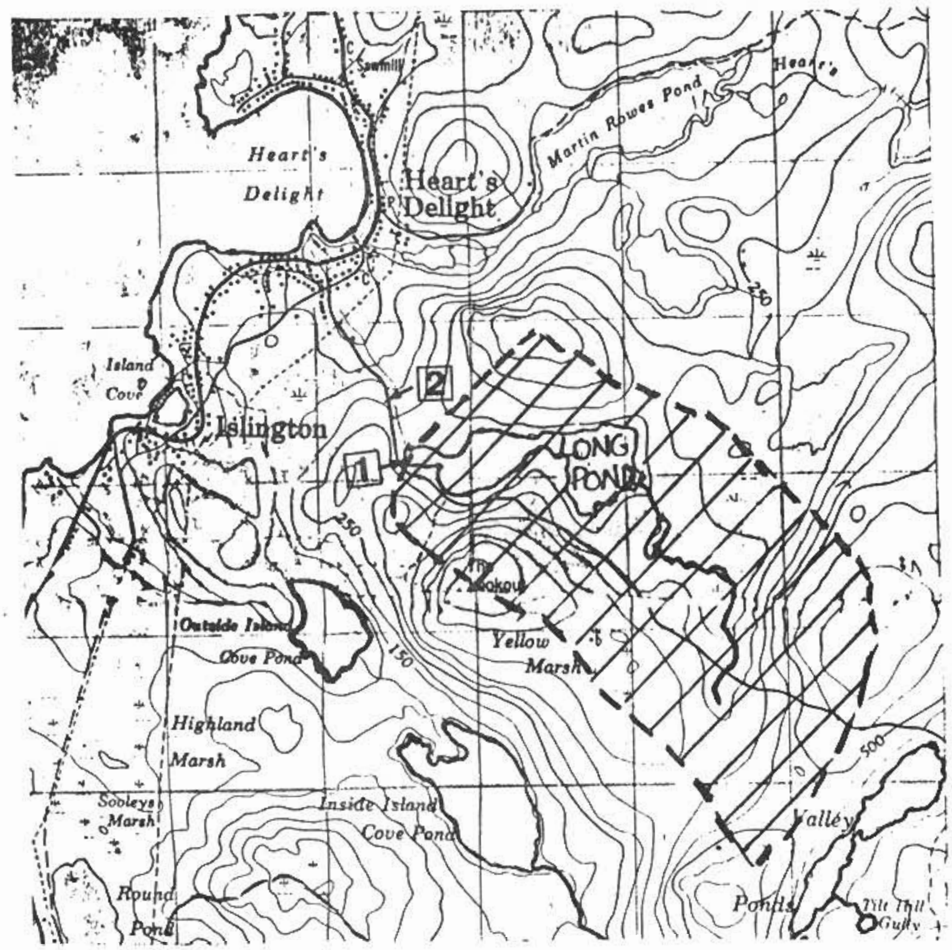
Water quality: The poor chemical quality of the raw water (high iron and organisms) remains a problem. The solutions are: (1) full treatment with filtration of present source, or (2) find a source with suitable raw water that can feed by gravity without treatment. Such a source possibly exists in the hinterlands but the transmission line would likely be several kilometers in length. A report by Thomas Kendall, March 1985, looked at several nearby surface water sources to use instead of Long Pond. These sources would require pumping and the report concluded that treatment of Long Pond water would be more feasible.

FUTURE CAPITAL REQUIREMENT

Could be $500,000 or more if full water treatment is installed. Otherwise minimal.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF HEART'S DELIGHT/ISLINGTON

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF HEART'S DESIRE

Information:
Town Clerk: Eleanor Andrews
Maintenance Foreman: John St. George

Population: 600 (1986)

Water source: Terrance Pond. Town is sole user. Gravity supply.

Wells: Nil.

DEMANDS

Domestic: 127 homes out of 130 presently hooked up.

Educational: 1 school, occupied by 62 students. (Serviced by Town supply.)

Industrial: 1 fish plant, Trinity Bay Fisheries, (mostly caplin) with 150 mm main supply, broken down into 12, 25 mm hoses with twenty-four 12 mm lines, no metering.

Wastage or losses: Very few leaks reported, but some tap bleeding in winter.

Metering: There is a water meter in the chlorination station installed on the 200 mm main line which measures total demand, but readings were never observed on a regular basis.

Factors in Future Demand: No major population growth or major increase in industrial usage is expected. Town has full sanitary sewer system so consumption patterns represent fully serviced dwellings.

Variation in demand: Large decline in demand this year due to lack of raw material for the fish plant.

SUPPLY SOURCE

Terrence Pond. A natural pond in a remote area.

Status of watershed protection: Protected.

Dam: No dam.

Intake pipe and screens: 200 mm of ductile iron pipe leading to screen chamber which has two sets of stainless steel screens (4 screens). Exposed gantry for screen lifting. Valve located in screen chamber also.

STORAGE/DEMAND FACTORS

Live storage head: Normal pond water level to top of intake pipe 1.8 m (estimated in field, A. Slaney).

Adequacy of supply, summer 1987: Level dropped 250 mm below normal during dry period (foreman's information), which left about 1.6 m of water on top of intake.

Ways to increase live storage: Low dam at outlet brook could raise WL a few centimetres. An increase in live storage volume does not appear necessary.

WATER QUALITY

Bacteriological: Laboratory, Dept. of Health, Harbour Grace. No problems reported.

Chemical: Data not available.

Problems: No problems reported with water quality, although chlorination system was not working at time of survey (Oct.23/87). (Boil order was in effect.) Awaiting parts on order for the chlorinator.

WATER TREATMENT

Gas fed chlorinator located about 1300 m downstream from Terrance Pond and about 500 m from first residence.

TRANSMISSION AND DISTRIBUTION

Gravity fed system: From intake to start of Town 200 mm DI, reduced to 150 mm DI and 100 mm DI around the Town itself, except for 150 mm direct line to fish plant.

FACTORS IN SYSTEM REPLACEMENT COST ESTIMATE

Intake, 45 m, 200 mm DI
Screen chamber with gantry
Gas chlorinator
Transmission main 1800 m 200 mm DI
Access road
127 connections

COMMENTS/PROBLEMS

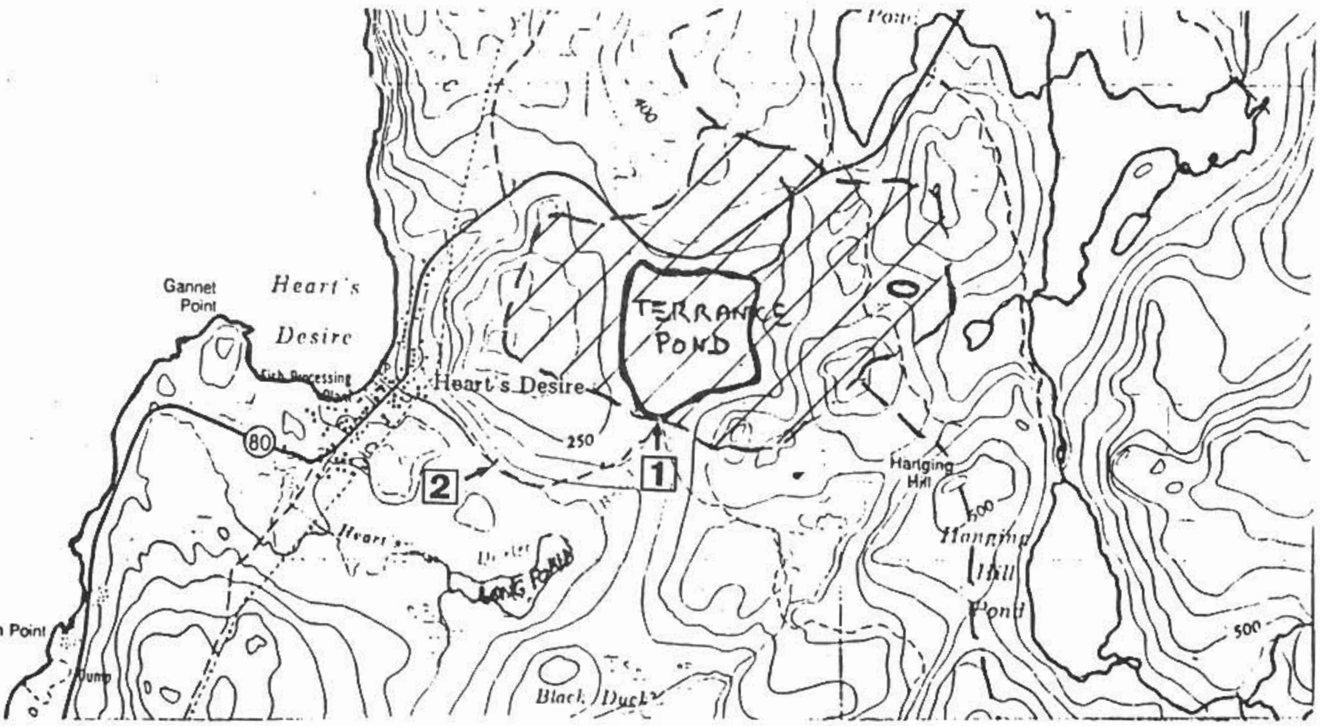
No apparent problems.

FUTURE CAPITAL REQUIREMENTS

Routine, e.g. eventual replacement of chlorinator.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF HEART'S DESIRE

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY-SURFACE WATER SOURCE

TOWN OF JERSEYSIDE

Information:
Don O'Keefe, Town Manager
Robert Kennedy, P.Eng., DelCan

Population: 1103 (1981), 841 (1987)

Water source: Larkins Pond, shared with Towns of Freshwater and Placentia.

Placentia and Jerseyside are served by the same intake and treatment plant. Distribution in both Towns is achieved by gravity flow and pumping. The treatment plant is operated by Jerseyside.

DEMANDS

Domestic: About 220 houses are served in total (all houses in the Town are hooked up) About 135 served by pumps are 85 served by gravity.

Commercial: About four local businesses.

Industrial: Fish plant with 100 mm connecting lines to the gravity flow part of the system. No meter. Plant has no salt water line. Plant carries out the initial processing of fish, employs between about 40 and 100 people on a seasonal basis.

Wastage or losses: In Jerseyside a few serious leaks were repaired recently. In Placentia in 1978, leakages were estimated at 7,860 m^3/day, but by late 1982 these had been reduced to about 1050 m^3/day through corrective action (report by DelCan NW 1982).

Metering: The new treatment plant, recently commissioned, meters the total flow from Larkins Pond for Jerseyside and Placentia. DelCan have installed a meter to record output of the pumps to Jerseyside. This meter indicated a consumption much higher than warranted for domestic consumption, thereby identifying the major leak losses referred to above. The Town has requested the fish plant to instal a meter.

Variations in demand:
- fish plant, seasonal
- repair of leaks has reduced demand

Factors in future demand (Jerseyside):
No significant population growth is expected unless major development takes place in Argentia.

SUPPLY SOURCE
Larkins Pond, and Clarkes Pond watershed. See "Argentia".

Intake: Open ended intake pipe, 300 mm diam. CMP is surrounded with ballasted crib to keep out slush ice. Pipe projects about 15 m into pond.

Screens: In the new pumphouse/water treatment building about 100 m from intake. Screens are changed and cleaned about once per week.

Adequacy of supply, summer 1987: Water level dropped about 1 m below normal. No shortage of water.

STORAGE/DEMAND FACTORS
See "Argentia" report.

WATER QUALITY

Bacteriological: Dept. of Health, Whitbourne. No problems reported.

Chemical: Good quality raw water except negative Langelier Index (-3.5). The water has a low alkalinity 5 mg/L.

Problems: Raw water is potentially corrosive to metal pipes.

WATER TREATMENT

Investigation: A study by Pollutech, October 1982, recommended treatment with 50 mg/L of sodium bicarbonate ($NaHCO_3$) to buffer the corrosive effect of the water. Soda ash was the chemical finally recommended for use.

Treatment plant layout: The intake runs by gravity to the screen chamber and thence to a wet well. The wet well serves the gravity flow line for Lower Jerseyside and Placentia; and also two vertical turbine pumps, for Jerseyside.

Chlorination: Chlorine gas.

Corrosion buffering: Soda ash.

Treatment control: Metering for treatment control purposes takes place on the intake line. A Rockwell flowpaced system controls the rates of injection for chlorine solution and soda ash liquid into the screen chamber well.

TRANSMISSION AND DISTRIBUTION

Pumps: Two turbine pumps in parallel, each 18 L/S electric motor driven, plus a standby diesel driven pump, 38 L/S. The turbine pumps are controlled by a pressure switch.
Storage tank: Steel tank at ground level, 90 m^3 capacity.

Mains: CI mains and copper building connections with fire hydrants. Installation starting in 1956. The network is sufficient except that a few dead ends should preferably be looped.

FACTORS IN REPLACEMENT COST ESTIMATE

Intake
Pumphouse/treatment building
225 connections
Extra 200 mm DI line to serve Placentia, length 600 m

COMMENTS/PROBLEMS

Corrosion of mains: The mains are iron pipe with some up to 30 years old. Only recently has the potentially corrosive water been buffered. The rate of pipe repairs for leakage has not proven a major problem. However, the question remains as to the additional life of the pipes and building connections and the time horizon for their replacement.

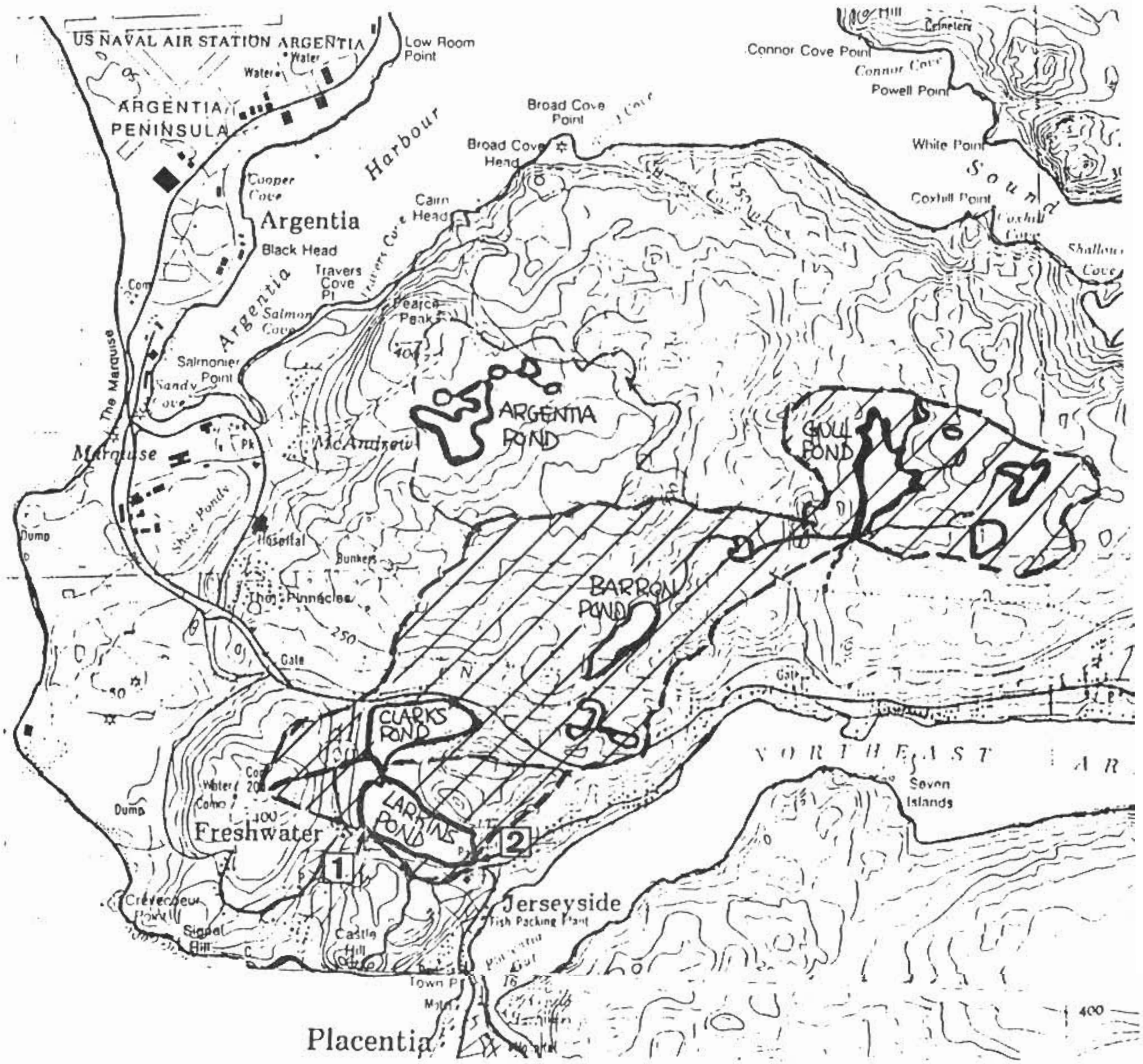
FUTURE CAPITAL REQUIREMENTS

1. The pressure switch control should be replaced by a control directly from the storage tank water level. Cost $15,000.

2. Complete or partial distribution system replacement within a 25 year horizon?

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWNS OF FRESHWATER/JERSEYSIDE

1. Intake-Freshwater
2. Intake-Jerseyside

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

LOCAL SERVICE DISTRICT, LITTLE HARBOUR EAST

Information:
Harry Smith, former Chairman, LSD
Norman Parsons, P.Eng., DMA
Tony Kelly, Dept. of Health, Whitbourne

Population: About 175.

Water source: Abstraction dam on brook. Sole user. All houses formerly on Council wells have now been connected to the surface water source.

DEMANDS

Domestic: 65 houses served.

Industrial: Fish plant. This uses fresh water for ice making, wash down and washrooms. The plant has a salt water line. Plant not working in recent years.

Other: Two local commercial outlets. One church, one community centre, no schools.

Wastage or losses: None reported.

Variations in demand: Normal domestic demands. However, if the fish plant is reactivated, there will be a very large increase in demand. Plant operated up to two or three years ago, and when the plant was working the storage dam was frequently drawn down.

Future demands: (1) Three houses served by one private well, which ran short in summer of 1987; (2) Probably a fish plant.

SUPPLY

Brook, from a pond (no name). It is hard to gauge the size of the brook since it runs in waterfalls down a rocky cliff behind the dam.

Dam: Concrete gravity dam about 12 m wide of a height sufficient to raise WL about 2 m. Some excavation has been done behind to increase storage. Ponded surface area about 60 m^2. Bottom covered with crushed stone to keep down mud. The dam has a drain.

Spillway: In dam, 200 mm x 1200 mm. (From Harry Smith. The dam and spillway were iced over at the time of the survey.)

Intake: 150 mm pipe.

Problems: Concrete in dam has deteriorated. Former Chairman feels dam must be refaced and built higher.

Adequacy of supply in summer 1987: Water ran short. The bed of the feeder brook upstream of the dam was cleared out to increase the flow from the first upstream pond.

Status of watershed protection: Record states "not protected (source not identified)".

STORAGE/DEMAND FACTORS

Essentially a run-of-the-river supply system with a limited amount of storage.

Live storage head: Spillway to top of intake at dam. About 2 m (Harry Smith).

Ways to increase live storage:

(1) Raise dam using reinforced concrete. The dam could be raised up to 3.5 m since there is a cliff behind the present reservoir. Engineering needed.

Other more nebulous procedures that could be looked at would include:

(2) Control storage on upstream pond(s) by building low dam with gates or valves, and (3) excavate additionally behind dam.

WATER QUALITY:

Bacteriological: Dept. of Health, Whitbourne. Difficulties in holding a chlorine residual since summer 1987. Boil Orders issued.

Chemical: No data. Water is reported to be good tasting, and of reasonable appearance.
Problems: The bacteria problem was apparently due to a faulty chlorinator, now rectified by installing a new chlorinator.

WATER TREATMENT

Chlorinator is about 200 m downstream of dam. Electronic pulse chlorinator. Prominent A0503, using sodium hypochlorite solution (DIBAC in 20L containers).

TRANSMISSION AND DISTRIBUTION

Starting at dam 150 mm diam. then 100 mm diam. to extent of east side of harbour. Along the west side of harbour the mains are 50 mm diam. - too small. Mains are probably PE or PVC. About 100 m downstream of the dam there may be a "high point" in the line. This is probably why the larger (150 mm) main was used.

COMMENTS/PROBLEMS

1. No isolation valves in system.
2. Storage inadequate if fish plant operates. Future demands and the means of improving the storage should be investigated. However, it is not likely that the systems, even if improved, could supply an uncontrolled quantity of fresh water to the plant.
3. New main 100 mm needed on west side up to fish plant (about 400 m).

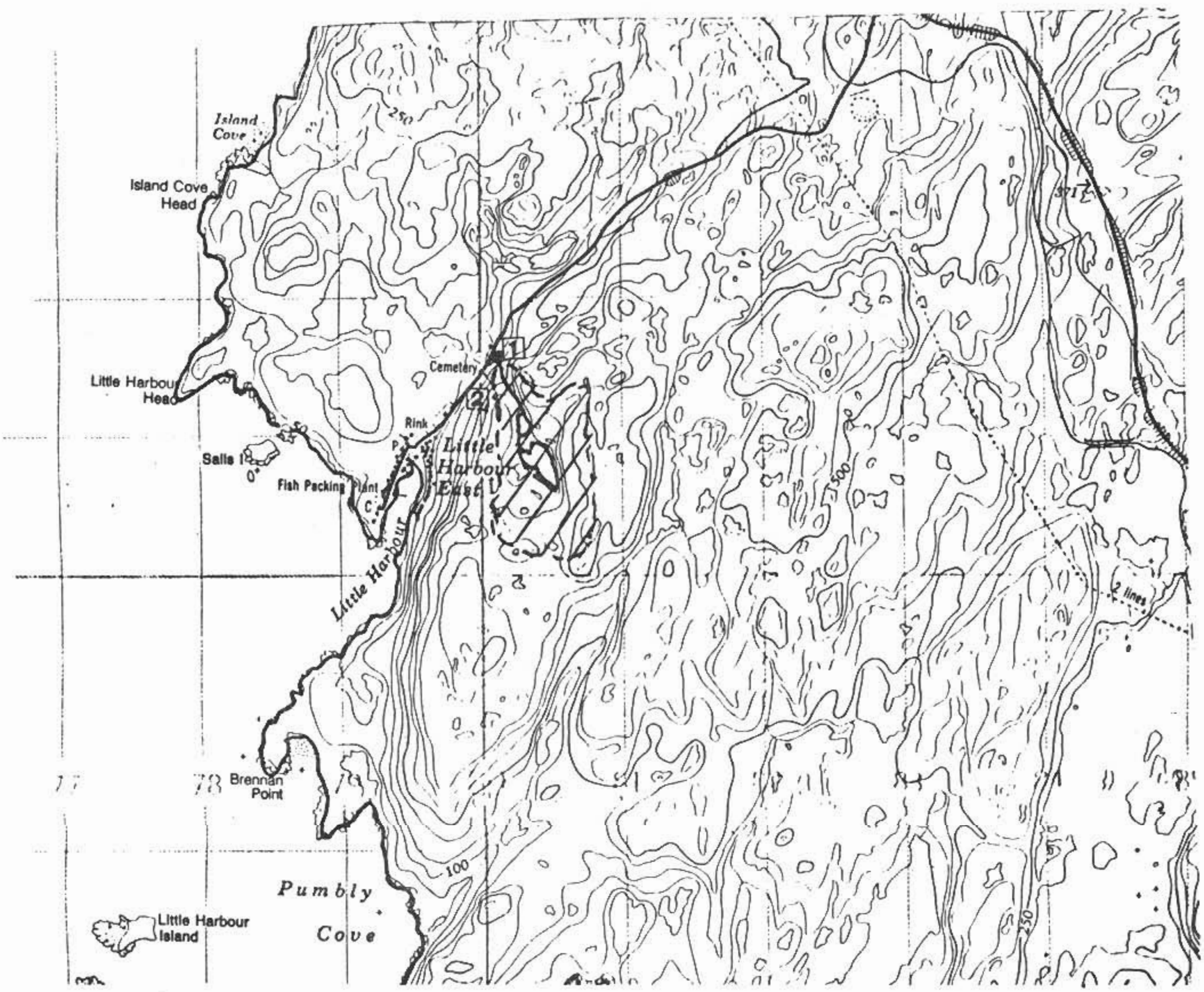
FUTURE CAPITAL COSTS

After investigation, new, higher dam, say $80,000.
New 100 mm main and house connections, say $100,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

1. Dam and Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. January 1988

ERCO PHOSPHOROUS PLANT, LONG HARBOUR

Information:

Garry Hickey, Engineer, and ERCO files
R.W.Matthews, Engineering Manager (letter)

Water sources: (All are gravity supplies, with pressure boosting within the plant as required.)

1. Main source; Lake B, developed 1968.
2. Back-up (to Lake B); Lake C, developed 1968. Lake C is called Rattling Brook Big Pond on the 1:50,000 topo sheets.
3. Emergency: dam on Rattling Brook.
4. Drilled well; occasionally used for drinking water.

Use of water:

a. Process - washing aggregate
 - other processes
 - cooling water (not recycled)

b. Domestic - 350 workforce, majority in 8.00 to 4.00 p.m. shift.

c. Fire fighting

See Figure 1.

DEMAND

Industrial/domestic: Total demand 23,000 m^3/day.

Variations in demand: Very slittle change.

Potential future demand: No major changes are planned at present.

Wastage or losses: None reported.

Metering: At main entry to plant. See Figure 1.

SUPPLY SOURCE #1

Lake B. A natural pond iun an isolated area with a string of back-up lakes.

Status of watershed protection: Not protected.

Dam: No dam.

Spillway: Natural outlet, Rattling Brook.

Live storage head: Information from the drawings of the intake structure:

Pond HWL	101.1 m
Pond LWL	100.2
Live storage head	0.9 m

The top of the intake structure is elevation 99.4 m and the pipe itself is slightly below this. However with any significant drawdown in Lake A the back-up Lake B would be activated.

Intake: 660 mm steel pipe within a screened underwater structure.

SUPPLY SOURCE #2

Lake B. A natural pond feeding Lake A.

Dam: No dam.

Spillway: Natural brook, feeding to Lake A.

Intake: A pipe terminating in about 5.4 m depth of water, and supplying a pipe running from Lake B to Lake A.

Screens: Not screened.

Live storage head: Effectively 5.0 m water.

Operation: Water is fed from Lake C to Lake B by means of a siphon. The intake is carried into deep water in Lake C and the pipe rises over the ground between Lake C and Lake B a distance of about 800 m. At a high point there is a diesel operated vacuum pump. When this is started, the air is drawn from the line until siphon flow commences from Lake C to Lake B. The siphon pipeline was installed in 1968 along with the main system, but has been used very little in the past - excepting for test purposes. However, the siphon was used extensively in 1987 to replenish Lake B.

Adequacy of supply in summer 1987: Lakes B and C combined provided sufficient water.

TRANSMISSION

The initial portion of the main is steel with the remainder wood stave pipe, diam. 660 mm. Total length from intake to plant is 2744 m. An all-gravity system, with a rated capacity of 660 L/S, and providing a static pressure at the ERCO plant of 73.9 m of water.

WATER QUALITY

Bacteriological: (drinking water), Dept. of Health, Whitbourne.

Chemical: Data not readily available.

Problems: Water in the past has been found to be of good quality for processing and potability. During 1987 some discolouration and smell was noted. This may have been due to using Lake C water or the stirring up of bottom layers or sediments through the siphon flows.

WATER TREATMENT

Fire flows: Untreated.

Industrial users: Filtered (pressure filters).

Domestic: Filtered and chlorinated (by gas).

SUPPLY SOURCE #3

An emergency supply system installed about 10 years ago.

Dam: On Rattling Brook, the outlet brook from Lake B. Height of dam, up to 3 m. Width of dam 20 m (estimated by eye). Dam is reinforced concrete wall with buttresses.

Spillway: Full width of top of dam.

Live storage head: Spillway to top of outlet pipe 2.18 m (taped).

Storage capacity: 250,000 US gal. (ERCO records) 947 m^3.

Transmission: A 300 mm diam. PE line about 500 m in length feeds to the plant where it is pressure boosted by diesel driven pumps. (See Fig.1). Capacity of emergency system 253 L/S (ERCO).

SUPPLY SOURCE #4

Drilled well. This supplies boiler feed water to a steam plant for heating phosphorous into liquid for rail car shipments. With the bad tasting water in 1987 this well was used to provide containers of drinking water for the employees.

COMMENTS/PROBLEMS

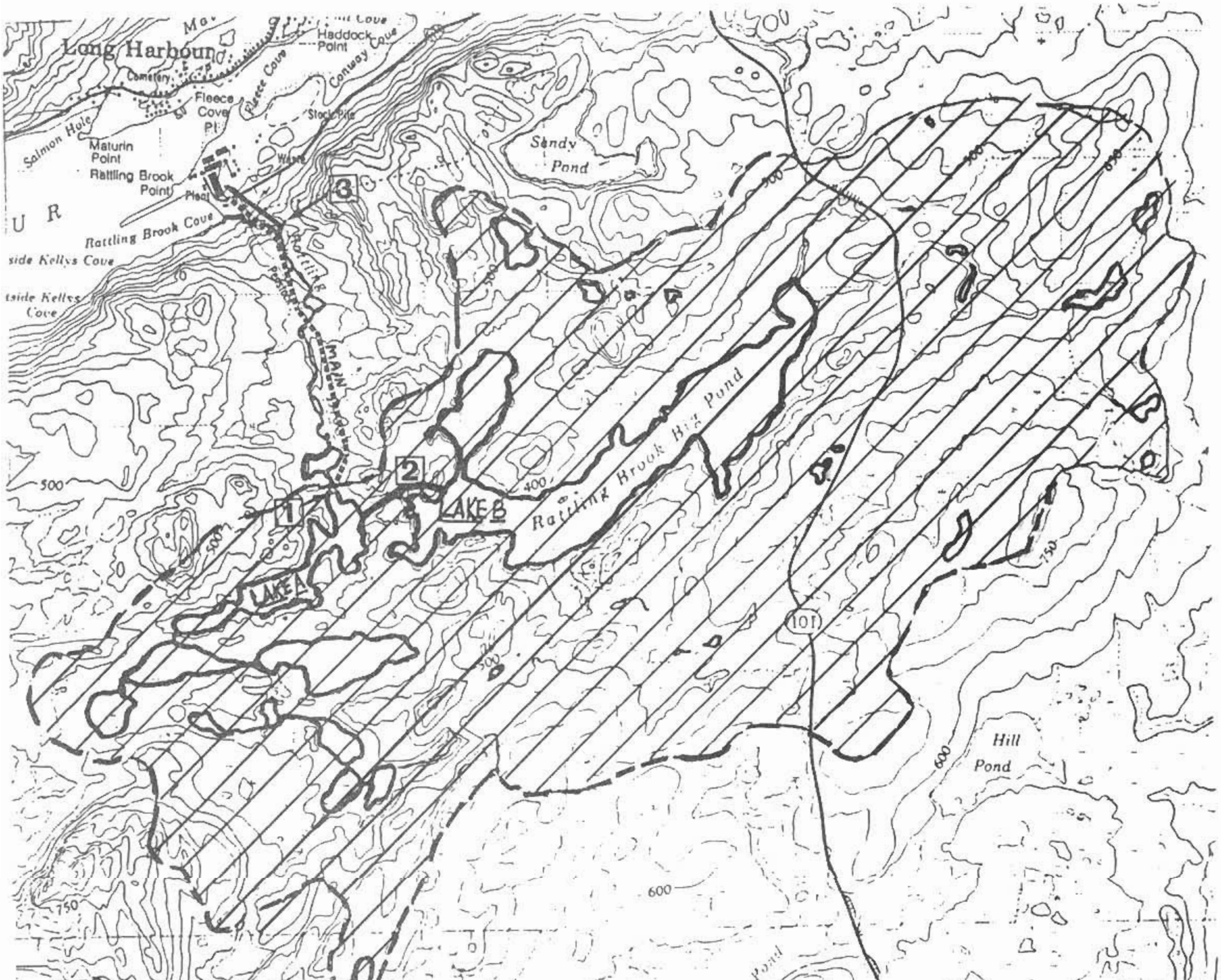
None.

FUTURE CAPITAL COST REQUIREMENTS (GOVERNMENT)

None.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

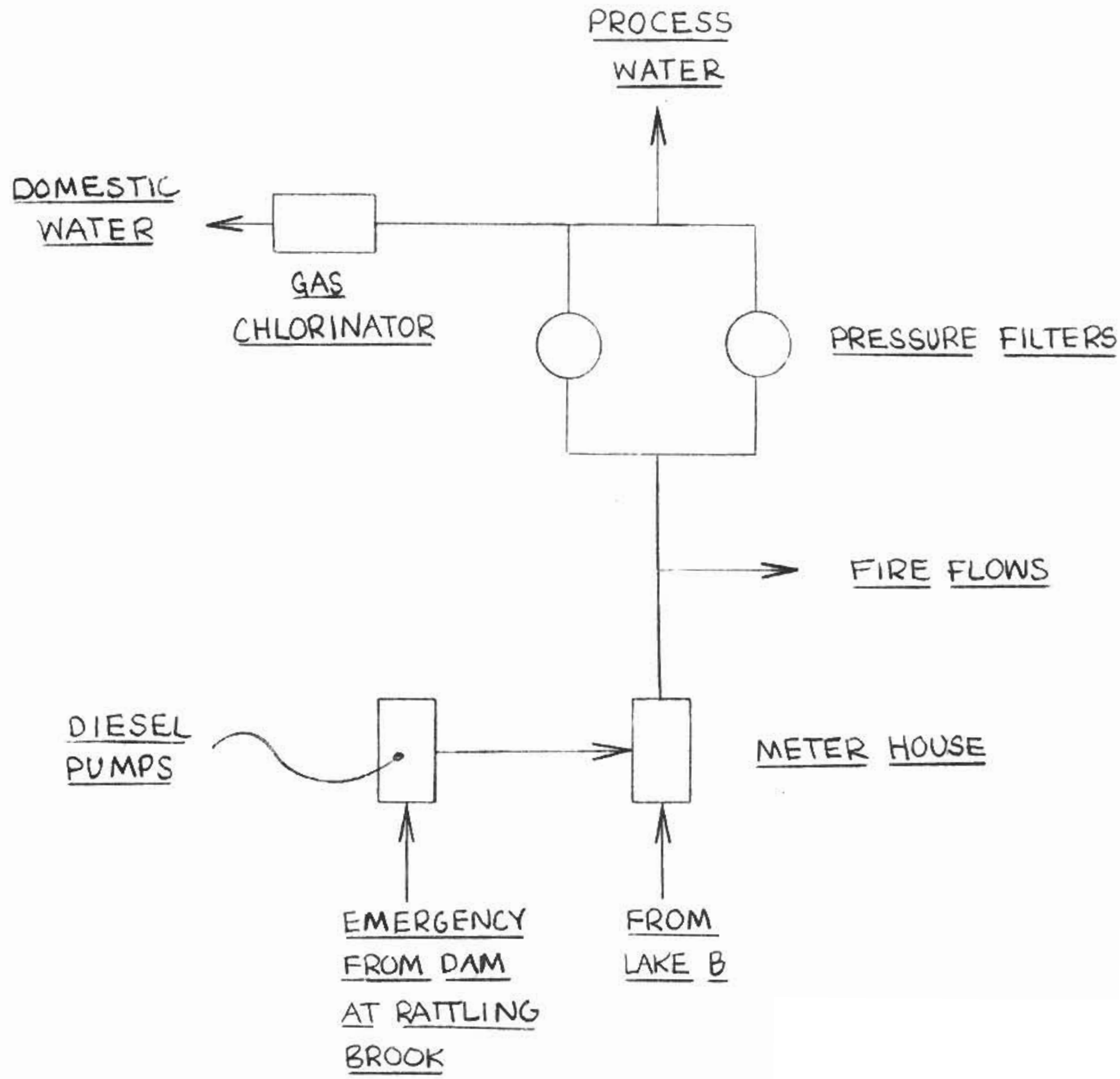
SCALE 1:50,000



ERCO PLANT, LONG HARBOUR

1. INTAKE
2. SIPHON
3. EMERGENCY SUPPLY DAM

Consulting Engineer: Colin Karasek Ltd. November 1987



ERCO PLANT

FIGURE 1

MUNICIPALITY - SURFACE WATER SOURCE

COMMUNITY OF LONG HARBOUR - MOUNT ARLINGTON HEIGHTS

Information:

Chairman of Council: James Nolan
Ed Bruce, Deputy Mayor
Report, Colin Karasek, P.Eng., January 1984
Tony Kelly, Department of Health

Population: 660 (1981) The water main through Long Harbour and Mount Arlington Heights is about 5 miles long.

Water source: Shingle Pond. Bait depot also has a line to the same pond.

Wells: No Council wells.

DEMANDS

Domestic: 120 houses are connected.

Commercial: Local stores.

Institutional: Church, parish hall, club, Town office.

Educational: Regional High School, 150 students.

Industrial: Community stage, 38 mm line; bait depot 100 mm line.

Metering: Meter in chlorination building. 1 m^3 per revolution generally takes 2 mins 38 secs in late 1983 (according to the operator, Mr. Power). Indicated flow 6.3 L/s (83 Igpm).

Wastage or losses: The metered flow, in comparison with the flow *obtained from empirical household consumption data, suggests high* unit consumption or losses; say 1 or 2 L/s for losses. (At that time the bait depot was served by a separate line, so that the meter did not record the consumption of the bait depot.)

Variations in demand: Normal.

Factors in future demand:

- About 60 houses have private wells and could become connected in the future.
- No major growth is expected.
- Bait depot could require up to 4 L/s.

SUPPLY

Shingle Pond, a shallow natural pond in an isolated area, originally less than 1.5 m deep, which has been raised about 400 mm by a dam. The watershed is steep sided, wooded, and has a second feeder pond.

Status of watershed protection: Unprotected according to records.

Dam: Berms of local glacial till have been pushed up along the south and westerly part of the pond to raise the water level.

Spillway: Main spillway; dimension lumber with opening about 1800 x 550 mm at the outlet brook. Flood spillway; in a very large flood the water would overflow the pond into an intermittent brook on the south side of the pond. This spillway is of rip-rap through the berm. The spillway is about 1500 mm wide.

Intake: 150 mm PVC pipe which connects to a corrugated steel pipe set vertically with a coarse screen across the top open end. Installed about 1978.

Screen: Water is screened under pressure in a fitting in the chlorination building through a screen with holes about 3 mm diam. The screen is removed and cleaned about every two weeks.

Adequacy of supply, summer 1987: The water level dropped but the supply held out.

STORAGE/DEMAND

Live storage head: About 0.9 m from spillway level to top of intake. The spillway in the main dam discharges after heavy rain but frequently does not discharge.

Ways to increase live storage: (1) Lower the intake; (2) use Trout Pond by pumping into a shallow ditch to be dug about 100 m long from Trout Pond to a ravine which runs into Shingle Pond. Or dam the outlet brook to Trout Pond so that the flow can run by gravity; (3) investigate the capture of a brook and pond to the northeast by means of a ditch to Shingle Pond.

WATER QUALITY:

Bacteriological: Dept. of Health, Whitbourne. A satisfactory chlorine residual has not been achieved since November 1987. Boil order requested summer and fall 1987.

Chemical: Tested Feb.2/88. Before chlorination, colour somewhat high at 40 units. Iron at 0.9 mg/litre is well over the recommended maximum of 0.3 mg/litre. After chlorination the colour test reduced to 25 units and iron to 0.11 mglitre. Thus chlorination greatly improved water quality.

Problems: In recent months the screen has been clogging up more frequently and the chlorine demand has increased. No chlorine residual has been achieved in the last few months, indicating that a higher chlorine dosage is needed. Possibly this is due to a higher load of organic particles which can support bacteria growth.

WATER TREATMENT

Chlorination: Javex solution is used. The chlorination building contains a pressure gauge, flow meter, and basket screen. Recently improvements have been made to the chlorination system to overcome the problems mentioned above.

Problem: There is no access road to the chlorinator, which makes operating the plant more difficult.

TRANSMISSION AND DISTRIBUTION

Main line from Shingle Pond is 150 mm diam PVC. This runs via the chlorinator across the bed of Maturin Pond through Long Harbour and on to Mount Arlington Heights. Mount Arlington Heights is about 1.5 km separated from Long Harbour.

The bait depot has a 100 mm line from Shingle Pond. However, this line is now served by the Town's intake.

Transmission line problems: About 150 m from the intake the 150 mm diam. supply line starts to drop rapidly down a hillside. At this point a vacuum situation has probably occurred under high flows, which has led to air locks in the pipe. When this happens, water has to be pumped from Maturin Pond into the pipeline at the chlorinator with the downstream valve closed. The water is pumped up the pipeline until the air is driven out at the intake.

Raising the pond level in 1984 alleviated this problem, but it has re-occurred recently.

Factors in system replacement cost estimate:

- Low dams of earth, spillways
- 150 m diam. PVC transmission main
- Chlorinator
- 130 connections

COMMENTS/PROBLEMS

1. Live storage should be increased by lowering and redesigning the intake.

2. Air lock problem should be eliminated by using larger diameter pipe for the first 160 m out of the pond.

3. Better screening for the raw water.

4. Access road to the chlorinator.

FUTURE CAPITAL REQUIREMENTS

1. To cure the air lock problem. Build 160 m of new 200 mm or 250 mm diam. water main on 0.7% grade to connect with the existing 150 mm pipe. Instal a standpipe at the junction of the 150 mm and new mm pipe.

2. The intake site could also be excavated so that intake could be lowered to increase live storage.

3. In conjunction with this a screening system should be built.

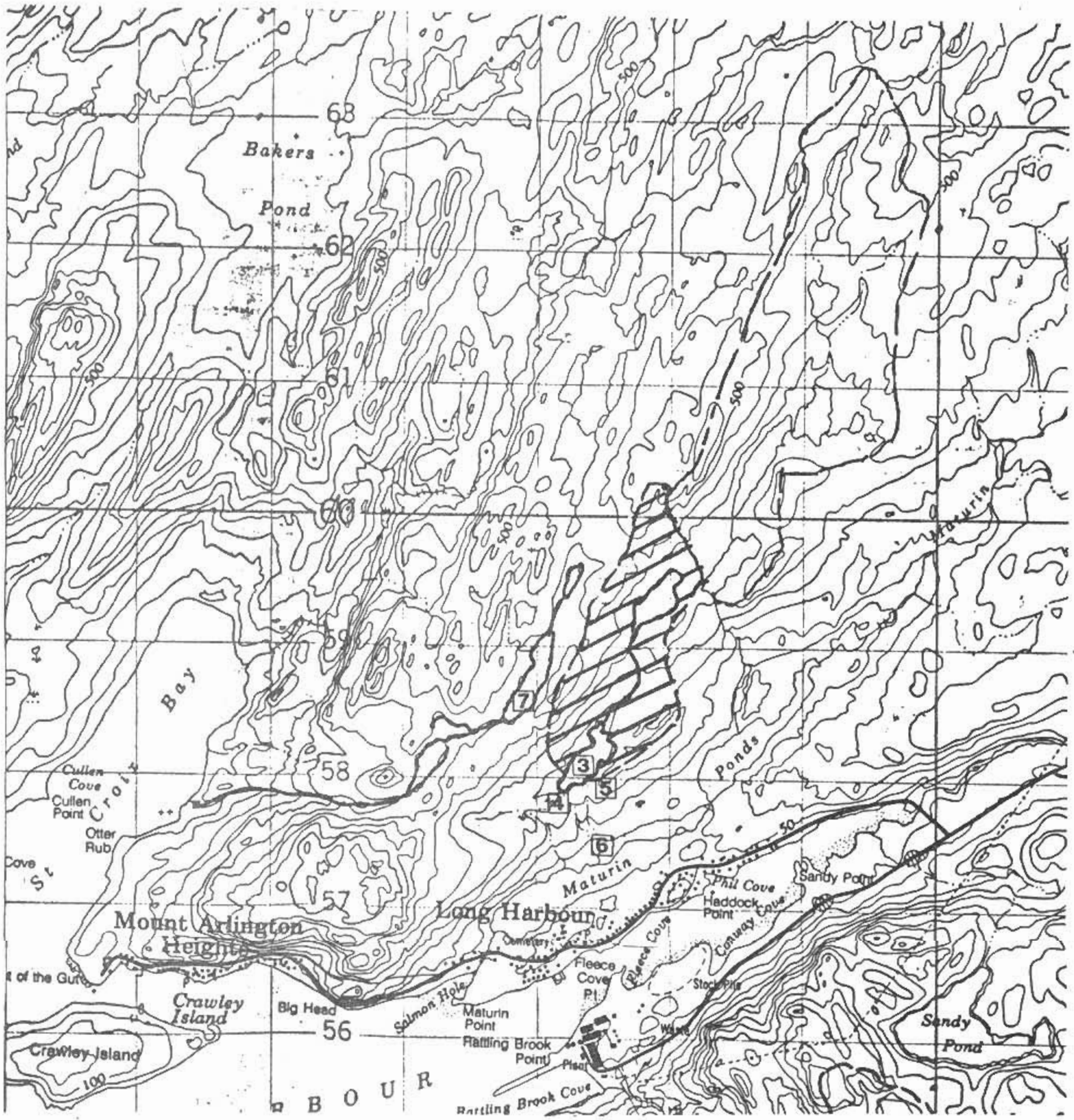
   Cost of 1, 2 and 3 about $70,000.

4. Access road to chlorinator: $15,000

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

3. Shingle Pond
4. Dam
5. Intake
6. Chlorinator
7. Trout Pond

Consulting Engineer: Colin Karasek Ltd. January 1988

MUNICIPALITY - SURFACE WATER SOURCE

LSD OF NEW CHELSEA - LEAD COVE

Also includes communities of Brownsdale, New Melbourne and Sibley's Cove.

Information: Clyde Button, Vice Chairman of LSD.

Water source: Sibley's Cove Pond. Pumped system serving Sibley's Cove and Lead Cove. Other user of the pond is the fish plant.

Wells: No Council wells. New Chelsea, Brownsdale and New Melbourne are served by private wells.

DEMANDS

Domestic: About 80 homes in system.

Other: Local stores.

Metering: Not metered.

Wastages or losses: None reported.

Variations in demand: Normal.

Factors in future demand: (1) About 10 more homes could connect to present system; (2) In Brownsdale about 65 homes could use the pond as a source, but this would be a separate system (Clyde Button). The Regional High School in Brownsdale, 200 students, could also be served by such a system.

SUPPLY

Sibley's Cove Pond, with an isolated watershed. Reported as over 6 m deep in places.

Dam: No dam.

Spillway: Natural brook.

Intake: Submersible pumps on a steel rack about 30 m into pond with 50 mm discharge line. This discharge runs through a chlorinator near the shoreline and up a hill to a gravity storage tank.

Screens: Basket screen on chlorinator.

Status of watershed protection: Protected.

STORAGE/DEMAND

Live storage head: Normal pond level to top of pump; about 1.0 m.

Adequacy of supply in summer 1987: Outlet brook ceased to flow but there was sufficient storage in the pond to carry through.

WATER QUALITY

Bacteriological: Dept. of Health, Harbour Grace. Generally satisfactory disinfection.

Chemical: No tests data readily available.

Problems: Bad taste in water, said to be due to algae after ice break-up. In hot summers this problem often recurs in late summer.

WATER TREATMENT

Chlorinator, activated by pump. The chlorinator building is located near the edge of the pond.

TRANSMISSION AND DISTRIBUTION

Pump: Submersible pump in pond, 3.5 hp, controlled by a pressure switch in the chlorinator building.

Storage tank: Located at ground level about 500 m from the chlorinator. Includes two 4500 L capacity gravity tanks in a building. The tank is "in-line" with inlet flows controlled on-off by a float valve. System started about 1972.

Control: A drop in the tank WL lowers the float valve and reduces line pressures back to the pump pressure switch to start the pump. After the WL rises in the tank the float valve closes so that the line pressure to the pressure switch increases, shutting off the pump.

Distribution: Covers Lead Cove and Sibley's Cove. Mains are 100 mm and 75 mm diam. About 460 m of main and 12 connections replaced during highway reconstruction recently.

COMMENTS/PROBLEMS

Relocate pump: Plans are under consideration to provide an arrangement so that the pump will be housed on shore and therefore accessible for maintenance. This has been a problem in the past with the pump under water or ice.

Higher pressures needed: With the stretched-out system the line losses are high on occasion, leading to low pressure in some areas. This problem is exacerbated by the fact that buildings are on ground almost as high as the tank so that the initial static pressures are low in any case.

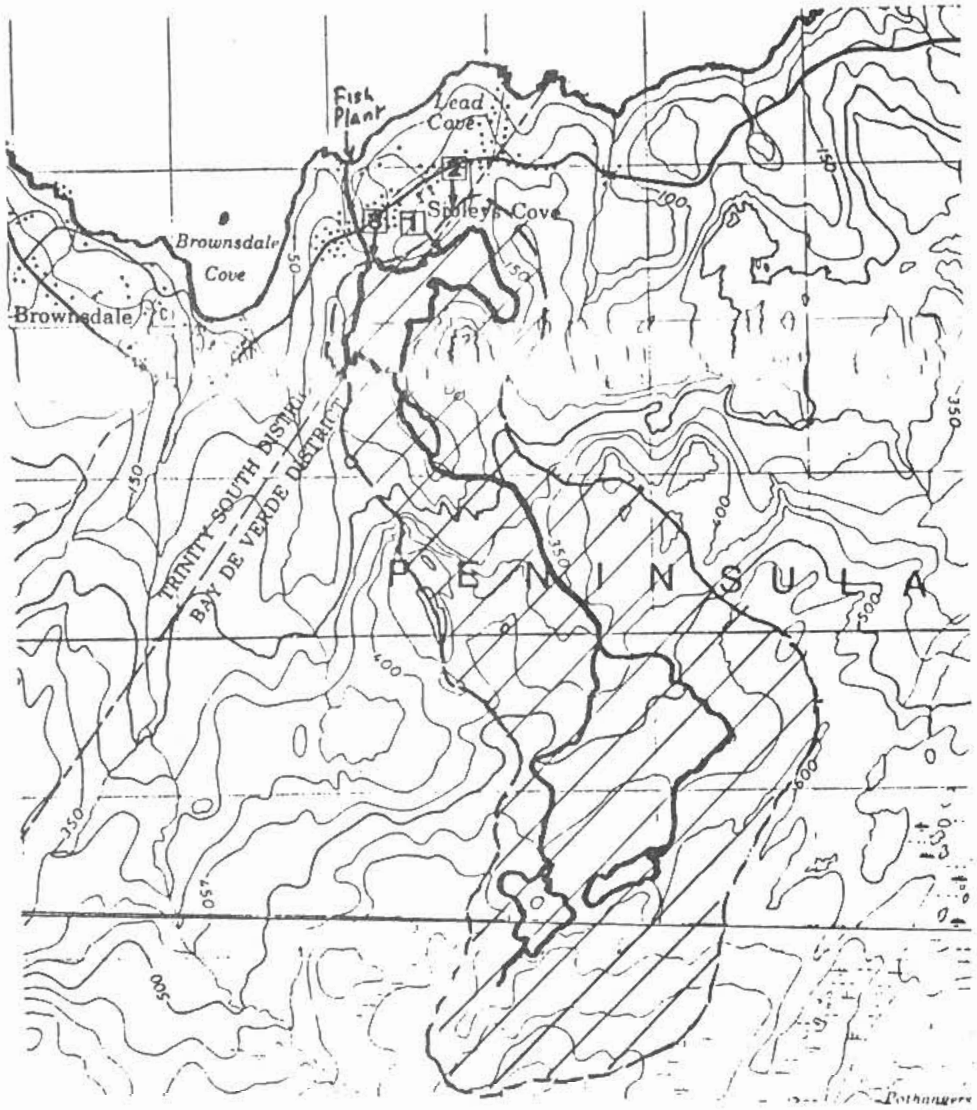
Service Brownsdale: A population of several hundred could be served by mains water.

FUTURE CAPITAL COSTS

Could be extensive. See "Comments" above. No detailed information available. Say $500,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



SIBLEYS COVE POND

1. INTAKE, CHLORINATOR, DOMESTIC SERVICES
2. TANK, DOMESTIC SERVICES
3. INTAKE, FISH PLANT

Consulting Engineer: Colin Karasek Ltd. November 1987

INDUSTRIAL USE - FISH PLANT SURFACE WATER SUPPLY

LOCAL SERVICE DISTRICT OF NEW CHELSEA - LEAD COVE

FISH PLANT LOCATED AT SIBLEY'S COVE

Information:
Willis Spurrell, Earle Bros. Fisheries Ltd.
Clyde Button, Sibley's Cove LSD

Water source: Sibley's Cove Pond. Gravity flow. Other user is the LSD for domestic purposes.

Owner of water system: Earle Brothers Fisheries Ltd., Carbonear

DEMANDS

Current: Fed by 100 mm line from the pond to the plant. No metering. The plant carries out initial processing of fresh fish (no freezer), stores salt fish. Employs 60 to 70 people in season; June, July and August. The plant also has 50 mm line to the wharf for the use of vessels. No salt water line (seas too rough). Volume of fresh water available at the plant is limited on account of the restricted gravity head available in conjunction with the relatively small size of the line (100 mm diam).

Future demand: May increase if bigger line is installed or booster pumps used.

SUPPLY

Sibley's Cove Pond.

Intake: This is located near the outlet brook in rather shallow water. When the pond dropped in the summer of 1987 the line had to be extended.

STORAGE/DEMAND FACTORS

Live storage head: About 0.9 m.

Ways to increase live storage: Build intake into deeper water.

WATER QUALITY

Satisfactory. Tested by Department of Fisheries.

WATER TREATMENT

Chlorination in the fish plant.

TRANSMISSION

About 700 m of 100 mm PVC line.

COMMENTS/PROBLEMS

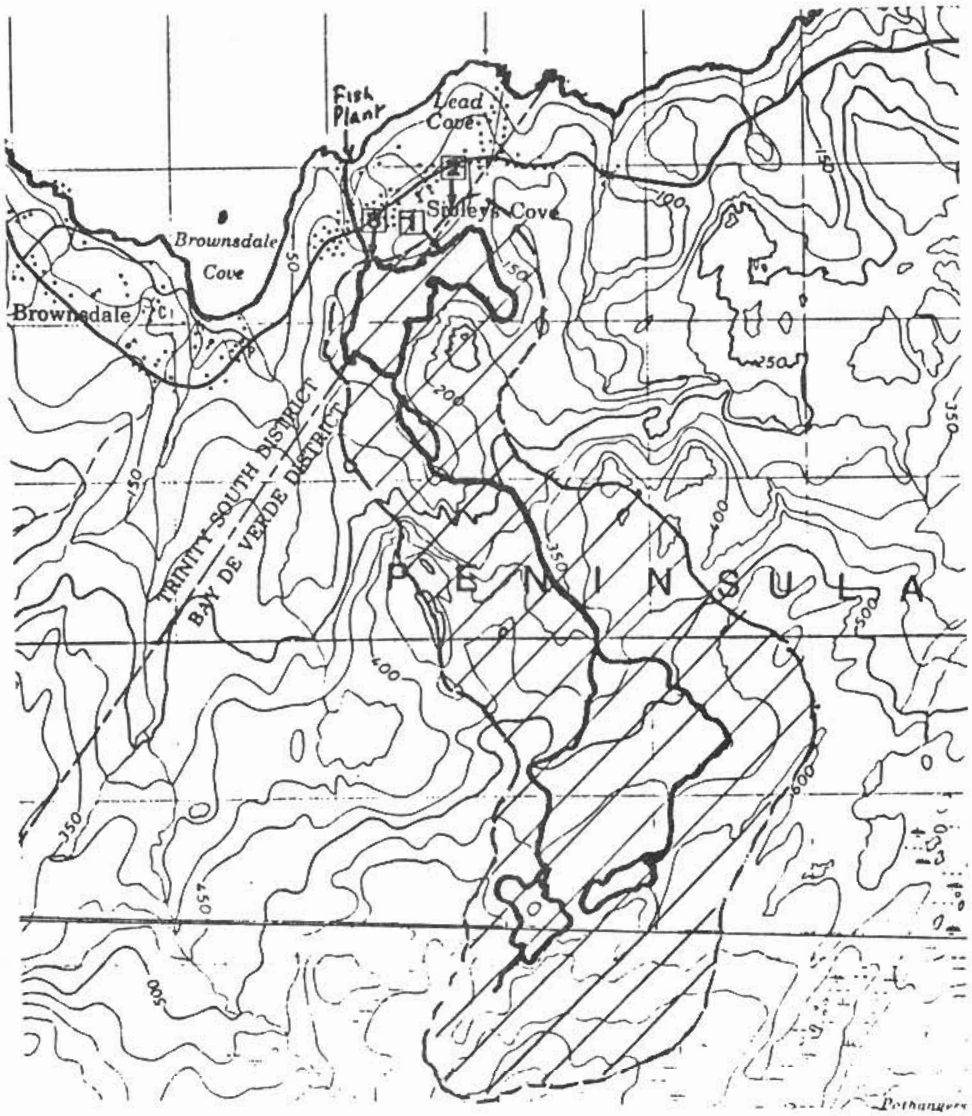
The pond elevation is about 32 m. Assuming a residual pressure in the plant of 14.1 m of water (20 psi) the maximum available flow is about 14.5 L/s (230 US gpm). The plant would prefer a greater flow.

FUTURE CAPITAL REQUIREMENTS (GOVERNMENT)

Nil.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



SIBLEYS COVE POND

1. INTAKE, CHLORINATOR, DOMESTIC SERVICES
2. TANK, DOMESTIC SERVICES
3. INTAKE, FISH PLANT

Consulting Engineer: Colin Karasek Ltd. November 1987

INDUSTRIAL USE - FISH PLANT SURFACE WATER SUPPLY

NEW HARBOUR

Information:
Uday Shah, P.Eng., Dept. of Municipal Affairs
Cecil Reid, Local plant operator
Colin Karasek, P.Eng.
Gerry Healey, CET, Dept. of Municipal Affairs

Units served: Two fish plants, Higdon and Woodman plants, in New Harbour.

Water source: Pumping from the Broad Cove River. Upstream the river is also used by the Dildo pumping system. Otherwise no other known user, except probably summer cottages on the upper watershed.

Owner: Department of Municipal Affairs

DEMANDS

Industrial: Two fish plants in New Harbour which rely also on salt water lines. The plants meet their requirements with fresh water, with the balance made up with salt water.

Metered Consumption Records: Meter readings are taken at each fish plant for billing purposes. Total consumption is also metered at the pumphouse.

Variations in demand: These are considerable depending upon whether or not the plants are in processing operation. Based on DMA data used for billings: Maximum, December 1987, 1497 m^3/d; minimum 49 m^3/d. Average FY 1986/87: 701 m^3/d.

Wastage or losses: None known in system.

Metering: Metering on main pumping station and at each plant.

Factors in future demand: The limit of supply to the plants has been reached in terms of pipe capacity. However, a domestic demand can be anticipated some time in the future, in addition to industrial demand. To accommodate increases in demand the supply system will have to be increased.

SUPPLY SOURCE

A portion of the Broad Cove River, about 30 m wide, 4 m deep at the intake.

Description of watershed: The watershed is large, say 100 sq. km, with no development apparent except for a few summer cottages on some of the higher ponds.

Status of watershed protection: Not protected.

Dam: No dam.
Intake pipe: PE pipe, 900 mm diam, length 45.3 m, open ended pipe, with coarse screen held by a rock filled timber crib.

Screen chamber: Two screens with an exposed gantry for lifting.

Adequacy of supply summer 1987: Local observers say this was the lowest the river has been seen in the lifetimes of most local inhabitants. Stream dropped about 0.9 m below normal. Remaining live storage head about 0.9 m over the top of the intake pipe. (Cecil Reid, Dept. of Municipal Affairs plant operator for New Harbour and South Dildo)

STORAGE/DEMAND FACTORS

Live storage head: Normal WL to top of intake pipe 1.8 m (from design drawings, Karasek). The live storage head at any time depends upon the water level in the river, and is not dependent on how much volume of water is withdrawn. The flow of river water is vast as compared with the pumphouse water consumption.

Ways to increase live storage: Dam river to prevent dropping too low.

WATER QUALITY

Bacteriological: Testing, Dept. of Fisheries. After simple chlorination the water is free of coliforms and a chlorine residual of 0.3 ppm is maintained to the plants.

Chemical: Quality is suitable for fish processing. Colour slightly high at 30 units.

Problems: The water prior to screening often contains numerous small green particles of vegetation. No problems reported with water quality.

WATER TREATMENT
Chlorinator. For higher flows there is a flow paced chlorinator. This is governed by a signal responding to the rate of flow in the discharge line. (Rockwell meter). For low flows there is a fixed rate chlorinator.

TRANSMISSION AND DISTRIBUTION

Pumps: A staged continuous pumping system. The pumphouse near the river includes a battery of four vertical turbine pumps drawing from a wet well (Synchro flow type system).

Pump #	1	2	3	4
Capacity L/S	1.89	11.86	15.77	15.77
HP	5	20	25	25

Pump 1 cuts out when any of the other pipes cut in. Conventionally such continuous pumping systems have had two or three pumps. The smallest pump, Pump #1, was designed as an energy conservation measure to be used on its own during the frequently extended low demand periods.
Construction of pumphouse completed in 1966. This replaced a smaller pumphouse.

Transmission mains:
Main line. 250 mm diam. length 213 m
200 mm diam. length 1720 m

The system then branches:

Higdon Plant	150 mm main, length 976 m
Woodman plant	200 mm main, length 107 m
	150 mm main, length 503 m

Total length of main: 3519 m

Pipes are Class 52 DICL (Ductile iron cement lined).

The system includes fire hydrants.

Disused pressure filters: About 213 m downstream of the pumphouse there is a building which houses a battery of six pressure filters. These include granular carbon in the media and were intended to dechlorinate the water after a bacteria kill had been completed by a large chlorine dose. In the original design no provisions for rechlorination were made. Subsequently this was taken care of by a modification in the piping, which bypassed a part of the chlorinated water around the filters. However, the chlorination process works satisfactorily without using the filter plant.

FACTORS IN REPLACEMENT COST ESTIMATE

Pumphouse and intake	$500,000
Transmission mains, hydrant	$500,000

COMMENTS/PROBLEMS

This system may ultimately be converted to a gravity tank system. The Department of Municipal Affairs has already purchased the land for the tank. The pumphouse controls will need to be modified from synchro flow to telemetering from the tank water level.

Domestic needs could be served if the tank system were installed, but pumps would need to be enlarged.

Potential population that could be connected to existing piping: 500 persons.

With new branch lines the system could serve New Harbour and Dildo north. No population count is available. Say 1500 people.

FUTURE CAPITAL REQUIREMENTS

- Improve pumphouse and instal storage tank.
- Distribution system to Dildo and New Harbour.

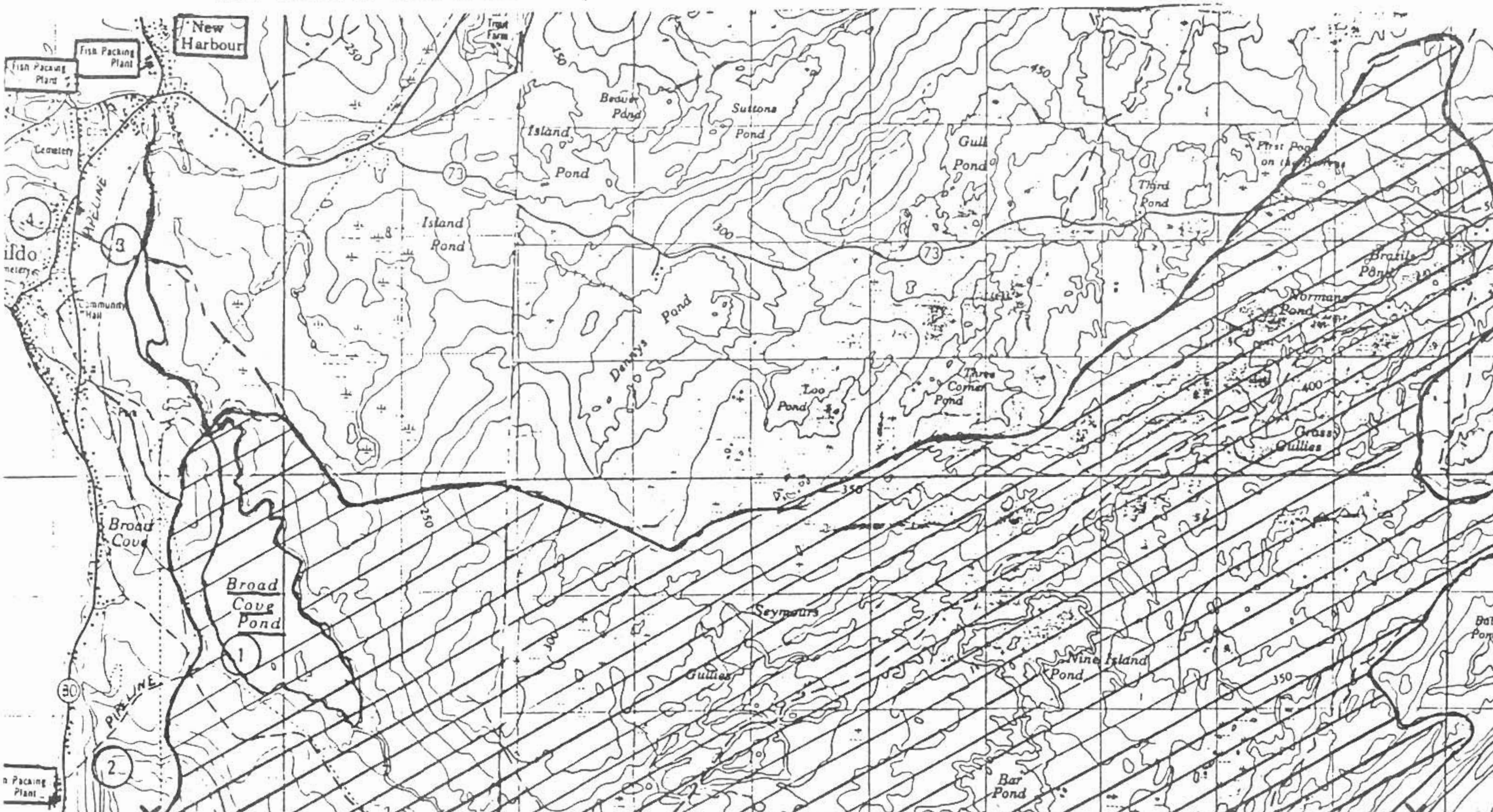
REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

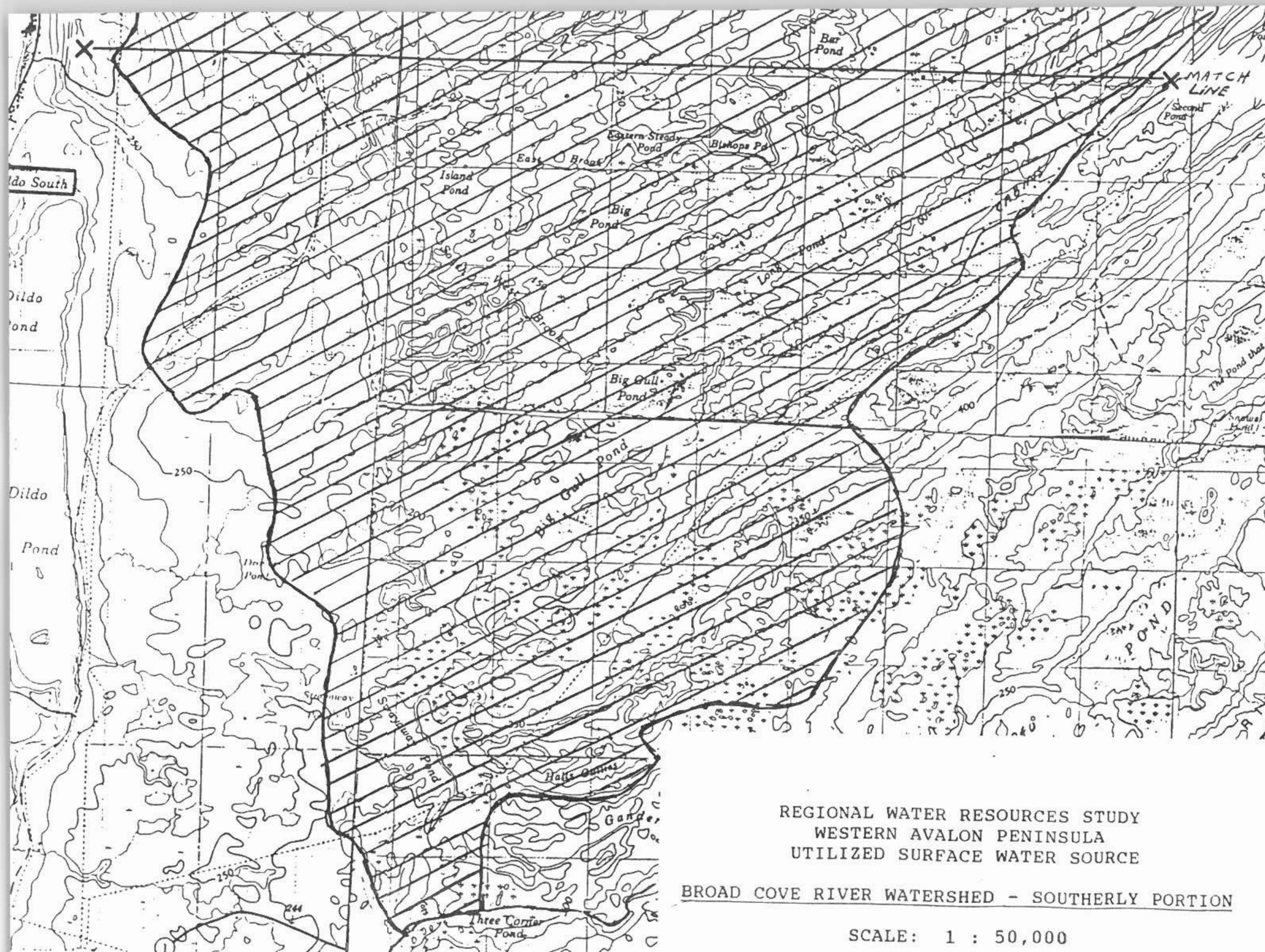
BROAD COVE RIVER WATERSHED - NORTHERLY PORTION

SCALE: 1 : 50,000

LEGEND

1. Intake and Chlorinator, Dildo South Pumphouse
2. Gravity Storage Tank, Dildo South
3. Intake and Chlorinator, New Harbour Pumphouse
4. Future Storage Tank, New Harbour Pumphouse





REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

BROAD COVE RIVER WATERSHED - SOUTHERLY PORTION

SCALE: 1 : 50,000

MUNICIPALILTY - SURFACE WATER SOURCE

TOWN OF NEW PERLICAN

Information:
Councillor Dennis Smith, Council employee
Town Foreman: Sam Burrage
Town Clerk: Diane Smith

Population: 350 (1981)

Water Source: Mount Misery Pond. Town is sole user. A gravity system.

Wells: No wells used by Council.

DEMANDS

Domestic: Virtually all of the community is served. Abvout 250 to 300 houses.

Commercial: A few local stores.

Educational: No schools.

Industrial: No industrial demand. (Fish plant, packing squid, has been inactive for five to six years.)

Wastage or losses: No excessive leaks reported, or tap bleeding in winter.

Metering: No metering is carried out. Estimated consumption 25,000 gpd (figure provided by Town Foreman from metered readings taken about five years ago).

Variations in Demand: None reported.

Factors in Future Demand: Slight population growth. Possible reactivation of the fish plant. Most of town has main sewage collection and disposal.

DESCRIPTION OF SUPPLY SOURCE (main source, no back-up source)

Mount Misery Pond. A natural pond in a remote area.
The watershed area is well defined with slight slopes and covered with vegetation of trees and scrub. There are no feeder brooks. The outlet brook (on the far side of the pond from the intake) dwindles considerably in flow in summer.

Status of watershed protection: Protected.

Dam: There is no dam on the outlet brook.

Intake: A new intake pipe, 457 mm PE ,was installed in 1984. This carries the intake pipe on a support about 3 m above the bottom of the pond and 1.8 m below normal pond surface. Maximum observed drawdown, summer 1987, was to about 0.7 m above the top of the intake pipe.

Screens: The water passes into a screen chamber with a wood frame building about 2.5 m x 3.5 m near the pond. There is one screen in place at a time. The screens are cleaned and replaced about once every two months.

STORAGE/DEMAND FACTORS

Live storage head: 1.8 m (normal pond elevation to top of intake pipe, estimated).

Ways to increase live storage: There is no way to significantly increase storage volume, except perhaps a few centimetres by a dam on the outlet brook (this was not investigated).

WATER QUALITY

Bacteriological: Lab., Dept. of Health, Harbour Grace. No problems reported with bacteriological quality after treatment.

Chemical: Test May 15/86. Apparent colour 50 (recommended 15 maximum)., pH 5.7 (recommended 6.5 - 8.5). "Colour is high, pH is low. Supply tends to be corrosive but is generally acceptable for consumption."

Problems with water quality: For about two or three months each year the water has a bad colour (reddish) and a bad taste. This could be due to seasonal algal growths or to wind induced currents bringing up the bottom waters. A report by Marlene Hooper, MUN Cehmistry Department, May 15/86, states: "The bottom mud was inspected and found to contain numerous empty filaments of crensthusc polypora, an iron bacterium. There were probably killed when the pond was drained. The red discolouration is the oxidized iron in the bacterial sheaths."

When the intake was being installed, the residents used water from New Perlican River which they found to be of good quality.

WATER TREATMENT

Chlorination. The present chlorinator is a fixed feet rate solution type using calcium hypochlorite liquid, 65%. This chlorinator was installed during early 1987. The system is maintained by the Town Foreman. The original system was probably variable input, controlled by a water meter.

TRANSMISSION AND DISTRIBUTION

An all-gravity system, built 1972-73. The main line to the town is 200 mm iron pipe, installed about 1973. Distribution mains are 200 mm and 150 mm iron, with fire hydrants. No air lock or other problems are reported with the system. There is about 640 m of main between the screen and chlorinator and a further 525 m to the first house (auto speedometer and 1:50,000 map sheet).

FACTORS IN REPLACEMENT COST ESTIMATE

- intake
- screen building
- chlorination building
- transmission main 1165 m, 200 mm diam DI
- access road
- 280 connections

COMMENTS/PROBLEMS

The main problem is poor water quality during two or three months a year. The Town has requested a study from the Department of Municipal Affairs to look at the problem and feels that the New Perlican River would be a good source.

The New Perlican River could provide a gravity source from some distance upstream, or a pumped source from Beaver Pond on the river. (See topo sheet)

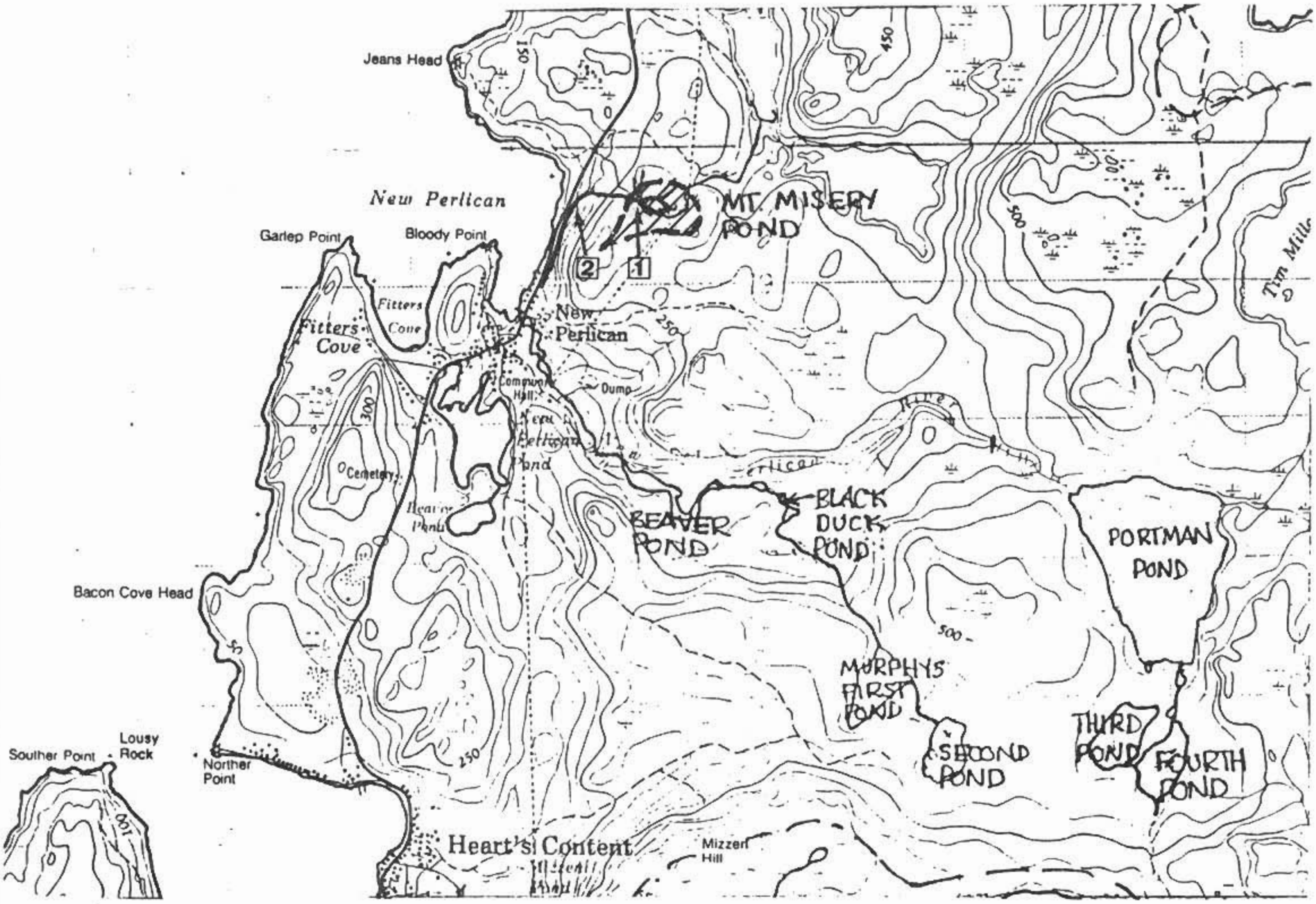
An alternative would be to treat the water from Mount Misery Pond when needed.
Since the distribution is metal pipe, the corrosion potential of the water should be investigated, and buffered if necessary.

FUTURE CAPITAL REQUIREMENTS

Improvements to water quality. $100,000 to $500,000

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF NEW PERLICAN

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

<u>SURFACE WATER SUPPLY SOURCE - OPERATED BY THE DEPARTMENT OF MUNICIPAL AFFAIRS (DMA) FOR THE TOWN OF OLD PERLICAN AND INDUSTRIAL USE</u>

<u>Information:</u>

Judy Barter, Town Clerk
Morley Bufton, System Maintenance (DMA)
Harvey Button, System Maintenance (DMA)
Gerald Healy, CET (DMA)

<u>Population of Municipality:</u> 709 (1981), 761 (1986)

<u>Water Source:</u> Big Bell Pond, a much enlarged natural pond. The DMA is the sole user.

<u>Management:</u> The system manager is the Department of Municipal Affairs (DMA).

<u>Charges for water:</u> Charges for water delivered are based on consumption. The Town currently pays 35¢ per 1000 gal. for the treated water supplied by the Department of Municipal Affairs. Typical cost $670.00/month for the water plus O and M costs for the distribution network by the Town.

<u>DEMANDS</u>

<u>Domestic:</u> 250 houses approximately, including about 15 summer homes.

<u>Educational:</u> Elementary school, 150 students.

<u>Commercial:</u> Local and local regional needs.

<u>Industry:</u> Two large fish plants. These operate year-round, depending on whether or not fish is available.

<u>Hospital:</u> Regional hospital.

<u>Meter readings:</u> Water is metered at five locations: (1) total consumption at the treatment plant; (2) for the Provincial Hospital; (3) for the Ocean Harvest Plant; (4) at the fishermen's wharf; (5) for Quinlan's fish plant. However, the main meter at the plant is not used to arrive at the volume for which user charges are made. Billings are made on the basis of meter readings, Meters 2, 3, 4 and 5 plus an estimate for the Town based upon per capita consumption. The main meter is either reading too high, or else there are excessive leaks in the AC main transmission line. The meter has been checked so the officials believe that leaks might be the problem.

Wastage and losses: Not certain; might be considerable. See above.

Variations in demand: Mainly caused by operating/non-operating of the fish plant.
Low month, December 1986, 281 m^3/d; high month July 1986, 2262 m^3/d. Average daily consumption for FY 1986/87; 971 m^3/d.

Factors in future demand:

- About 12 more houses to be hooked up to the water system.
- Sanitary sewer now serves all houses which have main water.
- No major population growth is expected.
- Future industrial demand depends upon the availability of raw fish. No plant expansion planned at present.
- Education and hospital. No significant changes are expected.

SUPPLY SOURCE

Big Bell Pond. This was enlarged to its existing volume by building a long main dam across the outlet brook, plus a side dam to prevent spillages.

Status of Watershed Protection: Protected.

Dams: Two extensive earth/rockfill dams with rip-rap wave protection. Main dam has length about 230 m, maximum height about 5 m and top width about 3.5 m. Secondary dam has length of 135 m (eyeball and as-built drawings).

Spillway: The spillway is a rectangular steel grate, about 1200 x 1200, which lies horizontal on the top of a draft tube located in the reservoir about 15 m from the crest of the dam. The draft tube connects to a 900 mm diam. culvert which runs through the dam to discharge into the original brook. Thus it is the elevation of the grate which establishes the maximum water level in the pond for normal conditions. After a dry spell in 1985/86 the draft tube was extended upwards about 1200 m so that it is now about 3 m above the horizontal culvert. (Information, Morley Button) The freeboard from top of dam to the grate at the top of the draft tube is now about 900 mm (eyeball, Karasek).

Intake: This is connected by a 250 mm diam., pipe and lies 108 m into the pond from the dam centre-line according to the "as-built" drawings 1968,FENCO. The depth to the intake below the spillway grate is not known exactly but is estimated at least 3.5 m. In the dry period of low water 1985/86 there was still about 2.5 m of water over the intake (Harvey Button). However, the pond surface area was much reduced, e.g. 50% of present surface area. The intake is probably a large concrete tube or box with a solid bottom and with coarse screens at the top or top of sides.

Screening: Screening takes place in the chlorination building which is about 180 m downstream of the intake (scaled from design drawing). The original screen which may have been the basket strainer type, was replaced in about 1969 with a rotating micro-screener because of an infestation of insects. The present screen is drum shaped, about 2 m long, and 1.5 m diam., and is driven by a motor to rotate on a horizontal axis in an open top tank. There were once ultraviolet lights to shine on the exposed top of the screen as it rotated, presumably to resist biological growths, but these lights have been inoperative for many years. The screens are automatically back-washed at frequent intervals. The system operates under gravity when running, but pumps are needed for start-up.

Adequacy of supply, summer 1987: Water level fell to about 2200 mm below the grate of the spillway (which had been raised about 1200 mm the previous year, see above, "spillway").

STORAGE/DEMAND FACTORS

Live storage head: According to the "as-built" drawings the elevation of the top of the intake structure is 1.88 m below the top of the supply main at the dam. Hence for non-siphonic flow the live storage head would be spillway grate to top of pipe through dam. No exact dimensions have been found for this but this head is probably about 2.7 m.

Ways to increase live storage: The dam could be raised and also the spillway. To raise the WL by about 600 mm may cost about $500,000.

WATER QUALITY

Bacteriological: Department of Health, Harbour Grace. No problems reported.

Chemical: No tests readily available.

Problems: The major problem concerns infestations of tiny insects in summer. Samples examined in 1982 revealed them as: Cladocera Daphina, Copepoda Daiptomas Minutus. The micro screen removes these.

WATER TREATMENT

Main chlorinator: Gas is used. This is a two stage flow device. At low flows a low dosage chlorine liquid flow tube is used. A flow increase triggers the use of the second flow tube, thus increasing the dosage. According to the operator this two stage chlorination system produces satisfactory levels of chlorine dosage, through the range of flows.

Standby chlorinator: This supplies a fixed rate of dosage and does not provide adequate chlorination at high flows.

TRANSMISSION AND DISTRIBUTION:

DMA: The DMA owns and operates the supply system and the 250 mm diam. main line of AC pipe up to the fish plants with a total length, starting from the dam, of about 2230 m.

Town: The Town system is of DI, and branches from the DMA AC pipe. The distribution system for the Town includes fire hydrants.

FACTORS IN REPLACEMENT COST ESTIMATE

Dams
Intake
Chlorination plant
Supply main

COMMENTS/PROBLEMS

Screen/chlorination bldg: There is no separated room for the operating chlorine cylinders. Although there is a storage room for cylinders awaiting use, the cylinders in use permit exposure of leaked gas to the operators, electrical equipment, etc. Also, the electrical panels are exposed to the damp air generated by the rotating screen drum, although this is probably less serious than the chlorine problem.

Spillway: There is no emergency (flood) spillway (or at least none was found in the brief survey carried out). The grate spillway is susceptible to blockages by floating debris. DMA officials report that the reservoir would overflow on the west side at a minor depression along the natural ground perimeter before the dam was overtopped.

Screen: Replacement parts for the screen system are reported as difficult to get.

Transmission line: This is probably leaking but should be checked to find out the leakage points.

FUTURE CAPITAL REQUIREMENTS

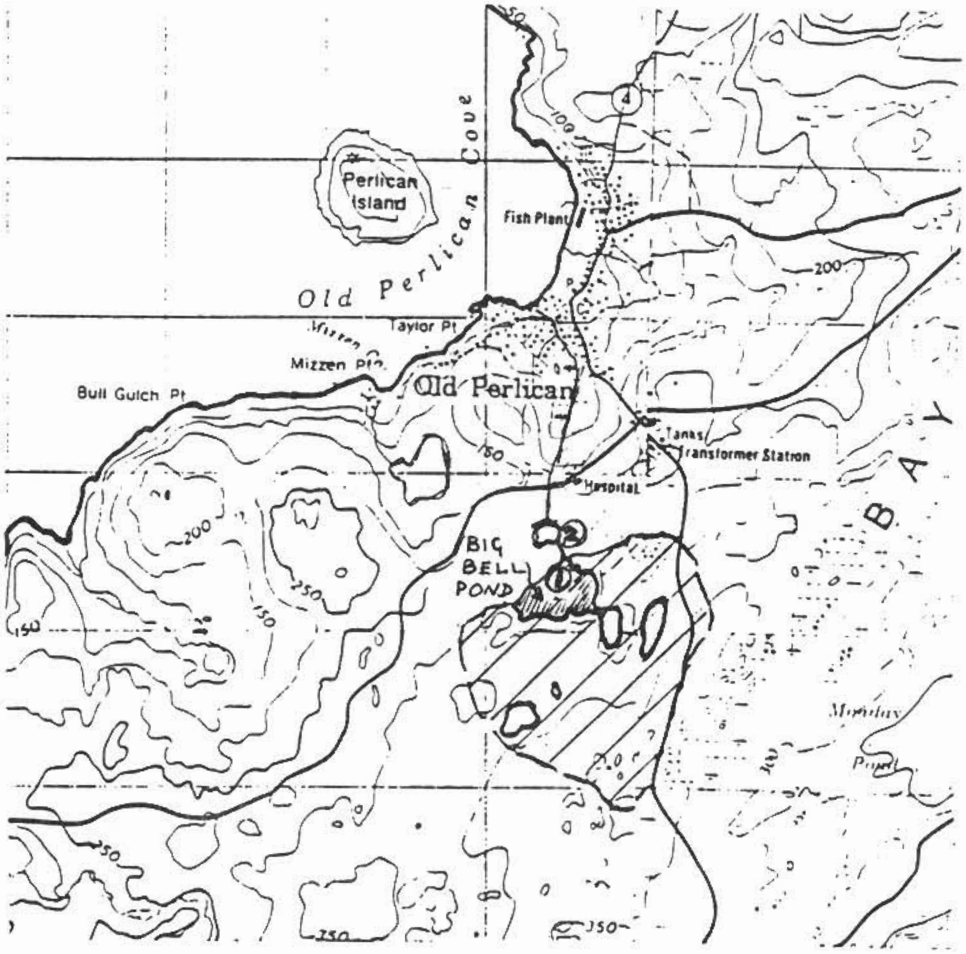
1. Build room for chlorination equipment so that only vacuum gas lines enter the main screen chamber. In the process it may be possible to provide a separate room(s) for the

electrical panels which could be kept warm to reduce damp. Cost: $25,000.

2. Replace AC transmission main with PVC. $600,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF OLD PERLICAN

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF PLACENTIA

Information:
Margie O'Keefe, Assistant Town Clerk
Robert Kennedy, P.Eng., DelCan

Population: 2204 (1981), 2276 (1987 census by Town) The Town is considered in two portions: Placentia Beach, the lower area, and South East Placentia, a higher area to the south of Placentia Beach.

Water sources:

Main source: Larkins Pond and Jerseyside treatment plant by gravity to Placentia Beach, thence pressure boosting to SE Placentia.

Standby source: Intake on Southeast River serves SE Placentia directly by gravity, and Placentia Beach by gravity through an automatic control valve located at the south end of the beach area.

Intertie of systems: The static water pressure in Placentia Beach at the control valve is about 35.2 m of water. On the Southeast Placentia side of the valve the pressure is about 73.9 m. The Southeast river intake at 74.7 m elevation is 32.9 m higher than Larkin's Pond. If water pressure in Placentia Beach drops below 31.7 m, the valve automatically opens to feed Southeast Placentia water into Placentia Beach. Hence water will feed to Placentia Beach if a heavy water demand occurs, e.g. for fire fighting, or main break in the underwater connection from Placentia Beach to Jerside and the Larkin's Pond source. However, the control valve is "normally closed". The Southeast Placentia pipeline is pressurized by booster pumps at the south end of Placentia Beach, using Larkins Pond water, to feed a storage tank at ground level near the Southeast River intake. *(From report by DelCan)*

DEMANDS, PLACENTIA BEACH

Domestic: About 350 connections.

Commercial: About 40 connections.

Educational: Two elementary schools (624 pupils). One high school (444 pupils). One vocational school (300 pupils). Total 1368 pupils.

Institutional: Nursing home, 75 residents.

Metering: No regular historic records. Regular metering is now possible at the treatment plant.

Wastage or losses: In Placentia in 1978, leakages were estimated at 7,860 m^3/day, but by late 1982 these had been reduced to about 1050 m/day through corrective action. (Report by DelCan Nov.1982)
Variations in demand: Historically the demand has declined because of the cutdown on leaks and wastage.

Factors in future demand:

- Not much space for urban expansion in Placentia Beach. Some commercial expansion expected.
- Searching for leaks and their elimination. Leaks are hard to find because the water is absorbed readily into the beach gravel subsoil. Hence a leak loss rate of about 1050 m^3/day may have to be accepted as a long term demand.

DEMANDS, SE PLACENTIA

Domestic: About 85 connections.

Other connections: Few.

Metering: No meter records.

Wastage or losses: None reported.

Variations in demand: No unusual variations reported.

Factors in future demand:

- There are about 75 homes on private wells. These may choose to be connected in the future.
- All new homes are obliged by Council to be connected to the mains. In the region this is the area that is expected to grow appreciably through residential development.
- No significant commercial or institutional demand is expected.

SUPPLY SOURCE AND WATER QUALITY, LARKINS POND

See "Jerseyside" and "Argentia".

SUPPLY SOURCE, SOUTHEAST RIVER.

Run-of-river supply; no storage.

Intake: In river bed.

Watershed protection: Protectfed. Watershed includes a highway.

<u>Screens:</u> In a building near the intake.

WATER QUALITY AND TREATMENT, SOUTHEAST RIVER

<u>Bacteriological:</u> Dept. of Health, Whitbourne. No problems reported.

<u>Chemical:</u> The raw water is of poor quality. It is potentially corrosive to metal pipes (Langelier Index - 6.4, - 7.7). Rainfall causes the colour to increase considerably, e.g. 52 units to 130 units. Iron content is high (0.36 and 0.65 mg/L).

<u>Water treatment tests:</u> (Pollutech Report, Oct.1982). This was a series of tests for various chemical treatment procedures. These tests indicated that the iron content of the water could be removed and the colour improved only by raising the pH of the water to 12. This was achieved in the tests by a chemical dosage of 1000 mg/L of 80/20 lime/soda mixture. ($Ca(OH)_2$, NA_2 CO_3)

The cost of purchasing these chemicals, for water to supply all of Placentia was estimated by DelCan at $528 per day. Hence, improving the quality of Southeast River water by chemical treatment is deemed prohibitively expensive.

<u>Chlorination:</u> A gas chlorinator is housed in a building about 1300 m downstream of the intake. If the Southeast River supply is actively in use, then the chlorinator is started manually.

TRANSMISSION AND DISTRIBUTION

<u>Transmission main from Jerseyside plant:</u> Two pipelines each 200 mm diam CI lead from the treatment plant down the hill through lower Jerseyside to Placentia Gut. These lines serve connections in Jerseyside. A single submarine line of 200 mm PE pipe crosses Placentia Harbour to connect with the DI network in Placentia Beach.

<u>Transmission main from Southeast River source:</u> From the source to booster pump, Placentia Beach, length 10,000 m 300 mm diam DI. Houses are served along the way.

<u>Pumps:</u> The pumping station to serve Southeast Placentia has two pumps in parallel, each 7.6 L/S. These pumps are controlled by the water level in the storage tank near the Southeast River. A radio beam signal is used.

<u>Storage tank:</u> This is a ground level tank of reinforced concrete, capacity 341 m^3.

FACTORS IN SYSTEM COST REPLACEMENT

550 m submarine PE line 200 mm diam.
10,000 m DI line 200 mm diam (SE Placentia)
concrete storage tank
booster pump station
400 connections (Placentia Beach)

COMMENTS/PROBLEMS

1. Submarine line: This has given problems over the years with washouts and freezeups. Plans are to replace this with an insulated PE line over the bridge.

2. Corrosion of pipes: The construction of the iron mains and copper building connections was commenced several decades ago. Water treatment to reduce corrosion potential has only just started, so the question is the remaining life of the pipes.

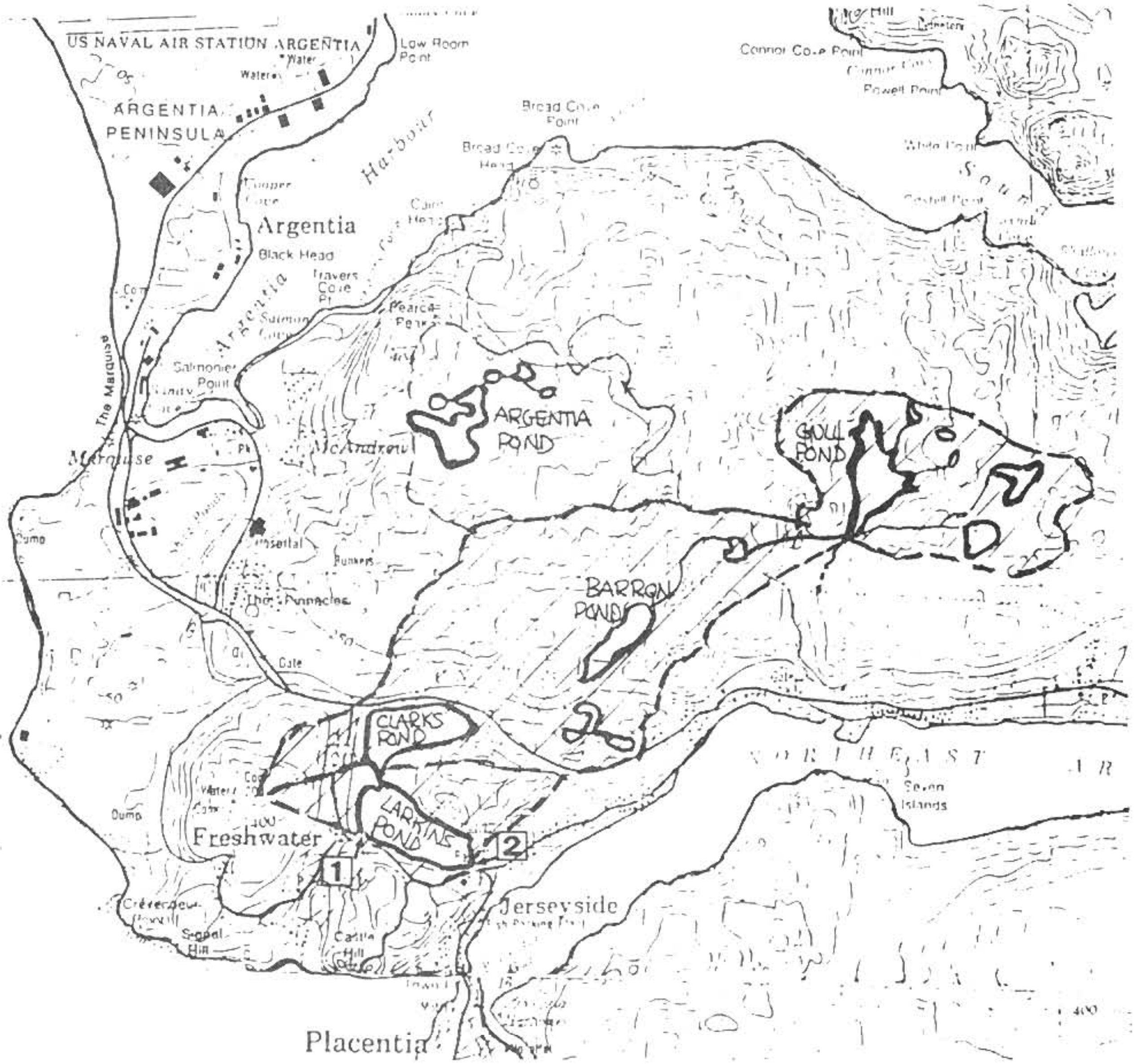
3. The SE Placentia booster pump (augmented by the tank) has the capacity for several hundred connections. Ultimately the pumps may have to be increased in size if there is a large population growth. However, this will not be a major cost item.

FUTURE CAPITAL REQUIREMENTS

1. Replacement of submarine line with line over bridge-$90,000.
2. Replacement of iron mains?

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

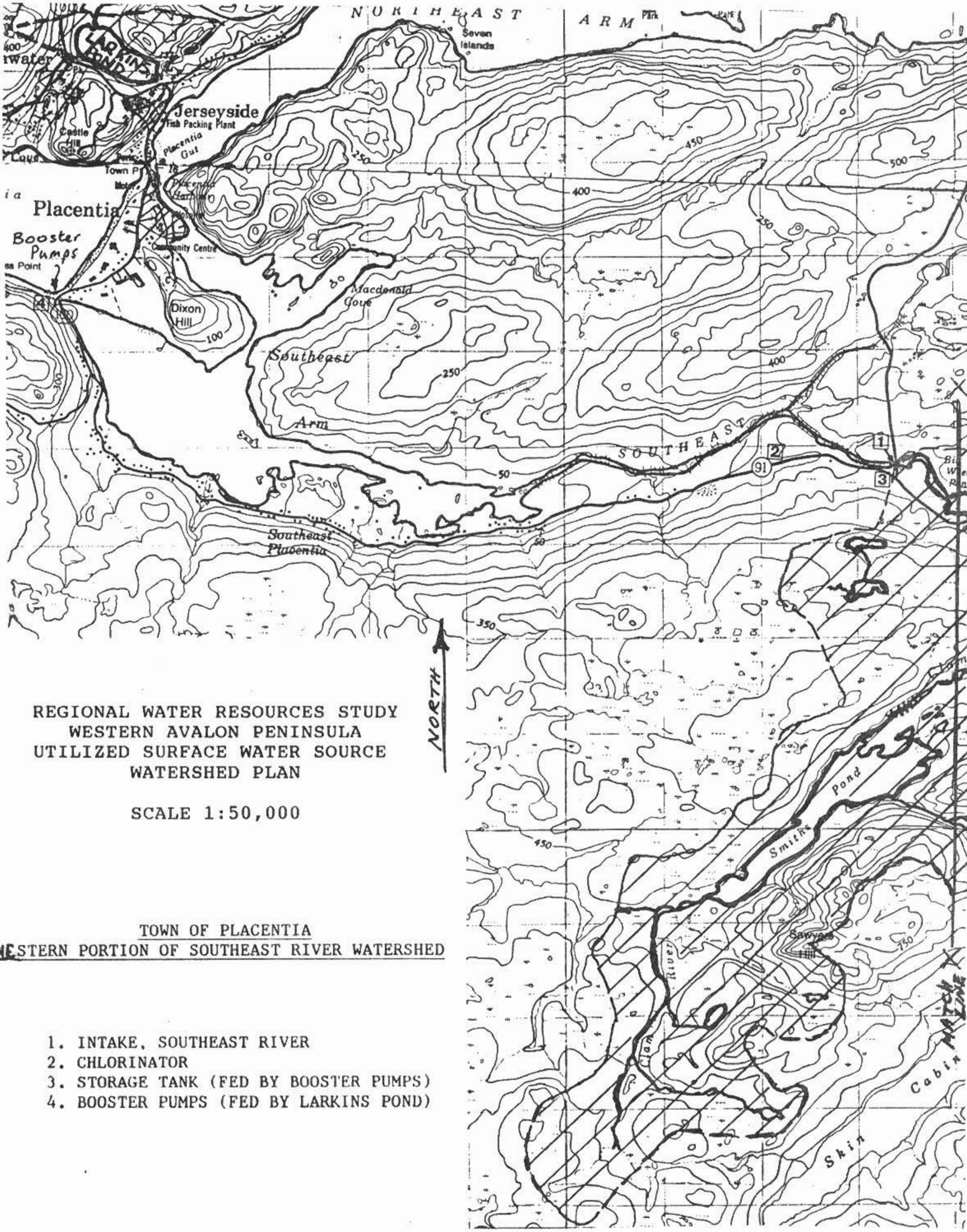
SCALE 1:50,000



TOWNS OF FRESHWATER, JERSEYSIDE

1. Intake-Freshwater
2. Intake-Jerseyside

Consulting Engineer: Colin Karasek Ltd. November 1987



REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000

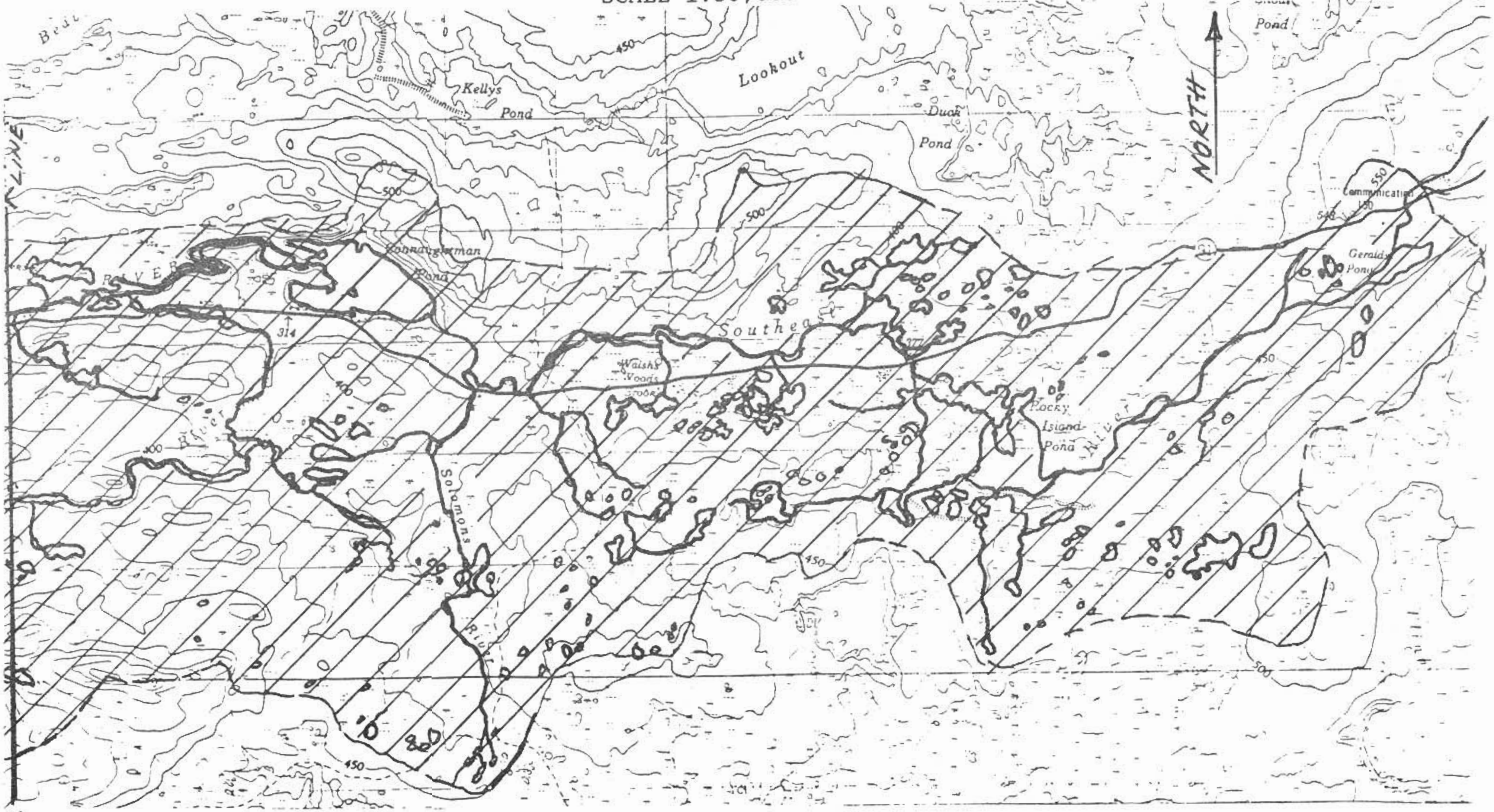
TOWN OF PLACENTIA
WESTERN PORTION OF SOUTHEAST RIVER WATERSHED

1. INTAKE, SOUTHEAST RIVER
2. CHLORINATOR
3. STORAGE TANK (FED BY BOOSTER PUMPS)
4. BOOSTER PUMPS (FED BY LARKINS POND)

Consulting Engineer: Colin Karasek Ltd. November 1987

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF PLACENTIA
EASTERN PORTION OF SOUTHEAST RIVER WATERSHED

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

COMMUNITY OF POINT LANCE

Information:
Town Clerk: Bernadette Careen
Maintenance Foreman: Andrew Green

Population: 151 (1981), 151 (1986)

Water source: Abstraction dam on a brook, fed from a pond (no name). Community is sole user. This source has been used for some years, but a new dam and transmission main are being constructed.

Wells: Nil

DEMANDS

Domestic: Approximately 40 homes (check), connected to 50 mm plastic line.

Industrial: Nil

Wastage or losses: No major leaks, some tap bleeding in winter.

Metering: Nil

Variations in demand: Not significant.

Factors in Future Demand: There may be some increase in demand as 8-10 families have moved into Point Lance in recent years and the trend may continue.

SUPPLY SOURCE (MAIN SOURCE)
Pond (no name). Watershed topography undulating, vegetation barrens type.

Status of watershed protection: Protected.

Dam: Recently constructed. Reinforced concrete, maximum height 2.4 m. Approximately 6m in length, with a stop log sluice gate 0.9 m wide which also acts as a spillway. No flood spillway. (Information from local sources and DMA drawing.)

Intake pipe: One 50 mm ϕ plastic line, which residents are still using and one 150 mm ϕ PVC which is the intake for the new system under construction

Adequacy, summer 1987: Water level dropped "very low" this summer but no specific information available.

Status of new system: The dam and 150 mm ϕ PVC transmission main was installed through Job Strategy Program over the last three years. (DMA has drawings.) Hoping to complete main line with chlorination and residential hook-ups in 1988. No residential hook-ups completed at present. Fire hydrants are proposed.

WATER QUALITY

Bacteriological: Department of Health. Whitbourne. During summer, tests on raw water show levels of coliform which are acceptable for treatment by simple chlorination.

Chemical: Water sample Jan.13/84 . Colour was 20, which is slightly high but acceptable. All other parameters met those Canada Drinking Water limits (CDW) that have been issued as standards. During winter, parameters such as colour are often somewhat better than in summer.

Problems: Local report is that the water has a boggy taste and is smelly in summer. This could be through high natural organic content at certain periods of the year (organic content is not a CDW standard).

WATER TREATMENT

Simple chlorination is proposed.

TRANSMISSION AND DISTRIBUTION

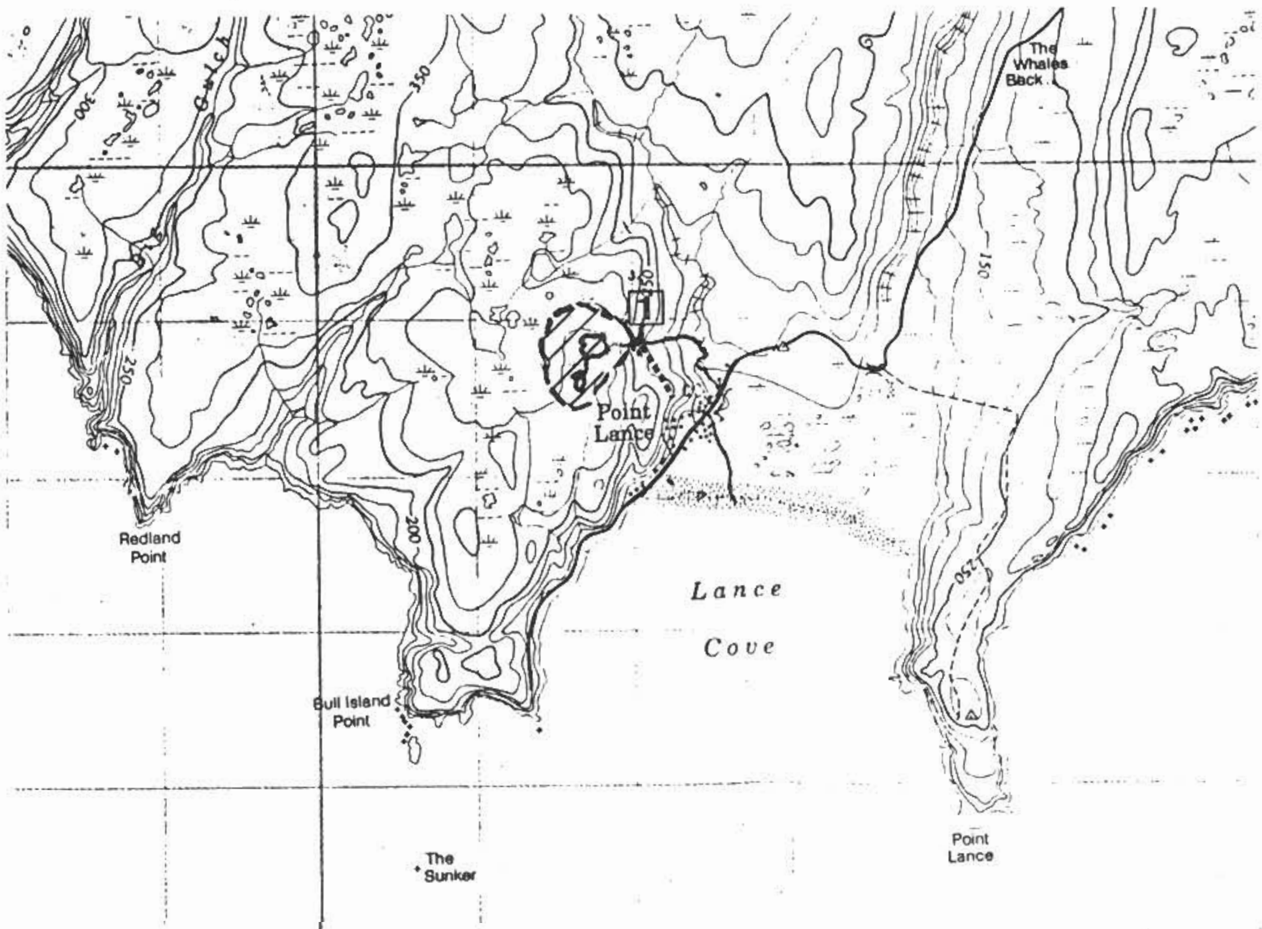
The proposed 150 mm transmission main to the first house will be about 500 m. The main community line will probably be 150 mm diam. The distribution network will probably be 50 mm diam.

COMMENTS/PROBLEMS

System should be re-examined when complete and in full operation. There may be problems with water quality, not revealed by the test results.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



TOWN OF POINT LANCE

1. Intake

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

COMMUNITY OF ST. BRIDE'S

Information:
Eugene Manning, Mayor
Vincent Conway, Town Clerk

Population: 599 (1981)

Water source:

North of St. Bride's River: Dam on Murphy's Brook, a gravity system.

South of St. Bride's River: Dam on Conway Brook, a gravity system.

Wells: No Council wells. School uses a well.

DEMANDS:

North: 62 houses plus 6-room motel and a few local commercial outlets.

South: 82 houses plus a few local commercial outlets.

Metering: No metering.

Wastage or losses: None reported. However, the type of pipe connection used (straps) can cause leaky joints if the straps corrode or fail.

Variations in demand: Normal.

Factors in future demand:

SUPPLY
Small brooks with no ponds on the watersheds.

Dam: Abstraction dams of concrete which create back-up reservoirs with one or two thousand cubic metres of storage. The dam on Conway Brook is in good condition, whereas the concrete in the dam on Murphy's Brook is deteriorating. The dams were installed in the mid sixties.

Spillway: Each dam has a spillway and channel guide walls of concrete through the middle of the dam.

Intake: 150 mm PVC pipe.

Sources: No fine screens.

Adequacy of supply, summer 1987: Ample supply. The brooks continued to run all summer.

Status of watershed protection: Protected.

STORAGE/DEMAND

These are run-of-the-river systems with enough storage to cover most droughts.

Live Storage head: About 2.5 m Conway Brook dam and 1.5 m Murphy's Brook dam.

Ways to increase live storage: Reservoirs could be increased by excavation.

WATER QUALITY

Bacteriological: Poor. Always a Boil Order in force. There is no chlorine residual in the water because no chlorination is carried out.

Chemical: Conway Brook. Poor from April to October. Highly coloured, poor taste. Usually satisfactory from November to March. From the description given, the water in summer appears to suffer from high colour and high iron. (Bleach in washing brings out brown stains.)

Murphy's Brook is reported to have better quality water.

Problems: Raw water chemical quality is a serious problem. Whether it is possible to treat the water at reasonable cost is not known. But information on water treatment in a few places elsewhere in the Western Avalon suggests that the cost of treatment would be too expensive for poor quality raw surface water of high colour.

The Boil Order problem could probably be cured with simple chlorination. With highly organic water the use of chlorine can create trihalomethanes which may be carciogenic for very long term consumption. However, the Department of Health, for Newfoundland in general has never recommended that chlorination not be used.

WATER TREATMENT

None.

TRANSMISSION AND DISTRIBUTION

PVC main 150 mm down to 40 mm with insert couplings and metal strap clamps. Installed 1965 to 1982. The mains total several thousand metres in length. The distance between the north and south dams is about 5 km. In the last year or so a program to replace the original 150 mm mains with PVC bell and spigot mains has begun. A total of 2440 m of 150 mm PVC BS pipe has been installed. Also four hydrants have been installed; three south system, one north system.

Factors in replacement cost estimate:

Two dams.
Transmission and distribution.

COMMENTS/PROBLEMS

1. The community wishes to stay with gravity supply to avoid pumping costs, which leaves using the fish plant supply out of the question.

2. The water quality chemical problem may be intractable. The Community proposes to extend a 150 mm line through the Community to replace the smaller main lines. By connecting the Conway and Murphy's Brook system it should be possible to extend the area served by Murphy's Brook. This would be done by opening or closing valves strategically located so that the users could be supplied by either source as far as permitted by gravity. The Murphy's source has elevation 60 m. It could serve the Community excepting most of the residences on the Branch Road.

3. A sample for chemical analysis should be taken of the waters in their periods of worst quality. This should help to assess whether or not treatment is feasible (e.g.to reduce colour and iron content). A water treatment feasibility study may be warranted.

4. Chlorinators should be installed.

FUTURE CAPITAL REQUIREMENTS

Replace much of distribution system and instal chlorinators, possibly water treatment if not infeasible because of cost. No estimates available. Say $500,000.

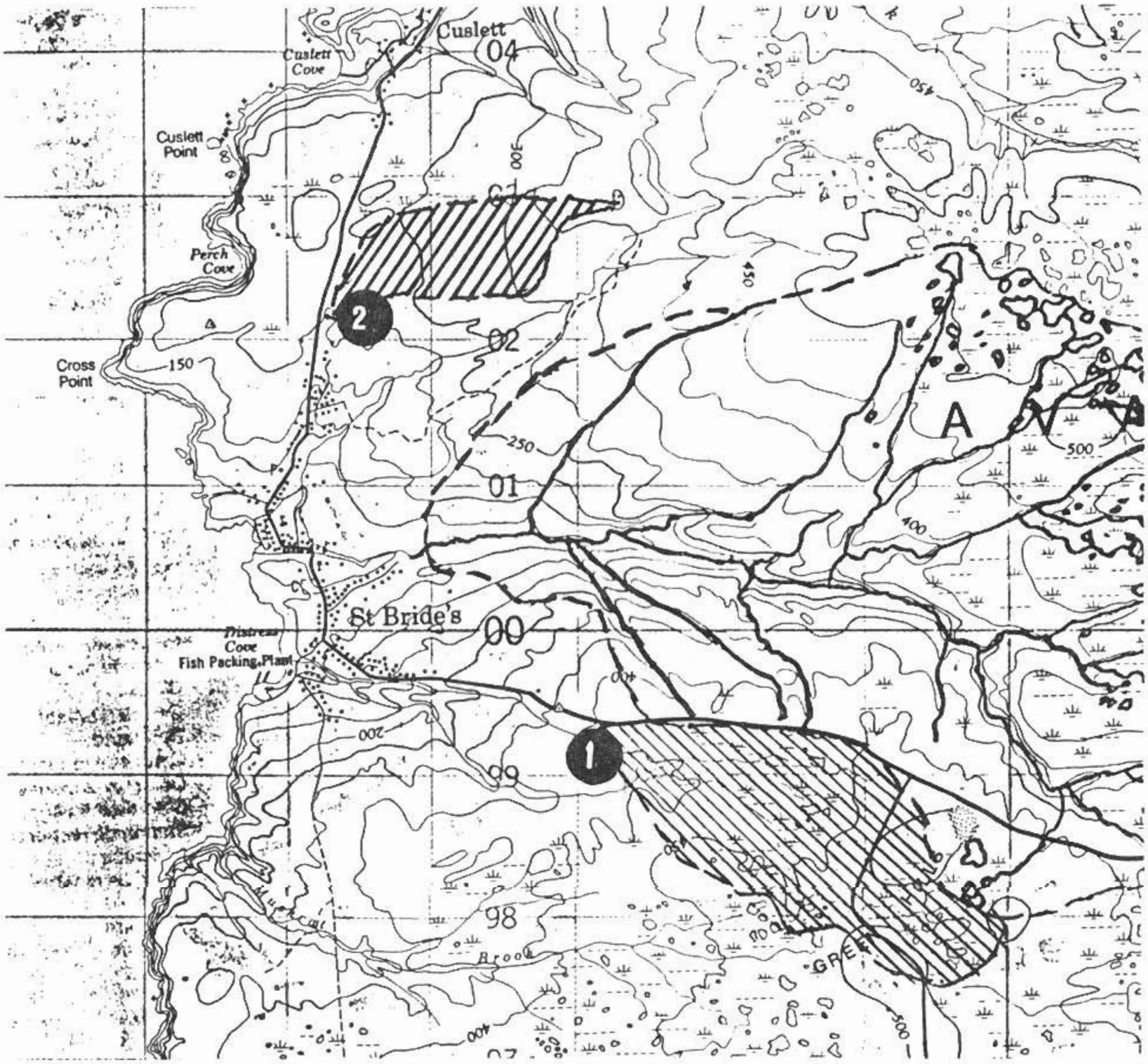
NOTE ON WATERSHED PLAN

Using the 1:50,000 mapsheet information, the watershed for Conway Brook would be very small. It is drawn larger and conforms with the Protected Watershed plan.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

1. Intake, Dam Conway Brook *
2. Intake, Dam Murphy's Brook
   * location of dam may differ from that shown on map (brook to south)

Consulting Engineer: Colin Karasek Ltd. January 1988

FISH PLANT SURFACE WATER SOURCE

ST.BRIDE'S FISH PLANT

Information: Gerald Healey, CET, DMA

Water source: Abstraction dam on St. Bride's River. No other users. Pumped system.

Management: The system is owned by the Department of Municipal Affairs (DMA) and is operated by Cape Pine Fisheries of Witless Bay.

Charges: No user charges are made. Capital improvements have been carried out by the DMA.

DEMANDS

Future demands: Unable to contact fish plant owner.

SUPPLY

Information from drawings by Nolan Davis Associates, September 1976, and Elliot and Elliot, 1986.

Intake: The intake is two 150 mm diam. Slot 100 well screens each 3 m long in parallel, buried in the river bed. Water is ponded over these buried pipes by a dam.

Dam: The original concrete dam disintegrated and was replaced with a rock-filled timber crib type structure. This dam creates a pond about 1 m deep.

Spillway: The spillway is built into the dam.

Fishway: The dam includes a fishway 1200 mm wide.

Screening: Screening done by intake.

Status of watershed protection: Not recorded as protected.

Adequacy of supply, summer 1987: No information.

Storage/Demand Factors: No effective storage in supply, a run of the river system. The watershed does not contain any significant ponds which could be used for upstream storage and control.

WATER QUALITY

Bacteriological: Testing by Dept. of Fisheries. No problems reported.

Chemical: No data readily available.

Problems: Unable to contact fish plant owner.

WATER TREATMENT

Gas chlorinator located in pumphouse.

TRANSMISSION AND DISTRIBUTION

Pumphouse: Two pumps to lift about 35 m to TWL of storage tank. Pump control system not known.

Storage tank: A ground level gravity steel tank balancing on the line, 7.32 m high, 7.62 m diam, capacity 300 m^3. El.bottom of tank 44.4 m.

Transmission main: About 146 m of 100 mm main run from the pumphouse to a T, with a 200 mm branch to the tank which extends 287 m. From the T to the plant is about 1900 m of 200 mm main. There are one or two fire hydrants on the line near the plant.

COMMENTS/PROBLEMS

Management: The fish plant is the sole beneficiary of this system. Government could consider passing the ownership of the system to the fish plant.

Supply all of community: By relocating the tank to higher ground (and with a telemetering control from the tank to the punmps) the system could be used as a supply for the whole community. However, the Chairman of St. Bride's Community Council, Eugene Manning, states that the Communmity is not interested in using the system because of the pumping costs that would be incurred.

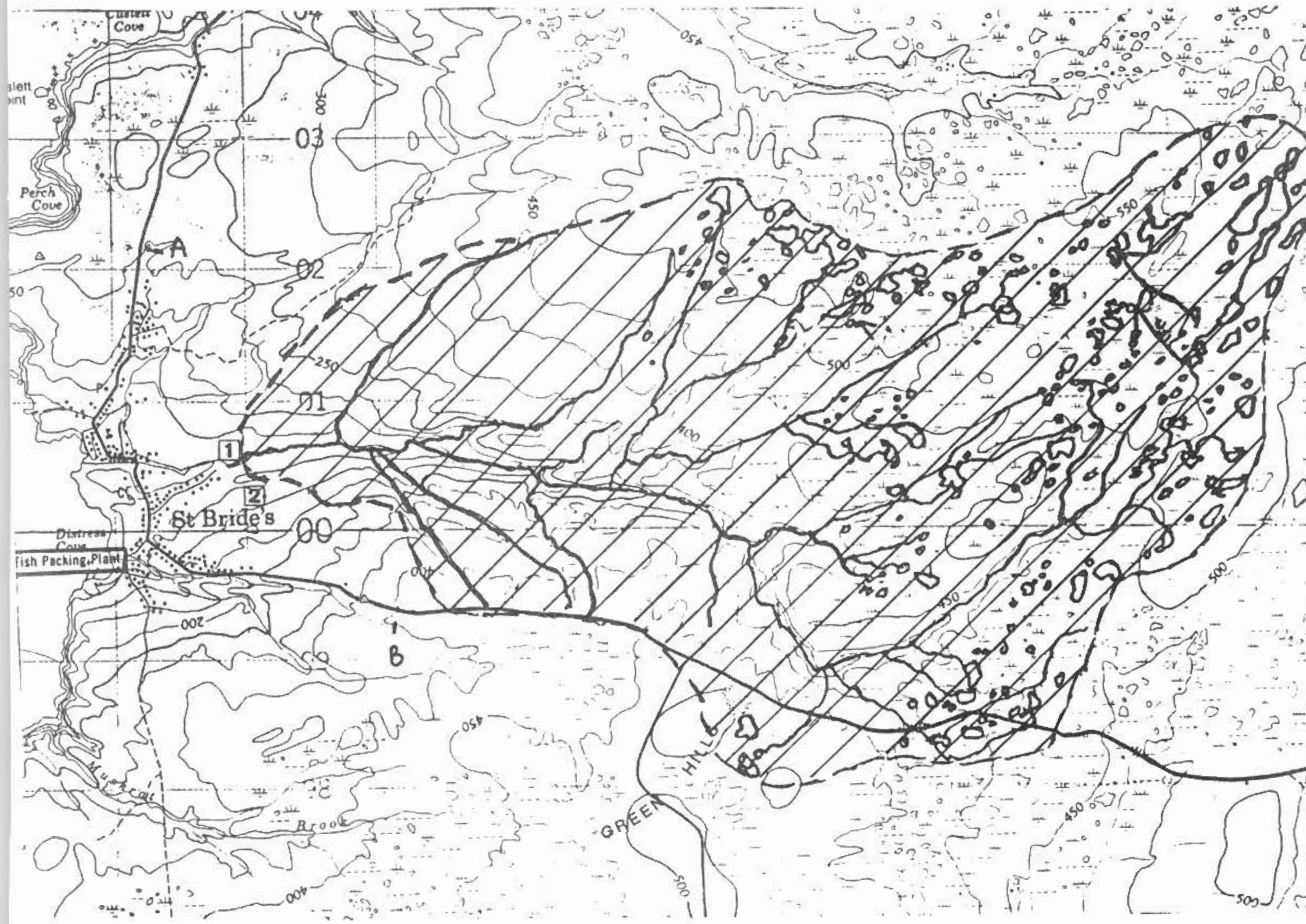
FUTURE CAPITAL REQUIREMENTS

Dam is untreated lumber, so probably it will need to be replaced in, say, ten years.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

1. Intake and Chlorinator
2. Tank

Consulting Engineer: Colin Karasek Ltd. January 1988

INDUSTRIAL/DOMESTIC SYSTEM, SURFACE WATER SOURCE

SOUTH DILDO

Information:
Uday Shah, P.Eng., Dept. of Municipal Affairs
Cecil Reid, Plant Operator

Owner: Department of Municipal Affairs

Water source: Broad Cove Pond, Broad Cove River watershed.

Demands: (All located in South Dildo)

1. Industrial. Three fish plants: Carino Company Seal Plant, Fishery Products International, Woodman's Sea Products. Also Fur Farmers plant. The seal plant operates in spring, and Fishery Products in season.

2. Domestic. About 45 households, in South Dildo and Broad Cove, through local water service committees.

Variations in demand: Due to changes in demand at fish plants.

Wastages or losses: None reported.

Metering: Meter at each fish plant plus fur farmer's plant. A total of four meters are read for charging. The two water service committees are charged a flat rate.

Factors in future demand: Possibly more domestic connections could be added.

Supply source: Broad Cove Pond. See comments for "New Harbour".

Intake: Intake of 400 mm CI pipe runs out 64 m from the screen chamber into about 5.7 m of water. Cross at head of pipe, with coarse screens. (This was the original intake 1967; it may have been enlarged since.)

Screens: Screen well is inside pumphouse near the pond.

Adequacy of supply, summer 1987: Pond water level dropped about 0.6 m but no shortage of water at pumphouse.

STORAGE/DEMAND

Live storage head: The intake pipe at the screen chamber is higher than the head of the intake. Live storage head 1.3 m normal WL to top of intake pipe at screen chamber.

Ways to increase live storage: Instal dam to raise pond about 0.3 m.

WATER QUALITY

Bacteriological: Department of Health, Whitbourne.

Chemical: No information.

Problems: None reported.

WATER TREATMENT

Chlorination by gas.

TRANSMISSION/DISTRIBUTION

Pumphouse: 3 x 40 HP pumps controlled by the water level in a gravity storage tank. Float in tank sends signal (four levels) through telemetering line to pumphouse.

Storage tank: On high point of transmission line (elevation 58.5 m) from pumps to demand points in Dildo South. Wood stave tank on concrete dwarf wall. 7.6 m diam. 6.7 m high. Vol.300 m^3.

Transmission Main: Chainages, from design drawing, Newfoundland Design Associates, 1968, converted to metric.

Pumphouse to tank	1395 m	300 mm diam. DI
Tank to first plant connection	561 m	do.
First plant connection to last plant connection	176 m	do.
Total length	2132 m	

COMMENTS/PROBLEMS

New pumps and new telemetering systems, recently installed. (New intake? Check)

FUTURE CAPITAL REQUIREMENTS

Minor.

1. Intake and Chlorinator, Dildo South Pumphouse

2. Gravity Storage Tank, Dildo South

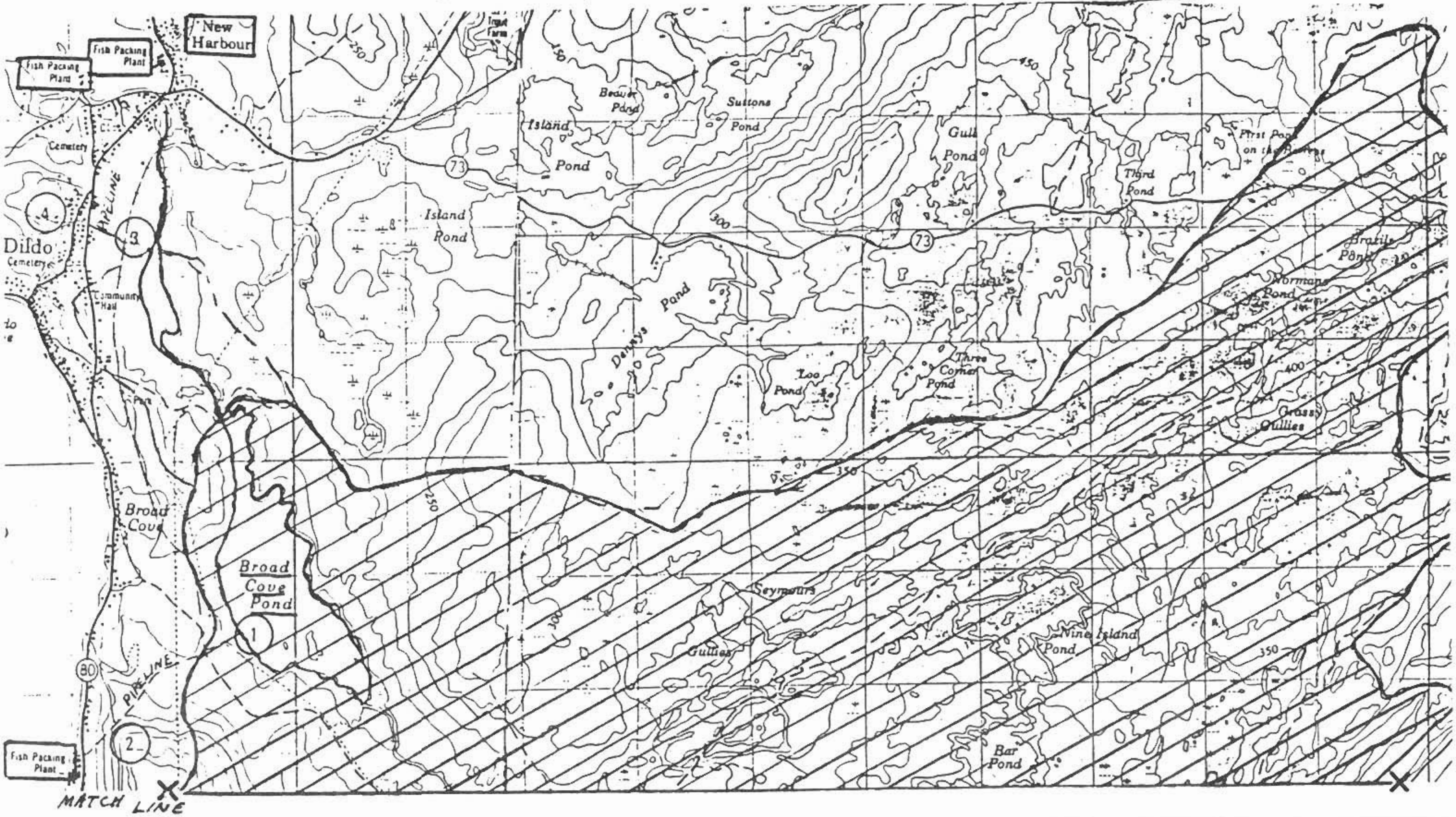
3. Intake and Chlorinator, New Harbour Pumphouse

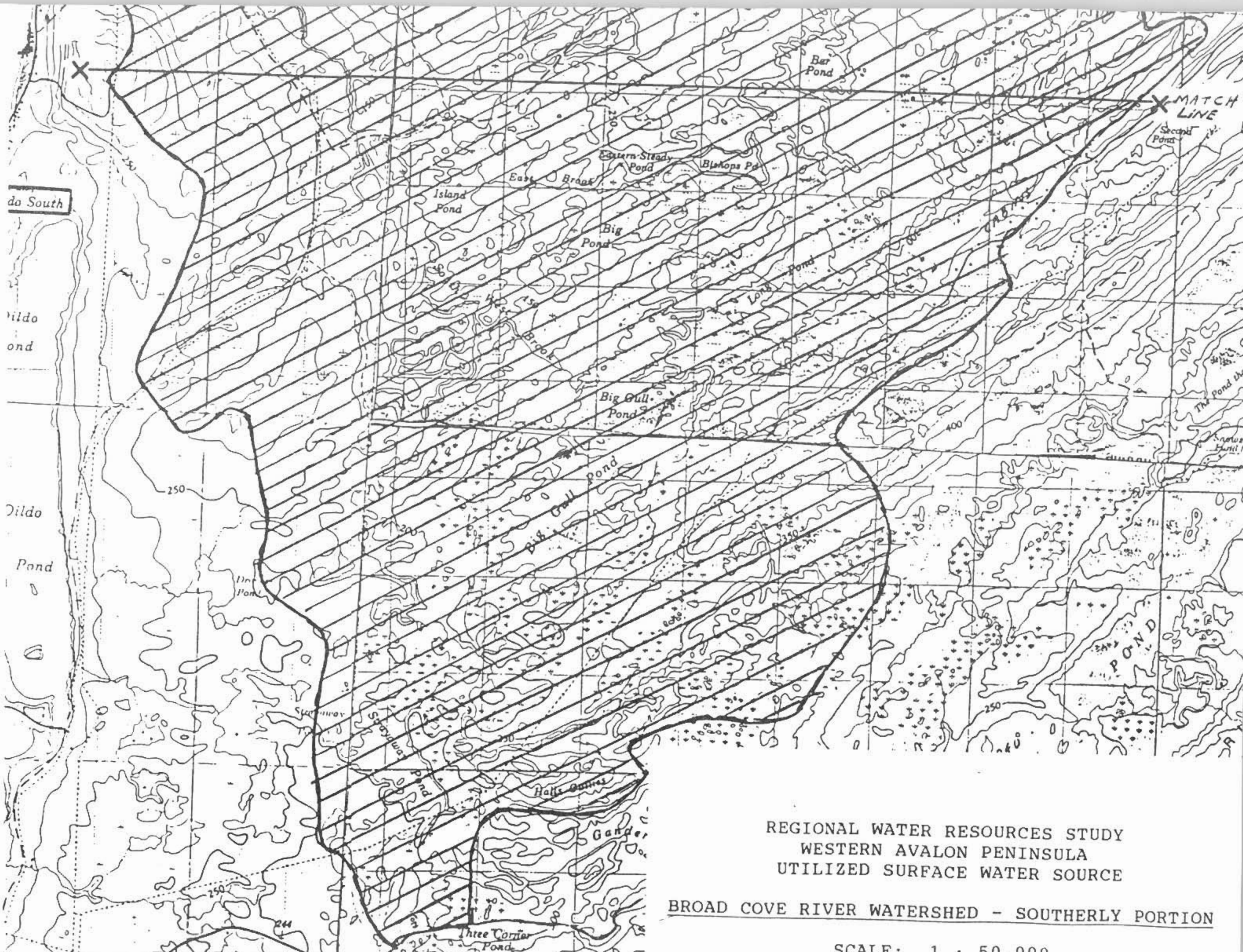
4. Future Storage Tank, New Harbour Pumphouse

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

BROAD COVE RIVER WATERSHED - NORTHERLY PORTION

SCALE: 1 : 50,000





REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

BROAD COVE RIVER WATERSHED - SOUTHERLY PORTION

SCALE: 1 : 50,000

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF SOUTHERN HARBOUR

Information:
Mayor: David Hickey
Town Clerk: Mrs. Linda Ryan
Town Foreman: Alex Anderson
Drawings: Gorman Butler 1974

Population: 772 (1981)

Water source: Brigade brook and pond system. Gravity supply. Town is the sole user.

Ownership: This sytem is owned by the Department of Municipal Affairs, but is operated by the Town. The situation in regard to capital improvements is not clear.

DEMANDS

Domestic: Approximately 125 homes. All of community is connected.

Commercial: Four local stores.

Educational/Institutional: School, church.

Industrial: Fish plant, Port Enterprises Ltd. Fresh frozen product plant.

Metering: Water meter has not worked for several years.

Wastage or losses: No excessive leaks or tap bleeding reported.

Factors in future demand: No major population growth is expected. Fish plant will normally have a much greater water demand than in 1987.

SUPPLY SOURCES AND STORAGE/DEMAND FACTORS

A two stage storage system: An abstraction dam ("downstream dam") across a brook creates a small reservoir to feed the intake and transmission main. Upstream there is a larger natural pond which is augmented by a dam ("upstream dam"). This reservoir provides the main storage and feeds through the natural brook to the lower dam.

Status of watershed protection: Not protected.

A. DOWNSTREAM DAM

Concrete gravity dam, length about 42.4 m, spillway width 9146 mm, depth 1220 mm. Stored volume 600 m^3 (estimate based on design drawings).

Intake: Intake passes through concrete dam from the screens.

Screens: Screening is carried out within the dam reservoir at the intake.

Live storage head: spillway to top of intake, 1.8 m from notes.(To be checked)

B. UPSTREAM DAM

An earth and rock fill dam with sheet steel pile core, and concrete spillway. Top width of dam about 45.5 m (scaled from design drawing). Height of dam maximum about 2 m.

Intake: This is a 250 mm pipe extending through the dam. An upturning elbow on the end has been added to reduce the drawdown of silt. Not screened.

Pond storage volume: 45,000 m^3, approximately. Based on pond area of 125,000 m^2 estimated by eye.

Live storage head: (spillway to top of intake). About 0.75 m. This is based upon the design drawings, which required only 3 ft. of water over intake. (At that time a straight pipe, not an elbow, was specified).

Adequacy of system in 1987: The upper reservoir was drawn down to about 60% of its full volume, with the water level only about 300 mm above the top of the 259 mm intake pipe. The fish plant operated for only about one month (lack of product). If it had been operating normally the problems would have been more severe.

Ways to increase live storage:

1. Downstream dam: Reduce depth of spillway by means of a stop-log. If necessary, construct a new spillway to bypass the dam and act as a flood spillway to supplement the reduced spillway at the dam.

2. Upstream dam:

   (a) Raise the dam and spillway with impermeable local soil (needs investigation).

   (b) Also check the depth of the reservoir to see if the intake could be extended into deeper water.

NEARBY GARBAGE DUMP

An old town dump had used a side valley of the watershed to the north of the downstream dam. This dump has now been closed and an intercepting groundwater drain has been built which discharges the collected groundwater flow from the dump. The drain pipe discharges just downstream of the downstream dam.

WATER QUALITY

Bacteriological: Tested by Department of Health, Whitbourne.

Chemical: No data available.

Problems: No problems reported.

WATER TREATMENT

Gas chlorinator, fixed feed rate, Wallace and Tiernan, located about 500 m downstream of downstream dam.

TRANSMISSION AND DISTRIBUTION

Upstream dam to reservoir of downstream dam: a short distance of 250 mm main, thence flow along the original stream bed.
Downstream dam to chlorinator: approx. 500 m, 250 mm main
Chlorinator to first house: approx. 2000 m, 250 mm main
Fish plant has 150 mm main. Town system 200 mm and 150 mm mains.

Factors in replacement cost estimate:

- two dams
- 2600 m 250 mm transmission main
- chlorinator
- connections

COMMENTS/PROBLEMS

1. Not enough live storage.

2. Chlorinator not flow-paced.

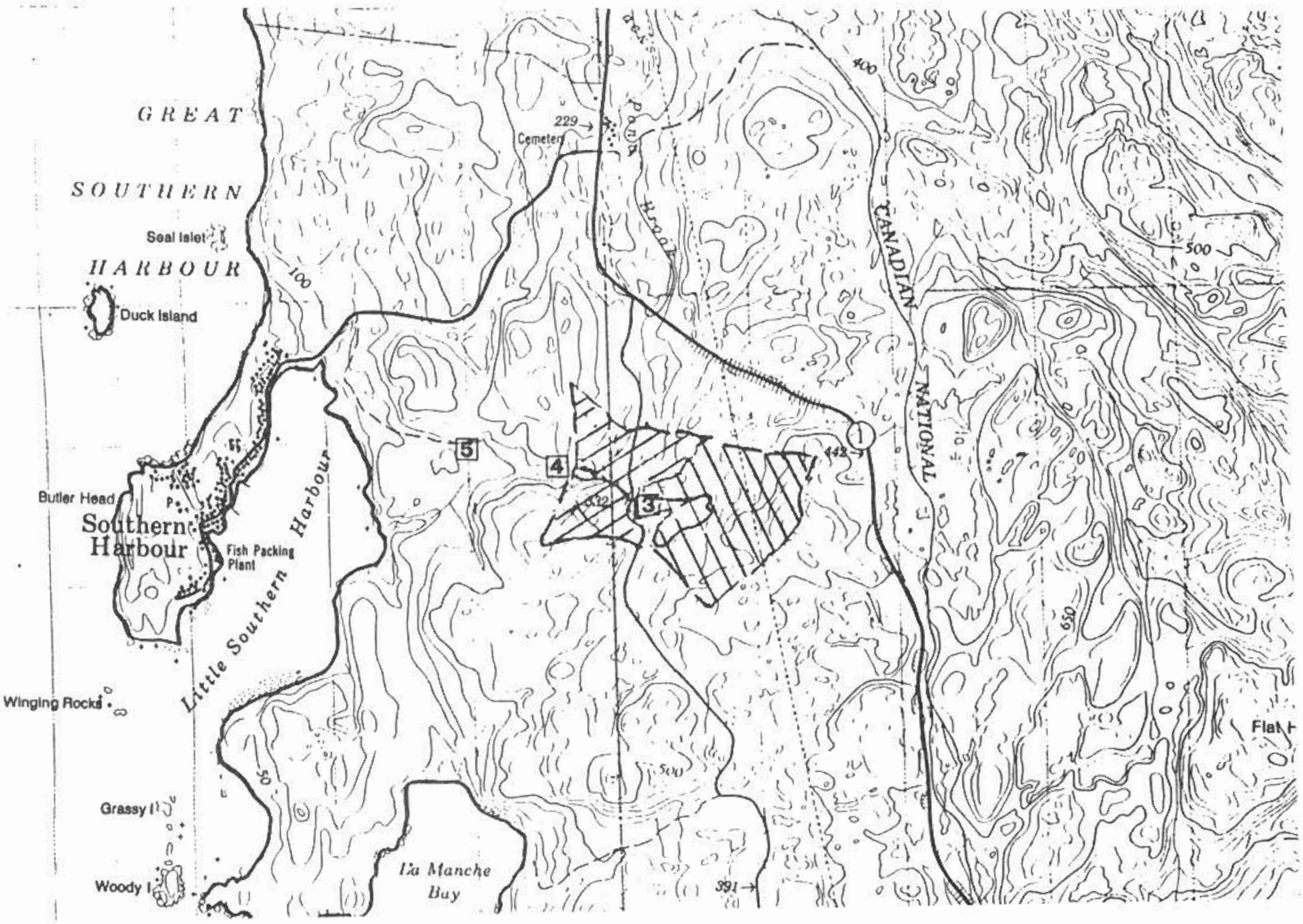
FUTURE CAPITAL COSTS

Downstream dam, work on spillway.	$20,000
Upstream dam, raise dam.	$120,000
Improve chlorinator.	$60,000

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

3. Brigade Pond, Dam
4. Lower Dam and Intake
5. Chlorinator

Consulting Engineer: Colin Karasek Ltd. January 1988

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF SPANIARD'S BAY

Information:

Mayor: Lewis R.Gosse
Town Clerk: Gloria Jewer
Town Manager: Wayne Smith
Maintenance Foreman: Hedley Clarke
Fred Taylor, Resident Engineer, construction of supply system.

Population: 2125 (1981), 2190 (1986)

Water sources: (both gravity supplies)

1. Main source: Spider's Pond, plus watershed with six back-up ponds. NOTE: This source of supply is shared with the Town of Tilton and the Town of Upper Island Cove.

2. Back-up source: Rocky Pond by means of a connection to the Bay Roberts transmission main.

Wells: About 60 private wells.

DEMANDS

Domestic: About 590 homes connected. Program is continuing as funds permit.

Commercial: About 70 connections.

Educational/Institutional: About 500 pupils.

Industrial: Small fish plant, not yet in operation.

Metering: The meter, in the chlorination building, has not worked for several years.

Variations in demand: No unusual variations in demand.

Wastages or losses: None reported.

Factors in future demand:

- About 100 additional houses to be connected.
- No significant population growth is expected.
- Connections to the main sewer are made along with the extensions of the water main.
- See also Tilton and Upper Island Cove.

SUPPLY SOURCE - MAIN SOURCE

Spider Pond, a natural pond in a remote area.

Watershed protection: Kellys Pond/Spider Pond is not a protected water supply, nor is it protected by planning and land use controls. (Alice Graesser)

Dam: No dam.

Spillway: Natural brook 3 m wide x 0.6 m deep when running full.

Intake: 400 mm diam. pipe extends into the pond. It terminates with a cross, coarse screens. The design drawings designate a 0% grade for the intake but it probably slopes downward slightly to the screen chamber wet well (Fred Taylor).

Screens: Enclosed in separate building near edge of pond.

Supply in dry period 1987: Normally outlet brook runs at depth of about 0.6 m and there is 2.6 m of water over the intake pipe. In the dry period the WL dropped to 1.8 m over the intake. (Maintenance Foreman)

STORAGE/DEMAND FACTORS, MAIN SOURCE

Live storage head: The design drawings of the wet well and intake show a pond level of 426.19 feet and the invert of the 16 inch intake pipe at 417.00 feet. This gives a live storage head to normal pond WL of 2.4 m (Newfoundland Design Associates, 1977).

Ways to increase live storage: (1) Deeper water is reported to exist in the pond; extend intake into pond, deepen the screen chamber and tranmission line. (2) Low dam on outlet brook 60 m wide (Fred Taylor).

NOTE: Spider Pond will spill over to the west. This needs to be checked before determining how much the WL could be raised.

SUPPLY SOURCE, BACK-UP

Water by gravity flow can be made available from the transmission main from Rocky Pond to Bay Roberts. Spaniard's Bay has a 300 mm diam. connection controlled by a gate valve normally closed.

WATER QUALITY

Bacteriological: Dept. of Health, Harbour Grace. No problems reported.

Chemical: No data available.

WATER TREATMENT

Gas chlorinator: 1. Wallace and Tiernan
2. Standby, Penwalt

First house (in Tilton) is about 1.7 km downstream of chlorinator.

TRANSMISSION AND DISTRIBUTION

Source: design drawings, Newfoundland Design Associates, 1977, and scaling from 1:50,000 map.

Intake to screen chamber, approx.	65 m,	400 mm DI
Screen chamber to chlorination building	2475 m	"
Total main from screen chamber to pressure reducing valve (PRV)	6860 m	"

After the PRV, the depressurized main, reduced to 300 mm diam., continues south to Spaniard's Bay, and a fully pressurized branch 400 mm diam. continues east to Upper Island Cove.

From the PRV through Spaniard's Bay the 300 mm main continues as far as the connection with the Bay Roberts Rocky Pond system. Branches are 200 mm and 150 mm diam. with fire hydrants.

The system described above is "all gravity" flow. To serve some of the unserviced houses on higher ground would require pressure boosting.

FACTORS IN CAPITAL COST REPLACEMENT (SYSTEM EXTENT, 1987)

Intake
Screen chamber and building
Gas chlorinator
6860 m 400 mm transmission main
6000 m 300 mm main
1000 m 200 mm main
500 m 150 mm main
Access road

COMMENTS/PROBLEMS

Ownership of system: The system is essentially a regional system, serving Spandiard's Bay, Tilton and Upper Island Cove. It could also be extended to serve the community of Bishop's Cove. It is maintained by Spaniard's Bay from the intake via the chlorinator along the main through Tilton to the PRV and on into Spaniard's Bay. Upper Island Cove maintains the branch from the PRV. A committee has recently been established to oversee the overall system.

Future Demands: The current and potential demands on the system are illustrated below:

Municipality	Pop.1986	Existing Connections	Potential Additional Connections
Spaniard's Bay	2190	590	60
Tilton	566	15	135
Upper Island Cove	2055	300	420 (a)
Bishop's Cove	370 ±	-	80
Totals	5181	905	695

(a) Also new fish plant is under consideration.

Hence the future demand on the supply could be double the present drawdown.

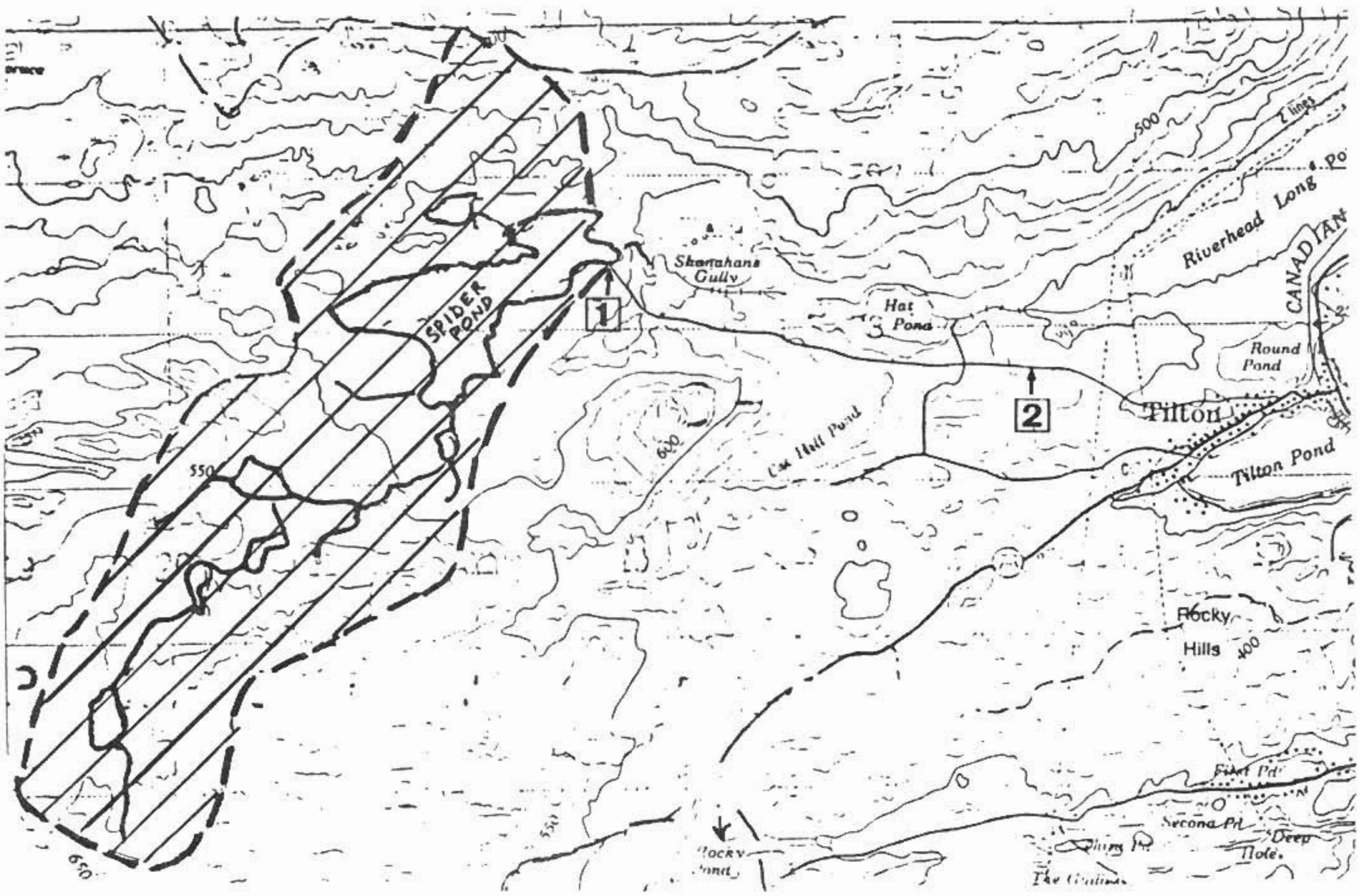
FUTURE CAPITAL REQUIREMENTS (REGIONAL SYSTEM)

For the complete regional system in the order of $4.5 million or perhaps more. A more exact figure would require a determination by the Department of Municipal Affairs from their records and knowledge.

Spaniard's Bay has established a 5 year plan, according to Department of Municipal Affairs requirements, for water and sewer extensions and improvements. (Prepared by Newfoundland Design Associates Ltd.)

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



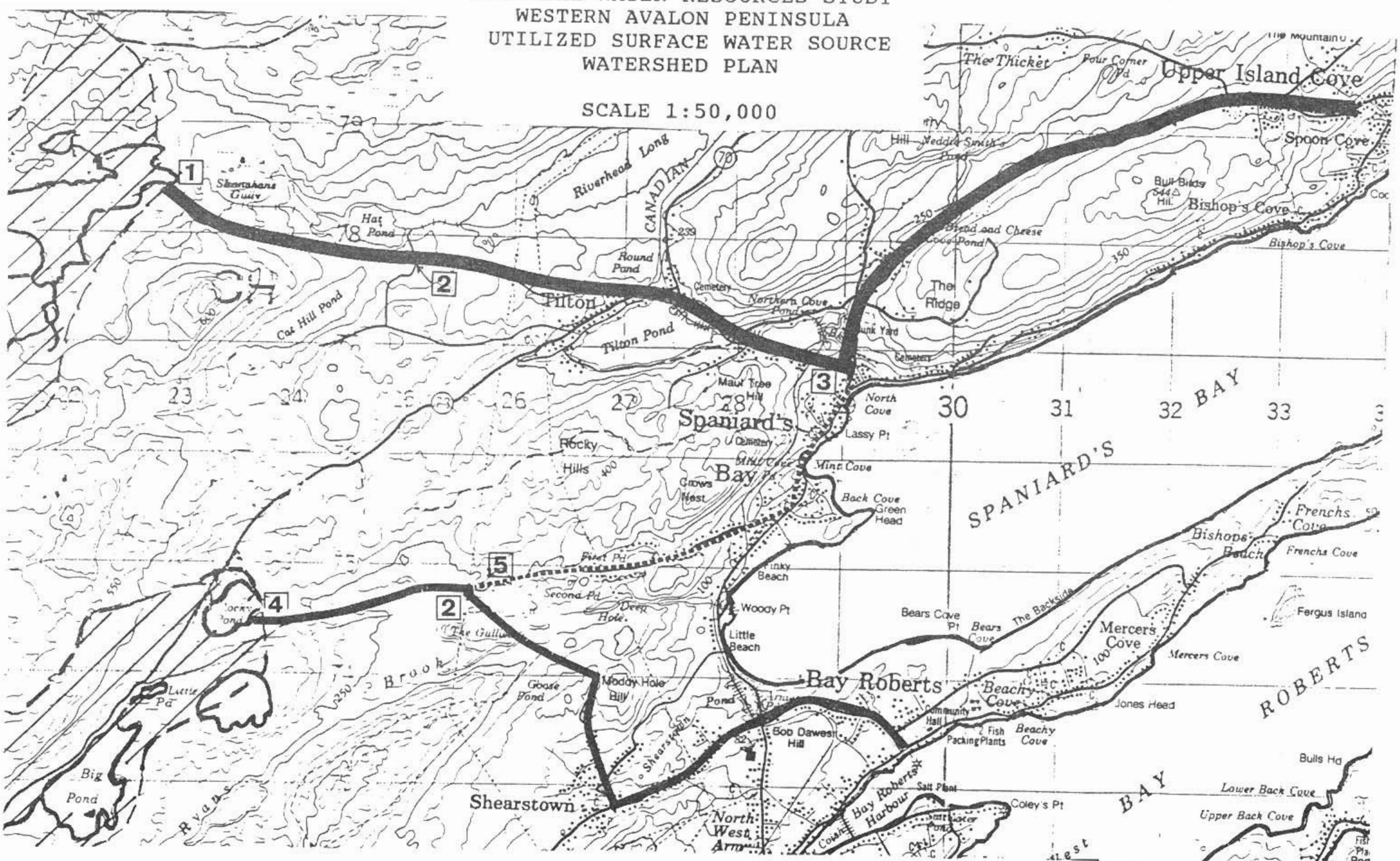
<u>WATERSHED FOR TOWNS OF SPANIARD'S BAY,</u>
<u>TILTON, AND UPPER ISLAND COVE</u>
<u>WESTSIDE</u>

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



MAIN LINE SYSTEMS: SPANIARD'S BAY, TILTON, UPPER ISLAND COVE, AND BAY ROBERTS

1. Intake-Spider Pond
2. Chlorinator
3. Pressure Reducing Valve
4. Intake-Rocky Pond
5. Gate Valve, Normally Closed

TRUNK MAIN SIZE

400 MM DIAM.

350 MM DIAM.

300 MM DIAM.

LOCAL GOVERNMENT - SURFACE WATER SOURCE

TOWN OF SUNNYSIDE AND NEWFOUNDLANDAND LABRADOR HOUSING CORPORATION SUBDIVISION

Information:
Grace Hiscock: Town Clerk
Jim Burton: NLHC

Population: 703 (1981), 703 (1986)

Surface source: Brook 5 m x 300 mm for NLHC 50 lot subdivision. Most of subdivision is vacant. Surface water supply serves about 6 buildings.

Private wells: Remainder of community. Number unknown.

NLHC Surface Supply: There is an intake buried in the river bed leading to a pumphouse with a hydropneumatic system and a chlorinator. Water quality reported as adequate.

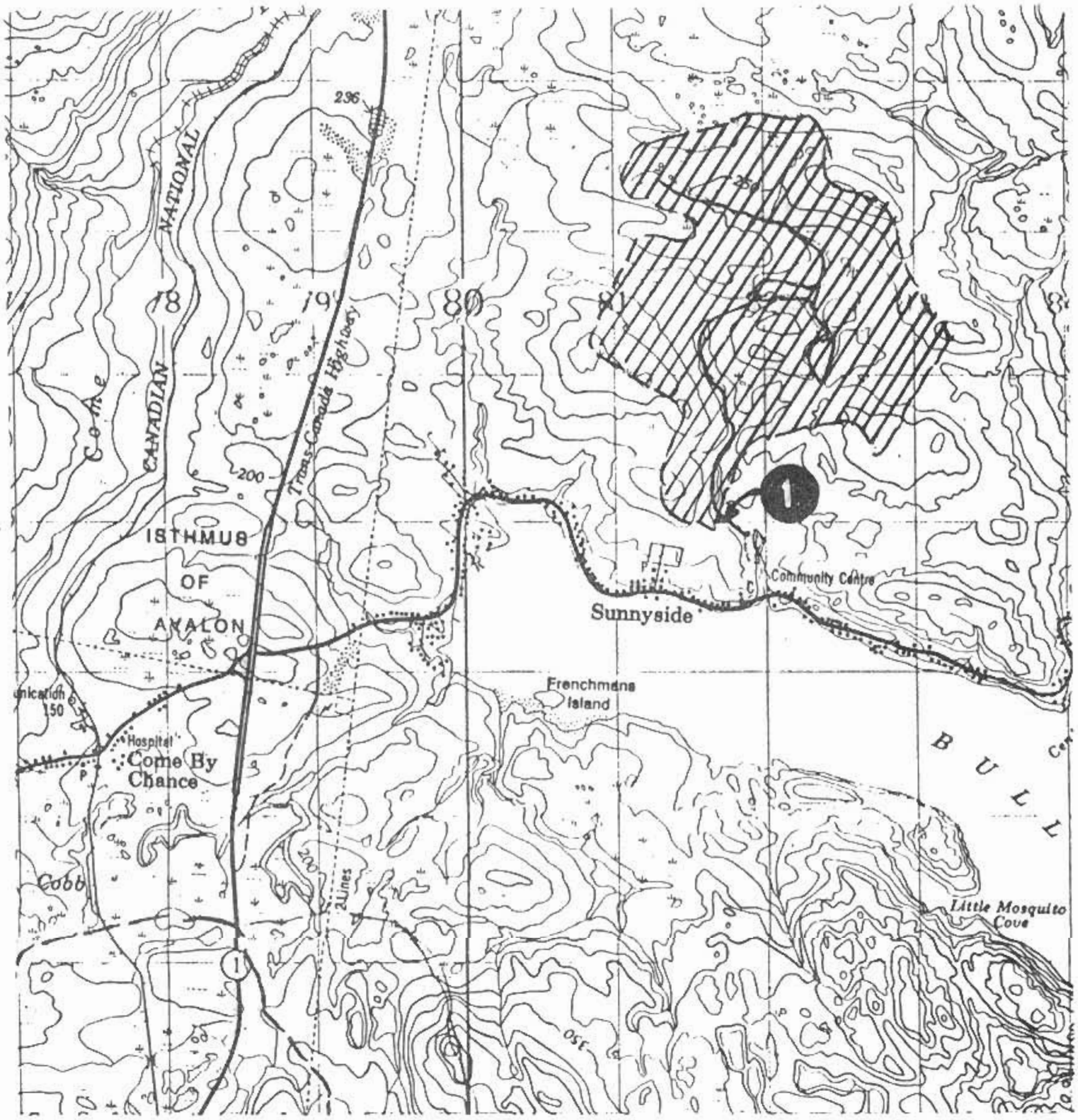
Adequacy of wells, summer 1987: Many people ran short of water.

Comments/Problems:
(1) The lines from the pumphouse system could be extended to serve a number of private houses. (The subdivision lots have remaimed unsold for years.)
(2) Drilled wells could be used to serve groups of houses. (The buildings in the Town extend over several miles.)

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

1. Intake and Chlorinator

Consulting Engineer: Colin Karasek Ltd. January 1988

MUNICIPALITY - SURFACE WATER SOURCE

THORNLEA, LOCAL SERVICE DISTRICT

Information:
William Thorne, Chairman
Walter Vere-Holloway, Dept. of Municipal Affairs

Water source: Bake Apple Pond. Sole user. System is under construction. Work started in 1986; part of community already hooked up.

Wells: No Council wells. Twelve houses on private wells, to be connected to the surface supply in 1988.

DEMANDS

Domestic: All houses, totalling 55, will be connected in 1988.

Other: A few other demands such as a few local stores.

Metering: No meters.

SUPPLY

Bake Apple Pond, a natural pond in an isolated area.

Dam: No dam.

Spillway: Small brook, 3 m x 150 mm.

Intake: 150 mm plastic pipe extends into the pond.

Status of watershed protection: Not recorded as protected.

STORAGE/DEMAND

Live storage head: The critical point (highest point) is probably where the pipeline emerges from the pond. There is an air release standpipe here. Elevation in respect to pond is not known. Estimated 900 mm live storage head.

Adequacy of supply, summer 1987: Pond OK, private wells went dry.

Ways to increase live storage: Dam outlet brook or extend intake into deeper water.

WATER QUALITY

Bacteriological: Dept. of Health, Whitbourne. They report tests are satisfactory.

Chemical: No information. No complaints.

WATER TREATMENT

Chlorination. Javex solution. Located about 600 m from pond, and about 400 m from first house.

TRANSMISSION/DISTRIBUTION

Mains are PVC bell and spigot.
From pond 150 mm dia. for about 160 m, followed by 100 mm diam.
No hydrants.

COMMENTS/PROBLEMS

Comnments by Committee: "There should have been more cut-off valves placed throughout the system to avoid unnecessary shut-down to many homes. Currently there are only four such valves."

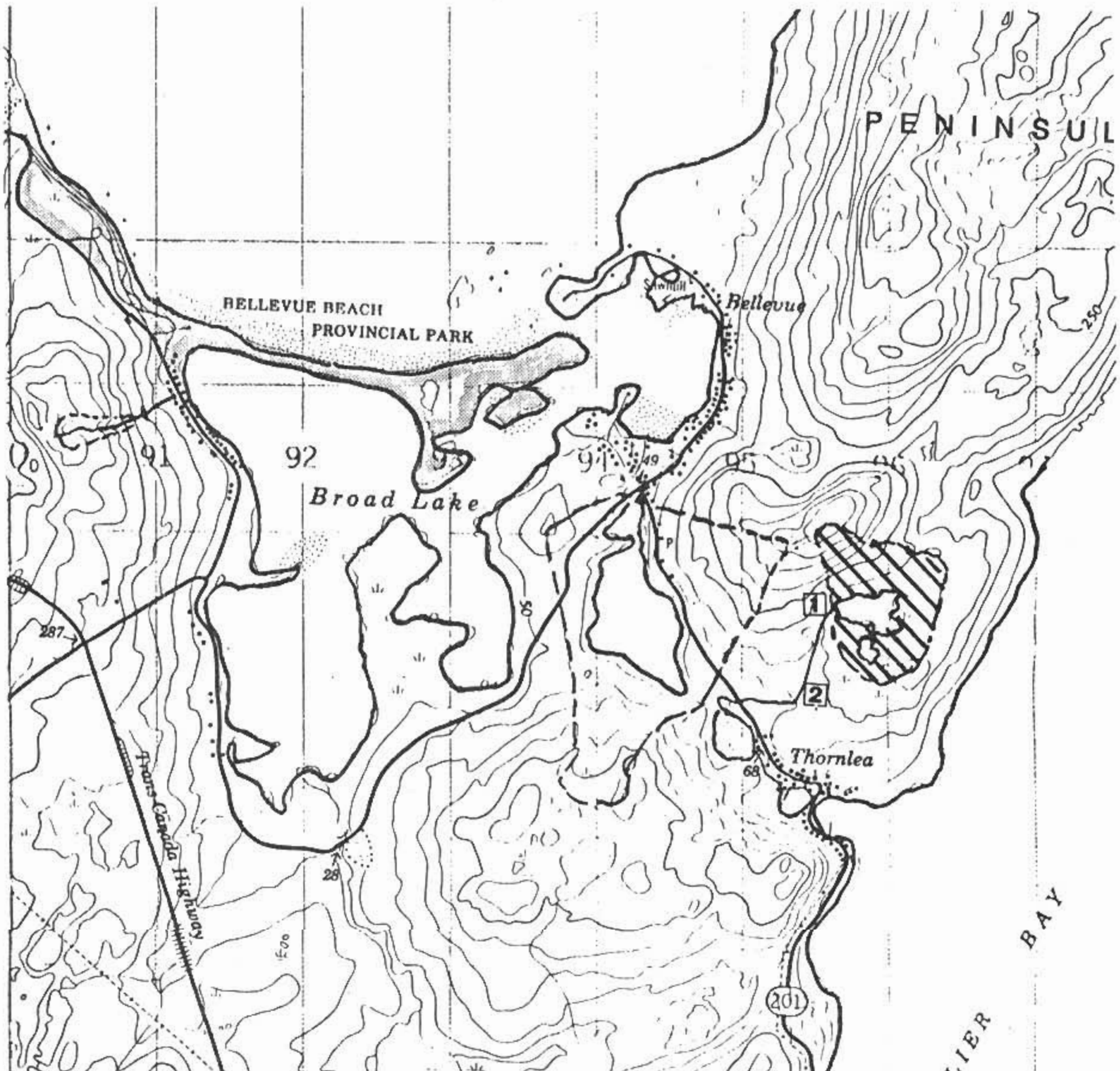
FUTURE CAPITAL COSTS

Comments by Committee: "This Committee can foresee another branchline approximately 600' in length, probably using 2" hose as means of supply, to service approximately eight homes who now have to supply their own 3/4" lines up to 400' to the main waterline. We can also foresee the installation of some sort of fire hydrants to service those homes which are in a 'danger zone' in that they are not readily accessible to a supply of water for the volunteer fire brigade which does not have a pumper truck but instead two portable pumps."

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

WATERSHED PLAN

SCALE 1 : 50,000



LEGEND

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. January 1988

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF TILTON

Information:
Mayor: Joe Smith
Town Clerk: Harry Richards
Maintenance Foreman: Harry Richards

Population: 575 (1981), 566 (1986)

Water source: Spider Pond. Shared use with Upper Island Cove and Spaniard's Bay.

Wells: 135 private wells. No sewer lines.

DEMANDS

Domestic: Approximately 15 homes hooked to the main water system. These are houses that are nearest to the 400 mm main line.

Educational: Nil.

Industrial: Nil.

Commercial: Local stores.

Wastage or losses: No leaks. Some tap bleeding in winter.

Metering: No meter to Tilton users.

Factors in future demand: An additional 120 homes could be connected.

SUPPLY, TREATMENT

See Spaniard's Bay.

COMMENTS/PROBLEMS

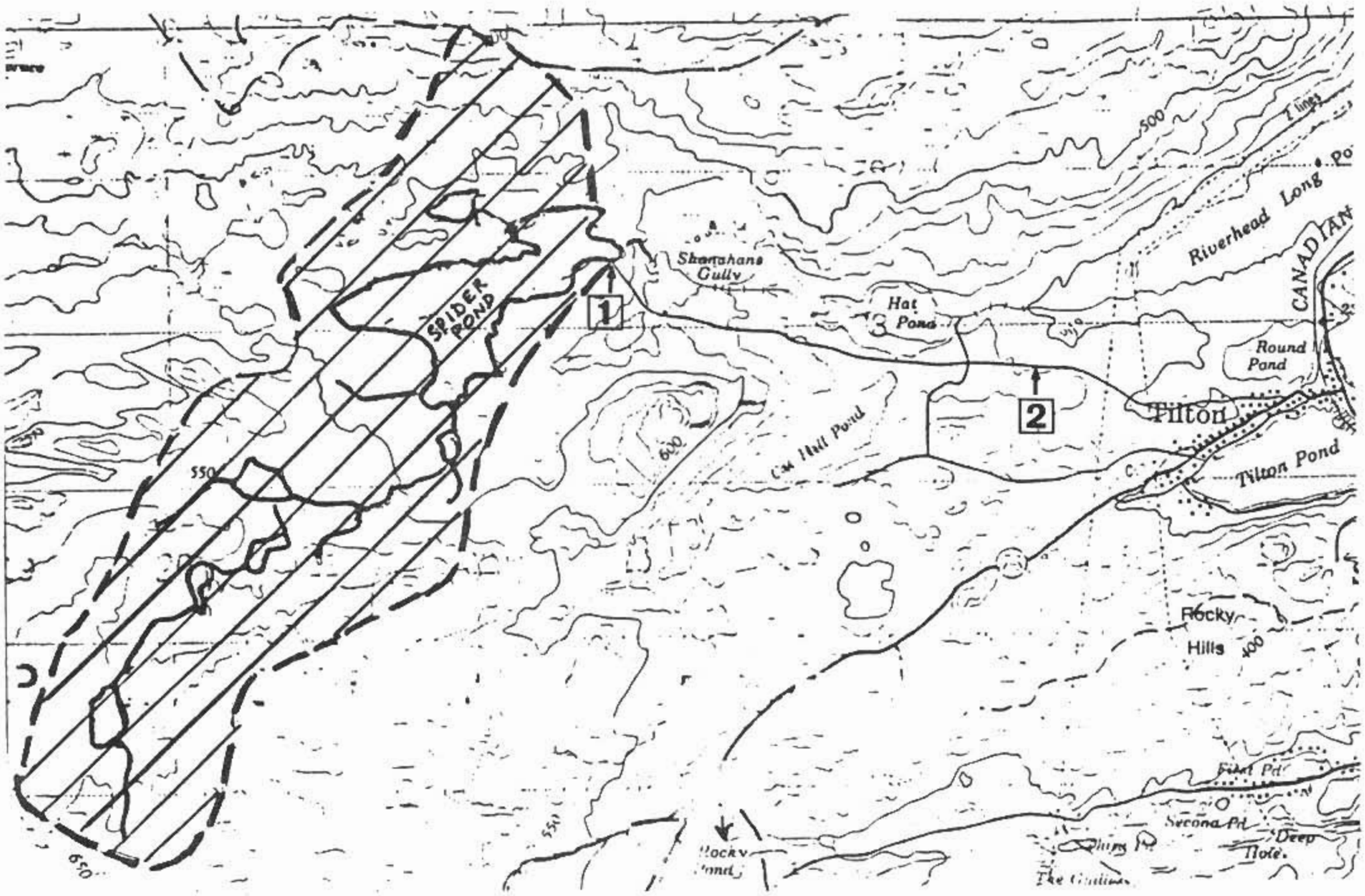
All local wells went dry this year and residents had to bucket water from Tilton Pond for toilet and washing purposes.

FUTURE CAPITAL COSTS

Distribution system for 120 connections, fire hydrants, gravity system.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



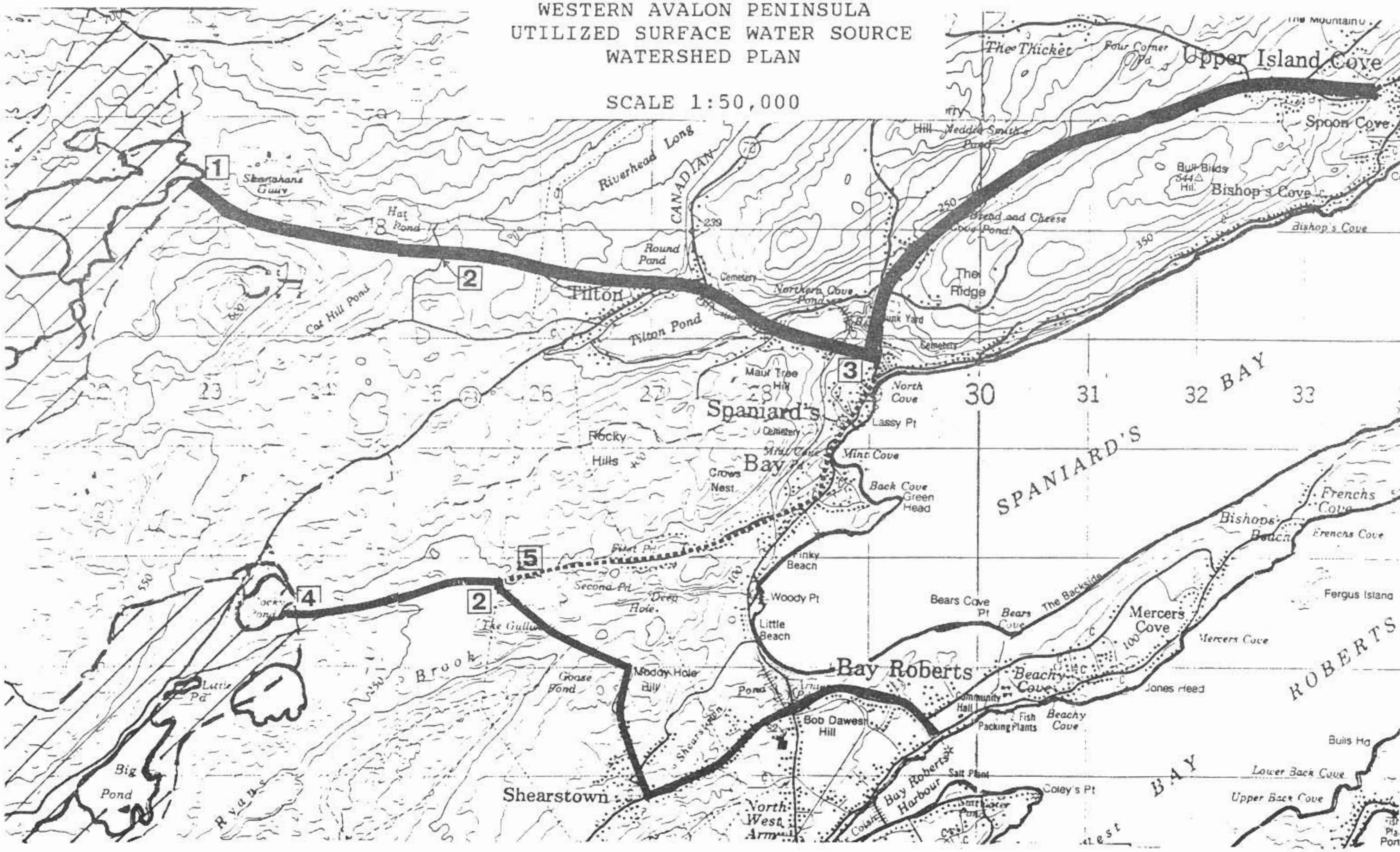
WATERSHED FOR TOWNS OF SPANIARD'S BAY, TILTON, AND UPPER ISLAND COVE WESTSIDE

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



<u>MAIN LINE SYSTEMS: SPANIARD'S BAY, TILTON,</u>
<u>UPPER ISLAND COVE, AND BAY ROBERTS</u>

1. Intake-Spider Pond
2. Chlorinator
3. Pressure Reducing Valve
4. Intake-Rocky Pond
5. Gate Valve, Normally Closed

TRUNK MAIN SIZE

400 MM DIAM.

350 MM DIAM.

300 MM DIAM.

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF UPPER ISLAND COVE

Information:
Town Clerk/Manager: Baxter Drover
Maintenance Foreman: Arthur Mercer

Population: 2025 (1981), 2055 (1986)

Water source: Spider Pond. Shared with Tilton and Spaniard's Bay.

Wells: About 40% of houses are on private wells.

DEMANDS

Domestic: Approximately 350 homes hooked up, mostly the higher elevations of the Town.
Commercial: 22 businesses, local service.

Educational: Elementary school, approximately 500 pupils.

Industrial: No demands foreseen at present (March 22/88).

Wastage or losses: No major leaks reported. There is some tap bleeding in winter.

Metering: No metering for Upper Island Cove users.

FACTORS IN FUTURE DEMAND

About 260 existing homes to be connected to the water system. In addition the average number of house building permits is about 10 per year.

SUPPLY, TREATMENT

See Spaniard's Bay.

TRANSMISSION AND DISTRIBUTION

Continuation of Tilton line 400 mm DI to pressure reducer station located at north end of Spaniard's Bay, then 400 mm ϕ DI on to Upper Island Cove, 6 km. Mains through Town consist of 300 mm and 250 mm ϕ DI, with short feeders of 150 mm ϕ DI.

COMMENTS/PROBLEMS

On higher parts of the system line pressure tests show about 14.0 m of water pressure (20 psi). (Information from Council staff)

This is usually the minimum pressure allowable in a system under flow with an open fire hydrant in order for the system to be rated by insurance underwriters. There is concern that pressures may fall to unsatisfactory levels when more demands are placed on the system.

At present there are no deficiencies in the system, but if large scale extensions were to take place, the whole system covering Tilton, Spaniard's Bay, Upper Island Cove and Bishop's Cove, should be re-evaluated.

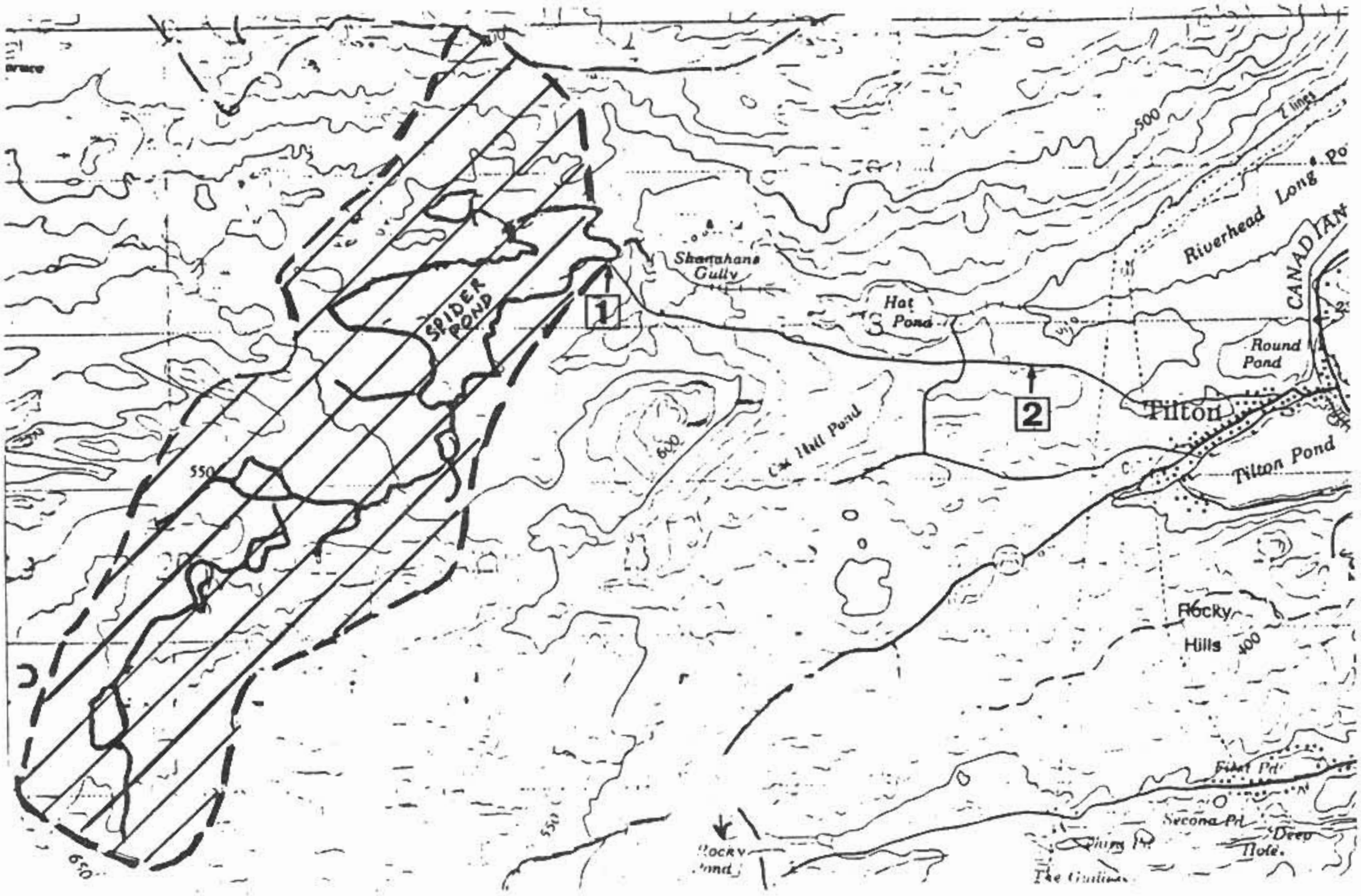
FUTURE CAPITAL REQUIREMENTS

1. To serve several hundred new connections. (The Town has developed a five year plan.)

2. Measures to improve local water pressures if found necessary.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



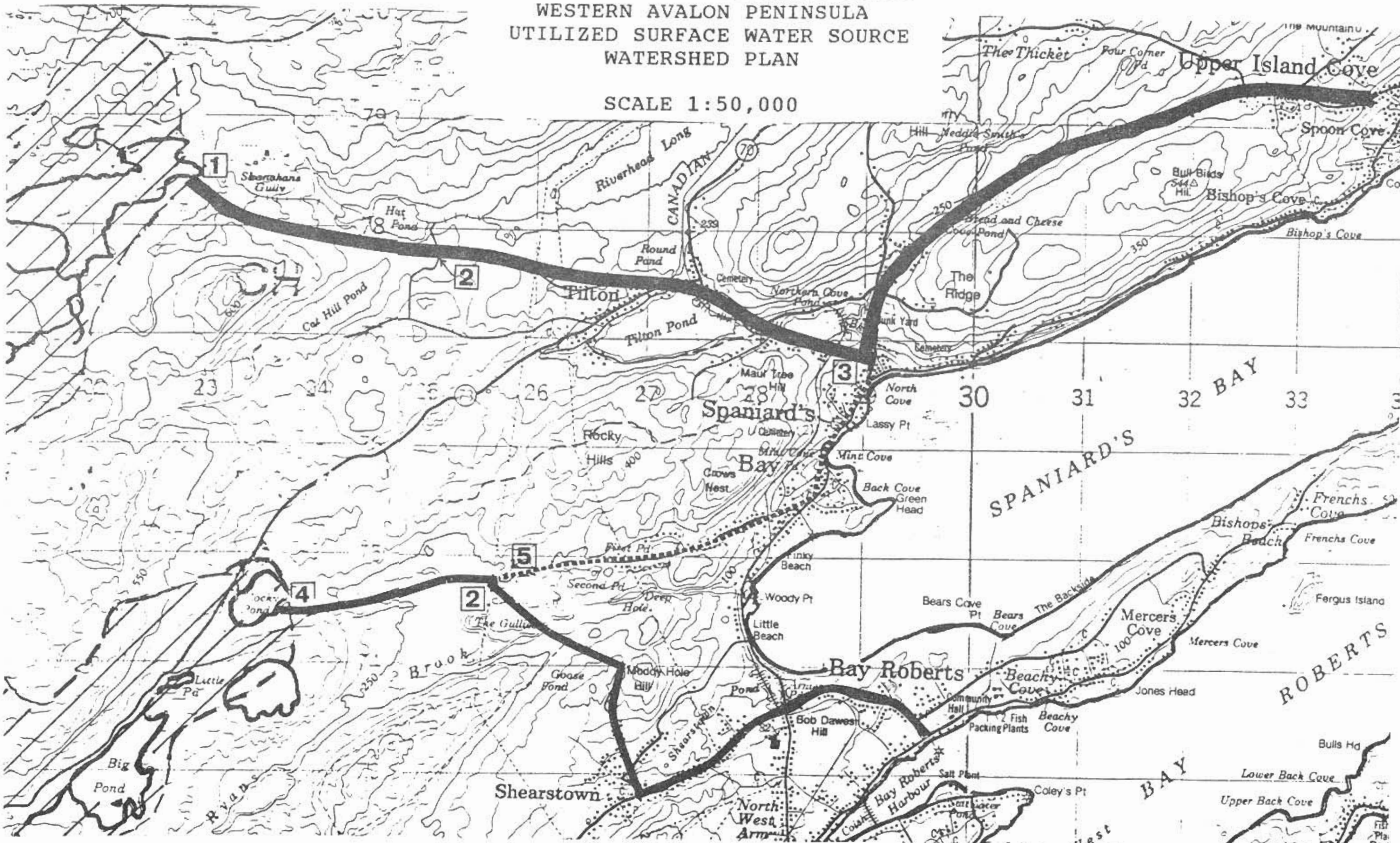
WATERSHED FOR TOWNS OF SPANIARD'S BAY,
TILTON, AND UPPER ISLAND COVE
WESTSIDE

1. Intake
2. Chlorinator

Consulting Engineer: Colin Karasek Ltd. November 1987

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



MAIN LINE SYSTEMS: SPANIARD'S BAY, TILTON, UPPER ISLAND COVE, AND BAY ROBERTS

1. Intake-Spider Pond
2. Chlorinator
3. Pressure Reducing Valve
4. Intake-Rocky Pond
5. Gate Valve, Normally Closed

TRUNK MAIN SIZE

400 MM DIAM.

350 MM DIAM.

300 MM DIAM.

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF VICTORIA

Information:

Town Manager: Vivian Hiscock
Town Clerk: Sharon Snooks
John Evans, P.Eng., Vice President, Newfoundland Light and Power Co.Ltd.(NLP)

Population: 1870 (1981), 1883 (1986)

Water source: Intake on Spout Brook which flows from Rocky Pond (under control of NLP).

NLP control: The NLP has rights to control the watershed and discharges from it. NLP permits municipal use; the demand is slight. However, any increased demands, e.g. serving Salmon Cove, or construction works (see later, new intake) should be referred to NLP (advice from John Evans).

Wells: One Council well serving about 4 houses. About 5 houses on private wells.

DEMANDS (ON NLP SUPPLY)

Domestic: Victoria - about 570 residences.
Salmon Cove - 18 residences.

Commercial: Fourteen local businesses, including tourist accommodation.

Institutional: Three schools, two churches. Number of pupils about 665.

Metering: In chlorination plant. Metered Dec.18 1986 to Jan.13 1987. Average flow 180,100 US gpd, 682 m^3/d. (Given in a report by Harris Associates on Salmon Cove.)

Wastage or losses: None reported.

Variations in demand: Normal domestic variations.

Factors in future demand: About 15 or 20 houses in Victoria require to be serviced with water. Also future demand will occur from an anticipated slight population increase.

Salmon Cove may eventually be served by an extension to the Victoria system. Cost $5 million. About 200 potential connections. (Population 790, see Salmon Cove, wells serviced section of report.)

SUPPLY

The system was developed by NLP to serve their Victoria generator. See attached 1:50,000 map.

1. Control dam: The flow from Rocky Pond to Spout Brook is controlled by an NLP dam on Rocky Pond. This is the basic control for the water supply to the Town.

2. Intake and screen chamber: About 500 m downstream of the dam a concrete structure has been built to take water from the stream bed. The water flows from the river through a 600 x 600 hole in the wall into the screen chamber. The bottom of the screen chamber is 2.4 m below the river bed.

Problems with intake: The design of the intake makes it act like a settling basin for the river. Hence it fills with sludge. Other problems result from large amounts of leaves and other debris which block the screen (not removable). A redesign is recommended. See later.

Status of watershed protection: Protected.

Adequacy of supply, summer 1987: No shortage.

STORAGE/DEMAND FACTORS

Supply volume is under control of NLP. A "run-of-the-river" supply system.

WATER QUALITY

Bacteriological: Dept. Health, Harbour Grace. No problems reported.

Chemical: No data.

WATER TREATMENT

Chlorination: Gas chlorinator, about 200 m downstream of intake. "Advance", by Capital Controls, installed 1974, upgraded 1986. No problems reported with chlorination system.

TRANSMISSION AND DISTRIBUTION

System built about 1974. Intake to chlorinator, 300 mm dia. DI, approximately 200 m. Chlorinator to Main Road, Route 70,(first house),300 mm diam.DI, approximately 1200 m.

Pressure reducing valve at junction of Access Road and Route 70. Pressure is reduced for connections to the east. Pressure is maintained for connections to the west.

Remainder of distribution system is DI down to 100 mm diam, with fire hydrants.

A continuous pumping station was installed in 1987, to pressurize the water to serve 36 houses connected to the system at higher levels.

Factors in replacement cost estimate:

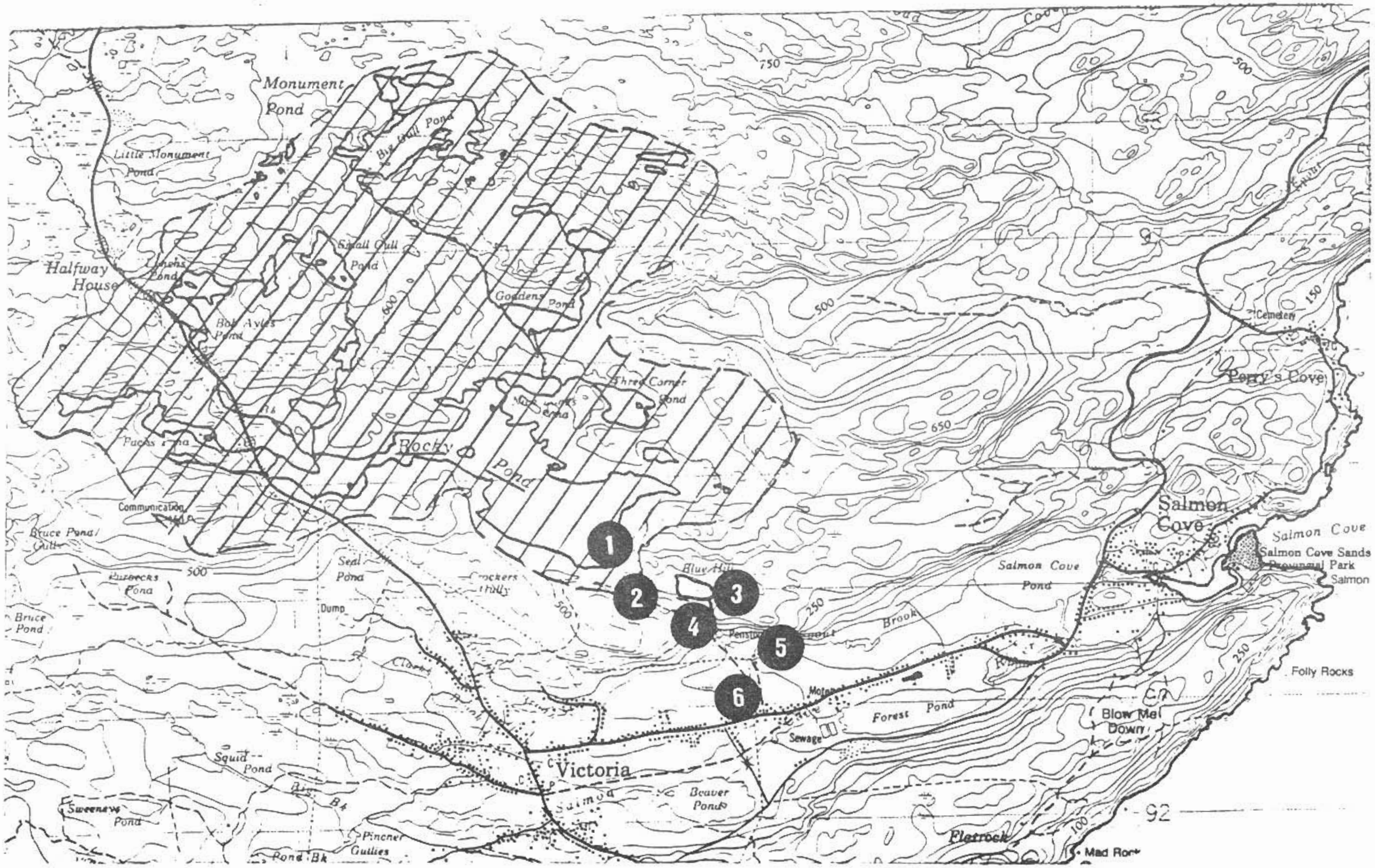
Intake structure
1400 m of 300 mm DI transmission main
Chlorination
About 650 connections

COMMENTS/PROBLEMS

Intake: This structure needs rectification so that it can be more readily cleaned and maintained. (The well has not been cleaned since it was installed.) The following proposal should be investigated. A concrete dam about 7.5 m long and 1.5 m high should be built between the screen chamber and the river. This dam should have a gate to cut off the flow to the screen chamber to permit cleaning. Preferably the screen chamber should be duplicated so that one can be used while the other is being cleaned. Removable screens should be intalled to facilitate cleaning.

FUTURE CAPITAL COSTS

1. Improve intake, see above. $40,000
2. Extend system into Salmon Cove?



LEGEND
1. NLP Control Dam, Rocky Pond
2. Intake, Town of Victoria water supply
3. Blue Hill Pond Dam. This controls flow into NLP pipeline to generator at the foot of the hill.
4. Chlorinator
5. NLP Powerhouse
6. Pressure Reducing Valve

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1 : 50,000

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF WHITBOURNE

Information: Jan.1988
Wanda Lynch: Town Clerk
John Vokey: Maintenance Staff

Population: 1233 (1981); 1051 (1986)

Water source: Run-of-river intake, Hodges River (sometimes called Rocky River).

Wells: Boys' Home has drilled well. About 44 houses served by private wells.

DEMANDS ON SURFACE SOURCE

Consumer demands:

Domestic	385 homes
Businesses	6
School complex	600 people
Clinic	
Govermnent offices	about 15 workers
Group Home	6 occupants

Wastage or losses: Probably extensive through pipe leakages. About 15 leaks/year are required in the main lines. The mains are DI. Breakages are either a clean shear right across or a longitudinal split. Cause of the frequent breaks is unknown. In addition, bleeding to resist freeze-up of house connections is carried out by some of the older houses this time of year.

Metering: Cumulative metering is not done but it could be carried out at the pumping plant, with some modifications. Flow metering shows an average flow of 8 to 12 L/s. On day of survey, one pump 15 hp operating the flow was 10 L/s.

Comment on consumption: The flow of 19 L/s (132 Igpm) represents a daily consumption in the order of 700 L (150 Ig). This is high and suggests either excessive use, or losses. There are no industries using large quantities of water.

fUTURE DEMANDS: Growth of about 5 new connections per year has been the pattern in recent years. The 44 units on private wells are probably too far away from the main system to be connected.

SUPPLY

Hodges River. A perforated pipe or well screen is buried in the bed of the river.

<u>Dam:</u> No dam.

<u>Intake:</u> The intake buried in the river leads by gravity to a wet well in the pumphouse.

<u>Screens:</u> The intake acts as a screen, but there is also a screen in the wet well.

<u>Adequacy of supply, summer 1987:</u> No real shortage although W.L. in river dropped below normal. A temporary low dam of granular material was dumped downstream of the intake to pond water over the intake.

<u>Status of watershed protection:</u> Not recorded as protected.

STORAGE/DEMAND

<u>Ways to increase storage:</u> The river could be raised by a low dam about 70 m long. This would likely involve raising the pumphouse.

WATER QUALITY

<u>Bacteriological:</u> Department of Health, Whitbourne. Generally satisfactory disinfection.

<u>Chemical:</u> Water is potentially corrosive. Water highly coloured in summer.

<u>Problems:</u> A musty taste is sometimes reported. The corrosive potential of the water is of concern because of pipe breakages.

WATER TREATMENT

A Dulcometer/Essex system which is a flow paced impulse device, provides simple chlorination (by gas) and soda-ash injection. The injection of the chlorine solution and dissolved soda ash is into the wet well.

TRANSMISSION AND DISTRIBUTION

<u>Pumps:</u> The system is a batery of three pumps (7.5 hp, 15 hp and 15 hp) working on the continuous pumping principle. There are automatic controls, but during the time of the survey the pump on-off controls were on manual. The system pressure is kept at 60 psi by automatic control valve which passes water pressurized up to 160 psi by the pumps. With a single pump, when the pump pressure drops to about 100 psi, a larger pump or second pump is turned on. The reason for using manual on-off for the pumps at the time of the survey is not known. The original pump controls (built about the mid 70's) were rehabilitated about 1984.

Standby diesel: There is a standby diesel unit in a separate building (which was not inspected during the survey).

Problem: The pumphouse is built rather low and has flooded in the past. Sometimes ice jams the river and raises the W.L.

Mains: These are DI with copper building connections. For reasons unknown, possibly lack of proper bedding during installation, this system has been troublesome since installation.

COMMENTS/PROBLEMS

This has been a troublesome system. Major corrosion was found in the building connections a few years ago. The soda ash treatment (installed in 1982) is expected to help this problem.

The frequent breakages have been mentioned. Also, from the flow data one is led to suspect that there is an excessively high water consumption. (This should be investigated if not already done.)

All these factors make the system expensive to maintain.

Pumping costs would be reduced by connecting to a pump gravity-tank system, but this would incur substantial capital costs (mainly for the tank).

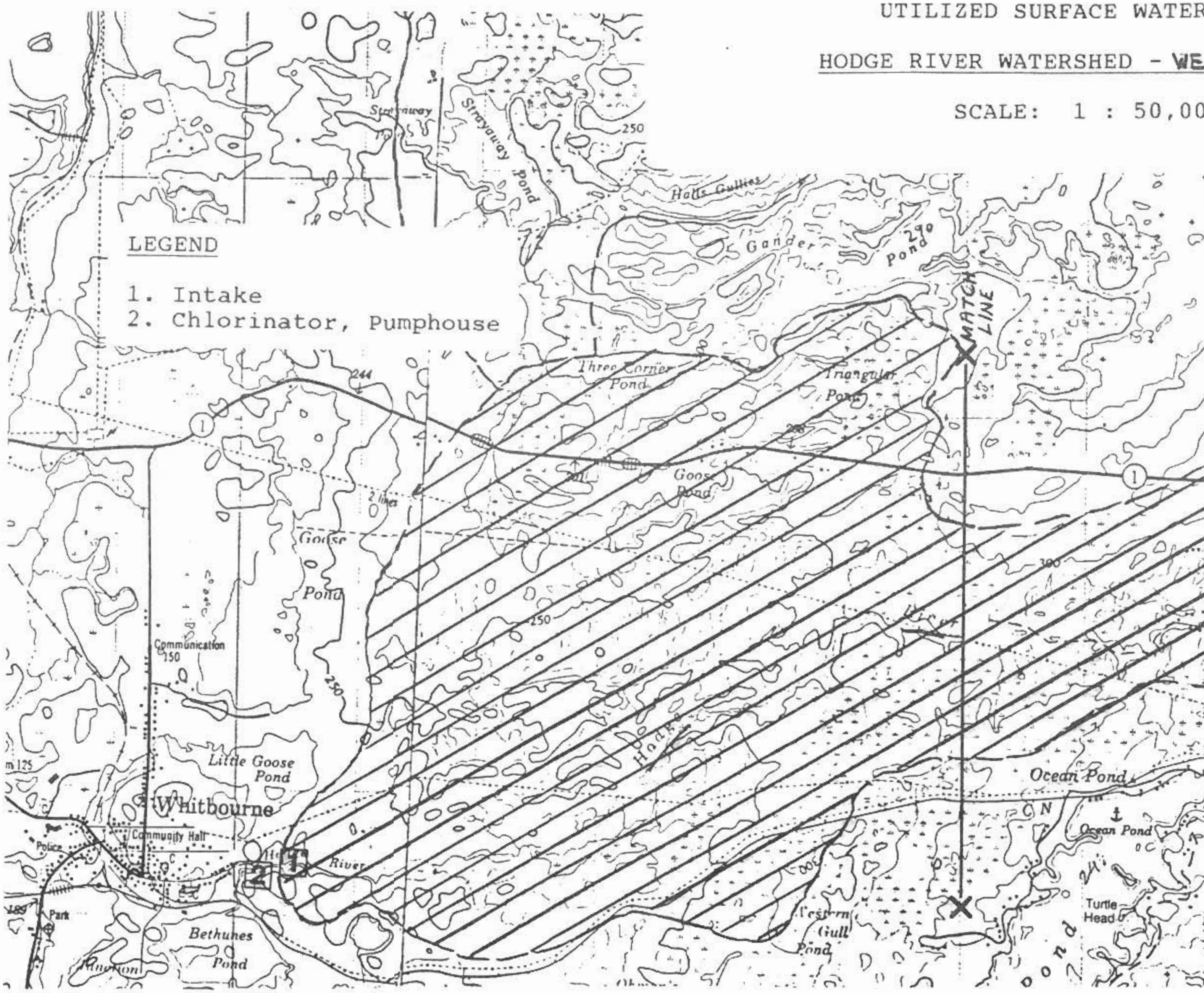
FUTURE CAPITAL COSTS

Could be extensive for mains replacement and other measures to reduce O and M costs.

REGIONAL WATER RESOURCE STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

HODGE RIVER WATERSHED - WEST PORTION

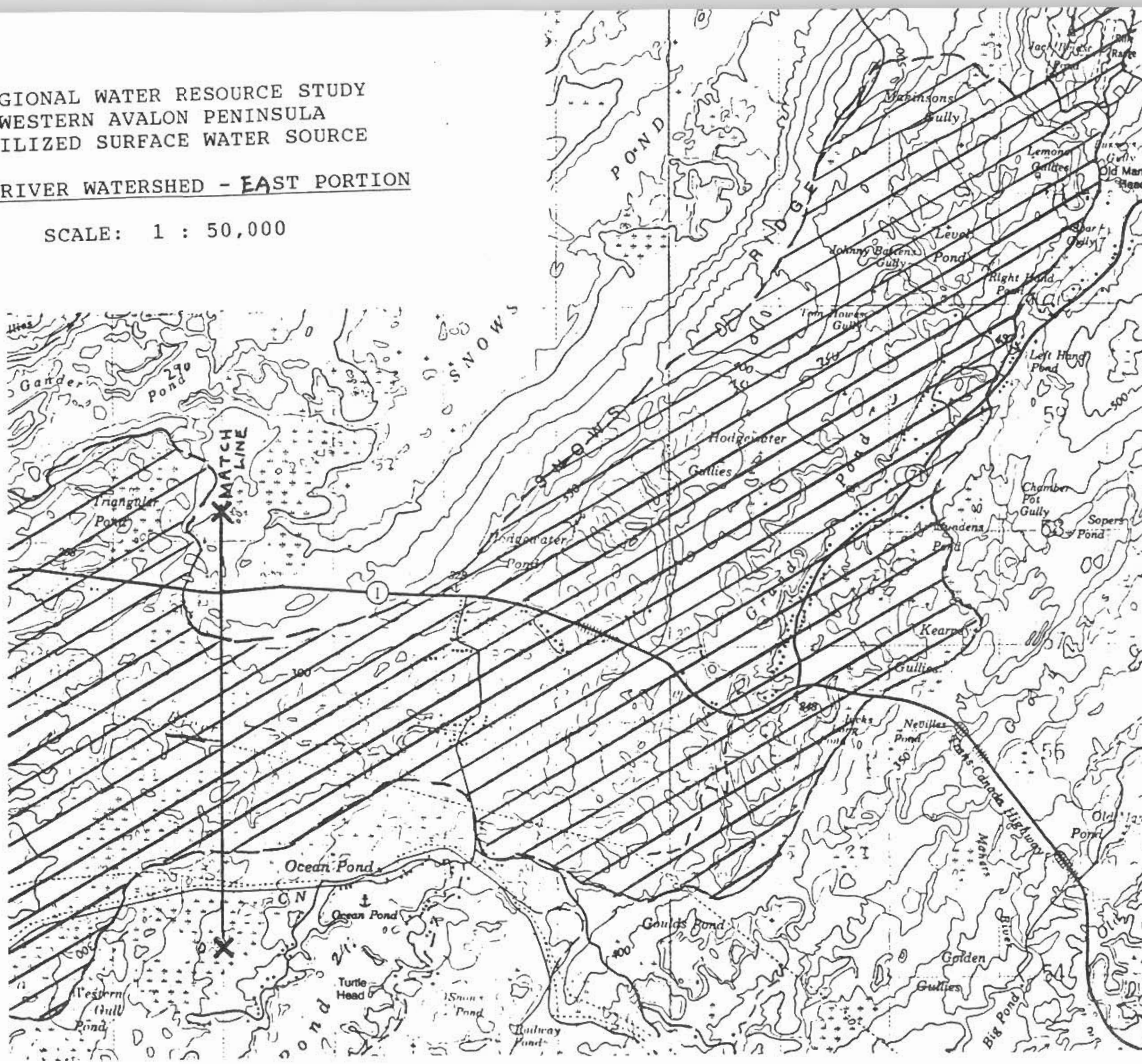
SCALE: 1 : 50,000



REGIONAL WATER RESOURCE STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE

HODGE RIVER WATERSHED - EAST PORTION

SCALE: 1 : 50,000



MUNICIPALITY - SURFACE WATER SUPPLY

COMMUNITY OF WHITEWAY, WHICH INCLUDES WHITEWAY AND EASTERN CORNER

Information:
Fred Burgess, Whiteway
Roy Legg, Eastern Corner
Walter Vere-Holloway, DMA

Population: 291 (1981) for total community

Water sources: South: Jimmy Rowe Pond - pump supply.
North: Long Pond (under construction) proposed pumped supply.

Wells: The north area is presently served with three Council wells.

DEMANDS

Existing, South: About 25 houses, possibly two or three extra houses might connect.

Metering: No metering.

Wastage or losses: None reported.

Factors in future demand:
South: Could total say 30 houses.
North: About 200 people
Cavendish: Potential 350 people. Cavendish is the settlement immediately to the north of the Community of Whiteway.
No industrial loads of any significance are anticipated.

SUPPLY (SOUTH)

Jimmy Rowe Pond, with a large watershed. Highway crosses western part of watershed and also extreme northeast of watershed.

Watershed protection: Whole watershed protected.

Dam: No dam.

Spillway: Natural brook.

Intake: Pipe 75 mm diam. about 120 m into pond from the pumphouse.

Adequacy of supply, summer 1987: Adequate.

STORAGE/DEMAND (SOUTH)

Live storage head: Depends on depth of intake. Assume 1.5 m.

WATER QUALITY (SOUTH)

Bacteriological: Satisfactory. Dept. of Health, Harbour Grace.

Chemical: No information.

Problems: None reported.

WATER TREATMENT (SOUTH)

Chlorinator activated by water service pump. Uses Javex-12. Chlorinator building is located at edge of pond.

Problems: May be insufficient chlorine contact time (not investigated).

TRANSMISSION AND DISTRIBUTION (SOUTH)

Pump: One pump with hydropneumatic tank (four tanks), pressure switch control.

Main line: 50 mm diam.

COMMENTS/PROBLEMS (SOUTH)

None apparent.

FUTURE CAPITAL REQUIREMENTS

Minimal.

SUPPLY (NORTH)

Long Pond. No other users draw from this pond as far as is known.

Status of Watershed Protection: Not protected.

Comment: Long Pond is a large pond which is used for wood hauling in winter and motor boating in summer, according to local report.

PROPOSED TRANSMISSION/DISTRIBUTION

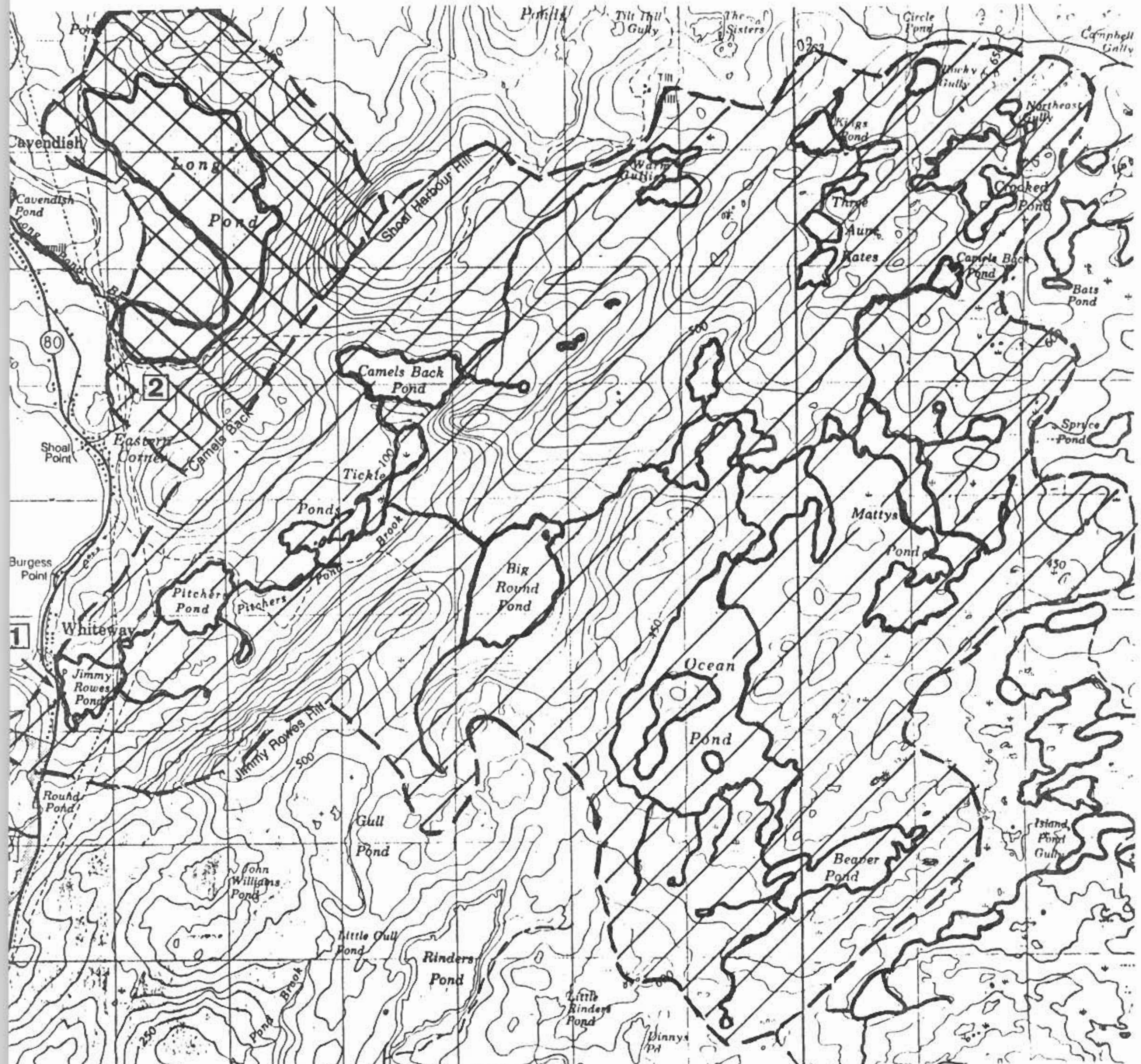
A 150 mm line is being installed, starting at the pond. Pumps will be required.

FUTURE CAPITAL REQUIREMENTS

Will be sizeable, particularly if Cavendish is served. Say $1.6 million.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



1. INTAKE, CHLORINATOR, PUMPHOUSE, EXISTING WHITEWAY
2. SYSTEM UNDER CONSTRUCTION FROM LONG POND

Consulting Engineer: Colin Karasek Ltd. November 1987

MUNICIPALITY - SURFACE WATER SOURCE

TOWN OF WINTERTON

Information:
1. Mayor: Irvin Green
2. Deputy Mayor: John Pinhorn
3. Foreman: Sandy Mugford
4. Town Clerk: Joan Hiscock

Population: 753 (1981), 749 (1987)

Water source: Western Brook

DEMANDS

Domestic: About 200 connections for year round houses, plus 68 for summer use only.

Commercial: Local needs.

Educational: Elementary school (serving Winterton, New Perlican, Heart's Content, Turk's Cove), with about 220 pupils.

Industrial: Fresh fish and salt fish plant, Green Seafoods Ltd. Has an approved salt water line and two 100 mm connections to the fresh water system. New construction work includes a fish dryer. Plant employs up to 100 employees.

Wastages or losses: None reported.

Variations in demand: Mainly due to fish plant.

Metering: No metering carried out.

Factors in future demand: No major population growth is expected. About six houses remain to be hooked up to water system. Expansion to plant might occur, but the two 100 mm lines will suffice. Almost all houses have main sewer.

SUPPLY SOURCE

An abstraction dam on Western Pond Brook, fed by Western Pond, which is a natural pond fed by other ponds within an isolated watershed. The Town is the sole user of the watershed.

Status of watershed protection: Protected.

Dam and spillway: Concrete gravity dam, built about 1966. Dam is about 1.8 m high and the top of the dam 6 m wide is the spillway, excepting for a central sluice gate 750 mm wide vertically operated within guides.

Reservoir: The reservoir was excavated from the bed of the brook, about 3 m wide at the water surface. Vertical concrete walls were built to line the sides of the excavation to about 25 to 30 m upstream. These were later raised a foot or so, by concrete block walls. Storage volume about 400 m^3 (estimated by Karasek).

Intake: Intake is a pipe through the dam. Head over top of intake pipe to spillway, measured from design drawing as 1140 mm. Intake is 300 mm CI pipe, with coarse screens.

Problems with intake: As freezing takes place in the reservoir before the surface is frozen over solid, the ice particles in the water are drawn down to the intake and there solidify and block it. A larger and deeper reservoir might reduce ice problems at the intake. Also, a much larger intake, lying along the bottom on a gravel pad, could be used, e.g. well screen. This measure would reduce the flow velocity into the intake pipe, and therefore may help to reduce the drawdown of ice particles.

Screens: The screen chamber is in a building adjacent to the dam. Two sets of screens 1050 x 1350 mm. (Information from design drawings).

Adequacy of supply summer 1987: The flow from Western Pond practically dried up and the storage reservoir level almost dried up. Fresh water consumption in the fish plant was curtailed and salt water used instead. Council issued a Notice to Householders to conserve the use of water.

STORAGE/DEMAND FACTORS

Live storage head: At intake at dam about 1.15 m (scaled from design drawing). Live storage volumes about 400 m^3 + run of river.

Ways to increase live storage: Western Pond in its natural stage has only about 300 mm of live storage before the outlet brook closes off. The proposal is to by-pass this with a water conduit pipe. Also the dam at the reservoir could be raised. (See following notes on "Comments/Problems").

WATER QUALITY

Bacteriological: Dept. of Health, Harbour Grace, tests for bacteria and chlorine residual. Usually about 1 to 2 ppm residual. When water was low in the summer of 1987 a "boil order" was issued. No explanation found for the high bacteria. May be through having to use bottom waters heavy with organic micro organisms and growths.

Chemical: No tests available. Water appears of potable quality in the glass.

Problems: The problem of deterioration in bacteriological quality when the level was low has been mentioned.

Fish plant: The fish plant has a gas chlorinator which increases the chlorine dosage to 8 ppm for general purposes or to 15 to 20 ppm for washdown.

WATER TREATMENT

Formerly there was a gas chlorinator (Wallace and Tiernan). This was replaced a year or so ago with a fixed rate injection chlorinator (with manual adjustment to the injection rate), using bleaching power in solution. The dosage is varied by increasing or decreasing the injection rate and by increasing or decreasing the volume of calcium hypochlorate in the solution mix tank. The chlorinator is about 1000 m upstream of the first connection through a 250 mm AC main.

TRANSMISSION AND DISTRIBUTION

The transmission main is 250 mm AC about 1500 m long into the town where it branches into two 200 mm mains. The chlorinator is about 400 mm downstream of the dam and screen building. The distribution system includes fire hydrants.

FACTORS IN SYSTEM REPLACEMENT COST ESTIMATE

- dam and small reservoir
- 1500 m of 250 mm supply main
- chlorination plant
- screen chamber and building
- access road

COMMENTS/PROBLEMS

Shortage of supply: Western Pond is amply deep for a drawdown of a metre or more. Hence it is proposed to construct an intake into the pond at a depth of say 1.5 m and build a water transmission line from the intake to drop by gravity to a point in the river below the pond. The river drops fairly rapidly from the pond. The length of pipe required would be about 80 m from the downstream discharge to the edge of the pond. The location of the intake needs to be determined by survey. The conduit would be closed by a sluice gate or valve. The estimated cost of this work is $30,000. This pipeline will be opened only when required to fill the downstream reservoir.

Improvements at intake to reduce ice blockage: Try a much larger intake to reduce intake velocity - see "Problems with Intake". Approximate cost $2000.

Improvements to storage: Instal timber or concrete stop-logs on top of existing dam to raise WL by about 450 mm. Check and patch joints in concrete block side walls. Estimateed cost $2000.

Water quality: The quality of the water should be checked to see if it is aggressive to asbestos cement water mains. If this is found to be the case then carbonate of soda or an appropriate alkali should be added at the chlorination building. Also the inside of the mains may need to be cleaned out (pigged).

Chlorination: The present chlorination works well and is simple to use but is not flow paced. A simple type of flow paced chlorinator uses a flow driven impeller inside the pipeline which creates an electric signal which is used for a chlorine liquid dosometer. This same device can also be used to simultaneously inject another
chemical liquid, e.g. alkali solution. See "Water Quality", above. Estimated cost, using same building, $20,000.

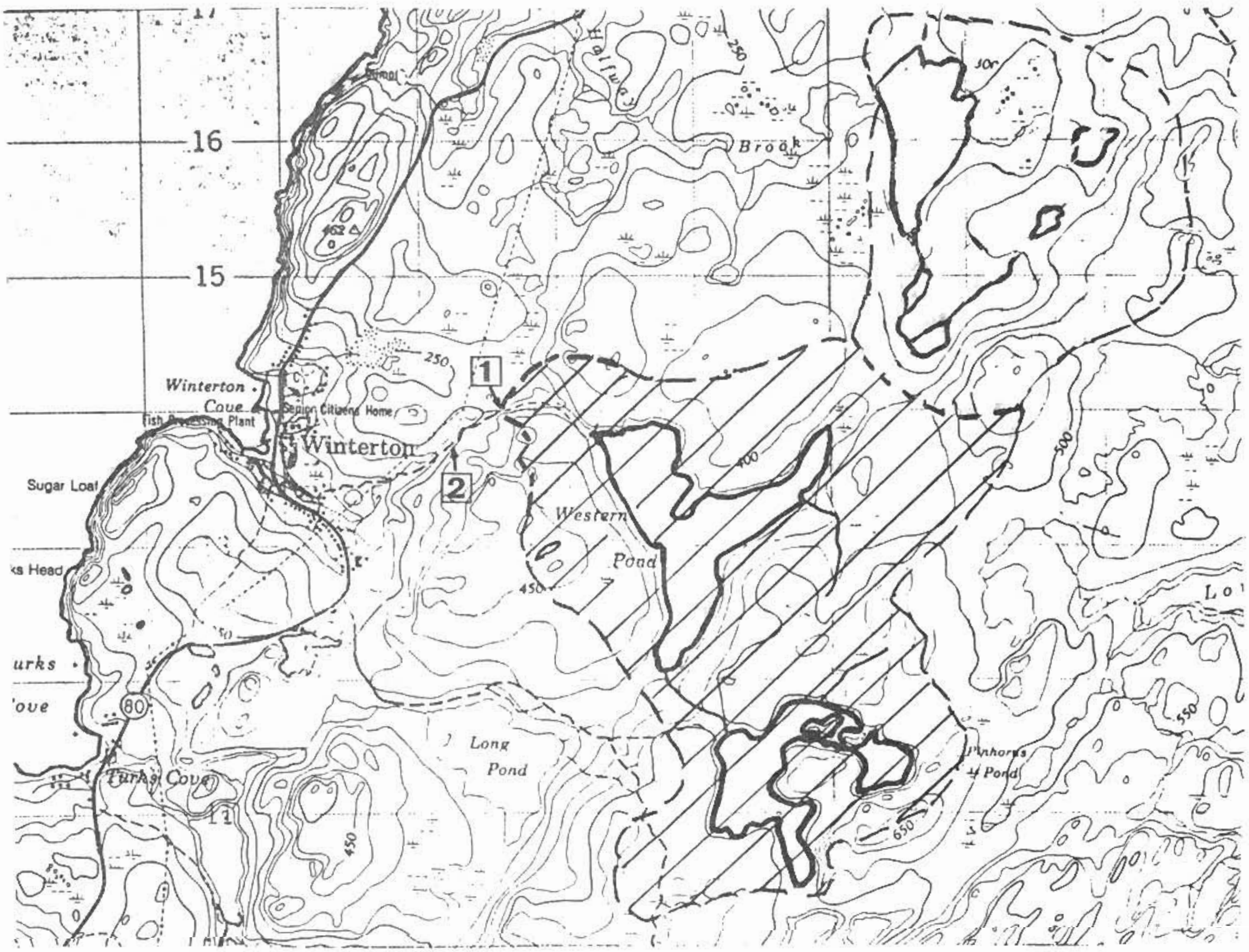
Environmental: The dam on Western Brook has no fish ladder. The extent of fish migration (brook trout) is not known, hence the requirement for a fish ladder is not known. (Neil Woodman, Federal Fisheries Officer, Harbour Grace)

FUTURE CAPITAL REQUIREMENTS

See "Comments" above. Say $55,000.

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA
UTILIZED SURFACE WATER SOURCE
WATERSHED PLAN

SCALE 1:50,000



1. Intake
2. Chlorinator

TOWN OF WINTERTON

Consulting Engineer: Colin Karasek Ltd. November 1987

LOCAL GOVERNMENT- GROUNDWATER SOURCE

TOWN OF AVONDALE

Information January, 1988
Clerk: Doreen Cantwell

Population: 890 (1981)

COUNCIL WELLS: 1

Type: drilled
Number of connections: 20
Branch of Dept. of Health testing: Holyrood
Chlorinator working

Bacteriological Quality: Satisfactory

Quantity: adequate

PRIVATE WELLS: 250 (approx.)

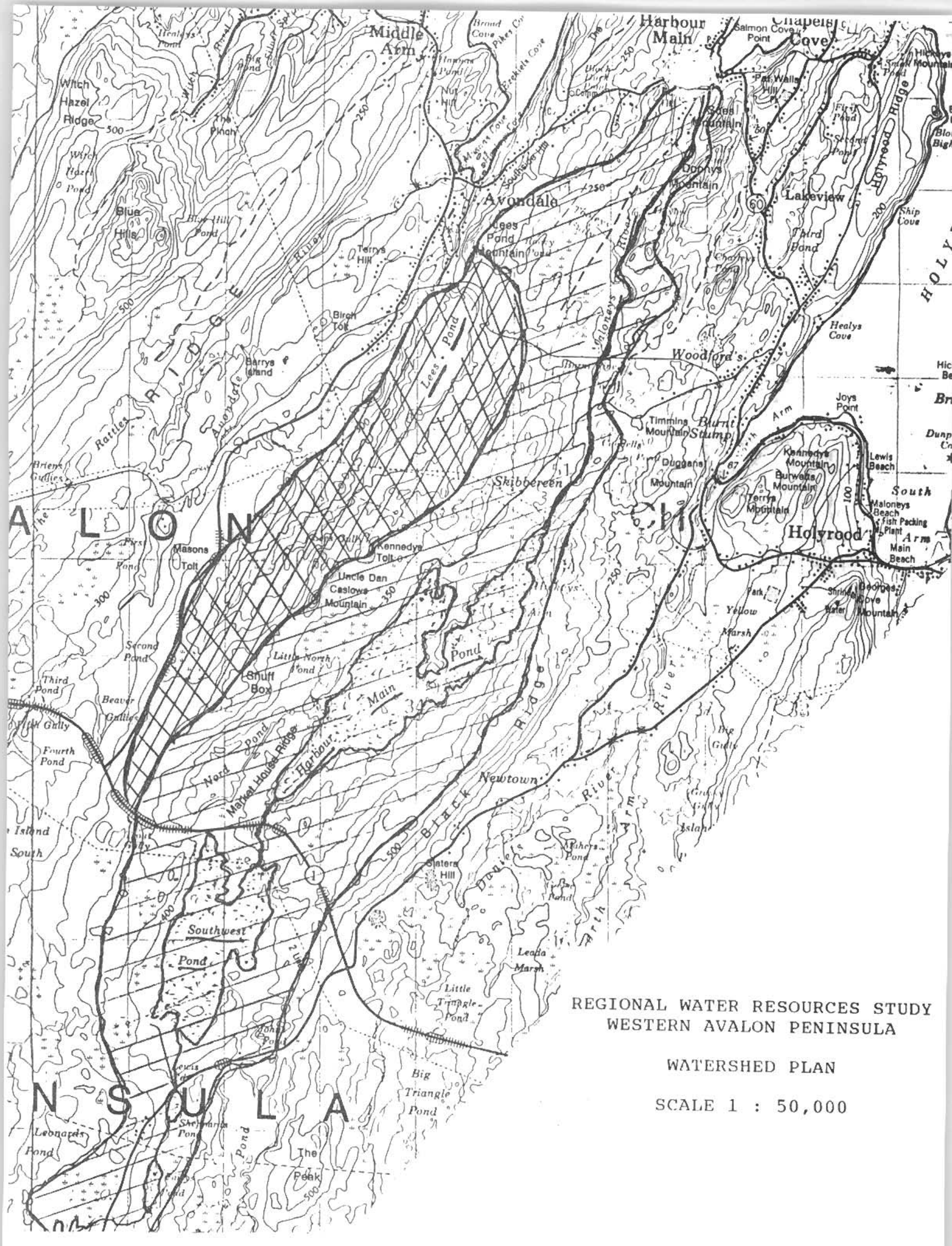
Number of connections: 250 (approx.)

Other wells: Three schools, elementary, junior high and central high, have their own wells.

Quantity: shortage with at least 50% of wells, summer 1987.

Alternative source used in emergencies: other wells

FUTURE PLANS: Another source needed, according to clerk: more drilled wells, Lee's Pond likely future sources of water.



REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA

WATERSHED PLAN

SCALE 1 : 50,000

LOCAL GOVERNMENT-GROUNDWATER SOURCE

COMMUNITY OF BISHOP'S COVE

Information January, 1988
Mayor: Wallace Williams

Population: 369 (1981)

COUNCIL WELLS: 1

Type: Drilled
Number of connections to houses: 1
Connections other than houses: none
Branch of Dept. of Health testing: Harbour Grace
Chlorinator working

Bacteriological Quality: Satisfactory

Quantity: adequate

PRIVATE WELLS: 65 (approx.)
Number of connections: 80 (approx.)
Connections other than houses: none

Quantity: About 15 wells went dry, summer, 1987.

Alternative sources used in emergencies: Other private wells

FUTURE PLANS: New source needed, according to Mayor. Connection to Upper Island Cove Water System most likely future source of water.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT-BRIGUS JUNCTION

Information-January, 1988
Chairman: Ronald Rose

COUNCIL WELLS: 2

Type: drilled
Number of connections: 2
Connections other than houses: none
Branch of Dept. of Health testing: Holyrood
Chlorinators working

Bacteriological Quality: Satisfactory

Quantity: Adequate

Comment: There are three other drilled wells but these yielded insufficient water to be of use.

PRIVATE WELLS: 20 (approx.)

Number of connections: 20 (approx.)
Connections other than houses: none

Bacteriological Quality: About half of these wells are tested each month.

Quantity: 8 (approx.) wells ran dry, summer, 1987.

Alternative sources used in emergencies: new private wells dug, private wells shared.

FUTURE PLANS: Supply adequate at present but more drilled wells (government) will be necessary in the future.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

COMMUNITY OF BRYANT'S COVE

Information January, 1988
Clerk: Louise Noseworthy

Population: 380 (1981)

COUNCIL WELLS: 2

Type: drilled
Number of Connections: 55 (approx.)
Connections other than houses: none
Branch of Dept. of Health testing: Harbour Grace
Chlorinators working

Bacteriological Quality: Satisfactory

Quantity: adequate

PRIVATE WELLS: 60 (approx.)
Number of connections: 60 (approx.)
Connections other than houses: 1 school, 1 lounge

Quantity:50 (approx.) had dry wells, summer, 1987.

FUTURE PLANS: Artesian well source needed, according to clerk. No study done.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT - CAVENDISH

Information January, 1988
Chairman: Victor Bishop

COUNCIL WELLS: 7

Type: drilled
Number of connections: about 90
Connections other than houses: none
Branch of Dept. of Health testing: Harbour Grace
Chlorinators working at each well

Bacteriological Quality: Satisfactory

Quantity: Adequate. No shortages in 1987.

PRIVATE WELLS: About 9

Number of connections: About 9
Connections other than houses: none

Quantity: Adequate

FUTURE PLANS: The water lines to the wells, which were built in 1967, are deteriorating according to Chairman. Probably the best solution is a new system from a surface water source (Long Pond). No study has been done.

See also report on Whiteway.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF CHANCE COVE

Information: August 1987 and January, 1988
Mayor: David Smith
Town Clerk: Debbie Collet

Population : 498 (1981)

COUNCIL WELLS: 4

Type: drilled

Number of Connections: 80

Connections other than houses: 1 church

Branch of Dept. of Health testing: Whitbourne

Chlorinators working. (Dept. of Health reports chlorinator on well #3 is not functioning in a satisfactory manner.)

Bacteriological Quality

Boil orders issued summer, fall 1987 to 30 houses. (Well #3)

Quantity: Generally adequate. Well in Lower Cove, dry in summer 1987.

Quality: One well has problem with taste and colour.

Alternative water sources used in emergencies: private wells

PRIVATE WELLS: 125 (approx.). no specific information available, except as noted below.

Fish plant has a well.

FUTURE PLANS: None. Water supply adequate.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF CHAPEL ARM

Information August, 1987
Mayor: Ann Vaters

Population: 689 (1981)

COUNCIL WELLS: none

PRIVATE WELLS: 150 (approx.)

Number of connections: 150 (approx.)
Connections other than houses: 2 churches, school, supermarket, drug store, clinic, 2 service stations.

Bacteriological Quality: Adequate. A few years ago some were contaminated.

Quantity: shortage, summer 1987.

Alternative water sources used in emergencies: Brooks.

FUTURE PLANS: According to Mrs. Vaters a sanitary sewer system is a priority, to prevent contamination of wells. No survey carried out.

LOCAL GOVERNMENT -GROUNDWATER SOURCE

TOWN OF CLARKE'S BEACH

Information January, 1988
Clerk: Joan Wilcox

Population: 1009 (1981), 1200 (1987). Almost entirely residential growth.

COUNCIL WELLS: 11

Type: drilled
Number of connections: 110 (approx.)
Connections other than houses: 1 store, 1 church, one 7-unit apartment building.
Branch of Dept. of Health testing: Bay Roberts
Chlorinators on 2 wells. (Provincial regulation is that all new wells have to be chlorinated.)

Bacteriological Quality: Satisfactory

Quantity: adequate

PRIVATE WELLS: 300 (approx.)

Number of connections: 300 (approx.)
Connections other than houses: none
A number of the dug wells are showing up with high bacteria counts.

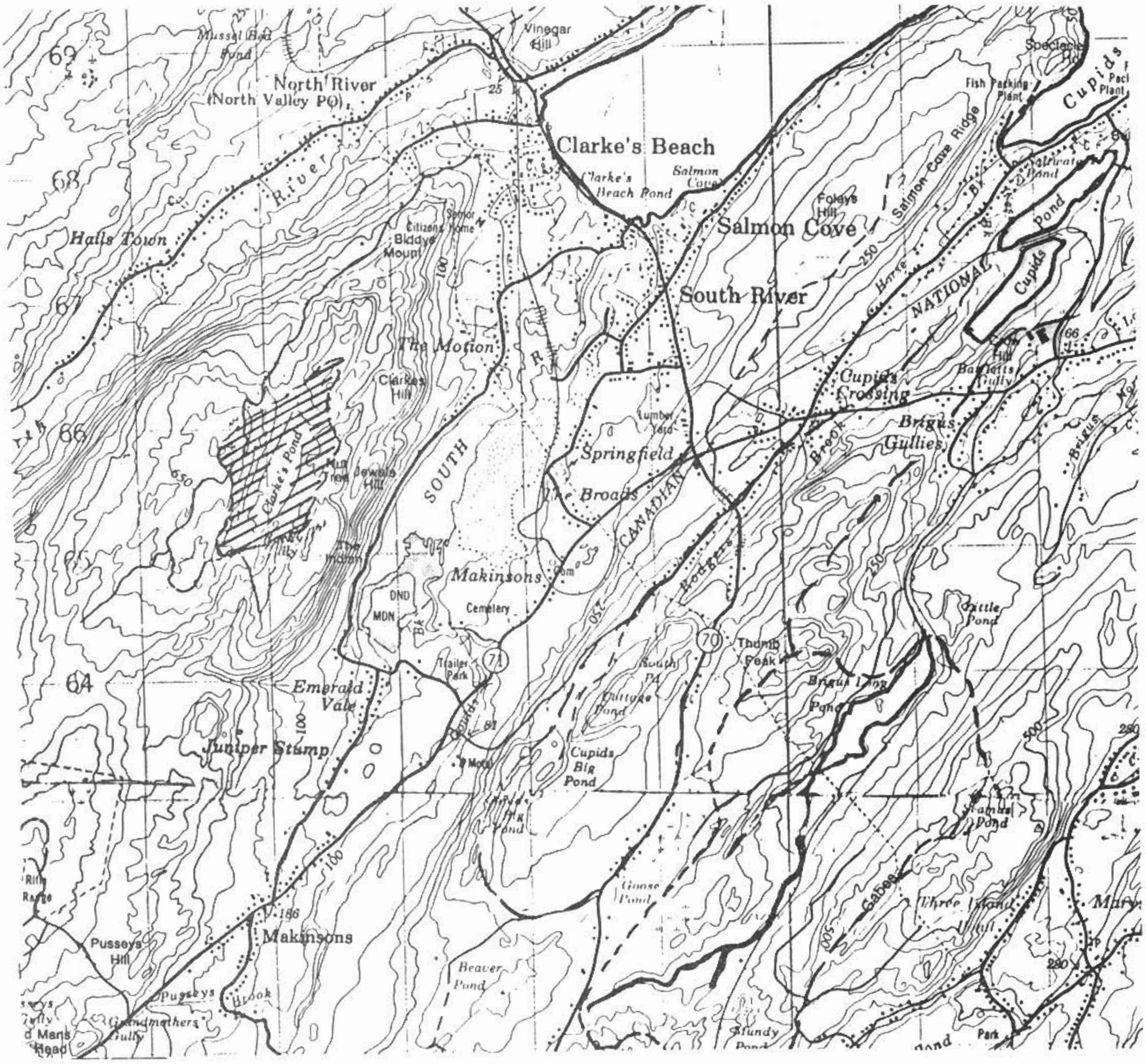
FUTURE PLANS: Surface water source needed to meet population growth, according to clerk. Study 1985 - E.K. Jerret & Associates, Bay Roberts. Clarkes Pond is the recommended source. The survey covered serving only Clarkes Beach (not serving North River, for example.)

PROBLEMS: Some wells are showing salt water intrusion. Some shallow wells are experiencing contamination and are unfit for drinking. (Clerk)

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA

WATERSHED PLAN

SCALE 1 : 50,000



Consulting Engineer: Colin Karasek Ltd. January 1988

LOCAL GOVERNMENT-GROUNDWATER SOURCE

COMMUNITY OF COLINET

Information January, 1988

Population (1981): 318

COUNCIL WELLS: none

PRIVATE WELLS: 55 (approx.)

No detailed information available. Supply believed to be adequate.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

COMMUNITY OF COLLIERS

Information: August 1987 and January, 1988
Mayor: Joseph Trahey
Clerk: Mrs.Geraldine Whelan-Hawco

Population: 832 (1981)

COUNCIL WELLS: 2

Type: drilled (in 1986/87)
Number of connections: 35
Connections other than houses: 3 stores
Branch of Dept. of Health testing: Holyrood
Chlorinators working

Bacteriological quality: Adequate

Quantity: adequate

PRIVATE WELLS: 180 (approx.)

Quantity: 90 (approx.) houses had dry wells, summer 1987. Fish plant has its own well.

Alternative sources used in emergencies: private wells

FUTURE PLANS: More wells needed, according to Mayor. Feasibility study done by Mayor.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF COME BY CHANCE

Information January, 1988
Mayor: Betty Gilbert
Deputy Mayor: Rex Benson
Clerk: Patsy Smith

Population: 337 (1981)

COUNCIL WELLS: none

PRIVATE WELLS: 75 (approx.)

Number of connections: 75 (approx.)

Bacteriological Quality and Quantity: 50% of wells contaminated, 70% have shortage, according to Mayor. No boil orders were issued in 1987.

Alternative source used in emergencies: other private wells

FUTURE PLANS: Another source needed, either drilled wells or dug wells most likely future source.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF CONCEPTION HARBOUR

Information August, 1987
Clerk: Anne M. Poole

Population: 904 (1981)

COUNCIL WELLS: 1 (drilled in summer 1987)
To be connected as soon as possible.
Type: drilled

Quantity: Well ran dry, summer, 1987.

PRIVATE WELLS: Number not known.

Type: drilled and dug
Connections other than houses: school, community hall both have drilled wells. New houses built under NLHC also have drilled wells.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF CUPIDS

Information January, 1988
Clerk: Leonard Martin

Population: 864 (1981)

COUNCIL WELLS: none

PRIVATE WELLS: 250 (approx.)

Number of connections: 250 (approx.)
Connections other than houses: 1 church, 1 fire hall, 1 town hall

Bacteriological Quality: Boil orders issued, 1987, Department of Health, Bay Roberts.

Quantity: 3o or 40 (approx.) dry summer, 1987.

Alternative source used in emergencies: private wells

FUTURE PLANS: Need another source, according to Clerk. Connection to Brigus Water Supply System most likely future source of water. Study-E.K Jerrett & Associates, Bay Roberts.

Fish Plant: Has a surface water supply from Cupids Pond.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT- FOREST FIELD-NEW BRIDGE

Information January, 1988
Chairman:

COUNCIL WELLS: none

PRIVATE WELLS: 28

Supply adequate

LOCAL GOVERNMENT - GROUNDWATER SOURCE

COMMUNITY OF FOX HARBOUR, PLACENTIA BAY

Information
Katherine Murray, Clerk of Council
Files, Colin Karasek Ltd.

Population: 538 (1981), 471 (1986)

COUNCIL WELLS: nil

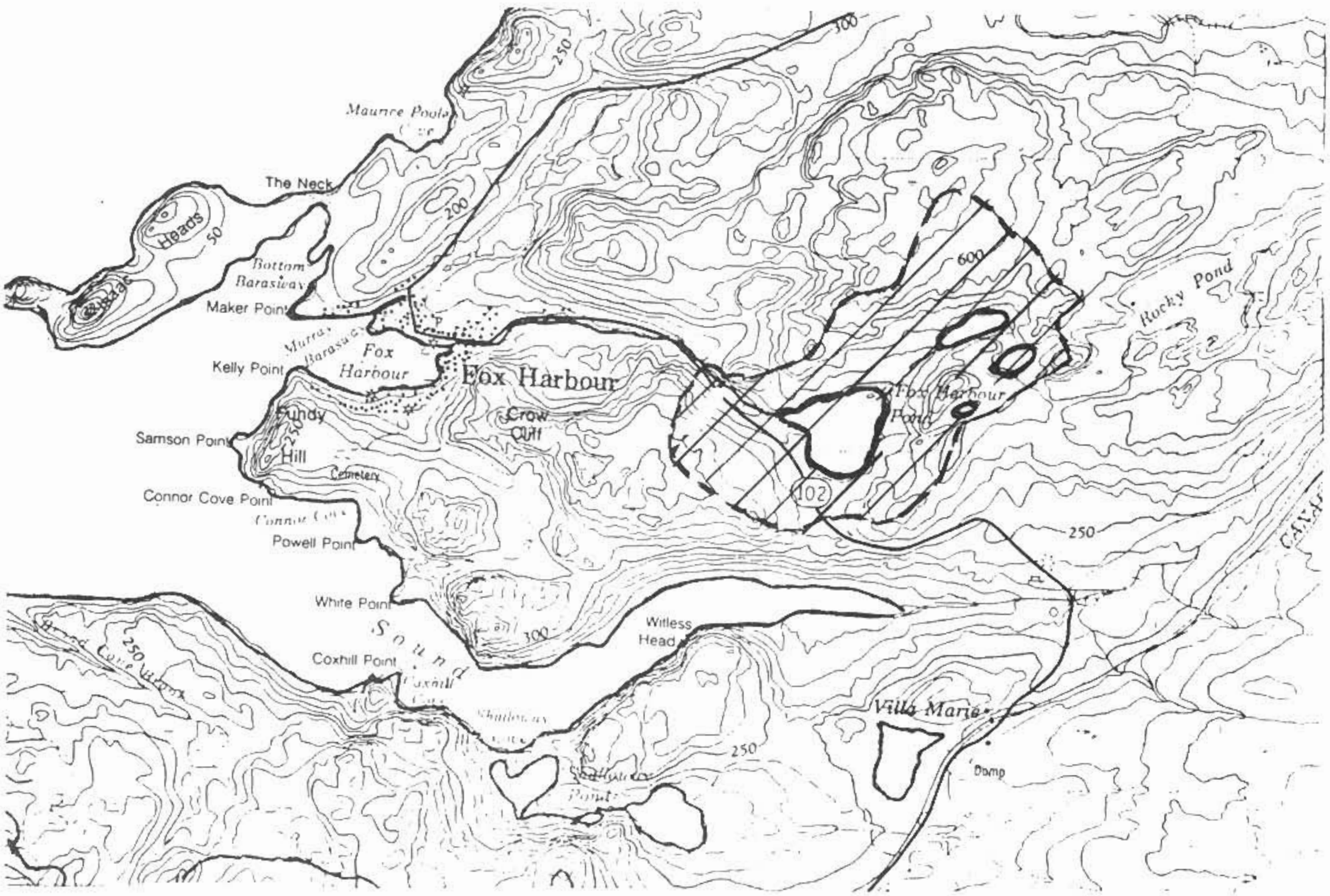
PRIVATE WELLS: All houses are served by private wells, also the school and church. About 100 wells.

Problem: Mostly the wells provide a satisfactory water supply. Contamination by sewage and surface run-off has occurred in a few cases.

FUTURE PLANS; When funds permit,a gravity supply could be provided from Fox Harbour Pond. (See attached watershed plan.) However such a project is not anticipated in the foreseeable future.

REGIONAL WATER RESOURCES STUDY
UTILIZED SURFACE WATER STUDY
WATERSHED PLAN

SCALE 1:50,000



Consulting Engineer: Colin Karasek Ltd. November 1987

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT OF GREEN'S HARBOUR

Information: September 1987 and January 1988
Chairman: Orville Cooper

COUNCIL WELLS: 1

Type: drilled
Connections: Serves 5 houses
Connections other than houses: none
Branch of Dept. of Health testing: Whitbourne
Chlorinator working

Bacteriological Quality: adequate

Quantity: adequate

PRIVATE WELLS: 7 (Water Supply Committees)

Number of connections: 100 (approx.)
Connections other than houses: none

Bacteriological Quality : About 60% chlorinated. All wells tested monthly.

Quantity: adequate

Problem: One well has developed a lot of silt in the water flow; this well will be condemned.

FUTURE PLANS: Council is drilling another well to serve 18 houses, and also acquiring another well. When this program is complete there will be sufficient water available.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

COMMUNITY OF HARBOUR GRACE SOUTH

Information January, 1988
Clerk: Gail Martin

Population: 365 (1981)

COUNCIL WELLS: none

PRIVATE WELLS: 75 (approx.)

Number of connections: 75 (approx.)

QUANTITY: About 15 houses had dry wells, summer, 1987.

FUTURE PLANS: Additional water source needed according to Clerk. Drilled wells most likely source.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF HARBOUR MAIN-CHAPEL COVE-LAKEVIEW

Information: September 1987 and January 1988

Clerk: Evangeline Dalton

Population: 1303 (1981)

COUNCIL WELLS: 4

Type: drilled
Number of connections: 43
Connections other than houses: fish plant*
Branch of Dept. of Health testing: Holyrood
All 4 wells chlorinated.

Bacteriological Quality: Satisfactory.

FUTURE PLANS: Surface water source from Maloney's River presently being constructed. This will hook into one of the well systems. Consultant - DELCAN.

*Gorman Fisheries Ltd. (Patrick Gorman). Fresh water mainly for use of personnel. Most of processing done with salt water. Lump fish roe needs fresh water. Will connect to main water system in spring 1988, with 150 mm diam. connection. Plant operates May to December. The plant does not expect to re-chlorinate the Town's supply.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT-HOPEALL

Information January,1988
Chairman: Martin Wall
Treasurer: Don Pitcher

COUNCIL WELLS: 2

Type: drilled
Connection: One well 15 houses, other 4 houses.
Connections other than houses: none
Branch of Dept. of Health testing: Whitbourne
1 well chlorinated

Bacteriological Quality: Boil order issued to 15 houses, 1987. The Department of Health regularly tests four wells in the community; generally satisfactory.

Problems: Well serving the 15 houses has silt problems. Funding now available to drill additional wells.

Alternative sources used in emergencies: Private wells shared, water taken from Hopeall River.

PRIVATE WELLS: 5

Number of connections: One well serves about 20 housholds, the remainder one house each.
Connections other than houses: none

Bacteriological Quality: Adequate

Quantity: Adequate

FUTURE PLANS: New source needed, according to Chairman. Study done a few years ago to consider using Hopeall River - too expensive.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

WATER AND SEWER SERVICE DISTRICT-MAKINSONS

Information January, 1988
Chairman: Fred Taylor

COUNCIL WELLS: 3

Type: drilled
Number of connections: 65 (approx.)
Connections other than houses: 1 store
Branch of Dept. of Health testing: Bay Roberts
Chlorinator working

Bacteriological Quality: adequate

Quantity: adequate

PRIVATE WELLS: 50 (approx.)
Number of connections: 50 (approx.)
Connections other than houses: none

Bacteriological Quality: 15 contaminated from septic tank pollution, according to Chairman.

Quantity: 15 have constant shortage.

Alternative sources used in emergencies: other private wells.

FUTURE PLANS: Need another source: no study done.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT-MARKLAND

Information January, 1988
Chairman:Clarence Baldwin

COUNCIL WELLS: none

PRIVATE WELLS: 100 (approx.)

Number of connections: 100 (approx.)
Connections other than houses: 2 churches, 2 stores.

Quantity: 75 (approx.) ran dry summer, 1987.

Problems: According to Mr. Baldwin, about 22 houses have strong potential for contamination by sewage. Untreated sewage is running into Hodges River about 15 ft. from the wells. Also, wells are only 10 ft. from the highway.

FUTURE PLANS: Need another source according to Chairman, no study done.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

WATER AND SEWER SERVICE DISTRICT-MARYSVALE

Information January, 1988
Chairman: James Ryan

COUNCIL WELLS: 2

Type; drilled
Houses connected: 8 and 70
Connections other than houses: 1 town hall, 1 church
Branch of Dept. of Health testing: Holyrood
Chlorinators working

Bacteriological Quality: Satisfactory

Quantity: adequate

PRIVATE WELLS: 20

Number of connections : 20 (approx.)

Quantity: all ran dry, summer 1987.

Alternative sources used in emergencies: New private wells dug, other private wells.

FUTURE PLANS: Need another source, according to Chairman. No study done.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF MT. CARMEL-MITCHELL'S BROOK-ST.CATHERINES

Information January, 1988
Mayor: Patricia Goudie-Buchanan
Deputy Mayor: F. David Power
Clerk: Lorraine Hurn

Population: 699 (1981)

COUNCIL WELLS: none

PRIVATE WELLS: 200 (approx.)

Number of connections: 200 (approx.)
Other wells: Two schools, parish house, convent, senior citizens' home, and several businesses.

Quantity: 50% have shortage of water, according to Clerk.

FUTURE PLANS: Another source needed, no study has been done.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

WATER AND SEWER SERVICE DISTRICT- NEW HARBOUR

Information January, 1988
Chairman: Wesley Williams

COUNCIL WELLS: 1

Type: drilled
Connections: 26 houses
Branch of Dept. of Health testing: Whitbourne
Chlorinator working
Other wells: Several buildings have individual drilled wells provided originally by Government.

Bacteriological Quality: Satisfactory. The Department of Health tests five wells in New Harbour.

Quantity: adequate

PRIVATE WELLS: 20 (approx.)

Number of Connections: 20 (approx.)

Bacteriological Quality: Not tested. No boil orders issued.

Quantity: No shortages reported.

FUTURE PANS: May connect in the distant future to the New Harbour industrial supply.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

COMMUNITY OF NORTH RIVER

Information January, 1988
Mayor: Nicholas Hurley

Population: 245 (1981)

COUNCIL WELLS: none

PRIVATE WELLS: 245 (approx.)

Number of connections: 245 (approx.)
Other buildings served by wells: 1 school, 8 businesses, 2 churches.

Bacteriologiucal Quality: School is tested by the Department of Health, Bay Roberts.

Problems: About 75 houses have high mineral content or lack of water.

FUTURE PLANS: Study required. Another source needed: connection to Bay Roberts or Clarke's Beach most likely future source of water.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT OF OLD SHOP

Information January, 1988

Chairman: Winston Day

Sec.-Treas.: Cyril Thorne

COUNCIL WELLS: None

Alternative water sources used in emergencies: Other private wells.

PRIVATE WELLS: 60 (approx.)

30 (approx.) experienced dry wells summer 1987.

FUTURE PLANS: Drilled wells needed.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT-PATRICK'S COVE-ANGEL'S

Information January, 1988
Chairman: Richard Coffey

COUNCIL WELLS: none

PRIVATE WELLS: 60 (approx.)

Number of connections: 65 (approx.)
Connections other than houses:none

Supply adequate

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF SALMON COVE

Information August, 1987

Population: 786 (1981), 790 (1986)

COUNCIL WELLS: 3 (Wells #1, #2 and #3)

Type: drilled
Number of connections: 80 (approx.)
Other wells: An additional well (#4) serves the fire hall and Council offices.
Branch of Dept. of Health testing: Harbour Grace

Poor chemical quality: 1 well (Well #2) connected to 18 houses, was condemned in 1987 because the levels of sodium chlorine, manganese, iron and arsenic were higher than the Canada Drinking Water recommendations.

Alternative sources : These 18 houses were connected to Victoria water supply system with $100,000 grant.

FUTURE PLANS: Connect remainder of Salmon Cove to Victoria water supply system. Feasibility study-Harris and Associates. Costs, including sanitary sewer, about $5 million.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF SMALL POINT-BROAD COVE-BLACKHEAD- ADAM'S COVE

Information:September 1987 and January 1988
Clerk: Loretta Diamond

Population: 539 (1981)

COUNCIL WELLS: 12

Type: drilled
Domestic connections: 104 houses
Connections other than houses: church, 3 community halls
Branch of Dept. of Health testing: Harbour Grace
Chlorinator used on one well.

Bacteriological Quality: Boil Orders issued, December, 1987.

Quantity: 2 wells ran dry summer, 1987.

PRIVATE WELLS: 200 (approx.)

Number of connections: 200 (approx.)
Other wells: Community hall.

Quantity: shortage 1987, unspecified number.

Alternative sources used in emergencies: other wells

FUTURE PLANS: Additional wells needed, according to clerk. One well is now under construction.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

TOWN OF SOUTH RIVER

Information January,1988

Clerk: Evelyn Crane

Population: 656 (1981)

COUNCIL WELLS: 3 (Water Supply Committees)

Type: drilled
Number of connections: 15
Other wells: town hall, shipbuilding plant.

Bacteriological Quality: Satisfactory. Dept. of Health, Bay Roberts.

Quantity: Adequate.

PRIVATE WELLS: About 200, each serving one house.

One gravity flow well serves about 20 families.

Bacteriological Quality:About 10% tested each month. Generally satisfactory.

Quantity About 20% of the houses are short of water.

FUTURE PLANS: Local concern is that the growing population will cause sewage disposal to contaminate water supplies. No study done. In future could connect to Brigus Pond system.

LOCAL GOVERNMENT-GROUNDWATER SOURCE

LOCAL SERVICE DISTRICT-THE THICKET

Information January, 1988
Chairman: Susie Galway

COUNCIL WELLS: 1

Type: drilled
Number of connections: 14
Connections other than houses: none
Branch of Dept. of Health testing: Harbour Grace
Chlorinator working

Bacteriological Quality: Satisfactory.

Quantity: adequate

PRIVATE WELLS: 5

Number of connections: 5

Bacteriological Quality: Satisfactory

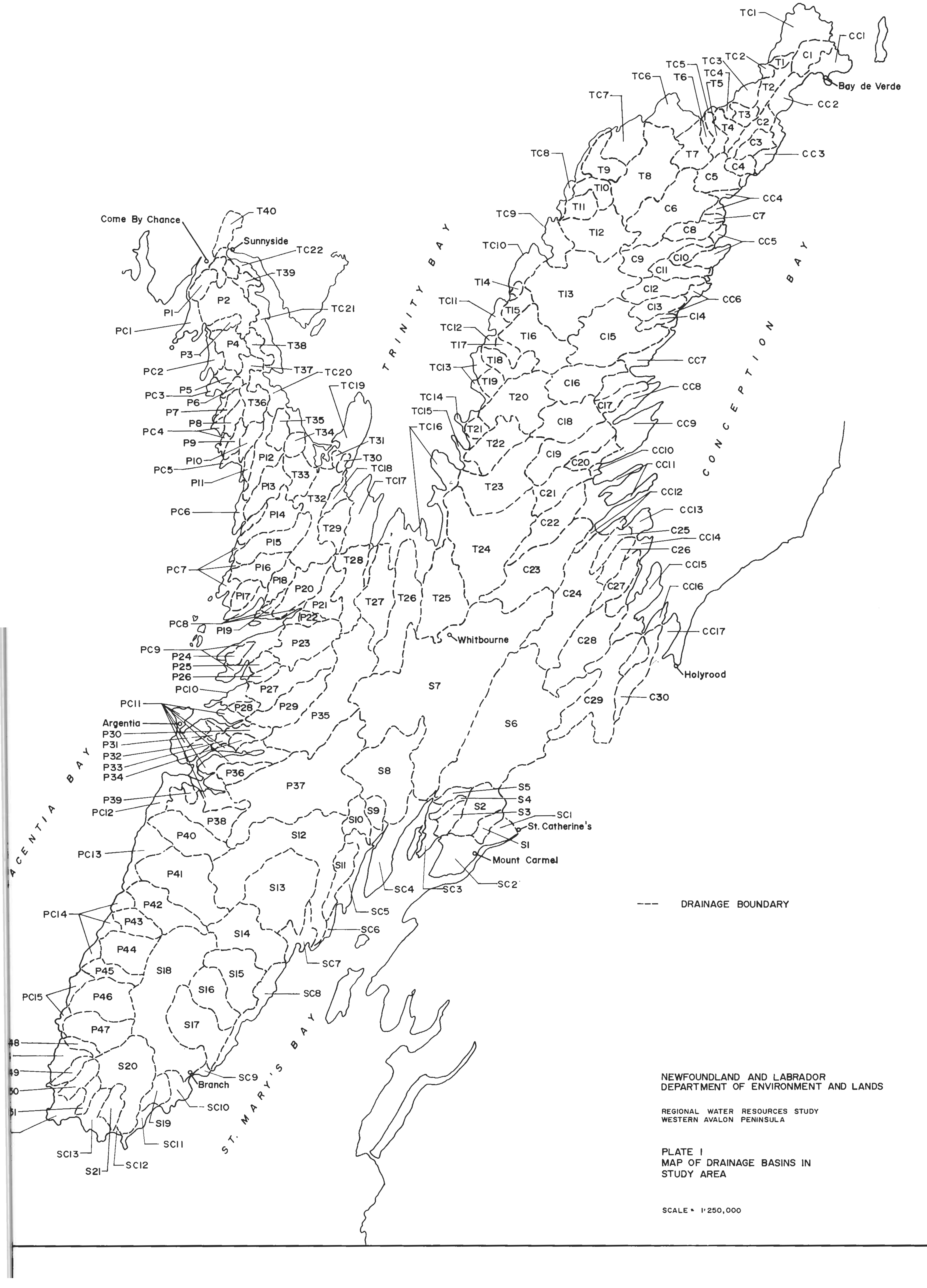
Quantity: adequate

FUTURE PLANS: Presently 6 houses without water supply. Another council well needed, according to Chairman: no study done.

TABLE I
SUMMARY, COMMUNITIES SERVED BY GROUNDWATER

MUNICIPAL STATUS*	NAME	WATER QUALITY PROBLEMS	WATER QUANTITY PROBLEMS	FUTURE PLANS
T	AVONDALE	No	Yes	Develop surface source
C	BISHOP'S COVE	No	Yes	Connect to Upper Island Cove
LSD	BRIGUS JUNCTION	No	Yes	More wells
C	BRYANT'S COVE	No	No	
LSD	CAVENDISH	No	No	Develop surface source
T	CHANCE COVE	Yes	Yes	None at present
T	CHAPEL ARM	No	Yes	Not specified
T	CLARKE'S BEACH	Yes	Yes	Develop surface source
C	COLINET	No	No	
C	COLLIERS	No	Yes	More wells
T	COME BY CHANCE	Yes	Yes	More wells
T	CONCEPTION HARBOUR	No	Yes	Not specified
T	CUPIDS	Yes	Yes	Connect to Brigus
LSD	FOREST FIELD-NEW BRIDGE	No	No	
C	FOX HARBOUR	Yes	No	Develop surface source
LSD	GREEN'S HARBOUR	No	No	
C	HARBOUR GRACE SOUTH	No	Yes	More wells
T	HBR.MAIN-CHAPEL COVE-LAKEVIEW	No	Yes	Surface system under constrn.
LSD	HOPEALL	Yes	Yes	New supply, unspecified
WSSD	MACKINSONS	Yes	Yes	New supply, unspecified
LSD	MARKLAND	Yes	Yes	New supply, unspecified
WSSD	MARYSVALE	No	Yes	New supply, unspecified
T	MT.CARMEL-MITCHELLS BROOK-ST.CATHERINES	No	Yes	New supply, unspecified
WSSD	NEW HARBOUR	No	No	
C	NORTH RIVER	Yes	Yes	Connect to Bay Roberts or Clarke's Beach
LSD	OLD SHOP	No	Yes	More wells
LSD	PATRICK'S COVE-ANGEL'S COVE	No	No	
T	SALMON COVE	No	No	Might connect to Victoria
T	SMALL POINT-BROAD COVE-BLACKHEAD-ADAM'S COVE	Yes	Yes	More wells
T	SOUTH RIVER	No	Yes	Connect to Brigus
LSD	THE THICKET	No	No	One well

* T = Town
C = Community
LSD = Local Service District
WSSD = Water and Sewer Service District

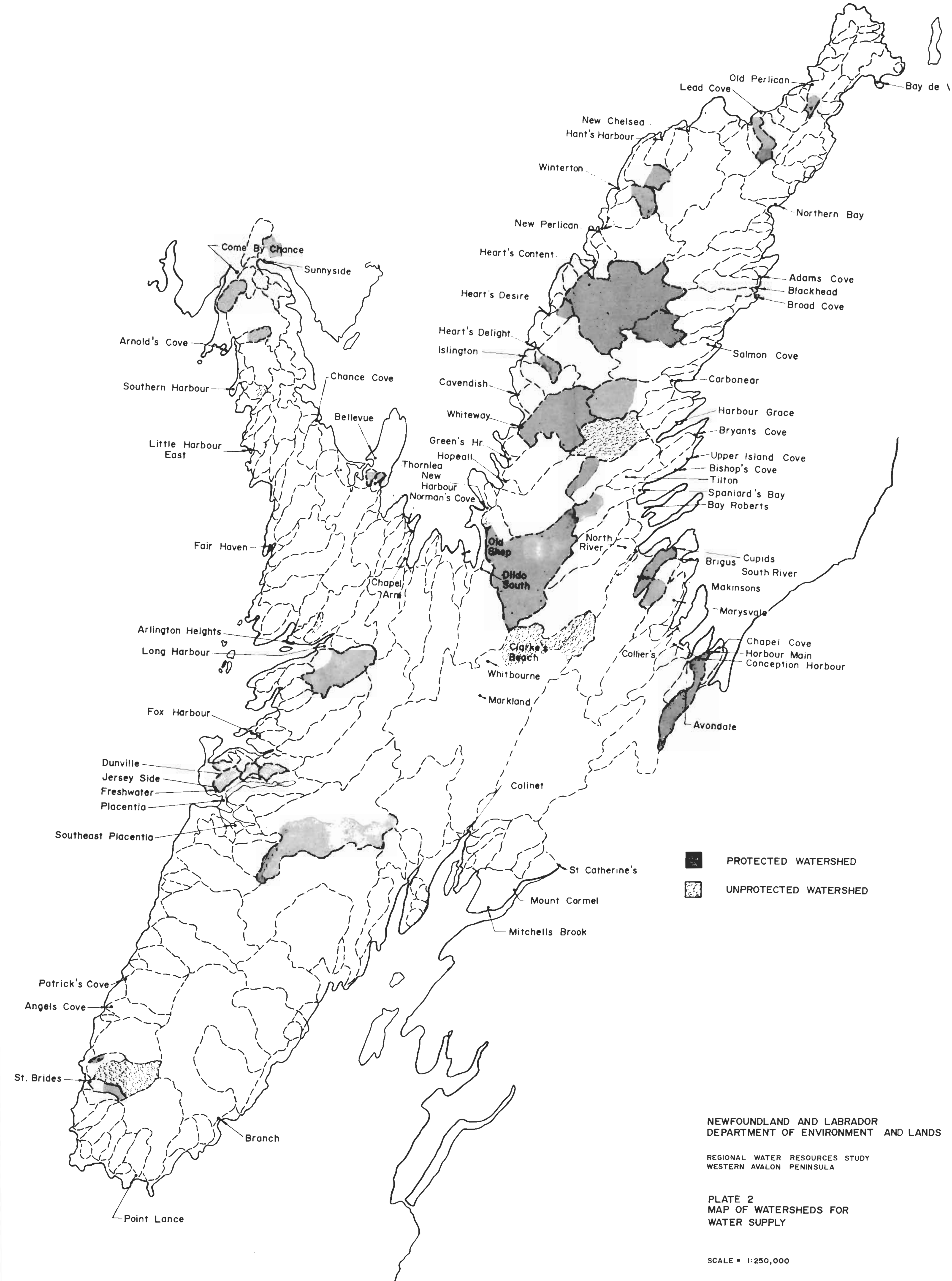


NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF ENVIRONMENT AND LANDS

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA

PLATE 1
MAP OF DRAINAGE BASINS IN
STUDY AREA

SCALE = 1:250,000



NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF ENVIRONMENT AND LANDS

REGIONAL WATER RESOURCES STUDY
WESTERN AVALON PENINSULA

PLATE 2
MAP OF WATERSHEDS FOR
WATER SUPPLY

SCALE = 1:250,000

PLATES