DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

# A REVIEW OF PREVIOUS WATER SUPPLY STUDIES
# GREATER HALIFAX - DARTMOUTH

MAY 1969

RESOURCES ENGINEERING OF CANADA LIMITED

RESOURCES ENGINEERING

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May 5, 1969

Dr. E. Weeks
Assistant Deputy Minister
Department of Regional Economic Expansion
161 Laurier Ave. W.
Ottawa, Ont.

Dear Dr. Weeks,

We are pleased to submit 10 copies of our report entitled "A Review of Previous Water Supply Studies - Greater Halifax - Dartmouth Areas".

This assignment was commissioned by the Atlantic Development Board in their letter of October 18, 1968. If you or other personnel in the Department of Regional Economic Expansion have any further questions regarding this report, we would be pleased to discuss these with you at your convenience.

Yours very truly,

A.J.G. Leighton
President

ms
Encl.

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# GREATER HALIFAX - DARTMOUTH

MAY 1969

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RESOURCES ENGINEERING

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1 CONCLUSIONS AND RECOMMENDATIONS

# A REVIEW OF PREVIOUS WATER SUPPLY STUDIES GREATER HALIFAX-DARTMOUTH AREAS

## SECTION 1

## CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of a review of previous reports by two consultants for the long term development of potable water supplies to the cities of Halifax and Dartmouth and their suburban areas.

The methods of economic presentation used by both consultants didnot produce strictly comparable present values for the various selected alternatives. A complete economic re-assessment has therefore been carried out. Our conclusions and recommendations are:

1. Long and Chain Lakes should not be abandoned. A treatment plant should be constructed around 1970 for the entire existing Halifax water supply system to upgrade the quality of the water supplied. This is compatible with the long term water supply plan. The estimated cost of the treatment plant is about $3,700,000.

2. When the Halifax water demand approaches the yield of the existing system (15.5 m.g.d.) in the mid-1970's, Lake Nichols should be developed for an additional yield of 3 million imperial gallons per day. The estimated cost of this work is about $1,170,000. This should be followed at a future date by the staged development of the Birch Cove Lake System which includes the Birch Cove Lakes, Stillwater Lake and Fraser Lake. If this recommendation is accepted, the P.S.C. should take immediate measures to reserve land and water rights for these lakes and their watersheds. It is also expedient to reserve similar rights for Lake Parr and Lake Moody, as a shift of land development to the south of Halifax might render these sources economically useful in the future. Land and water rights at Lake Major and Soldier Lake should be separately established for Dartmouth.

3. The development of Lake Pockwock or Lake Major either solely for Halifax or jointly with Dartmouth is less economic than the recommended development.

4. If policy reasons preclude the use of Lake Nichols, the development of Birch Cove Lake should be the next choice. The project should be developed in stages of about 3 m.i.g.d. and the water fed to the Halifax system at Rochingham. The estimated cost of the first stage of the Birch Cove development is about $1,480,000.

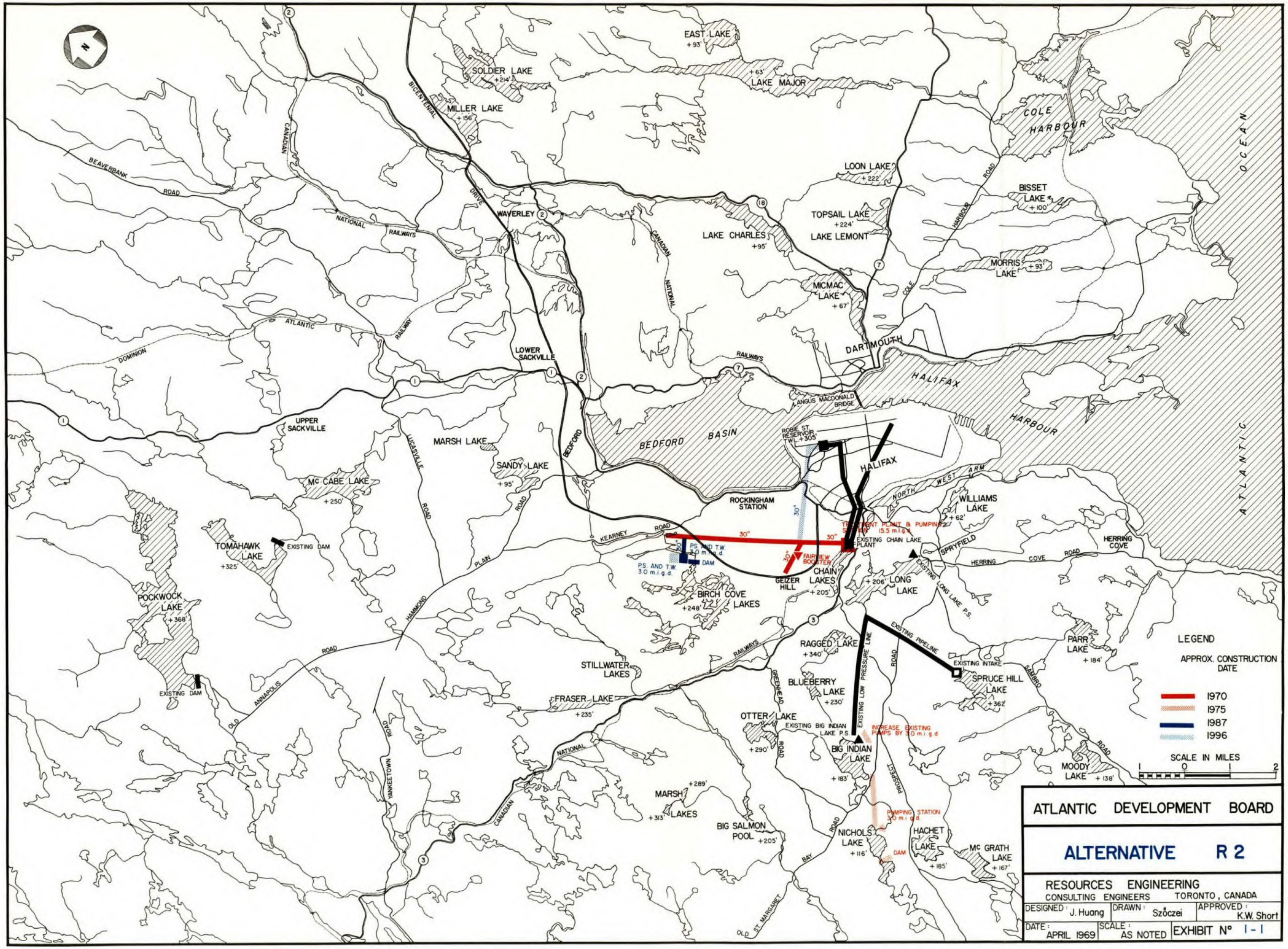
5. An agreed short term water demand projection for the next 5 years should be developed for Halifax to establish the timing of the introduction of the Lake Nichols scheme (or the Birch Cove scheme).

6. The capacity of the Dartmouth water supply system should be increased in the near future by modification of its pumping system at Lake Major at a cost in the order of $100,000. Further system expansion around 1980 will require duplication of the pipe-line between Lake Major and Lake Lemont.

7. Because of the small water demand in Bedford, Waverley and Sackville, neither a piped supply from Halifax, nor a separate reservoired supply are found to be economical. Well water supply should continue to be used. Local central supplies for more densely populated communities may be investigated.

8. A study should be undertaken to determine the reasons for the present high water rates. The study should cover a breakdown of costs, deployment of staff, efficiencies of supply distribution and system operation, and the economics of loss detection.

The recommended scheme and its tentative estimated costs are shown in Exhibits 1-1 and 1-2 in the various stages of development up to the year 2000, together with the anticipated dates of development of each stage based on present available water demand estimates.


ATLANTIC DEVELOPMENT BOARD
ALTERNATIVE R 2
RESOURCES ENGINEERING
CONSULTING ENGINEERS TORONTO, CANADA
DESIGNED: J. Huang
DRAWN: Szöczei
APPROVED: K.W. Short
DATE: APRIL 1969
SCALE: AS NOTED
EXHIBIT Nº 1-1
LEGEND
APPROX. CONSTRUCTION DATE
1970
1975
1987
1996
SCALE IN MILES
1 0 1 2
EAST LAKE +93'
SOLDIER LAKE +214'
LAKE MAJOR +63'
MILLER LAKE +156'
COLE HARBOUR
LOON LAKE +222'
BISSET LAKE +100'
TOPSAIL LAKE +224'
LAKE LEMONT
LAKE CHARLES +95'
MORRIS LAKE +93'
MICMAC LAKE +67'
WAVERLEY
LOWER SACKVILLE
UPPER SACKVILLE
DARTMOUTH
HALIFAX HARBOUR
ANGUS MACDONALD BRIDGE
BEDFORD BASIN
BEDFORD
ROBIE ST. RESERVOIR T.W.L. +305
HALIFAX
NORTH WEST ARM
ROCKINGHAM STATION
MARSH LAKE
SANDY LAKE +95'
Mc CABE LAKE +250'
TOMAHAWK LAKE +325'
EXISTING DAM
POCKWOCK LAKE +368'
WILLIAMS LAKE +62'
TREATMENT PLANT & PUMPING STATION 15.5 m.i.g.d.
EXISTING CHAIN LAKE PLANT
FAIRVIEW BOOSTER
P.S. AND T.W. 3.0 m.i.g.d.
DAM
GEIZER HILL
CHAIN LAKES +205'
BIRCH COVE LAKES +248'
LONG LAKE +206'
SPRYFIELD
HERRING COVE
EXISTING LONG LAKE P.S.
EXISTING PIPELINE
EXISTING INTAKE
EXISTING LOW PRESSURE LINE
PARR LAKE +184'
SPRUCE HILL LAKE +362'
RAGGED LAKE +340'
BLUEBERRY LAKE +230'
STILLWATER LAKES
FRASER LAKE +235'
OTTER LAKE +290'
EXISTING BIG INDIAN LAKE P.S.
INCREASE EXISTING PUMPS BY 3.0 m.i.g.d.
BIG INDIAN LAKE +183'
MOODY LAKE +138'
MARSH LAKES +289' +313'
BIG SALMON POOL +205'
PUMPING STATION 3.0 m.i.g.d.
NICHOLS LAKE +116'
HACHET LAKE +185'
Mc GRATH LAKE +167'
ATLANTIC OCEAN
30"

## CAPITAL COST BY STAGES OF RECOMMENDED DEVELOPMENT PROGRAM

### Alternative R2 (Existing - Birch Cove - L. Nichols)

### Water from all schemes is fully treated

| Year | Item | Cost | Cumulative Total Cost |
|---|---|---|---|
| 1970 | Construct treatment plant for entire existing system | $3.70 m. | |
| | (Transmission main from Chain L. to Geizer Hill )<br>(Fairview Booster Pumping Station )<br>(Transmission main to Rockingham ) | $0.95 m. | |
| | | $4.65 m. | $4.65 m. |
| 1975 | 3 m.i.g.d. from Lake Nichols | | |
| | Dam at Lake Nichols | $0.14 m. | |
| | Roads and bridges | $0.04 m. | |
| | Pumping Station @ Lake Nichols | $0.02 m. | |
| | Power lines and substations | $0.03 m. | |
| | Pipeline from Lake Nichols to Big Indian Lake (6000 ft. 18" Ø ) | $0.18 m. | |
| | New Pumps at Big Indian Lake | $0.01 m. | |
| | Extend treatment plant | $0.72 m. | |
| | Extend Chain Lake Pumping Station | $0.03 m. | |
| | | $1.17 m | $5.82 m. |
| 1987 | 3 m.i.g.d. from Birch Cove | | |
| | Dam at Birch Cove and land clearing | $0.36 m. | |
| | Roads and bridges | $0.02 m. | |
| | Treatment Plant @ Birch Cove | $0.90 m. | |
| | Pumping Station @ Birch Cove | $0.02 m. | |
| | Pipeline from Birch Cove to Bicentennial Drive (6 m.i.g.d.) | $0.14 m. | |
| | Provision for Compensation to Moirs Ltd. | $0.02 m. | |
| | | $1.46 m. | $7.28 m. |
| 1996 | 3.0. m.i.g.d. from Birch Cove | | |
| | Extend Treatment Plant at Birch Cove | $0.72 m. | |
| | " Pumping Station at Birch Cove | $0.02 m. | |
| | Transmission main from Fairview to Robie St. (depending on demand) | $0.40 m. | |
| | | $1.14 m. | $8.42 m. |

EXHIBIT 1 - 2

2 TERMS OF REFERENCE AND INTRODUCTION

2 TERMS OF REFERENCE
AND INTRODUCTION

## SECTION 2

## TERMS OF REFERENCE AND INTRODUCTION

Resources Engineering of Canada Limited was commission by the Atlantic Development Board in February 1969, to review certain reports prepared by two other consulting engineering firms on the long term development of a potable water supply to the City of Halifax and its suburban areas, and to recommend the course of action to be taken in the immediate and near future which is conducive to long term benefit.

During the course of the review it was found that the reports did not contain a complete array of all possible development alternatives. The two consultants had also used different methods of economic analysis for their various chosen alternatives, and neither of these methods tended to produce strictly comparable present values between alternatives. It was therefore necessary to reconduct a cost study covering all possible sequences of developing the various water sources mentioned in the reports with all alternatives designed for approximately equal system capacities at corresponding dates in the period of assessment. Present values have been discounted from capital and operating expenditure instead of from amortized capital charges to avoid differential debt balances at the end of the assessment period, i.e. the year 2000.

The water supply for the City of Halifax, and its suburbs is derived from four lake systems, viz. Long Lake, Chain Lake, Big Indian Lake and Spruce Hill Lake, located on the west side of the City. The only treatment the water receives is the addition of chlorine, fluoride and lime. Water quality is inferior to established health standards elsewhere in Canada and in the United States, particularly in colour. Although the colour does not necessarily constitute a health hazard, it detracts from the appearance of a pure and wholesome water supply. The reliable yield of the whole system is estimated to be 15.5 m.i.g.d. by both consultants.

The present demand now served under the P.S.C. system is about 13.2 m.i.g.d. According to the demand estimate by the second consultant (retained by A.D.B.) the system yield should be adequate until about 1975. However, to achieve this, considerably more water will have to be drawn from Big Indian Lake where the water is of poorer quality. This would result in further deterioration of the currently inferior water quality. The P.S.C. is now faced with the following immediate alternative courses of action:

(a) To treat the water from the existing system for colour removal, or

(b) To accept a deterioration in colour quality. This case is a possibility, but has not been pursued.

(c) To introduce a new source of better quality water to replace the existing source.

(d) To introduce a new source of better quality water to supplement the existing source and to accept present colour quality.

After this further system expansion will be required around 1975.

Another issue that must be considered by the P.S.C. is the planning of land development in the watersheds of the Long and Chain Lakes presently used for water supply. These lakes yield about 6.3 m.i.g.d. A decision has to be reached on the necessity to abandon or retain these lakes when land development takes place.

Capital costs for the various schemes presented in this report have been based on those developed by the second consultant, adjusted as necessary pro rata to the capacity used. Operating costs have been calculated from unit rates based on past experience elsewhere, and include only fuel, chemicals and labour costs for pumping and treatment, since these are the only costs affecting the comparison.

A list of the reports reviewed can be found in the Bibliography at the end of this report.

3 ABANDONMENT OR RETENTION OF LDNG-CHAIN LAKES

## SECTION 3

## ABANDONMENT OR RETENTION OF THE LONG-CHAIN LAKES WITH LAND DEVELOPMENT

The Long and Chain Lakes, apart from yielding about 6.3 m.i.g.d. for the Halifax water supply, also serve as a conveyance system and mixing reservoir for water from Big Indian Lake and Spruce Hill Lakes. The abandonment of the Long-Chain Lakes will result in a loss of a yield of 6.3 m.i.g.d and require the construction of a new conveyance system and treatment plant to allow continued use of water from Big Indian Lake and Spruce Hill Lake. The cost of this work is about $3,140,000.

On the other hand, the retention of Long and Chain Lakes would require the construction of a full treatment plant for the whole existing system and this would cost about $3,700,000. Thus the actual cost of retaining Long-Chain Lakes for their yield of 6.3 m.i.g.d. is $560,000 (i.e. $3,700,000 minus $3,140,000), or about $90,000 per m.i.g.d., while the unit cost of providing treatment facility to the whole system is about $240,000 per m.i.g.d.

Exhibit 3-1 shows the approximate unit capital costs of developing individual schemes in the area when constructed to their full capacities. It will be seen that the unit cost of retaining Long-Chain Lakes is less than the unit cost of developing a new scheme, and the unit cost of providing treatment facility for the whole existing system is only bettered by the unit cost of developing Lake Major.

It is therefore not economically advantageous to abandon the Long-Chain Lakes if the rest of the existing system continues to be used. The alternative of abandoning the entire existing system and using a single source from Lake Major is of economic interest ($189,000 per m.i.g.d.).

The array of alternatives can now be reduced to those contained in the following two sets:

(1) Those with the entire existing system abandoned.

(2) Those with the entire existing system retained.

Any scheme involving partial abandonment is not recommended.

## COMPARATIVE UNIT CAPITAL COSTS OF DIFFERENT SCHEMES

| System | At Full Capacity | Cost | Capital Cost per m.i.g.d. |
|---|---|---|---|
| Lake Pockwock | 23.9 m.i.g.d. | $ 8,290,000 | $ 347,000 |
| Lake Major | 24.0 | 4,530,000 | 189,000 |
| Birch Cove | 24.8 | 9,090,000* | 366,000 |
| Nine-Mile River | 25.0 | 10,060,000* | 402,000 |
| Parr Lake | 6.71 | 3,730,000* | 555,000 |
| Moody Lake | 6.38 | 3,340,000* | 523,000 |
| Nichols Lake | 3.00 | 1,220,000* | 406,000 |
| Treatment Plant for Existing System | 15.5 | 3,700,000 | 240,000 |

* Full water treatment is assumed.

EXHIBIT 3-1

4 WATER DEMAND AND
SYSTEM CAPACITIES

## SECTION 4

## WATER DEMAND AND SYSTEM CAPACITIES

The demand projections estimated by the two consultants are shown in Exhibit 4-1. The two respective estimates, Projections "A" and "B" for Halifax, which exclude a supply to Bedford, Waverley and Sackville, differ by 2 to 4 m.i.g.d. within the period of projection, 1970 to 2000. From 1970 to 1975 the difference is about 2.5 m.i.g.d. There is an early need to obtain an agreed demand projection, particularly for the next few years, to allow the planning, design and execution of the next stage of system expansion to be properly timed.

For the purpose of this study, the estimate by the second Consultant, Projection "A", has been used. Proposed design system capacities are shown by the solid line in the Exhibit. Each increase to the system capacity is arbitrarily assumed to be 3 m.i.g.d., and is executed when the demand reaches 90% of the current system capacity. On this basis, increases would be required in the years 1975, 1987 and 1996.

The demand projection for Bedford, Waverley and Sackville is shown by Projection "C" on the same exhibit.

# HALIFAX WATER DEMAND

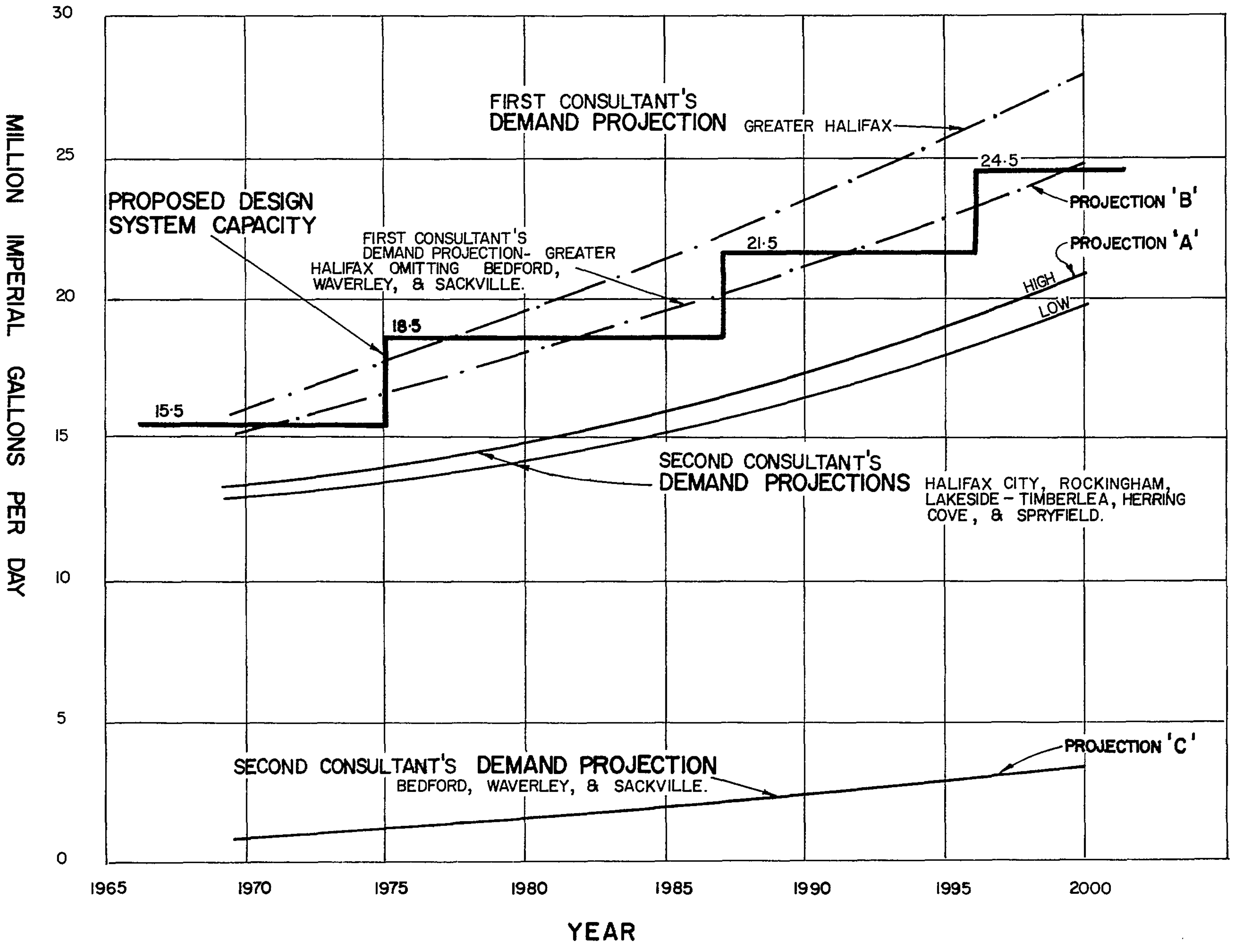



EXHIBIT 4-1

5 STUDY OF ALTERNATIVES

## SECTION 5

## STUDY OF ALTERNATIVES

Economic examination of an array of 15 alternatives has been carried out in the study. The process is fully described in the technical appendix at the end of this report. This Section contains only the results of the examination, and the interpretation of these results to allow a judgment on the correct choice of alternatives to be made.

The three best schemes evolved from the examination are:

Alternative R1:

Abandon entire existing system and replace by a single source system from Lake Major, initially with a capacity of 15.5 m.i.g.d. and with increments and 3 m.i.g.d. in 1975, 1987 and 1996. Water treatment will consist only of chlorination, fluoridation, and the addition of lime, and this process will be referred to as "conditioning" in the rest of this study.

(1970 Present Value for i @ 6% = $7.44 m
1970 Capital Expenditure $5.04 m)

Alternative R2:

Construct a new treatment plant for the entire existing system. Develop Lake Nichols for 3 m.i.g.d. in 1975. Develop Birch Cove Lakes for 3 m.i.g.d. in 1987 with a 3 m.i.g.d. extension in 1996. Water treatment will consist of coagulation, sedimentation, filtration, chlorination, fluoridation, and lime addition, and this process will be referred to as "treatment".

(1970 P.V. for i @ 6% = $8.12 m
1970 Capital Expenditure $4.65 m)

Alternative R2-5:

Construct a new treatment plant for the entire existing system. Develop Birch Cove Lakes for 3 m.i.g.d. in 1975. Extend Birch Cove Lake system for 3 m.i.g.d. in 1987 with a further extension of 3 m.i.g.d. by developing Stillwater Lake in 1996.

(1970 P.V. for i @ 6% = $8.15 m
1970 Capital Expenditure $4.65 m)

The two alternatives recommended by the other consultants are included below:

First Consultant's Alternative of Jan. 1966:

Construct a treatment plant for the Big Indian and Spruce Hill Lake system and develop Lake Pockwock for 15.5 m.i.g.d. in 1970. Water from Lake Pockwock will be conditioned, while water from Big Indian and Spruce Hill Lakes will be fully treated.

(1970 P.V. for i @ 6% = $10.78 m
1970 Capital Expenditure $10.39 m)

Second Consultant's Alternative B1:

Develop Lake Major for 3.0 m.i.g.d. in 1970, and construct a treatment plant for the existing system when land development in the Long-Chain watersheds take place. Extend Lake Major system by 3.0 m.i.g.d. in 1987, with a further extension of 3.0 m.i.g.d. in 1996. Water from Lake Major will be conditioned, while water from the existing system will be fully treated after the treatment plant is built.

(1970 P.V. for i @ 6% = $9.56 m
1970 Capital Expenditure $7.24 m)

The 5 alternatives are shown in Exhibit 1-1 and Exhibits 5-1 to 5-4, and their capital costs in the various stages of development are shown in Exhibit 1-2 and Exhibits 5-5 to 5-8. Comparative annual operating costs for the alternatives are illustrated in Exhibit 5-9.

Total 1970 present values of capital and operating costs have been worked out for each of the 5 alternatives over a range of discount rates and these are illustrated in Exhibit 5-10.

The lowest present value alternative is R1. R2 and R2-5 have approximately the same present values and are more expensive than R1 by about $500,000 to $1,200,000 over the range of discount rates. The amounts by which the present values of the alternatives of the first and second Consultants exceed those of R1 and R2 (R2-5) are given in the Table below:

| | R1 | R2 and R2-5 |
|---|---|---|
| First Consultant's Alternative | $1.9m to $3.6m | $0.7m to $3.2m |
| Second Consultant's Alternative B1 | $2.1m to $2.3m | $1.1m to $1.6m |

Before forming any decision from the above economic analysis, it is necessary to examine other policy factors that could affect the economic ranking of these alternatives. The two most important items in this category are:

1. The likelihood of full treatment of Lake Major water being required at some future date.

2. The possibility of delay in the provision of full treatment for the existing system.

The present quality of Lake Pockwock water is good while that of Lake Major water is already inferior to accepted Canadian standards. These qualities can only be maintained if it were possible to sterilize the lake watersheds from any future land development, an action which is seldom practical nor economical. Improved living standards also tend to increase consumers' demand for better water quality. The prospect of any lake water supply never requiring full treatment at all is most unlikely.

The 1970 present values for additional capital and operating costs incurred by the future introduction of full treatment at Lake Major have been calculated and added to the present values for Alternative R1. The results are shown by the broken lines in Exhibit 5-11, for treatment required in the years 1970, 1980, 1990 and 2000. It can been seen that even if treatment is required after the year 2000, the revised present values of Alternative R1 will be higher than those of Alternatives R2 and R2-5 which are also shown in the same exhibit. This consideration, and the higher initial capital outlay, together with other practical points illustrated in Exhibit 5-12, lead to the recommendation to reject Alternative R1 in favour of Alternative R2 or R2-5.

A delay of land development in the Long-Chain watersheds would allow the construction of the treatment plant for the existing system to be postponed. This would cause a reduction of present values for Alternatives R2, R2-5 and B1. To maintain present water quality, it will be necessary to accelerate development of other sources of better quality water to allow the average drawoff from Big Indian Lake to be kept at its present level. This rules out benefits for alternative R2 as any supply from Nichols Lake has to be routed through Big Indian Lake.

The reduced present values caused by delaying construction of plant for full treatment of the existing system without deterioration of water quality have been calculated. The following Table displays these present values for a discount rate of 6% p.a.

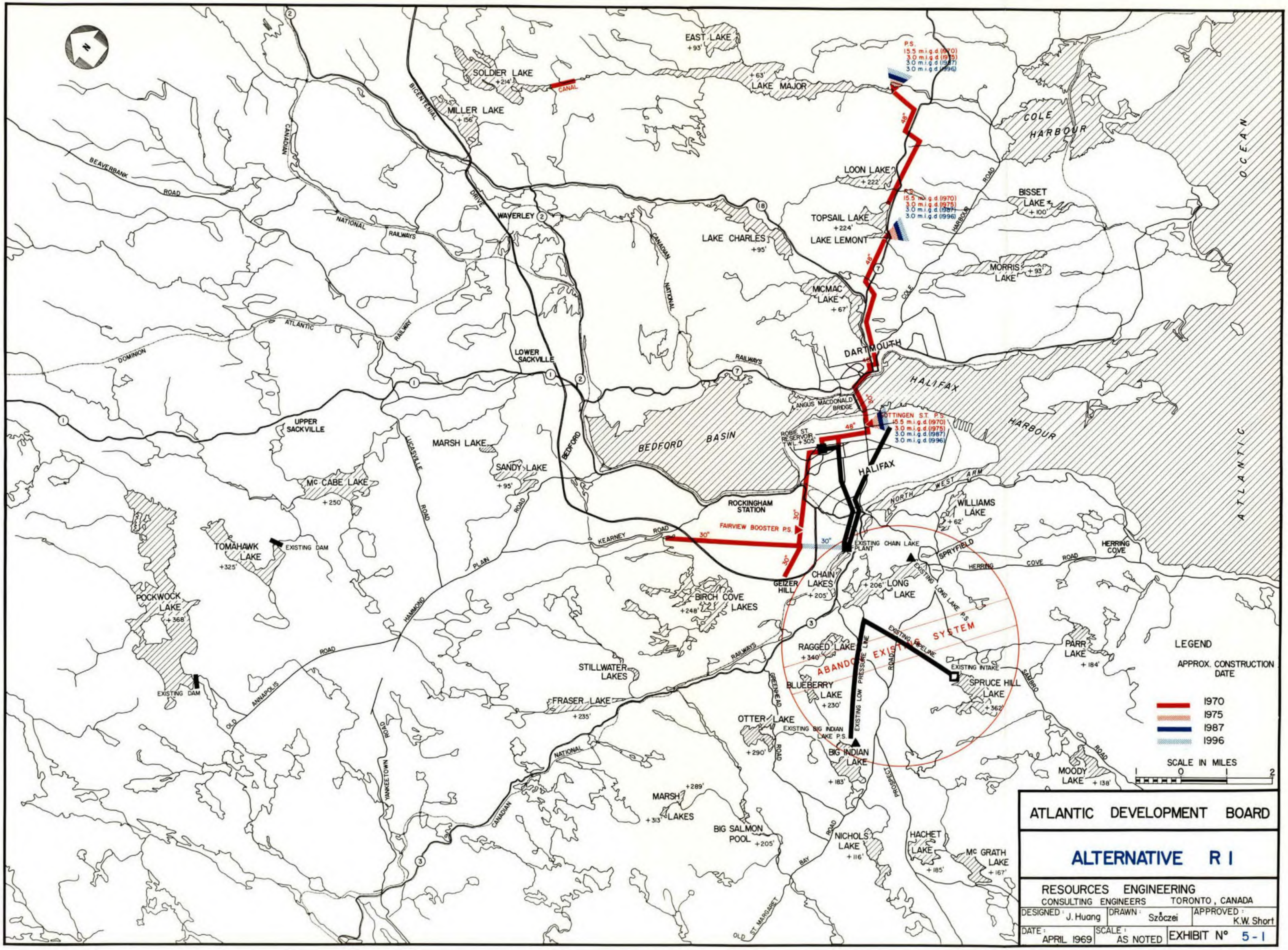
| Alternative / Date | R2 | R2-5 | B1 |
|---|---|---|---|
| 1970 | \$8.12 m | \$8.15 m | \$9.56 m |
| 1980 | | 6.79 m | 7.76 m |
| 1990 | | 5.83 m | 6.70 m |

The present value of Alternative B1 is now seen to be higher than those of R2 and R2-5 by \$1.4 m if water treatment is required for the existing system in 1970, and over \$0.9 m higher than the present value of R2-5 if the water treatment is required after 1980. The above estimates have not considered the possibility of future treatment required at Lake Major, which effect, if added, would increase the cost differences. It can also be seen from Exhibit 5-10 that the alternative by the First Consultant is far more expensive than R2 or R2-5 at current discount rates. There is therefore sufficient grounds for rejecting the alternatives by the two Consultants.

It now remains to be considered when treatment should be provided for the existing system. This depends on the quality of the water which is safe to supply and which the consumers will readily accept, and is a policy question rather than an economic one. With imminent industrial development in the Long-Chain watersheds, consequential pollution will require the water supply to be treated not later than 1975. If treatment were postponed from 1970 to 1975, a saving of not more than \$1.0 m would ensue. We recommend, however, that treatment should be planned for 1970, as the additional cost of \$1.0 m will most likely be recovered from better inducement for industrial development due to immediate improvement in water quality. If this is accepted then both alternatives, R2 and R2-5 have the same economic ranking. We then recommend the adoption of R2 for the development of

Lake Nichols around 1975, since this scheme allows the use of a single treatment plant at Chain Lake for the entire system up to year 1987, and therefore provides better control of water quality.

Land and water rights at Lake Nichols and the Birch Cove Lake System (comprising the Birch Cove Lakes, Stillwater Lakes and Fraser Lake) should be reserved at an early date. It is expedient also to reserve similar rights at Lake Parr and Lake Moody, as a shift of land development to the south of Halifax might render these lakes economically useful in the future.


EAST LAKE
SOLDIER LAKE
CANAL
MILLER LAKE
LAKE MAJOR
P.S.
15.5 m.i.g.d.(1970)
3.0 m.i.g.d.(1975)
3.0 m.i.g.d.(1987)
3.0 m.i.g.d.(1996)
COLE HARBOUR
OCEAN
LOON LAKE
BISSET LAKE
TOPSAIL LAKE
LAKE LEMONT
LAKE CHARLES
MORRIS LAKE
MICMAC LAKE
DARTMOUTH
HALIFAX HARBOUR
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PARR LAKE
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BIG INDIAN LAKE
MOODY LAKE
BEAVERBANK ROAD
WAVERLEY
CANADIAN NATIONAL RAILWAYS
BICENTENNIAL DRIVE
ATLANTIC
DOMINION
LOWER SACKVILLE
UPPER SACKVILLE
MARSH LAKE
SANDY LAKE
BEDFORD
MC CABE LAKE
LUCASVILLE ROAD
KEARNEY ROAD
PLAIN
TOMAHAWK LAKE
EXISTING DAM
POCKWOCK LAKE
HAMMOND
STILLWATER LAKES
FRASER LAKE
OLD ANNAPOLIS ROAD
YANKEETOWN ROAD
MARSH LAKES
BIG SALMON POOL
NICHOLS LAKE
HACHET LAKE
MC GRATH LAKE
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APPROVED: K.W. Short
DATE: APRIL 1969
SCALE: AS NOTED
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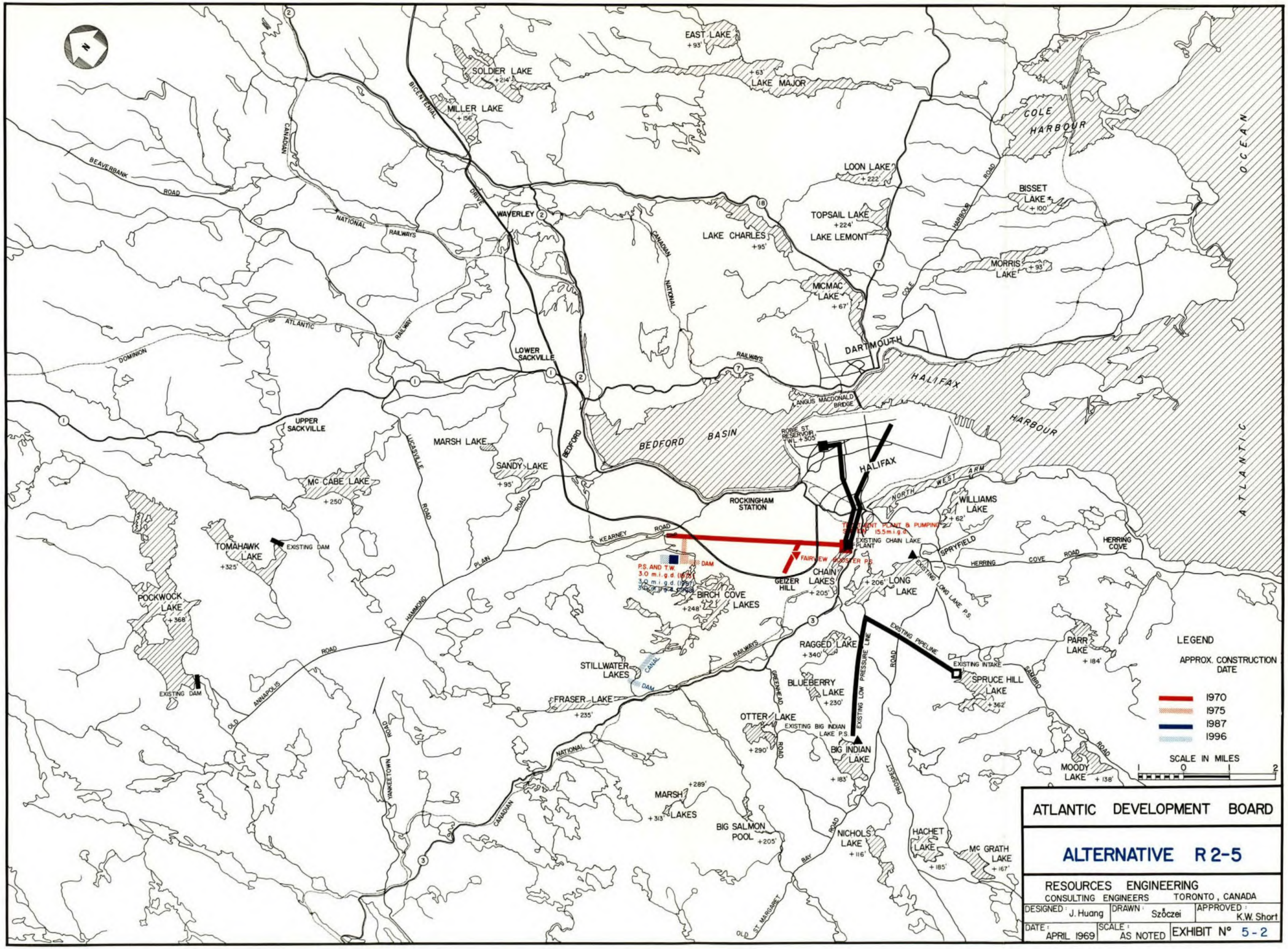
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DRAWN: Szőczei
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DATE: APRIL 1969
SCALE: AS NOTED
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LAKE MAJOR
MILLER LAKE
+156'
COLE HARBOUR
OCEAN
LOON LAKE
+222'
BISSET LAKE
+100'
TOPSAIL LAKE
+224'
LAKE LEMONT
LAKE CHARLES
+95'
MORRIS LAKE
+93'
MICMAC LAKE
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WAVERLEY
LOWER SACKVILLE
UPPER SACKVILLE
DARTMOUTH
HALIFAX HARBOUR
ANGUS MACDONALD BRIDGE
BEDFORD BASIN
ROBIE ST. RESERVOIR T.W.L. +305'
HALIFAX
NORTH WEST ARM
ATLANTIC
ROCKINGHAM STATION
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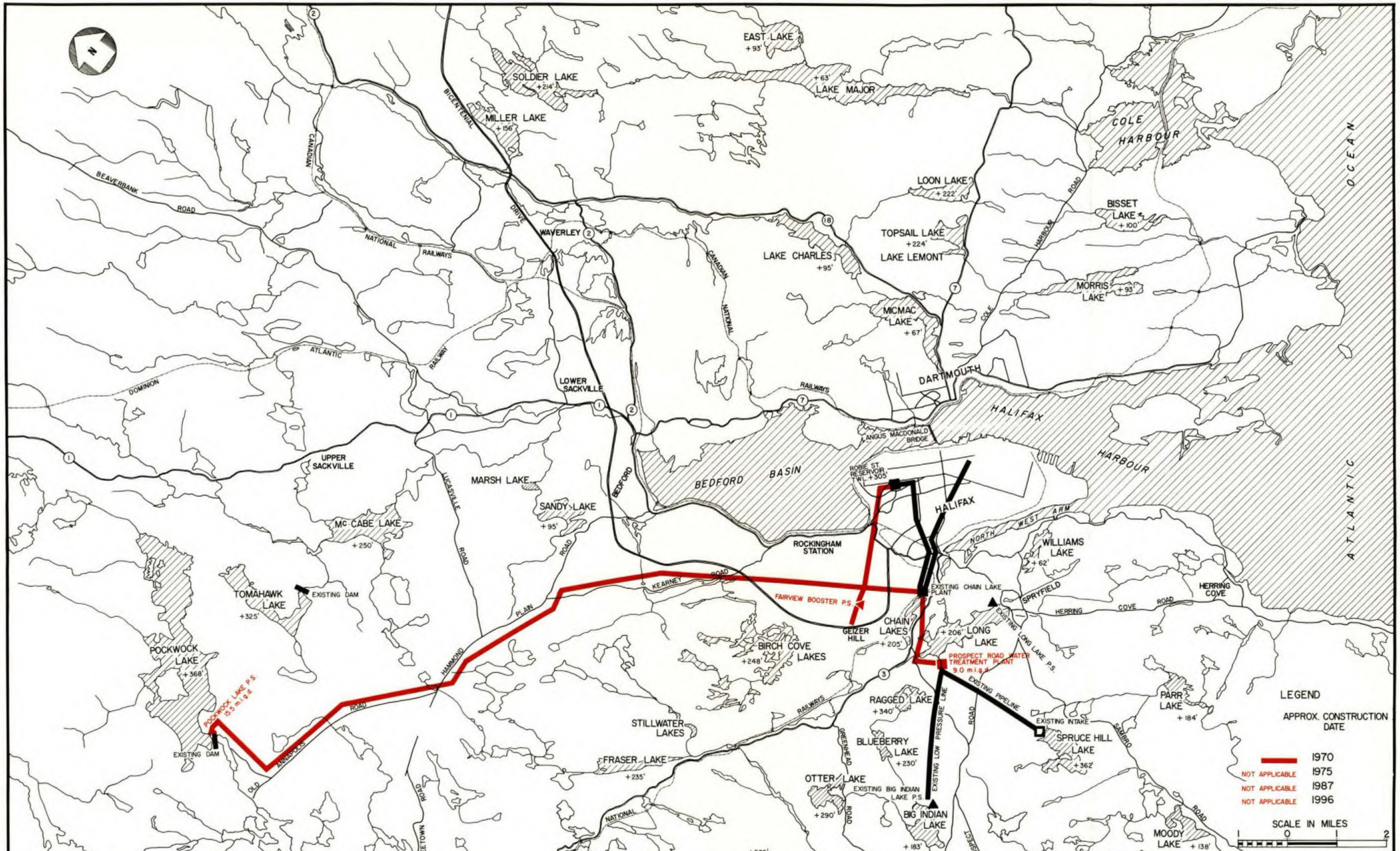
HERRING COVE
HERRING COVE ROAD
TREATMENT PLANT & PUMPING STATION 15.5 m.i.g.d.
EXISTING CHAIN LAKE PLANT
FAIRVIEW BOOSTER P.S.
GEIZER HILL
CHAIN LAKES
+205'
+206'
LONG LAKE
EXISTING LONG LAKE P.S.
EXISTING PIPELINE
EXISTING INTAKE
EXISTING LOW PRESSURE LINE
P.S. AND T.W.
DAM
BIRCH COVE LAKES
+248'
MARSH LAKE
SANDY LAKE
+95'
Mc CABE LAKE
+250'
TOMAHAWK LAKE
+325'
EXISTING DAM
POCKWOCK LAKE
+368'
EXISTING DAM
KEARNEY ROAD
STILLWATER LAKES
CANAL
DAM
FRASER LAKE
+235'
RAGGED LAKE
+340'
BLUEBERRY LAKE
+230'
OTTER LAKE
+290'
EXISTING BIG INDIAN LAKE P.S.
BIG INDIAN LAKE
+183'
SPRUCE HILL LAKE
+362'
PARR LAKE
+184'
MOODY LAKE
+138'
MARSH LAKES
+289'
+313'
BIG SALMON POOL
+205'
NICHOLS LAKE
+116'
HACHET LAKE
+185'
Mc GRATH LAKE
+167'
BEAVERBANK ROAD
NATIONAL RAILWAYS
CANADIAN NATIONAL RAILWAYS
ATLANTIC
DOMINION
RAILWAY
BICENTENNIAL DRIVE
BEDFORD
LUCASVILLE ROAD
HAMMONDS PLAIN ROAD
ANNAPOLIS ROAD
OLD
YANKEETOWN ROAD
PROSPECT ROAD
ST. MARGARET BAY ROAD
SAMBRO ROAD
HARBOUR ROAD

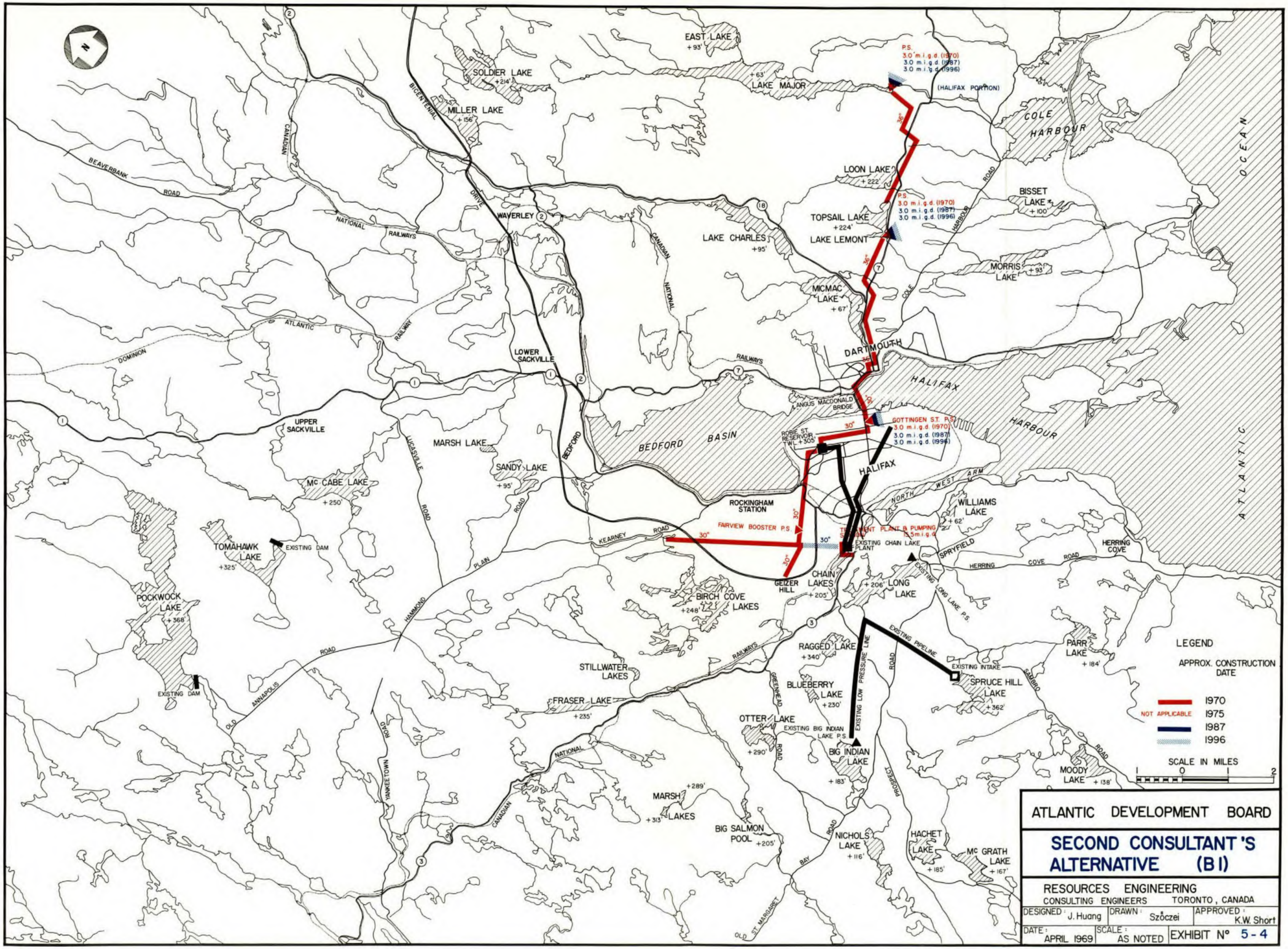



ATLANTIC DEVELOPMENT BOARD

**FIRST CONSULTANT'S ALTERNATIVE**

RESOURCES ENGINEERING
CONSULTING ENGINEERS TORONTO, CANADA

| DESIGNED: J. Huang | DRAWN: Szőczei | APPROVED: K.W. Short |
|---|---|---|
| DATE: APRIL 1969 | SCALE: AS NOTED | EXHIBIT N° 5-3 |




ATLANTIC DEVELOPMENT BOARD

**SECOND CONSULTANT'S ALTERNATIVE (B1)**

RESOURCES ENGINEERING
CONSULTING ENGINEERS TORONTO, CANADA

| | | |
|---|---|---|
| DESIGNED: J. Huang | DRAWN: Szőczei | APPROVED: K.W. Short |
| DATE: APRIL 1969 | SCALE: AS NOTED | EXHIBIT Nº 5-4 |

## ALTERNATIVE R1 (L. MAJOR)

| Year | Item | Cost | Cumulative Total Cost |
|---|---|---|---|
| 1970 | 15.5 m.i.g.d. from Lake Major | | |
| | Lake Major - Topsail Lake delivery main 16,000 ft. (24.5 m.i.g.d.) | $ 1.14 m | |
| | Lake Major pumping station and water conditioning plant (15.5 m.i.g.d.). | $ 0.45 m | |
| | Power lines and substations | $ 0.03 m | |
| | Pipeline - L. Lemont to east end Angus Macdonald bridge, 20,500 ft. (24.5 m.i.g.d.) | $ 1.46 m | |
| | Transmission main across bridge (30" Ø) | $ 0.48 m | |
| | Transmission main to Geizer Hill ) Fairview Booster Station ) Transmission main to Rockingham ) | $ 1.28 m | |
| | Diversion of Soldier Lake | $ 0.20 m | |
| | | $ 5.04 | $ 5.04 m |
| 1975 | 3.0 m.i.g.d. from Lake Major | | |
| | Extend Lake Major Pumping Station and Water Conditioning Plant | $ 0.08 m | |
| | Extend Gottingen Street Pumping Station | $ 0.02 m | |
| | | $ 0.10 m | $ 5.14 m |
| 1987 | 3.0 m.i.g.d. from Lake Major | | |
| | Extend Lake Major Pumping Station and Water Conditioning Plant | $ 0.08 m | |
| | Extend Gottingen Street Pumping Station | $ 0.02 m | |
| | | $ 0.10 m | $ 5.24 m |
| 1996 | 3.0 m.i.g.d. from Lake Major | | |
| | Extension Gottingen Street Pumping Station ) Transmission mains - Gottingen St. to Robie St. East end Chain L. to Fairview ) | $ 0.77 m | |
| | Extend Lake Major Pumping Station and Water Conditioning Plant | $ 0.08 m | |
| | | $ 0.85 m | $ 6.09 |

NOTE: Conditioning of water only.

EXHIBIT 5-5

## ALTERNATIVE R2-5 (EXISTING - BIRCH COVE - STILLWATER)

| | | | Cumulative Total Cost |
|---|---|---|---|
| 1970 | Construct treatment plant for existing system | $ 3.70 m | |
| | Transmission main from Chain L. to Geizer Hill ) Fairview Booster Pumping Station ) Transmission main to Rockingham ) | $ 0.95 m | |
| | | $ 4.65 m | $ 4.65 m |
| 1975 | 3 m.i.g.d. from Birch Cove | | |
| | Dam at Birch Cove and land clearing | $ 0.36 m | |
| | Roads and bridges | $ 0.02 m | |
| | Treatment Plant @ Birch Cove | $ 0.90 m | |
| | Pipeline from Birch Cove to Bicentennial Drive (9.00 m.i.g.d.) | $ 0.18 m | |
| | Compensation to Moirs Ltd. | $ 0.02 m | |
| | | $ 1.48 m | $ 6.13 m |
| 1987 | 3 m.i.g.d. from Birch Cove | | |
| | Extend treatment plant at Birch Cove | $ 0.72 m | |
| | Extend pumping station at Birch Cove | $ 0.02 m | |
| | | $ 0.74 m | $ 6.87 m |
| 1996 | 3 m.i.g.d. from L. Stillwater | | |
| | Dams at Stillwater Lake, land clearance and canal system | $ 0.39 m | |
| | Road and bridges | $ 0.13 m | |
| | Extend treatment plant at Birch Cove | $ 0.72 m | |
| | Extend pumping station at Birch Cove | $ 0.02 m | |
| | Transmission main from Fairview to Robie St. | $ 0.40 m | |
| | | $ 1.66 m | $ 8.53 m |

NOTE: All water fully treated.

## FIRST CONSULTANT'S ALTERNATIVE (JAN. 1966)

| Year | Item | Cost | Cumulative Total Cost |
|---|---|---|---|
| 1970 | Re-establish 9.0 m.i.g.d. from Big Indian and Spruce Hill | | |
| | 24" main from present termination point to treatment works<br>Prospect Road Treatment Plant<br>30" main from treatment plant to east end of Chain Lake | $ 3.14 m | $ 3.14 m |
| 1970 | 15.5 m.i.g.d. from L. Pockwock | | |
| | L. Pockwock Pumping Station<br>36" main from L. Pockwock to Fairview | $ 6.40 m | |
| | Fairview Booster Station<br>24" main from Fairview B.S. to Geizer Hill<br>30" main from Fairview to Robie St. Reservoir | $ 0.85 m | |
| | | $ 7.25 m | $10.39 m |

NOTE: To achieve uniformity for comparison, cost estimates have been revised using capital cost rates from the second consultant's report. Several distribution items appearing on the original list of the first consultant have also been omitted.

NOTE: Big Indian and Spruce Hill water fully treated.
L. Pockwock water conditioned only.

## SECOND CONSULTANT'S ALTERNATIVE B1 (EXISTING - L. MAJOR)

(With time of introduction of Lake Major Scheme delayed one year to render scheme compatible with other alternatives.)

| Year | Item | Cost | Cumulative Total Cost |
|---|---|---|---|
| 1970 | Construct treatment plant for existing system | $ 3.70 m | $ 3.70 m |
| 1970 | 3 m.i.g.d. from Lake Major | | |
| | Lake Major - Topsail Lake delivery main & Lake Major pumping station | $ 0.55 m | |
| | Delivery main - Lemont Lake to Gottingen Street, and Gottingen Street booster station | $ 1.71 m | |
| | Transmission main to Geizer Hill; Fairview Booster Station; Transmission main Rockingham | $ 1.28 m | |
| | | $ 3.54 m | $ 7.24 m |
| 1987 | 3 m.i.g.d. from Lake Major | | |
| | Lake Major - Topsail Lake delivery system | $ 0.55 m | |
| | Extend Gottingen Street Pumping Station | $ 0.02 m | |
| | | $ 0.57 m | $ 7.81 m |
| 1996 | 3 m.i.g.d. from Lake Major | | |
| | Lake Major - Topsail Lake delivery system | $ 0.55 m | |
| | Extension of Gottingen Street Pumping Station; Transmission mains - Gottingen St. to Robie St.; East end Chain Lake to Fairview | $ 0.77 m | |
| | | $ 1.32 m | $ 9.13 m |

NOTE: Water from existing system fully treated.
L. Major water conditioned only.

EXHIBIT 5-8

## ANNUAL OPERATING COSTS (COMPARATIVE ONLY)

(in thousands of dollars per year)

| Year / Alternative | 1970 | 1975 | 1975 | 1987 | 1987 | 1996 | 1996 | 2000 |
|---|---|---|---|---|---|---|---|---|
| R1 (L. Major) | 127 | 133 | 133 | 159 | 159 | 185 | 185 | 200 |
| R2 (Ex.+ L.Nichols + Birch Cove) | 110 | 115 | 115 | 141 | 133 | 158 | 151 | 164 |
| R2-5 (Ex. + Birch Cove) | 110 | 115 | 111 | 133 | 129 | 151 | 147 | 159 |
| 1st Consultant's (Big Indian + Spruce Hill + L. Pockwock) | 17 | 19 | 19 | 30 | 30 | 52 | 52 | 65 |
| 2nd Consultant's B1 (Ex. L. Major) | 110 | 115 | 115 | 139 | 139 | 165 | 165 | 180 |

NOTE: The derivation of these annual operating costs can be found in Table 6 in the Technical Appendix.

PRESENT VALUES OF ALTERNATIVE SCHEMES

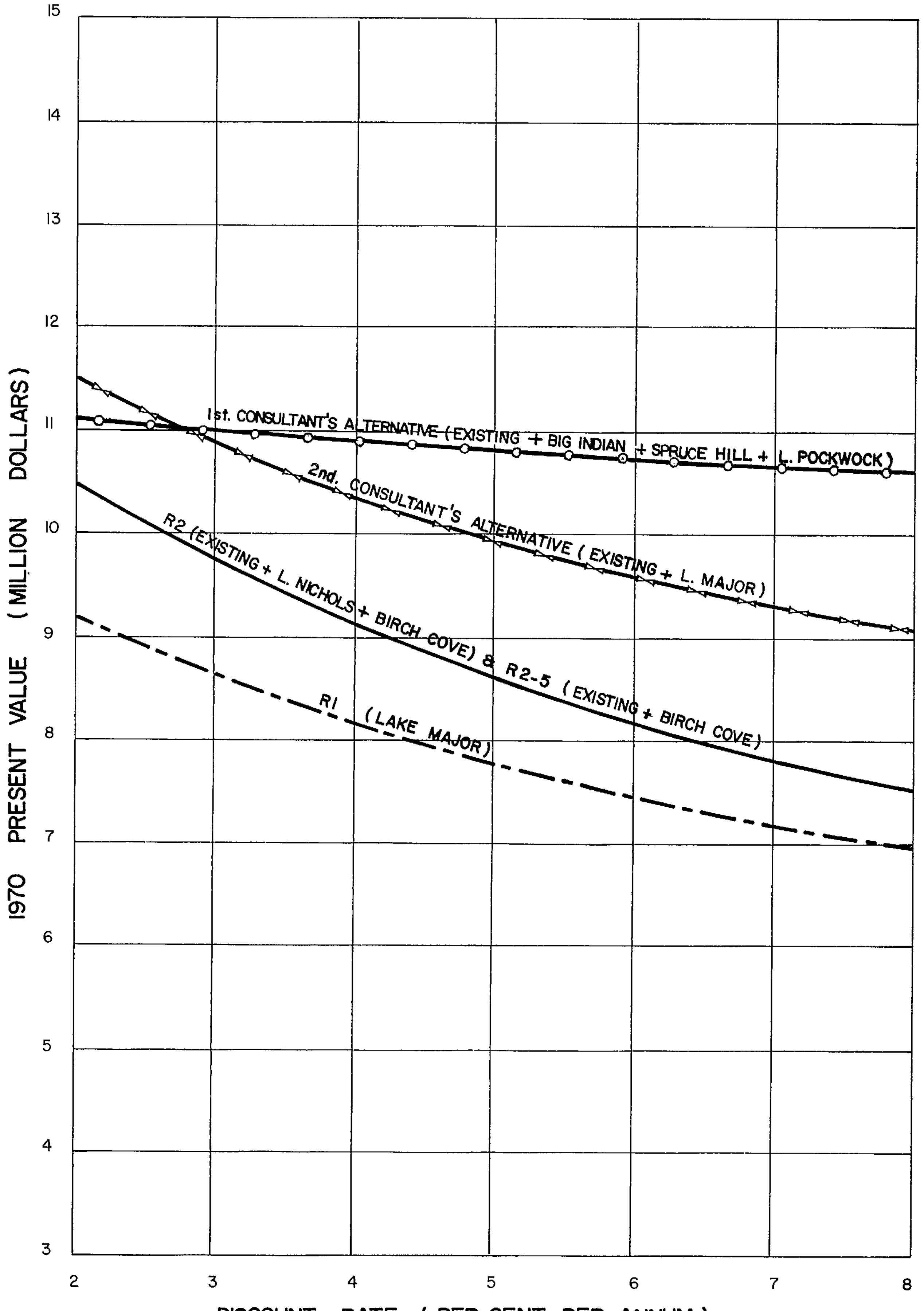



EXHIBIT 5-10

# ECONOMIC EFFECT OF WATER TREATMENT AT L. MAJOR

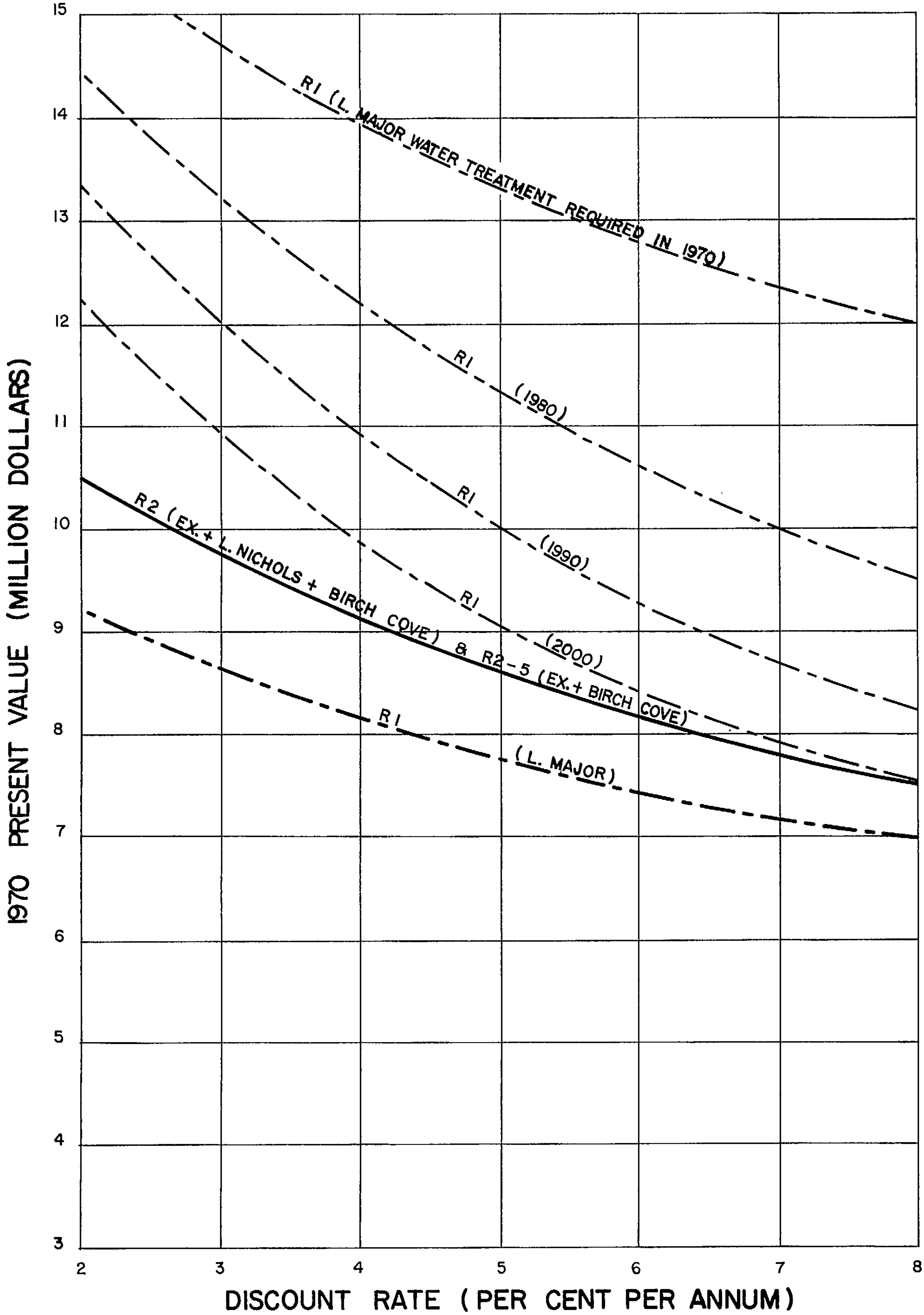



EXHIBIT 5-11

## PRACTICAL POINTS RELEVANT TO DEVELOPMENT

| | | Alternative R1 | Alternative R2 or R2-5 | Alternative B1 |
|---|---|---|---|---|
| 1. | Inconvenience to Dartmouth | Much | None | Much |
| 2. | Difficulties during construction resulting in increase in engineering costs | Likely | Not likely | Likely |
| 3. | Quality of water supplied to consumer | Conditioning only | Treated | Mixture of treated and conditioned water. |
| 4. | Date on which Lake Major yield is fully committed | 2000 | Far beyond 2000 | Beyond 2000 |
| 5. | System flexibility | Rigid (single source) | Good | Good |
| 6. | Problem with land and water rights | More | Little | More |
| 7. | Benefit to Dartmouth | Little | None | Little |
| 8. | Technical staff required | Existing | Requires trained staff for water treatment | Requires trained staff for water treatment |
| 9. | Long-Chain Lakes released for recreational purposes | Yes | No | No |

EXHIBIT 5-12

6 DARTMOUTH WATER SUPPLY

## SECTION 6

## DARTMOUTH WATER SUPPLY

This Section considers the relative merits of joint or separate use of Lake Major water by Dartmouth with Halifax.

The development of Lake Major for the joint use of Dartmouth and Halifax has been considered for the following two cases:

1. A moderate supply is provided for Halifax which is used to supplement the yield from the existing system.

2. A large supply is provided for Halifax and this replaces the yield from the existing Halifax system.

Joint benefit for Case 1 is dealt with in Alternative B1 by the second Consultant with the use of an arbitrary method of cost-sharing of the portion of the system between Lake Major and Lake Lemont. Despite having to commit Dartmouth to an unnecessary high early expenditure, this measure does not give Alternative B1 a favourable economic ranking in the present study.

Only Alternative R1 needs consideration under Case 2. The pipe-line between Lake Major and Lake Lemont will now have to carry the supplies for two cities. To keep the size of this pipe-line within realistic dimensions, the pipe-line will become fully committed by 1980, after which a second pipe-line will have to be constructed.

On the other hand, by expanding its present pumping capacity and still using existing pipe-lines, Dartmouth is able to increase its system capacity to meet demands up to 1980. The cost of this work is in the order of $100,000. This amount will also be what Dartmouth would be willing to contribute for joint use of the Lake Major system, and therefore the likely saving for Halifax.

Alternative R1 has further disadvantages. The combined water demand of Halifax and Dartmouth approaches the yield limit of the Lake Major System (including Soldier Lake) around the year 2000. When this happens, either Dartmouth will have to develop some other more expensive source of water, or, what is more likely, Halifax will be forced to relinquish to Dartmouth some of its water rights at Lake Major. This will then render the constructed system for Halifax to be partially redundant.

We, therefore, conclude that the development of Lake Major for the joint use of Halifax and Dartmouth is not the most satisfactory long term plan. Lake Major, however, remains to be the best source of water supply for Dartmouth and it is advisable to confirm rights for its land and water use. The capacity of the Dartmouth system should be increased in the near future by modification of its pumping system at Lake Major at a cost in the order of $100,000. This proposal was mentioned in a report on the "Dartmouth Water Supply" prepared in October, 1968. Further system expansion, possibly around 1980, will require the addition of a new pipe-line and increase of the pumping system capacity.

7 SUPPLY TO BEDFORD, WAVERLEY AND SACKVILLE

## SECTION 7

## SUPPLY TO BEDFORD, WAVERLEY AND SACKVILLE

The present and estimated future water demands at Bedford, Waverley and Sackville are shown by Projection "C" in Exhibit 4-1. The present water supply in these three communities is almost entirely from private wells varying from 50 feet to over 500 feet in depth. There is no indication of groundwater exhaustion of the aquifer in the foreseeable future. The only complaint appears to be excessive iron content in the water at certain localities.

The present small water demand at Bedford, Waverley and Sackville makes a piped supply from the Halifax system uneconomic. The development of a local reservoired supply such as that proposed by the second Consultant at Marsh and Sandy Lakes would still cost in excess of $700,000 per m.i.g.d. even at a demand of 3.0 m.i.g.d. which would not likely be realized before year 2000. To this must be added the cost of a long trunk main to Waverley and a distribution system for an area which is large and sparsely populated. We therefore conclude that both these proposals are not economically justifiable.

The following courses of action remain open:

1. The present use of well water should be continued.

2. If better controlled water quality is desired, consideration may be given to the installation of one or more water supply centres located near the nuclei of development. These centres may utilize water from deep wells where this source is good, or water can be extracted from adjacent lakes or streams. The degree of treatment will depend on the demand requirement.

8 ECONOMIC COMMENTS

# SECTION 8

# ECONOMIC COMMENTS

## Economics

The previous reports by two Consultants treat the economic aspects of their respective alternatives for adding water supply increments to the Greater Halifax Region differently, and without equivalence in system capacities. Consequently the merits of the various alternatives cannot be resolved with ease. Neither of the reports firmly establish the need and justification for any increment before the early 1970's. The reports do not present cash flow analysis for the alternatives nor do they appear to incorporate any effects of such increments on the total operating costs of the existing Halifax and Dartmouth water systems. Without discounted cash flow analysis the identity of the best course of action is obscured.

## Water Rates

The relatively high water rates currently in effect in the Halifax area should be a matter of concern. The reasons for the high rates are not readily apparent from available information and they should be determined through separate inquiries.

The suggestion that water rates be increased by some 35% to assist in financing a water supply increment needs serious reconsideration. This added cost on top of an already high water rate would hinder local industrial development objectives because the cost of water could be a serious deterrent to location of new industries that might require moderate to large supply of water. The ideal result from adding a water supply increment should be to maintain or lower water rates, especially to large users.

## Accounting

An examination of recent annual reports of the Public Service Commission of Halifax did not furnish answers to the following key questions:

1. What is the breakdown of water cost per thousands gallons in terms of the critical elements of,

   a) primary source cost
   b) treatment cost
   c) distribution cost
   d) administration cost

2. How many employees are in each department of the P.S C. and what is the breakdown of the annual corresponding payroll?

3. What is the annual quantity of water treated and what is the metered quantity? There are suggestions of abnormally high leakages and other losses. If so an engineering study of system losses and remedial costs should be instituted.

A management study of the P.S.C. and an analysis of water costs would be worthy undertakings before a major investment is made in new facilities, either for additional water supply, new treatment plants, loss reduction or distribution systems.

Financing

The recommended alternatives of the two Consultants would both entail large capital investments. Such capital outlays would almost double the present assets of the P.S.C. and impose a serious financial burden in the form of long-term carrying charges. From a financial point of view the P.S.C. cannot afford and does not need a 100% increase in debt at this point in time. There is no apparent economic or financial advantage in constructing the long-term needs today. Development of a long-term water plan for water supply and a capital expenditure program synchronized with the forecast demand growth of the Greater Halifax area would permit a staged program involving modest capital expenditures every five to ten years. This approach would conserve capital, match supply with demand, and result in overall economies.

Examination of the Annual Reports of the P.S.C. suggests that the present debt ratio is very high. More than half of the reported annual total operating expense is due to the payment of interest, carrying charges, and provisions for debt retirement. By inference, more than half of the water rates are a consequence of the high debt burden. Some means should be sought to retire a substantial portion of the debt by equity infusions into the P. S. C. of funds from municipal, provincial or federal governments, or from the local municipal taxes.

Recommendations

1. The Atlantic Development Board or its successor should standardize and clearly define at the outset, the approach and format for economic analysis that Consultants are to follow when presenting their alternatives for consideration. We recommend that discounted cash flows should be employed as part of the overall cost-benefit study. The method of financing should be excluded from the project analysis.

2. A study should be undertaken to determine the reason for the high water rates, the breakdown of costs, the number of people employed by the P. S. C. and the quantity of losses in the existing system.

3. A staged approach based on a long term Master Plan for Water Supply in the Greater Halifax area will make it possible to delay premature large commitments and thereby improve the financial position of the P. S. C. Further debt issues should be restricted if possible.

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5. Development of Public Water Supply for the Greater Halifax Area Jun. 1967

6. Dartmouth Water Supply - Development, Past and Future Oct. 1968

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8. Twenty-Second Annual Report for Year ending Dec. 31, 1966, Public Service Commission of Halifax

9. Twenty-Third Annual Report for Year ending Dec. 31, 1967, Public Service Commission of Halifax

10. Memoranda No. 327, 390A, 510 and 533 on Water Supply for the Greater Halifax-Dartmouth area by A. D. B. staff. 1967/68

9 TECHNICAL APPENDIX

## TECHNICAL APPENDIX

This appendix contains a description of the method of economical analysis used in the review, and the calculation of the present values for the various alternatives.

Table 1 shows an array of 13 alternatives (R1 to R2-9) which form a complete set of combinations of possible long term water supply plans for the city of Halifax within the context of Section 3 of this report. The alternatives proposed by the two consultants are also shown. Staging of the alternatives is based on demand projection "A" found in Exhibit 4-1. The alternatives are divided into 4 sub-sets which are defined at the foot of the table.

Cumulative Capital and Operating Expenditures have been worked out for each alternative and these are entered on Table 1. They are the cumulative totals of capital and certain operating costs from 1970 at the various dates shown without regard to present value discounting. Where two different values are shown for any date, these are the values before and after a capital expenditure has been made. Operating costs have been assumed to consist only of pumping energy cost and the difference in costs between "full treatment" and "conditioning". The unit annual operating costs for all prospective water schemes in the area are shown in Table 2.

A number of alternatives in each sub-set can be eliminated by examining the cumulative expenditure tableau in Table 1. These are the alternatives with all cumulative expenditure values equal to or higher than corresponding values of one or more other alternatives in the same sub-set, as they then become decisively more expensive. Eliminated alternatives are indicated in the table.

The remaining alternatives (8 in number including the alternatives of the two consultants) require present value analysis for economic ranking. The capital costs of the various stages of development for the 8 alternatives are shown on Exhibits 1-2, 5-5 to 5-8 and on Tables 3 to 5, and their annual operating costs are shown on Table 6. Using these costs the total 1970 present values for each alternative have been calculated on Table 7 with discount rates of 2, 4, 6 and 8%. The present value formula used is given at the foot of the table. The following assumptions on expenditure have been made:

1. Capital expenditure for any one stage is incurred in a single year. This is equivalent to assuming the capital expenditure over a series of years to occur in one sum at the centroid of the period.

2. Annual operating expenditures vary linearly between the values shown for the beginning and end of a period.

If water treatment is required at Lake Major at some future date, the present value for any scheme using Lake Major water has to be increased by the present value of these future expenditures, which include capital cost of construction and an increase in annual operating cost. The amounts by which the present value of Alternative R1 has to be increased from a treatment requirement in 1970, 1980, 1990 and 2000 are calculated in Table 8.

Delay in the construction of a water treatment plant for the existing system results in a reduction of present value for any alternative containing this item of work. The amount of present value reduction can be calculated by introducing a saving (negative expenditure) equal to the capital cost of the plant in 1970 and an expenditure of the same amount at the date when the treatment plant should be installed, together with the estimated reduction in annual operating cost during this period. The calculations are shown on Table 9.

To maintain water quality standard when construction of the treatment plant for the existing system is delayed, it is necessary to advance construction of some other capital scheme. This is explained in Section 5 of the report. The amount of present value increase associated with this requirement is calculated in Table 10 for Alternatives R2-5 and B1. The net present values of these two alternatives for a treatment plant for the existing system installed in 1980 and 1990 are displayed in Table 11.

POSSIBLE DEVELOPMENT PROGRAMMES FOR HALIFAX

| Alternative | 1970 | 1975 | 1987 | 1996 | Cumulative Capital & Operating Expenditure ($ Million) 1970 | 1975 | 1975 | 1987 | 1987 | 1996 | 1996 | 2000 | Sub-set | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R1 | 15.5 m.i.g.d. from L. Major | 3.0 m.i.g.d. from L. Major | 3 m.i.g.d. from L. Major | 3 m.i.g.d. from L. Major | 5.04 | 5.69 | 5.79 | 7.54 | 7.64 | 9.19 | 10.04 | 10.81 | 1 | |
| R1-1 | 15.5 m.i.g.d from L. Pockwock | 3.0 m.i.g.d. from L. Pockwock | 3 m.i.g.d. from L. Pockwock | 3 m.i.g.d. from L. Pockwock | 8.11 | 8.20 | 8.28 | 8.53 | 8.61 | 8.83 | 9.31 | 9.41 | | |
| R1-2 | 15.5 m.i.g.d. from Birch Cove Lake System | 3.0 m.i.g.d. from Birch Cove System | 3 m.i.g.d. from Birch Cove System | 3 m.i.g.d. from Birch Cove System | 7.85 | 8.31 | 9.01 | 10.25 | 10.99 | 12.09 | 13.23 | 13.77 | | Eliminated by Examination |
| R2 | Treatment Plant for existing system (15.5 m.i.g.d.) | 3 m.i.g.d. from L. Nichols | 3 m.i.g.d. from Birch Cove | 3 m.i.g.d. from Birch Cove | 4.65 | 5.21 | 6.38 | 7.92 | 9.38 | 10.69 | 11.83 | 12.46 | | Lowest cost in sub-set |
| R2-1 | " | " | 3 m.i.g.d. from L. Major | 3 m.i.g.d. from L. Major | 4.65 | 5.21 | 6.38 | 7.92 | 10.15 | 11.49 | 12.81 | 13.48 | | Eliminated by Examination |
| R2-2 | " | " | 3 m.i.g.d. from L. Pockwock | 3 m.i.g.d. from L. Pockwock | 4.65 | 5.21 | 6.38 | 7.92 | 11.41 | 12.61 | 13.11 | 13.65 | 2-A | " " " |
| R2-3 | " | " | 3 m.i.g.d. from L. Parr | 3 m.i.g.d. from L. Parr | 4.65 | 5.21 | 6.38 | 7.92 | 10.53 | 11.90 | 13.04 | 13.72 | | " " " |
| R2-4 | " | " | 3 m.i.g.d. from L. Moody | 3 m.i.g.d. from L. Moody | 4.65 | 5.21 | 6.38 | 7.92 | 10.20 | 11.59 | 12.83 | 13.53 | | " " " |
| R2-5 | " | 3 m.i.g.d. from Birch Cove | 3 m.i.g.d. from Birch Cove | 3 m.i.g.d. from L. Stillwater | 4.65 | 5.21 | 6.69 | 8.16 | 8.90 | 10.16 | 11.82 | 12.43 | | Lowest cost in sub-set |
| R2-6 | " | 3 m.i.g.d. from L. Parr | 3 m.i.g.d. from L. Parr | 3 m.i.g.d. from L. Nichols | 4.65 | 5.21 | 7.72 | 9.25 | 9.99 | 11.35 | 13.07 | 13.75 | 2-B | Eliminated by Examination |
| R2-7 | " | 3 m.i.g.d. from L. Moody | 3 m.i.g.d. from L. Moody | 3 m.i.g.d. from L. Nichols | 4.65 | 5.21 | 7.39 | 8.92 | 9.66 | 11.05 | 12.05 | 13.47 | | " " " |
| R2-8 | " | 3 m.i.g.d. from L. Major | 3 m.i.g.d. from L. Major | 3 m.i.g.d. from L. Major | 4.65 | 5.21 | 7.80 | 9.33 | 9.90 | 11.27 | 12.59 | 13.28 | | |
| R2-9 | " | 3 m.i.g.d. from L. Pockwock | 3 m.i.g.d. from L. Pockwock | 3 m.i.g.d. from L. Pockwock | 4.65 | 5.21 | 8.67 | 9.94 | 10.02 | 10.99 | 11.47 | 11.87 | 2-C | |
| 1st Consultant | Treatment plant for Big Indian & Spruce Hill +15.5 m.i.g.d. from L. Pockwock | | | | 10.39 | 10.48 | 10.48 | 10.77 | 10.77 | 11.01 | 11.01 | 11.11 | | |
| 2nd Consultant B1 | Treatment plant for ex. system +3.0 m.i.g.d. from L. Major | | 3 m.i.g.d. from L. Major | 3 m.i.g.d. from L. Major | 7.24 | 7.80 | 7.80 | 9.33 | 9.90 | 11.27 | 12.59 | 13.28 | | |

NOTE: Sub-set 1 - Existing system abandoned. A large new system to be developed.
Sub-set 2-A - Existing system retained. A small new system requiring full treatment (L. Nichols) to be delivered next.
Sub-set 2-B - Existing system retained. A large new system requiring full treatment to be developed next in stages.
Sub-set 2-C - Existing system retained. A new system requiring conditioning only to be developed next in stages.

TABLE 1

## UNIT ANNUAL OPERATING COSTS (COMPARATIVE ONLY)

| Source | Reservoir Elevation | Type of Treatment | Annual Pumping Cost per m.i.g.d. | Annual Treatment Cost per m.i.g.d. | Total Annual Op. Cost per m.i.g.d. |
|---|---|---|---|---|---|
| Existing System | 190 Ft. | Full | $ 4,660 | $ 3,650 | $ 8,310 |
| Lake Nichols | 116 | Full | 7,370 | 3,650 | 11,020 |
| Birch Cove | 248 | Full | 3,140 | 3,650 | 6,790 |
| Lake Pockwock | 368 | Conditioning | 1,330 | 0 | 1,330 |
| Lake Major | 63 | Conditioning | 9,590 | 0 | 9,590 |
| Lake Parr | 184 | Full | 5,300 | 3,650 | 8,950 |
| Lake Moody | 138 | Full | 6,600 | 3,650 | 10,250 |

NOTE: Pumping and treatment costs do not include annual charges for capital.
Pumping costs are based on a delivered water elevation of 310 feet above sea level (approx. inlet elevation of Robie Street service reservoir). An energy cost of 15 mills per K. W. H. is used.
Treatment costs are based on the following comparative rates
Conditioning 0
Full Treatment 10 Mills per 1000 gallons
Reservoir elevation for the existing system is the weighted mean of the elevations of Long-Chain Lakes, Spruce Hill Lake and Big Indian Lake.
Reservoir elevations are related to mean sea level.

TABLE 2

## ALTERNATIVE R1-1 (L. POCKWOCK)

| Year | Item | Cost | Cumulative Total Cost |
|---|---|---|---|
| 1970 | 15.5 m.i.g.d. from Lake Pockwock | | |
| | Dams and spillways | $ 0.36m | |
| | Land clearing, roads & bridges etc. | $ 0.60m | |
| | Power lines and substations | $ 0.03m | |
| | Lake Pockwock - Chain Lakes delivery main 84,000 ft. (24.5 m.i.g.d.) | $ 6.00m | |
| | Lake Pockwock pumping station & water conditioning plant (15.5 m.i.g.d.) | $ 0.32m | |
| | Transmission main to Geizer Hill and Fairview booster station | $ 0.30m | |
| | Compensation to Nova Scotia Power Commission | $ 0.50m | |
| | | $ 8.11m | $ 8.11m |
| 1975 | 3.0 m.i.g.d. from Lake Pockwock | | |
| | Extend Lake Pockwock Pumping Station and Water Conditioning Plant | $ 0.08m | $ 8.19m |
| 1987 | 3.0 m.i.g.d. from Lake Pockwock | | |
| | Extend Lake Pockwock pumping station and water conditioning plant | $ 0.08m | $ 8.27m |
| 1996 | 3.0 m.i.g.d. from Lake Pockwock | | |
| | Extend Lake Pockwock pumping station and water conditioning plant | $ 0.08m | |
| | Transmission main from Fairview to Robie St. | $ 0.40m | |
| | | $ 0.48m | $ 8.75m |

NOTE: Conditioning of water only

TABLE 3

## ALTERNATIVE R2-8 (EXISTING-L MAJOR)

| Year | Item | Cost | Cumulative Total Cost |
|---|---|---|---|
| 1970 | Construct treatment plant for existing system | $3.70m | |
| | Transmission main from Chain Lake to Geizer Hill; Fairview Booster Pumping Station; Transmission main to Rockingham | 0.95m | |
| | | 4.65m | $ 4.65m |
| 1975 | 3 m. i. g. d from Lake Major | | |
| | Lake Major - Topsail Lake delivery main & L. Major Pumping Station | $ 0.55m | |
| | Delivery main - Lemont Lake to Gottingen Street, and Gottingen St. Booster Station | $ 1.71m | |
| | Delivery main to Robie St. reservoir | $ 0.33m | |
| | | $ 2.59m | $ 7.24m |
| 1987 | 3 m. i. g. d. from Lake Major | | |
| | Lake Major - Topsail Lake delivery system | $ 0.55m | |
| | Extend Gottingen St. Pumping Station | $ 0.02m | |
| | | $ 0.57m | $ 7.81m |
| 1996 | 3 m. i. g. d. from Lake Major | | |
| | Lake Major - Topsail Lake delivery system | $ 0.55m | |
| | Extend Gottingen St. Pumping Station; Transmission mains-East end Chain Lake to Fairview | $ 0.77m | |
| | | $ 1.32m | $ 9.13m |

NOTE: Full treatment for water in existing system.
Conditioning for L. Major Water.

TABLE 4

ALTERNATIVE R2-9 (EXISTING-L. POCKWOCK)

| Year | Item | Cost | Cumulative Total Cost |
|---|---|---|---|
| 1970 | Construct treatment plant for existing system | $ 3.70m | |
| | Transmission main from Chain L. to Geizer Hill<br>Fairview Booster Pumping Station<br>Transmission main to Rockingham | $ 0.95m | |
| | | $ 4.65m | $ 4.65m |
| 1975 | 3 m.i.g.d. from L. Pockwock | | |
| | Roads & Bridges | $ 0.08m | |
| | Pipelines (9 m.i.g.d.) L. Pockwock to Rockingham | $ 3.10m | |
| | Pumphouse & water conditioning plant | $ 0.08m | |
| | Power lines and substations | $ 0.02m | |
| | Compensation to N.S.P.C. | $ 0.18m | |
| | | $ 3.46m | $ 8.11m |
| 1987 | 3 m.i.g.d. from L. Pockwock | | |
| | Extend L. Pockwock pumping station & water conditioning plant | $ 0.08m | $ 8.19m |
| 1996 | 3 m.i.g.d. from L. Pockwock | | |
| | Extend L. Pockwock pumping station & water condition plant | $ 0.08m | |
| | Transmission main from Fairview to Robie St. | $ 0.40m | |
| | | $ 0.48m | $ 8.67m |

NOTE: Full treatment for water in existing system
Conditioning for L. Pockwock water

TABLE 5

ANNUAL OPERATING COSTS
(COMPARATIVE COSTS ONLY)

| | YEAR | 1970 | 1975 | | 1987 | | 1996 | | 2000 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Demand (m. i. g. d.) | 13. 2 | 13. 9 | | 16. 6 | | 19. 3 | | 20. 8 | |
| Alternative R1 (L. Major) | Av. Annual Drawoff | | | | | | | | | |
| | From L. Major | 13. 2 | 13. 9 | 13. 9 | 16. 6 | 16. 6 | 19. 3 | 19. 3 | 20. 8 | m.i.g.d. |
| | Annual Op. Cost | 126. 7 | 133. 3 | 133. 3 | 159. 2 | 159. 2 | 185. 2 | 185. 2 | 199. 6 | X$1,000 |
| R1-1 (L. Pockwock) | Av. Annual Drawoff | | | | | | | | | |
| | From L. Pockwock | 13. 2 | 13. 9 | 13. 9 | 16. 6 | 16. 6 | 19. 3 | 19. 3 | 20. 8 | m.i.g.d. |
| | Annual Op. Cost | 17. 6 | 18. 5 | 18. 5 | 22. 1 | 22. 1 | 25. 7 | 25. 7 | 27. 6 | X$1.000 |
| R2 (Ex. System + L. Nichols + Birch Cove) | Av. Annual Drawoff | | | | | | | | | |
| | From Ex. System | 13. 2 | 13. 9 | 13. 9 | 15. 5 | 13. 6 | 15. 5 | 13. 3 | 14. 8 | m.i.g.d. |
| | L. Nichols | | | | 1. 1 | - | 0. 8 | - | - | " |
| | Birch Cove | | | | | 3. 0 | 3. 0 | 6. 0 | 6. 0 | " |
| | Annual Op. Cost | 109. 8 | 115. 3 | 115. 3 | 140. 9 | 133. 4 | 158. 2 | 151. 2 | 163. 7 | X$1,000 |
| R2-5 (Ex. System + Birch Cove) | Av. Annual Drawoff | | | | | | | | | |
| | From Ex. System | 13. 2 | 13. 9 | 10. 9 | 13. 6 | 10. 6 | 13. 3 | 10. 3 | 11. 8 | m.i.g.d. |
| | Birch Cove | | | 3. 0 | 3. 0 | 6. 0 | 6. 0 | 9. 0 | 9. 0 | " |
| | Annual Op. Cost | 109. 8 | 115. 3 | 110. 9 | 133. 4 | 128. 9 | 151. 2 | 146. 7 | 159. 2 | X$1.000 |
| R2-8 (Ex. System + L. Major) | Av. Annual Drawoff | | | | | | | | | |
| | From Ex. System | 13. 2 | 13. 9 | 13. 9 | 15. 5 | 15. 5 | 15. 5 | 15. 5 | 15. 5 | m.i.g.d. |
| | L. Major | | | | 1. 1 | 1. 1 | 3. 8 | 3. 8 | 5. 3 | " |
| | Annual Op. Cost | 109. 8 | 115. 3 | 115. 3 | 139. 4 | 139. 4 | 165. 3 | 165. 3 | 179. 7 | X$1,000 |
| R2-9 (Ex. System + L. Pockwock) | Av. Annual Drawoff | | | | | | | | | |
| | From Ex. System | 13. 2 | 13. 9 | 10. 9 | 13. 6 | 10. 6 | 13. 3 | 10. 3 | 11. 8 | m.i.g.d. |
| | L. Pockwock | | | 3. 0 | 3. 0 | 6. 0 | 6. 0 | 9. 0 | 9. 0 | " |
| | Annual Op. Cost | 109. 8 | 115. 3 | 94. 5 | 117. 0 | 96. 1 | 118. 5 | 97. 6 | 110. 0 | X$1,000 |
| 1st Consultant's Alternate (Big Indian + Spruce Hill + L. Pockwock) | Av. Annual Drawoff | | | | | | | | | |
| | From Ex. System | - | - | - | 1. 1 | 1. 1 | 3. 8 | 3. 8 | 5. 3 | m i.g.d. |
| | L. Pockwock | 13. 2 | 13. 9 | 13. 9 | 15. 5 | 15. 5 | 15. 5 | 15. 5 | 15. 5 | " |
| | Annual Op. Cost | 17. 6 | 18. 5 | 18. 5 | 29. 8 | 29. 8 | 52. 2 | 52. 2 | 64. 6 | X$1 000 |
| 2nd Consultant's (Ex. System + L. Major) | Av. Annual Drawoff | | | | | | | | | |
| | From Ex. System | 13. 2 | 13. 9 | 13. 9 | 15. 5 | 15. 5 | 15. 5 | 15. 5 | 15. 5 | m.i.g.d. |
| | L. Major | | | | 1. 1 | 1. 1 | 3. 8 | 3. 8 | 5. 3 | " |
| | Annual Op. Cost | 109. 8 | 115. 3 | 115. 3 | 139. 4 | 139. 4 | 165. 3 | 165. 3 | 179. 7 | X$1,000 |

NOTE: 1. Drawoffs to meet the demand are built up from preferential extraction from systems with lower operating costs up to their reliable yields.

2. Annual operating costs are shown at the beginning and end of the time periods.

TABLE 6

# PRESENT VALUE CALCULATIONS

(All values are in Millions of Dollars)

| ALTERNATIVE | | 1970 | 1970 to 1975 | 1975 | 1975 to 1987 | 1987 | 1987 to 1996 | 1996 | 1996 to 2000 | Total 1970 P.V. |
|---|---|---|---|---|---|---|---|---|---|---|
| R1 | Cap. Cost | 5.04 | | 0.10 | | 0.10 | | 0.85 | | |
| (L. Major) | Total Op. Cost | | 0.65 | | 1.75 | | 1.55 | | 0.77 | |
| | 1970 P.V. | | | | | | | | | |
| | @ i = 2% | 5.04 | 0.62 | 0.09 | 1.41 | 0.07 | 1.02 | 0.51 | 0.46 | 9.22 |
| | 4% | 5.04 | 0.59 | 0.08 | 1.15 | 0.05 | 0.67 | 0.31 | 0.27 | 8.16 |
| | 6% | 5.04 | 0.57 | 0.07 | 0.94 | 0.04 | 0.45 | 0.19 | 0.14 | 7.44 |
| | 8% | 5.04 | 0.54 | 0.07 | 0.77 | 0.03 | 0.31 | 0.11 | 0.10 | 6.97 |
| R1 - 1 | Cap. Cost | 8.17 | | 0.08 | | 0.08 | | 0.48 | | |
| (L. Pockwock) | Total Op. Cost | | 0.09 | | 0.25 | | 0.22 | | 0.10 | |
| | 1970 P.V. | | | | | | | | | |
| | @ i = 2% | 8.11 | 0.09 | 0.07 | 0.20 | 0.06 | 0.14 | 0.29 | 0.06 | 9.02 |
| | 4% | 8.11 | 0.08 | 0.07 | 0.16 | 0.04 | 0.09 | 0.17 | 0.08 | 8.75 |
| | 6% | 8.11 | 0.08 | 0.06 | 0.13 | 0.03 | 0.06 | 0.11 | 0.02 | 8.60 |
| | 8% | 8.11 | 0.07 | 0.05 | 0.11 | 0.02 | 0.04 | 0.06 | 0.01 | 8.47 |
| R2 | Cap. Cost | 4.65 | | 1.17 | | 1.46 | | 1.14 | | |
| (Ex. System + | Total Op. Cost | | 0.56 | | 1.54 | | 1.31 | | 0.63 | |
| L. Nichols + | 1970 P.V. | | | | | | | | | |
| Birch Cove) | @ i = 2% | 4.65 | 0.54 | 1.06 | 1.23 | 1.04 | 0.86 | 0.68 | 0.36 | 10.42 |
| | 4% | 4.65 | 0.52 | 0.96 | 1.01 | 0.75 | 0.57 | 0.41 | 0.21 | 9.08 |
| | 6% | 4.65 | 0.49 | 0.88 | 0.81 | 0.54 | 0.38 | 0.25 | 0.12 | 8.12 |
| | 8% | 4.65 | 0.47 | 0.80 | 0.65 | 0.39 | 0.26 | 0.15 | 0.07 | 7.44 |
| R2 - 5 | Cap. Cost | 4.65 | | 1.48 | | 0.74 | | 1.66 | | |
| (Ex. System + | Total Op. Cost | | 0.56 | | 1.47 | | 1.26 | | 0.61 | |
| Birch Cove) | 1970 P.V. | | | | | | | | | |
| | @ i = 2% | 4.65 | 0.54 | 1.34 | 1.18 | 0.53 | 0.82 | 0.99 | 0.35 | 10.40 |
| | 4% | 4.65 | 0.52 | 1.22 | 0.96 | 0.38 | 0.54 | 0.60 | 0.20 | 9.06 |
| | 6% | 4.65 | 0.49 | 1.11 | 0.78 | 0.28 | 0.36 | 0.36 | 0.12 | 8.15 |
| | 8% | 4.65 | 0.47 | 1.01 | 0.62 | 0.20 | 0.24 | 0.22 | 0.07 | 7.47 |
| R2 - 8 | Cap. Cost | 4.65 | | 2.59 | | 0.57 | | 1.32 | | |
| (Ex. System + | Total Op. Cost | | 0.56 | | 1.53 | | 1.37 | | 0.69 | |
| L. Major ) | 1970 P.V. | | | | | | | | | |
| | @ i = 2% | 4.65 | 0.54 | 2.34 | 1.23 | 0.41 | 0.90 | 0.79 | 0.40 | 11.26 |
| | 4% | 4.65 | 0.52 | 2.13 | 1.00 | 0.29 | 0.59 | 0.48 | 0.23 | 9.89 |
| | 6% | 4.65 | 0.49 | 1.94 | 0.81 | 0.21 | 0.39 | 0.29 | 0.13 | 8.91 |
| | 8% | 4.65 | 0.47 | 1.76 | 0.65 | 0.15 | 0.27 | 0.18 | 0.09 | 8.22 |
| R2 - 9 | Cap. Cost | 4.65 | | 3.46 | | 0.08 | | 0.48 | | |
| (Ex. System + | Total Op. Cost | | 0.56 | | 1.27 | | 0.97 | | 0.40 | |
| L. Pockwock | 1970 P.V. | | | | | | | | | |
| | @ i = 2% | 4.65 | 0.54 | 3.13 | 1.02 | 0.06 | 0.63 | 0.29 | 0.23 | 10.55 |
| | 4% | 4.65 | 0.52 | 2.85 | 0.83 | 0.04 | 0.42 | 0.17 | 0.13 | 9.61 |
| | 6% | 4.65 | 0.49 | 2.59 | 0.67 | 0.03 | 0.28 | 0.11 | 0.08 | 8.92 |
| | 8% | 4.65 | 0.47 | 2.36 | 0.54 | 0.02 | 0.19 | 0.06 | 0.05 | 3.34 |
| 1st Consultant's | Cap. Cost | 10.39 | | | | | | | | |
| Alternative | Total Op. Cost | | 0.09 | | 0.29 | | 0.38 | | 0.23 | |
| (Big Indian + | 1970 P.V. | | | | | | | | | |
| Spruce Hill + | @ i = 2% | 10.39 | 0.09 | | 0.23 | | 0.25 | | 0.13 | 11.09 |
| L. Pockwock) | 4% | 10.39 | 0.08 | | 0.19 | | 0.16 | | 0.08 | 10.90 |
| | 6% | 10.39 | 0.08 | | 0.15 | | 0.11 | | 0.05 | 10.78 |
| | 8% | 10.39 | 0.07 | | 0.07 | | 0.07 | | 0.03 | 10.63 |
| Second Consultant | Cap. Cost | 7.24 | | | | 0.57 | | 1.32 | | |
| B1 | Total Op. Cost | | 0.56 | | 1.53 | | 1.37 | | 0.69 | |
| (Ex. System + | 1970 P.V. | | | | | | | | | |
| L. Major ) | @ i = 2% | 7.24 | 0.54 | | 1.23 | 0.41 | 0.90 | 0.79 | 0.40 | 11.51 |
| | 4% | 7.24 | 0.52 | | 1.00 | 0.29 | 0.59 | 0.48 | 0.23 | 10.35 |
| | 6% | 7.24 | 0.49 | | 0.81 | 0.21 | 0.39 | 0.29 | 0.13 | 9.56 |
| | 8% | 7.24 | 0.47 | | 0.65 | 0.15 | 0.27 | 0.18 | 0.09 | 9.05 |

NOTE: The present value "P.V." of a sum of money "S" which will be spent after "t" years is given by the Formulae: $P.V. = S.\ (1+i)^{-t}$ where "i" is the discount rate in percent per annum.

TABLE 7

## ADDITIONAL PRESENT VALUE COSTS OF TREATMENT PLANT AT LAKE MAJOR FOR ALTERNATIVE R1

(All Costs in Million Dollars)

| | | 1970 | 1970 to 1975 | 1975 | 1975 to 1980 | 1980 | 1980 to 1987 | 1987 | 1987 to 1990 | 1990 | 1990 to 1996 | 1996 | 1996 to 2000 | 2000 | Total 1970 P.V. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Demand | (m. i. g. d.) | 13.2 | | 13.9 | | 14.8 | | 16.5 | | 17.2 | | 19.3 | | 20.8 | |
| Treatment | Cap. (when required) | 15.5 | | 18.5 | | 18.5 | | 21.5 | | 21.5 | | 24.5 | | 24.5 | |
| Treatment required in 1970 | Capital Cost | 3.70 | | 0.65 | | | | 0.65 | | | | 0.65 | | | |
| | Annual Op. Cost | | 0.048 0.051 | | 0.051 0.054 | | 0.014 0.060 | | 0.060 0.063 | | 0.063 0.070 | | 0.070 0.076 | | |
| | 1970 P.V. | | | | | | | | | | | | | | |
| | i = 2% | 3.70 | 0.24 | 0.59 | 0.23 | | 0.30 | 0.46 | 0.13 | | 0.25 | 0.39 | 0.17 | | 6.46 |
| | 4% | 3.70 | 0.23 | 0.53 | 0.20 | | 0.24 | 0.33 | 0.09 | | 0.16 | 0.23 | 0.10 | | 5.81 |
| | 6% | 3.70 | 0.22 | 0.49 | 0.17 | | 0.18 | 0.24 | 0.06 | | 0.10 | 0.14 | 0.06 | | 5.36 |
| | 8% | 3.70 | 0.21 | 0.44 | 0.15 | | 0.14 | 0.18 | 0.04 | | 0.07 | 0.09 | 0.03 | | 5.05 |
| Treatment required in 1980 | Capital Cost | | | | | 4.35 | | 0.65 | | | | 0.65 | | | |
| | Annual Op. Cost | | | | | | 0.054 0.060 | | 0.060 0.063 | | 0.063 0.070 | | 0.070 0.076 | | |
| | 1970 P.V. | | | | | | | | | | | | | | |
| | i = 2% | | | | | 3.57 | 0.30 | 0.46 | 0.13 | | 0.25 | 0.39 | 0.17 | | 5.27 |
| | 4% | | | | | 2.94 | 0.24 | 0.33 | 0.09 | | 0.16 | 0.23 | 0.10 | | 4.09 |
| | 6% | | | | | 2.43 | 0.18 | 0.24 | 0.06 | | 0.10 | 0.14 | 0.06 | | 3.21 |
| | 8% | | | | | 2.01 | 0.14 | 0.18 | 0.04 | | 0.07 | 0.09 | 0.03 | | 2.56 |
| Treatment required in 1990 | Capital Cost | | | | | | | | | 5.00 | | 0.65 | | | |
| | Annual Op. Cost | | | | | | | | | | 0.063 0.070 | | 0.070 0.076 | | |
| | 1970 P.V. | | | | | | | | | | | | | | |
| | 1 = 2% | | | | | | | | | 3.37 | 0.25 | 0.39 | 0.17 | | 4.18 |
| | 4% | | | | | | | | | 2.28 | 0.16 | 0.23 | 0.10 | | 2.77 |
| | 6% | | | | | | | | | 1.56 | 0.10 | 0.14 | 0.06 | | 1.86 |
| | 8% | | | | | | | | | 1.07 | 0.07 | 0.09 | 0.03 | | 1.26 |
| Treatment required in 2000 | Capital Cost | | | | | | | | | | | | | 5.65 | |
| | Annual Op. Cost | | | | | | | | | | | | | | |
| | 1970 P.V. | | | | | | | | | | | | | | |
| | 1 = 2% | | | | | | | | | | | | | 3.12 | 3.12 |
| | 4% | | | | | | | | | | | | | 1.74 | 1.74 |
| | 6% | | | | | | | | | | | | | 0.98 | 0.98 |
| | 8% | | | | | | | | | | | | | 0.56 | 0.56 |

TABLE 8

## SAVINGS FROM DELAY OF WATER TREATMENT FOR EXISTING SYSTEM

(All Values are in Million Dollars)

| Treatment Delayed To | | 1970 | 1970 to 1980 | 1980 | 1980 to 1990 | 1990 | 1990 to 2000 | 2000 | Total 1970 P. V. (Net) |
|---|---|---|---|---|---|---|---|---|---|
| 1980 | Capital Cost | -3.70 | | +3.70 | | | | | |
| | Annual Op.Cost | | -0.048 -0.054 | | | | | | |
| | 1970 P.V. | | | | | | | | |
| | i = 2% | -3.70 | -0.46 | +3.04 | | | | | -1.12 |
| | 4% | -3.70 | -0.42 | +2.50 | | | | | -1.62 |
| | 6% | -3.70 | -0.38 | +2.06 | | | | | -2.02 |
| | 8% | -3.70 | -0.35 | +1.71 | | | | | -2.34 |
| 1990 | Capital Cost | -3.70 | | | | +3.70 | | | |
| | Annual Op. Cost | | -0.048 -0.054 | | -0.054 -0.056 | | | | |
| | 1970 P.V. | | | | | | | | |
| | i = 2% | -3.70 | -0.46 | | -0.41 | +2.49 | | | -2.08 |
| | 4% | -3.70 | -0.42 | | -0.30 | +1.69 | | | -2.73 |
| | 6% | -3.70 | -0.38 | | -0.23 | +1.15 | | | -3.16 |
| | 8% | -3.70 | -0.35 | | -0.17 | +0.79 | | | -3.43 |
| 2000 | Capital Cost | -3.70 | | | | | | +3.70 | |
| | Annual Op.Cost | | -0.048 -0.054 | | -0.054 -0.056 | | -0.056 -0.056 | | |
| | 1970 P.V. | | | | | | | | |
| | i = 2% | -3.70 | -0.46 | | -0.41 | | -0.34 | +2.04 | -2.87 |
| | 4% | -3.70 | -0.42 | | -0.30 | | -0.21 | +1.14 | -3.49 |
| | 6% | -3.70 | -0.38 | | -0.23 | | -0.13 | +0.64 | -3.80 |
| | 8% | -3.70 | -0.35 | | -0.17 | | -0.08 | +0.37 | -3.93 |

NOTE: A +ve Value indicates an expenditure while a -ve Value indicates a saving.
Annual Operating cost is the difference between costs of "conditioning" and "full treatment"

TABLE 9

## PRESENT VALUES INCREASES FOR ALTERNATIVES R2-5 & B1 CAUSED BY ADVANCED DEVELOPMENT OF MAJOR SCHEMES

| Alternative | Water in Ex. System Treated in | | 1970 | 1975 | 1987 | 1996 | Total 1970 P.V. Increase |
|---|---|---|---|---|---|---|---|
| | | | | -1.48 | | | |
| R2-5 | 1980 | Capital Cost | +1.48 | +0.74 | -0.74 | | |
| | | | | -0.74 | | | |
| | | 1970 P.V. | | | | | |
| | | i = 2% | +1.48 | -0.67 | -0.53 | | +0.28 |
| | | 4% | +1.48 | -0.61 | -0.38 | | +0.49 |
| | | 6% | +1.48 | -0.55 | -0.27 | | +0.66 |
| | | 8% | +1.48 | -0.50 | -0.20 | | +0.78 |
| | 1990 | Capital Cost | +1.48 | -1.48 | -0.74 | -1.26 | |
| | | | | +0.74 | +1.26 | | |
| | | | | -0.74 | +0.52 | | |
| | | 1970 P.V. | | | | | |
| | | i = 2% | +1.48 | -0.67 | +0.37 | -0.75 | +0.43 |
| | | 4% | +1.48 | -0.61 | +0.27 | -0.45 | +0.69 |
| | | 6% | +1.48 | -0.55 | +0.19 | -0.28 | +0.84 |
| | | 8% | +1.48 | -0.50 | +0.14 | -0.17 | +0.95 |
| B1 | 1980 | Capital Cost | 0 | +0.57 | -0.57 | | |
| | | 1970 P.V. | | | | | |
| | | i = 2% | | +0.52 | -0.41 | | +0.11 |
| | | 4% | | +0.47 | -0.29 | | +0.18 |
| | | 6% | | +0.43 | -0.21 | | +0.22 |
| | | 8% | | +0.39 | -0.15 | | +0.24 |
| | | | | | -0.57 | | |
| | 1990 | Capital Cost | 0 | +0.57 | +0.55 | -0.55 | |
| | | | | | -0.02 | | |
| | | 1970 P.V. | | | | | |
| | | i = 2% | | +0.52 | -0.01 | -0.33 | +0.18 |
| | | 4% | | +0.47 | -0.01 | -0.20 | +0.26 |
| | | 6% | | +0.43 | -0.01 | -0.12 | +0.30 |
| | | 8% | | +0.39 | -0.01 | -0.07 | +0.31 |

NOTE: All costs are in Millions of Dollars.
Positive costs are Expenditures and Negative costs are Savings.

TABLE 10

## PRESENT VALUES INCREASES FOR ALTERNATIVES R2-5 & B1 CAUSED BY ADVANCED DEVELOPMENT OF MAJOR SCHEMES

| Alternative | Water in Ex. System Treated in | | 1970 | 1975 | 1987 | 1996 | Total 1970 P.V. Increase |
|---|---|---|---|---|---|---|---|
| | | | | -1.48 | | | |
| R2-5 | 1980 | Capital Cost | +1.48 | +0.74 | -0.74 | | |
| | | | | -0.74 | | | |
| | | 1970 P.V. | | | | | |
| | | i = 2% | +1.48 | -0.67 | -0.53 | | +0.28 |
| | | 4% | +1.48 | -0.61 | -0.38 | | +0.49 |
| | | 6% | +1.48 | -0.55 | -0.27 | | +0.66 |
| | | 8% | +1.48 | -0.50 | -0.20 | | +0.78 |
| | 1990 | Capital Cost | +1.48 | -1.48 | -0.74 | -1.26 | |
| | | | | +0.74 | +1.26 | | |
| | | | | -0.74 | +0.52 | | |
| | | 1970 P.V. | | | | | |
| | | i = 2% | +1.48 | -0.67 | +0.37 | -0.75 | +0.43 |
| | | 4% | +1.48 | -0.61 | +0.27 | -0.45 | +0.69 |
| | | 6% | +1.48 | -0.55 | +0.19 | -0.28 | +0.84 |
| | | 8% | +1.48 | -0.50 | +0.14 | -0.17 | +0.95 |
| B1 | 1980 | Capital Cost | 0 | +0.57 | -0.57 | | |
| | | 1970 P.V. | | | | | |
| | | i = 2% | | +0.52 | -0.41 | | +0.11 |
| | | 4% | | +0.47 | -0.29 | | +0.18 |
| | | 6% | | +0.43 | -0.21 | | +0.22 |
| | | 8% | | +0.39 | -0.15 | | +0.24 |
| | | | | | -0.57 | | |
| | 1990 | Capital Cost | 0 | +0.57 | +0.55 | -0.55 | |
| | | 1970 P.V. | | | -0.02 | | |
| | | i = 2% | | +0.52 | -0.01 | -0.33 | +0.18 |
| | | 4% | | +0.47 | -0.01 | -0.20 | +0.26 |
| | | 6% | | +0.43 | -0.01 | -0.12 | +0.30 |
| | | 8% | | +0.39 | -0.01 | -0.07 | +0.31 |

NOTE: All costs are in Millions of Dollars.
Positive costs are Expenditures and Negative costs are Savings.

TABLE 10

## NET PRESENT VALUES FOR ALTERNATIVES R2 - 5 AND B1

(No deterioration in water quality)

| Water in Existing System Treated in | i | R2 - 5 | B1 |
|---|---|---|---|
| 1980 | 2% | $9.56 | $10.50 |
| | 4% | $7.93 | $ 9.91 |
| | 6% | $6.79 | $ 7.76 |
| | 8% | $5.91 | $ 6.95 |
| 1990 | 2% | $8.75 | $ 9.61 |
| | 4% | $7.02 | $ 7.88 |
| | 6% | $5.83 | $ 6.70 |
| | 8% | $4.99 | $ 5.93 |

NOTE: The present values shown on this table are the algebraic sums of the original values from Table 7, the savings from Table 9 and the increases from Table 10.

TABLE 11